

Special edition 2016

transmission

The DFS magazine



Talking about a revolution –

DFS is making an important contribution to the development of drones.

Top drone flight school – Learning how to fly a drone.

Drones are turning into flying smartphones – DFS and Deutsche Telekom have launched a joint project.

Guardian of safety

DFS is for the safe and fair integration of unmanned aircraft systems

Dear reader

This issue of the DFS magazine is devoted to unmanned aircraft, or as they are commonly known, drones. Drones have become a hot topic in the world of air navigation services. As the guardian of safety in German airspace, a duty that is at the very core of air navigation services, DFS wants to ensure that drones are integrated fairly and, in particular, safely into air traffic. The company has called together a team of in-house experts to deal with the issue. Our basic attitude is clear: DFS wants to see mandatory registration for all drones that are used commercially or that weigh more than 250 grams.

Anyone who takes to the sky has to comply with the rules, even if the aircraft concerned was bought at the local toy store. Most airspace users adhere to the rules. A search through the records reveals almost no incidents involving model aircraft, for example. This can probably be attributed to the fact that pilots of such aircraft are normally aviation enthusiasts who take their hobby very seriously. Drones, however, seem to appeal to a different group of users. DFS has noticed more and more incidents where drones have come dangerously close to manned aircraft. Some drone pilots seem to operate in blissful ignorance of the rules, or even the fact that there may be rules. This is a situation that DFS cannot tolerate. Anyone who is incapable of complying with the rules and procedures needs to be identified and be identifiable. Rule infringements must be pursued. We need to eliminate the risks associated with the operation of drones. This not only applies to the risks from carelessness or ignorance. Premeditation or malice, whether from criminals or terrorists, could also be the cause. When the safety of air traffic is called into question, then it is high time to take action. Safety must remain our paramount concern.

When diverging interests collide, disputes can arise, as is the case with mandatory registration. Pilots of model aircraft only see mounting red tape and manufacturers of drones fear slumping sales if drones are subject to stricter regulations. These concerns are understandable. But without a new set of rules, the integration of unmanned aircraft will not succeed.

It must be made clear that DFS is not an opponent of this technology. Drones are the technology of the future. This explains our involvement in several research projects in this area. One such project was started with Deutsche Telekom AG in October. This project aims to test how unmanned aircraft systems can be monitored and piloted using mobile telephony in areas below controlled airspace.

Drones represent progress and DFS welcomes progress. But, this progress cannot be made at the expense of safety. We need solutions and rules that are fit for purpose. These are not hurdles placed in the way of progress but the basis for progress itself.

We hope you enjoy reading our magazine.

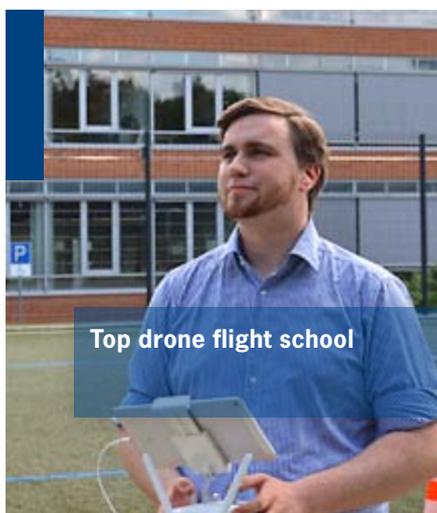


Prof Klaus-Dieter Scheurle
Chief Executive Officer of DFS



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Talking about a revolution

Regardless of the role unmanned aircraft systems play in the future – DFS will make an important contribution to this development. The objective of DFS is the safe and fair integration of drones into both controlled and uncontrolled airspace.



Angela Kies is member of the Issue Management UAS Coordination Team



Will pizzas someday be delivered by drones? Will unmanned aircraft someday be deployed as a cost-effective substitute for satellites? Will cargo aircraft someday fly without any crew on board? It is all possible. That is why experts around the world are now working on how to deal with unmanned aircraft systems. DFS is both directly and indirectly involved in a number of international working groups and research projects. As the guardian of the airspace above Germany, DFS is looking for sensible solutions for dealing with this revolutionary technology. In the end, the objective is the safe and fair integration of unmanned aircraft systems (UAS), commonly known as drones.

At DFS, an issue management team has been created to deal with the subject. Staff hailing from a variety of departments shed light on the topic from various points of view – ranging from the legal framework to airspace structure. Their work concentrates on two main aspects. The first is to find a way to integrate UAS into uncontrolled airspace which is also used by private pilots under visual meteorological conditions. The second is the integration of UAS into controlled airspace which is primarily used by commercial airlines.

A system known as UAS traffic management (UTM) needs to be established for uncontrolled airspace. “Theoretically, DFS could offer a number of services,” says Andreas Udovic, a member of the DFS issue management team on unmanned aircraft systems. “What will actually be included in these services is still being researched and discussed.” For example, DFS could protect certain areas – such as airports – by establishing no-fly zones. Drones would be programmed so that they are not able to enter airspaces protected by virtual boundaries created on the basis of GPS data. This technology is known as geofencing. In addition, unmanned aircraft systems can be equipped with a device that prevents collisions. Initial trials have already taken place. For example, Deutsche Telekom has developed a chip for registering drones which can also be used for geofencing.

Drone pilots are often quite inexperienced

It may take a while before all these technologies are finally implemented. “Full operations are likely to start in five years, at the earliest,” predicts Udovic. Geofencing is not only required because of the sheer number of commercially used drones that will most likely be deployed in the future. The main challenge we are facing is hobby drone pilots. Drone pilots are different from the model aircraft pilot community in that they are often quite inexperienced in handling their toys.

“The classic model aircraft pilot makes sure they know the rules which need to be observed for using the airspace. In the past decades, there have hardly ever been any incidents with model aircraft,” explains the issue manager. Drones are another story altogether. DFS has seen an increasing number of incidents where drone pilots flew their devices too close to aeroplanes. The crews of rescue and

DFS and research

DFS is involved in various research projects. For example, the DFS division Aeronautical Solutions (in future: DFS Aviation Services) has been tasked by Airbus to develop standard as well as emergency procedures for autonomous take-offs and landings of unmanned aircraft.

In addition, DFS and the Fraunhofer Institute have submitted a project proposal to the German Federal Ministry of Education and Research. The project will research systems that can detect when an unmanned aircraft has entered controlled airspace without authorisation.

DFS was also part of the Parcelcopter research project for DHL and its research partner RWTH Aachen University which tested parcel delivery. Another important project involves the integration of the US Air Force unmanned surveillance aircraft Global Hawk into German airspace.

police helicopters also regularly report incidents in which drones were dangerously close.

 *All associations that advocate the interests of manned aviation are in favour of mandatory registration*

This is why DFS is advocating mandatory registration of unmanned aircraft systems which are used for commercial purposes or weigh more than 250 grams. In the United States, registration is already mandatory. DFS is in good company. Many organisations in Germany agree with the mandatory registration including the German Airline Pilots' Association (VC) and the German Airports Association (ADV). "All associations that advocate the interests of manned aviation are in favour of mandatory registration," says Udovic. However, model aircraft lobbyists are unhappy about such a regulation. Until now, the German Federal Ministry of Transport and Digital Infrastructure (BMVI) only wants to introduce a rule requiring drones to be labelled with the owner's identification.

Drones bring both promise and peril. Drone pilots may unwittingly or intentionally cause serious damage and/or injuries. Normal liability insurance does not cover the costs of damage caused by unmanned aircraft. Generally, it can be said that whoever causes the damage must be held liable. Whoever does not play by the rules must be able to be identified so that the authorities or the public prosecutor can punish violations or criminal offences.

A boom is expected

"This all is part of a comprehensive UAS traffic management," says Udovic. The commercial applications of drones are so diverse that we can safely predict a real boom in their use. Unmanned aircraft could deliver blood between hospitals or defibrillators to rescue sites. They can transport packages to remote islands or help roofers discover damage. These are just a few of many possible applications.

A strategic challenge

"With unmanned aircraft systems (UAS), we are witnessing a rapid influx of a whole new airspace user into the established aviation system. This poses a threefold challenge for DFS. First of all, it will be necessary to integrate UAS in a way that ensures the continued safety of air traffic. Secondly, integration must be fair – it should not disadvantage manned aviation. Thirdly, drones are a strategic challenge for DFS because of their autonomous capabilities, aided by sensors and intelligent algorithms, that in the medium term could revolutionise the existing aviation system. We, as the guardian of safety in German airspace, must face these challenges head on."

Oliver Pulcher is Director of Corporate Development, Organisation and International Affairs at DFS.



The International Civil Aviation Organisation sets the tone

In controlled airspace which will have to be shared between UAS and conventional manned aircraft, other challenges of integration must be met. The International Civil Aviation Organisation (ICAO) sets the tone in this case. Andreas Udovic represents DFS in its working group for unmanned aircraft. This group decides, for instance, which licences are needed by a drone pilot (officially called a remote

pilot). By the year 2024, all documentation has to be amended to reflect these changes – including the air navigation service providers' bible, ICAO Document 4444. While up until now, UAS in controlled airspace have been almost exclusively a military subject, this is now changing. Civil users in the future may include the US space agency NASA or cargo airlines.

"The problem is that up until now, all rules and regulations have been based on the fact that there is a pilot in the cockpit who can look out of the window," explains Udovic. But what will happen when this is no longer the case? It means that important principles such as "see and avoid"



UAS will change air traffic control

Drones have become a consumer electronics device. Manufacturers and future users, such as Amazon, Google and Facebook, are key players in the digital age. These companies see drone technology as a promising new business opportunity and are not afraid to push for the introduction of new airspace surveillance methods. Intuitive controls, a high level of automation and inexpensive services are the pillars on which this new world of airspace surveillance will be built on. In short, ease of operation is key. New solutions by new providers will have far-reaching consequences for air traffic control as drones are integrated into the air transport system. The DFS Group has the resources, skills and competencies to exploit the opportunities offered by these changes and position itself in this new market.

Angela Kies, Issue Management UAS Coordination Team.

include ethical ones, such as, how much should an onboard computer decide autonomously and when does a human being have to intervene?"

The current airspace structure will not be changing soon. The airspace classes that regulate who can fly where and how will remain as they are. Whoever operates drones must comply with the applicable rules and regulations. Integration will not be simple but it is necessary as unmanned aircraft systems are the future.

— Sandra Ciupka —

will no longer work. Another problem also has to be solved. How can pilots on the ground be protected, for example, from terrorist attacks? In manned aircraft, the locked cockpit door was introduced. What would be the equivalent on the ground?

"It will be particularly difficult to regulate unmanned aircraft taxiing at airports," stresses Udovic. In this situation, it is especially important for pilots to have a good view out of the cockpit. For example, pilots and marshalls, who guide aircraft to their aircraft stand, communicate to each other with hand signals. So, for example if a pilot extends their arm in front of their face with outstretched fingers, then makes a fist, it means that the brakes have been activated. But how would a remote pilot who operates the unmanned aircraft from a ground station communicate this to the marshaller? Another question is: how can remote pilots be enabled to reliably see the stop bar lights on taxiways? "Unmanned aviation requires us to rethink everything," says Udovic.

Ethical questions

Technical solutions have already been developed for some problems – so, for example, instead of an optical barrier there may someday be electronic stop bars that automatically stop an aircraft at the holding position. Other questions have yet to be resolved. For example, what should an air traffic controller do if the connection between the ground station and the drone is cut off? How would the drone need to be programmed to deal with such a situation? "The questions also



Andreas Udovic (left) and Ralf Heidger, members of the Issue Management UAS Coordination Team.

Drones have to follow rules, too

Rules and regulations for drones are taking shape. A new regulation in Germany plans to introduce a remote pilot's licence and a mandatory identification label. But registration would be a much more sensible step.

IDENTIFICATION AND REGISTRATION

Whoever wants to drive a car on Germany's streets has to register their vehicle at the motor vehicle registration office. A central register stores all the data related to the vehicle, its owner and the number on the registration plate. In the world of aviation, it is not much different. All aircraft registered in Germany are recorded in the aeronautical register of the German Federal Aviation Office. It would make sense to have a similar register for unmanned aircraft systems. If a drone caused damage or even an accident, a register would make it easy to identify the owner. The European Aviation

Safety Agency (EASA) is also a proponent of registration. In August, the agency submitted the prototype regulation on unmanned aircraft operations which would require registration for owners of drones that exceed certain performance parameters.

“If we want to safely integrate unmanned aircraft systems into the air transport system, it is imperative that drones be registered”

In contrast to countries such as Belgium, the Netherlands and Austria where drones have to be registered or carry some kind of identification, Germany does not yet have this type of regulation. The current version of the relevant German regulation only contains very few regulations concerning drones. A new version with more comprehensive provisions is currently in the works. However, it only provides for a method of identification and not registration. The regulation would require privately used model aircraft and commercially used unmanned aircraft systems with a take-off weight of more than 250 grams to be inscribed with the name and address of the owner in permanent and fireproof lettering on a visible part of the drone.

DFS thinks that this is insufficient. “If we want to safely integrate unmanned aircraft systems into the





air transport system, it is imperative that drones be registered,” says Ralf Heidger, member of Issue Management UAS Coordination Team. To demonstrate that such a registration database is not an insurmountable obstacle, DFS has developed a prototype.

DFS is developing a database for drone users

The database has a similar structure to the AIS portal of DFS where private pilots log in to submit their flight plans online and also to take advantage of other services offered by the AIS. Pilots can, for instance, use the AIS portal to find relevant NOTAMs, which contain information they need about restrictions and special situations in the airspace or at airports. “It would be possible to offer similar services that could be integrated into the registration database,” says Heidger. Then drone pilots would be able to prepare their flights in a professional manner in the future.

Registration is also necessary for the future when the increasing numbers of drones will need to be monitored and controlled from the ground. DFS is presently working with Deutsche Telekom on such a project (see the interview on pages 22-25). At present, it is not permissible to operate a drone outside the user’s direct line of sight unless special permission has been granted. The technical monitoring of drones could extend their range and improve their safety. Heidger added, “To provide a well-functioning air traffic management system for drones in the future, we need to introduce registration now. The registration can be used as a unique identifier to plan and control missions as well as for drone surveillance.”

REMOTE PILOT LICENCE

Whoever wants to drive a car in Europe needs a driving licence; whoever wants to fly a plane needs a pilot’s licence. The regulations for drone pilots are inconsistent in comparison.

Some regulations differentiate depending on what the drone is going to be used for. In some European countries, all drone operators need a licence. In others, only commercial operators need to demonstrate their remote pilot abilities while further countries have no regulations whatsoever. Germany has decided on a compromise. Private drone operators are allowed to pilot drones with a take-off weight of up to five kilograms without a test. Commercial drone operators are allowed to pilot drones weighing up to 25 kilograms without a test. In order to be allowed to fly, remote pilots need the approval of the aeronautical authority of the respective Federal State. Potential remote pilots have to prove that they have liability insurance coverage and a sufficient amount of knowledge – this can be demonstrated by attending an appropriate course. The German Federal Government and the Federal States have agreed this point. The current version of the German Aviation Regulation does not have any provisions in this regard.

The amended version which is currently being worked on takes up the topic of mandatory training for remote pilots. If the draft version is approved, then the following will apply from 1 May 2017: All commercial operators of drones heavier than five kilograms must prove that they know how to operate their devices, know how to navigate, understand the basics of aviation law and the structure of the airspace where they operate. The remote pilot’s licence would be valid for a period



of ten years. Then, the test would have to be taken again. The organisation that issues these licences must be approved and designated by the German Federal Aviation Office.

Remote pilots should be required to take a test every three years

The DFS Group is currently working on a comprehensive and high-quality training initiative. “DFS has decades of experience in training and knows how to effectively teach aviation subject matter,” says Heidger. The goal is to provide remote pilots with the necessary theoretical and practical knowledge so they can safely pilot their flying devices. “We think, however, that remote pilots should be required to take a test every three years due to the rapid pace of change on the drone market. We also think that training courses should be required for drones with a take-off weight of 250 grams or more.” The contents of the training courses should be standardised across Germany. “This could be ensured by a nationwide centralised pool of questions based on the EASA syllabus.”

— Christopher Belz —

“We need an efficient infrastructure for drones”

TV journalist Ranga Yogeshwar believes drones are a great opportunity. He also advocates clear rules and a sensitive handling of data protection issues.



Drones are actually quite simple devices – you don’t need much more than electric motors, propellers and a remote control. Aren’t they a bit boring for you as a physicist?

RANGA YOGESHWAR: No, not at all. Drones have opened the door to a world of miniaturisation of sensors – compasses, GPS receivers, accelerometers: all these components interact with each other in a hugely complex way. As a result, drones are now easy to use even for the unskilled. However, this doesn’t mean that the technology behind them is dull. The control of drones is one example of a very interesting area of research – the Swiss Federal Institute of Technology in Zurich (ETH) is one of the leading lights in Europe working on this. For instance, its scientists have developed drones that can navigate independently in unfamiliar terrain, and a software package that ensures that the drone flies safely even if a propeller fails. The field of drone research is really exciting.

Do you use drones in your own work?

YOGESHWAR: For me as a TV journalist, drones provide new opportunities, some of which are fantastic. Yesterday, for example, I filmed a TV programme about the LIGO gravitational-wave observatory in the US State of Louisiana. The



facility is made up of two four-kilometre-long tunnels. Without the use of a camera drone, I wouldn't have been able to show the audience the scale of this facility. Overall, drones have massively changed the visual landscape in the medium of television. In good productions, it's almost impossible to get by without using a drone. For me, this is a huge opportunity to show the world from a new perspective. What is more, drones are now very affordable. A good camera drone is now less expensive than a simple camera used to be.

 *A very good camera drone costs less than a simple camera used to*

When you visited the accident site of the Chernobyl Nuclear Power Plant, you also used a drone ...

YOGESHWAR: Yes, we shot drone footage above the old sarcophagus – the concrete shell that was built around the wrecked reactor in 1986. Immediately after the explosion, helicopters were flown



Herds of Przewalski's horses populate the Chernobyl Exclusion Zone.
Photo: Shutterstock

over the site of the accident to see what was wrong below – there was no other option at the time. The pilots who had to do this were exposed to huge amounts of nuclear radiation. Back then, they would have been grateful for the technical possibilities we have now. Today, a camera drone could be used. We also had a drone with an infra-red camera to count the wild horses around Chernobyl.

Wild horses?

YOGESHWAR: The region in a 30-kilometre radius around the reactor that was

declared an exclusion zone is hugely exciting to biologists. A habitat has emerged that can be monitored closely to answer questions such as: how does nature change when humans leave it virtually untouched? How do populations of individual species develop? And what kind of new balance emerges? This habitat is home to the rare Przewalski's horse that used to populate the entire Eurasian Steppe, but has since almost been wiped out by hunting. I knew from previous visits that they had settled there again. However, not only the wild horses but also biological predators such as wolves are on the increase. If you want to take stock of how the horse population is doing, you have no chance of doing it on foot, but it's really easy with a drone. It could also be used elsewhere – for example to count the surviving numbers of certain endangered species and establish whether poachers have decimated the populations.

All possible applications of drones are currently under discussion – from monitoring power lines to flying pizza deliveries. What do you think the main areas of use will be in ten years' time?

YOGESHWAR: That's a tough question. If you'd asked me 100 years ago what the main application of a car would be,



The camera drone shows the transformation of the zone around the reactor.
Photo: Yogeshwar

I'd probably have said there will be lots of different uses. It has ended up being used partly for driving pleasure, while it is also a key pillar of our economy, taking people to work and goods to their destination. It is much the same with drones: there is a huge range of applications here. There are some areas for which they are ideal, such as security tasks, i.e. monitoring properties or protecting borders. Another field is special-purpose logistics. Fifty percent of the world's population live in cities where dense traffic and long traffic jams are common – resulting in equally long delivery times. Here, drones provide an opportunity to make time-critical deliveries quickly – for instance transporting medicines from one hospital to another. There will also be lots of special applications. And, as with car-driving, there will be people who use drones simply because they enjoy it, or because they can take great pictures with them.

 *You will be more*

likely to find autonomous vehicles in the air than on the ground

That is sure to cause conflicts with data protection. Not everyone is keen to be photographed from the air.

YOGESHWAR: We need to be clear about this one thing: There's more to it than the neighbour being able to look at my property from above. Drones can also be used to track specific people with optical image-processing methods. This makes it possible to identify people even in large crowds. Obviously, this is a sensitive issue – but I believe that it must be used in some areas, as security comes at a cost. On the other hand, it has to be

said that there has been a big change in what we regard as private data. Just look at social media: these days, we reveal much more about ourselves than a drone can see – and we do it of our own free will, indeed deliberately. It's much the same as with fashion in the early 20th century. Back then, when a woman went bathing on the beach here in Germany, she wore a long bathing costume. Now, my daughters run around in bikinis, something they could have been arrested for 100 years ago. Even so, data protection is important, and we need to talk about it.

On the road, driverless cars are a hot topic at the moment. What is the situation with autonomous drones?

YOGESHWAR: In my view, autonomous vehicles are more likely to become widespread in the air than on the ground. Every engineer knows that in road traffic, an autonomous car has to react to all kinds of unforeseeable things – from people crossing the road to car drivers

who suddenly switch lanes without indicating. All these imponderables don't exist in airspace. The world is much easier for autonomous aircraft than for autonomous cars on the ground. The question is which areas will see most growth? Will drones be used to deliver pizza or only expensive spare parts or for medical purposes? The second exciting question is how drone traffic will be organised in the future. We need to be clear about this: there are now more drones than conventional aircraft such as aeroplanes and helicopters. It's a new trend.

People are talking about whether there should be compulsory registration for drone owners and whether a drone licence is a good idea. What do you think legislators should regulate – and what should they leave alone?

YOGESHWAR: Drones were initially small exceptions in a field that was not covered by legislation. Some restrictions are now in place – for instance, drones cannot be used in the immediate vicin-



Pizza delivery by drone? Probably not. But ideal for other urgent deliveries.
Photo: Shutterstock



ity of an airport and altitude restrictions must be observed. This is because drones have been identified as a potential risk to other aircraft. However, we must be aware that when the drone business takes off and we move from a few spontaneous deployments to professional use, we need clear rules. We should avoid one mistake here: it would be fatal if people had to fill in a heap of forms every time they wanted to fly a drone. We need organisations like DFS which ensure an efficient infrastructure that allows safe drone traffic. We should also look beyond borders and get in line with what other countries are doing. Drones have great potential. It would be a shame if the rules were designed in a way that curbs this development.

“An aircraft designed in the same way as a modern drone would never be allowed

Are the drones currently in use safe enough for large-scale use?

YOGESHWAR: When we have a lot more drones to deal with, we will see a new level of quality. Safety and security aspects will have to be taken into account: who is liable in the event of drone accidents? How can collisions be prevented? A few things also need to happen on the technical side: in civil aviation, the systems have a technically redundant design and are checked regularly. By contrast, the drones currently in use are carelessly designed. An aircraft designed in the same way as a modern drone would never be allowed.

Drones were originally a military development: a country can use them to fight

a war without putting its own soldiers at risk. In the future, there could even be autonomous drones that identify and strike against their enemies. What do you think of this?

YOGESHWAR: Many people have a critical view of this development. I am one of them. To me, it comes down to an ethical principle: I believe that the decision to strike against an enemy should always be a human one. If drones ever come to make this decision themselves, that is dangerous. There are signs of a new arms race, and this should be nipped in the bud. However, autonomous drones could also become a threat in another way. Terrorist organisations could use a drone that independently seeks out its destination in order to place explosives there, for instance.

So are drones a threat or an opportunity?

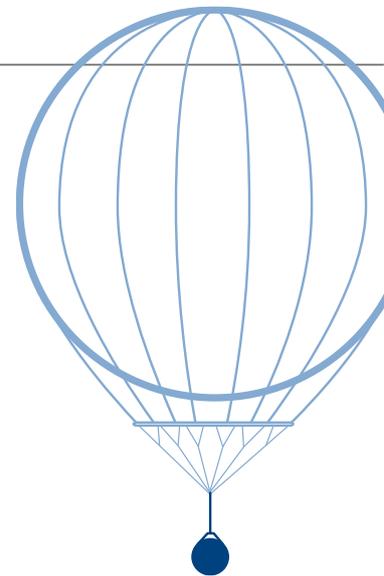
YOGESHWAR: Both. At present, the drone debate is mainly centred on the visions of companies like Amazon. This will change massively if the first drone attack by terrorists ever happens. We need to think about how we can prevent this. We must be aware that it is no longer enough to protect a building or a nuclear power station against attacks on the ground with a fence and cameras. Drones have added a third dimension. We need to adapt to this. As is so often the case in science, a technology is never only good or only bad. A drone can save a life if it takes the donor organ to the hospital on time. But it can also be used to destroy life.

— Christopher Belz —



Ranga Yogeshwar was born in 1959 in Luxembourg, the son of an Indian engineer and a Luxembourgian artist. He spent most of his early childhood in India, where he went to primary school. After taking his secondary school leaving examinations in Luxembourg, he studied physics (“experimental elementary particle physics and astrophysics”) at RWTH Aachen University and worked at the Swiss Institute for Nuclear Research, CERN in Geneva and the Jülich research centre. In 1987, he joined the German radio broadcaster Westdeutscher Rundfunk in Cologne as an editor, and headed the science programme team for several years. Since 2008, he has been working as a freelance journalist and author. He has developed, produced and presented numerous TV programmes, and is one of Germany’s best-known science journalists. Yogeshwar is the father of four children and lives near Cologne with his family.

Count Radetzky – a drone pioneer



Unmanned flying devices were deployed for the very first time 170 years ago. Although the first ones did not achieve their mission, drones nevertheless established themselves in the 20th century.

The Austrian field marshal Count Joseph Radetzky became famous for his victories on the battlefield as well as for having the composer Johann Strauss write a march bearing his name. Not many people are aware that it was first Radetzky's idea to deploy unmanned remote-controlled flying devices. In the summer of 1848, Radetzky laid siege to Venice to put down an insurgency of the northern Italian States against the Habsburg monarchy. As the cannons did not reach the city due to the difficult terrain, the field marshal called on the artillery general, Franz von Uchatius, to

develop a new weapon: balloons that dropped bombs. The balloons were connected by insulated copper wires to a galvanic battery stationed at the coast. This mechanism allowed bombs to be dropped and ignited by remote control.

The Wright Brothers first flew unmanned tests

In 1863, the New Yorker Charles Perley had a similar design patented. He had constructed a hot-air balloon that carried a basket holding a bomb. A timing mechanism tripped a hammer that hit a hinge pin which opened the hinged basket, thus causing the bomb to drop out.

Unmanned, remote-controlled flying devices have been used for many purposes since the beginning of the 20th century. In addition to military deployment, they have also been used for experimental purposes. For example, at the beginning of the 20th century, the Wright Brothers first flew unmanned tests with tethered gliders, which used wing warping, a predecessor of ailerons, for lateral control. In 1914, Lawrence Sperry demonstrated the first autopilot in Paris, stabilising his Curtiss biplane with a gyroscopic device.

Unmanned Aircraft Systems (UAS) were initially used by the military for simulating targets in air defence. In 1931, for example, the Royal Air Force equipped three Fairey III floatplanes with radio controls and deployed these so-called "Fairey Queens" as target drones for fighter pilots. In principle, even the V-1 flying bomb could be considered a drone.



The Habsburg artillery general, Franz von Uchatius developed balloon bombs in 1848. Photo: picture-alliance



Drones in the Cold War

After World War II, deploying drones for reconnaissance missions grew more prevalent as the Cold War escalated. After the embarrassing incident in which a United States U-2 spy plane piloted by Gary Powers was shot down above Sverdlovsk by the Soviets in May 1960 and Powers was captured, the Pentagon decided to invest more money into research and the construction of prototypes of unmanned reconnaissance aircraft.

One result of these efforts was the Lockheed D-21, a supersonic reconnaissance drone that was launched in March 1966. In the Vietnam War, the US Air Force used a reconnaissance version of the Ryan Firebee drone to take photographs of combat zones.

In the Middle East, Israel developed the Mastiff drone after its air force suffered heavy losses in the 1973 Yom Kippur War. In the First Lebanon War in 1982, it was used to locate all of Syria's air defence sites. In the Iran-Iraq War, Iranian engi-

neers mounted anti-tank grenades on model aircraft – and thus invented a reusable armed combat drone in the 1980s.

In the 1990s, the United States developed the Predator and Reaper drones that can fire anti-armour missiles and bombs. Today, they are mainly being deployed in areas of conflict in Afghanistan, Pakistan, Somalia and Yemen.

“As with other technological advances, the military has been the forerunner in research and development

example, estate agents are increasingly using drones to capture images of properties from the air. As drones equipped with cameras can also be used for monitoring purposes, topics related to the basic rights such as self-determination over personal data and data protection have gained importance. Just as with other technological advances, the military has been the forerunner in research and development with civilian uses following later.

And in case you were wondering, Venice was not damaged 170 years ago because the winds were unfavourable for the balloons. They were blown back over the Austrian lines and the new weapon was abandoned. Thankfully, we can all still enjoy the beautiful lagoon city today.

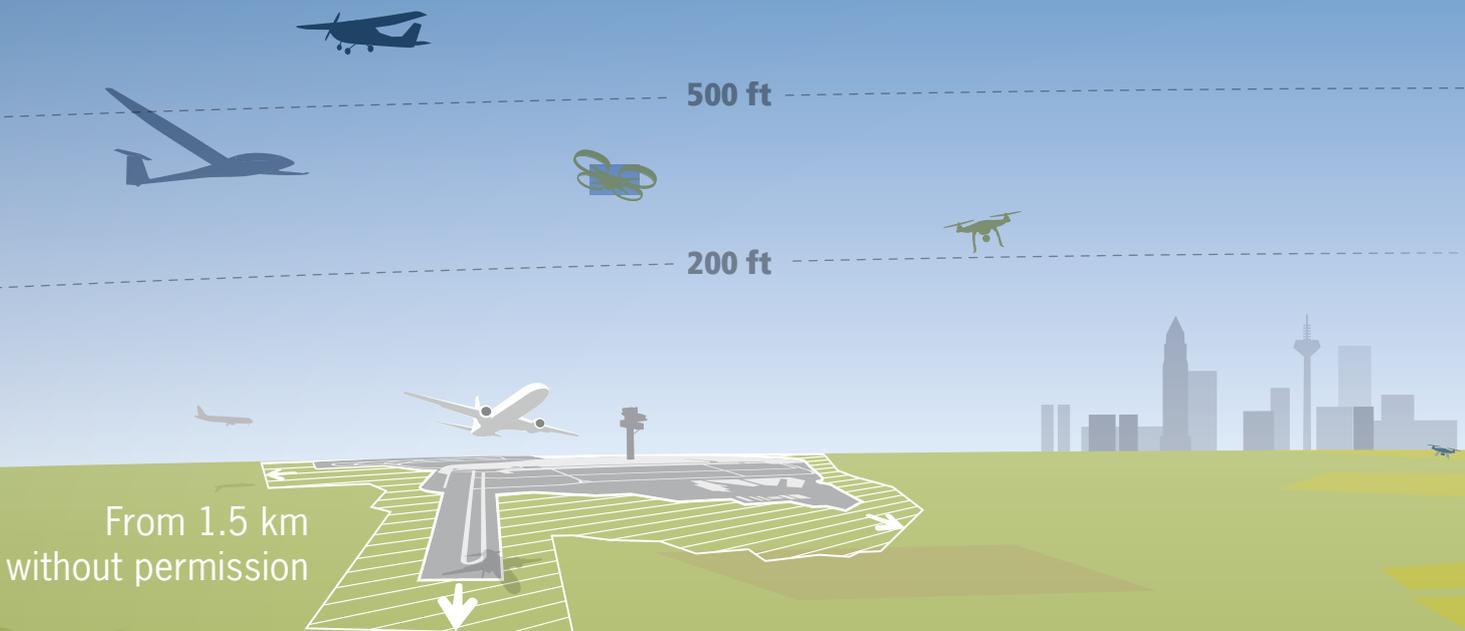
— Holger Matthies —

In addition to the military sector, current development is focusing on models with recording capabilities to be used in industry and commerce as well as by the media and private citizens. So, for



The Euro Hawk is the European version of the US Global Hawk. Photo: H. Matthies

Drones and air traffic



When are drones forbidden?



Hospitals



Power stations



Prisons



Military facilities



Groups of people, e. g. concerts



No photos or videos of people without their consent



What rules must be complied with for drones in Germany?

Generally, it can be said that if you want to use an unmanned aircraft system you need to maintain a direct visual line of sight with your naked eye without the use of technical aids, such as binoculars or night vision goggles.

During the flight, the drone user has to keep the weather and the airspace under observation at all times. Manned aircraft are to be avoided at all times.



Clear rules are in place to prevent conflicts with air traffic. In the vicinity of airports, i.e. **less than 1.5 kilometres from the airport fence**, you need a clearance from the control tower before you can operate a drone.

Drone users also need a clearance for the control zones around international airports, regional airports and military aerodromes.

When certain conditions are complied with, drones can be flown in a control zone without permission: Beyond the 1.5-kilometre boundary, systems for commercial purposes **up to 25 kilograms** can be used up to a **maximum height of 50 metres**. For private use, the **weight limit is 5 kilograms and the vertical limit is 30 metres**.

Commercial users need permission from the aeronautical authority of the respective Federal State (Land).

Currently, the relevant German regulation is being revised. The draft includes mandatory registration for unmanned aircraft systems. In addition, drone users need to prove that they have sufficient knowledge to pilot a drone.

For what purposes are drones being used?

Main uses of drones in % (Source: FAA)





Top drone flight school

Drones are becoming a standard tool of the trade for many people in media, trade and industry. **U-ROB, a company based in Bielefeld, Germany, offers flight training for private and commercial customers at ten locations in Germany.** The demand is there; what is missing is the legal framework for what exactly remote pilots have to prove they can do.

Joseph Metz, managing director of U-ROB, pictured flying a Phantom drone, believes his company's training courses can provide a framework for how the legislator could formulate the rules for the training of remote pilots.

U-ROB is located on the outskirts of Bielefeld, opposite a furniture store and beside a specialist for custom kitchens. The name of the kitchen store immediately jumps into view when you pull up: 'KüchenTrend' or KitchenTrend. The company promises 'the best service from the experts' with kitchen technology that offers "a vision of the future". A vision of the future can also be found in a long flat-roofed building nearby which houses U-ROB. The words 'Unmanned Systems

and Robotics Centre' can be seen on a sign above the entrance and the company specialises in the operation of unmanned aircraft, or drones. Flying drones has not only become a hobby for many people, numerous companies in media, trade and industry have also discovered how useful drones can be as a tool of the trade.

U-ROB offers training courses for such drone users and advises companies on how best to operate and deploy drones.

"We offer a one-stop shop," explains the managing director of U-ROB, Joseph Metz. "We bring together expertise in the areas of production, service and training under one banner." This ranges from beginner courses, through an advanced training course for the inspection of nuclear power stations to advice on how to use drones to record a falcon hunt. Joseph Metz has been working in the drone sector for eleven years as a service provider and manufacturer. He set up U-ROB two years



ago to manufacture drones and to operate a training centre for users of all drone brands.

Real-time images in high resolution

On the day we visited, they were holding an introductory course for the Phantom and Inspire multicopters. The jobs of the participants show how widely drones are being used. There were two people from roofing companies, three from a property company and one freelance photographer from a multi-media agency. Before the class even began, Metz showed the participants just what the Phantom 4 drone could do in the courtyard in front of the building: flying acrobatic routines 15 meters overhead. He held the control unit at waist height, with an iPad attached to its mounting. The 9.7-inch screen showed the bird's eye view of the building and surroundings.

The image from the attached camera was transmitted in real time and in high resolution. The image from the hovering drone was perfectly stable, even though a light breeze was blowing. To all appearances, it was like looking at a picture frame. This illusion was only broken when a car drove through the frame. "I am flying the drone in GPS mode," explained Metz. The advantage here is that the aircraft holds its position in the sky even when the user releases the controls. The disadvantage according to Metz is that users can get lazy, relying too much on the technology rather than on piloting skills. "One hundred flights might go well, but what about the 101st? What happens if the GPS fails and the drone crashes into something because the user has forgotten how to fly without GPS?"

“The Phantom 4 can reach speeds of 70 km/h in sport mode

To illustrate his point, Metz switched from GPS to ATTI mode, where the drone no longer holds its position automatically. Immediately, the drone started drifting to the side until Metz took the joystick again. "Without GPS, you really notice how strong the wind is. The user needs to react immediately." Then Metz accelerated the aircraft and the drone swished past the participants. The Phantom 4 can reach speeds of 70 kilometres per hour in sport mode. The Inspire model maxes out at 80 kilometres per hour. "But that's it. No one needs to fly faster, except maybe to record motor sports."

After landing the Phantom a few metres in front of the group, the participants headed into the classroom. The desks and floor were full of various models of unmanned aircraft systems (UAS), as they are officially known; some with only four rotors, others with eight. Many different manufacturers were represented, includ-

ing some models from Metz's firm. Parts and accessories had been placed on a sideboard against the wall: a battery for the Phantom 4, pairs of propellers for the Phantom 3 and 4, mobile device holders for the Inspire 1, a brochure with the rules for flying unmanned aircraft in airspace GOLF and the ICAO chart Hannover.

ICAO chart provides some answers

The participants spent the morning learning the theory with their instructor, Dirk Höxtermann. Höxtermann has worked for U-ROB for a year, after initially studying electrical engineering and then working in the software sector. Höxtermann spent the morning working his way through the 60-page training documentation with the class: air law, airspace structure, meteorology, aerodynamics, technical data and functioning of the aircraft system and finally all aspects of a drone flight from preparation to maintenance. He explained the difference between airspace GOLF, where drones are allowed to fly but with some exceptions, and airspace DELTA, which is a no-go zone for drones.



Dirk Höxtermann, the instructor, (left) explains how to use an ICAO chart.

One of the participants, Andreas Traumann, wanted to know where he could find out more about the different types of airspace. Höxtermann then spread out an ICAO chart published by DFS and explained the various types of airspace found on it. Traumann is the managing director of a local property company, BV Werther Immobilien GmbH, and booked the introductory course with his colleague, Alexander Baer, and his trainee, Maximilian Blome. They plan on using drones to produce images of the properties on their books. Traumann feels that images taken from the ground often give a distorted view. More often than not, there is simply not enough space on the ground to move far enough away from the property to get it completely into the picture. Images from drones would be especially useful for commercial properties, as the whole property, including access roads, parking and warehouses, can be captured in one image. "Photos

taken from the street cannot do this. Any interested parties would only see a small section of the whole."

A distance of 1.5 kilometres must always be kept from the airport boundary

In the meantime, Höxtermann explained the rules for operating drones in the vicinity of airports. A distance of 1.5 kilometres must always be kept from the airport boundary and a height of 50 metres may not be exceeded. "You can very easily reach a height of 100 metres, for example if the drone is being used to inspect wind turbines."

The next subject on the curriculum was meteorology. Höxtermann explained the dynamic up-winds that can be found between buildings. He reminded the participants of the lesson Metz made so clear that morning. When the GPS fails, the user has to react quickly to stop the drone drifting off. The instructor recommended fitting protectors, or bumpers, just in case. "They would be particularly interesting for anyone who needs to inspect the tops of buildings," said Höxtermann, turning to the two roofers.

One of these was Hans-Joachim Maassen, who runs a company for roof and wall repairs, solar technology and landscaped roofs. He has been using a Phantom 2 in his work for the past two years. He recalls the strange looks he got when he first bought the device. However, he has not regretted his investment for one second. He uses the drone to inspect roofs for damage and take photos and



Stefan Finis-Weifenbach, photographer, (left) and Hans-Joachim Maassen, master roofer, take control.



videos for later analysis. "I used to send up two of my team onto the roofs. That was a lot more expensive and took much more time, especially considering they had to be secured safely at all times." His drone is also very helpful for the documentation needed for insurance companies.

He said that the roofing industry has a lot of uses for this kind of technology and he had already held a talk on the topic in front of the members of the craft guild. He recently added an Inspire model to his fleet, to join the Phantom he already owns. "Many other roofing companies operate drones in Düsseldorf now. But no one else has an Inspire." Maassen went on to explain the advantages of the retractable landing gear that the Inspire has. It allows the camera to swivel not just vertically but also horizontally by 360 degrees. "You don't have to turn the whole drone anymore."

No take-off without public liability insurance

In the afternoon, the participants headed out for the practical flight training. The training area was a little distance away on the edge of a field. Metz brought several Phantom and Inspire models with him. The property specialists first wanted a little practice to familiarise themselves with the flight characteristics. Stefan Finis-Weifenbach, on the other hand, displayed a sure hand and flew the device safely and seemingly without effort. He wanted to take the U-ROB test to get his certificate of competence to operate drones straightaway. He had already taken out the necessary public liability insurance.

The 20-year-old operates the Agnitio Media agency with a friend and works there as a photographer and creative director. The agency specialises in multimedia marketing for companies and event organisers and does web design,



Dirk Höxtermann, instructor at U-ROB, with an octocopter. Photos: Holger Matthies

from websites to filming image videos. "It was my idea to buy a drone," said Finis-Weifenbach, who recently came back from six months working as a mountain bike tour guide in New Zealand, where he discovered his passion for photography. "Being able to offer drone images as part of our portfolio will allow us to attract new customers."

The ball is in the legislator's court

U-ROB has a strict set of rules for the practice and test flights that have to be mastered. One of the hardest parts is landing the aircraft safely in an emergency situation at a set location within 15 seconds. And all this without the help of GPS. Those who land the drone safely often exceed the time limit. Others have problems getting the drone safely on the ground without it falling over. "Keep the joystick down after you land. Otherwise, it'll topple over," advised Metz. "Small movements with the controls. That's the key."

In Germany, the requirements you have to meet to get a certificate of competence to fly drones vary from Federal State to

Federal State. There is no uniform code for Germany as a whole. Local aeronautical authorities welcome the kind of certificates issued by U-ROB when deciding on specific permissions to operate drones. "We have invested a lot of time and money to get a step ahead of the game," said Metz. "The legislator needs to catch up. This technology is not standing still."

He feels that his company's solution has been tried and tested in the field and could function as a framework for any statutory regulations. Metz would like to offer longer courses spanning several days but at the moment he does not have the legal framework around which to design his courses. "Training academies like ours ensure that there is a basic level of quality on the market and boost the level of safety. Without us there would be more incidents and more people flying illegally." At the moment he feels he is operating in a legal no-man's land. But for Metz, one thing is clear: "The ball is in the legislator's court."

— Holger Matthies —



Drones are turning into flying smartphones

DFS and Deutsche Telekom have launched a joint pilot project aimed at testing the use of the mobile network for the integration of unmanned aircraft systems (UAS). transmission talked to Ralph Schepp, Vice President for Program & Project Management at Deutsche Telekom, and Thilo Vogt, Head of the Corporate Strategy department at DFS.

Thilo Vogt (DFS, right) and Ralph Schepp (Deutsche Telekom, left) talk about the joint project at the DFS Headquarters in Langen.

What do DFS and Deutsche Telekom aim to achieve with their project?

RALPH SCHEPP: There are still a lot of unsolved problems facing commercial operators of drones. All parties are ready to move forward but many important questions remain unresolved.

THILO VOGT: Drones still need to be integrated into the air traffic management system and legal and regulatory uncertainties still need to be clarified. A functioning system for registering

drones is not yet in place, for example, and there is no common technical basis to stop drones in their tracks should that be necessary for safety or security reasons. At the moment, only flights within the remote pilot's visual line of sight are allowed so that they can avoid other air traffic.

SCHEPP: From a technical point of view, flights outside this visual range are not even possible as there is only a local radio connection. The mobile network could be the ideal solution to

this problem. We aim to demonstrate that no additional infrastructure is needed to monitor and control unmanned aircraft systems in uncontrolled airspace. Deutsche Telekom's mobile network can be used instead. From a technical perspective, there are two aspects here. Firstly, it's about connecting the drones to the mobile network. Secondly, we want to develop a concept for UAS traffic management and test a demonstrator using real-world applications. There is also a third aspect: cost-effectiveness. We plan on demonstrating that a UAS traffic



management system can be operated commercially.

Monitoring and controlling drones via the mobile network – how is that supposed to work in technical terms?

SCHEPP: A mobile phone module that establishes a connection to the mobile network is installed in the drone. This connection can be used to transmit the data generated by the drone, such as GPS coordinates or system information, so that they can be processed by the air traffic management system. The drone can also receive additional information using this data channel. This basically turns the drone into a flying smartphone that we can identify via the SIM card, ensuring that we know its position. However, the technical side is not as easy as it sounds.

What is the problem?

SCHEPP: Our mobile network is designed for use on the ground. A normal mobile phone is usually in contact with three or four radio masts – and it searches for the one with the best signal. To ensure that it works when you move with your mobile phone, the network is based on a complex operating system that controls the transition from one cell to the next. The problem with drones is that the higher the mobile phone module rises, the greater the number of radio antennas which it is in contact with – and our operating system is not optimised for this. We are certain that we will be able to overcome these challenges. With the consent of the local aviation authority, we took a drone up several hundred metres during a test run in the Ruhr region of Germany. Broadband streaming was possible during the entire flight. This test showed what is already possible with our mobile network.

What role does DFS have in the project?

VOGT: We want to show what a UAS traffic management system might look like. Our aim is to show the position reports transmitted via the mobile network in an air situation display. When it comes to tracking a large number of aircraft, DFS has a huge amount of experience that we want to use. Such a tracking ability would be the prerequisite for operating drones beyond the remote pilot's line of sight – something that is not allowed currently. To increase safety, this information could then also be made accessible to the air traffic controllers who monitor manned air traffic – we therefore need interfaces with our air traffic management systems. In turn, we need to consider what important information we can supply to drone users, such as information on other air traffic or on noise restrictions.

 *The UAS traffic management system would allow drones to be operated beyond the remote pilot's direct line of sight. Today, this is not yet allowed.*

Will there be air traffic controllers who monitor the drones?

VOGT: That will depend on the circumstances. At the end of the decade, we will have more than a million drones in Germany, so a UAS traffic management system will have to be highly automated. This is especially true for small drones operating close to the ground. However, it must be borne in mind that as soon as we get close to the control zone of an

airport, using just the mobile network for surveillance will not be sufficient. I assume that such drones will need to be equipped with transponders, too. Safety assessments will need to be carried out to determine the exact requirements. This is standard operating procedure. When drones are operated in controlled airspace, air traffic controllers will still be in control – I am thinking here of unmanned cargo aircraft transporting goods between two production sites, for example. In addition, there might even be cases where air navigation service providers take on the role of drone pilots.

What happens if contact with the drone is lost or the airborne device goes out of control?

VOGT: This is something we will have to work on intensively in the project. What do we do in areas without consistent mobile coverage? What happens if the network fails? But we also need to address the equipment requirements for UAS: Do the systems have a redundant design? Are there emergency systems if the drone crashes? We won't find answers to all these questions straight away. Our aim is to show what is feasible on the basis of specific applications.

What specific applications are these?

SCHEPP: We have set up three specific areas of application. The first case involves fire-fighting: when an alarm is sounded, a drone could take off at the same time as the fire engine is sent out and fly to the scene of the fire. There, it could provide aerial photos or use an infrared camera to check whether there is anyone still left inside the building. Fire-fighters would then have an overview of the situation on arriving at the scene – this would be a huge advantage. A second case involves logistics, namely the delivery of goods by drone. The third area is agriculture.

What are your plans there?

SCHEPP: We plan to examine the use of drones in viticulture with the university in Geisenheim, Germany, which specialises in wine-growing. This is about using drones to inspect vineyards and, later, carry out other work, spraying fertiliser for example. In steep locations, helicopters are used for this at the moment. If small drones could be deployed instead, this would save a great deal of time and money and the environment would benefit, too.

“It is important that all drone users are obliged to register their devices. If we want to control drone traffic, we need to know who is doing what and where.”

What sort of timeframe do you have in mind?

SCHEPP: We want to start the first flights next year. We will keep the system simple at the beginning and add complexity as we move forward. Staying with the example of wine-growing, at the moment, the drone looks down on the vineyard, and the remote pilot stands by and operates it. By 2019 or 2020, I see the drone flying independently from the winery to the vineyard and carrying out work on its own.

VOGT: What we are doing is also important as guidance for legislators: If this project can demonstrate that drones can be integrated safely and fairly into



Three concrete application areas are being investigated: logistics, viticulture and fire-fighting. Camera drones are already proving their worth by delivering images from the air. Sensors could be added to reveal heat sources and search for poisonous materials.

our aviation system using a UAS traffic management system, then this will be a major step towards creating the preconditions necessary for this market to grow. At the moment, these preconditions for growth are missing. It is vitally

important that all drone users are obliged to register their airborne devices. If we want to control drone traffic, we need to know who is doing what and where.



also be used to offer additional services to drone users, such as meteorological information or the option of taking out some form of mandatory insurance prior to launch. This would be one way of generating extra income. However, we would need compulsory registration for this, too.

SCHEPP: My dream would be for all drones to be fitted with a SIM card. As well as providing an opportunity to check user authenticity, the SIM card could also authorise users to fly in the first place. In addition, the card could be used to bill supplementary services.

 *The UAS traffic management system will be developed step by step. This project will lay the foundations and kick off the process.*

When could a UAS traffic management system of this kind be ready?

VOGT: The UAS traffic management system will be developed step by step over a period of several years. This project will lay the foundations and kick off the process. We have to try out new things and test new ways of doing things. Coming up with a finished solution was never one of our aims in this research project.

— Interview by Christopher Belz —



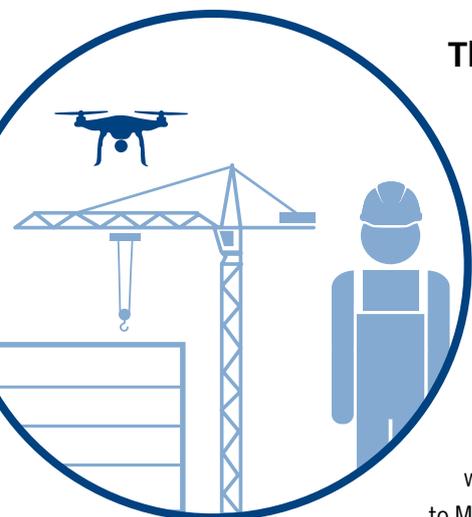
Goods deliveries to even the most remote regions could be made possible with drones. DHL is experimenting with the 'parcelcopter' developed by RWTH Aachen University. The photo shows a specially modified self-service collection station for parcels. In the joint project, DFS and Deutsche Telekom are testing the use of drones beyond the remote pilot's direct line of sight.

How would a service like this be financed?

VOGT: That is another question that legislators have to answer to a certain extent. Each user could be charged for

the service individually. But you could also regulate it in the same way as for VFR pilots in uncontrolled airspace. The expenses incurred by DFS are refunded on a flat-rate basis by the German Federal Ministry of Transport. The system could

Drones at the airport



The German airport operator Fraport is developing ways to put drones into service at Frankfurt Airport. Initial trials have already taken place with support from DFS.

Drones being deployed at airports? What might at first sound like an unconventional idea turns out to be quite a good one upon closer inspection. “In the future, drones could be used for a wide range of jobs at the airport,” according to Manfred Reinhard, Fraport’s project manager of FRADrones2020. The project team, with staff from IT management and flight operations control, launched this forward-looking project in 2013. It was clear from the very beginning that this project could only reach fruition together with DFS as Fraport’s partner. Fraport is continuing development on a wide range of applications for drones at the airport.

For example, unmanned aircraft could be helpful for surveying and monitoring construction sites, security, flight operations, wildlife control as well as fire-fighting services. “The assumption is that the scope of uses will continue to grow,” explains a member of the project team, Felix Toepsch. In the long term, drones could also be used as an additional way to transport documents from one part of the airport to another.

At the end of 2015, a number of initial trials with drones were carried out at Frankfurt Airport. The main objective was to assess how practical it would be to deploy drones for tasks which until now have just been theoretically possible. During the trials, the northwest runway was closed during a period with low traffic so the unmanned aircraft could carry out its





tasks undisturbed. Fraport and DFS were joined by Lufthansa's consulting subsidiary Lufthansa Aerial Services. The five-kilogram radio-controlled camera drone used for the trials was equipped with a transponder and measured 120 centimetres in diameter.

 *Unmanned aircraft are too small for primary radar. They can only be detected when they are equipped with a transponder.*

DFS played an important role during the trials. "Drones can only be integrated into the airspace when they can be picked up by secondary radar and ground situation display systems used for air traffic control," states Dr Ralf Häscke, head of the DFS department Tower Operations. "The trials at Frankfurt Airport showed that unmanned aircraft can be detected by secondary radar when they are equipped with a transponder. This allows air traffic controllers to identify them. Primary radar, however, cannot pick up the drone due to its small size."

The trials also tested whether the camera drone was able to locate objects on the runway. The project team placed various objects on the northwest runway such as tie-down straps and lashing rings used by the baggage transport vehicles. Such objects can damage an aircraft when it rolls over these items during take-off or landing. To prevent such damage, airports carry out regular inspections of the runway to make sure they are free of such dangerous objects. This trial was



Initial trials with five-kilogram drone at Frankfurt Airport.

also a success as the drone camera was able to identify the objects on the runway.

Lufthansa Aerial Services provided the drone pilots for the trials. Two remote pilots were responsible for the drone: one of them was in charge of voice communications with air traffic control while the other did the actual piloting. "Any future operations at the airport will always require two pilots to operate the drone to ensure safety," stresses Reinhard. In addition, it is also necessary for these remote pilots to hold an aeronautical radio operator's certificate and to be well-versed in procedural rules and regulations. The drones themselves are programmed so they will not cross runways or enter other areas where commercial airlines fly. This is ensured by a technology called geofencing.

Two pilots needed

"As the trials last year were so promising, the FRADrones2020 project is being continued," reports Reinhard. Quite a lot still has to happen before drones are deployed in regular operations, however. One step in the process will probably be, for example, to use drones to survey the

construction site of Terminal 3. A further concrete application could be to conduct a cadastral survey of the roof surfaces. "With such an inspection, we could check whether chimneys or other objects on the roof cause reflections that interfere with the radar," explains Reinhard. "Without drones, somebody would have to climb up to the roof and take measurements up there."

DFS will conduct a safety assessment before regular operations with the drones are allowed to begin. "It goes without saying that unmanned aircraft can only be deployed when they do not endanger normal flight operations," says Gerd-Martin Praus, head of the DFS department responsible for tower safety assessments and requirements. "Generally speaking, DFS does not want to stand in the way of this development. But, the most important aspect will be to see whether our air traffic controllers can work safely with this technology."

— Sandra Ciupka —

From lasers to birds of prey: stopping drone misuse in its tracks

The market for drones is booming. But this boom is not without its negative consequences. Concerns about drone misuse are growing. **This has led to a surge in the market for drone detection and protection systems.**

The growing number of drones sold to private enthusiasts has opened up a completely new market: systems that offer protection from drones. Drones are becoming easier and easier to operate; you can even use your own smartphone. They are also becoming more and more affordable. If they come equipped with a camera, operators can capture spectacular images. A head-mounted display makes shooting images even easier. Display glasses worn on the head project the camera image directly before your eyes. You are transported into a direct bird's eye view of the world and it makes you feel as if you yourself are flying through the sky.

The question which more and more people are posing is when the fun factor for one person turns into a nuisance or threat for another. What happens when someone pilots a drone over another's private property? You may feel like you are being watched, or even worse, being

spied on. This represents an intrusion on your privacy and an infringement of your rights to control your own image. The list of potential threats from misuse is long. Companies are worried about competitors finding out trade secrets. Airports are worried about the safety of aircraft. Many are worried about criminals using drones to gather information about potential targets. In the future, there could be more and more reasons why it makes sense to consider deploying detection and protection systems against drones. Companies are already offering innovative products and services.

Airbus provides the jammer

The German start-up company DeDrone has developed an anti-drone system called DroneTracker. This multi-sensor system can be mounted on the sides of buildings or on stands and detects drones

using acoustic and optical sensors as they get closer. The sensors detect the shape, flight characteristics and noise profile of the approaching aircraft. A Wi-Fi sensor also allows detection based on the Wi-Fi signal. The DroneTracker's functions will be augmented using technology provided by Airbus DS Electronics and Border Security. Airbus can supply countermeasures, such as jammers. These jam, or disrupt, the radio contact between the drone and its remote control unit. The fact that a global company like Airbus is involved shows just how much interest in this business exists.

The American research institute Battelle has developed a device, the DroneDefender, that uses radio waves to disrupt the communication between the drone and the pilot. This device is basi-





cally a radio cannon designed for easy aiming. According to Battelle, the Drone-Defender is currently only available to government agencies.

Systems designed to disrupt radio communication offer a higher safety factor. Many drones have a built-in safety system. When radio contact is disrupted between the control unit and the drone, the drone automatically either lands or returns to its starting position. This prevents the drones from simply falling from the sky.

Other technologies are available and OpenWorks Engineering in the United Kingdom uses a net-containing projectile to bring down drones. They have developed a shoulder-mounted compressed-air launcher called SkyWall 100. It fires a projectile with a net and a parachute to bring the drone back down to earth. A system developed by Michigan Technological University also uses nets to catch renegade drones. In this case, however, another drone is itself equipped with a net to capture the drone being misused. This net remains attached to the catcher drone.

Capturing a drone is one solution, destroying it is another. Both MBDA in Germany and Boeing in America are researching the use of lasers as a means to counteract intrusive drones. Such laser-

based systems can knock-out drones with strong infrared lasers that can burn a hole through their targets. The Boeing system looks a little like a speed camera you might see set up on the side of the road and is also intended for use on private properties, including in people's gardens. Such anti-drone systems are still in the test phase, however, and it cannot be said with certainty when they will be available commercially.

“Nature can provide a field-tested solution. The Dutch police are looking into using birds of prey to capture drones.”

Nature may already have provided a solution which has been tested in the field for thousands of years. The Dutch police are currently looking into using birds of prey to capture drones. These birds intercept the drones before flying back to earth with the drone still in their claws. Animal rights groups have raised concerns about the practice and it remains open to question how many private households will take up falconry.



DroneTracker is an all-round sensor that can be attached to buildings, barriers or stands.

There are also legal issues that need to be considered with anti-drone systems. People could be injured if drones simply fall from the sky, whether through a net, laser or bird of prey. The drone itself is someone else's property and the damage to or destruction of such property could be a civil or criminal offence. Drones have already been shot from the sky in the United States using handguns. In many jurisdictions, protecting yourself from drones flying or filming unlawfully would probably be considered a form of lawful self-defence. Most statute books allow members of the public to use force if exposed to some form of unlawful and immediate danger. Whether such defences are lawful, especially as regards to how immediate or imminent any danger was, will probably keep the courts busy for the next few years. At the very least, operators of drones might have a legitimate claim for compensation for any damage caused. If people are injured, the legal consequences could be much more severe.

— Sven Chamberlain —



SkyWall 100 fires a net-filled projectile at drones.

Science & fiction – Fun & facts

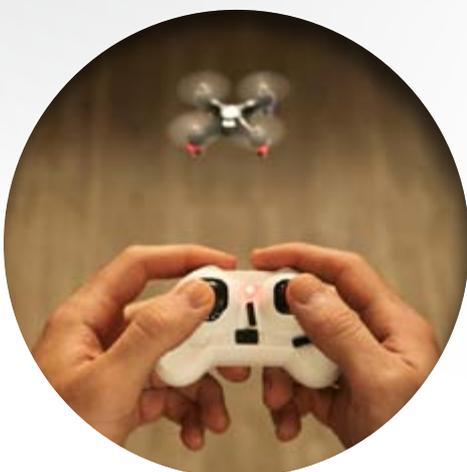
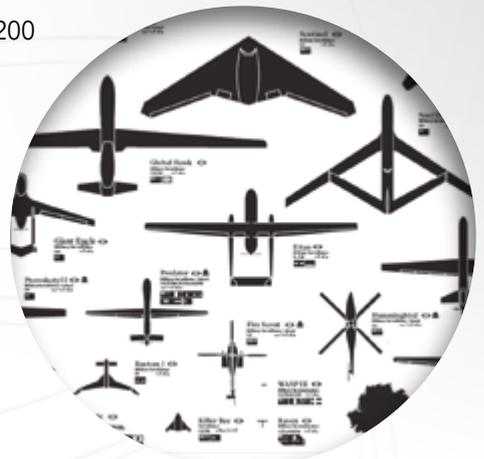
Although the military have been the driving force behind many unmanned aircraft systems, the variety of civil uses of drones is increasing rapidly. They are also being used in film productions, replacing expensive shots from helicopters. Drones themselves have played a role in the fictional world of films and books for a long time, particularly in science fiction. **Once, drones were a vision of the distant future; now, they are becoming part of our recent history.**

All manner of drones

According to the Brandenburg Institute for Society and Security, there are roughly 1,200 different drone models available worldwide, including both military and civil drones.

There are currently around 70 manufacturers competing in the market for recreational drones.

The Dutch designer and researcher, Ruben Pater, has created the Drone Survival Guide. It functions as a spotter's guide to the most popular civil and military drones and displays the true-to-scale silhouettes of 30 drones. It also describes the type and characteristics of each drone. You will be able to tell if the drone you can see is a military observation or an attack drone, or a recreational drone with a camera. Printed on the other side are survival tips on how to protect yourself from drones. It is printed on reflective material to blind drone cameras.



Probably the world's smallest drone

A drone hardly bigger than a two-euro coin. Produced by Aerix, the Aeriux drone, which measures three centimetres from wingtip to wingtip, is probably the smallest drone available to hobby users. The drone can fly aerobatic stunts, such as flips and rolls. The company also produces the Vidius, which is only a bit bigger and comes equipped with a camera.

Scientists at Harvard University are currently working on a drone that looks like a fly, flies like a fly and is the same size as a fly. The wings beat at 120 times a second and it only weighs 106 milligrams.



Drone fiction

In 1919, Jules Verne wrote about unmanned flying vehicles in his novel: *The Barsac Mission*. These were free-flying weapon systems called 'wasps'. They were directed to destroy targets by exploding after being flown there by remote control.

Almost one hundred years have passed since unmanned flying objects made their way into the world of science fiction. In the meantime, fiction has become reality. Stories of drones no longer have to come from the minds of authors, they are today's reality. Drones have played a role in a number of films and books:

Hilldiggers (science fiction novel 2007)

A mysterious space drone enters the solar system and is intercepted by humans. A research scientist who comes into contact with the object becomes pregnant and gives birth to four children with supernatural powers.

Oblivion (science fiction film 2013)

In a post-apocalyptic future, the earth is guarded by combat drones following a war with extra-terrestrials that left the earth almost completely uninhabitable and abandoned.

Drone (documentary 2014)

Documentary on the use of drones in war.

Drone country (science fiction novel 2015)

Europe has become a surveillance state monitored by police drones. Surprisingly, the murder of a politician remains unobserved and the crime has to be solved the old-fashioned way.



When every second counts – using drones for first aid

While Johanna and her father are out shopping, he suffers a heart attack. She contacts the emergency medical services immediately by mobile phone. Instead of sending an ambulance, they send a drone. The video of this scenario is part of a research project that is testing such a drone at Delft University of Technology in the Netherlands. The drone has been specially fitted with loudspeakers and a defibrillator to save human lives. While Johanna is speaking to the emergency services, her position is located and a drone is sent her way. It flies straight to her location unhindered by the traffic on the busy city streets. An emergency doctor can follow what is going on via a livestream video and audio connection and can give lay responders at the site concrete instructions via the loudspeakers until an ambulance arrives. Johanna is told to take the electrodes of the defibrillator out of the drone and place them on her father's chest. The webcam allows the doctor to confirm that the electrodes are in the correct position. A dose of electric current is administered after all bystanders have moved away from the patient. Johanna manages to successfully resuscitate her father after only a few minutes.



Uniform European regulation for the use of drones

The drone market is moving so fast that individual States have already had to start solidifying their regulatory approaches on their use. The European Aviation Safety Administration (EASA) has been tasked by the European Commission with delivering a uniform regulatory framework for Europe.

Two concrete goals are being pursued with these amendments to the existing aviation legislation. One goal is to boost the integration and raise the acceptance of drones in aviation. The other is to maintain the competitive and innovative pressure, especially on small- and medium-sized companies, in the strongly growing drone industry and promote the creation of new jobs. Other issues in EASA's focus include collision hazards, danger of injury to other people and damage to other people's property.

In 2015, EASA drew up an A-NPA (advanced notice of proposed amendment) with its proposals to provide those involved in the drone industry with solid foundations for their future planning. In addition, all parties involved were able to

submit their comments and proposals, which were incorporated by EASA after being assessed and reviewed. In August 2016, a 'prototype' Commission Regulation on unmanned aircraft operations in Europe was published with 33 proposals.

First of all, both commercial and non-commercial drones should be subject to the same set of rules as both can be used for commercial and non-commercial purposes. The mass should no longer be used as a basis for the system of classification. Up until now, unmanned aircraft that weighed over 150 kilograms were subject to the same rules as manned aircraft. The regulation of drones under 150 kilograms is a matter for the individual EASA Member States. According to EASA, the hazards posed by drones do

not depend on mass but on the environment in which the drones are deployed. A drone over water poses a smaller risk than a drone over a heavily populated area. The new approach requires drones to be placed into three risk-based categories depending on the type of use. The 'open' category is for drones that pose a negligible risk because of operational limitations, such as internal restrictions on the level flown or on their range. The 'specific' category is for cases where the risk posed for third parties is higher. This could be, for example, because the airspaces being used are also used by manned aircraft. In these cases, a risk assessment needs to be conducted and the competent authority has to issue an authorisation before the operation takes place. The use of drones in the 'certified' category requires a licence for both the remote pilot and of the drone itself. The rules for this category correspond to the rules in place for manned aviation.

Privacy rights and data protection should remain matters for the individual EU States according to EASA. The individual Member States should also designate the competent authority to monitor the rules. EASA strongly recommends the introduction of no-fly zones for drones. Geofencing technology could be used to protect these areas. This technology uses an electronic system to prevent drones from entering areas deemed off limits. In addition, EASA believes that there should be mandatory registration for drones.

— Sven Chamberlain —



DFS subsidiary Air Navigation Solutions Ltd. (ANS) to provide air navigation services at Edinburgh Airport

The UK subsidiary of DFS, Air Navigation Solutions Ltd. (ANS), has been awarded the contract to provide air navigation services at Edinburgh Airport. As of 1 April 2018, the company will be responsible for tower and approach control at the Scottish capital city's airport. The contract was signed by Paul Reid, Chairman of the ANS Board of Directors, and the CEO of Edinburgh Airport, Gordon Dewar. The DFS Group will take over from NATS, the UK's main air navigation service provider.

After taking over operations at Gatwick Airport on 1 March of this year, Edinburgh will be the second UK airport to have its air navigation services provided by the DFS Group. The contract between ANS and the airport operator is for ten years. NATS will continue to provide air traffic control at the airport until the transfer has taken place in spring 2018. In addition, NATS has committed itself to continue to provide air traffic control staff until ANS has been able to employ enough staff of its own. This model of temporarily leasing employees has already been used successfully at Gatwick Airport. Edinburgh Airport is the sixth busiest airport in the United Kingdom. It has two runways and handles over eleven million passengers per year. At present, 32 air-

lines serve 173 routes to 122 destinations. In 2015, it handled almost 115,000 aircraft movements, a five percent traffic increase over the previous year. Edinburgh Airport is owned by the American investor Global Infrastructure Partners (GIP) that also operates Gatwick, the second busiest airport in the UK. "We are very proud to have been awarded the contract for Edinburgh. This success reflects the DFS Group's ambitions for growth and shows that we are on the right course in the European market," stated Klaus-Dieter Scheurle, Chairman and CEO of DFS.



DFS staff help young refugees

The people who work for DFS are of a practical nature. When they see a problem, they take action. This is the case with the 19 staff members who have signed on to support young refugees who have come to Germany from crisis areas. The mentors and their charges recently met at a get-to-know-you session at the Headquarters on the DFS Campus.

The young people are all attending special integration classes at a nearby secondary school where they are working towards a lower-secondary school leaving certificate. Under the auspices of the InCharge initiative, the mentors will introduce their charges to life in Germany and work together with them on potential career and education choices over the course of the three-month programme.

“Without education and work we will have a generation without hope. This also applies to the young people who have made their way to us from regions dominated by war and persecution,” said Klaus-Dieter Scheurle, CEO of DFS, on the involvement of DFS. “Europe cannot afford such hopelessness. That is why it is important for us to send a signal.”

DFS became a partner of the InCharge initiative in June 2016 and has been actively supporting the InCharge mentor programme. The InCharge initiative was called into life in 2014 to fight youth unemployment in southern Europe. Since 2015, the InCharge network has also been helping asylum seekers to find their feet in the German labour market.



Dr Michael Hann, Managing Director Human Resources, meets the young refugees and the staff members. Photo: Holger Matthies

DFS, LVNL and Indra will implement the next-generation technology that will manage German and Dutch air traffic

The German and Dutch air navigation service providers DFS and LVNL have signed agreements with their technology partner INDRA to introduce the iTEC Centre Automation System (iCAS) at all DFS control centres (Karlsruhe, Bremen, Munich and Langen) as well as the LVNL control centre in Amsterdam.

DFS Deutsche Flugsicherung and Air Traffic Control the Netherlands (LVNL) each signed contracts with the technology supplier Indra at LVNL's headquarters for the development and commissioning of the air traffic management systems known as iCAS (iTEC Centre Automation System). Indra, one of the world's leading global consulting and technology companies, will implement the next-generation systems that will manage air traffic in the airspace of Germany and the Netherlands. The signing of the contracts kicks off phase II of the iCAS project, which aims to equip the control centres for lower airspace with a state-of-the-art system. This solution complements the system that Indra will implement at the Karlsruhe Upper Area Control Centre in Germany, from which DFS controls flights above 24,500 feet (7.5 km) over most of Germany.

DFS to modernise air navigation technology in Luxembourg

Luxembourg Air Navigation Administration (ANA) and DFS are planning to collaborate on the modernisation of ANA's air navigation technology by DFS.

The contract negotiations have already begun. The term of the contract is planned to be ten years.

In addition to the installation of technical systems, project management and certification by a service provider, ANA had originally planned to contract out approach control at Luxembourg's international airport. However, the Luxembourg Approach Controllers Association (LACA) expressed its opposition to the plan. Con-

sequently, the contract is now just limited to the modernisation of air navigation technology.

This is another area of international business activity for DFS. The German air navigation service provider already provides air traffic control at London Gatwick Airport and will soon assume control at Edinburgh Airport as well.



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