



The journey toward autonomous drone solutions and AI-powered analysis

The global wind turbine inspection and drone technology space is dynamic and fast-moving, so PES wanted to speak with Peter Fromme-Knoch, CEO; Thorsten Zander, CTO; Christian Raml, Head of R&D and Dan Baseley, Marketing, at Austria-based Aero Enterprise, one of the leading companies in both technology advancements and inspection services in this field.

PES: Welcome to PES all of you. We'd like to know some more about Aero Enterprise, what you are doing right now, and how you are transforming the wind turbine inspection process.

Peter Fromme-Knoch: Hi, thanks for inviting us. Yes, there are currently several exciting things happening here at our HQ in Linz, Austria. Hopefully, we can let you know about some of them today. But in short, we are a multifaceted technology company, specialising in wind turbine inspection solutions. We like to think we are a team of smart people, creating smart, innovative products and services for the wind energy sector.

Dan Baseley: The best way to look at what we do is to break it down into three different areas, but all are integral parts of the same machine. We have our hardware development team creating clever, real-time, autonomous drone solutions like our AERO Flight Intelligence System for wind turbine inspections; our software team creating AI-powered analysis and digital reporting software; and our operations management, who oversee and manage international project campaigns.

In essence, we are an end-to-end solution provider for our global customers and partners.

PES: Aero Enterprise has been on an interesting journey, which is highlighted

by your recent technological advances and growth in inspections, as well as global business uptake. What factors are driving this in your opinion?

PF-K / DB: Yes, we have had a very interesting journey and have been involved with inspecting wind turbines for some years, from our award-winning AERO SensorCopter, initially pushing what is possible in data acquisition in this sector, moving to now using professional DJI M300/350 drones with our proprietary hardware which makes the inspection flight fully autonomous.

It was clear to us that as technology moved fast and forward, we needed to try and keep ahead of the curve. How we do this is by first asking the questions, is this the best way to do this? What can we create to make this process better, faster, easier, and more cost-effective? There is often a better way.

We are now in the 10th year since Aero Enterprise was founded and the journey has been that of a typical start-up with all of the ups and downs, of course, also exacerbated by the Covid-19 crisis.

Today, we are one of the leading inspection providers because we have aligned our strategy very well to the requirements of the market and, with an excellent team of employees, have built up very strong services and products, both hardware and software.

PES: Your mission is, as you say, to make the inspection process more efficient and cost-effective for all key stakeholders. Tell us more about this and what challenges you face in pursuit of these goals.

PF-K: The inspection process consists of on-site data acquisition, the evaluation, and finally the reporting.

Our goal from the start was to operate all parts professionally, whilst continually investing in hardware and software development. We have seen how quickly one new development of drone-based inspections replaces the next, the development in this sector is incredibly dynamic.

The challenge for us is to place smart, marketable products and services correctly while at the same time working on the next generation of products.

From a long-term perspective, the entire technology can still be described as young, so there is always room for improvement. We are continuously working on digitisation, automation, and standardisation alongside our in-house hardware and software.

PES: There is a lot of progress in this market, how do you see where it is now and where it is heading in the coming years?

Thorsten Zander: We expect to see the trend toward automated rotor blade inspections continue. As a result, the inspection market



will consolidate, and the volume will be handled by only a few technology providers in the future.

This trend is further encouraged by the fact that OEMs are increasingly favouring global service providers to obtain standardised inspection results for their turbine fleets. For technology providers of autonomous inspection systems like Aero Enterprise, the challenge will be to continually improve their hardware and software in terms of image quality, inspection speed, scalability, and usability. With our AERO Flight Intelligence System, we already have a very good basis for meeting future requirements.

PES: How do you think the acquisition of data and analysis has changed and what are the challenges companies face?

TZ: Many inspection results are still delivered and managed in the form of PDF documents. This makes the work of the rotor blade experts considerably more difficult. Recognising recurring damage patterns, damage progression, and the resulting repair campaigns is extremely time-consuming. Autonomous inspections in combination with damage databases can help here.

Standardised recording and exact localisation of damages are the foundations of an effective damage database, which can then be used to identify and plan maintenance and repair strategies. The challenge is to provide

rotor blade experts with an automated overview and recommendations that they can then use to implement into their company's repair strategy.

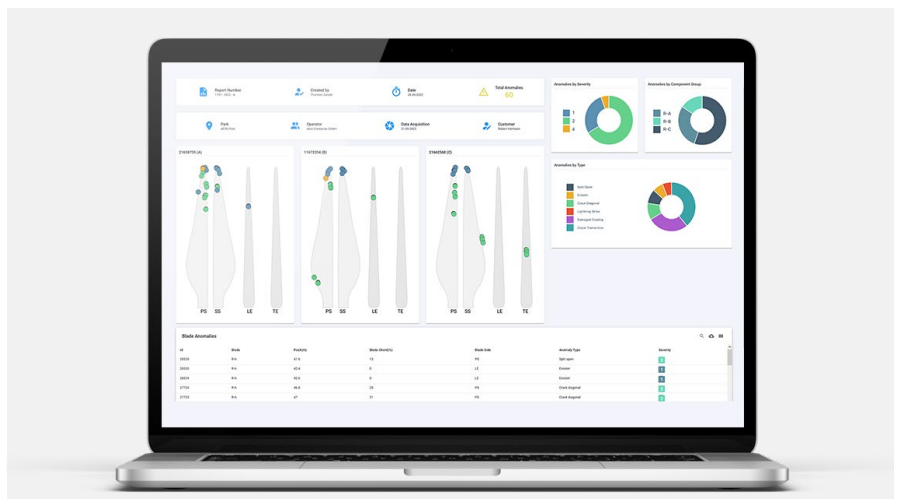
PES: The process of data capture and time management is a difficult thing to get right and with consistently high quality. Tell us more about what you are doing to solve this industry-wide problem.

Christian Raml: We have worked intensively on digitising the entire workflow over the past few years. From order inquiries to reporting, all processes are digital.

The heart consists of a database and cloud storage. The connected clients such as web dashboards and desktop applications were developed by us and are precisely tailored to the needs of the industry.

An immense advantage of our process chain is that data can be brought in and taken out at different stages via different interfaces. Thanks to this flexible design, we do not have to force a complete system on our customers, which is very well-received in the market.

To do this, we try to make the interfaces for the different user roles as convenient as possible. Be it the pilot who collects the



data in the field, the backend developer who transfers data into the company's own ERP system, or the independent rotor blade expert who has to evaluate the results, we are constantly working on optimising and improving our solution.

At peak times, we currently process almost 100 inspection data sets per day. Dozens of pilots worldwide use our AERO Flight Intelligence System to collect standardised and process-reliable data of the highest quality. These pilots are either employed directly by us, subcontracted by us, employed by the customer, or subcontracted by the customer.

This makes no difference, the AERO Flight Intelligence System collects data fully autonomously, always in the way we need it, with the quality our customers expect, and within 15 to 30 minutes, which is incredibly fast. After uploading everything into our central system via an application we provide, a few minutes later, the data is checked and processed.

Most of our customers are already retrieving the results at this point via an API or specifically designed interfaces according to their requirements. If they want, we can enrich the data further, for example with the results of our deep learning algorithms, which segment components and annotate abnormalities.

PES: AI is the current buzzword and is being used by a lot of companies in some form or another. How do you see the benefits of AI in the inspection space?

CR: To be able to handle such quantities of images, deep learning is very helpful, not to say it's a must.

But what we have learned is that you can't solve everything with AI, and there is certainly no 'one neural network' to generate the final results from images. Because what is the final result? There is no dedicated specification here.

Data, processes, and algorithms must be cleverly cascaded and linked together to



Peter Fromme-Knoch



Dan Baseley



Thorsten Zander



Christian Raml

meet the diverse requirements and fulfill the different demands.

Our workflow is structured in such a way that we increasingly enrich and build up data sets and data points with information. AI provides essential building blocks in this process, but

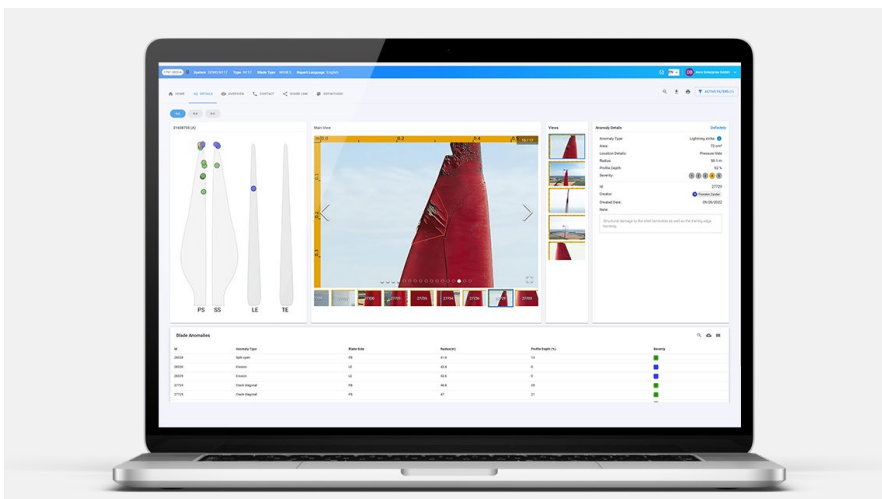
cannot, yet, deliver the desired outputs on its own.

To make the topic a little more tangible. Our current neural networks can identify many types of damage very accurately in individual images. But this might not always be a perfectly useful result.

If cracks were found in several images, the question arises, is it the same crack? It becomes even more difficult if the damage extends over several images. Fortunately, this is rarely the case with cracks, but common with leading-edge erosion.

This example shows that although AI makes a very significant contribution, further steps are required to convert these intermediate results into meaningful, usable results.

Ultimately, it is up to the customer how much information we add and how far the data should be processed in our recommended workflow. Because, at any time it can be transferred to another system and further processed there.



PES: Managing inspection campaigns in multiple regions comes with its challenges. What is the key to successfully managing these regional and global projects in multiple locations?

TZ: Our software enables a completely digital workflow from order placement to report creation. This digital workflow makes it possible to manage multiple global inspection campaigns simultaneously. The customer dashboard includes country-specific campaign and route planning functionality as well as providing digital reports and detailed statistics once completed.

The pilots can upload data directly to our cloud from the wind farm through our software, which offers functions for documenting waiting times, comments, etc. Additional information such as GPS coordinates of the individual systems, telephone numbers of the contacts, system-specific information, sheet numbers, etc. considerably reduces the need for support.

PES: What are some of the challenges providers of global wind turbine inspection services have to overcome?

PF-K: The entire concept of on-site data acquisition is based on a comprehensive network of partners. Choosing the correct drone and pilot partners for example is imperative for successful campaigns. Standardisation plays a major role in maintaining quality. All partners we work with have the same equipment, the same software, the same training, and the same specifications, this is the only way to produce quality across the board that impresses customers and satisfies them in the long term.

PES: You have created a unique and innovative product with your AERO Flight Intelligence System, tell us more about this and where it is being used.

PF-K / DB: The AERO Flight Intelligence System has been a key and significant



technology breakthrough for us and in turn our partners. There are autonomous systems on the market, but these systems require predefined information to be able to inspect 'autonomously', which is time-consuming and requires extra work. Where the AERO Flight Intelligence System differs is it inspects all three sides of all three blades in one flight, fully autonomously, without interruption, all calculated in real-time, so no RTK or previous information is required to conduct the inspection.

Not only is this faster, but it's also more exact, as the real-time calculations keep the drone at the optimal speed and distance from the turbine at all times, achieving the best results possible. This year we have already sold over 50 units to our global partners. In 2024 inspections have been carried out across Europe, APEC region, the US and Australia, with data processed and managed back at our HQ in Austria.

We believe this is the most advanced and efficient solution on the market currently and we are continuously updating and improving. Our systems have now inspected in the region of 10,000 blades, our AERO AI has

scanned over 1.5 million images, helping to discover over 41,000 anomalies, which is not only great but fast progress.

We think the system is a real game changer, but it is only one part of an entire chain of products and services we offer within an entire inspection package.

As Dan says, our AERO Flight Intelligence System is currently in use worldwide on four continents and throughout the EU, we are a little proud of that. Of course, this also brings with it new challenges, but our motto has always been 'there are no problems, just opportunities to be creative!'

PES: Thank you for this insight into the autonomous inspection process and Aero Enterprise. How can people contact you to find out more about your wind turbine inspection solutions?

PF-K: Thank you. We are happy to share some insights into the challenges and solutions in this space and are always happy to speak with interested parties in more detail. You can visit our website, or email us directly at office@aero-enterprise.com.

aero-enterprise.com

