



Aracnóptero EOL6

Novel and efficient solution for wind turbine blade inspection

Carlos Bernabéu González

The Salamanca-based firm, Arborea Environmental Management, and its founder, Carlos Bernabéu, have been dedicated for more than a decade to design in applied technology and threatened fauna management in many different countries around the world. Nevertheless, their last innovation—the product of an extensive collaboration with the University of Salamanca Science Park—was presented at the last edition of the International Wind Energy Conference, HUSUM wind energy.

The aracnóptero Eol6 is a novel, micro UAV (Unmanned Aerial Vehicle) designed to inspect the condition of wind turbine blades. This remotely-piloted aircraft inspects each wind turbine meticulously, photographing all of the irregularities that the turbine could have suffered, with the aim of identifying them for their subsequent repair.

Despite its small size, the aracnóptero is capable of transporting electronic assessment equipment, such as high resolution cameras that provide high-quality, detailed images. This makes it an alternative to traditional methods of rotor blade inspection that involve the use of cranes and highly qualified personnel.

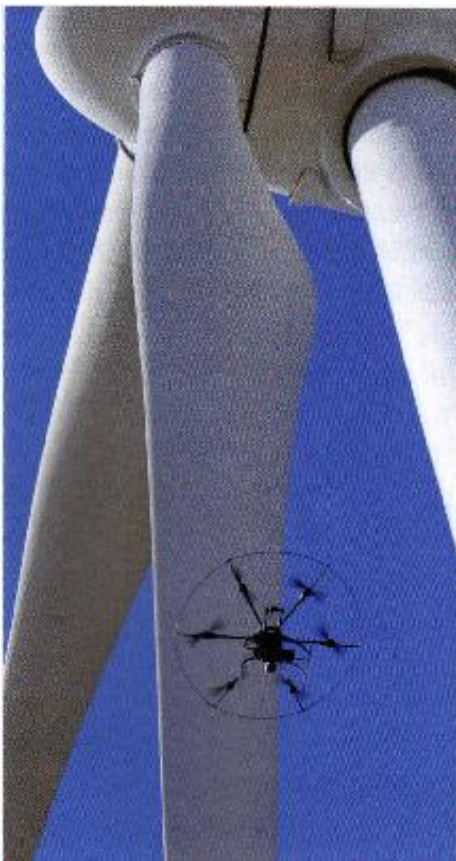
Bernabéu himself shares with EOLUS a flight with the Eol6 so that we can see it in action.

The Present

The dry summer has increased the amount of the typical erosive particles that are transported by the wind, projecting them against the wind farm's rotor blades. Approaching the wind farm is a small SUV, the contents of its boot noisily jumping around as each pothole is crossed on the dusty path. Once they arrive, the routine is simple. The futuristic machine—which was inspired by a science fiction film—is surprisingly light. In barely three minutes, it's been removed from its cushioned, hard-shelled suitcase and unfolded. The protocol gives us the green check-light and, with a slight buzz, its carbon helices propel it at a surprising speed towards the edge of the blade.

It's a pleasant day, but the intense sunlight generates increasing wind currents and significant air turbulence near the rotor. The wind turbine's location on the edge of a slope of a badland formation receives a gust of uneven and increasingly hot air that wears out the blade, accelerating its deterioration. The aircraft hums, compensating for wind changes automatically, hovering above the edge of the blade. The pilot positions the craft easily and delicately. With a slight nudge of the joystick, the robot resumes its graceful vertical rise. Meanwhile, the co-pilot observes the unmoving surface, engrossed by and concentrated on the image that their virtual reality glasses provide. Their head tilts for a few moments, reflecting the turns of the aircraft. It's an interesting spectacle. Their brain interprets the movements of the image, triggering the corresponding muscles to "compensate", just like the aracnocóptero's processor does when the wind attempts to destabilize it.

After inspecting both sides of the



The EOL6, with its new foldable, anti-collision system.



Approaching the blade. Photo taken from the Aracnocóptero.

rotor blade, the aircraft passes unhindered a few metres to the leading edge. Here its ascent is slower, the edge of the blade is key. A few new holes and cracks have appeared. The pilot realizes this on seeing out of the corner of his eye the repetitive movement of the co-pilot's thumb as they press the remote shutter button. Landing and a quick change of batteries while the next blade is placed in position; then, the sequence plays out again. Several wind turbines later, it's been a good and productive day, despite the turbulence at some points of the day. In the office, the software reveals the location of the irregularities. Compared to the last report, new erosion can be detected and only two blades need physical intervention. The necessary reparation is communicated to the specialised team. With the precise information that has been captured, working on the blade will be notably much easier.

The new aircraft, the Aracnocóptero EOL6, is reducing the amount of man hours necessary in physical blade inspection—usually performed with cords and costly cranes—and also the amount of time per person spent of repair tasks. The inspection

volume of each technical team evidently has increased at the same rate as the safety and image quality. The new, 24MP cameras and the capability to capture the image at the right angle provide a clarity that increases the dependability of the diagnosis.

The Origins, April 2008

After nine years of intense work in the development of practical solutions applied to urban pest bird control, the small firm in the University of Salamanca Science Park stands out for its innovative solutions that combine ethology with cutting edge technology. This innovative approach is reflected in the effective results they achieved in the population reduction of the domestic pigeon in Spanish cities, a species which is unsanitary, causes damage to historic sites, and presents public health risks. Nevertheless, there's always a recurring problem in these projects: certain isolated and derelict buildings cannot be adapted to the means of control, given that they are inaccessible to technical teams due to collapse risks.



The EOL6, with its new, foldable, anti-collision system.

Additionally, due to their location in historic preservation zones, the required bureaucratic processes drag out their demolition or rehabilitation. Taking advantage of these caved in roofs, the pigeons make nests that then produce young reproductive pairs that invade terraces, interior patios, and any sort of opening in adjoining properties.

Once the general population of the urban pigeon was reduced to manageable numbers, the need to eliminate these weak points in breeding arose, to really treat the root of the problem. Arbórea launched a research and development team to provide efficient and affordable solutions. An experimental procedure was established to treat birdseed with a hormone inhibitor that affects egg laying, which is supplied to the pigeons by placing it on the deteriorated roofs. This would limit reproductive success, progressively diminishing the number of birds in each group through the high stress of selective capture in the entire environment. Key questions: How to place the treated birdseed atop the roof of a deteriorating building in an exact location, in the historic centre of a densely populated city? And specifically, how do to it with simple and repeatable logistics at a

reasonable cost?

When confronting this challenge more than four years ago, the availability of a VTOL (vertical take-off and landing) aircraft with more than 2 kilos of load capacity on the market was analysed. There was nothing available, for civil purposes, that was efficient, safe and easy to



The author of the EOL6 with Kraus Roland Berg of LM wind power after the successful trail of the EOL6's now, foldable anti-collision protection in Aragón.

use. Although there were military aircrafts available that fit the bill, but they were not permitted for civil uses. Already having experience in taking on technical challenges— in large part due to past projects developed by Arbórea—a group of experts were convened, made up of engineers, members of the air force, and researchers at USAL in artificial intelligence. They determined that developing an aircraft for these uses would be possible. A strong investment allowed for the construction of the first prototype, with a foldable chassis made of titanium alloy and carbon, capable of carrying the payload securely and with stability. Another requirement was that it could be transported, once broken down, in the boot of a normal sized car.

After the first trials, the effectiveness and advantages of the first prototype made its original use secondary to other potential uses. The platform that was created quickly resulted in other more interesting civil and military uses. Simultaneously, Spanish Public Administration, the principal clients of Arbórea's services for 16 years, began to show signs of a worrying and growing insolvency. Something could be felt in the air and it wasn't good.

PARADIGM SHIFT

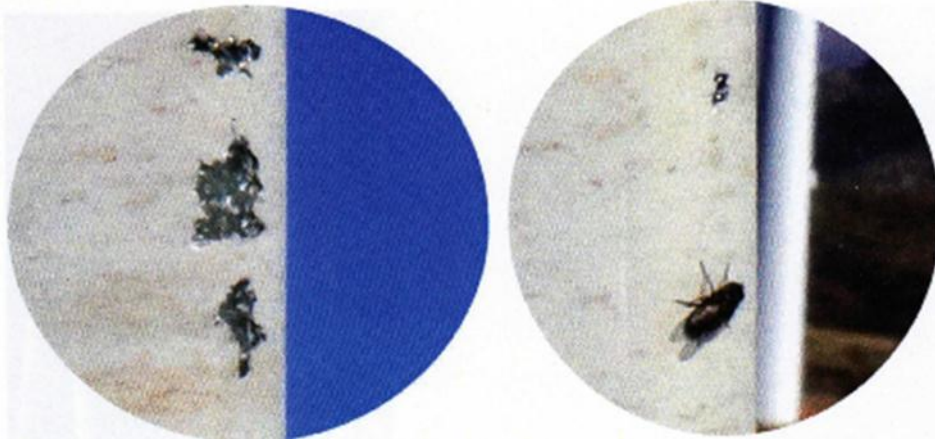
If we compare a stable economic environment with a mature, natural ecosystem, large companies would be the equivalent of a highly evolved species whose genes have been adapted to take advantage of very concrete niches, improving with time and becoming highly efficient in a fixed environment. These species have developed specializations, such as complex physical structures, conduct patterns, physiological mechanisms and reproductive strategies. This equals to investments in their infrastructure and team: a staff increase, investment programs, distribution networks...nevertheless, on occasion, the systems destabilize, sometimes in a rapid and dramatic way, leading to

drastic changes. The changes force out those that are excessively specialised, whose genes have sacrificed adaptation potential in favour of greater efficiency and success. There's no going back. On repeated occasions, these disturbances have left their mark on the earth's fossil records by way of massive extinctions: the impact of large meteorites, extreme volcanism, or the humanization of ecosystems have been and are confirmed causes. In the economic environment, a sudden situation of severe recession is the equivalent of a climatic catastrophe in the natural world. The large specialised corporations are being strangled by their investments and expenses while, at the same time, facing the growing absence of contracts and defaults, without the support of financial entities. In an abruptly



Leading edge damage, in detail, photographed by the EOL6.

An advertisement for aracnoptero and EOL6. The background is a close-up of a white wind turbine nacelle. A small black drone is mounted on a horizontal component of the turbine. The aracnoptero logo, featuring a stylized spider, is positioned above the text 'aracnoptero' in yellow and black. To the right is the EOL6 logo, with 'EOL' in black and '6' in yellow. At the bottom left, the website address 'www.aracnoptero.com' is displayed in yellow and black text.



Enlarged details show a fly and damages in millimetres of the gel coat that leave exposed the underlying glass fibre. Certain species of flies approach the leading edge, possibly attracted by a concentration of animal protein that is accumulated as a consequence of the continuous impact of insects. (Author's note)

changed ecosystem, there comes a moment for non-specialised species, those whose genes have banked on the exploitation of diverse resources. Those that can eat, hunt, or collect a variety of nourishment and also resist a wide range of temperatures. Normally, those also equipped with social strategies and the ability to impart this instinctive and cultural exploration type conduct—let's call it curiosity. This is the case of birds, such as Starlings or Crows, rodents such as some species of mice, primates such as man, and insects like the ant.

The equivalent in the economic environment could be SMEs with little investment in infrastructure and a definitive capacity of keeping

things in check so that they can adapt according to the demands of new market scenarios.

In this new environment, the incipient Aracnocóptero platform is presented and received with great interest at the NATO symposium. It provides a work system and intelligent swarm patterns based on learning and communication protocols of Starlings. The stability of the aircraft—built with carbon fibre and titanium— and its control interface through a military tablet impress the international delegates. The aracnocóptero is moving away from its origins; beginning as a work tool envisioned to cover the necessities of Arbórea's specific projects, developed for Public

Administrations, it has now started its course as a more versatile product. A business strategy in a new context that requires internationalization. A fantastic entrance to the beginning of the age of UAVs (Unmanned Aerial Vehicles), produced in Spain, and backed by extensive business experience in technical solutions that they have behind them. The reach of the product in related fields is immense and the first steps towards the market—deciding which sector to orient its first commercial model to— have been analysed carefully.



EOL 6

In a fortuitous meeting with leadership in Altertec, Enerpal Group, they meet the Aracnocóptero. Experts in wind energy maintenance product development, in many ways unrepresentative of the status quo and sustained by ingenuity and creativity, realize quickly the potential of the platform for its sector. The meeting is positive. Arbórea strongly believes in a research and development approach in hardware and software development specifically oriented to the wind energy sector, believing in Altertec's demands. Some months later, the first commercial Aracnocóptero launches in this sector. The EOL6, designed for the wind turbine blade inspection, is



First prototype of Aracnocóptero with foldable chassis made of titanium and carbon fibre.



already a reality. The international wind fair HUSUM (18th-22nd of September 2012) enthusiastically welcomes the EOL6 in the Altertec booth with the unveiling of units and special adaptations for the Wind Energy sector, created by Arbórea. With several hundreds of inspections already commissioned, the EOL6 is defined, and in such a short period of time, as an efficient alternative to ground inspections. That's only the beginning. The Aracocóptero will fly around Wind Turbines all over the world and in the upcoming months and many innovative surprises will be unveiled, such as new features in the hardware and the software. The marine version, offshore, is still rehearsing...but that will be a whole different story.

Carlos Bernabéu González
Director of Arbórea

[Link to original story](#) (Spanish)