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UST 32 : JUNE/JULY 2020

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UK £15, USA $30, EUROPE €22

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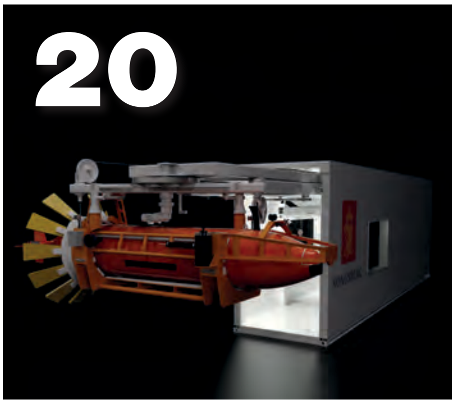
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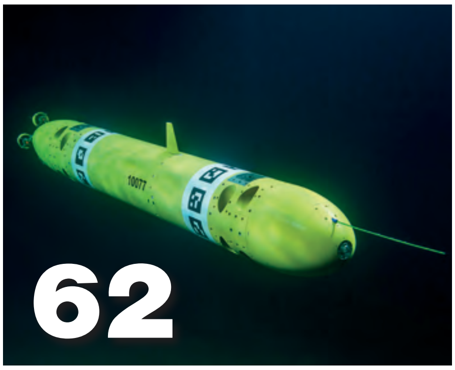
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Connecting, developing, sourcing, solving

In these challenging times we're all facing, innovation continues regardless, perhaps none more so than in the unmanned sector. The engineers who serve the industry continue to deliver with unrivalled imagination and speed. To help accelerate this process further we're delighted to announce the launch of our Unmanned Systems Engineering (USE) Network.

Over the past six years we've worked tirelessly to build this magazine into a trusted, independent, communications hub for the world of unmanned systems engineering. The USE Network is a natural next step, and consists of technical consultants, scientific researchers and engineering firms, who are all on hand to solve the challenges with designing, manufacturing and operating unmanned vehicles, and the systems that support them.

The USE Network philosophy is based entirely on teamwork. It will provide unmanned enterprises with the technical support and connections they need to implement efficient and sustainable technological solutions.

Take for example two of the companies featured in this issue. First, UAV Works with its VALAQ family of UAVs (page 24) is looking to build a completely 3D-printed alternative to its current platform, as well as further developing the auxiliary electronics and choosing a definitive data link system.

Meanwhile MARIN (page 62) is looking for improvements in its modular AUVs' endurance in order to move to sea trials, which will require a rethink of their current power system.

Does either company need to work alone in determining the best solutions to match their requirements? The answer is no! The USE Network has been developed to help further understand the specifics of the technical challenges that members of this community want to overcome, and to help find the best solutions provider for each task.

By sending a technical enquiry to the USE Network you will have unrivalled access to problem-solvers. Every enquiry is treated with the same due diligence, whether it is sourcing a relevant component or helping you find technical partners for an unmanned systems project.

There is no cost, no commitment, no small print. Access to the USE Network is free of charge. Just send any technical enquiries that you need assistance with or clarification on, or an alternative viewpoint, to **thenetwork@unmannedsystemsengineering.com** and we'll take on the task of helping. All enquiries will be treated as strictly confidential and your contact information will be protected.

We look forward to hearing from you.

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UNMANNED systems TECHNOLOGY
Critical intelligence for land, sea and aerospace engineers

Volume Six | Issue Four
June/July 2020

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Tel: +44 (0)1934 713957
www.highpowermedia.com

ISSN 2056-9823
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ALSO FROM HPM

Sitting pretty

Peter Donaldson reports on how this tail-sitter marries vertical take-off and landing with fixed-wing range and speed

Combining VTOL capability with long range, endurance and high speed is a perennial challenge in aerospace engineering and, unencumbered by human occupants, UAVs give designers a degree of freedom to explore configurations that are unavailable with manned aircraft. Spanish company UAV Works' founder David Ortiz wanted to build a VTOL aircraft with these attributes but free of the mechanical complexities and inefficiencies of helicopters, tilt rotors and machines with separate propulsion systems for VTOL and cruising flight.

The concept he chose to explore for what has become the VALAQ family was a vehicle with a flying-wing planform and a trapezoidal quadcopter propeller configuration that would take off vertically from a tail-sitting position, transition to horizontal flight to conduct most of its mission and transition back for a vertical landing.

This eliminates the need for rotor tilting mechanisms or vertically mounted motors and propellers, which are used only for the take-off and landing portions of the mission and contribute nothing but extra weight and drag for the rest of a flight. However, controlling a vehicle without these between vertical and horizontal flight isn't easy.

Assessing the competition

Business development manager Yago Osset notes that many types of UAVs are operated in the types of missions for which

The VALAQ 120 ready to launch, sitting on its three-point landing gear. The two elevons, one on each wing, are the only moving control surfaces (Images courtesy of UAV Works)

the VALAQ family has been designed and that, in the end, technology and innovation for their own sake matter far less than whether the vehicle does the job well.

"For example, we see many local police using small multi-rotors with simple video cameras for ground surveillance or traffic control," he says. "That can help if you want to inspect a small piece of ground for 10 minutes, say.

"Those UAVs are not made for tracking a car, surveying large areas or staying in the air for more than 30 minutes, though. When we show them what the VALAQ can do – multiplying flight time by three, flight within a 5 km radius, transmitting live thermal video and automatically tracking moving vehicles, all while retaining VTOL capability – they feel the limitations of what they have and want more."

However, he gives respectful nods to Wingtra in Switzerland and Swift Engineering in the US, whose respective Wingtra One and Swift021 also use the VTOL flying wing concept. "They have different MTOWs and payloads, but they have definitely found a solution to manage the transition," he says. "This is the cleanest configuration, with no complex parts to maintain.

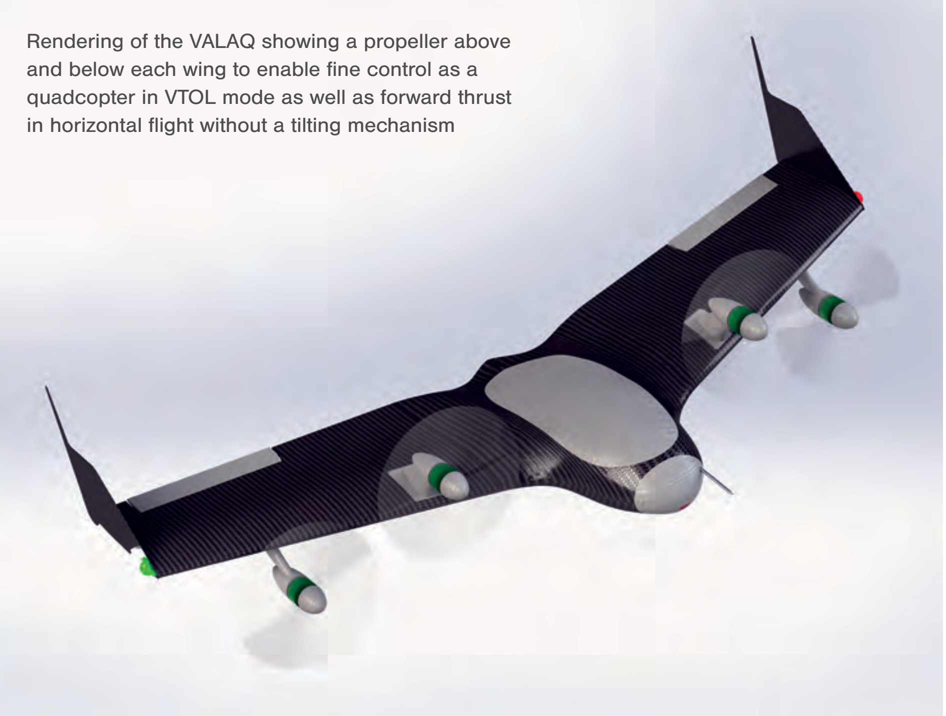
"Many other manufacturers have opted for tilting the engines. It is the second-best solution as it keeps the aerodynamics clean, but there are mechanical parts to be maintained.

"If something can break, it will, so the best choice is usually to omit it. However, some parts are reasonably robust, although maintenance is always needed."

The rest, he says, are the multi-rotor/aeroplane fusions. "This is the quickest way to find a solution, but it's not efficient at all," he adds. Although development is inexpensive, requires little investment, and all the technology is known, permanent drag from the added rotors makes such fusions unsuitable for the purpose, he says.

He says the VALAQ's automated transition from a hover to aeroplane mode and back under reliable control is its principal innovation, emphasising that it will scale up to much larger vehicles while retaining the system's essential simplicity and aerodynamic efficiency.

He also points to the simple and "absolutely reliable" retractable and dynamic landing gear, which he says proved a key part of solving the


Rendering of the VALAQ showing a propeller above and below each wing to enable fine control as a quadcopter in VTOL mode as well as forward thrust in horizontal flight without a tilting mechanism

problem of landing in gusty winds. "Another key might be the inclusion of 4G comms as standard to serve as a second comms link and extend operational range," he says.

Deep understanding

The main challenges in the VALAQ's development lay in achieving a deep understanding of its aerodynamics – the polar plot that shows the relationship between the coefficients of lift and drag in particular. In addition, the multi-copter propulsion systems, controls, aircraft physics and performance and their mutual interactions had to be understood and embodied in the autopilot software.

In refining the airframe's structure, its strength and weight had to be optimised. Along with the stiffness needed to eliminate a vibration problem, that led to a switch from a solid foam-cored structure to an all-carbon fibre airframe.

Another necessary trade-off was the time spent in vertical flight and overall range and endurance. That meant the autopilot's programming had to ensure that the transition to forward flight would be as fast as possible while remaining stable and safe.

Developing the software for the autopilot was the principal task facing Ortiz as, during 2014, he thought through the idea for a novel UAV that would be the subject of his final project for his masters in aerospace vehicles course.

He knew he could use his aeromodelling skills to build a proof-of-concept vehicle, but he also knew he needed a partner to help with the software, so he teamed up with fellow student Salva Puig to pursue the project. Puig was working towards his masters in propulsion systems.

The two began to study programming in the C and C++ languages, and within three months they had gained enough knowledge of them to understand how to program the autopilot. At the time, Multiwii was the most accessible software, so they adapted it to create the code they needed to control the transition process.

Building and flying this proof-of-concept vehicle successfully earned Ortiz and Puig a good grade in their final thesis, bagged them the best project in the helicopters section of an Airbus-sponsored engineering award and sowed the seeds of further development.

They built a second prototype in 2015, logging a lot of flight data that they used to improve the autopilot code. During flight tests with this second vehicle, which had a slightly smaller wingspan than the first, they encountered vibrations that caused major control problems, prompting the switch to a stressed skin monocoque made from carbon fibre reinforced plastic (CFRP) for the vehicle's next iteration.

Flight control development

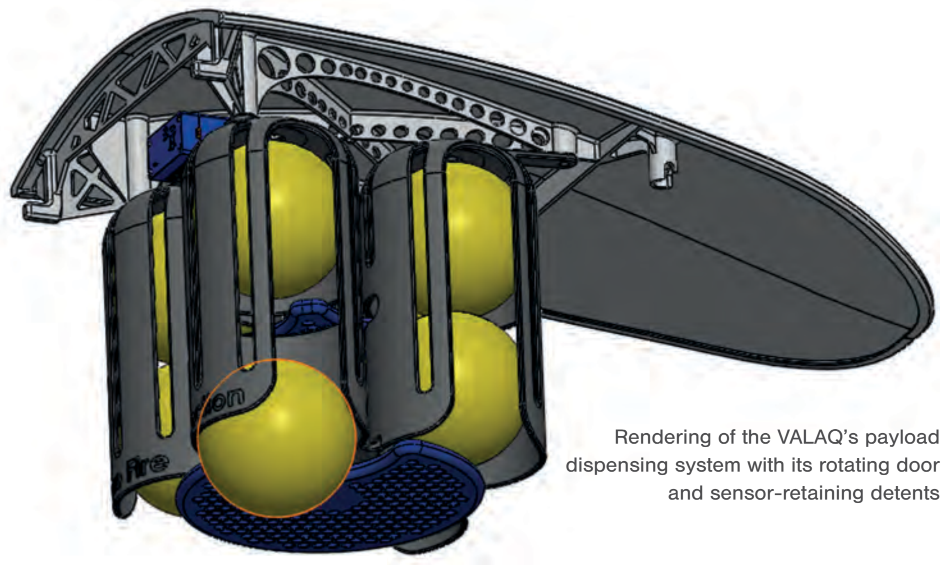
While early autopilot development work was centred on the Multiwii system, the current autopilot is built on the Pixhawk Cube architecture by Hex Technology, and the software is a PX4 flight stack customised by UAV Works. It commands the motor controllers and the elevons, the latter through open-loop digital metal-gear slim servos to which they are directly attached, and which serve as the hinge at one end of each control surface.

During the development process, the way in which the transition between vertical and horizontal flight is managed has changed. On the first prototype, the method was to accelerate vertically until the airspeed exceeded the wing's stall speed, at which point the multi-copter control system was switched off and, using the elevons alone, the aircraft was pitched forward into horizontal flight.

"This was very inefficient, but because the whole flight envelope was not yet understood it was the safest approach," Ortiz explains.

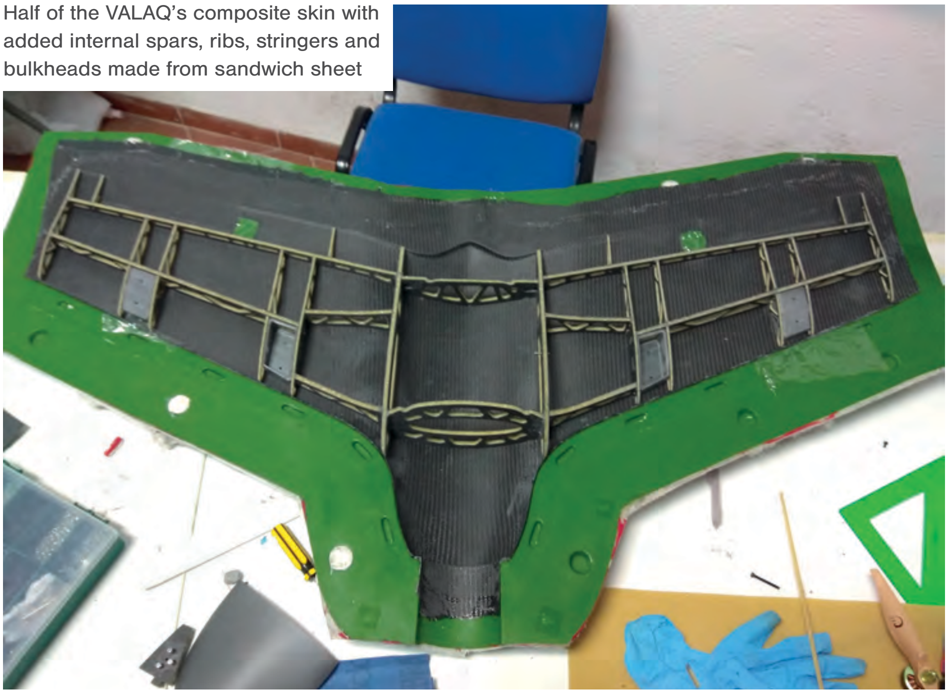
Subsequently, he says, the company worked to improve the efficiency of the transition progressively using the second and third prototypes before arriving at what they regard as the best method.

These days the aircraft is capable of stable flight at all speeds up to 120 kph, so the control strategy is to make the transition by increasing forward speed while holding a constant altitude, using a combination of propeller thrust and elevons, then using the elevons when above the (theoretical) stall speed of the wing to pitch the vehicle over into horizontal flight.



Rendering of the VALAQ's payload dispensing system with its rotating door and sensor-retaining detents

Half of the VALAQ's composite skin with added internal spars, ribs, stringers and bulkheads made from sandwich sheet



Managing transitional flight was one of the hardest aspects of the development programme, Ortiz recalls. "It was a very tough challenge at the beginning when we coded the transitions on top of the Multiwii flight stack," he says. "You need a deep understanding of aerodynamics, coding and control. We worked with the PX4 developers to improve the transitions into the main stack."

The autopilot takes advantage of all the redundancy built into the Cube architecture in terms of navigation electronics, while UAV Works' own power management electronics duplicate as many supply paths as possible. They also isolate payload signals from the autopilot to avoid a major failure in the former leading to a consequent failure in the latter.

"With enough altitude, a motor failure in any flight mode can be managed by putting the aircraft into a controlled glide down to a belly landing," says Ortiz.

The VALAQ 120

It is the third prototype on which the current VALAQ 120 is based, although the 120 is 10% larger with an MTOW of 4 kg, a payload of 800 g, a range of up to 70 km and a flight time of at least 40 minutes with the maximum payload.

While the combination of VTOL with long range and endurance is the VALAQ's main USP, it also exhibits very good behaviour in rough winds, says Osset, and is particularly stable in landing. Low maintenance costs, quietness and ease of use are also plus points, he adds.

Osset also says that, in terms of maturity, the aircraft has reached Technology Readiness Level 9 and is ready to go into service with customers. The company will shortly be ready to begin series production of the surveillance and security version, known as the VALAQ Patrol, which is equipped with NextVision's Colibri 2 stabilised electro-optical turret. Mapping and package delivery configurations as well as larger versions are also in the pipeline.

While small, delta-winged UAVs are common, closer examination of the VALAQ reveals some unusual details of its configuration. In planform, it is not a pure delta as the trailing edges are swept and run out to substantial winglets that as well as being aerodynamic surfaces also support the landing gear. The only other movable aerodynamic control surfaces are the elevons, one on the trailing edge of each wing.

Trapezoidal quadcopter

The propulsion system is also remarkable. It consists of two pairs of electric motor/propeller combinations in pods that, instead of being integrated into the leading edges of the wings, are mounted on pylons, the inner pair above the wing and the outer pair below – or ahead of the wing and behind it if the vehicle is in a vertical attitude. It is this arrangement that makes it a trapezoidal quadcopter for take-off and landing.

This combination of a flying wing and trapezoidal propeller arrangement, Ortiz explains, produces the best synergy between the multi-copter propulsion system and wing aerodynamics, maximising the wing's efficiency and control effectiveness throughout the flight envelope.

One of the principal benefits is that the wing is practically immune to stalling, because the propellers always provide it with an energised airflow, which also ensures that the elevons remain effective down to very low forward speeds. Ortiz says the aircraft remains controllable down to 40 kph without the use of differential thrust.

Also, with the underside of the airframe clear of obstructions such as landing gear, sensors under the nose and belly have a clear view through almost 360º.

The difficulties that the configuration presents include complexity of control. That is partly because the aerodynamic interactions between the propellers and the wing make the latter hard to tune, and partly due to structural complexity that stems from the way the thrust loads from the propellers are fed into the wing through the mounting pylons.

The most difficult aspect to get right, Ortiz says, was determining the proper relationship between the positions of the propellers and their effects on the performance of the wing and the elevons.

The aerofoils are all of UAV Works' own design and were developed using its own design software and wind tunnel testing.

Structure and materials

The VALAQ's fuselage, wings and tail surfaces are all moulded from carbon fibre reinforced epoxy resin. Ortiz describes it as a conventional aerospace structure with spars, ribs, bulkheads and a stressed skin bonded with epoxy adhesive.

The VALAQ can be described as a blended wing-body design. The wings consist of 10 structural parts, each including the skin's spars and ribs. The fuselage is integral with the wing structure, to which it is connected by a pair of internal bulkheads, the configuration of which varies between versions to accommodate different payloads.

The aircraft's entire skin is a single piece, while the internal structural components slot together using a

The motor pylons are 3D printed, with brushless DC motors and two-bladed fixed-pitch propellers. Flow from the props over the wing eliminates stalling

Specifications

VALAQ 120

Maximum take-off weight: 4 kg
Payload: 800 g
Wingspan: 1212 mm
Length: 705 mm including gimbal
Maximum speed: 120 kph
Maximum altitude: 4500 m for take-off and landing (theoretical)
Range: 70 km
Video & telemetry link range: 15 km
Endurance: more than 40 minutes with maximum payload
Power plant: lithium-ion and lithium-polymer batteries driving four electric motors

Some key suppliers
Batteries: Sanyo
Motors: BrotherHobby
Motor controllers: DALRC
Propellers: Xoar
Servos: Shantou Jianxian Electronic Technology
GNSS/inertial navigation sensors: Drotek
Ground control station: in-house
Stabilised cameras: NextVision
CAD/CAM software: Solidworks, KiCad
Video & telemetry link: Suntor

tongue-and-groove system and are fixed in place with adhesives from 3M's Scotch Weld range. Small bolts hold the winglets on, and these screw into nuts bonded into the CFRP structure. Other small nuts and bolts secure internal components, with nuts bonded into sandwich structures and press-nuts installed in solid sheets.

The large winglets incorporate two fixed landing gear struts, while a third deployable strut is mounted on the fuselage and extended by an actuator during the approach to landing, cued by a ground detection algorithm. "Landing in high winds, with low motor rpm and close to a 45° pitch forward requires an algorithm to detect the shock of ground contact," Ortiz explains.

The landing gear and the entire structure are designed to be robust enough to shrug off the landing loads, which can be as high as 8 *g*, he adds.

These days, a few components – including the pylons on which the motors are mounted, some internal support structure and enclosures, and the removable panels that provide access to components – are additively manufactured using the synthetic laser sintering method of 3D printing. However, UAV Works is keen to investigate replacing this conventional structure with a completely 3D-printed alternative, which it believes will allow an even higher strength-to-weight ratio and improve the production process.

Propulsion and power

The company turned to Chinese UAV motor design and manufacturing giant BrotherHobby for custom-built brushless DC motors for the VALAQ family, and to Xoar in the USA for the two-bladed, fixed-pitch propellers. UAV Works' development process addressed the motors and propellers together, using a test bench and a wind tunnel to refine their configurations, with Xoar's expertise helping it to optimise the diameter, twist and pitch for this demanding application.

"After many tests we found the most efficient tandem using the chosen brands, but this changes every six months so we always have to be testing new products to get the best configuration at all times," Ortiz explains.

While the VALAQ uses the same motors and propellers for VTOL and horizontal flight, it uses different batteries for them: a lithium-polymer battery powers the motors during vertical flight, and a lithium-ion unit takes over in aircraft mode.

Lithium-polymer batteries are better suited to the kind of short-duration, high-power operation needed for VTOL operations, because they can deliver higher currents in relation to their size and weight than lithium-ion ones, even though the latter have higher energy densities overall. Lithium-ion's higher energy density is exploited in horizontal flight to maximise the range and endurance, as this flight mode does not require as much power from the motors.

UAV Works designed its own power regulation and safety electronics board,

The VALAQ 120's payload dispenser in the aircraft's belly was loaded with golf balls as test substitutes for the forest fire re-ignition sensors tried out in the Ethon firefighting project

fitting it with regulators made mostly by Traco and Mean Well, and sourced from Digikey, RS-Online and Mouser. A key safety feature is the complete isolation of the payload from the autopilot, as mentioned, to avoid an electrical failure in the former affecting the latter.

Most of the electrical wiring and connectors come from Molex, which supplies custom-made harnesses, combined with in-house harnesses for a few critical parts, says Ortiz, in particular the high-power harnesses that connect the batteries to the electronic speed controllers.

Navigation, comms & control

The multi-sensor navigation system integrates a GPS/INS module, a digital magnetic compass under the skin at the nose and a barometric pressure sensor in the avionics bay. While standard GPS accuracy is adequate for the VALAQ Patrol version's requirements, the company also offers a real-time kinematic system for applications that require centimetric accuracy.

The comms system for command and control, telemetry and payload data is still taking shape, as the company is testing a number of systems to determine the best combination of range and reliability in various locations and situations,

Ortiz explains, although a 4G system will be part of what the final system becomes. However, the vehicle uses the MAVLink protocol that was designed primarily for communicating between ground stations and small UAVs.

The VALAQ's flight is completely automatic once programmed and can be managed from an Android tablet or a PC running Linux; there is an optional joystick for manual control.

Also, Ortiz says, the 4G installation enables monitoring and control of the vehicle from another base station located anywhere and with a 4G link. The comms hardware aboard the aircraft includes dipole antennas and an associated printed circuit board.

The mission management software is a custom version of QgroundControl, which runs on Windows, macOS, Linux, iOS and Android, and also supports multiple autopilots including PX4 Pro and ArduPilot as well as any vehicle that communicates using MAVLink.

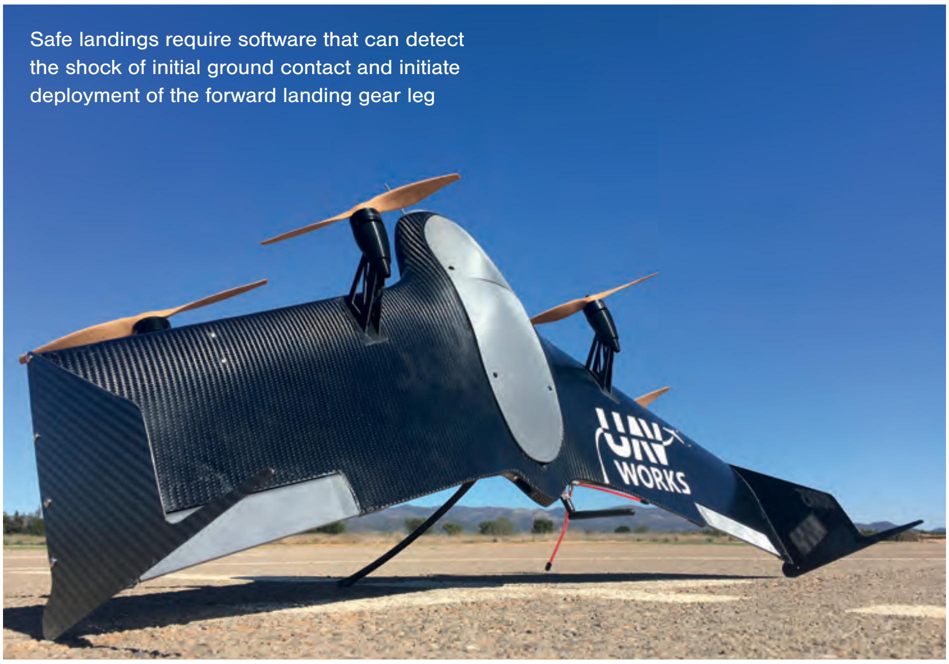
Key features include mission planning for autonomous flight, a map display showing the vehicle's position, track, waypoints and instrument readouts, plus video streaming with instrument display overlays. It also supports management of multiple UAVs.

Payloads and integration

Data and power support for payloads include MAVLink, pulse width modulation and Ethernet interfaces, plus 5 and 12 V electrical sockets rated at up to 20 W each.

In addition to NextVision's Colibri 2, payloads integrated so far include FLIR Systems' Vue Pro thermal camera and a custom sensor deployment system. Weighing 180 g and measuring 50 mm in diameter and 81 mm tall, the Colibri 2 is a stabilised turret housing an infrared sensor and a daylight electro-optical camera. The system also has a 20x optical zoom lens with an additional 2x electronic zoom that brings the total magnification capability to 40x.

The imaging IR sensor is a 640 x 480 element focal plane array. The system



Safe landings require software that can detect the shock of initial ground contact and initiate deployment of the forward landing gear leg

is designed to provide images sharp enough to read vehicle number plates and recognise faces, says NextVision. The turret provides a field of regard (the field of view of the sensors plus the angle through which they can move) of +45/-90° in pitch and ±180° in roll.

The FLIR Vue Pro is a thermal camera, a thermal measurement instrument and a recorder in one that measures 2.26 x 1.75 in with the lens and weighs between 3.25 and 4 oz, depending on the configuration. Its core sensor is an uncooled vanadium oxide microbolometer.

The payload dispenser is essentially a removable magazine that can hold up to eight golf ball-sized sensors that can be dropped into a forest fire, for example, to provide data from selected points over an extended period. They can be dropped one at a time on pre-programmed waypoints and controlled through the kind of software that can trigger a stills camera, Ortiz explains.

The VALAQ 120 used the combination of the FLIR Vue Pro and the sensor dispenser in a firefighting demonstration in Spain known as project Ethon. It was a cooperative effort that involved the Valencian Innovation Agency, the Valencian Polytechnic University, smart technologies and comms house ETRA and firefighting technology specialist Pyro as well as UAV Works.

The Ethon project's goal was to develop a firefighting information management system for use in advanced command posts. The idea is to help firefighters to make decisions based on real-time thermal surface scanning and key indicative data from the sensors dropped by the UAV to create a map of hotspots from which a fire might reignite after being extinguished.

Ortiz reports that the payload dispensing system was the most challenging to integrate, as sensor deployment affects the aerodynamics and changes the vehicle's weight in flight by about 500 g, but it is a critical capability. "Having a cargo bay available on the aircraft's centre of gravity was truly a go/no-go feature," he emphasises.

Flight testing

To date, the flight test programme has logged almost 500 hours on all the development aircraft. Five prototypes were built through the programme as a whole, the first three being very different and the last two very similar, with some slight differences incorporated to test different payload configurations.

Next Vision's Colibri 2 stabilised sensor turret, integrated into the VALAQ 120, packs IR and day TV cameras with a 40x zoom capability into a 180 g package

This sequence of images has been combined to show the trajectory of a golf ball fire sensor substitute being deployed during trials as part of the Ethon project

Once UAV Works had arrived at the final structural design with the third prototype, there were three main test points to validate, Ortiz explains.

The first was focused on the landing process that would allow the aircraft to cope with rough, gusty winds – an essential element of which is the landing gear's ability to control its position automatically.

The second was to make transitions to and from vertical and horizontal flight more efficient, as described above. The third was to demonstrate the robustness of the airframe, calculate its service life and determine when maintenance should be carried out on the few moving parts.

Of these test points, those associated with achieving safe landings in all conditions were the most challenging, Ortiz says, adding that ensuring full control and operation of the gimbal and its integration into the system were also critical.

He says there are many lessons to be learned when designing things from scratch, and highlights three of them.

The first, he says, is to be prepared to crash. "When you are finding the limits of your platform, even if you try to have as much as you can under control, there will be events you have not thought about," he says. "For example, we found that the system can reach 10 *g* for a few seconds and still be capable of landing in a gliding trajectory."

The second lesson is that investing in extra planning and preparation yields better test results. "Errors are minimised and solutions to identified problems are found sooner," he explains.

Lastly, he stresses, experiencing the limits – and sometimes overstepping them – is what makes the platform safe.

The main changes to the vehicle that were made in the light of the flight test results, he says, involved optimising the motor arrangement and two algorithms – one that controls the transition process and one that detects the ground in the landing process.

In terms of development work still to be done, Ortiz notes, the team needs to address some details of the auxiliary electronics and to make a final choice of data link system. They also want to perform some more flight endurance and maintenance tests.

Manufacturing approach

Much of the manufacturing process is carried out at UAV Works' own facilities, in Valencia, including final assembly, some electronics assembly, composite fabrication, CNC machining and some flight testing.

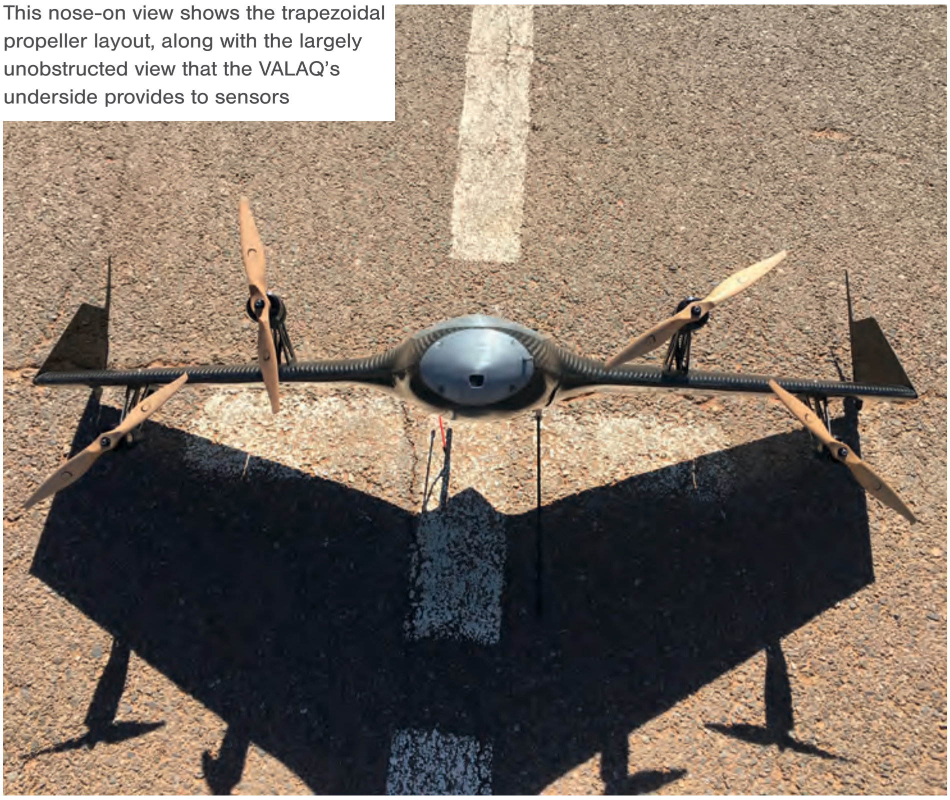
The facility consists of an electronics workshop, an enclosed CNC zone, workbenches dedicated to specific tasks, composite tooling, 3D printers and a general assembly area. Specialist tools include a CNC router and small soldering tools used to attach surface mount devices to printed circuit boards. None of the composite parts require an autoclave.

In preparation for series manufacture, the company has implemented a detailed production plan with key performance indicators and a process control system, and is ready to apply for ISO certification.

Most of the VALAQ's development has been self-funded by business partners and principal inventors Ortiz and Puig, particularly through the construction and testing of the first three prototypes, which took about three years.

In the past year, UAV Works was selected by Business Factory Aero (BFAero) for its acceleration programme. BFAero grew out of a civil UAV initiative from the regional government of Galicia, a

This nose-on view shows the trapezoidal propeller layout, along with the largely unobstructed view that the VALAQ's underside provides to sensors



self-governing region in the north-west of Spain. With support from major industrial companies Indra and Babcock, BFAero fosters the creation and development of innovative companies in the Galician aeronautics and unmanned vehicles industry. To date, around €650,000 has been invested in the VALAQ programme.

Gauging the market

Osset stresses that it is very difficult to measure an emerging market, as reliable market indicators are hard to come by. However, UAV Works did some calculations based on sources of information about public tenders around the world, judging these sources to be reliable because they use quantitative data on governmental and public-sector demand.

Over the first half of 2019, the estimated value of worldwide public tenders for UAV systems, components and specific services related to UAV operations was estimated at $478 million, or nearly $1 bn annually. It is harder to get accurate data on private-sector demand, Osset adds, but says it is estimated that it equals or even exceeds public demand for UAVs costing $6000 or more.

He emphasises that the absolute size of the market is less interesting from UAV Works' point of view than how fast it is growing and how many new applications are emerging – ideas that the company is compiling into what Osset calls an applicability index.

"Many new functionalities will appear in the near future to cover lots of unknown needs," he says. "We ourselves have discovered new markets thanks to being near a specific area or talking to a particular sector expert.

"He or she imagines what a UAV might do and asks: 'Could I do this with yours?' Then you realise that you would never have had that idea if you had not met that expert. This applicability index will definitely help market development."

Ossett says the VALAQ Patrol will be priced at a little less than €35,000 for a fully equipped machine and support equipment, while a cartographic version known as the VALAQ Mapper will be just under €19,000 and a delivery version has an estimated price of €13,000.

Larger VALAQ versions

In terms of future developments, there is more to come in addition to the mapping and package delivery versions of the 120. The company is also in the process of designing a larger version with a 25 kg MTOW, to be known as the VALAQ 360. "Our first calculations show very promising ranges and fight times with a remarkable payload capability," Ortiz says.

Initial performance estimates for the VALAQ 360 include a maximum payload of 10 kg, up to 3 hours of endurance with a 2 kg payload and a range of up to 315 km (170 nautical miles). A maritime version, known as Sea-VALAQ and incorporating the ability to take off from and land on moving vessels, is also proposed.

The VALAQ 360 is also at the centre of a project to combine a 3D-printed airframe and a fuel cell-based power plant in a project supported and coordinated by BFAero.

UAV Works says this will be the first UAV of a specific organic and reticular (net-like) design intended to be largely 3D printed, adding that team member and additive manufacturing house Lupeon is leading this part of the project, with H2 Dron Energy Galicia providing the hydrogen fuel cell technology. The three companies presented the project at a monthly evaluation meeting in November last year under BFAero's first edition programme.

Preliminary analyses show that the UAV built to the VALAQ 360 design using this new technology will achieve an endurance of 5 hours with an 8 kg payload after a vertical take-off using what UAV Works describes as 100% clean energy – a capability that the company believes is unique.

In mechanical terms, the tail-sitting flying wing design is arguably the simplest way to achieve an efficient combination of helicopter-like VTOL capability with fixed-wing range, endurance and speed. Time will tell whether it will prove the most popular. □