



Hydrogen

*Is it the future of
carbon-free
aviation?*

Boosting the aerospace supply chain

*through automotive
innovation*

Maintenance of military drones

*A key challenge
for the Army*

SHAPING THE AERONAUTICS OF TOMORROW

Ramping up production successfully



EDITORIAL

The aerospace industry is going through an exciting and challenging time. Production rates have never been higher, and the expectations of major customers have never been more strategic.

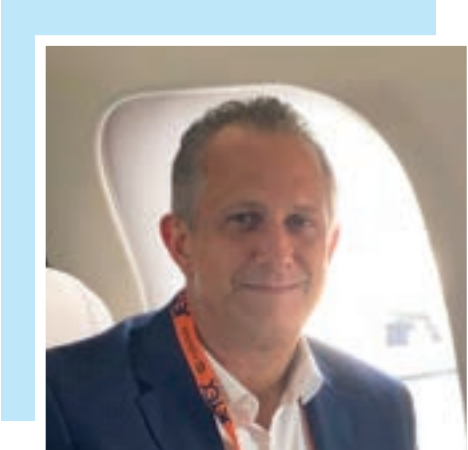
This **ramp-up** is taking place against a backdrop of ageing fleets, which requires quick and effective responses from the entire industry. In this constantly changing environment, SEGULA Technologies is asserting its role as a trusted partner, with a **comprehensive offering** covering all the key business areas in the sector: manufacturing engineering, production services, maintenance, engineering and tooling.

We support our customers as they ramp up production, providing them with agile and robust solutions tailored to their current requirements. Our long-standing relationship with **major players in the aerospace industry** enables us to work closely with them to meet their needs, with recognised expertise in both helicopters and aircraft, in both civil and military environments.

Today, in a world marked by strong geopolitical tensions, aerospace plays a major role in security and sovereignty. At SEGULA, we are supporting this **transformation** by helping our customers make their fleets more available, their operations more fluid and their technologies more reliable, particularly in rapidly evolving fields such as drones and embedded systems.

We are also committed to working alongside our partners in the transition to **greener aviation** by exploring and integrating environmentally friendly technological solutions. Behind every successful project is a committed team. And this is undoubtedly our greatest source of pride: seeing our employees recommend SEGULA to those around them. A third of our recruits are hired through referrals, which is a great testament to the trust and satisfaction they have in us.

The future of the sector will be shaped by new challenges: producing more and better, improving the supply chain, integrating alternative energies and imagining the aeronautical solutions of tomorrow. And we will be there. Welcome to the aeronautical world of SEGULA.



Richard Demoucelle,
Senior Vice President of the
Aerospace Business Line



Cédric Elbaz,
Division Director, France

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TRAIN AND RECRUIT

To support the sector's growth, SEGULA actively trains and recruits people for careers in aeronautics.

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INTERNATIONAL

The aerospace industry is experiencing unprecedented growth. With a presence in over 30 countries, SEGULA acts as an international catalyst.

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ENGINEERING

Aeronautical engineering optimises every stage of an aircraft's life cycle, from design to maintenance, to meet the challenges of today and tomorrow.

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TOOLING

Equipment essential for the smooth running of maintenance, assembly or transport operations.



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PRODUCTION SERVICES

These activities cover all operations related to assembly, finishing, quality control, maintenance and integration of industrial sub-assemblies.

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MAINTENANCE

Faced with the challenges of sustainability, digitalisation and increased traffic, maintenance is reinventing itself, becoming a strategic lever for the aviation industry of tomorrow.

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DEFENCE

The growing demand for defence systems is forcing the aerospace industry to shift gears. SEGULA stands alongside its customers to meet this challenge.

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INNOVATION

New materials, cutting-edge technologies and sustainable solutions are enabling us to rethink the performance, efficiency and environmental impact of aircraft.

SUMMARY



A combination of expertise serving major players in the aerospace industry

SEGULA Technologies now has more than 15,000 employees in over 30 countries. This international presence allows it to work closely with its customers thanks to a strong regional network. By evolving its model towards high value-added services, SEGULA has gradually established itself as a leading technology partner. In the aerospace industry, the group now employs nearly 2,000 people worldwide. SEGULA provides global solutions in product and process engineering, as well as production services for the aerospace, space and defence sectors.

A DIVERSITY OF PROFESSIONS MOBILISED TO SUPPORT THE INCREASE IN PRODUCTION

The aerospace industry is experiencing an unprecedented period of significant increases in production rates. With order books full for the next 10 to 15 years, **SEGULA's objective is clear: to support the industry's ramp-up and deliver on time.**

Airbus currently assembles 57 A320 aircraft per month. This figure is expected to reach 75 by 2027, representing a 33% increase in two years. The A350 is following the same trend: production, currently at six aircraft per month, is expected to double to 12 units by 2028. This is more than the record level achieved before the health crisis.

To meet these needs, SEGULA is strengthening its teams and actively recruiting in all delivery-related professions. This includes production, quality, manufacturing engineering, on-site technical functions, as well as supply chain, industrialisation and MRO (Maintenance, Repair and Overhaul). The most sought-after profiles include **workshop technicians** (fitters, cable installers, boilermakers), **design and calculation engineers**, and **embedded systems specialists**. These are essential skills to support industrial efforts and accompany the sector's ambitions.



↑ Fine deburring and quality control on a stainless steel casing



Checking the flatness of a sheet metal part →



↑ Bending operation on a metal part



BUILDING LOYALTY AND SUPPORTING EMPLOYEES IN THEIR SKILLS DEVELOPMENT

SEGULA's aerospace teams enjoy real stability: most employees have been with the company for more than five years. Turnover is historically low in this sector thanks to an HR policy that promotes internal mobility, skills development and loyalty through a series of concrete initiatives:

- ▶ Certified continuing education programmes (Lean, CATIA, Airbus Process, etc.)
- ▶ A personalised career development plan
- ▶ Internal mobility opportunities between sites or business sectors
- ▶ Mentoring initiatives to support young recruits
- ▶ Committed partnerships, such as with the Elles Bougent association, to promote women's careers in engineering

Finally, at SEGULA, one third of recruitment is done through co-optation. This is a strong sign of commitment, which demonstrates the

confidence of our employees, many of whom recommend their company to their friends and family.

Hugo's career path

Hugo's career path is a great example of the opportunities for growth at SEGULA. He joined us in March 2021 as a helicopter maintenance technician in Vitrolles (Southern France) and quickly took on more responsibilities. After a secondment to the military base in Pau with the MRO teams, he joined the production teams in Toulouse in 2023 as team leader for Airbus. He is now operations manager for ATR, where he oversees the complete integration of cabins. His career path demonstrates the diversity of the roles on offer and the trust placed in employees to develop within the group.



RECRUIT AND TRAIN NEW TALENT

To anticipate tomorrow's needs and meet the challenges facing the sector, SEGULA mobilises all available resources (partnerships, training, events) to attract, train and retain the best talent.

Operational Employment Preparation Scheme

For several years, SEGULA has been relying on the "Operational Employment Preparation programme": a pre-employment training course set up to address recruitment pressures in technical professions. This long-standing partnership enables job seekers to be trained, in conjunction with certified organisations, in aerospace manufacturing professions (particularly for positions such as fitter-adjuster, cable installer and quality inspectors) with a view to securing permanent employment with SEGULA. Thanks to this programme, more than 20 such training courses have been organised. This has enabled the training and recruitment of around 50 people, who are now SEGULA employees.

- Dounia's career path
- Dounia benefited from this programme with training as a Quality Inspector in 2022 before being hired for this position.
- She has been developing her skills ever since.

Partnerships with leading universities

SEGULA maintains strong relationships with local schools, particularly vocational high schools and technical colleges. Thanks to these partnerships, the group recruits many talented individuals each year for internships or work-study

programmes, which often lead to permanent contracts with SEGULA. **The group is also present in engineering schools to present its professions through several initiatives:**

- ▶ Internship and work-study programmes
- ▶ Professional presentations in classrooms or at forums
- ▶ Educational projects supervised by engineers

All of these measures help to nurture a pool of talent, identify future employees as soon as they complete their training, and promote SEGULA's expertise among young people.

The group's international yet local structure allows employees to flourish within small teams while benefiting from opportunities in more than 30 countries around the world.

Other initiatives are implemented throughout the year, such as participation in numerous recruitment forums and trade shows and the organisation of job dating events (SEGULA Days).

THE MAJOR CAREERS IN AERONAUTICS

'What drives me every day is achieving the goals set by the customer while ensuring quality.'
Hugo, Activities Manager



'The internal training courses at SEGULA have helped me greatly in successfully completing my projects.'
Lamyae, Crash Calculation and Rapid Dynamics Engineer



'SEGULA offered me rich and varied assignments with a gradual increase in skills.'
Eric, Project Leader



'Joining SEGULA means enjoying all the benefits of an international group with large-scale projects and real opportunities for advancement.'
Cédric, Division Director

At SEGULA Technologies, the aeronautics sector encompasses a wide range of professions, divided between technical functions (production, industrialisation, maintenance) and expertise and management roles (engineering, project management, R&D).

Structural engineer, systems engineer, project manager, methods/industrialisation technician, aeronautical fitter-adjuster, quality technician, FAI quality inspector, manufacturing engineer... Many professions contribute to the daily life of SEGULA's aeronautics department.

5 reasons to join SEGULA:

- ▶ A variety of assignments with a strong technical focus
- ▶ Integration into major projects in the aviation industry
- ▶ Opportunities for rapid advancement
- ▶ A multicultural and innovative environment
- ▶ Personalised career paths and close managerial support

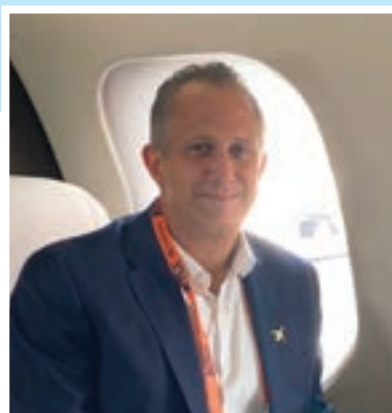
To discover other profiles and all of our job offers, please visit:
▶ careers.segulatechnologies.com

'At SEGULA, we can provide technical skills through training. What we are looking for above all are human qualities, with creative, curious profiles, eager to learn and excel on innovative and stimulating projects. Our motto is clear: Let's shape the future together. So join us!'

Arnaud Longuefosse, Vice President, Strategy and Business Development

'SEGULA is not content to simply support the transformation of the aerospace industry: it is one of its driving forces. Thanks to its international network, the agility of its teams and its capacity for innovation, the group is rising to the major industrial and technological challenges of tomorrow, for a more sustainable, more efficient and smarter aviation industry: inventing the aerospace industry of tomorrow is already SEGULA's present.'

Richard Demoucelle,
Senior Vice President of the
Aerospace Business Line



Developing the aeronautics of tomorrow, a GLOBAL project

The aerospace industry is currently at a turning point, with unprecedented growth in global demand, both civil and military, and increasingly complex industrial challenges linked, among other things, to the ambition of carbon neutrality for the new generation of aircraft. With a presence in more than 30 countries, SEGULA Technologies acts as an international catalyst in this profound transformation, accelerating the entire value chain: from design to production, including technical support and maintenance.



INCREASING PRODUCTION: A GLOBAL CHALLENGE

The aerospace industry is experiencing unprecedented growth. Major contractors are aiming for production rates never before achieved, putting pressure on the entire supply chain, industrial performance and human resources.

'It is precisely in these areas, supply chain, operational efficiency and skills management, that SEGULA makes the difference,' emphasises Richard Demoucelle, Vice President Aerospace at SEGULA.

Drawing on its long-standing industrial expertise in **France**, SEGULA now has nearly 2,000 employees working alongside major names such as Airbus, Dassault, Safran and Thales. This territorial network, combined with multi-sector expertise (automotive, energy, defence), constitutes a unique

competitive advantage to support the acceleration of the sector.

A GLOBAL FOOTHOLD AT THE SERVICE OF INNOVATION

Beyond its French roots, SEGULA is pursuing ambitious expansion in **North America**, **Africa** and **Europe** (**Spain**, **Italy** and **Germany**), while preparing for development in the **Middle East** and **Asia**. The launch of projects in **Dubai**, in particular, demonstrates a desire to establish a foothold in high-potential areas.

In just two years, the group has opened around 15 new sites, enabling it to combine cutting-edge expertise in supply chain management, industrial engineering and emerging technologies (hydrogen, batteries, electrification).

'Our strength lies in our ability to establish ourselves as close as possible

to our customers, wherever they are in the world, to support large-scale projects by drawing on the best of our expertise.'

Arnaud Longuefosse,
Vice President, Strategy
and Business Development



ACCELERATED GROWTH IN NORTH AMERICA

SEGULA is experiencing rapid growth in North America, particularly in **Canada** and the **United States**, with players such as Airbus, Boeing, Spirit and Bombardier. The country is also home to many high-level direct subcontractors (Safran, RTX). These companies work directly with major aircraft manufacturers, supplying components or systems that are integrated into aircraft.

SEGULA's teams are involved in every stage of the cycle: design (aircraft architecture, propulsion systems, sub-assemblies), operations (assembly of complete sub-assemblies, pre-flight, quality, methods and tooling), maintenance and testing.

In addition, the group has opened new offices in **Mexico**, already involved in interior design, industrial production, advanced logistics and the supply chain, to support the sector's global growth.

GLOBAL SERVICE DELIVERY CENTRES : A COMPETITIVE ADVANTAGE

To remain competitive while offering high-quality, responsive services, SEGULA relies on three service delivery centres strategically located in America, Europe and Africa. Multilingual, multi-sector and interconnected, they provide operational support to local offices around the world.

► In **Morocco**, with extensive experience in calculation and simulation (CAE), the teams work on tooling design, engineering and design, as well as assembly methods.

► In **Tunisia**, SEGULA's teams are involved in aircraft interior design and supply chain management, with reference projects for Safran Seats.

► In Europe, **Romania** plays a key role in manufacturing. It is involved in major industrial projects, including the robotisation of a final aircraft assembly line for a major French manufacturer.



INDIA, A PROMISING FUTURE FOR TECHNOLOGICAL INNOVATION IN AERONAUTICS

With its wealth of technological expertise, **India** offers promising prospects for development:

'France has a high level of maturity in aerospace manufacturing, while India offers excellent skills in information and digital technologies. This opens up opportunities for collaboration between the two countries to shape the future of digital manufacturing. This collaboration should focus on joint research and development, training, localised production and supply chain diversification.'

Suresh Latchoumanassamy,
Vice President, Aerospace,
Asia Pacific and Middle East

A man in a workshop, wearing a dark t-shirt and blue trousers, is crouching and looking up at a large, metallic aircraft component. He is holding a smartphone in his right hand and a flashlight in his left hand. The component is suspended in the air, and the workshop floor is visible in the background. The lighting is bright, creating a high-contrast scene.

ENGINEERING

With cutting-edge technical expertise and advanced digital tools, aerospace engineering optimises every stage of an aircraft's life cycle, from design to maintenance, to meet the challenges of today and tomorrow.

From idea to workshop: the key role of Manufacturing Engineering

In the aerospace industry, where technological excellence and industrial rigour are inseparable, production engineering (or manufacturing engineering) plays a pivotal role. At the interface between design, production and quality, it translates ideas from the design office into manufacturable, compliant, repeatable and competitive solutions. At SEGULA Technologies, this expertise is at the heart of our projects and reinforces the robustness of industrial chains.

cific needs of each project. This agile model is perfectly suited to ramp-up requirements, particularly on final assembly lines.

ADAPTING TO NEW CHALLENGES: TOWARDS MORE DIGITAL AND GREENER PRODUCTION ENGINEERING

SEGULA is committed to Industry 4.0 with the deployment of digital twins (to simulate workstations or lines), the use of augmented reality to guide operators or validate assemblies, and document automation. The aim is to accelerate industrialisation while improving data reliability and reducing low value-added tasks.

Reducing environmental impact is also an important strategic focus. This involves streamlining processes (reducing material and energy consumption, cutting waste), choosing low-impact technologies and integrating eco-design criteria into manufacturing ranges.

A TAILOR-MADE COMMITMENT MODEL

Faced with the challenges of industrial agility, today's contractors are looking for partners capable of getting involved from start to finish: from co-design to production, including industrialisation and workshop support. SEGULA meets this expectation by offering flexible commitment models: one-off interventions, management of complete batches or project management via dedicated platforms or outsourced service centres. This global commitment guarantees responsiveness, performance and cost control throughout the industrial cycle.

TURNING AN IDEA INTO INDUSTRIAL REALITY

Production engineers transform digital specifications into robust, industrialisable manufacturing processes. This involves analysing the feasibility of parts (Design for Manufacturing), defining the necessary equipment (machines, tools, workstations, logistics) and preparing industrial documentation. Acting as a technical conductor, they coordinate exchanges between the design office, quality teams, logisticians and workshop operators to ensure the consistency and efficiency of the entire process. This work makes it possible to anticipate difficulties and avoid errors while optimising production time and costs.

CONTRIBUTING TO CONTINUOUS IMPROVEMENT

But the role of production engineering does not stop at initial manufacturing. It is part of a continuous improvement process. Lean, 5S, FMEA and Six Sigma methodologies are among the tools used to reduce waste, streamline workshop organisation and control risks. In contexts of ramp-up, digitalisation or industrial transformation, SEGULA relies on these tools to strengthen the methods teams of manufacturers and equipment suppliers.

GUARANTEEING QUALITY AND

SEGULA ensures compliance with industrial standards (EN9100, NADCAP), carries out the necessary process controls and ensures rigorous management of technical documents. Thanks to complete traceability, every part and every operation can be tracked. The teams also manage any deviations and implement control plans to ensure production compliance.

MEETING TECHNICAL CHALLENGES THROUGH A LARGE NETWORK OF EXPERTS

At SEGULA, production engineers face significant technical challenges and are required to work with particularly demanding materials such as titanium, composites and Inconel, which require specific skills. The parts produced often have to meet very strict tolerances, with little margin for error. Added to this are advanced processes such as high-speed machining, friction stir welding (FSW), multi-axis drilling and robotic automation. To meet these requirements, SEGULA mobilises an international network of experts who can respond quickly to multi-site projects and adapt to peak workloads. This deployment capacity is accompanied by contractual flexibility that allows resources to be adjusted to the spe-

MANUFACTURING ENGINEERING: MEETING WITH JEAN-PAUL BAILLE, DIVISION MANAGER

At the Vitrolles site in southern France, more than 80% of SEGULA's business is dedicated to Manufacturing Engineering. Jean-Paul Baille, Division Director, has been working there for 18 years.



What exactly does manufacturing engineering involve in the aerospace industry?

J-P.B. Manufacturing engineering can be compared to creating a recipe in a top restaurant: the design office plays the role of the chef who imagines the dish (design stage), while we are responsible for writing the detailed recipe so that the dish can be made in the kitchen (production stage). In practical terms, based on the plans provided by the design office, we define the manufacturing and assembly solutions best suited to each part and provide technical support throughout the production process.

Additive manufacturing is one of the key drivers of manufacturing engineering. What are its advantages?

J-P.B. Additive manufacturing makes it possible to quickly transform a design plan into a real part without resorting to complex or costly pro-

cesses. Unlike traditional methods, which remove or deform material, additive manufacturing builds the part layer by layer from materials such as powder, filament or resin. It allows parts to be produced directly from a digital model (CAD), without the need for moulds or specific tools, which are often very expensive to design for small quantities. It is a fast, flexible, efficient and economical solution.



Additive manufacturing machines used to produce parts and tools.

What types of projects do SEGULA teams work on?

J-P.B. We mainly work on helicopters for Airbus Helicopters, from light models such as the Écureuil to the Super Puma, including intermediate aircraft (H160, H175, NH90). We work on the structure as well as on the dynamic components and transmission systems to the propellers. Our assignments cover both new aircraft (Part 21) and those undergoing maintenance (Part 145). Whether for manufacturing or replacement, the skills

required are the same: we check the technical feasibility based on the plans provided by the design office. In maintenance, we are involved in periodic inspections, major overhauls and retrofit operations, which involve dismantling an entire helicopter for modernisation.

In your opinion, what is SEGULA's added value and what makes it unique in this field?

J-P.B. Industrialisation is part of SEGULA's DNA, particularly through its automotive expertise. Today, we are a major player in manufacturing engineering, with an established international presence in France, Morocco, Romania and North America. These locations enable us to respond quickly to calls for tenders and reduce costs. What sets us apart is above all our comprehensive offering, which covers the entire value chain, from design to production. We also have solid experience with Airbus Helicopters, a partner with whom we have been working continuously since 2006. This long-term relationship has enabled us to develop a detailed understanding of their internal processes.

How is the Vitrolles team composed, and what profiles are you looking for?

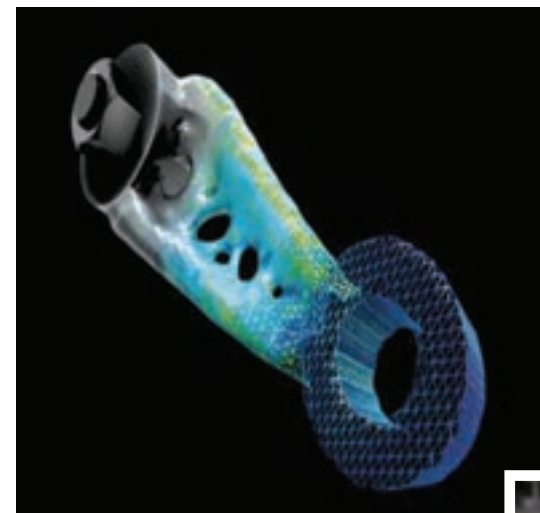
J-P.B. The team includes both technicians and engineers, mainly with backgrounds in mechanical or aeronautical engineering, with expertise in parts design and manufacturing. Our activities cover a wide range of technical fields such as machining, sheet metal work, electrical engineering and raw material processing.

It is important to have a good understanding of the logistical challenges, particularly in terms of procurement. Today, recruiting qualified staff is a real challenge because technical fields have long been undervalued,

which has led to a lack of interest in these professions among younger generations. That is why we offer a training policy that enables our employees to develop their skills.

What digital tools do you use?

J-P.B. We use ERP (Enterprise Resource Planning) software such as SAP to centralise and manage all technical, logistical and production data. These databases enable us to monitor each stage of the manufacturing process with precision. In addition, computer-aided design (CAD) software, from CATIA V5 to the latest iterations of 3D Experience, geared towards MBSE (Model-Based System Engineering), which is now part of our engineers' daily routine, enables us to design, visualise and adapt parts even before they are manufactured. These digital tools have become indispensable for improving efficiency, reliability and responsiveness.



Metal part produced using additive manufacturing (left: CAD drawing / bottom: physical part held in place by support strips)



SEGULA'S ADVANTAGE: CROSS-SECTOR BRIDGES

SEGULA also operates in the automotive, naval, rail, energy and defence sectors. This wealth of experience enables the group to transfer innovative technologies to the aerospace sector:

→ **From the automotive industry,** SEGULA imports a culture of Lean (production optimisation), automation and industrial cadence.

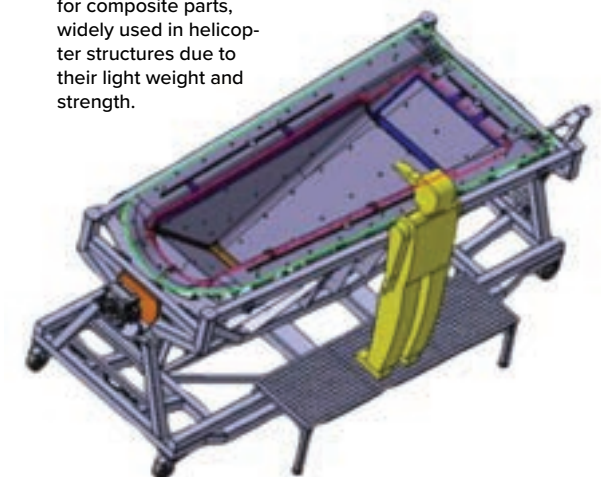
→ **From the naval and rail industries,** the group draws on its expertise in systems engineering, large assembly production, product life cycle management and complex supply chain management.

'Production engineering in aeronautics is much more than a support function: it is the industrial catalyst for performance, guaranteeing the feasibility, quality and competitiveness of products. With its multi-sector experience, cutting-edge technical skills and commitment, SEGULA is positioned as a strategic partner capable of supporting aerospace manufacturers in their current and future challenges'.

Arnaud Longuefosse,
Vice President, Strategy
and Business Development



Moulding process for composite parts, widely used in helicopter structures due to their light weight and strength.



Support engineering: the art of extending the life of machines

In aeronautics, support engineering designs solutions to optimise the maintenance, repair and overhaul of aircraft throughout their life cycle. The goal is to ensure that every system and piece of equipment is not only effective as designed, but also easy to maintain and repair. In line with efforts to adapt to regional needs and strengthen local capabilities, efforts are currently underway to develop these activities in Canada and the Middle East.

Support engineering optimises MRO in several ways

Reduced downtime: by designing systems that are easy to maintain and providing clear and accurate documentation, it minimises the time required for repairs and inspections.

Reduced maintenance costs: it optimises spare parts inventory, enables efficient maintenance planning and reduces the need for specialised tools and equipment.

Improved reliability and safety: by anticipating potential problems and implementing preventive maintenance procedures, it helps increase system reliability and ensure operational safety.

Optimised training: it facilitates the creation of effective training programmes for maintenance personnel by providing clear and appropriate training materials.

Digitising support engineering

At SEGULA, digital technology as a whole is playing an increasingly important role in support engineering:

Digital tools: maintenance management software (CMMS), augmented reality systems to guide technicians, and collaborative platforms to facilitate communication between maintenance teams are all digital tools that improve the efficiency of MRO at SEGULA.

Digital twins: virtual replicas of aircraft and their components enable maintenance scenarios to be simulated, problems to be anticipated and procedures to be optimised before real operations even begin.

► At Airbus Helicopters, the HATS (Helicopter Aircrew Training System) training platform has been set up to train teams: thanks to digital twins,

pilots and technicians can practise complex scenarios in a realistic virtual environment.

Data and AI: AI applied to the analysis of maintenance data (failure history, repair times, etc.) enables data to be quickly standardised, root causes to be identified and operational availability and customer experience to be optimised.

What is the future of support engineering in aeronautics?

Widespread predictive maintenance: AI and machine learning will enable faults to be predicted with greater accuracy, further optimising maintenance schedules.

► Teams are already using HUMS (Health and Usage Monitoring System), an onboard system that collects real-time data on the health and usage of critical aircraft components (engine, transmission, vibrations, etc.). This data makes it possible to anticipate breakdowns, schedule maintenance only when

necessary, and thus reduce costs while improving aircraft safety and availability.

Augmented and virtual reality for training and support: technicians will be equipped with augmented and virtual reality devices that will provide them with real-time information and guide them through maintenance procedures. These technologies will reduce human error, speed up interventions and standardise practices.

3D printing: 3D printing, which enables the manufacture of spare parts on demand and in accordance with the design office's specifications, is an effective solution for reducing aircraft downtime and overcoming supply chain difficulties, thanks to its speed and low cost.

Expertise and professions related to support engineering:

Maintenance engineers design and optimise maintenance programmes

Maintenance data analysts analyse data to identify trends and optimise operations or design.

Technical documentation designers create clear and precise maintenance manuals and procedures.

The technical training specialist develops and delivers training courses for maintenance personnel.

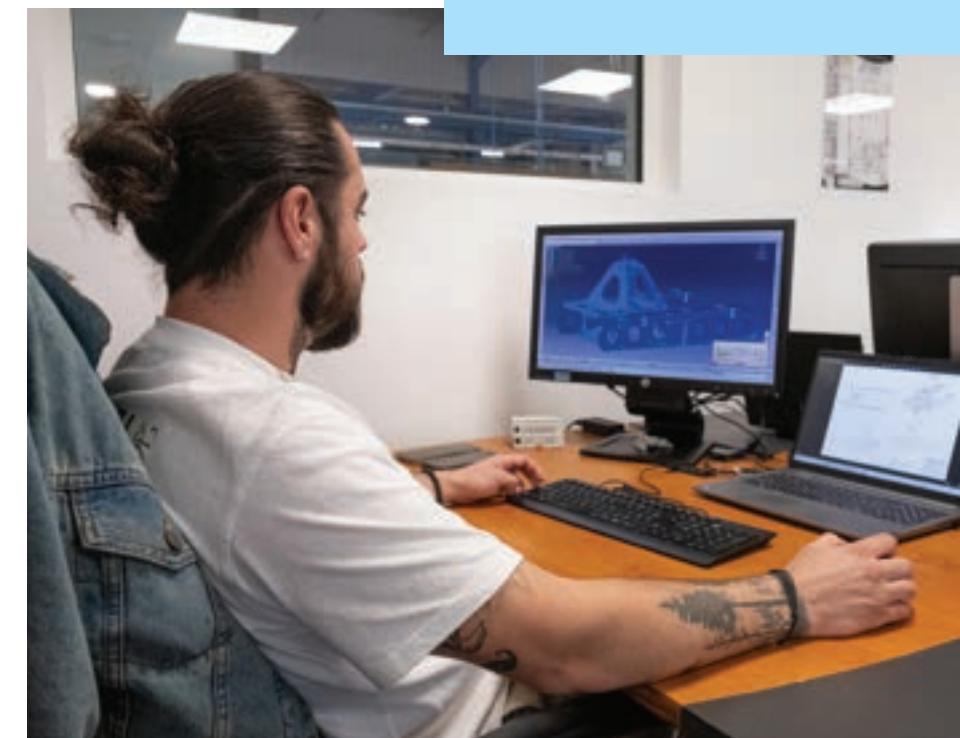
The reliability engineer evaluates and improves the reliability of systems.

Maintenance support experts provide technical support and solutions to maintenance teams.



'Although support engineering is increasingly recognised as an essential discipline, there are still relatively few people with specific training in this field. However, training programmes and university courses now include support engineering modules, which should help to increase the number of qualified professionals. More and more SEGULA employees are sharing their expertise and giving lectures at schools and universities as part of bachelor's and master's degree programmes.'

Mickaël Pagnier,
Sales Director
Aeronautics



Technical documentation design

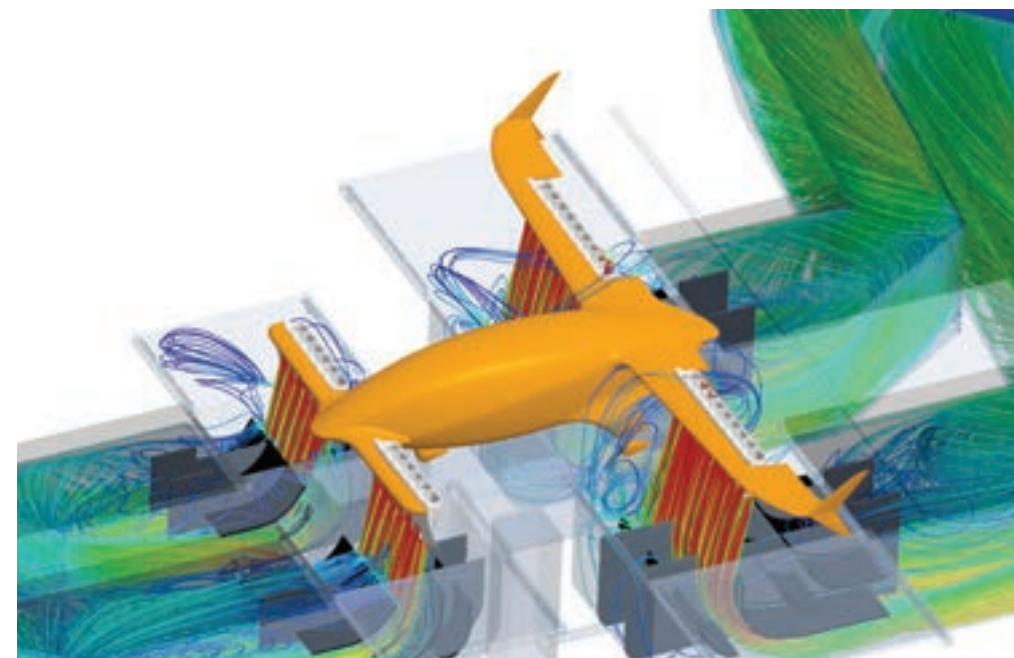
A high-level digital simulation

With digital simulation, innovation in aeronautics is becoming faster, safer and more sustainable. That is why SEGULA Technologies has had dedicated design offices for some twenty years. Presentation by Hugo Tricou, Digital Simulation Business Manager, who heads a team of engineers specialising in calculations in France near Lyon.

Gelatin birds catapulted onto aeroplane wings

Bird strikes pose a considerable danger in aviation. To protect against this risk, manufacturers conduct numerous tests to reinforce aircraft fuselages. This is even essential in aircraft validation processes. 'These tests involve firing gelatin bird dummies from a catapult at a piece of fuselage to observe how it behaves,' explains Hugo Tricou. 'But these tests take time – a lot of time – and

are very expensive. You also need pieces of fuselage that you are willing to destroy. It's a huge waste! It's much better to use digital simulation!' This technology involves virtually representing physical phenomena... without damaging any aircraft. 'In concrete terms, to model an aircraft part, we use the discretisation technique: it is divided into a multitude of elements (mesh), to which we apply physical laws, translated into mathematical equations.' This allows engineers to minimise testing, speed up development, reduce costs and optimise designs.



Digital study of air flows in a vertical take-off aircraft mounted on a test bench.

A technology tailored for aeronautics

Even more than in other sectors, digital simulation has found a privileged field of expression in aeronautics. First, because aircraft parts are very expensive. Without sacrificing safety, the aim is therefore to limit the number of destructive tests to ensure that everything works properly. Simulation is therefore key to digitally validating everything possible before moving on to physical testing. 'Another unique feature of aeronautics is the challenge

posed by the variety of materials used and their conditions of use,' says Hugo Tricou. 'In an aircraft, you find metals, composites and polymers that are subjected to high stresses in terms of pressure, vacuum, vibration and temperature. The more you are faced with a mix of situations, the more interesting numerical simulation becomes. Today, we know how to translate every physical phenomenon into an equation.' The third specific feature is safety. In aeronautics, there is no room for error. Digital simulation makes it possible to anticipate all risks at every stage of development. There are no limits!

Already 25 years of experience and resources to match

SEGULA Technologies is no newcomer to digital simulation. 'Today, we have 300 calculation engineers spread across France and abroad, and we have our own calculation servers located in our design offices, with more than 1,000 processors (CPUs - Central Processing Units) dedicated to the calculation tasks re-

quired by our customers and for our own developments, enabling us to remain at the forefront of the industry.' These significant resources enable Hugo Tricou to serve more than 50 customers each year and handle around 30 simulation projects at the same time, in collaboration with the Research and Innovation teams. These projects have led SEGULA to achieve some real success stories. Among the most iconic is their contribution to the **Lilium** project. This start-up has developed the first electric aircraft capable of vertical take-

off and landing. 'We modelled the fluid flows around the aircraft and designed a test bench using digital tools. We ensured its resistance to the strong thrusts of a vertical take-off and the reliability of its measurements.' Another notable example is the support provided to **Safran Seats** for emergency landing tests on planes and helicopters. The aim was to monitor the behaviour of the seats and assess the risks in these extreme conditions. To this end, Hugo Tricou and his team carried out rapid dynamic calculations.

A contribution to making aviation more sustainable

In addition to the applications mentioned above, digital simulation opens up endless possibilities. Not only does it **reduce costs and lead times** by drastically reducing the number of prototypes, limiting wind tunnel and flight testing, and accelerating iterations during the design phase, but it also enables **detailed analysis of material stresses and modelling of extreme conditions**. 'In aeronautics, parts and equipment must perform perfectly the first time, while

being optimised in terms of weight, robustness and defence level for military applications,' emphasises Hugo Tricou. 'This is precisely the role of modelling, before physical testing is carried out.' Numerical simulation is revolutionising research into lighter parts, optimising energy consumption and studying alternative fuels such as hydrogen to reduce environmental impact: less use of raw materials and lower CO2 emissions. It also extends the service life of aircraft when integrated well upstream in the development process. When an aircraft flies for 50 years instead of 30, that's a new benefit for the environment!

Digital validation of aircraft seat design for crash scenarios.



Tomorrow, simulation enhanced by Artificial Intelligence

In aeronautics, Artificial Intelligence is already integrated into processes. 'It's still exploratory, but it's clearly the future,' according to Hugo Tricou. 'For example, it could be extremely useful for automatically generating digital meshes of parts in simulation, which is still a very time-consuming

step.' SEGULA's Lyon design office is increasingly interested in these topics and in the use of AI to predict the behaviour of parts before they undergo conventional simulation. This is a new challenge for Hugo Tricou and his team, who are always on the lookout for innovation, as they continue to assert themselves as a key player in digital simulation in aeronautics!



Design at the service of the passenger experience

Founded in 1978, Technicon Design is an internationally renowned industrial design agency. Part of the SEGULA Technologies group since 2017, it operates on three continents (Europe, Asia and North America) and supports its clients in a variety of fields, particularly the automotive industry, its traditional core business. Since 2019, the agency has expanded its scope to include aeronautics, working with seat manufacturers and airlines.

One Unit: modular aircraft seats to suit all types of cabins

One Unit is a high-end transport seat designed to easily adapt to different cabin configurations. This unique modular system has been designed to meet the challenges faced by airlines in terms of cost (reducing the variety of parts), efficiency and customisation, without ever compromising the passenger experience. *'Every detail has been thought out to offer a refined and personalised cocoon-like feeling. It is an interior micro-architecture that combines fluidity, ergonomics and sophistication. One Unit explores modularity to reinvent the passenger experience, combining comfort, design and innovation.'*

For this project, SEGULA was responsible for the entire design process, from ideation to 3D modelling and XR visualisation, including the creation of presentation films and immersive views. A multidisciplinary team of exterior and interior designers, colour and material experts, Ui&Ux designers, 3D modellers, graphic designers and studio engineers was mobilised.



Envisioning the future of air mobility: desi- gning a new genera- tion of eVTOLs

The result of ambitious creative work, the design of this eVTOL (Electric Vertical Take-Off and Landing) concept, a fast-moving flying taxi with vertical take-off, was developed by Technicon Design's international studios in Shanghai and Chennai. *'The design of this eVTOL embodies a smooth and sleek sculpture, where every curve seems to have been drawn by the wind. Its sleek, taut and fluid silhouette evokes both performance and elegance. The cockpit is panoramic and bathed in light. The formal language combines tension and softness for a futuristic yet reassuring aesthetic.'*

The teams (exterior and interior designers, colour and material experts, 3D modellers, graphic designers and studio engineers) designed the exterior and interior of the concept, overseeing the stylistic research, architecture, 3D modelling and visualisation phases.



MEET Pierre Authier
Design Director

What are the specific features of design in aeronautics?

It is high-precision design that must combine aesthetics, ergonomics, regulations, weight and industrial feasibility. There are many constraints, but it's an exciting field for expressing a futuristic vision and thinking about the user experience in a holistic way (i.e. taking into account all aspects of the experience as a whole). The result is a balance between emotion and rationality, in constant dialogue with engineers.

Why are design and ergono- mics fundamental in industry?

Design acts as an ambassador for people in industry, translating consumer needs and desires into meaningful solutions. Understanding and anticipating these needs early in the design process not only saves time, but also creates products that are better suited to future user expectations, while promoting continuous innovation.

'Design will be more emotional, more digital and increasingly integrated with environmental issues.'

What are the stages of desi- gning a project ?

It all starts with an analysis of passenger trends and expectations, combined with constant technological monitoring by our teams in all industrial and fashion sectors. The creative phase includes ideation through sketches, architecture validation and Class-A 3D modelling with the Design Office. The project is then presented through renderings (visual representations), films and immersive experiences (augmented reality). In collaboration with engineers and manufacturers, our experts optimise perceived quality by drawing inspiration from best practices in other industrial sectors, such as the automotive industry.

How do you see the future of design in aeronautics?

It will be more emotional, more digital and increasingly integrated with environmental issues. Design will be a lever for industrial efficiency and transformation of the user experience, and therefore a key differentiator between manufacturers: Digitalisation, with 3D tools and virtual reality, will play a key role in the design and presentation of projects.

Design will also need to create sensitive and intuitive experiences, while recyclable and eco-friendly materials will become increasingly important. Finally, modularity will reduce the number of parts and promote perceived quality, profitability and industrialisation. Design is a universal language that we evolve according to uses, cultures and technologies.

TOOLING

In aeronautics, nothing can be done without tools. This equipment is essential for the smooth running of maintenance, assembly and transport operations. It enables operators to carry out precise operations such as assembling a part, moving an engine or holding a structure in place during an assembly operation.

A wide range of expertise for tailor-made solutions

At SEGULA Technologies, a wide range of expertise revolves around tooling, involving numerous employees at various sites. Among these talented individuals, in Marignane, in the south of France, a dedicated team led by Clément Le Flahec, Technical and Operational Manager for the business, designs tailor-made solutions to meet the sector's specific requirements.

A tailor-made solution for every project

Each project begins with the receipt of specifications issued by the customer. An initial analysis is then carried out to assess the team's ability to respond effectively to the request. If the green light is given, the project managers and designers take over to design a preliminary project. This phase includes costing, exploring the various technical disciplines involved, and developing a specific industrial diagram.

Once the offer has been formalised and submitted, the project team springs into action to structure the rollout (drawing up a schedule, validating critical milestones, managing safety constraints related to end use, design and finite element analysis). Manufacturing is then launched, followed by delivery and, if necessary, on-site installation.

'On a day-to-day basis, the organisation is based on a central duo consisting of the project manager and the designer. Both are responsible for technical consistency and act as the main point of contact for the customer. At the same time, a project team oversees cross-functional issues such as schedule compliance, budget management and general reporting. This small team structure facilitates

smooth communication and allows us to better adapt to the needs of each assignment.' Clément Le Flahec

Supporting major players in the aerospace industry

Design, certification and shipment of jackpads for Canada

SEGULA is working with Airbus Canada on the A220 programme to design a specific tool: the jackpad. Essential for aircraft assembly, this component acts as an interface between the fuselage and the transport and handling cradles.

For this project, SEGULA is responsible for the design, certification and shipment of the jackpads. Only the manufacturing is outsourced. The project is characterised by its regulatory complexity, as the jackpads must withstand heavy loads and comply with the standards of four different countries.

The team must integrate very strict technical requirements from the design phase, validated by calculation. Beyond the technical aspect, this contract illustrates SEGULA's ability to establish itself as a trusted supplier internationally.

Modelling of a jackpad



'Our strength lies in the diversity of our expertise. We offer tailor-made solutions, because every project is unique and requires constant adaptation. We are able to work in many different fields, from mechanical welding to machining, automation and composite moulding. Each member of the team brings their own area of expertise to the table.'

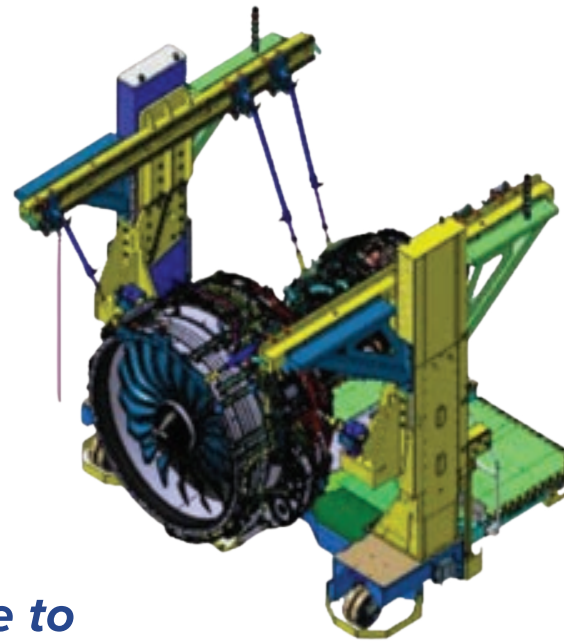
Clément Le Flahec,
Tooling technical and operations manager in Marignane (southern France)

! TOOLING

Design and manufacture of a transport trolley for aircraft engines

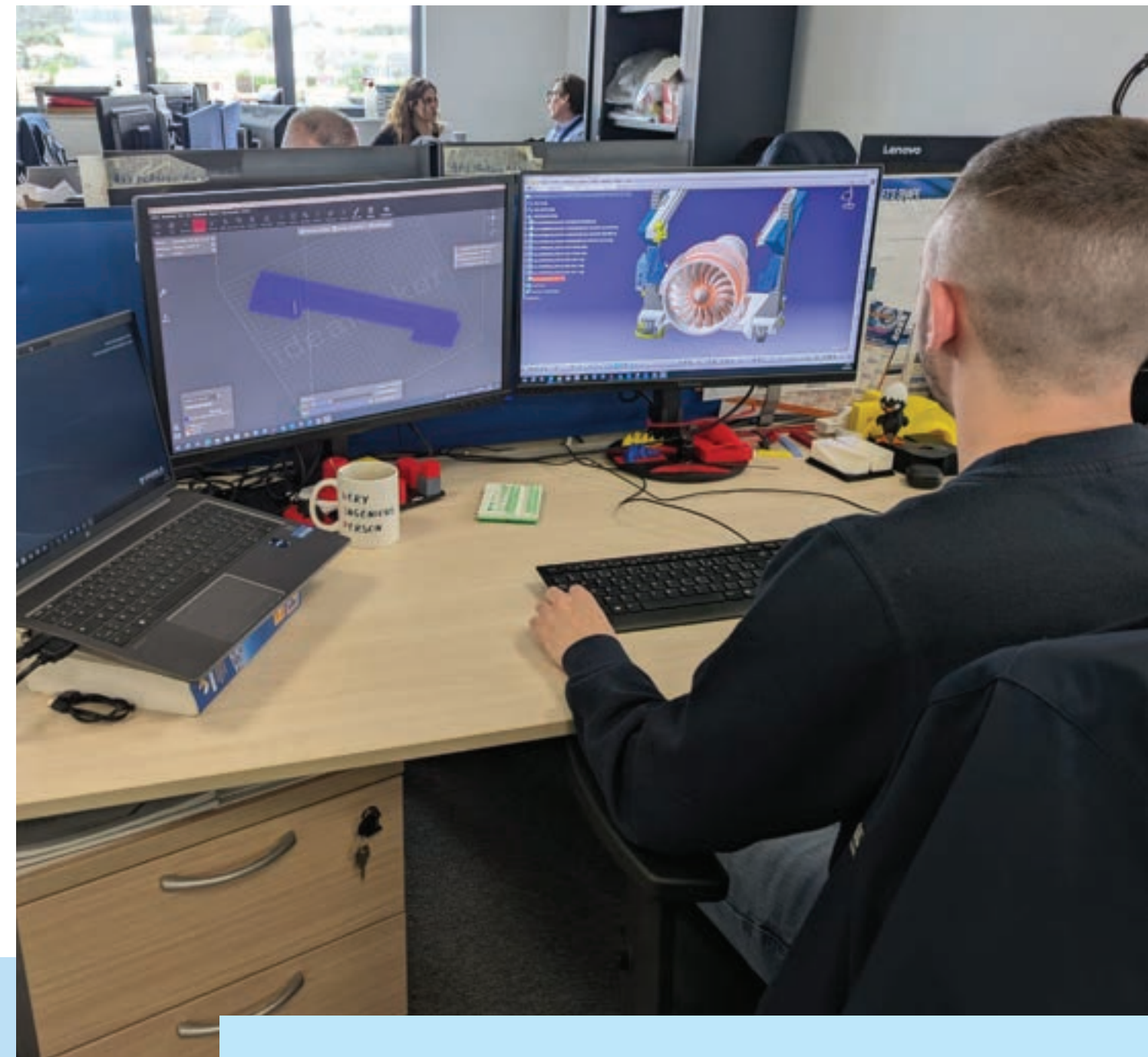
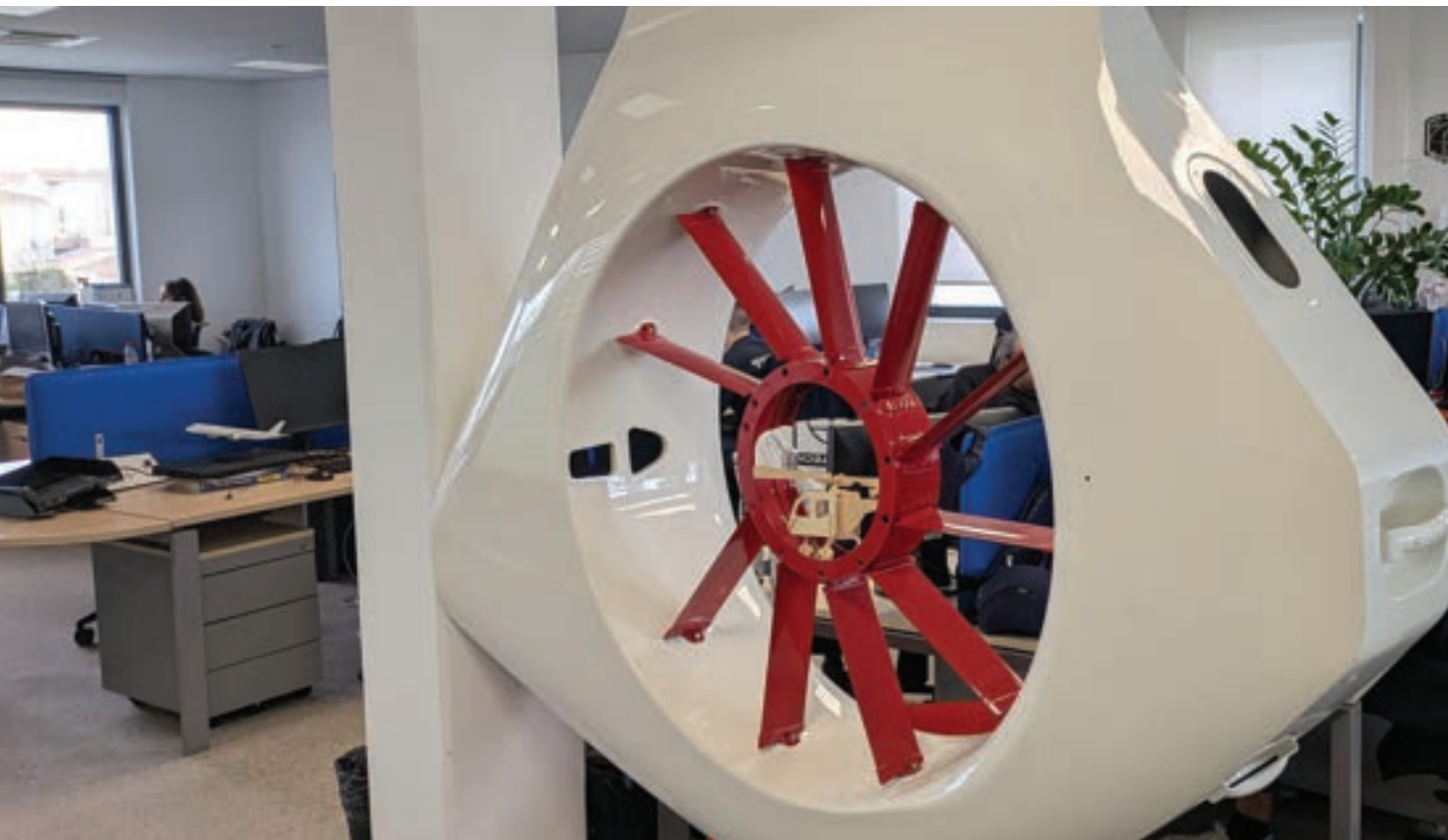
This equipment, ordered by Safran, is intended for heavy maintenance operations requiring the complete dismantling of engines. One of the major challenges is the versatility of the trolley, which must be able to adapt to several engine configurations (CFM56 and LEAP). This involves high technical requirements, particularly in terms of stability and geometric precision, as the

engines, which can weigh between 4 and 7 tonnes, must be handled without deformation to ensure perfect alignment of the mechanical components during reassembly. The project is being managed from start to finish by SEGULA: design, structural calculations, PLC programming, manufacturing, certification and on-site assembly by a dedicated team. Ergonomics is at the heart of the development process to ensure efficiency, comfort and safety for operators.



‘Before adapting to the machine, you have to adapt to the people who will be using it. To ensure that products are relevant to users, project managers and designers visit the field and talk to operators to best meet their specific constraints and needs.’

Clément Le Flahec, Tooling technical and operations manager in Marignane (France)



Jean-Michel Caroul,
Design engineer

After completing his work-study programme at SEGULA, Jean-Michel Caroul decided to continue his career with the Group. Now a design engineer, he works on a wide variety of projects, ranging from engine transport trolleys to drilling tools, turning systems and test benches. 'My job is to create custom parts that cannot be produced using

standard methods. For example, if a panel needs to be moved, I have to design a custom trolley that will fulfil this specific function. Once the specifications have been established, I model the solution in 3D and check its feasibility. What I particularly like is the diversity of the projects I work on. We can design anything from small boxes to more complex structures, such as civil engineering.'

TEXTILE CABLES 10 TIMES LIGHTER THAN STEEL, CAPABLE OF SUPPORTING UP TO 1,000 TONNES

Jérémy Stigliano, project manager, led an innovative project involving ultra-compact textile cables that can fit into a simple briefcase while lifting over a tonne of equipment!

This new GSE (Ground Support Equipment), developed in partnership with Nodusfactory, addresses the many constraints encountered in the field by operators.

'In industry, conventional cables are often heavy, bulky, susceptible to rust, and can damage equipment or cause physical pain to operators during handling. Thanks to the use of textiles, these new cables are lighter, more manoeuvrable and much easier to transport. It is estimated that 15 kilos of fabric can replace 150 kilos of steel, and all this with no real load limit (breaking load can reach 1,000 tonnes),' explains Jeremy Stigliano, project manager.

The system is based on a three-strand main ring. A clever stitching technique allows the length to be adjusted as required by compressing the strands. *'Despite the small diameters used, this GSE is CE certified for a maximum working load of 550 kg, in accordance with Directive 2006/42/EC.'* This impressive technical innovation is protected by SE-GULA's intellectual property rights.

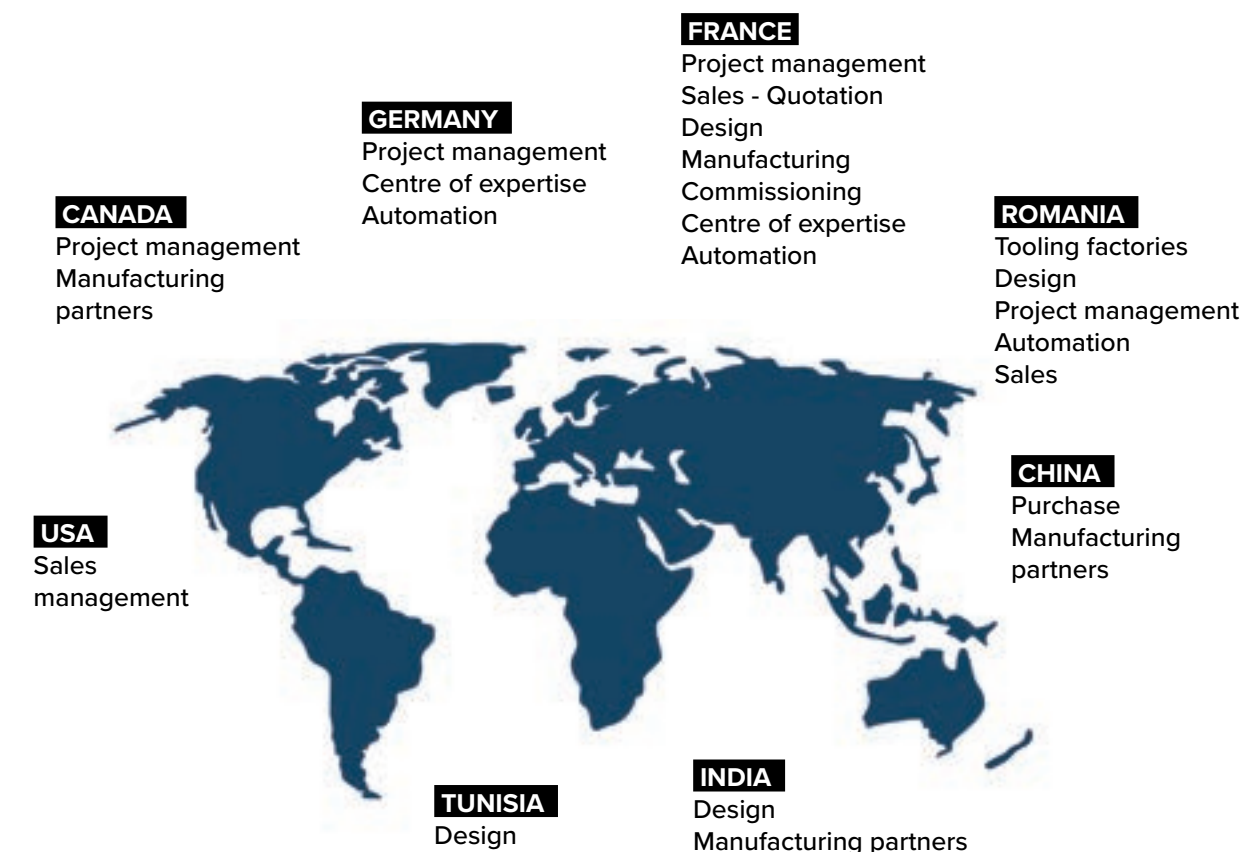


Jeremy Stigliano,
Project Manager,
Tooling Design

With a technical degree in electronics, Jérémy Stigliano began his career in technical documentation before moving on to design offices. He now works as a tooling design project manager at SE-GULA. *'My role is to respond to a need expressed by our customers through a set of specifications and*

to manage the entire development process from start to finish. What I particularly enjoy is being able to work on a wide variety of topics. We touch on everything: mechanics, manufacturing, packaging... It's very comprehensive. I have the freedom to make suggestions and be proactive. If I identify a relevant solution or partnership, such as the one developed with Nodusfactory, I am given the resources to implement it.'

TOOLING around the WORLD



TOOLING in FIGURES

- + de 400 talented employees
- 8 countries
- 11 sites
- 2 centres of expertise (France and Germany)
- 2 tooling factories in Romania
- + 25 clients
- + 50 suppliers in Europe, India, China and South America

'TEST BENCHES are central to the industry.'

Test benches play a crucial role in the particularly demanding aerospace industry. This technical equipment simulates the operating conditions of all or part of a system to validate its functionality, quality, safety, reliability and compliance with standards. Quentin Palayer, Division Director at SEGULA Technologies, oversees engineering activities at several strategic sites. He gives us a behind-the-scenes look at these test devices and the expertise that SEGULA Technologies brings to bear to remain at the forefront of this field.



What exactly is meant by 'test benches' in aeronautics?

Q.P. A test bench is a system that allows a product to be placed in configurable and controlled operating conditions in order to observe and measure its behaviour. It is a piece of mechanical equipment weighing from a few kilograms to several hundred kilograms, designed to qualify all or part of the aircraft system. The most modular test equipment can take the form of a suitcase. The heaviest are trolleys incorporating several subsystems and weighing more than half a tonne. In practice, we connect the test equipment to an aircraft function to check that it is working properly. These are known as functional tests.

What is SEGULA's role?

Q.P. SEGULA manages the design, manufacture and supply of the test equipment and tools required for their

operation and daily use. We base our work on our customers' requirements and on test procedures in order to develop tailor-made solutions. We also provide support to our industrial customers on new construction or maintenance projects and on the modification of industrial installations. Our employees can work on projects requiring a few hours of work or on design projects involving tens of thousands of hours. We pride ourselves on our flexibility.

What are the three types of test benches offered by the group?

Q.P. **Hydraulic test benches** are used to test gas or liquid fluid circuits in an aircraft, such as oxygen, air conditioning or fuel. These are known as network, leak or flow tests. **Electrical test benches** are used to test the electrical connections and wiring throughout the aircraft. Finally, **electromechanical and instrumented test benches** are used to test sensors and simple systems that analyse behaviour or validate the operation of a physical measuring instrument such as temperature or pressure.

At what stages of the development cycle are these test benches used?

Q.P. Test benches enable our customer Airbus to qualify systems or subsystems directly on the production lines, depending on the aircraft programme concerned (A320, A330, A350, A400, etc.). They are designed to be used by on-site operators, who connect the equipment to the sec-

tion to be tested during the manufacturing phase. Once the tests have been validated, the sections are sent to the Final Assembly Line for final testing. It is therefore vitally important that the intermediate tests are reliable, otherwise the customer may have to dismantle parts of the aircraft to modify the defective systems.

What are the specific features of test benches in aeronautics?

Q.P. We are involved in qualifying functional systems that enable a means of transport to fly at an altitude of several thousand metres. We are therefore subject to the EN9100 standard. In addition, the current production rates of the A320 programme require reliable, robust equipment that requires little maintenance. Airbus test equipment is like clockwork, requiring precision and reliability in the measurements taken and the analysis performed.

What roles do digital simulation and artificial intelligence (AI) play today?

Q.P. Digital simulation is an essential prerequisite for the development of a physical test bench: it helps guide technological choices, pre-dimension equipment and optimise the development time of a resource. Artificial intelligence is also playing an increasingly important role in test benches. First, it helps to better structure requirements by automatically

analysing the data transmitted by the customer, which helps to precisely define the tests to be carried out. Second, it ensures greater consistency of information by standardising the data handled throughout the process. AI is also a valuable tool for analysing test results more quickly and reliably, limiting human error and anticipating breakdowns through predictive maintenance. It makes test benches smarter, more efficient and safer.

What is SEGULA's added value?

Q.P. SEGULA stands out thanks to its dedicated 'glocal' (global and local) approach: we draw on the wealth of experience of our technical support staff, who are particularly agile in their approach to customer issues, while

benefiting from high value-added expertise in areas that require rigour and experience. We have all the necessary skills in-house, from process teams to procurement.

How do you see the future of the sector and the evolution of test benches?

Q.P. Test benches are central to the industry. Their use has become widespread at all stages of product or project development, from validation test benches to maintenance test benches, endurance tests, qualification tests, etc. In a context of energy and industrial transition, test benches will always be essential for industry, particularly in research and development and continuous improvement.



↑ One of the teams working on the test bench activity at SEGULA.

Mounted on a trolley, this mobile air test bench is designed to check air conditioning systems. It uses test scenarios to check pressure, flow and temperature, verifies the airtightness of ducts and the proper functioning of valves and flaps, and continuously records measurements via 70 sensors. →



About the size of a small briefcase, this compact device is used to test flight control systems. It measures how a mechanism reacts to movements or signals and checks its resistance to stress. ↓



Key roles in aerospace test bench operations

Project management

Planning, scheduling deliverables, customer relations, configuration management, change management, project validation

Mechanical design, including hydraulics

Schéma architectural, participation au P&ID, validation du modèle, dimensionnement des réseaux, études d'intégration, interfaçage entre les lots

Electrical

Network dimensioning, calculation notes and technical notes, equipment selection

Instrumentation

List of inputs/outputs, loop diagrams, P&ID (Piping and Instrumentation Diagram) and equipment selection

Automation

Operating philosophy, functional analysis, equipment selection, programming and commissioning

Industrial IT (databases)

Technical note on data use, system architecture, database development and operation.

Procurement

Supplier selection, identification of alternatives, delivery and work planning

TAS: at the heart of industrial automation

Within SEGULA Technologies, the TAS (Tooling Automation Systems) division brings together specialists in industrial automation. Their mission is to support major industry players in optimising their production processes by intervening throughout the entire project life cycle, from initial design to equipment commissioning. With more than 400 employees in eight countries (France, Canada, Germany, Romania, China, India, Tunisia and the United States), the TAS team carries out large-scale projects in the automotive, aerospace and rail sectors. Its dual technical and international expertise enables it to meet the performance, competitiveness and modernisation challenges faced by its customers.

A wealth of expertise

TAS's business is based on a set of skills covering the entire industrial automation value chain:

ROBOTISED

PRODUCTION LINES are complete installations for mass production using robots:

► **Design:** cutting-edge engineering allows us to create robotised production lines tailored to each customer's specific needs, optimising the configuration to maximise efficiency and productivity.

► **Manufacturing:** SEGULA manufactures equipment that meets high quality standards through rigorous processes and the use of advanced technologies.

► **Commissioning:** on-site integration and thorough testing ensure safe commissioning and that each production line operates optimally from start-up.

► **Production line optimisation:** even after installation, production lines can be improved (better throughput, reduced downtime, energy or space savings, adaptation to new products, etc.). SEGULA offers continuous optimisation services, adjusting processes to improve performance and reduce production costs.

AUTOMATED

PRODUCTION CELLS are autonomous units made up of machines or robots dedicated to a specific task (such as welding, drilling or screwing). They offer greater precision, flexibility and speed:

► **Design:** the design team works closely with customers to develop customised cells, incorporating the

latest robotic and automated technologies.

► **Manufacturing:** the equipment for the automated cells is manufactured with precision, ensuring quality and durability.

► **Commissioning:** on-site installation is accompanied by rigorous testing to ensure that the cells function properly, minimise the risk of downtime and optimise productivity.

INDUSTRIAL

TRANSFER involves moving a production line or an entire factory from one site to another, while ensuring a quick and efficient restart:

► **Relocation of industrial lines:** SEGULA dismantles, moves and reinstalls industrial equipment with precision and efficiency.

► **Space optimisation:** by reorganising the production space, SEGULA

optimises the use of space to improve ergonomics and increase productivity.

► **Time optimisation:** good time management minimises production interruptions and ensures a quick and efficient restart.

► **Secure commissioning:** by securing each stage of commissioning, SEGULA ensures a quick restart without disrupting production.

TOOLMAKING:

the tools, templates and assemblies required for the manufacture or assembly of industrial parts can be custom-designed for each project.

► **Design :** in-depth technical studies enable us to design custom tools that meet specific customer requirements.

► **Machining:** the use of state-of-the-

art machinery ensures extreme precision in the manufacture of tooling components.

► **Assembly:** assembly is carried out with great rigour to guarantee the reliability and performance of the tools.

► **Geometry:** rigorous geometric checks are carried out to ensure that each tool complies with the defined tolerances and specifications.

Project focus: robotising the final assembly line for aircraft

As part of the modernisation of one of its European sites, a French aircraft manufacturer called on SEGULA Technologies to increase its industrial capacity. The objective was to integrate an innovative robotised production system in order to optimise performance and support ramp-up.

This large-scale project will involve 50 people over a period of three years and should enable the company to increase its production rate.

SEGULA's TAS division was chosen for this task thanks to its expertise in integration. The teams are working on four areas:

► Design

In collaboration with the customer's American Robotics Innovation Unit, TAS is adapting the production processes in 3D based on the customer's specifications, including the installation of robotic lines and the programming of the controllers.

► Manufacturing

SEGULA manufactures the necessary equipment in collaboration with partners and using the group's internal production resources in Romania, then adjusts and delivers it to the customer's site.

► Commissioning

SEGULA installs and adjusts the lines at the customer's production site, ensuring their reliability and ramping up production.

► Project management

SEGULA coordinates the various tasks, in accordance with the manufacturer's schedules and quality standards.

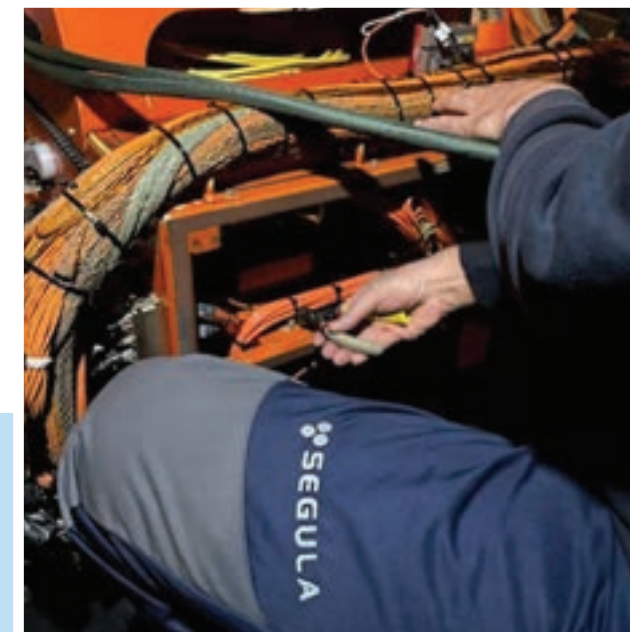
PRODUCTION SERVICES

Manufacturing an aircraft or helicopter is a complex process involving dozens of specific professions and operations at every stage of the production chain: these are known as production services. These essential activities cover all operations related to assembly, finishing, quality control, maintenance and the integration of industrial sub-assemblies.

SEGULA, a key partner in PRODUCTION SERVICES

SEGULA Technologies manages its projects in work packages, i.e. autonomous work units. This management method ensures that each part of the helicopter or aircraft is produced with precision, according to criteria tailored to the customer's requirements. SEGULA is committed to results, while pursuing a process of continuous improvement. The objective is to guarantee high-quality manufacturing, on time and in compliance with the most stringent safety standards.

Historically very active in the helicopter sector, the group is now extending its expertise to the entire aerospace industry, both civil and military.



Adjustment technician, electrical engineer



Cable installer

Meet Jean-Marc Peretz and Christophe Villaescusa

Christophe Villaescusa, Director of Production Services, and Jean-Marc Peretz, Director of the Helicopter Division, offer their joint analysis of the challenges and missions of production services in the aerospace industry.

What does SEGULA offer in terms of production services?

Jean-Marc Peretz : In the helicopter segment, we are involved in several key stages of the industrial chain, such as final product assembly, maintenance in operational conditions and industrial process monitoring. The SEGULA group also handles the 'finishing' of sub-assemblies from various industrial sites in other countries. This stage involves carrying out the final finishing operations, adjustments, quality control and integration, in order to prepare the parts for final assembly. This is also referred to as OSW (Outstanding Work). Working in Work Packages ensures that each stage of manufacturing is carried out with rigour and in accordance with the customer's specific requirements.

Christophe Villaescusa : In the aviation sector, we are involved in crisis management, providing rapid and effective solutions to our customers, as well as in medium- and long-term strategies, thanks to this work package organisation. We recently set up a team of fitters, quality inspectors and methods agents to assemble a sub-assembly for the Rafale, a fighter jet deployed by Dassault. This project was set up in two months.

What types of aerospace components or programmes are you involved in?

Christophe Villaescusa : We work on commercial programmes (short, medium and long-haul for ATR and Airbus), on Dassault Aviation's Business Jet and on the Rafale programme. We also regularly work with manufacturers of parts and sub-assemblies.

Jean-Marc Peretz : For helicopters, we work at all Airbus Helicopters' specialised sites in France, Germany and Spain. Our teams work on aerostructure components (central section, tail boom, etc.) as well as on complete aircraft maintenance. This includes both civil helicopters (Super Puma, H160, H175) and military helicopters used by the French army, such as the Tiger and NH90 models.

What are the main professions involved in the processes?

Christophe Villaescusa : Fitters, mechanics, electricians, cabin integrators, machinists, boilermakers, but also all production support professions are represented (supply chain managers, technical coordinators, quality inspectors, etc.). Team and service managers are also an essential part of our services.

Jean-Marc Peretz : We set up fully autonomous teams with highly qualified employees who have a wide range of skills. They play a vital role in all phases of production, from finishing to aircraft maintenance.

What are SEGULA's specific strengths and added value ?

Christophe Villaescusa : Our strength lies in the flexibility of our organisation, which can quickly adapt to challenges in the field. We support our customers in achieving their objectives by helping them fulfil order books that sometimes span a decade. We cover a wide range of services, as we are able to work on aircraft structures, electrical installations and cabin installations.

Jean-Marc Peretz : We offer local, turnkey solutions with a genuine commitment to results. By pooling the skills and best practices of each site and different countries (France, Germany, Spain), we are able to respond more effectively and consistently to the needs of Airbus Helicopters. Our added value lies in our ability to offer our customers end-to-end solutions.

'Our added value lies in our ability to offer our customers end-to-end solutions.'



Jean-Marc Peretz,
Head of the Helicopters
Department



Mechanic



MAINTENANCE

MRO. Key skills for aerospace maintenance

MRO (Maintenance, Repair, Overhaul) encompasses all activities necessary to ensure the safety, reliability and availability of aircraft (airplanes, helicopters, drones, etc.). SEGULA offers a service covering the entire MRO process. This involves taking full responsibility for the customer's aeronautical maintenance needs, without any interruption in service or the need to call on multiple service providers.

'By combining cutting-edge expertise, solid regulatory knowledge and a thorough understanding of industrial challenges, SEGULA provides tailor-made, high-performance solutions to optimise maintenance operations and reduce downtime. The result: guaranteed high aircraft availability.'

Mickaël Pagnier,
Sales Director
Aeronautics



Support from A to Z

Maintenance planning and management: defining preventive maintenance programmes, scheduling inspections and overhauls, and managing schedules.

Logistics and procurement: managing spare parts, consumables and tools required for maintenance, including storage.

Maintenance execution: performing inspections, repairs, overhauls and modifications on aircraft in accordance with applicable standards and regulations.

Documentation and record management: maintaining all maintenance

records, technical documentation and certifications, ensuring regulatory compliance.

Monitoring and reporting: providing regular reports on maintenance status, costs, deadlines and performance indicators.

Online support: performing routine maintenance and resolving minor issues between flights to ensure aircraft operational availability.

Technical and engineering support: providing technical assistance, diagnostics, troubleshooting and engineering services to optimise maintenance operations.

AT SEGULA, MRO HAS THREE OBJECTIVES:

- **Ensure that aircraft remain airworthy,** i.e. that they comply with safety and operating standards.
- **Extend the service life of aircraft** and their components.
- **Optimise** airlines' operating costs.

THIS INVOLVES THE FOLLOWING ACTIVITIES:

- **Preventive maintenance:** regular inspections, replacement of parts and checks to prevent breakdowns.
- **Corrective maintenance:** repairs following breakdowns or detected problems.
- **General overhaul:** complete disassembly of aircraft for thorough inspections and major repairs.
- **Modifications and upgrades:** installation of new technologies or structural modifications to improve performance or compliance.

Before every take-off, well after landing, and throughout the entire life cycle of aircraft, aviation maintenance works behind the scenes. It encompasses all inspection, repair, prevention and optimisation operations that ensure the proper functioning and safety of aircraft. In a sector where standards are extremely high, this discipline combines technical expertise, constant innovation and regulatory rigour. Faced with the challenges of sustainability, digitalisation and increased traffic, maintenance is reinventing itself, becoming a strategic lever for the aviation industry of tomorrow.

EXPERTISE AT THE SERVICE OF MAJOR PROJECTS

In the defence sector, SEGULA Technologies collaborates with Airbus Helicopters on the NH90, Tiger and Super Puma military programmes. The Group has also entered into a partnership with the Industrial aerospace maintenance workshop on the Tiger programme at the Atelier Industriel de l'Aéronautique in Clermont-Ferrand (France). In the civil sector, SEGULA supports major players in the aeronautics industry such as RTE.



Maintaining the performance of rescue helicopters: SEGULA's expertise

Since July 2022, SEGULA has been responsible for maintaining RTE Airtelis helicopters designed for fighting forest fires. Capable of carrying up to 4,000 litres of water, these aircraft are equipped with a flexible tank called a Bambi Bucket. As part of this project, SEGULA operators are responsible for ensuring the availability and proper functioning of the helicopter and its tank. They carry out maintenance operations, as well as pre- and post-flight checks.

DRONE MAINTENANCE: DIGITALISATION IS TRANSFORMING THE SECTOR

SEGULA is now a major player in MRO and is continuing to grow in this field by offering new digital solutions, such as the drone maintenance system developed in partnership with Armtek (see p.42).

'The aim of these technologies is to facilitate collaborative working. In addition to reducing time and costs, they enable all contributors to work on the same centralised data and avoid duplication, which is a source of errors. It also makes all paper-based data that was previously unused accessible. Finally, thanks to the deve-

lopment of digitalisation, we will be able to draw on a wealth of feedback from the data recorded,' explains Marc Normand, Technical Director.

SEGULA is also interested in integrating Artificial Intelligence (AI). The SEGULA TRANSFORM department was created specifically to address this challenge:

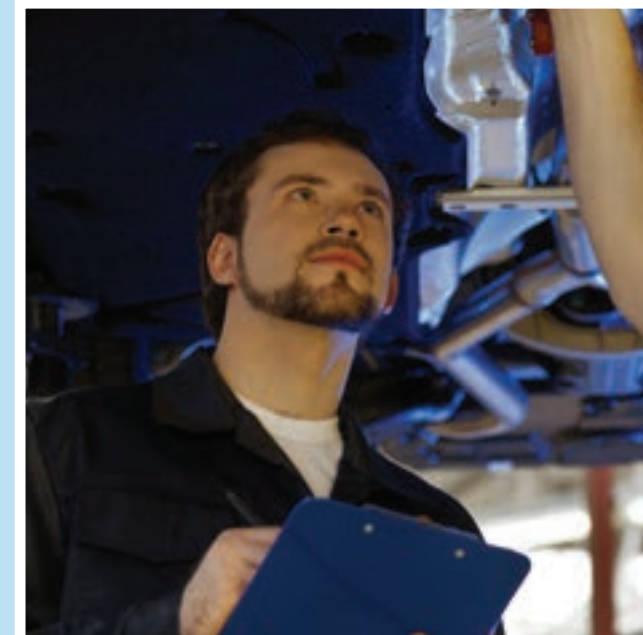
'Team workshops are being set up to identify which deliverables or processes could be more efficient with the introduction of AI. The aim is to work faster and focus on ana-

lysis rather than formatting or performing low value-added tasks.' Already well established in industry and defence, drones could one day become commonplace in other sectors and fly over our cities.

'In the future, we will need to fly and coordinate a whole new population of drones, with challenges in terms of safety, environmental protection, work management and regulation. This is a rapidly growing sector where SEGULA will be able to contribute its expertise.'

A WIDE RANGE OF PROFESSIONS

The skills of technicians have been recognised for several years, with a high customer satisfaction rate. Faced with market pressure regarding the skills of PART 66 B or C licensed mechanics and docmans, SEGULA has set up targeted training courses to meet the needs of its customers, in partnership with schools for the qualification of mechanics, and with RTE for the training of docmans.



Aeronautical boilermaker: checking the flatness of a metal part ↓



MAINTENANCE AND STRUCTURAL REPAIR

Aircraft adjusters are responsible for adjusting, assembling and repairing aircraft structures (fuselage, wings or other structural components). Aviation boilermakers work with metals to manufacture and repair aircraft parts, often using welding techniques.

Composite technicians specialise in handling and repairing composite materials used in aircraft.

MANAGEMENT, SUPERVISION AND NAVIGABILITY

Maintenance managers oversee maintenance operations and ensure compliance with regulations. **Maintenance planners** schedule activities, manage resources and coordinate schedules. **The docman** manages all MRO documentation, from creating and updating technical manuals to regulatory compliance and management system administration.

SYSTEM MECHANICS AND MAINTENANCE

Part 66 B or C licensed mechanics

Mechanical (B1) or avionics (B2) mechanics perform routine maintenance on aircraft on the ground between flights. **Mechanical (B1) or avionics (B2) maintenance technicians** perform various levels of maintenance (VI/VP/GV) at the base.

ENGINEERING AND DESIGN

Part 66 C licensed mechanics or docmans

Aeronautical design: Some MRO professionals are involved in aircraft design and modification through RDAS repair solutions or STC modifications.

Maintenance support engineering plays a crucial role in providing technical support and solutions to maintenance teams.

DEFENCE



Defence aeronautics plays an essential role in ensuring national security. Increasing defence requirements are forcing the aeronautics industry to change pace. Players in the sector must both improve the performance of existing tools and increase their production capacities. SEGULA Technologies stands alongside its customers to meet this challenge.

MAINTENANCE: CERTIFIED TEAMS AT THE HEART OF MILITARY OPERATIONS

In order to respond quickly, reliably and efficiently to the availability requirements of equipment deployed by the army, SEGULA Technologies' certified teams work directly on military bases.

FLYTEAMS: PART 66-CERTIFIED CREWS SERVING TIGER AND NH90 HELICOPTERS

SEGULA deploys mobile teams of aviation maintenance experts, known as flyteams, to support its customers directly at military bases. Composed mainly of former military personnel, these teams combine

technical expertise with a defence culture, enabling them to respond effectively to the specific requirements of the sector. Each member holds a Part 66 licence, guaranteeing service that meets the most demanding standards. This organisation ensures local, agile support tailored to the needs of the armed forces.

SEGULA, KEY PARTNER FOR TIGRE MAINTENANCE

In Clermont-Ferrand (France), as part of a contract with the Industrial aerospace maintenance workshop, SEGULA is specifically involved in the maintenance of Tiger helicopters: twin-engine reconnaissance and attack aircraft deployed by the army.

'With over 20 years of partnership with Airbus Helicopters and solid knowledge of military base operations, we are able to efficiently deploy qualified personnel, ensuring a perfect match with customer needs, optimal responsiveness and cutting-edge expertise.'

Mickaël Pagnier,
Sales Director
Aeronautics

PART 145 APPROVAL: ENSURING THE PERFORMANCE OF SUPER-PUMA HELICOPTERS, WHEREVER THEY ARE

In 2024, SEGULA obtained EASA Part 145 approval for line maintenance on Super Puma helicopters, mainly used for troop transport. This certification allows SEGULA to carry out maintenance operations directly at operating sites. The application for certification is currently underway, with a target date of summer 2025.

► **The PART 66 licence** is a European certification issued by the EASA (European Union Aviation Safety Agency) to aircraft maintenance technicians. It authorises the holder to certify maintenance work carried out on aircraft and to sign off on their return to service.

► **The Emar 145 approval** concerns maintenance organisations certified on military programmes (base and line). SEGULA will obtain this approval by the end of 2025.

These two certifications guarantee a high level of technical expertise and compliance with the most stringent European aeronautical standards in terms of safety and quality.

COMPLIANCE WITH STANDARDS AND CUSTOMER SATISFACTION AT THE HEART OF AERONAUTICAL QUALITY

Quality in the aerospace industry is based on strict compliance with international standards, in particular EN9100, which covers all systems and processes in the sector (organisation, management, operational activities, but also sales, IT, purchasing, etc.). This certification is an essential prerequisite for meeting customer requirements and participating in calls for tenders.

Thierry Rousseau, Quality Director, emphasises that every operation, particularly those related to maintenance and production of aerospace parts, requires strict qualifications that are regularly renewed. 'Employees working directly with customers must be certified for specific processes. The aim is to ensure a high level of expertise throughout the project life cycle.'

Quality processes are subject to annual audits, conducted in particular by organisations such as AFNOR, to ensure compliance with standards and meet customer expectations.

Customer performance and satisfaction remain a key focus and are measured through a questionnaire submitted after each service. SEGULA obtained an average score of **17.8/20** in **2023**, then **18.2/20** in **2024**. This regular monitoring enables the group to remain attentive to customer feedback and to focus its actions on continuously improving its services.

Maintenance of military drones: a key challenge for the Armed Forces

The Army is constantly evolving to remain effective in today's tense environment and is equipping itself with state-of-the-art drones. To ensure their long-term effectiveness, the issue of their availability and maintenance is becoming central. Marc Normand, Technical Director at SEGULA Technologies, sheds light on the challenges and developments in a sector undergoing a digital revolution.

Reliable, fast and agile, drones are becoming increasingly common in both civilian and military applications. In the armed forces, these devices range from small models used for photography to aircraft-sized drones capable of carrying out support missions.

Each of them is subject to specific regulations and must undergo customised maintenance tailored to the needs of the defence sector: 'Today, the Army is seeking to opti-

mise drone availability, reduce maintenance costs, integrate digital tools to facilitate administrative and operational management, and train personnel in these new technologies.'

To meet these needs, SEGULA offers a digital solution developed in partnership with Armtek.

'The solution provides drone operators and maintenance technicians with the knowledge they need to carry out their tasks and report ope-

rationnal data from the field,' explains Marc Normand. 'It records comments and technical facts during maintenance operations, which are then sent back to the design office to enhance the value of the data collected and improve documentation.'

Thanks to this solution, the Army can monitor the status and availability of its drone fleet, while having a digital maintenance log for each aircraft.



'SEGULA's added value lies in bringing its expertise in helicopter maintenance and transferring it to the world of drones through a digital solution provided by Armtek.'

Marc Normand, Technical manager

Specialising in the integration of defence technologies, Armtek had already deployed this software on land-based military equipment.

The partnership with SEGULA, recognised for its expertise in aeronautical MRO (Maintenance, Repair, Overhaul), has enabled this solution to be adapted to the specific requirements of drone maintenance.

'With Armtek, we organised workshops to train operators in the operation and logic of the software.

In return, we provided Armtek with all the regulatory constraints related to drone maintenance. It is therefore our knowledge of all the regulations and aeronautical constraints that we have brought to bear in customising this solution.'

In the future, this solution could be extended to other sectors:

'Our common goal, once the solution is mature, is to offer it to drone users in the civil sector, but also to open it up to other areas beyond drones.'



Marc Normand,
Technical manager



This model was designed by the tooling team to present and test the solution to visitors at the 2025 Paris Air Show.

‘In a war economy, we seek to produce better, faster, and cheaper.’

In a volatile geopolitical environment, the defence sector must prepare for major challenges: producing faster and better, while ensuring equipment reliability and controlling costs. This requires genuine agility and industrial expertise. Alexis Nicolaÿ, Director of the Naval Defence and Security Business Line, explains how factory and production optimisation plays a central role in supporting acceleration in the context of preparing for a “war economy”.

Which major defence companies does SEGULA currently work with? How does the Group support them?

A.N. SEGULA has solid expertise in the aerospace and defence sectors, covering aircraft, submarines, frigates, wheeled vehicles, drones and other military capabilities.

We work with all the major French defence players. For example, we are involved in the production of the Rafale, and all future Rafale will incorporate SEGULA's work. Another example is in the naval sector, where we are involved in integrated logistics support, design, innovation and propulsion.

Thanks to our 15,000 employees and our design offices, which are highly

specialised in many disciplines such as calculation, simulation, mechanics and electricity, we can intervene throughout the entire programme life cycle, from detailed design to maintenance.

Due to the diversity of our customers, we maintain these high-level skills, which some manufacturers only use on an ad hoc basis. **We therefore act as an outsourced skills centre for them, providing rare and immediately available expertise.** When one of their programmes falls behind schedule, it is not uncommon for our customers to ask us to quickly reinforce their project in difficulty: in such cases, thanks to our already trained and operational teams, we can deploy a design office or a complete technical platform within a few

days, with a mix of ‘white-collar’ and ‘blue-collar’ profiles tailored to the needs of the situation.

Thanks to this expertise in defence professions and products, we are able to **recommend more efficient production methods** tailored to the specificities of the sector.

Precisely, in the current context of ramp-up, how do you optimise production processes?

A.N. To prepare for the war economy, defence manufacturers must produce better and faster, ensure the operational availability of equipment and meet budgetary constraints, in other words, do better with what they have and do more. To support them in meeting these

crucial challenges, we draw on our extensive experience in the automotive industry. This highly competitive sector has pushed our customers to optimise their industrial processes in order to produce faster, cheaper and with higher quality. Today, these best practices and feedback can be transferred to the aerospace and defence industries.

One of the most effective tools resulting from this expertise is manufacturing engineering, which enables the industrialisation process to be structured in the most efficient way possible. This involves drawing up a precise production plan and assessing the time, machinery and human resources required. **The aim is to ensure that the factory operates at maximum capacity.**

Another factor that enables ‘better production’ is supply chain management. In programmes as complex as those in the defence sector, this aspect is essential. That is why we assist our clients in qualifying and monitoring their supplier base. When it comes to creating new production capacities, we offer a comprehensive consulting approach that optimally combines existing resources with future investments. Finally, to improve production quality, we provide expertise as well as a wide range of tools that are increasingly based on AI functionalities. We can also assist our clients with project management and

site management, offering a wide range of services and, once again, innovative and high-performance tools.

In this dynamic industrial transformation, **the automation of production lines** can play a key role by reducing manufacturing costs and making processes more accurate, faster and more reliable. It also offers greater **flexibility to quickly adapt lines to variations in demand.**

What about maintenance?

A.N. Maintenance is particularly important in the defence sector, as it both extends the life of equipment and reduces downtime to maximise the operational potential of equipment in service with the armed forces. The more equipment is used, the more it is exposed to breakdowns, hence the need to optimise maintenance.

On behalf of our industrial and government clients, we carry out scheduled (regular) and corrective (ad hoc) maintenance. We also carry out predictive maintenance studies. Using on-board sensors (which generate operational data) and physical models, we model the probability of failure, for example based on the fatigue of a critical helicopter part depending on flight conditions. This makes it possible to anticipate failures or, conversely, to postpone

intervention if it is not yet necessary. In either case, the operational availability of the equipment is improved. Integrated Logistics Support (ILS) is also a key lever. Specialised engineers design everything that facilitates maintenance from the outset: documentation, spare parts, procedures.

What are the other major challenges facing the defence sector today for future programmes?

A.N. In addition to the ramp-up challenges associated with the war economy, we also need to prepare the operational capabilities of tomorrow. Designing an aircraft, an armoured vehicle or a submarine takes time. Faced with increasingly rapid technological change, a real challenge is to **develop scalable and modular operational capabilities from the outset** so that new features can be integrated more easily and deployed more quickly within the armed forces.

At the same time, there is a challenge to **integrate innovations available in the civilian sector very quickly and ‘militarise’ them.** The key is not to focus on high-performance but complex and costly technological marvels, but rather to favour simple, quick-to-produce and more numerous solutions. SEGULA has innovative proposals for this approach through its R&I activities.



INNOVATION

Innovation is essential to meeting the challenges of tomorrow in aeronautics and plays a major role in SEGULA Technologies' growth strategy. New materials, cutting-edge technologies and sustainable solutions are enabling us to rethink the performance, efficiency and environmental impact of aircraft. SEGULA supports its customers in exploring these new avenues to shape a lighter, cleaner and more efficient future.

In order to offer its customers solutions adapted to changes in the world and industrial practices, SEGULA is involved in skills sponsorship initiatives and certain industrial chairs to develop applied research. All 150 Research & Innovation projects carried out by the group are focused on ecological transition, and several of them have resulted in SEGULA patents.

BOOSTING THE AEROSPACE SUPPLY CHAIN WITH AUTOMOTIVE INNOVATION

The paradox: full order books, a strained supply chain

The aviation industry is in excellent health and performing very well. 'To cite just one example, aircraft manufacturer Airbus has orders for no less than ten years,' says Kevin Guerif. But behind this growth lies a much more complex industrial reality, rooted in the Covid-19 health crisis.

'This period has led to a significant loss of skills in the aviation supply chain, with early retirements among the most experienced workers and young talent seeking new career paths,' he explains. 'At the same time, some companies, weakened by the crisis, have found themselves limited in their investment and recruitment capabilities.' As a result, the supply chain is struggling to keep pace with the increase in production.

The dual driver of civil and defence

Aircraft orders are coming from both the civil and defence sectors. 'The environmental concerns of travellers who are conscious of their carbon footprint are not slowing down demand for aerospace,' notes Kevin Guerif. 'Rather, they are stimulating manufacturers' ingenuity to develop alternative fuels and more efficient and less polluting civil aircraft that incorporate advanced technologies to reduce their greenhouse gas emissions.'

In addition, the market is booming in Asia, which is set to become the world's largest, establishing China and India as new aviation champions. On the defence side, aerospace growth is even stronger. This is due to global geopolitical tensions in the Middle East, Ukraine and between India and Pakistan. 'Never in recent history has the military budget reached such levels,' he observes. 'France has an important card to play and, moreover, Dassault, the industrial spearhead of national defence, is mobilising its partners, including SEGULA, on its military programmes.'

While the aerospace industry is operating at full capacity with order books well filled, the supply chain is struggling to keep pace. Kevin Guerif, head of the French West Division at SEGULA Technologies, analyses this striking paradox and explains how experience in the automotive supply chain can come to the rescue of the aerospace industry.



Innovation as a solution

To support this boom in aeronautics and overcome logistical weaknesses, SEGULA can play a leading role by leveraging methods developed in the automotive industry. 'This sector is often one step ahead because, since the advent of Taylorism, it has become a master in managing the performance of its supply chain,' says Kevin Guerif. 'And we are able to implement best practices and technologies that we have developed for the automotive sector.'

Here, SEGULA uses artificial intelligence, digital twins and augmented virtual reality. This technological component is essential to make up for lost time in the supply chain and accelerate its transformation.

'In 2023, we created a dedicated department, SEGULA Transform. The team in this department is unique in that it draws on business expertise to add technological building blocks such as Big Data, Cloud Computing and AI. This is our strength and our added value.'

Comprehensive support for the supply chain

SEGULA uses artificial intelligence to intervene at all levels of the supply

chain, from industrial design to human resources, process optimisation and documentation. 'Take Airbus Helicopters, for example,' suggests Kevin Guerif. 'We were tasked with optimising the maintenance of NH90 combat helicopters to ensure that they return to flight as quickly as possible, fully validated and operational.' With this in mind, SEGULA has designed a digital application that tracks each stage of maintenance in real time, with a whole range of performance indicators. This tool radically changes the way the customer works and guarantees maximum flight hours for the aircraft by drastically reducing repair and maintenance time on the ground.

Another area of innovation in SEGULA's supply chain is human resources. Safran has entrusted SEGULA with upgrading the skills of its supply chain. 'In just 18 months, we were able to support their supply chain by recruiting and training 180 new talents from 18 of the group's sites in France. Mission accomplished, with the help of our teams and our AI tool SmartRecruiters! As a result, the Safran group was so impressed by our supply chain expertise that it has listed SEGULA Technologies as a key engineering and industrialisation partner. It's a success story we're really proud of!'

DRONES: allies for operator safety and mission efficiency

In an industrial environment undergoing rapid change, drones are becoming key tools for enhancing operator safety, improving efficiency and optimising operations, particularly in highly complex environments. With its expertise in engineering and innovation, the SEGULA Technologies group develops drone solutions tailored to the most demanding challenges in the field.



TotalEnergies project in Grandpuits: inspecting a high-voltage electrical substation

In 2024, SEGULA had the pleasure of supporting TotalEnergies on its Grandpuits platform (France) for the inspection of its 63kV high-voltage electrical substation. Traditional methods such as the use of cherry pickers or scaffolding were not only risky but also extremely difficult to implement in this confined environment, where every intervention represents a major challenge. To ensure maximum safety, SEGULA opted for a drone inspection.

The results? High-quality images, a fast and safe intervention, and a comprehensive diagnosis that enables TotalEnergies to efficiently optimise its maintenance and renovation planning.

ATLAS: REPLACING TRADITIONAL CONVEYORS ON ASSEMBLY LINES

Compact, intelligent and collaborative, this drone, developed by SEGULA, incorporates lifting capabilities. Four drones can lift a vehicle up to 1.80 m and move easily along the assembly line. This flexible solution can be adapted to other sectors and promises significant economic gains by reducing heavy infrastructure.



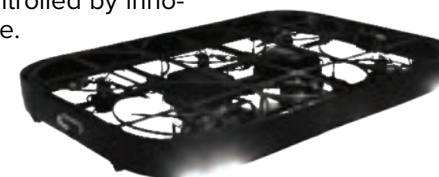
AROD: MONITORING COMPLEX ENVIRONMENTS

SEGULA Technologies has developed an embedded system for recognising and tracking moving targets using real-time image processing. This intelligent software enables surveillance drones to operate autonomously and efficiently in hard-to-reach areas. An innovative and easy-to-deploy solution for improving security in complex environments.



TOPONE: SECURING INSPECTIONS IN HAZARDOUS AREAS

Developed by SEGULA's Spanish teams, TOPONE enables safe inspection of power lines in tunnels, protecting technicians from the risks associated with confined spaces (lack of oxygen, harmful gases, high temperatures, etc.). The result of two years of research, this prototype incorporates advanced technologies: high-precision cameras, gas and temperature sensors, autonomous navigation and 3D modelling, all controlled by innovative software.



IMADRONE: MAKING INSPECTIONS OF HARD-TO- REACH AND ROUGH TERRAIN MORE RELIABLE

IMADRONE aims to make the inspection of engineering structures more reliable. An algorithm adapts the flight to weather conditions, such as gusts of wind, to ensure accurate and complete 3D reconstruction, even in bad weather. SEGULA uses image processing technologies to stabilise the flight and detect obstacles in all directions, without needing to know the area in advance.



DRONE H2: OPTIMISING THE ENDURANCE OF DRONES IN FLIGHT

Long battery life and fast recharging: fuel cells offer a promising alternative to traditional batteries. To exploit this technology, SEGULA has developed a 25 kg drone demonstrator equipped with a fast-filling hydrogen tank and a complete energy management system. An innovative solution for longer, more efficient and more environmentally friendly missions.



COMMANDO: SWARMS OF DRONES TO IMPROVE PRECISION AND SPEED OF MISSION EXECUTION

SEGULA Technologies has developed advanced control laws for piloting drone swarms. The aim is to improve the accuracy and speed of collective missions, while reducing the need for sensors for localisation. An effective solution for coordinating formation flights in surveillance, maintenance or mapping operations.



Hydrogen: the future of carbon-free aviation?

For Frédéric Claude, Head of Research and Development near Montbéliard in France, hydrogen represents a promising avenue for decarbonising aviation in the long term. This vision is shared by SEGULA Technologies, which has been involved in this innovative field for over twenty years.

A GLOBAL SHIFT TOWARDS LOW-CARBON AVIATION

Hydrogen is emerging as the solution of the future for a rapidly changing aviation sector. In 2022, players in the aviation sector gathered in Toulouse for the European Aviation Summit dedicated to air transport. The event resulted in the adoption of the Toulouse Declaration by 42 states and numerous stakeholders in the sector, committing to a zero-carbon target by 2050.

Among the decarbonisation options being explored, sustainable aviation fuels are set to play a key role. Hydrogen, in particular, is emerging as a major solution. SEGULA has been firmly committed to this path since 2005. This is a rare approach for engineering companies, where few players have a dedicated R&D department.

TWO TECHNOLOGICAL APPROACHES: DIRECT COMBUSTION OR FUEL CELLS

'In 2018, I conducted fuel cell tests on a drone. The aim was simply to show that it could take off, fly and land using hydrogen,' recalls Frédéric Claude. In aeronautics, two technologies currently dominate: direct hydrogen combustion and fuel cells.

Direct combustion, which involves burning liquid hydrogen in aircraft turbines, is a prin-

ciple that has already been proven in Ariane space launchers. It has the advantages of being compatible with current aircraft architecture, producing power comparable to conventional long-haul engines and reducing carbon emissions by 100% and nitrogen oxide (NOx) emissions by 80%.

Frédéric Claude is focusing his work more on fuel cells, which convert hydrogen into electricity to power electric motors. *'It's a very clean energy source because fuel cells emit nothing but water and are particularly efficient. Their energy conversion capacity is two to three times higher than combustion, reducing the climate impact by 75 to 90%. They are particularly well suited to low-powered aircraft.'*

A DIFFICULT BALANCE BETWEEN POWER, AUTONOMY AND LIGHTNESS

Since this initial work, Frédéric Claude and his team have launched numerous other research projects to improve their understanding of hydrogen systems. *'The difficulty in integrating hydrogen into aeronautics, even more so than in other sectors, is achieving the delicate balance between power, energy efficiency and the weight of the hydrogen system,'* continues Frédéric Claude. *'For example, aircraft using hydrogen combustion technology require 10 to 30% more energy than*

kerosene, mainly due to the weight of the cryogenic tanks that keep the hydrogen in liquid form at very low temperatures.' SEGULA is therefore seeking to meet the challenge of producing thrust equivalent to that of combustion engines using electricity, without increasing the weight and load of the aircraft.

Storing hydrogen is also a challenge, because the aircraft must carry as much energy in the form of hydrogen as kerosene provides, without increasing the overall weight. And while fuel cell systems are energy efficient, their weight remains a major obstacle.

LIGHTER FOR CLEANER FLIGHT

In practical terms, Frédéric Claude's R&D team works on designing complete hydrogen systems, from tanks to converters, for drones, zeppelins and light aircraft, according to the needs of client companies.

It supports them through to the prototype stage and proof of concept. *'We are working on using new materials to make fuel cells lighter,'* he says. *'And our research has already enabled us to produce low-power fuel cells weighing one kilogram per kilowatt. This is a real technological leap forward, as the current standard is five kg/kW. Some cells even exceed 5 kg/kW for those in the 2 kW range!'* Among their most notable innovations, the team is conducting research on "flexible" tanks for storing low-pressure hydrogen gas on board a Zeppelin airship. It is also developing converters to adapt the direct current produced by small fuel cells that operate at high current and low voltage. These are used to deliver voltage according to the requirements of the equipment. *'We couldn't find any converters from manufacturers that could meet our needs without causing too much energy loss and without being too heavy. So we decided to invent one!'*

RESEARCH FOCUSED ON EXCELLENCE

To remain at the forefront of their field, Frédéric Claude and his colleagues do not work alone. They are supported by PhD students, whose theses they supervise, and collaborate with renowned academic

laboratories such as Femto-ST, a world-class research laboratory associated with the CNRS, and FC-LAB, a service and research centre dedicated to hydrogen systems. This structure, located in Belfort (France), is part of the CNRS, the University of Burgundy Franche-Comté, the University of Technology Belfort-Montbéliard and the Ecole Nationale Supérieure de Mécanique et des Microtechniques. *'We also cooperate with start-ups,'* he continues. *'Our expertise spans mechanics, artificial intelligence, control systems and electrical engineering.'*

Their latest challenge is to develop and commission a test bench for in-house testing of low-power fuel cells. *'It will be operational in its dedicated room by the end of 2025,'* concludes Frédéric Claude. *'We even plan to produce our own hydrogen for these tests using an electrolyser, so as to guarantee optimal quality and continuous availability. This is a huge asset for the promising future of hydrogen in aeronautics!'*



Frédéric Claude,
Head of Research
and Development

AHEAD OF THE CURVE IN ENVIRONMENTAL ASSESSMENT IN THE INDUSTRY

Even when Life Cycle Assessment (LCA) was not a key concern for industry, SEGULA Technologies was visionary in creating a dedicated department years ago. Today, with LCA governed by ISO 14040 and 14044 standards and regulations becoming increasingly stringent, environmental assessment has become a key issue. SEGULA's experience enables it to respond effectively to demand from businesses, which has grown significantly over the past three years.



one environmental aspect leads to the deterioration of another. For example, a change made to a product to reduce its CO2 emissions may increase another environmental indicator at another stage of its life cycle.

This phenomenon highlights the importance of using multiple criteria in LCA to avoid shifting environmental problems rather than actually reducing them. The indicators most often used by SEGULA mentioned by Clara Delpech are those related to climate change, measured in kg of CO2 equivalents, the depletion of mineral and metal resources, and the depletion of fossil resources.

The four steps to a successful LCA

When Clara Delpech conducts an LCA to evaluate a product, she follows a rigorous four-step methodology in accordance with ISO 14040.

The first step is to define the objectives and scope of the study. The idea is to clarify the purpose of the LCA, the scope of the product study and the relevant parameters. 'It's in the second stage that we get into the nitty-gritty of the LCA,' explains Clara Delpech. 'This highly technical phase, which is essential for establishing a solid basis

for the study, requires a Life Cycle Inventory (LCI) to be carried out.'

At this stage, the client must provide a Bill of Materials (BOM), which lists precise details on materials, suppliers, modes of transport and energy consumption. 'If the client is unable to provide specific data that they have actually measured, I can work from generic data taken from databases, at the risk of straying from the reality of the product and producing a less accurate LCA.'

The third step uses the data collected in the second step to translate it into environmental indicators. This involves modelling the inflows and outflows during a product's life cycle using specialised software, such as LCA for Expert used at SEGULA. 'The difficulty lies in selecting the right data and favouring specific data over generic data. But sometimes we have no choice when the customer does not have the actual information,' explains Clara Delpech. 'This is particularly noticeable when modelling end-of-life. In this situation, I systematically apply the "worst-case" principle, in this case incineration or landfill at the end of life, when data is lacking.'

The final step is to interpret the results according to the chosen indicators and write a report, where the critical points of the life cycle are analysed and recommendations are made to reduce these impacts. This report serves as a reference for keeping track of the parameters and assumptions used in the LCA study.

Simplified, comparative or comprehensive LCAs tailored to your needs

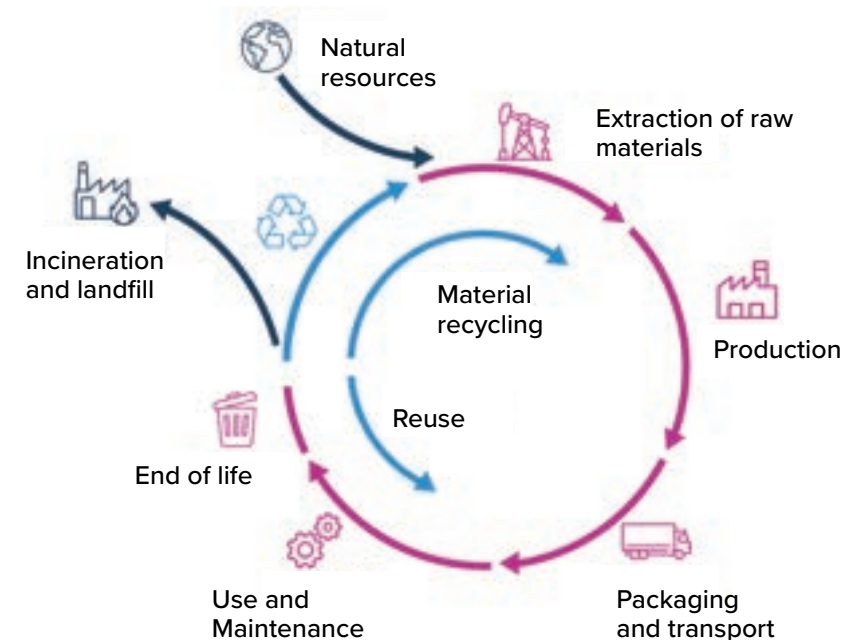
SEGULA offers three types of analysis – simplified, comparative and comprehensive – tailored to the objectives of each project. 'The simplified LCA is mainly for internal use, to provide visibility on the environmental impacts of the product concerned and to quickly guide eco-design or innovation choices,' explains Clara Delpech. 'It is an initial estimate, an effective decision-making tool between different hypotheses, sufficient to guide choices.'

SEGULA's clients request simplified LCAs to target priority areas for reducing their carbon footprint.



In addition, there is the comparative LCA, designed to compare two generations of products. It is based on a rigorous methodology, using homogeneous data sets to ensure consistency between the two versions of the products studied. The aim is to effectively quantify the environmental improvement of the new product compared to the previous range. Conversely, a full LCA represents a comprehensive analysis of the entire life cycle, carried out in accordance with ISO procedures.

It is preferably based on actual, measured data, for example to develop breakthrough materials or new aircraft. It allows detailed scenarios to be compared in terms of resin, fibre or process choices. 'We have produced Environmental Product Declarations (EPDs) for the bus manufacturer IVECO,' reports Clara Delpech. 'This project perfectly illustrates the complexity of our LCA work: the bus we studied had 13,000 different parts, and analysing it took several months of data collection from the client and its suppliers.'



Unique expertise at the forefront of LCA

SEGULA Technologies' LCA department stands out thanks to its unique position in the industrial landscape. 'While this activity is common within agencies dedicated to the environment, it is rare in a multi-activity engineering group,' emphasises the LCA engineer. 'Our advantage is our ability to identify and highlight critical environmental issues in a wide range of sectors (aeronautics, but also automotive, rail, space, naval, energy, etc.).'

The real added value lies in SEGULA's ability to support its customers in reducing the environmental impact of their products, in synergy with its other business lines, such as digital simulation and the development of innovative materials. Today, integrating life cycle analysis is no longer an option. It is a strategic necessity in order to meet regulatory requirements, satisfy market expectations and anticipate environmental challenges.

'I strongly advise aerospace manufacturers to prepare for this by raising awareness among their teams and streamlining information about their products. It is not technically complex, but it does require anticipation and a methodical approach.'

The answer to the conundrum of composite materials in aviation

In 2005, the Airbus 380 marked a decisive step forward, becoming the first civil aircraft to incorporate 25% composites into its structure at launch. More recent programmes, such as the competing Airbus A350 and Boeing 787 aircraft, have pushed this limit even further, with more than half of their structure made of composites, up to 53% for the A350. The trend is continuing, with new-generation aircraft making even greater use of these materials. In line with this dynamic evolution in aviation, SEGULA Technologies has been investing for many years in the development of new materials for aeronautics. Luc Becker, Composite Advisor and Collaborative Project Manager, and Loïc Durual, Composite Team Project Manager, explain.

What priorities must new composite materials meet?

Loïc Durual : In aeronautics, weight is enemy number one. Even though composites are already lighter than traditional metal alloys, manufacturers always want more. The goal is to make structures even lighter to improve aircraft performance and range while reducing fuel consumption and therefore greenhouse gas emissions.

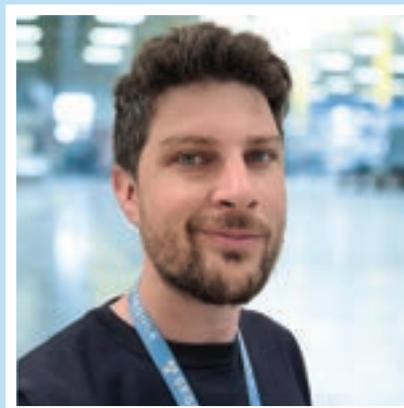
The environmental challenge is also key. Not all composite materials are equal in this respect. Epoxy, for example, is one of the most widely used resins in the aerospace industry. Used as a matrix in composites with carbon or glass fibres, it is lightweight, rigid, thermally stable and highly adhesive. But it is difficult to recycle. This thermosetting resin cannot be remelted once polymerised. That is why we are increasingly interested in thermoplastics such as PEEK, or polyetheretherketone.

Luc Becker : PEEK is indeed attractive to the aerospace industry because of its excellent mechanical properties, light weight and high thermal stability. This is because the thermal conditions of air travel are generally subject to significant temperature variations, ranging from over 50°C during a ground stop in summer to extremely low temperatures at a cruising altitude of 12,000 metres above sea level.

And unlike epoxy, which must be glued, PEEK can also be welded for cleaner, higher-quality assemblies, with the prospect of being remelted for a second life. Once heated, this polymer can be extracted and reprocessed, paving the way for strategies for reusing and repairing parts. But this solution comes at a cost. PEEK is a very expensive material, which currently limits its use to high value-added applications.

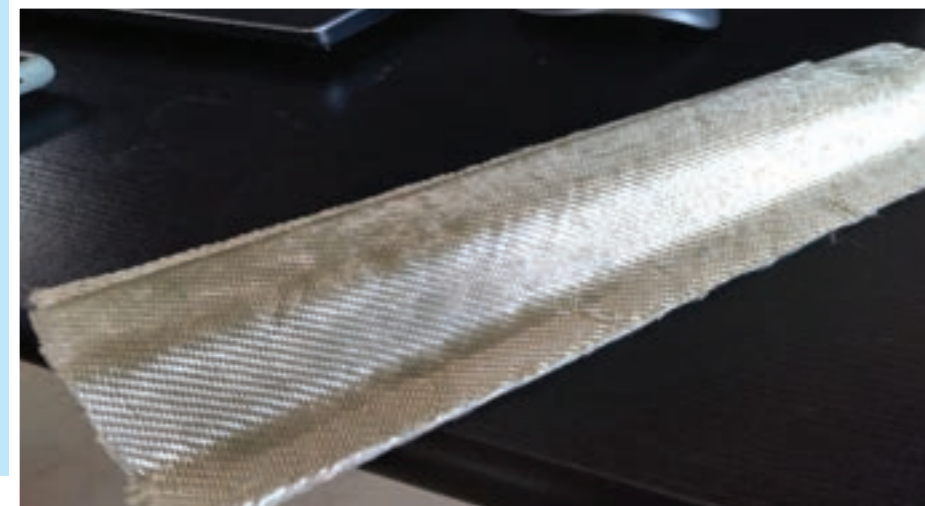


Loïc Durual,
Composite Team
Project Manager

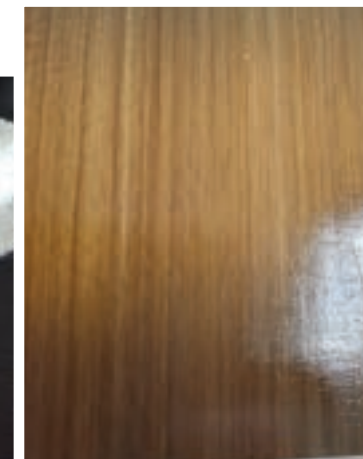


Luc Becker,
Composite Team
Deputy Project Manager

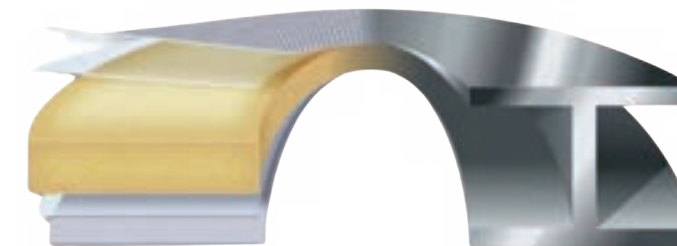
Modelling and simulation of an extrusion line for the development of innovative thermoplastic composites



Composite stiffener preform based on innovative thermoplastic materials



Pultrusion plate



From metal to composite

What challenges do you face in designing the composites of tomorrow?

Loïc Durual : When we talk about innovation in composite materials for aeronautics, the challenges go far beyond weight reduction or environmental impact. The choice of raw materials is a real issue. It's not just a question of fibre or resin. First and foremost, we need to find suppliers who can offer the right fibres, whether carbon, glass or textile, with the appropriate enzyme treatment to ensure good adhesion with the resin, with the aim of manufacturing composites that are lightweight, strong and durable. Such partners are still very rare today.

The second challenge lies in the development of the products themselves. Developing a composite is extremely expensive, especially

when it involves test plans as part of an iterative design process. Changing a single parameter, whether it be the manufacturing temperature, the proportion of fibres, the orientation of the layers in the material or the geometry of a part, can quickly increase the number of tests required. It is not uncommon to carry out 600 or even 1,000 tests before achieving the optimal version. However, carbon fibres can cost up to £50 per kilogram, and PEEK several hundred pounds per kilogram. In other words, each iteration must be carefully thought out in order to keep budgets within reasonable limits.

The final major challenge is assembling the parts. Three techniques (bonding, welding and mechanical assembly) are mainly used. Each has its advantages and limitations.

Adhesives, for example, can be a hindrance in certain parts of the structure and raise questions about recyclability. This must be taken into account when designing new parts. Welding is reserved for thermoplastic materials such as PEEK. It allows for single-material assemblies, which are easier to recycle and often more robust. Finally, mechanical assembly remains an option, but can make structures heavier.

Ultimately, every decision, whether it concerns raw materials, development or assembly, has a direct impact on performance, cost and sustainability. It is therefore essential to have an overview of each of our developments. It is precisely this cross-disciplinary expertise that we have mastered for the aerospace sector.

What are SEGULA's strengths in the field of composite materials for aeronautics?

Luc Becker : SEGULA stands out thanks to several key strengths. First and foremost is our cutting-edge expertise in numerical calculations and simulations, which is a powerful lever for accelerating innovation in the selection of raw materials, mechanical testing and component assembly. Thanks to these tools, we can significantly reduce costs and iteration times for new product development, and are now able to propose new ideas and prove that a material is functional.

We know how to model the behaviour of resin and fibres, optimise part design, play with a large number of process variants and consider every conceivable test without going through the manufacturing

stage, except at the end, particularly with a view to certification. This approach enables us to drastically reduce costs, but also to validate the reliability of new materials upstream.

This expertise is complemented by our ability to intervene throughout the value chain. SEGULA has all the skills required to support players in the aerospace industry, from formulation to industrialisation of parts, through extrusion or additive manufacturing, including life cycle analysis. We thus provide our customers with comprehensive, tailor-made solutions adapted to each aerospace project. Whatever the requirements for material optimisation, we have the capacity to meet them and have already

gained experience in this field. Another of SEGULA's strengths is our ecosystem of scientific partners.

By teaming up with research laboratories and suppliers of specific materials, we have permanent access to the latest advances in the materials sector, while at the same time conducting collaborative projects using our own funds to explore new avenues and remain at the forefront of innovation. It is this combination of expertise in digital simulation and a comprehensive overview that enables us to take on new challenges, both today and tomorrow. Rethinking composite materials, lightening structures and reducing the carbon footprint in aeronautics are all strategic areas in which we intend to play a leading role.

RESILIENCE PROJECT: INNOVATION FROM THE ROAD TO THE SKY

In 2024, Loïc Durual and Luc Becker combined their expertise within a multidisciplinary team (Design, Simulation, LCA, Processes, etc.) specialising in composites, as part of the Resilience project (Collaborative Projects Department), winner of the automotive and aerospace industry recovery plan.

Aimed at contributing to lighter, more sustainable and more efficient mobility, this project sought to fundamentally redefine the way vehicles are designed and manufactured, while offering considerable potential for all mobility sectors. In order to achieve the ambitious goal of reducing

weight by 40 to 50%, SEGULA Technologies and its partners focused on three key areas:

- ▶ A complete redesign that breaks with traditional architecture, while incorporating eco-design principles.
- ▶ The development of innovative, high-performance, sustainable, 100% recyclable and recoverable thermoplastic composite materials that can be integrated into structural parts.
- ▶ The search for new engineering processes to adapt these innovations to the production rates of the mobility sector, including land transport.

At the time, this goal seemed utopian. Challenge accepted! They began to validate a number of technological building blocks, thanks to the validation of a number of concepts (architecture, materials, manufacturing and processing methods), despite a demanding European regulatory framework, laying the foundations for a new generation of sustainable composites. Better still, the skills and implementation processes developed as part of the 'Resilience' project are fully transferable to the aeronautics sector. This opens up new applications and paves the way for promising developments.





↔ Fine deburring and quality control on a stainless steel casing



↑ Painting, touch-ups and metallisation



↓ Assembly and drilling

Painting in a booth ↓



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