SAFRAN

OUR IN-HOUSE MAGAZINE
NO. 5 — SEPTEMBER 2019

one

TEAM – BUSINESS – FUTURE

ONE TEAM

ONE BUSINESS

Marc-Antoine Colot, textiles engineer, Safran Tech (top). The CFM56® engine from CFM International has now logged over 1 billion hours in flight!

ONE FUTURE

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Design and production: - **Contents:** Cover: A. Daste / Safran, Editorial: P. Olivier / Capa Pictures / Safran, A. Daste / Safran, P. 3: T. Laisné / Safran, P. 4-5: B. Vallet / BABEL Safran, ESADP/Safran, M. CECENAS / Safran, P: 6-7: A. Daste / Safran, P. 8-9: R. Soret / Safran, T. Mamberti / Safran, C.Abad / CAPA Pictures / Safran, B. Vallet / Safran, P. 10-11: C. Sasso / CAPA Pictures / Safran, A. Brandan/Safran, P. 12-13: A.Marc / Safran, M. Robelet / Safran , H. Celin / Safran , E. Farnum / Safran, K. Radulph / Safran, Audimage / Safran P. 14-15: K. Radulph / Safran, A. Simon /Safran, O. Boyko /Safran, P. Boulen/Safran. P. 16-17: P. Olivier / Capa Pictures / Safran. P.18: A. Daste / Safran. P. 20-21: Air France / Cathay Pacific. P. 22-23: A. Daste / Safran, F. Rogozienski / Capa Pictures / Safran. P. 24-25: P. Boulen / Safran, P. Stroppa/Safran, Azul Brazilian Airlines. P. 26: R. Bertrand / Safran. P. 29: PepperBox., C. Abad / CAPA Pictures / Safran. P. 30-31: Freelances l'agence / Safran. P. 32-33: Airbus, T. Mamberti / Safran, C-E Bidard / Safran. P. 34-35: A. Marc / Safran. P. 37: C. Sasso / CAPA Pictures / Safran, C. Abad / CAPA Pictures / Safran, T. Mamberti / Safran . P. 38-39: R. Bertrand / Safran. P. 41: P. Stroppa / Safran. P.43: Freelances l'agence / Safran
Printer: Imprimerie Vincent.

Spotlight on green aviation at the Paris Air Show

Pivotal partnerships, innovations, contracts… The Paris Air Show, the global showcase for the aerospace industry, was once again a major success for Safran, reflecting the trust placed in us by customers and the public alike. The central theme of this year's show was managing the ecological aspects of air transport.

At Safran, we used this global stage to reiterate our involvement in key programs to reduce aviation's carbon footprint, starting with the electrification of aircraft. As we move towards "more electric" aircraft, we have to meet a number of technological challenges, not least reducing the weight of batteries so that larger aircraft can fly longer and further. In short, we have to meet several major milestones if we want to develop feasible all-electric airliners by 2050. Some of these objectives are close at hand. For instance, our propulsion systems are at the heart of several small aircraft which were showcased at *Le Bourget* and could enter service as soon as 2025: the EcoPulse™ with a distributed hybrid-electric propulsion system, or all-electric air taxis.

We have everything needed to make flying more eco-friendly, from technologies and know-how to values and a passion for what we do. By working together, we can rise to the challenge of making aviation green!

With vacation now over for most of us, we're "back in school". I hope you enjoy reading this very educational issue!

PHILIPPE PETITCOLIN,
Chief Executive Officer of Safran

ONE TEAM

SPORTS AND SOLIDARITY

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Fifteen athletes from Safran Transmission Systems took part in the 43rd Paris Marathon. They ran as a team, including two colleagues in wheelchairs, and finished with a time of 5 hours and 48 minutes.

SAFRAN ELECTRICAL & POWER: EXCELLENCE AWARDS IN MEXICO

The Safran Electrical & Power facility in Chihuahua, Mexico acknowledges the commitment and work quality of its staff every year. This year's awards recognized 238 employees, who each received a gift and recognition from senior management. The ceremony also reflects the effort and commitment needed to achieve industrial excellence.

INDUS'ART: WHEN WORLDS COLLIDE!

The "Customer Experience" project at Safran Helicopter Engines, dubbed Indus'Art, is designed to decorate our facilities for customer visits. Students from the *École supérieure d'art et de design des Pyrenées* have created artworks displayed along the main road at the Bordes plant in southwest France – a fusion of the worlds of art and industry.

25

Bruno Dambrine, a Safran distinguished expert in composite materials, has joined the Group's inventors and creators gallery at the Safran Paris-Saclay site. Bruno retired just a few months ago, but he's the one who designed the 3D-woven composite fan on the LEAP. The gallery now has 25 members.

WOMEN@SAFRAN INITIATIVE EXPANDS

Launched back in 2016 in France, our Women@Safran meetings allow female employees to discuss their careers and also hear talks by women recognized for their accomplishments, who discuss their careers and challenges. This initiative has now been expanded to the United States and Mexico, with the support of Beth de Young, VP Business Development, Aircraft Interiors Lease Customers at Safran Seats. The aim is for women at Safran to develop their networks and also share experiences and best practices.


SAFRAN
POWERED BY TRUST

FRANCE

2019 Paris Air Show

The 53rd Paris Air Show, in June 2019, proved to be an excellent vintage edition for Safran, with an expanded presence, record orders, prestigious visitors and much more. We take a closer look at France's very own "Le Bourget".

The Paris Air Show, or Le Bourget as it's known in France, is the world's leading aerospace exhibition and trade show. Held every two years at historic Le Bourget airport north of Paris, it features some 2,500 exhibitors and over 140,000 trade visitors. Even more than previous shows, the 2019 edition provided an excellent venue for Safran to spotlight its expertise and the breadth of its businesses.

GOING ELECTRIC

Specific areas at the main exhibition stand showcased Safran's different business sectors – propulsion, aircraft equipment, defense, data analysis and services, etc. – as well as the newly added aircraft interiors and aerosystems businesses. The increasing

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› electrification of aircraft was a focus of Safran's presence this year.

The overriding theme of this year's Paris Air Show was the environment, and the aviation sector's efforts to reduce its carbon footprint. *"Aircraft electrification addresses several objectives,"* explained Robert Vivier, head of innovation programs at Safran. *"First, it helps reduce fuel consumption and emissions, because electrical systems are generally lighter than the hydraulic and pneumatic systems they replace. Secondly, these systems are easier and cheaper to maintain. At the same time, they increase efficiency, because of greater operational flexibility."*

However, while "all-electric" aircraft harbor tremendous potential, we're still at the beginning of this learning curve. Safran is already conducting extensive research in areas that hinder development, including battery energy density and weight, management of high-voltage systems, protection of vehicles and passengers, certification of these new types of aircraft, etc.

"The first applications, some already in service and others on track, concern non-propulsive, low-power functions, such as starting, deicing, air conditioning, braking and flight controls," notes Robert Vivier. *"For electric propulsion, we're first looking at smaller aircraft such as delivery drones, vertical take-off and landing (VTOL) air taxis and micro-hybrid helicopters to gradually gain experience and mature these technologies, so we can develop larger platforms, such as commuter planes with six to nine seats, or even regional aircraft."*

Safran's stand at the air show reflected this strategy, with two podiums showcasing our expertise in aircraft electrical systems and electric propulsion – the e-Power zone. In a private showroom in the center of the stand, reserved for customers and partners, Safran displayed its innovative, even disruptive solutions to address the critical challenges facing aviation: energy and the environment, autonomous vehicles, additive manufacturing, new materials and artificial intelligence.

At the same time, Safran committed to developing greener aviation by teaming up with 22 fellow European companies to sign a joint statement encouraging a European partnership to largely eliminate carbon emissions by 2050. Safran also announced the formation of a partnership with Daher and Airbus to design and build a distributed hybrid propulsion aircraft demonstrator, dubbed the EcoPulse™, with Safran providing the propulsion system. Furthermore, Safran was one of the main exhibitors in the Paris Air Lab, a venue dedicated to innovation and long-term planning, located in the Concorde hall. Several Safran companies spotlighted their products and research work on five different stands: Tomorrow's Air Mobility; Cleaner and Quieter Aircraft, New Energies for Aerospace; Sustainable Aviation Fuels; and Big Data and Artificial Intelligence.

The largest order in the history of CFM, in terms of number of engines: Indian carrier IndiGo opted for the LEAP-1A to power 280 Airbus A320neo planes, including spare engines. This was a highly symbolic choice, since IndiGo had previously selected the rival engine. The contract is worth over $20 billion.

SHOWCASING SAFRAN

Always a key opportunity to raise Safran's profile, the Paris Air Show also allows the Group to welcome a number of official delegations.

The 2019 show marked the first time that Safran Seats, Safran Cabin and Safran Aerosystems appeared under the Safran banner. *"This isn't the main event for our business sectors, but for our image it's important that we take part,"* explained Walid El-Ghoz, head of business development for aircraft interiors. *"We always meet with both airlines and planemakers at the show. Joining Safran is particularly significant for us: our customers hope that it will help us quickly restore operational performance."*

Another major highlight of this year's show was record-setting business, with more than 1,150 orders and commitments for CFM International LEAP® engines, including long-term service contracts. These orders are worth $50.2 billion at list price, more than double Safran's annual revenues.

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After inaugurating the show, French President Emmanuel Macron visited the Safran stand. Ross McInnes, Chairman of the Board, and Philippe Petitcolin, Chief Executive Officer, showed off a few of our flagship products.

Over 100 years old, and more popular than ever! Since kicking off in 1909, the Paris Air Show has showcased some of the most iconic airplanes in aviation history. Once again this year, the static display attracted a large stream of visitors.

20 minutes to learn everything you always wanted to know about the electric future of aviation! Daily e-Power talks on the Safran stand explained the challenges involved in electrifying aircraft, and the skills and expertise that Safran brings to the table.

Volunteer staff on the Safran stand in the Careers Plane show how virtual reality is used in nacelle maintenance operations.

“I wanted to convey my passion for aviation and maybe even inspire some students to choose this profession… They were very surprised at how technical it is.”

CYRILLE NESNARD
Fitter, Safran Seats,
and participant in the Careers Plane

› VOCATIONAL INSPIRATION

The last major aspect of Safran’s participation in the show was recruitment, with demonstrations of various professions and an employment-training forum in the Careers Plane hall. *“These events were designed to promote our products and professions in the eyes of young visitors, from junior high to university students, who aren’t necessarily familiar with our business sectors or technologies,”* noted Keltoum Mirabel, Safran employer brand manager at the time.

Cyrille Nesnard, a fitter in the aircraft seats sector, volunteered to show what his job entails. *“I wanted to convey my passion for aviation and maybe even inspire some students to choose this profession. I was asked a lot of questions about how we assemble seats and how to become a fitter. The students were very surprised at how technical it is.”*

Not far away, an 8th grade student performed maintenance operations using a virtual reality system with a controller in each hand. *“I love watching airplanes fly,”* she said, *“and when I do an internship next year, I’d like it to be with a technology company.”* Next in line at the controls was a high school junior, who added, *“I’m fascinated by virtual reality… I knew how it worked in flight simulators, but not for maintenance.”*

After the first four days dedicated to trade visitors, the show opened its doors to the public for three days over the weekend. Whether children or adults, real aerospace buffs or just curious, they strolled through the endless aisles in the show, asked endless questions and marveled at the flight demonstrations, the highlight for most visitors. ■

AROUND THE WORLD OF SAFRAN

Introducing a team and six individuals from Safran companies, for a quick look at their career paths and vision of Safran.

Initium Aerospace

Safran Power Units, San Diego, California, United States

In May 2019, Philippe Petitcolin, Chief Executive Officer of Safran, and Stan Deal, President and CEO of Boeing Global Services, inaugurated Initium Aerospace, their new equally-owned joint venture for auxiliary power units (APU).
The ceremony took place in San Diego, and was attended by employees from both Initium Aerospace and Safran Power Units.

Guadalupe Arciga

Quality inspection supervisor,
Safran Cabin, United States

"I manage the Safran Cabin quality team at our Huntington Beach plant in California. Day to day, I oversee customer satisfaction by making sure that our products are always made according to the defined process. My objective is to train my team to comply with all quality, delivery and safety standards so we can supply flawless products."

Yann Burban

Machining-Micromechanics cell leader,
Safran Electronics & Defense, France

**"Here we do very-high-precision machining of mechanical parts. This is an expanding sector that demands expertise, rigor, compliance with health, safety and environmental rules, and advanced technical knowledge.
One of our top priorities is passing on these values to new hires."**

Abdellah Abadi

Machinist at the integrated forge-production unit in the rotating parts center of excellence,
Safran Aircraft Engines, France

"I coordinate a team of five operating the 80-ton drop hammer. We give forged parts their final shape before sending them off for heat treatment. This kind of job demands rigor, a sense of responsibility and safety, vigilance and presence."

Don Gardner

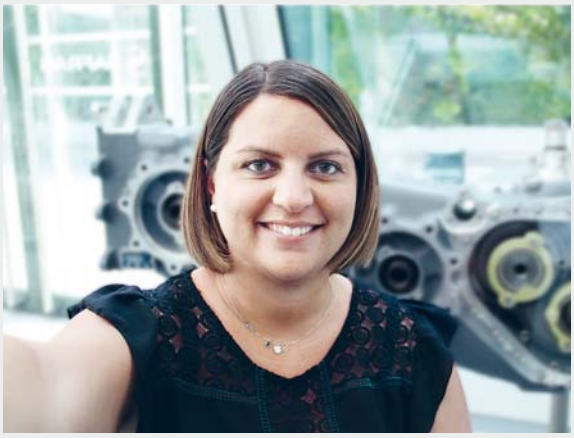
Production Manager,
Safran Oil Systems, United States

"Since joining Safran Oil Systems in 2011, I've worked in various job fields. Starting as a test engineer, I became a process and development manager, then a production manager. I also saw our entity change from an R&D shop to an integrated production center for oil reservoirs. We couldn't have done it without teaming up with Safran Aero Boosters in Belgium."

Aurélie Dhulut

External workflows manager,
Safran Transmission Systems, France

"My main role is to make sure that our assembly lines are given the right number of parts (gears, shafts, tanks and fasteners) so we can avoid any production shutdowns. We have to keep an eye on suppliers so they meet their deadlines and send parts to spec."



Firas Ben Hamed

Production engineering methods
engineer, Safran Seats, Tunisia

"I'm currently in charge of an innovation project to automate the positioning, programming and machining of composite panels for seat shells. We aim to improve efficiency and come up with ingenious solutions to meet our customers' quality requirements. It's an innovative job."

INNOVATION INITIATIVES: FEEDBACK FROM OUR COMPANIES

Innovation is a prime driver of Safran's performance and the continuous improvement of our products and services. To learn more about how our companies foster employee innovation, we asked five of our people to share their stories.

JORGE RODRIGUEZ-BRINGAS
Black Belt in the Improvement Department, Safran Transmission Systems

"Here at Safran Transmission Systems we set up the employee-driven innovation (EDI) of the month award to spur the creation of ideas that would boost our performance and enrich our daily lives. Each month, an idea applied within each of three categories earns an award: health, safety and the environment (HSE); product/process improvement; improvement in daily life. Our EDI correspondents select the best innovations according to three performance criteria: quick and simple application; reduced waste and/or risks; impact and influence in the company. To promote this initiative we also publish a monthly news release on the employee-driven innovation of the month, which is sent to managers who share it with their teams." ■

YVES BLEY
Vice President, Engineering Safran Engineering Services

"In 2017 and 2018 we organized a major Innovathon lasting more than 24 hours for teams from France and Morocco. Prior to this event, employees could register ideas on our dedicated app, for a product innovation, a new service or an improvement in our processes. Once the idea has been selected, a team is formed and uses the Innovathon to develop the idea and then present it to a jury comprising members from company and Group management. A pivotal part of our innovation approach, this event has two main benefits: it energizes the company's image and also underpins the development of new services. At the same time, it fosters employee motivation, networking and mutual trust, which will unify and strengthen our company going forward. In 2018, we had 80 participants. And since we have expanded this initiative to our international locations, there should be even more this year." ■

WE LOVE INTRAPRENEURS

From March to June, the seven intrapreneur teams from season 1 spent nine days with teams from the EM Lyon business school, who helped them complete their projects and draw up business plans.
Two of these projects made it to the in-house accelerator at Safran Paris-Saclay in early July, so the teams can work full-time on their projects for several months.
Season 2 is now open to candidate teams from around the world.

KYLE SCHMIDT
Vice President, Product Development and R&T Engineering Safran Landing Systems

"Our employees don't always have time during the day to look for innovative new ideas. That's why we decided to organize the Techno-Challenge, an incubation contest in which members of the engineering department submit an idea to the company's senior management and experts. The first step is to procure in-house funding and find the time needed to quickly prototype and test the concept. Subsequently, the concept could become a research and/or technology project.
"This initiative fosters an innovation culture, and results to date have been excellent. Several projects have already led to prototypes being built and 18 invention disclosure forms are being prepared. Our in-house contest has a promising future, with the latest challenge now slated for late 2019 or early 2020." ■

STÉPHANE TIREL
Project and Industrial Transfer manager Safran Nacelles

"Safran Nacelles has launched an initiative called ECRIN, the French acronym for creativity and innovation space (and the French word for "envelope"), to give employees the help and tools needed to come up with innovative ideas and build models. I participated in a session on 'more aerodynamic nacelles' where I came up with the idea of a thrust reverser without actuating rods, to decrease drag.
Still, it takes time and energy to assess the technical or technological potential of an idea. You have to really study it, weigh different opinions, defend it and prove its validity. And that in turn demands perseverance and a methodical approach, more than just throwing money at it. Plus, you have to carefully choose team members, keep an open mind and not lose focus. People are still the key to innovation!" ■

WOVEN COMPOSITE MATERIALS

Marc-Antoine COLOT

Textiles engineer, Safran Tech

Marc-Antoine Colot has worked at Safran Composites, the Safran Tech research center for composite materials, since 2012. His job is to develop and optimize new innovative processes for 3D-woven parts on upcoming engines, and also support production of these parts for the LEAP engines powering the Boeing 737 MAX, the Comac C919 and part of the Airbus A320neo commercial twinjets.

8:00 AM

We have a team meeting with the technicians from the weaving shop, led by the shop manager. This is an opportunity for me to make recommendations on issues such as machine problems or production difficulties.

Today we're taking delivery of a new-generation weaving machine designed to make prototypes of preforms for aircraft parts, such as fan blades based on carbon or ceramic fibers. Since the loom is only the first step in a long process, I take charge of commissioning and defining the settings needed to enhance production.

9:30 AM

2013
First loom installed at Safran Composites.

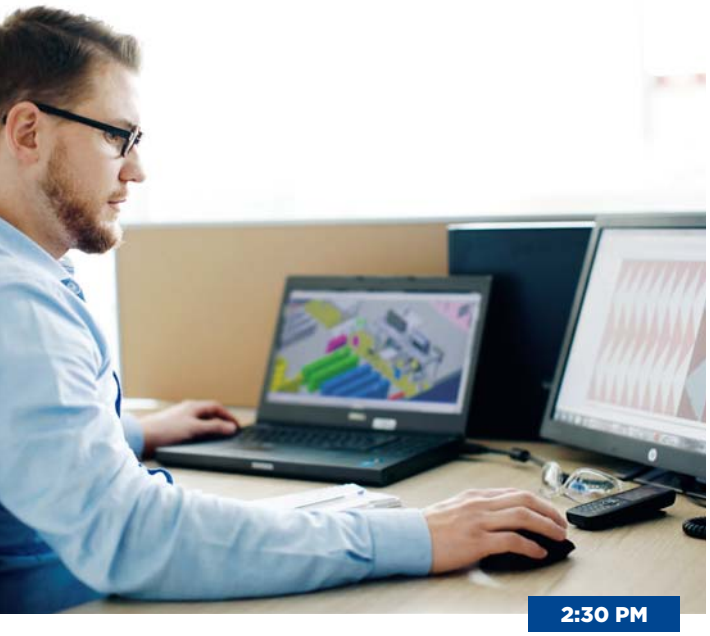
1.5
Number of months of programming needed to make the preform for a fan blade.

2024
Possible service entry date of the new ultra-high-bypass-ratio (UHBR) engine, which would make large use of these materials.

20
textile engineers working for Safran, including three at Safran Composites.

11:00 AM

When we make fan blades there are always a certain number of non-woven threads left, considered scrap. Along with a textiles expert we are studying ways to reuse these threads. For example, we could transform them into new fibrous materials for use on future applications at Safran.



2:30 PM

5:00 PM

Left: Using weaving software, I'm working on the definition of a 3D-woven part that's expressed as textile data. I create patterns showing the path of threads in both warp (width) and weft (length). Each thread will thus be precisely positioned for the production of 3D-woven preforms.
Above: My colleague is using a cold cutting technique, based on a high-pressure water jet. I then check the cut part against the specifications defined by the customer's design department.

ONE BUSINESS

RECORD

THIS SPRING, THE GLOBAL CFM56® FLEET PASSED THE MILESTONE OF 1 BILLION FLIGHT HOURS.
In less than four decades, planes powered by these engines have carried more than 35 billion passengers! To date, over 33,000 CFM56 engines have been delivered to 600 customers worldwide.

#1

On June 13, a Patroller™ drone from Safran Electronics & Defense took to the skies at the French defense procurement agency DGA's flight test center near Istres, northwest of Marseille. The first test in this final industrial qualification stage was hailed by French armed forces minister Florence Parly at the Paris Air Show: *"The first qualification flight with Safran's tactical drone system has been successfully completed. Feedback is positive and it's looking great for the rest of the program!"* Since the very first trials, Patroller has shown it fully meets its design criteria. The first complete system, comprising five aircraft and two ground stations, is already in production for delivery to the armed forces later this year.

BIG DATA

In a talk at the MRO Americas event in April 2019, Safran Analytics showed how clever use of big data can reduce costs and improve predictability of certain types of incidents.

1,000TH A320NEO NACELLE

In June, Safran Nacelles delivered its 1,000th Airbus A320neo nacelle. The LEAP®-1A powered plane is for TAP Air Portugal. Responsible for the design and integration of nacelles on these engines (in conjunction with Middle River Aerostructure Systems), the company is pursuing an ambitious industrial strategy to keep pace with unprecedented production rates, deploying robots and automation on production lines, Lean-Sigma methods, an international supply chain, smart assembly carts, etc.

CIRRUS, A GAME-CHANGER IN BUSINESS CLASS

Cirrus is the company's top-selling business class seat, with almost 18,000 delivered to date. We look at the milestones in this major success for Safran Seats.

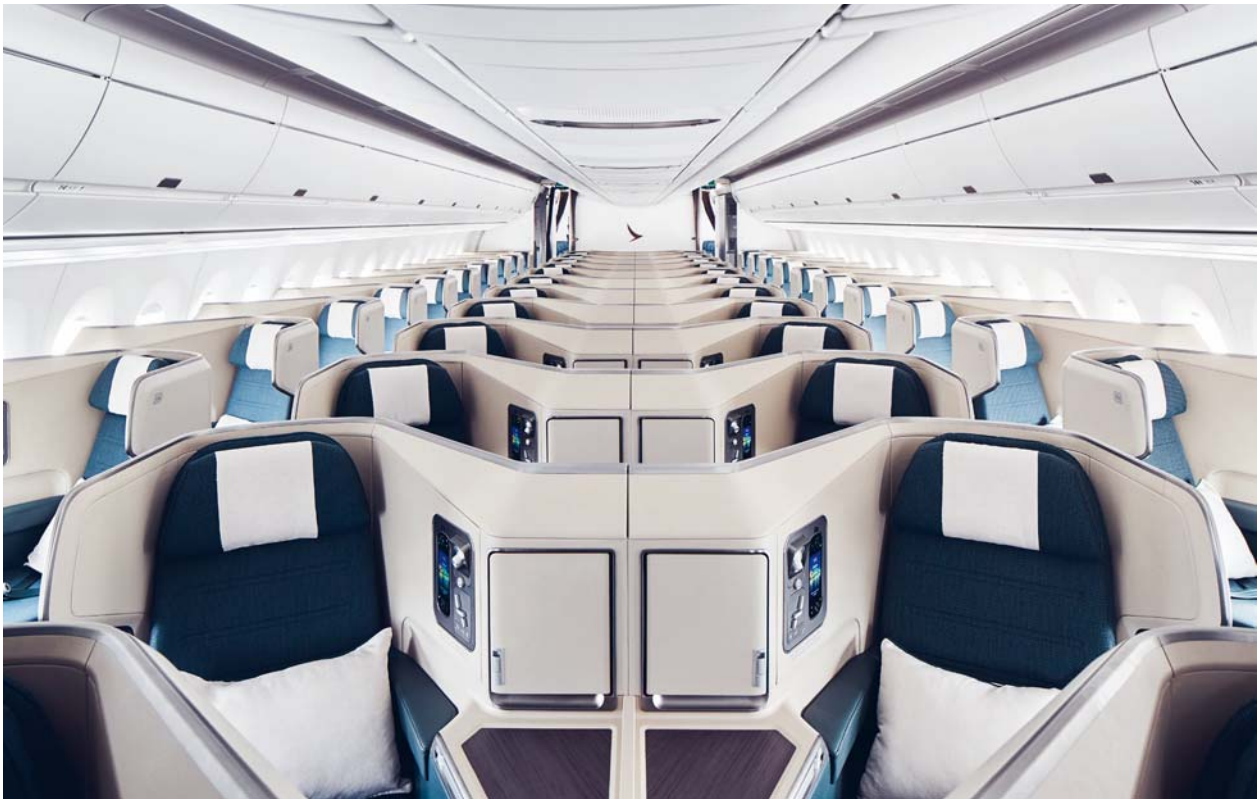
Air France chose a highly customized version of the Cirrus.

In the late 1990s, British Airways introduced a disruptive new concept with the first "full-flat" seat in business class. Supplied by Contour (now Safran Seats GB), it gave passengers unprecedented sleeping comfort. At the time, Contour, Sicma (now Safran Seats Issoudun), Avio and B/E Aerospace were all touting their angled lie-flat seats, which recline but aren't fully lie-flat.

A NOVEL DESIGN

In 2006, US Airways (later merged into American Airlines) issued a request for proposals for its Airbus A330 fleet. Safran Seats Issoudun responded with a novel concept, the Cirrus.

"Our sales guys didn't have a mockup to show them," recalls Walid El-Ghoz, then head of sales for Safran Seats Issoudun. *"We were running behind our competitors. Yet US Airways were so impressed with the concept that a PowerPoint was enough to convince*



Cathay Pacific Airbus A350. With Cirrus, the business class cabin offers a "full-flat" bed and direct aisle access for all passengers.

them. In 2008, the Cirrus made its first flight." Seats in a "herringbone" configuration were already in service, of course, but with this new concept — "reverse herringbone" — the window seats actually face the window, so passengers can look outside. They also enjoy privacy, direct aisle access and a lie-flat bed. *"The beauty of Cirrus is that all seats in the cabin are equally premium,"* says Jean-Christophe Gaudeau, marketing director for Safran Seats. *"This is a key factor for airlines, as is the seat angle, which can be adjusted to suit varying cabin widths, allowing us to offer a single product for an entire fleet."*

Cathay Pacific was the second Cirrus customer. This much larger order was for two aircraft types, the Boeing 777 and Airbus A330. With Cathay, the Cirrus effectively set a new standard for business class seats in the 2010s. Off-the-shelf and customized versions were sold to Delta Airlines, Eva Air, Air France, Finnair, China Eastern and, more recently, Virgin Atlantic. The Cirrus was emulated by rivals, and the reverse herringbone became a standard marketplace model.

However, between 2013 and 2015 it was beset by two major crises. First, new certification rules to help prevent passenger injuries required an upgrade to three-point harnesses. And Safran Seats began experiencing production issues. With the company's integration into Safran in 2018, however, the end of the crisis is now in sight, based on a number of strategic initiatives and the introduction of Group methods such as One Safran.

THE NEXT GENERATION

"The Cirrus is nonetheless a remarkable achievement," says Jean-Christophe Gaudeau. *"Indeed, it's our biggest sales success, one that has been widely emulated and also shaped the market for a decade!"*

Today, Safran Seats is focusing on the future. In April, at the Aircraft Interiors Expo in Hamburg, it unveiled the latest-generation herringbone type business class seat. The Versa is a real step forward, driven by changing markets, technological advances and the competition. It's built on a new modular platform approach to development, which maintains a high degree of personalization for airlines but also allows us to streamline production (*see also* One No. 4, *p. 42*), which is a key success factor in the business class market today. ■

CUSTOMERS RAVE ABOUT SAFRAN'S IFE!

With more people flying than ever before, in-flight entertainment (IFE) has become a key differentiator for airlines. Safran Aerosystems has unveiled its enhanced RAVE™ Ultra system, which offers an even-more connected passenger experience.

Designed and developed by Safran Aerosystems, the RAVE™ — Reliable, Affordable and Very Easy — in-flight entertainment system enables airlines to offer passengers a richer experience, thanks to a host of innovative technologies.

Chosen by over 45 carriers to date, RAVE offers a huge variety of entertainment and information choices, from recent movies and TV shows to music and interactive maps, with a vast catalog of content and things to do. For the thousands of users, RAVE also means connectivity. It provides high-speed WiFi internet access, as well as a GSM and 3G data transmission network that automatically starts up when the plane reaches an altitude of 10,000 feet (3,000 meters). To stand out from the crowd, Safran Aerosystems has taken its range of entertainment solutions for airlines to another level with the new RAVE Ultra system.

SLEEK AND CLEVER

Building on its award-winning RAVE solution, Safran Aerosystems has raised the bar even higher, with a reworked design, improved performance, easier maintenance and better connectivity. This new system, unveiled at Aircraft Interiors Expo 2019 in Hamburg, Germany, incorporates the latest advances in IFE. RAVE Ultra is 30% lighter and thinner than the previous version, making it easier to integrate into seats. Keen to support an array of cabin customization options, Safran Aerosystems offers screen sizes from 13.3 to 32 inches, compatible with all seats on the market today.

A 4K HD EXPERIENCE

The lighter, slimmer RAVE Ultra is also the first to offer a 4K high-definition in-flight experience. Passengers not only enjoy unmatched resolution, but thanks to the system's more powerful processor they can run multiple tasks in multiple windows, with multitouch functionality. Innovations also extend to RAVE Ultra's screen format, with totally minimized borders and a thinner profile for easy installation. Coupled

RAVE Ultra screens in various sizes at Aircraft Interiors Expo, Hamburg (Germany).

COMING SOON

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Safran Aerosystems is the first to offer 4K screens and Bluetooth audio for all airliner types. The company has already booked orders for the new system, with first deliveries in 2019 and commercial service entry in late 2020.

The RAVE Ultra screen weighs just 680 grams and at 8 millimeters it's as slim as your iPhone.

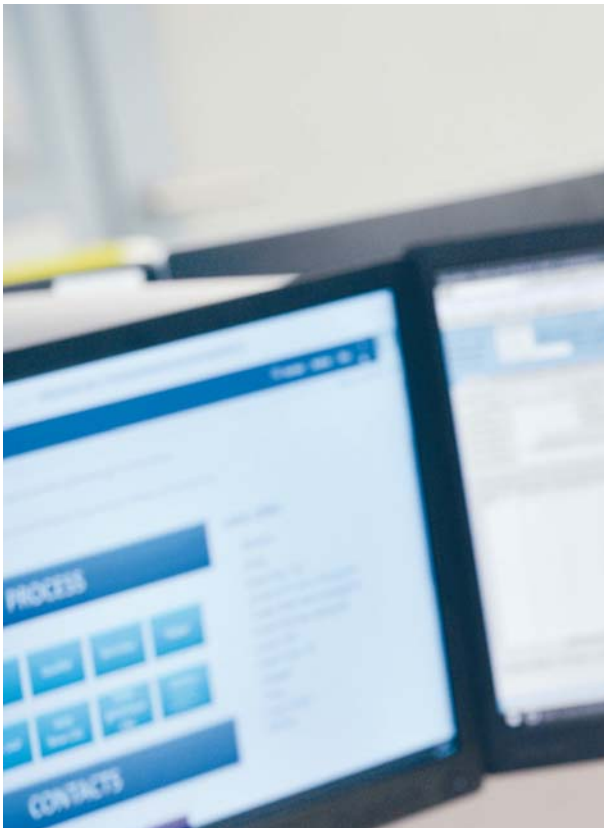
with the screen is a software platform that gives airlines the option of running any number of third-party applications to create a personalized in-flight experience.

BLUETOOTH FOR ALL

Each seat screen also features Bluetooth audio functionality. Due to frequency interference with other passengers, only 20 airline-provided headphones could previously be paired at the same time. But with the new RAVE Ultra system, all passengers can wirelessly connect via Bluetooth and enjoy content on their devices and audio via their own headsets. ■

NACELLELIFE: SUPERIOR SERVICES

Just a year after being introduced, the NacelleLife™ support package from Safran Nacelles has already won over 24 airlines. It features custom-tailored and flexible solutions to support operators throughout the service life of their nacelles. We take a closer look at this carefully planned success story.



A STRATEGIC MARKET

Azul, Corsair, Kuwait Airways, Loong Air… to date, 24 airlines have already opted for NacelleLife to service their nacelles. Launched in April 2018, this new service line reflects Safran Nacelles' product support strategy: work closely with customers by providing tailored solutions at every stage of the life cycle, from preparation for service entry to end of life.

"Services are a major source of revenues and also a growth driver for Safran," notes Paul Abribat, head of services at Safran Nacelles. "*But there are a number of competitors in this sector, including the airplane manufacturers themselves. We therefore revamped our offering to make it clearer. Under the new NacelleLife brand, we're offering a more targeted and better organized array of services, which makes choices clearer and facilitates sales. Services are simpler and clearer, allowing us to spotlight the advantages of our solutions and develop packages custom-tailored to user needs. This gives us the image of a comprehensive service partner, while also retaining the agility of a specialist."*

ENHANCED PROFESSIONALISM

The organization of teams and services has also been revamped. As Paul Abribat explains, *"Each customer now has a single contact person to help develop a closer relationship over the long haul. We have also added a number of innovative solutions, such as our JetLife mobile app, which makes it easier to read Service Bulletins online, and Presto, a system using infrared thermography to detect overheating in composite parts."*

The new contracts mainly cover three aircraft types. *"On the Airbus A320neo, we are primarily offering access to shared inventories to enhance equipment availability,"* explains Abribat. *"This gives airlines peace of mind, since they don't have to make major investments in building up their own stocks. For the Airbus A330 and A380 at mid- or end-of-life, airlines are generally opting for preventive maintenance and repair solutions to hold down service costs and reduce unscheduled events."* With the ongoing growth of A320neo and A330neo fleets, NacelleLife is set to be more successful than ever! ■

"Our NacelleLife services address strong demand from customers. It clarifies our position in the market and shows how we can help them operate their nacelles even more efficiently."

PAUL ABRIBAT
Vice President, Services, Safran Nacelles

Safran Nacelles offers
24/7 customer support
to meet airline requirements.

LEONARDO ZERBONE DA COSTA
Head of Supply Chain,
Azul Brazilian Airlines

—

"At Azul, our priority is to meet our commitments to customers in terms of on-time performance. We therefore form partnerships based on mutual trust with equipment suppliers such as Safran Nacelles, since they're capable of offering top-flight support solutions. With NacelleLife, for instance, we can guarantee the availability of our Airbus A330 fleet thanks to access to their global stock of spare parts. This helps us ensure service continuity by minimizing disruptions and reducing maintenance costs, while avoiding having to build up a large, expensive inventory of spares. We can therefore focus on reducing operating costs and meeting our primary objective, namely to give our customers the best service at the best price." ■

Above : Developing repair solutions.
Left : On-wing servicing.

XATIS: SOFTWARE FOR SYSTEM ARCHITECTS

In 2013, teams at Safran Engineering Services, a subsidiary of Safran Electrical & Power, introduced XATIS software to simplify and optimize the work of system architects. Based on the "Develop" process defined in the One Safran initiative, XATIS now has 350 users across Safran. We take a closer look at this powerful design tool.

The Safran Engineering Services team in Bordes introduces XATIS.

WHAT IS XATIS?

› A methodological guide integrated in a single software package, in line with the "Develop" process as defined in One Safran.

› Fast modeling, enabling engineers to evaluate and compare several technical solutions.

› Traceability to conduct agile impact analyses and help choose components.

SYSTEM ARCHITECTS, THE PILLARS OF PRODUCT DESIGN

System architects are at the heart of the "Develop" process as defined in the One Safran initiative. Working closely with the project manager, they guarantee the technical aspects of product design. At the same time, they take part in co-engineering by integrating production and support requirements. They also give project managers a technical-economic analysis of solutions being studied. Many of these architects manage complex system design using Excel, Visio or PowerPoint files. Emmanuel Hygounenc, a system architect senior expert at Safran Engineering Services, explains: *"This approach makes it hard to track changes and coordinate the different professions involved in developing a complex system, which impacts the consistency of results. Furthermore, it's never the same approach. But with our One Safran initiative, we're facilitating the use of a shared methodology."*

ONE SAFRAN, ONE SOFTWARE

Safran Engineering Services has therefore created XATIS, a scalable software package that simplifies and optimizes the design of complex systems. Right from the initial phase of identifying needs and defining specifications, architects use XATIS to fill out their Cesames design grid. They then apply the "Develop" process laid out in the associated guide. *"Because this approach is both fast and efficient, we can develop several alternative architectures,"* points out David Chatain, Vice President for Processes, Methods and Tools at Safran Electrical & Power, whose teams supported the project. *"XATIS automates tracking of updates and changes, and schematics are synchronized. It offers different inputs for different job fields and technical communities, giving us a highly practical and traceable solution."*

New functions have been added since the creation of the software in 2013, including automatic verification of design rules, dashboards, economic analysis, study of production organization, etc. *"The challenge is to consider the product lifecycle as a whole,"* explains Eric Clavé, XATIS project leader at Safran Engineering Services. *"An optimized technical solution should take into account all requirements, including production engineering, operation and maintenance. XATIS addresses these points, helping us improve product profitability and attractiveness."*

SATISFIED USERS

Safran Electrical & Power deployed XATIS on pilot projects that in turn provided input to improve the software. *"It's designed by system architects for system architects, based on their experience in the field,"* notes Jean-Pierre Garcia, head of system engineering deployment at Safran Electrical & Power. *"Today, it's mature, which means we could consider using it on strategic projects such as Boeing's planned New Middle Market Airplane."*

At Safran Electronics & Defense, Olivier Le Borgne, engineer in chief and senior expert, concludes: *"XATIS saved us a lot of time. It also allows severalof us to work at the same time, using an iterative approach to design complex systems – and in the final analysis, that boosts our creativity and performance."* ■

WHEN MAINTENANCE GOES DIGITAL

The digital transformation is a strategic challenge for Safran. Our landing and braking specialist, Safran Landing Systems, is an integral part of this dynamic process, which has now largely moved beyond the production aspects to encompass maintenance services. What's the deal with digital today?

While aerospace is gradually becoming paperless, new technologies continue to emerge and the volume of digital data keeps growing. This treasure trove of data offers all players, legacy companies and new entrants alike – opportunities to create or capture value. And that's why major changes are in store for Safran's service businesses. For the last year, Safran Landing Systems has been deploying a transformation initiative dubbed #HUB digital. It's designed to foster the emergence of innovative and differentiating projects, while also identifying new business opportunities unleashed by digital technology.

CONCRETE RESULTS

Some of these actions have already generated concrete results, starting with a new online service portal, launched in 2018. Called #GODigital, it applies agile project management methods. It was designed to continuously adapt to airlines' changing requirements for maintenance, repair and overhaul (MRO).

Several predictive maintenance tools are also in the testing phase. For example, Safran Landing Systems developed SPark (Scanner of Park), a smart test unit that automatically checks the operation of the park braking system supplied by the company for all Airbus jets, used to avoid costly flight delays in case of failure. Another project being tested, Dispatch Optimization, remotely monitors the landing systems on Singapore Airlines' Airbus A350s and uses flight data analysis to check that they're operating correctly.

Digitization also has benefits in ground maintenance. Safran Landing Systems now deploys a mobile maintenance-aid service for airplanes on the ground, called Streamline. Using this service, ground crews can check wear on brakes and landing gear with a single click of their app! ■

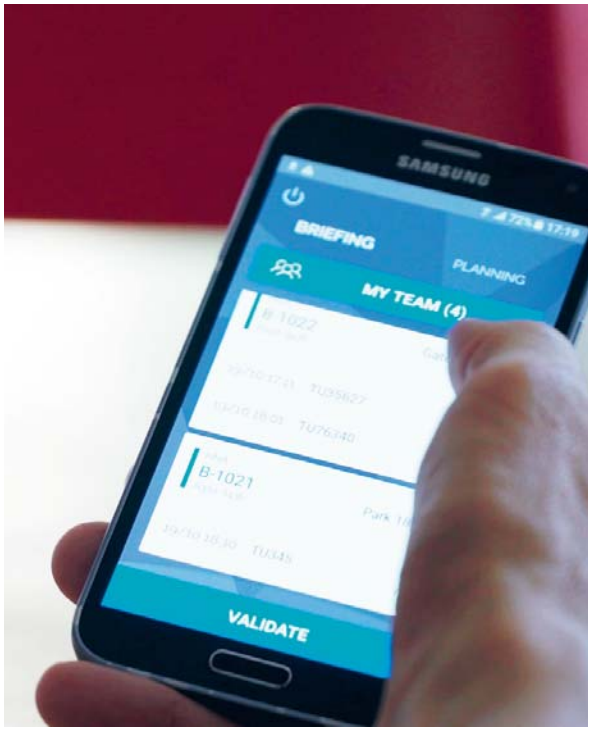
CONNECTED AIRCRAFT TIRES

Safran Landing Systems has teamed with Michelin to develop the first connected aircraft tire, PresSense. Designed to facilitate ground servicing of tires, this innovative device already logged successful initial flight tests on a Dassault Falcon 2000EX in mid-June 2019. Entry into service is slated for 2020.

REAL-TIME TESTING OF BRAKING SYSTEMS

—

Safran Landing Systems designed the SPark (Scanner of Park) test tool, featuring sophisticated health monitoring algorithms, by drawing on the extensive test data collected by its Molsheim plant in eastern France for both production and repair operations. Tests at easyJet and Air France have proven successful, with a commercial market entry planned for the end of 2019.

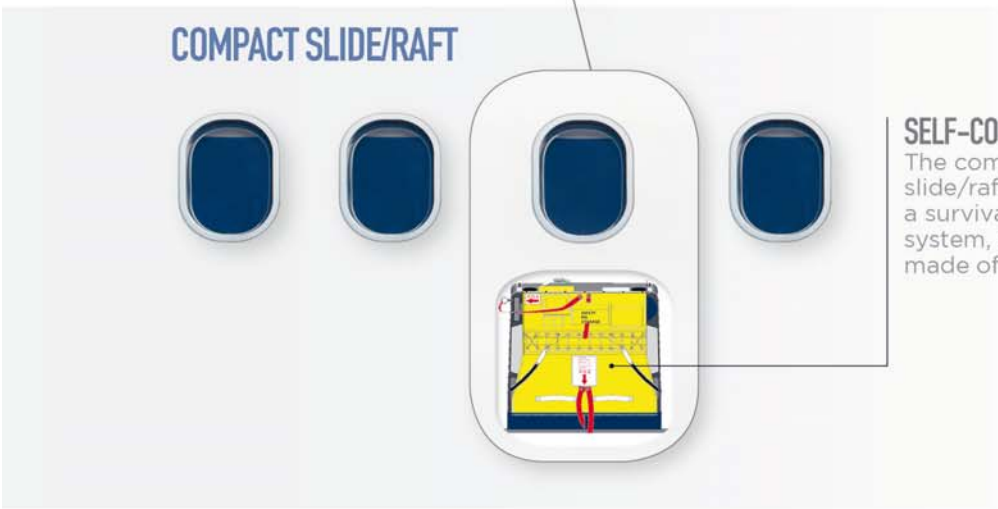


Streamline, the mobile maintenance-aid app for aircraft on the flight-line.

Jean-Paul Alary, CEO of Safran Landing Systems, and **Frank Moreau**, head of the Aircraft business line at Michelin, celebrate the success of PresSense flight tests on June 18, 2019.

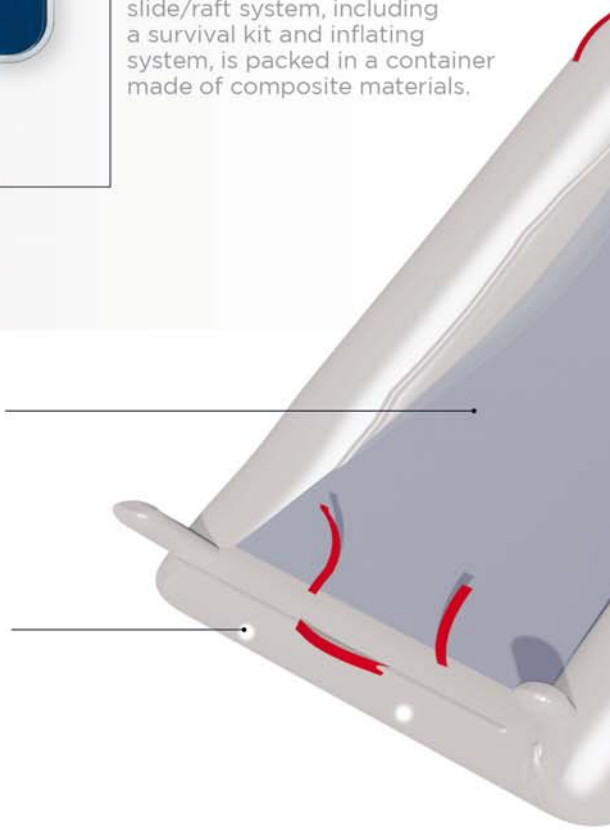
A PLUNGE INTO AN EVACUATION SLIDE/RAFT

Safran Aerosystems offers a complete line of inflatable safety equipment for aircraft, including evacuation slides, slide/rafts, rafts and life vests. Evacuation slides are made of a special urethane-coated nylon fabric with special radiant heat reflective characteristics. Here's a closer look at these vital systems.

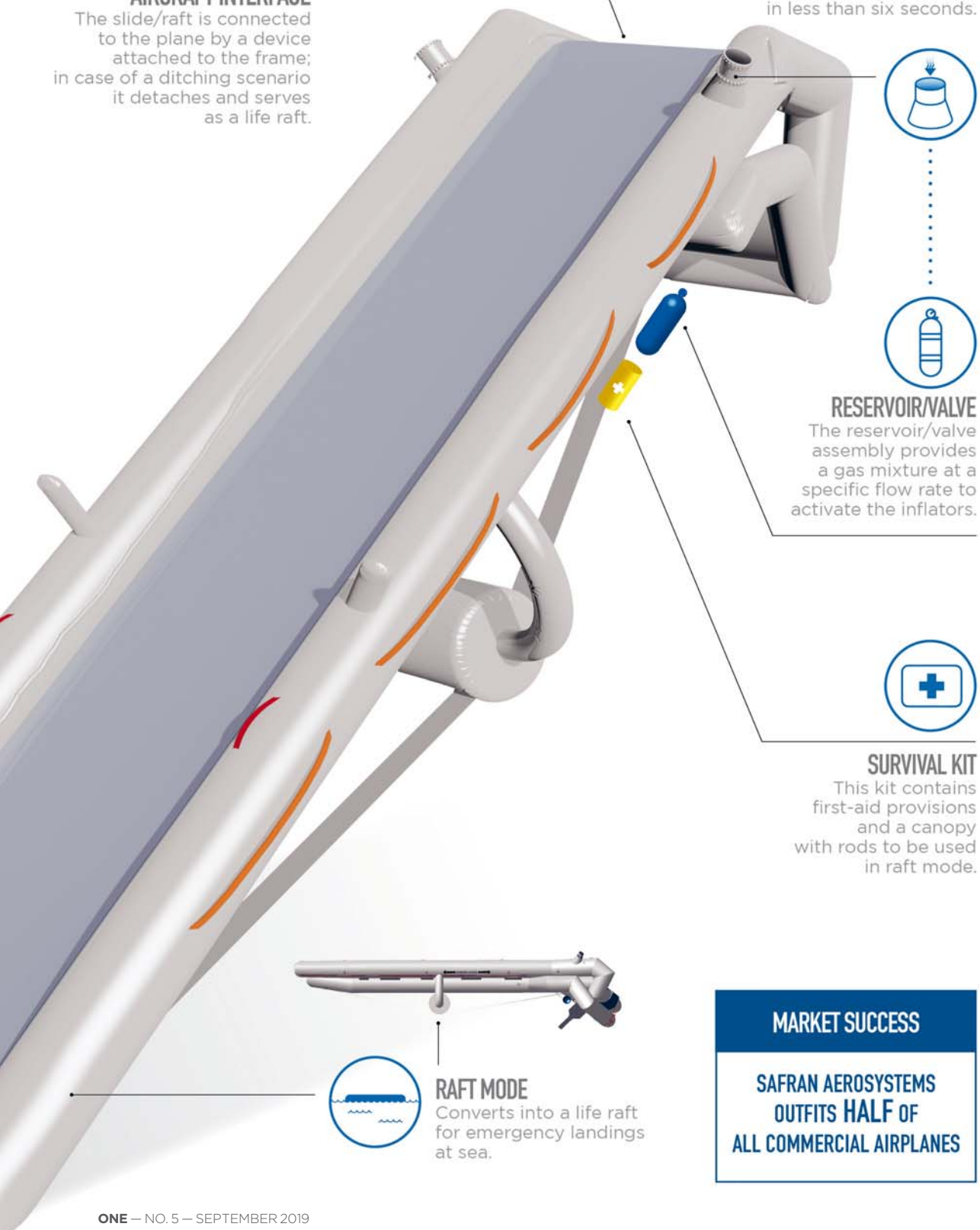


WORKS AT ANY ANGLE
The sliding angle is designed to work at any aircraft sill height and angle.

LIGHTING SYSTEMS
The slide/raft is fitted with independent LED lights to allow safe evacuation even at night.



DEPLOYED SLIDE/RAFT



AIRCRAFT INTERFACE

The slide/raft is connected to the plane by a device attached to the frame; in case of a ditching scenario it detaches and serves as a life raft.

ASPIRATORS

The aspirators use ambient air with a mixture of gas to inflate the slide in less than six seconds.

RESERVOIR/VALVE

The reservoir/valve assembly provides a gas mixture at a specific flow rate to activate the inflators.

SURVIVAL KIT

This kit contains first-aid provisions and a canopy with rods to be used in raft mode.

RAFT MODE

Converts into a life raft for emergency landings at sea.

MARKET SUCCESS

SAFRAN AEROSYSTEMS OUTFITS HALF OF ALL COMMERCIAL AIRPLANES

ONE FUTURE

ALL-ELECTRIC NOSE LANDING GEAR

At the Paris Air Show in June, Safran Landing Systems unveiled the first all-electric nose landing gear for business aircraft. It replaces the hydraulic systems that currently power the steering and extension/retraction functions. The complete system will be ground tested as early as 2020

In February 2019, Safran Aero Boosters' lubrication unit with a 3D-printed case was certified – a first for Safran! The first unit was delivered to Safran Aircraft Engines and installed on a LEAP-1A engine for an Airbus A320neo.

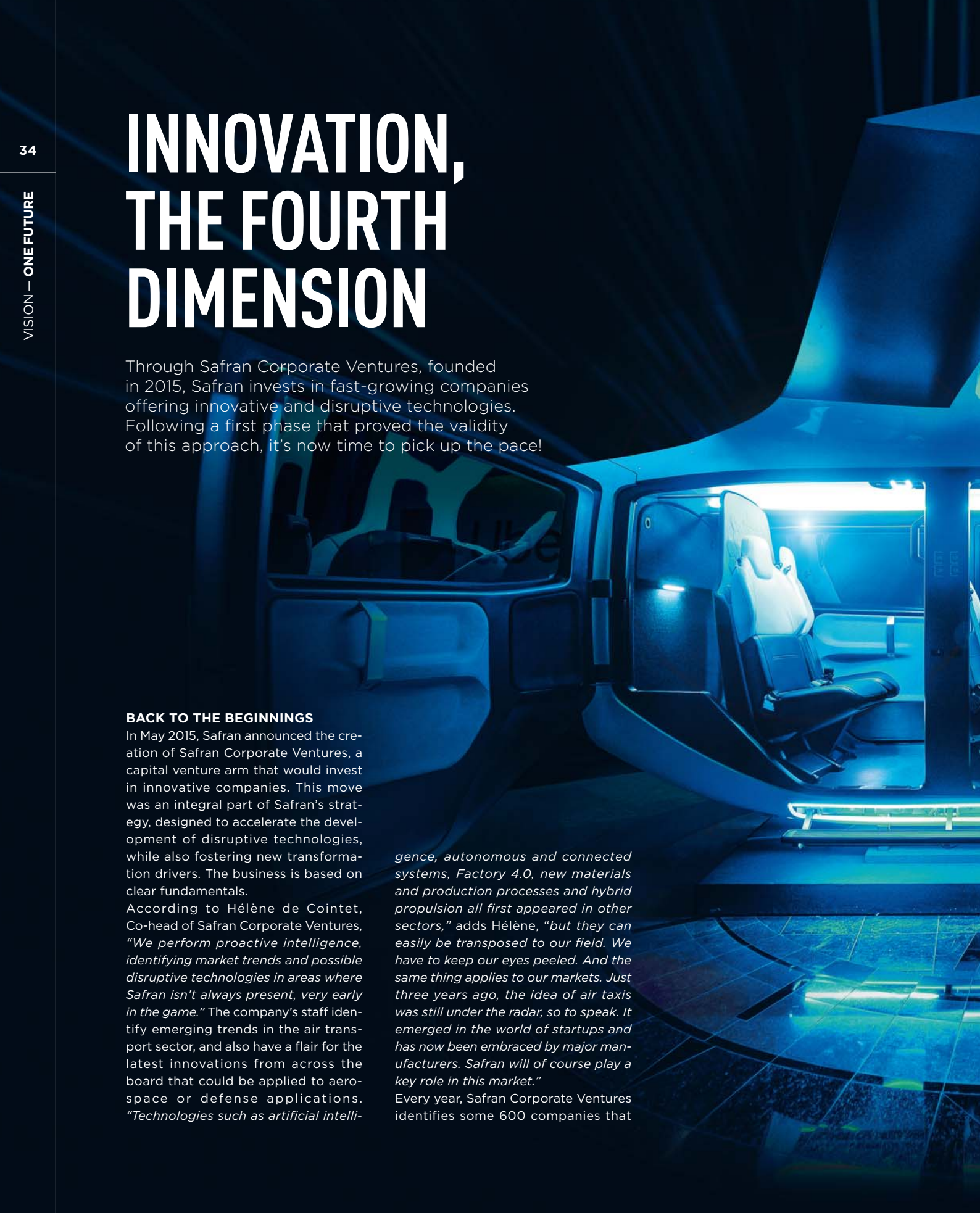
Safran Transmission Systems inaugurated its new R&D center in Colombes, near Paris, on June 14, welcoming nearly 150 engineers from design offices and research & technology units. Named "Marc Birkigt", in honor of the founder of Hispano-Suiza, now Safran Transmission Systems, this R&D center combines technical expertise with the ability to develop new technologies for the benefit of customers and partners.

Safran Cabin has teamed up with Airbus to market lower-deck beds for economy class passengers. This innovative solution gives airlines an opportunity to generate additional revenues, make better use of their cargo space and gain an edge in this highly competitive market. However, the real revolution is in comfort, since passengers will finally get to sleep in an actual bed. It will be offered on widebody airplanes flying long-haul routes.

Safran Seats, the Group's center of excellence for polymers, is about to certify its first part using an additive manufacturing process. Since product support is defined as a priority, this part will be sold as a spare, starting at the end of 2019.

INNOVATION, THE FOURTH DIMENSION

Through Safran Corporate Ventures, founded in 2015, Safran invests in fast-growing companies offering innovative and disruptive technologies. Following a first phase that proved the validity of this approach, it's now time to pick up the pace!



BACK TO THE BEGINNINGS

In May 2015, Safran announced the creation of Safran Corporate Ventures, a capital venture arm that would invest in innovative companies. This move was an integral part of Safran's strategy, designed to accelerate the development of disruptive technologies, while also fostering new transformation drivers. The business is based on clear fundamentals.

According to Hélène de Cointet, Co-head of Safran Corporate Ventures, *"We perform proactive intelligence, identifying market trends and possible disruptive technologies in areas where Safran isn't always present, very early in the game."* The company's staff identify emerging trends in the air transport sector, and also have a flair for the latest innovations from across the board that could be applied to aerospace or defense applications. *"Technologies such as artificial intelligence, autonomous and connected systems, Factory 4.0, new materials and production processes and hybrid propulsion all first appeared in other sectors,"* adds Hélène, "*but they can easily be transposed to our field. We have to keep our eyes peeled. And the same thing applies to our markets. Just three years ago, the idea of air taxis was still under the radar, so to speak. It emerged in the world of startups and has now been embraced by major manufacturers. Safran will of course play a key role in this market."*

Every year, Safran Corporate Ventures identifies some 600 companies that

MINORITY INVESTMENT CRITERIA

—

› Young high-tech companies.

› Businesses already generating revenues or with solid partners

› Special attention to the credentials of fellow investors, whether strategic or financial.

have come up with greener, more autonomous and more connected technologies, focused on new mobility modes, the passenger experience and enhanced productivity, via digitization and Factory 4.0. *"We have very specific investment criteria,"* notes Hélène de Cointet. *"Before we submit a candidate to Safran, we carry out due diligence on its intrinsic technical and organizational qualities, and on how well it fits Safran's own strategy. It's essential for each party to really want to team up to innovate and build things together."* If all of these conditions are met, Safran Corporate Ventures takes a minority stake in the company, paying careful attention to its fellow financial partners, and also participating in corporate governance to support its development. Now holding stakes in nine companies, Safran is building up knowledge capital to innovate today and build solid foundations for the future.

SHARED STORIES

One of Safran's first investments was in *Krono-Safe*, a specialist in operating systems for critical real-time software, which contributed expertise to Safran Electronics & Defense. The next was *Safety Line*, an expert in flight data analysis that teamed up with Safran Electronics & Defense to expand Safran's services in this field, especially in conjunction with a solution developed jointly with Safran Aircraft Engines that reduces airline fleet fuel

›

consumption. A third company, Kalray, had developed a processor technology giving unparalleled processing power in relation to energy consumed, for this size of components. Using this technology, Safran Electronics & Defense is creating next-generation digital cores for its critical embedded systems. Another company, *Prodways*, is working with Safran on additive manufacturing materials and processes, while *Turbotech* has launched a range of turbine engines and generators for light aircraft and hybrid propulsion systems, based on an innovative regenerative cycle turbine that could be used by Safran Helicopter Engines or Safran Power Units. *Oxis* is making a new line of lithium-sulfur battery cells, with higher energy density. All of Safran's businesses benefit from these operations and are forming close partnerships. *"Open innovation is one of the pillars of our R&D strategy,"* says Alain Sauret, Chief Executive Officer of Safran Electrical & Power. *"Safran Corporate Ventures facilitates collaborations that expand our technical knowledge, improve our understanding of the market and open new prospects, all in relation to our businesses."* His company is taking advantage of Safran investments in three technology companies, *Cailabs*, *Oxis* and *Diota*. *"The first two should enable us to develop new products:* Cailabs *for very-high-speed data transmission, and* Oxis *for advanced knowledge of batteries, a key to aircraft electrification."*

With *Diota*, Safran's approach is more inwardly focused. Using augmented reality techniques in production improves the working environment for operators, while also saving time and enhancing quality for Safran Nacelles, Safran Electrical & Power, Safran Landing Systems and Safran Aircraft Engines.

600
companies analyzed per year.

9
capital investments to date.

1 to 5 M€
invested per company.

RECIPROCAL ENRICHMENT

For these small businesses, Safran's investment helps drive growth and is also a key to opening sometimes closed markets. *"At the beginning, we had developed a data transmission technology for local networks in buildings,"* explains Jean-François Morizur, head of *Cailabs*. *"With Safran Electrical & Power, we first made sure this technology could be used on aircraft. Safran's investment in 2017 cemented a relationship that has become even stronger in the last few years. We're taking advantage of this new communications channel to better understand Safran's priority targets for innovative solutions, as well as identify long-term opportunities and call on technical experts if needed."*

Safran Corporate Ventures' role is not limited to negotiations and funding. As Hélène de Cointet points out, *"We support development and collaboration between companies. We speak both languages: our own as an industrial major, and that of the company we invest in. As a result, we can often clear the path to move forward even more effectively."* ■

Alain Sauret, *(left)* CEO of Safran Electrical & Power, and **Jean-François Morizur,** CEO of Cailabs, a startup specializing in very-high-speed data transmission, at the 2019 Paris Air Show.

STRONG BUDGET GROWTH

Safran announced in June a significant increase in the budget allocated to Safran Corporate Ventures, from 50 to 80 million euros, reflecting its growing confidence in taking minority stakes in a corporate venture capital approach. Our aim is to accelerate the pace of investments and also study investments in other sectors and countries. Safran has also appointed a new CEO of SCV, Florent Illat *(below left)*, who specializes i n startup investments.

A NEW TURBOPROP DEMONSTRATOR

At this year's Paris Air Show, Safran Helicopter Engines announced the first ground test of its Tech TP demonstrator in Tarnos, southwest France. Developed and built within the scope of Europe's Clean Sky 2 research program, this technology demonstrator could be used as the basis for a new type of turboprop engine.

Safran Helicopter Engines, Tarnos, June 19, 2019: Kickoff of the test program for the Tech TP, the demonstrator for a new-generation European turboprop that could power upcoming commuter or regional aircraft.

These tests have a two-pronged objective: evaluate the operation of the complete propulsion system, comprising gas generator, nacelle, air inlet and propeller; and validate the technological building blocks needed for this advanced turboprop, which is based on the Ardiden 3 turboshaft helicopter engine (rated at 1,700 to 2,000 shaft horsepower), already in service.

Featuring a new light and compact design, the Tech TP will reduce fuel consumption and CO_2 emissions by 15% versus current engines.

EUROPEAN KNOW-HOW

"Our Tech TP demonstrator draws on the skills and expertise of some twenty European partners, with the support of the European Commission through the Clean Sky 2 research program," explains Didier Nicoud, Executive Vice President, Engineering at Safran Helicopter Engines. *"This first ground test is a major step towards our aim of introducing a European turboprop in the coming years. It will offer high performance, low operating costs and a smaller environmental footprint."* In other words, this is a pivotal project that could facilitate Europe's entry into a market segment currently dominated by the competition.

NEXT STEPS

The Tech TP test program will also check out "more electric" technologies, especially for the reduction gearbox and propeller pitch control system. In upcoming tests, engineers will gradually increase the propeller pitch and assess various configurations to demonstrate the engine's full potential. ■

Go to Insite to see a video of the first ground test.

"This first ground test is a major step towards our aim of introducing a European turboprop in the coming years."

DIDIER NICOUD
Executive Vice President, Engineering, Safran Helicopter Engines

Tech TP ready for testing on a test cell dedicated to turboprop engines at the Tarnos plant in southwest France.

ARDIDEN 3, THE MODEL

The Ardiden 3 is a new-generation helicopter turboshaft engine in the 1,700 to 2,000 shp class, which has logged more than 10,000 hours of testing. Featuring a compact design, it offers one of the best power-to-weight ratios in its class, along with low operating costs and 10% lower fuel consumption than its competitors. Some 250 Ardiden 3 engines are now in service, recording over 200,000 flight-hours.

Safran staff closely monitoring engine tests, which are continuously filmed and transmitted to the control room.

FACTORY OF THE FUTURE

MACHINING: CLOSE THE DOOR!

Safran is deploying a technology known as closed door machining at its LEAP production facilities. This approach is based on autonomous machines which improve safety, quality, maintainability and cost, while helping operators move up the skills chain. To delve deeper into this subject, we spoke with Olivier André, Vice President, Strategy and Industrial Support at Safran Aircraft Engines.

What are the main principles behind closed door machining?

O.A.: It's an approach based on the secure automation of machining processes for mechanical parts. Overseen by a qualified operator, the machines function continuously, without manual input. This is made possible by advanced digital programming, human-machine interface and machine monitoring systems. Safran Aircraft Engines production facilities are incorporating this approach to machine parts for LEAP® engines.

What are the advantages?

O.A.: It offers a host of benefits in terms of ergonomics, cost, time and quality. With closed door machining, we can limit or even eliminate certain arduous tasks, such as moving parts around. Furthermore, by no longer having to open and close shop doors repeatedly, we increase machine utilization times. Eliminating these manual steps also significantly reduces safety risks for operators.

Another, non-negligible advantage lies in data analysis. By analyzing this data, for example, we can adjust settings to make sure parts come out right the first time, without having to be reworked. Data management also applies to machine monitoring, which means we can enhance maintenance operations and scheduling, based on predictive maintenance precepts. In short, closed door machining is a valuable tool to identify when processes go awry, and to forecast or correct these errors. Machining programs are adjusted in real time, by combining information from several sources.

What changes does this approach entail for your own activity?

O.A.: One of Safran Aircraft Engines' primary aims is to reduce manual input on LEAP parts by 75% by the end of 2019. We've set up a development plan that will be gradually rolled out at all of our plants. This trend will really come into its own with the advent of new "Big Data" type analytics, deployed as part of the Factory 4.0 (or Factory of the Future) concept. To maximize machinery use in the closed door machining approach, Safran Aircraft Engines has instituted high-level digital continuity. The fourth-generation machinery and equipment now in place generate a huge volume of data, thanks to the many embedded sensors and touch probes, which means we need an industrial network that's up to the task.

Changes are also visible from the operators' viewpoint, since closed door machining spurs real skills enhancement, an advantage welcomed by our people. On the latest production lines, operators no longer have to intervene

"At the Le Creusot plant, 14 complex operations for machining LEAP turbine disks now use the closed door machining approach."

The Le Creusot plant in Burgundy has 12 latest-generation computer numerical control (CNC) mill-turning machines, capable of operating with minimal human supervision.

within the machine area, but simply make sure that machines turn out the parts correctly. Operators oversee a production cell, comprising several machines, working closely with the maintenance, methods and quality teams.

Operators no longer have to take care of arduous but routine tasks that don't create value, such as manual measurements, handling parts or removing shavings.

In charge of overseeing the operation of production facilities, our teams are trained and supported to enhance their expertise in the use of this sophisticated machinery, along with automation, metrology and statistical analysis. But the objective remains the same: for the machine to "get it right the first time"!

In the final analysis, closed door machining is simply a way to ensure we use human intelligence solely for real value-added tasks. ■

"Closed door machining is a way to ensure that we use human intelligence solely for real value-added tasks."

INERTIAL NAVIGATION: MORE RELIABLE THAN GPS!

Satellite-based global positioning systems (GPS) have become part of our daily lives, but they still have significant weaknesses... unlike the inertial navigation systems developed by Safran Electronics & Defense.

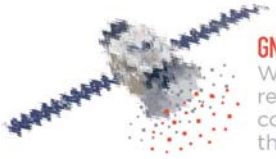
The United States developed GPS in the 1970s for its armed forces. About 30 years ago, the system started to be used for civilian applications as well. Today, the use of global navigation satellite systems (GNSS) has become ubiquitous. They fulfill a number of functions, from jetliner navigation and positioning of armed forces units, to helping people find their way almost anywhere in the world.
To avoid over-dependence on the American system, several countries or regions have developed their own GNSS, including Glonass in Russia, Beidou in China and Galileo in Europe. But these types of systems still have weaknesses. Signals emitted by GNSS satellites can be jammed, hacked of even cut off. In war zones such as Syria, there is permanent GPS jamming. This also applies to civilian uses. For example, commercial airplanes have to avoid certain parts of the arctic airspace because they do not have access to valid GPS signals. Given the problem of operating in GNSS denied zones, Safran Electronics & Defense capitalized on its expertise in inertial navigation to come up with reliable and accurate positioning solutions that could be used even when GPS is unavailable.

FROM INERTIAL TECHNOLOGY TO STELLAR POSITIONING

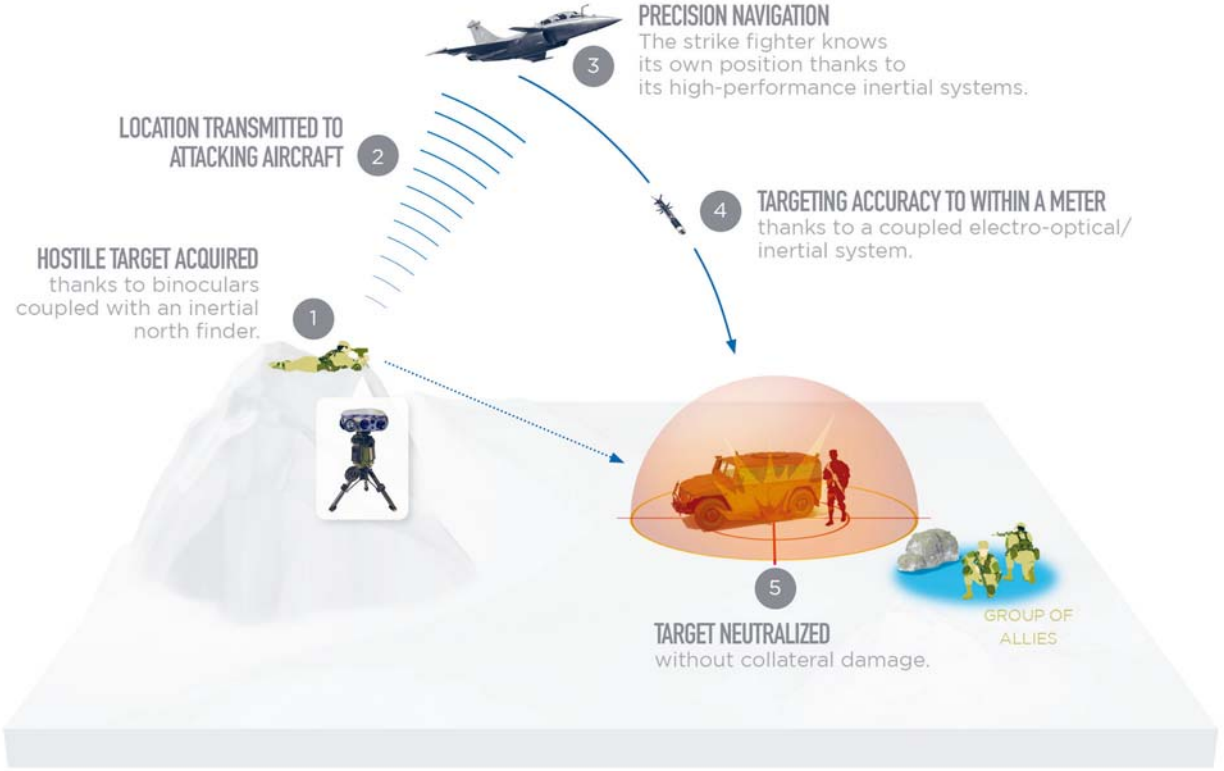
At the heart of the company's offering is the hemispherical resonator gyro, in particular the HRG Crystal product line. Safran Electronics & Defense has developed a range of high-performance HRG-based inertial navigation systems for air, land and naval platforms. These compact units measure rotation and acceleration to a high degree of precision. Totally autonomous and jam-proof, they indicate the carrier's attitude and position under any circumstances.
Another high-performance positioning method combines an inertial sensor with electro-optical (EO) systems, such as infrared binoculars. This technology provides a critical advantage on the battlefield, where troops need high-precision weapons to avoid friendly fire and collateral damage. Studies are also under way to refine aircraft positioning via star tracking. An electro-optical sensor on the fuselage could detect stars day or night and calculate the plane's position. At least for now, stars can't be jammed, unlike satellites! ■

AN ALTERNATIVE TO SATELLITE POSITIONING

Satellites provide critical position, navigation and time (PNT) information. But when satellite signals are unavailable, **Safran Electronics & Defense** offers alternative technologies to support military missions.



GNSS DENIED
When GNSS signals are jammed, military forces can't receive positioning information or the exact time needed to coordinate operations. To accomplish their missions, they can count on alternatives such as electro-optical systems, inertial technology and an embedded time base.



YOUR COMPANY IS EXPANDING... AND SO ARE YOUR HORIZONS!

Thanks to Safran employees Leila, Lorna, Melissa, Patrice, Pierre and Sébastien for helping us out! - Photo credit: William BEAUCARDET - WAT - wearetogether.fr

Go to your intranet to learn about Safran's 6 HR commitments.

SAFRAN