

one

TEAM - BUSINESS - FUTURE



Zodiac Aerospace integrated in Safran, as its companies adopt the Safran brand name.

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A330neo, three challenges
for a key program



The A330neo started revenue service mid-December, 2018 (top).
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Did you know?

VTOL:
Safran takes off!

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“Safran, a responsible enterprise.”

With more than 91,000 employees in 30 countries, a highly diverse range of products and services and annual revenues of 21 billion euros, Safran is now one of the world's largest aerospace companies. But there's no shortage of challenges ahead as we strive to make sure our customers are satisfied, uphold our competitiveness and make our Group even more unified. As we kick off the New Year, I would like to emphasize a key issue, namely safety in the workplace. No matter where we are located, from France to China, and from the United States to Tunisia, the wellbeing of our people is a top priority for Safran. Operating worldwide, we apply the most stringent standards in terms of our machinery and procedures. But there are still too many accidents and we have to do better. Any improvement depends above all on each person's exemplary behavior. No matter where we work, in a factory or at a desk, we all have to be even more vigilant. To encourage us, let's set a very demanding goal: zero accidents! Meeting this goal depends on our daily actions and paying attention to the tiniest details. We have to be irreproachable, here more than anywhere else. By paying close attention to this critical indicator, our accident rate, we will become even more aware of all the other indicators that spotlight our performance and competitiveness. I know that I can count on you to make 2019 even more successful than the past year. In closing, I would like to wish you, and all those dear to you, a very healthy and happy New Year.

PHILIPPE PETITCOLIN
Chief Executive Officer of Safran



ONE TEAM





IN-HOUSE TRAINING

A year ago, the Safran Aerosystems facility in Compiègne, not far from Paris, created its own training center for welders and fitters to keep pace with strong growth. Fifty employees have already completed training courses, two-thirds of them new employees.

GOLD LABEL FOR SĘDZISZÓW

The Safran Transmission Systems Poland facility in Sędziszów Malopolski earned Gold HSE (health, safety, environment) certification in 2018, reflecting Safran's highest standards of HSE maturity. This label encompasses ergonomics, fire prevention and emergency situations, raising the awareness of our employees and partners and other key factors, and resulted from a company-wide commitment to reducing HSE risks.



FRENCH MINISTER MEETS THE NEXT GENERATION

On September 3, 2018, French Minister of Labor, Muriel Pénicaud, visited the Safran Electronics & Defense plant in Poitiers, and its 450 employees. For this specialist in optronics (electro-optical) equipment, transmitting these particular skills is essential: the plant currently has 28 apprentices.



5,000

Safran Ventilation Systems has delivered sits 5,000th electric fan, for an Airbus A350 XWB. These fans are used to recycle air in the cabins, ventilate cargo bays and cool avionics and video screen central processing units. The team rose to the challenge to boost their performance and production rates.

FIGHTING SEXISM: SAFRAN AIRCRAFT ENGINES PAVES THE WAY

During the summer of 2018, more than 1,000 employees at Safran Aircraft Engines' Gennevilliers plant attended sessions to raise their awareness of sexist behavior and sexual harassment. These 17 sessions combined role-playing, discussions and legal information. The company's Corbeil plant organized its own successful workshops in November, and other Safran facilities will follow suit in 2019.





GERMANY

An all- Lean plant

In October 2018, Safran inaugurated a new plant in Hamburg dedicated to the integration of nacelles on the LEAP-1A engine for the Airbus A320neo. Designed according to best practices in Lean Manufacturing, it maximizes operational performance.

"It was a moment of great pride and a truly fitting ceremony, which will remain etched in our memories," says Serge Rièrè, then Vice President for Operations at Safran Nacelles, commenting on the inauguration of the new nacelle integration facility for the Airbus A320neo in Hamburg, Germany, on October 11. Safran has invested nearly €10 million in this strategic facility. This figure reflects the importance of the program, since the A320neo powered by LEAP-1A engines from CFM International — a 50/50 joint company between Safran Aircraft Engines and GE — is a resounding success, with the fastest production ramp-up in civil aviation history. This second integration facility will join its counterpart in Toulouse, and should



▶ enable us to meet the delivery schedules agreed with Airbus. *“The new plant clearly reflects Safran’s strategy of staying close to our customer Airbus to support the rapid ramp-up in production rates,”* said Safran CEO Philippe Petitcolin at the inauguration ceremony. The 8,000-square-meter site (86,400 sq ft) has 6,000 square meters (64,800 sq ft) of dedicated space for the assembly of nacelle components — air inlets, engine cowls, thrust reversers and exhaust systems — which are then painted and integrated on the engine. Next, the propulsion systems are inspected by customer airlines before being delivered to the Airbus final assembly line in Hamburg.

LEAN FROM THE GROUND UP

The newly inaugurated Hamburg plant has actually been operating since September 2016 and has already delivered more than 200 LEAP-1A propulsion systems to Airbus. *“It’s an impressive achievement for such a recent site,”* says Serge Rièrè.

The secret of its success is the decision to incorporate Lean Manufacturing principles into the plant’s very design. *“The building and its interior layout benefit from the company’s 20 years of expertise in Lean,”* adds Serge Rièrè. *“Design features include completely obstruction-free production spaces, with no vertical steel columns to impede workflows. Energy sources have also been placed higher and all machinery is modular and mounted on wheels or air cushions. If needed, this means workspaces can be completely reconfigured to take account of fluctuations in production rates.”*



“The Hamburg plant is the embodiment of Safran Nacelles’ know-how and the efficiency of Lean methodology. It’s a winning combination to make sure we meet our commitments on the A320neo.”

SERGE RIÈRÈ

Vice President, Operations, Safran Nacelles

The goal of reducing lead times and costs also influenced the choice of flooring, which is especially hard-wearing and doesn’t require any maintenance, thus avoiding the need to stop production at regular intervals for refurbishment. It’s ideally suited to the use of Smart Trolleys as well. Designed by Safran Nacelles, these mobile transport cradles make handling operations much easier for operators: a propulsion system can now be integrated in less than 11 minutes, compared to several hours before.

Part workflows have also been optimized. *“The line has been folded into a U-shaped cell,”* explains Serge Rièrè. *“This makes it easier to keep it supplied with components, without disrupting operators. They work inside the U and can reach positions on both sides easily, minimizing the amount of walking,*

especially from the first to the last station. Each part moves from one station to the next, never backward — the first part in is the first part out, which is a key principle of Lean.” Special consideration was also given to visitors, with a mezzanine where operations can be viewed without affecting production. All these clever features have allowed the Hamburg facility to achieve the same level of performance as Toulouse in two years; it now takes just six days to assemble and paint each propulsion system. An accomplishment hailed at the inauguration by Philippe Petitcolin, Cédric Goubet, CEO of Safran Nacelles,



Opposite: Sascha Dubber, assembly team leader at Safran Nacelles, Hamburg.
Above: Technicians at Safran Nacelles in Hamburg check the engine cowls on the A320 nacelle.



SAFRAN IN GERMANY

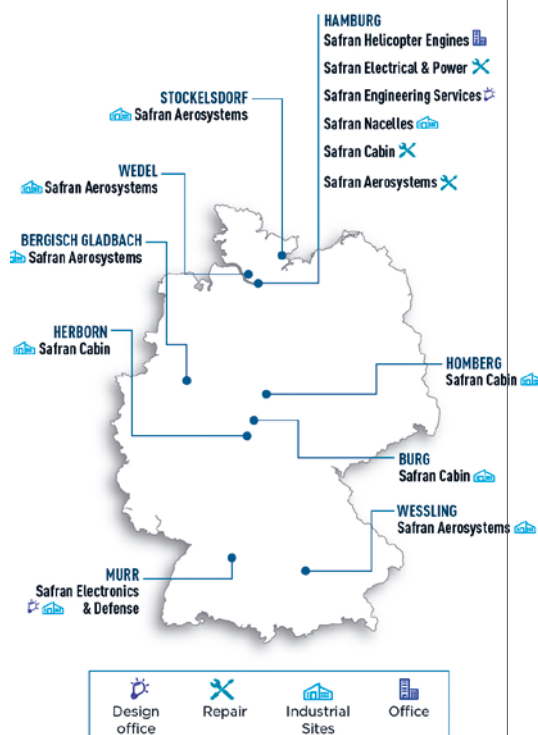
Safran has operated in Germany for nearly 30 years, with 2,500 employees now at 14 production and R&D sites spanning our core sectors of aviation (Safran Helicopter Engines, Safran Electrical & Power, Safran Engineering Services, Safran Cabin, Safran Aerosystems, Safran Nacelles) and defense (Safran Electronics & Defense). We're also a partner in four joint ventures: Europrop International GmbH, MTR GmbH, AES Aerospace Embedded Solutions GmbH and ArianeGroup.

and Klaus Richter, Chief Procurement Officer at Airbus. To capitalize on this successful experience, the Lean practices employed at Hamburg have since been adopted as the new Group-wide benchmark for plant construction.

SKILLS TRANSFER

While the design and organization of the Hamburg facility play a major role in its operational efficiency, the know-how of the people working there is at the heart of its performance. Today, around 70 mechanics, painters, inspectors and other highly qualified staff are bringing their expertise to the A320neo program. Ensuring they have the right skills has been the focus of a special effort, working closely with Toulouse. "The first operators we recruited spent six weeks in Toulouse to learn Safran's production processes and familiarize themselves with our procedures and safety rules," says Serge Rièrè. "Back in Germany, they passed on what they'd learned to their colleagues, who then spent two or three weeks in France to complete their training."

Sascha Dubber, 32, is one of the employees at the Hamburg facility who was trained in Toulouse. Previously at Safran Electrical & Power, changing jobs was a real challenge. "I had to learn it all from scratch — which wasn't easy!" he recalls. "I was also concerned that work methods would be too different from one Group entity and country to another. With my instructor, we started by chatting and getting to know each other, which made the skills transfer process so much easier. He didn't just teach me the assembly techniques I needed, he also gave me some really useful tips, based on his experi-



Safran sites
in Germany.



Integrating the nacelle on a LEAP-1A engine for the A320neo at the Safran Nacelles facility in Hamburg.

“We’ve worked hard to achieve the expected levels of performance — and the satisfaction expressed by Airbus at the inauguration was a fitting reward!”

SASCHA DUBBER

Assembly team leader, Safran Nacelles

ence. Back in Hamburg, I put all this know-how into practice and was up to speed in less than three months.”

The Toulouse instructors also valued this interaction. “I’m used to training new arrivals and I love passing on my knowledge,” says Jean-Luc Biasotto, a mechanic-fitter. “Our colleagues from Hamburg were especially motivated, inquisitive and quick learners. They picked things up quickly — which we could clearly see when we returned with them to Hamburg to help them assemble the first propulsion systems for the A320neo. Deliveries were made in record time, much to the customer’s satisfaction. That makes us all really proud. It’s been a truly rewarding experience, both professionally and on a personal level.”

RAMPING UP

It may stand as a model within the Group, but Hamburg isn’t a lone rider. “Hamburg operates in seamless continuity with Toulouse and our new facility in Mobile, Alabama, opened in early

2018,” adds Serge Rièrè. “All three sites are working toward the same goal of meeting the needs and expectations of our customer.” And there will be no letup, since production rates will continue ramping up. “From 216 propulsion systems in 2018, we’ll be delivering almost 400 a year by 2020,” concludes Serge Rièrè. “And to keep pace, the number of employees will be rising to about 100.” ■

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.



Electric taxiing team

The electric taxiing team is one hundred strong, including specialists from Safran Landing Systems (project pilot for the Group and systems integrator), Safran Electronics & Defense (printed circuit boards and software), Safran Transmission Systems (high-power reduction gears) and Safran Electrical & Power (power electronics, electric motors and wiring). They all share a single objective: get the system, which allows aircraft to taxi without using their jet engines, into commercial service by 2021-22.



Fatimazzahra Meziane

Management control supervisor, Matis Aerospace

“I’m a member of Techwomen, a mentoring and discussion program between women science and technology leaders in the Middle East and Africa, and their counterparts in the United States. I just finished an internship in Silicon Valley, where I developed a social project. In Morocco, I continue to encourage women to pursue technical careers.”



Philippe Graindor

Management assistant, Safran Aero Boosters

“I’m a cook, chauffeur and administrative assistant, all at once. My work is different every day. I’m part of corporate management, but I work with human resources, communications and other departments. I’ve got a lot of different functions, and that’s the way I like it!”



Laura Canet

Production engineering specialist,
Safran Aerosystems

“I optimized the production line for the passenger oxygen system at our plant in Plaisir, France. To configure these products, the production operator now uses visual aids and software aids. We will eventually be deploying augmented reality. Thanks to these improvements, we’ve decreased the incidence of poor quality.”



Ludovic Grimbel

Industrial program leader,
Safran Transmission Systems

—

“As the leader for the production engineering of a power transmission, I oversee its manufacturability, meeting deadlines and monitoring costs. I’m the liaison between the program team and our production management teams. There’s a lot of human contact in this job, plus challenges that make it very exciting.”

Guillaume Leblanc

Sales and support director,
Safran Helicopter Engines Germany GmbH

—

“I’ve worked in several different jobs at Safran, including customer support and programs, in France and the United States. In Germany, I’m working alongside our customers. Our network of local facilities and staff availability are key assets for operators and Safran alike.”

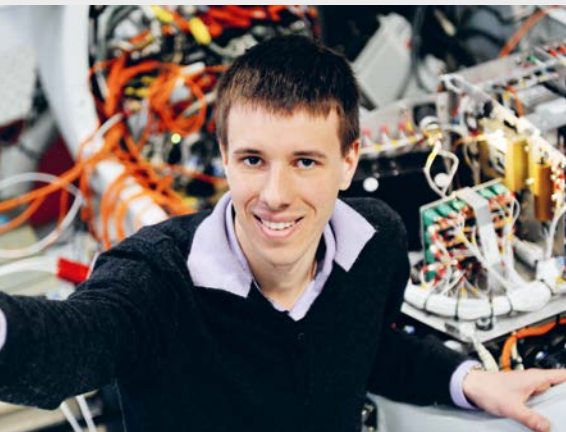


Thomas Léonard

Integration engineer and safety manager,
Safran Electronics & Defense

—

“The flight tests of the Patroller drone are an incredible adventure from both the technical and human standpoints. My contribution was troubleshooting the bugs that arise in any new development. My watchwords on a daily basis are challenge, agility, responsiveness and imagination.”



DIGITIZATION BENEFITS EMPLOYEES

“Digital technology has improved both company performance and employee working conditions wherever it’s been implemented at Safran,” notes Chief Executive Officer Philippe Petitcolin. We asked a few of our colleagues to explain how digital technology has impacted their work.



RENAUD DUVAL
Operations manager,
Safran Landing Systems

“The Sendayan plant in Malaysia is one of Safran Landing Systems’ carbon disk production facilities. We use the 5S methodology to improve our performance, allowing us to enhance our organization, cleanliness and workstation safety. We conduct regular audits

of shops and offices to make sure that Safran’s 5S criteria are met. Until recently, these audits used paper, which takes a lot of time. Since September 2018 we have been testing a solution based on a tablet, cell phone and computer, which speeds up the audit itself, as well as reporting and action follow-up. Initial feedback is very positive and we are planning to roll out this method in other company plants. We could also apply it to different kinds of audits, such as foreign object debris and scheduled general inspections.” ■

BENJAMIN PARISE
Wiring operator on the A350,
Safran Electrical & Power

“We used to monitor and check wiring harness production operations on paper. We had a 700-page printed report on which we had to stamp approval for each individual operation. With our new E-Tracea tool, everything is digital. Once identified in the application, each step in the manufacturing process is performed directly on a computer or tablet. This means tremendous space savings on our worktables, since we don’t have to lug the paper report between workstations. Digital data entry also means we can check progress in real time, while ensuring perfect traceability. We no longer have to consult our archives for the history of all operations on these harnesses. I helped my colleagues on the A350 team embrace this new tool, and now nobody wants to go back to paper!” ■





SAFRAN AERO BOOSTERS

Computerized assembly

The assembly department at Aero Boosters teamed up with operators to develop software allowing them to visualize each step in the assembly of a booster, along with the precautions needed to uphold quality and safety. The software allows the digital exchange of data between departments that used to send each other paper reports, resulting in a remarkable improvement in operator training and safety.



VIRGILE CLAUDE
Machinist, Safran Aircraft Engines

“I supervise an autonomous machining cell, comprising two grinding machines, two coordinates measuring machine and three robots, used to produce the three stages in the M88 engine’s high-pressure guide vanes. It’s brand new, and we’ve already improved safety, productivity and organizational efficiency. With the ramp-up in production, we’ve also repatriated certain work we had previously subcontracted. Before, I produced one part at a time; now we make nine parts simultaneously, via digital interfaces. I have greater responsibility and I manage all issues in the cell. It’s real teamwork, and it didn’t happen overnight. I took a training course, with support from the supplier and our methods department. I learned quickly, but there’s always a lot more to discover. With our current high production rates, we’ve made the switch to high-tech!” ■

YANNICK LÉBOUCHER

Numerical control machine pilot, Safran Transmission Systems

“Our shop installed numerical control (NC) machines for the precision machining of our cases. Since July 2018, we check threads and the diameter of machined parts using connected tools from our machine shop. Today, this applies to cases for the LEAP-1B, but we are eventually targeting computerized checking for all equipment, on both civil and military engines. For instance, every one of the 2,000 cutting tools in the shop is fitted with a chip. Via the computer system, these chips provide vital information, such as the tool reference number, its position and gauges, the case it’s working on and lifespan. Computerization plays an essential role in our daily work, greatly improving the reliability of demanding machining processes.” ■



CUSTOMER SUPPORT

Marc LASTRA

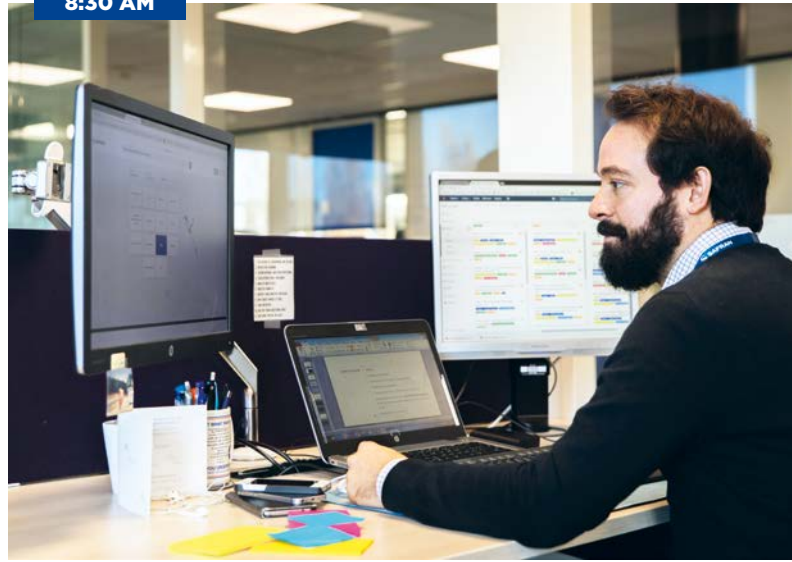
**#GoDigital product manager,
Safran Landing Systems**

After eight years in customer support, Marc moved to the #GoDigital project, designed to create a new online service platform. He represents repair firms and airlines in-house, to make sure we address their needs.

Today in Vélizy, I'm reviewing project progress after two weeks of development. I start by checking that the functions are operational, and that all bugs reported by users during platform testing are resolved.

I lead a demonstration of the new platform version for the project team. All Safran Landing Systems employees can attend if they want.

8:30 AM



10:00 AM



Immediately after, I talk with representatives of the different job fields involved in the project.



11:30 AM

2:00 PM



In Paris, I take part in the daily project progress review with the startup that is building our platform.



THE #GODIGITAL PROJECT

This project is designed to spur innovation by creating a new digital platform and aftersales services for our customers: operators and airlines. It's one of the first Safran projects calling on agile methods, which continuously adapt to users' changing needs.



2:30 PM



4:30 PM

Left: This fun exercise allows team members to share their feedback.

Above: We draw up the schedule for the next two weeks. The entire team estimates the workload needed for the planned new functions. New developments can now start.

ONE BUSINESS



10,000

COMMERCY SURPASSES 10,000 LEAP® BLADES

The Safran Aero Composite facility in Commercy passed the milestone of 10,000 fan blades and 500 cases produced for the LEAP engine, clearly demonstrating the industrial maturity of this plant in eastern France, inaugurated in November 2014.

7

Safran Aero Boosters has inaugurated an inertia friction welding workshop, spanning 1,800 square meters to house the seventh large machine of this type in the world. This makes our entity a leader in turbofan engine booster sections.

20MM

SAFRAN ELECTRONICS & DEFENSE INTRODUCES NEW NAVIGATION SYSTEMS

Whether on land, at sea or under it, you have to know your position and trajectory to get where you want to go! Using the HRG Crystal™ hemispherical resonator gyro, a 20 millimeter silica half-shell, Safran Electronics & Defense launched three new inertial navigation systems in 2018 for land and naval applications: Geonyx™, Argonyx™ and Black Onyx™. It has already signed an agreement with Nexter.

Pride

NETJETS EXPRESSES TRUST IN SILVERCREST®

NetJets, a world leader in business aviation, has announced its intention of ordering 150 Cessna Citation Hemisphere bizjets, powered by the Silvercrest engine from Safran Aircraft Engines. NetJets thereby confirms its determination to be the launch customer for this aircraft.

SAFRAN SUPPORTS DANISH ARMED FORCES

ARRIEL 1D1 ENGINE MAINTENANCE

At the end of 2018, Safran Helicopter Engines signed a maintenance contract for the Arriel 1D1 engines powering the Fennec helicopters deployed by the Danish Royal Air Force. The engines are covered by Safran's Global Support

Package (GSP), part of the company's EngineLife® service package for helicopter engines. Operators benefit from guaranteed engine availability, with a fixed cost per hour of flight, based on a full technical partnership with the manufacturer.

A330NEO: THREE CHALLENGES FOR A KEY PROGRAM

New engine, new cabin, new wing design — the revamped Airbus A330neo entered service in mid-December bearing the red and green livery of launch customer TAP Air Portugal. We look back at this remarkable program, what we've achieved and the challenges ahead.



THE DEADLINE CHALLENGE

"The deadline Airbus gave us was 18 months shorter than previous programs," says Laurence Chomette, A330neo program manager at Safran Nacelles. *"Starting with an almost blank sheet of paper, we designed the nacelles for the A330neo, completed production engineering and launched volume production in just 42 months — a first!"* The first challenge Safran faced on the reengineed airliner was naturally the timetable. This was a particular issue for the nacelles and the power transmission, which are directly affected by the change of engine. Safran Transmission Systems and Aero Gearbox International, a 50/50 joint venture with Rolls-Royce, also had a tight schedule to meet. *"Developed in under 24 months, this first program for our joint company was a real challenge in terms of design and deadlines,"* says Laëtitia Velluet, pro-

gram manager at Safran Transmission Systems. Safran Cabin also had to pull out all the stops to deliver the overhead bins, including responding to customization requests from each new operator, while staying on schedule.

For the other Group companies involved, the short timeframe was less of an issue. Systems and equipment are similar to the previous version of the plane, thereby requiring fewer modifications. Some designs have been upgraded, of course, but they've benefited from existing technologies and a

mature industrial organization. *"The only exception was Safran Landing Systems, which supplied a hydraulic unit for the nacelle and uplocks in record time,"* adds Guillaume Agamennone, program manager for equipment.

THE INNOVATION CHALLENGE

The shorter deadline and the need to reduce costs meant we had to accelerate the development of innovative design and production solutions. *"The landing gear supplied by Safran Landing Systems is more robust than the previ- ➔*

OCTOBER 2017, FIRST FLIGHT

The A330neo, the latest member of the A330 family of widebody airliners from Airbus, made its first flight over Toulouse on October 19, 2017. It features a wide variety of systems and equipment from Safran.

Safran team members celebrate the A330neo's first flight at our Toulouse facility.

A330neo enters service in the red and green livery of launch customer TAP Air Portugal.







NACELLES
—
3.65 M
DIAMETER


LANDING GEAR
WHEELS
AND BRAKES*
—
THE GEAR
SUPPORTS AROUND
40X
ITS OWN WEIGHT


ELECTRICAL
WIRING AND
SYSTEMS
—
160 KM
OF WIRING


TRENT 7000
ENGINE POWER
TRANSMISSION**
—
350 kW
POWER TRANSMITTED


OVERHEAD
BINS
—
66 larger
THAN THE ASSOCIO


DATA
LOADING
SYSTEM
—
A SINGLE
INTERFACE FOR
30
AIRCRAFT SYSTEMS

* The wheels and carbon brakes are developed by Goodrich-Messier, a joint venture of Safran Landing Systems and UTC Aerospace Systems.
** Developed by Aero Gearbox International, a 50/50 joint company between Safran Transmission Systems and Rolls-Royce.

The first A330neo was delivered
to Tap Air Portugal
on November 26, 2018.

›ous version, so it can better withstand the specific type of vibration from the new engine,” continues Guillaume Agamennone. Safran Landing Systems has also introduced new parts in compliance with the European regulation REACH (Registration, Evaluation, Authorization and restriction of Chemicals), to safeguard our environment.

The power transmission for the Trent 7000 benefits from the maturity gained with the current A330 engine, coupled with the latest innovations from Safran Transmission Systems. “We opted for a large fan case “machined from solid” and used a new manufacturing procedure, instead of the usual casting process, which allowed us to gear up for production more quickly,” says Laëtitia Velluet.

But furthest ahead of the technology curve is Safran Nacelles. In another step toward the digital factory of the

future, the A330neo program was a chance to introduce robotics and virtual reality. “The first application of VR at Safran Nacelles was the design of the assembly line for the transcowl — a large, complex component and a key element of the nacelle system,” explains Laurence Chomette. A new 3D room at Le Havre, France, allows team members to visualize the tooling needed on the production line before ordering it, as well as verify the optimum ergonomic conditions for workers at each step of production. VR was subsequently used to prepare for the assembly of thrust reversers at our Burnley site in the UK.

THE SERVICE ENTRY CHALLENGE

As the A330neo entered service in mid-December, development issues gave way to the challenges of volume production, with the requirement to improve industrial performance and

related support, while keeping costs under control. Aero Gearbox International has to finalize transfers to its new plant in Poland, which will handle the manufacture and assembly of the power transmission system.

At Safran Electrical & Power, volume production involves changes to its industrial organization. “It’s a mature program, where the real challenge is the transfer of electrical cabinets to Mexico for production, after being prototyped in France,” says Bahtiyar Boz, program manager for wiring.

Product performance is of course crucial. Safran Ventilation Systems is supplying a range of equipment for the A330neo, from cargo bay and avionics rack ventilation to cockpit heating and bleed air for the cabin, as well as brake cooling. These are identical in every way to the systems supplied for the A330. “We’re keen to offer Airbus lighter and more innovative solutions,

in line with what customers want,” says Flore Martineau, head of Airbus programs at Safran Ventilation Systems. Safran Electronics & Defense has also proposed innovative solutions for the A330neo, especially to optimize maintenance operations. *“We’re supplying the new onboard system for uploading configuration data,”* explains Raphaël Betsch, major account manager, sales & marketing department. *“This system digitizes the process of managing aircraft configuration operations. It lets airlines update the systems without having to physically exchange paperwork with the plane.”* Today, the company is working with Airbus to develop predictive maintenance services, based on advanced data analytics.

Safran Nacelles has developed the NacelleLife™ range of services, which offers customers tailored maintenance services from service entry to retirement. Equipment manufacturers also need to ensure that replacement parts are available when needed at the repair centers. With the A330neo now in service, the final challenge will be the timely provision of parts and repairs. ■

“We designed the nacelles for the A330neo, completed production engineering and launched production in 42 months – a first! The deadline Airbus gave us was 18 months shorter than previous programs!”

LAURENCE CHOMETTE
A330neo program manager,
Safran Nacelles

?

3 QUESTIONS FOR

CHAFIC HANNA-DAHER
Vice President, Services,
Safran Nacelles

What’s the challenge for Safran Nacelles in terms of services?

Airlines want to minimize operating risks with the nacelle, while at the same time reducing operating and maintenance costs. They want us to guarantee the availability of nacelle components so they can

limit their investment in repair inventories. That’s what we offer with NacelleLife™.

What’s the principle behind NacelleLife™?

NacelleLife™ is a new solution that provides operators with a range of maintenance services tailored to their specific requirements, from gearing up for entry into service to major shop visits to

retirement or resale of the aircraft.

What’s been their response?

We wanted to position ourselves on the services market with a consistent and distinctive value proposition. Since we launched NacelleLife™ six months ago, we’ve already signed seven new contracts!

ARIANEGROUP, A SPACE INDUSTRY GIANT

On September 25, the 100th Ariane 5 rocket lifted off from Europe's spaceport in Kourou, French Guiana (South America) on its latest successful mission. In a shifting global market, just two years before the first flight of Ariane 6, ArianeGroup — a 50/50 joint venture between Safran and Airbus — is gearing up for production of its future launch vehicle. Its strategic objective is to guarantee independent access to space for Europe.



Above: The 100th Ariane 5 launches successfully from Kourou, French Guiana, September 25, 2018.



AT THE HEART OF THE M51

—

A crucial component of France's nuclear deterrent force, the M51 strategic ballistic missile brings together a wide spectrum of cutting-edge expertise, under the direction of ArianeGroup. The company coordinates research and the design, development and production of the missiles, land-based launch infrastructure and command-and-control systems on French navy submarines. Its dual objective: dependability and operational excellence.

Ariane 5 has been in service for 22 years now and logged its 100th flight in 2018. The launcher's reliability set the standard in the space sector for many years — until the market became a whole lot more competitive with the advent of new private-sector players, who've really reshuffled the deck. To meet the challenges in this brave new paradigm, Europe has reorganized and rearmed with the creation of a space industry giant: ArianeGroup.

JOINING FORCES

Safran and Airbus formed this 50/50 joint venture in 2015 by merging their launch vehicle businesses. ArianeGroup is prime contractor for Europe's Ariane launchers as well as the missiles for France's ocean-going strategic deterrence force. It designs and builds Ariane 5 and Ariane 6 on behalf of the European Space Agency (ESA), while subsidiary Arianespace handles marketing and operations. The company's mission is highly strategic: guarantee independent access to space for

Europe. Today, while Ariane 5 continues to fly, with another 22 missions before the program ends, Ariane 6 is eagerly awaited. *"Production of the first Ariane 6 began in late 2018, leading to its inaugural flight in 2020,"* says Alain Charmeau, CEO of ArianeGroup*. *"The program is moving forward on schedule!"*

ALL MISSIONS, ALL ORBITS

Ariane 6 stands ready for all types of missions to all orbits, from low-Earth to geostationary, for government and commercial operators. It's an inherently modular rocket that can be tailored to market demand, with the ability to loft single, dual or multiple payloads. The two variants of Ariane 6 are the Ariane 62 with two strap-on boosters and the Ariane 64 with four boosters, giving it real flexibility and scalability. Other key features include two sizes of payload fairings and a complete set of dedicated support systems for payloads, enabling it to meet

a wide range of customer requirements. Its upper stage, powered by the reignitable Vinci® engine, makes it ideally suited to complex missions, such as the orbital injection of clusters of satellites for larger constellations. Ariane 6 is taller than its predecessor — 70 meters, compared to 50 meters for Ariane 5 — and has a larger payload volume, yet will cost 40 to 50% less to build. Several factors contribute to this cost-effectiveness: an optimized Europe-wide industrial organization, new design and build technologies, and industrial and cost targets factored in from the start of the project.

2020 AND BEYOND...

Ariane 6 launch contracts have already been signed for the Galileo system and with Eutelsat. Looking further ahead, ArianeGroup is working with ESA and French space agency CNES on future evolutions of Ariane 6. Alain Charmeau explains: "Ariane 6 will incorporate new technologies as soon as they're mature enough and will evolve over time — unlike Ariane 5, which was only really optimized in the last ten years." A prime example of this kind of technology insertion is the Prometheus main stage engine, currently at the demonstrator phase. Prometheus will be reusable and built at one-tenth the cost of a Vulcain®2 engine — which could prove vitally important in the future! ■

* André-Hubert Roussel was named CEO of ArianeGroup on January 1, 2019.

MORE FULLY INTEGRATED VIA ONE SAFRAN

Safran Seats at Issoudun, central France, is the first former Zodiac Aerospace entity to embark on the One Safran adventure, with a project focusing on operational excellence in production launched in early 2018. Dozens of projects have since been conducted at the three new companies.

Since February 2018, Safran and former Zodiac teams in operational excellence and integration departments have been keen to leverage the One Safran initiative to foster closer integration. Safran Seats at Issoudun was duly chosen to test the One Safran standards of operational excellence in production. The first project focused on the “shells” on Line 17, which makes business-class seats for Hong Kong-based carrier Cathay Pacific.

A PROMISING PROJECT

The teams were soon working with managers to discover, understand, select and implement standards as part of a One Safran project. With a clearly defined scope of application and a time limit of 16 weeks, operators, supervisors and managers achieved impressive outcomes. As well as improving working conditions — safety, ergonomics, cleanliness, etc. — the project reduced assembly time from 178 to 123 hours. The line is now operating as a single team, compared to two before. As a result, the site has more capacity to take on new orders.

COMMITTED TEAMS

The key success factor on this project was the clear commitment of everyone

involved, first and foremost the teams who tested this new methodology. At the project closing ceremony, production operators and members of the support functions said how proud they are of the results. The commitment of management was just as outstanding, providing vision and support for the teams from start to finish. Team members from Safran Electrical & Power, Safran SA and other Group companies also contributed to this collaborative effort.

AN EXAMPLE FOR THE GROUP

One of the methods used on this project was Value Stream Mapping (VSM). VSM is a way of reducing waste in production flows by identifying the causes and building “target” flows that better meet requirements. Remarkably rigorous, it now serves as a model for the entire Group and shows how much the new companies are contributing as we work together to build One Safran. ■



“We quickly realized we needed everyone onboard — all operational staff and the support functions. The buy-in by teams was remarkable!”

MICHEL COUREAU
Director, Operational Excellence,
Safran Seats France



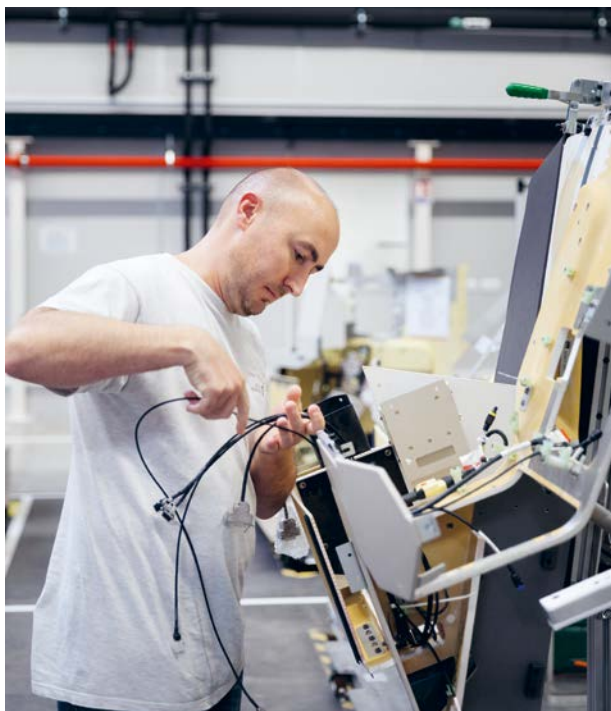
Moving forward together:
Visual management really helps
at the regular team briefings.



YANN DROUIN
Supervisor, Line 17, Cathay Pacific
at Issoudun

“When I told the teams
we’d be applying the

One Safran approach, I sensed some of them were dubious. We’d already tried various improvement initiatives in the past. But once we got over a few preconceptions, we launched into it! Right from the start, we enlisted the help of various support functions, like methods and quality. There was a great sense of teamwork, it was really rewarding for everyone. Implementing VSM took the most time — after that, the rest just followed. And the results are there for all to see! My message for any teams thinking of running a One Safran improvement project would be: Go for it! It’s been hugely beneficial, and deployment was easier than we thought.” ■

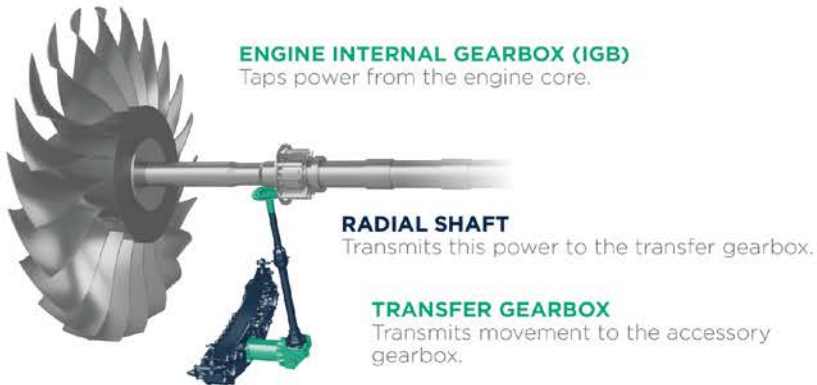


Above and opposite: A shell in production
on Line 17 for Cathay Pacific at Safran Seats,
Issoudun.

INSIDE THE POWER TRANSMISSION

Safran Transmission Systems is the world leader in mechanical power transmission systems for civil and military aircraft. Also called the accessory drivetrain, or ADT, this system transmits mechanical energy to the accessories needed for operation of the engine and aircraft.

THE ACCESSORY DRIVETRAIN



ENGINE INTERNAL GEARBOX (IGB)
Taps power from the engine core.

RADIAL SHAFT
Transmits this power to the transfer gearbox.

TRANSFER GEARBOX
Transmits movement to the accessory gearbox.

ACCESSORY GEARBOX

An assembly comprising a case (forged or cast), a cover plate and a geartrain (with gears and bearings), on which are mounted aircraft and engine accessories.

POWER TRANSMISSION FUNCTIONS

STRUCTURAL

The ADT supports the accessories mounted on the AGB.

STARTING

The ADT transmits the energy generated by the starter to spin up the engine and start it operating.

PROPULSION

The ADT taps energy generated by the rotating engine and distributes it to the accessories needed to ensure operation of the aircraft and engine.



ELECTRICAL GENERATOR

Provides electrical power for the aircraft's systems, including flight control systems.

CUTAWAY VIEW OF THE AGB WITH AIRCRAFT AND ENGINE ACCESSORIES

OIL PUMP

Lubricates and cools bearings and gears on the engine and AGB.

ALTERNATOR

Equipped with permanent magnets, provides power for the engine's electronic control unit.

SPIRAL BEVEL GEARS

Located in the transfer gearbox.

FUEL PUMP

Sends fuel to the engine.

CASE

GEARTRAIN

Comprises gears and ball bearings.

CASE

OIL TRAP

Uses centrifugal force to separate the oil from the air in the engine.

STARTER

Starts the engine.

HYDRAULIC PUMP

Used to operate the landing gear, flaps and control surfaces.

A woman with brown hair tied back, wearing a white hard hat, clear safety glasses, and a white lab coat, is smiling warmly at the camera. She is wearing teal nitrile gloves and holding several sheets of paper. The background is a blurred laboratory or industrial setting with white metal frames.

**ONE
FUTURE**



INAUGURATION OF SAFRAN CERAMICS

Our new research center for ceramic matrix composites (CMC), Safran Ceramics, was inaugurated on November 6, 2018, in a ceremony attended by Alain Rousset, President of France's Nouvelle Aquitaine region, Stéphane Cueille, Safran Senior Executive Vice President, R&T and Innovation, Eric Dalbiès, Senior Executive Vice President of Safran Helicopter Engines and Marc Montaudon, Managing Director of the center. Part of Safran Tech, the Group's research arm, this new 9,800 square meter (105,840 sq ft) building will be home to about 100 researchers, doctoral students and apprentices. Their work will underpin the development of ceramic matrix composite engine parts, combining lighter weight and greater resistance to very high temperatures.

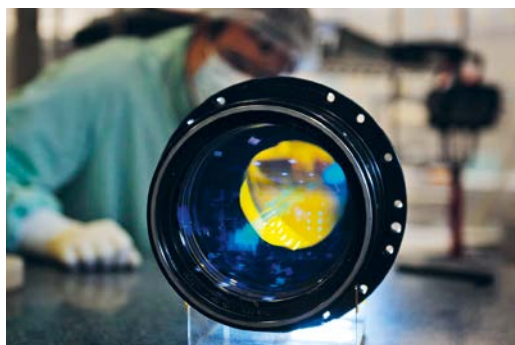
Safran Engineering Services, Alstom and IGE+XAO are creating a center of engineering excellence for electrical systems on rail vehicles. With up to 100 engineers at the Safran Toulouse facility, this new center will be a major asset in meeting tomorrow's mobility challenges.



WE LOVE INTRAPRENEURS

PROJECT SELECTION

From the end of 2018, Safran will be calling on your intrapreneurial skills! The 12 short-listed teams will present their projects at Safran Innovation Day 2019. Check back with us on February 4 to see the winning projects.



ACADEMIA MEETS INDUSTRY TO SPUR INNOVATION

On September 5, 2018, Safran Electronics & Defense and the Pprime Institute inaugurated their joint Primeo lab in Poitiers, France, dedicated to research on innovative optical materials.

Thinner, lighter, bigger! Safran Aerosystems is now offering optimized screens for airline passengers. What's more, the edges are narrower to increase the effective screen size. It's 35% lighter than the latest-generation screens, already the lightest on the market, and can be installed even in thin seats.

SAFRAN SUPPORTS THE BOOM IN AIRCRAFT LEASING

Over the last three decades, aircraft leasing firms have become major players in the aviation market. Today, they own about 40% of the global fleet, amounting to more than 10,000 airplanes – and their share should rise to 50% in the next ten years. The upshot is that aircraft lessors are now pivotal customers for Safran.





FREEING FUNDS BY LEASING

In the sale and leaseback transaction, the airline actually resells the airplane to the lessor, then immediately leases it back to operate it, reducing exposure to the risk of the airplane losing value.

"The first leasing companies, or lessors, primarily arose to provide airplanes to small carriers that couldn't buy their own," explains Claude Poulain, head of the lessors market at Safran Aircraft Engines. "In 1970, only 17 commercial airplanes worldwide belonged to lessors! Airlines of all shapes and sizes gradually realized that the leasing solution could increase their flexibility and lower their operating costs by giving them access to higher-performance models."

By calling on lessors, airlines can therefore focus on their core business, namely ticket sales, passenger transport and associated services.

DUBLIN: LOCATION, LOCATION, LOCATION

Today, there are more than 160 aircraft leasing companies worldwide, in a sector largely dominated by about 50 firms with more than 50 airplanes each. The uncontested market leaders are AerCap and GECAS, each deploying a fleet of over 1,000 aircraft.

A number of these companies, including the largest, have chosen to set up shop in Dublin, in the Republic of Ireland. "Dublin offers a very favorable

economic and regulatory environment," points out Claude Poulain. *"The country has signed a number of fiscal agreements that greatly facilitate leasing operations. In turn, this has stimulated the growth in Dublin of an entire ecosystem comprising lawyers, financiers and other experts."*

Asia has also seen the emergence of a key city, namely Hong Kong. Reflecting industry-wide trends, four of the twelve largest lessors are Chinese. With the Chinese government's fiscal advantages for aircraft deliveries, growth should continue.

The United States is the only major market where leasing firms still have a limited presence. According to Poulain, *"American carriers have access to more capital, and their strategy is to keep their airplanes as long as possible. In Europe and Asia, on the other hand, carriers generally keep their aircraft no more than a dozen years, and they cover the risks inherent in their planes' residual value by opting for leasing."*

LIQUIDITY

In practice, the average length of an operator lease is seven to twelve years, depending on the type of airplane. If applicable, the plane can also be transferred from one operator to another. *"The liquidity of the aircraft market is of capital importance for lessors: if an airline is not doing well in one region, the lessor can quickly shift its planes to another region,"* notes Claude Poulain. *"Lessors also try to maximize their profit when reselling airplanes, and they don't necessarily wait for the end of a lease to sell. They generally sell the plane and its associated lease to a smaller leasing firm. Market leaders are believed to sign a transaction of this type every day!"*



› WORKING HAND IN HAND

Given the size of lessors' fleets, they are critical business partners for aircraft and equipment manufacturers alike. In the single-aisle commercial jet market, one than a quarter of all planes are ordered by leasing firms. Furthermore, nearly 30% of all aircraft ordered by airlines are financed by lessors using the "sale and leaseback" method (see *previous page*).

With the market entry of the new LEAP engine from CFM International (the 50/50 joint company between Safran Aircraft Engines and GE), Safran is teaming up with lessors to win new contracts. On the Airbus A320neo, for instance, lessors can be very strong allies in convincing operators to choose the LEAP-1A instead of the rival engine.

CONFIGURABILITY

In addition to promoting its products as original equipment, Safran is also bolstering its position on "transition aircraft", referring to a period when the airplane is reconfigured by the lessor for a new customer. Safran offers easily reconfigurable products that support a quick transition, to maintain the aircraft value as high as possible. Safran Seats has developed a unique solution from this standpoint, offering two complete sets of seats that are available immediately, on the A320 (180 seats) and the Boeing 737-800 (189 seats). This type of quick reconfiguration is a key to market success.

"Over the last three years, we have seen fast-paced growth in specific actions targeting this segment," says Beth de Young, head of lessor business development at Safran Seats. *"Our aim is to enable the rapid reconfiguration*

of the aircraft, along with personalization. The cabin is a key to gaining a competitive edge. Top-tier airlines want very specific cabin configurations, while most other airlines want to retain easily reconfigurable aircraft, with standard interior layouts."

CFM International maintains relations with lessors throughout the airplane's service life and during the transition between lessees. *"For instance, we offer thrust upgrades when the transition is between a customer in a colder, low-altitude climate and one in a 'hot-high' climate like South America, where the engine has to deliver more thrust,"* explains Claude Poulain. *"In the case of a non-scheduled repossession, we may also recover an aircraft with engines needing performance restoration. Because we're in close contact with lessors, we can quickly assess the situation and offer services that allow them to transfer the airplane to another lessee without waiting too long."*

"Good relations with lessors favor the selection of our products in the catalogs of leading planemakers, because they have real negotiating power," adds Beth de Young. *"Lessors may be powerful, but we're still talking about small teams where good customer relations is the key." ■*





RAVE™, THE MOST POPULAR PASSENGER SCREEN

The RAVE passenger screen system from Safran Aerosystems is the preferred solution in the aircraft leasing market. RAVE quickly creates a brand image for the airline because of its modular graphical user interface. Safran Aerosystems can supply all the screens for a widebody jet in less than six months, twice as fast as the competition.



A FLEXIBLE GALLEY

Safran Cabin has adapted its product line to the requirements of leasing firms with the MaxFlex Galley, designed for the Boeing 737, for which a number of configurations are pre-certified. For instance, the operator may decide to change the coffee-makers, kettles and other components in the galley, without have to recertify it. The upshot is personalized equipment, plus time and money savings.



BIG DATA AND SERVICES

Bruno PALACIOS

Vice President, Marketing & Business Development, Avionics Division, Safran Electronics & Defense

Between the ongoing growth in air traffic and increasingly connected aircraft, the information stream from the global aircraft fleet is never-ending. Safran Electronics & Defense is now determining how Cassiopée, its flight data analysis service, should adapt to the fast-changing aviation market.



To what degree do changes in air traffic influence flight data management?

B.P.: Studies on passenger air traffic are unanimous: the global fleet will double in the next 20 years to a total of 48,000 aircraft. This growth entails major challenges for airlines, in terms of increasing flight safety, decreasing carbon emissions, optimizing maintenance services and more.

Flight data analysis plays a key role in meeting these challenges. Tens of thousands of parameters are recorded during each flight, including altitude, speed and attitude, of course, but also the temperature, pressure and vibrations affecting the aircraft's systems. Everything is monitored, from the engines and avionics bays to the ventilation system. With Cassiopée, Safran Electronics & Defense helps airlines analyze and understand their flight data. Interpreting this data allows them to determine how an aircraft performs

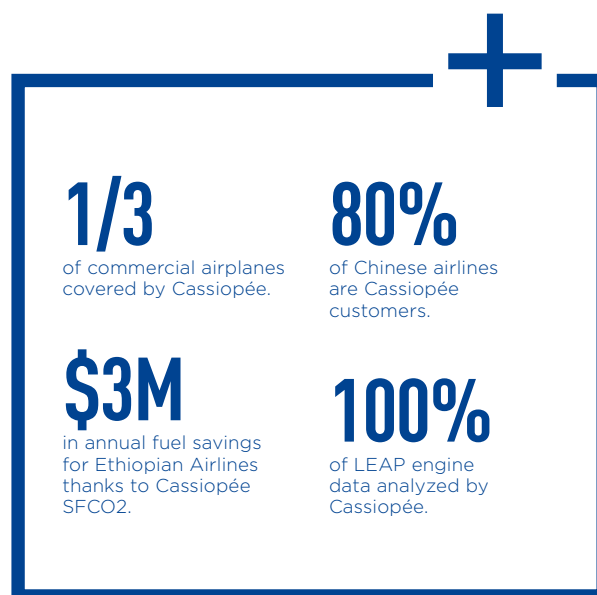
in each specific context. The ultimate goal is to help customers make better decisions concerning both maintenance and flight procedures.

We are currently experiencing a revolution in this area. On one hand, more and more actors are taking an interest in the data generated by aircraft, including airlines, planemakers, equipment manufacturers, MRO shops, etc. On the other hand, the volume of data to be analyzed is making a quantum jump - we're really entering the era of big data!

How is the digital transformation impacting the Cassiopée range of services?

B.P.: The volume of flight data now available is creating new service

“Flight data management is already undergoing a big data revolution. But with The Internet of Things, the volume of data to be collected and analyzed will grow even faster. Cassiopée is undergoing constant changes to adapt to this new reality.”



opportunities and new entrants in the data analysis market. To stay competitive, we continuously upgrade Cassiopée, starting with data access. All types of aircraft worldwide have to be monitored, quickly and automatically. Secondly, concerning our data analysis offering, we have teamed up with Safran Aircraft Engines and Safran Analytics to offer a service that helps carriers reduce their fuel consumption, known as SFCO2. The third main factor is accessibility: all Cassiopée services now operate in the cloud, and can be integrated by our customers in their digital environment.

All of these improvements are dictated by our drive to deliver innovative solutions to our customers, along with new applications that address their needs.

The digital revolution is also impacting how we capture customer feedback. We have supported the development of a community of users by creating online forums, moderated by dedicated staff. This means a radical change in the customer support environment, since customers become key contributors to Cassiopée upgrades.

What's the advantage of digital in marketing your products?

B.P.: We are dealing with a vast market of 1,400 airlines and several thousand helicopter and business aircraft operators. Pitching these potential customers one by one means we have to rethink our approach. The marketing profession is going digital to support the business development of

Cassiopée, including automated marketing, blogs, SEO, etc. These techniques help drive the success of the brand. Our objective is clear: to help sales teams identify the prospects who could quickly become customers. ■

VTOL: SAFRAN TAKES OFF!

The term VTOL – for vertical takeoff and landing – is increasingly in the news. It now mainly refers to helicopter type drones that are already being built in prototype form by startups, with the majors also keeping a close eye on developments. What distinguishes these platforms from previous VTOL iterations is their propulsion system, either all-electric or hybrid electric. Safran is rising to this challenge – vertically! – and has specialized in hybrid electric propulsion systems.

Pegasus, Bell Air Taxi and other names like these are spelling out the future of air transport. These new VTOL aircraft will first carry cargo, and eventually people. *“Remember that the first VTOLs were helicopters”*, notes Pierre-Alain Lambert, head of the Energy and Propulsion research group at Safran Tech. *“The first operational vertical takeoff aircraft, the BAe Harrier, dates from 1966. The Boeing-Bell V-22 Osprey tiltrotor also belongs to this family. Historically, this type of aircraft has been used for military applications, and helicopters have always been dominant.”*

SO WHAT CHANGED?

“Helicopters are limited when flying over inhabited areas, mainly because they’re noisy,” explains Pierre-Alain Lambert. *“One way of addressing this problem is a distributed electric propulsion system, involving a large number of rotors. Among other factors, we can now envisage far more autonomous vehicles, because of a quantum jump in computing power and artificial intelligence technologies.”* VTOL aircraft are seen as safer, quieter and less expensive than helicopters, with the added ability to take off and land autonomously at small fields. That makes them ideal for quick container carriage, medical evacuation, urban logistics, etc. However, we also have to wait for changes in air traffic regulations before we see VTOLs being used as air taxis.

THE SAFRAN CHALLENGE

Safran is staking out a position in this emerging market. *“We are keeping a close eye on the market, the different players and their approaches,”* says Robert Vivier, head of innovation programs at Safran. *“We are trying to understand and analyze the key factors in the development of VTOL designs.”* However, Safran does not intend to design the complete vehicle, but rather to form partnerships with mature airframe manufacturers that are taking a similar approach, such as Bell, Boeing and Airbus. As Pierre-Alain Lambert explains, *“With Safran Electronics & Defense and their Patroller tactical drone, we are capable of developing autonomous flight software. With Safran Helicopter Engines, we master power generation and the certification requirements for propulsion systems. Safran Electrical & Power covers the entire spectrum of electrical needs and Safran Aerosystems brings their expertise in batteries.”*

Safran has already signed certain partnership agreements, involving the supply of hybrid VTOL propulsion systems to Bell, and electric motors to Boeing. Our road map aims for initial demonstrations already starting in 2020, and for these technologies to hit the market by 2025. ■

HYBRID ELECTRIC PROPULSION HOW IT WORKS

An electrical generator is coupled to a gas turbine to form a turbogenerator. This system is then connected to batteries and powers several electric motors which drive rotors or propellers to propel the aircraft.

