WITH THE AIR TRANSPORT MARKET BECOMING MORE CHALLENGING BY THE DAY...

Higher fuel costs
Tougher environmental regulations
New players and new business models
SNÉCMA DELIVERS CUSTOM-TAILORED SOLUTIONS

Snecma (Safran) offers a broad range of powerful, reliable and durable engines for all segments of the civil aviation market. We work closely with our customers, whether aircraft manufacturers, airlines, operators, or leasing firms, which means we share the same vision of what’s needed to power commercial aircraft, today and for years to come. The result is powerplants such as the CFM56®, LEAP®, Silvercrest® and SaM146, all benchmarks in their market segments. And we will continue to offer the propulsion solutions attuned to their evolving requirements. Our proven ability to come up with innovative technologies gives our customers a competitive advantage in terms of performance, operating costs and environmental-friendliness. Our global MRO network and broad range of support services means unrivaled dispatch reliability for engine fleets, while protecting their long-term residual value. We also offer world-class production capabilities, solid long-term partnerships and the comprehensive support of parent company Safran, giving our customers the visibility they need to make strategic decisions in a fiercely competitive environment shaped by increasingly complex requirements.

CFM, CFM56, LEAP and the CFM logo are trademarks of CFM International, a 50/50 joint company between Snecma (Safran) and GE.
COMPETITIVENESS & RELIABILITY

The CFM56 is the acknowledged benchmark in the engine market for single-aisle commercial jets. It is developed, produced and marketed by Snecma (Safran) and GE through their 50/50 joint company, CFM International. Their success in this highly competitive market reflects the globally recognized expertise of the two engine-makers, who have renewed their partnership through 2040. The partners’ long-term vision also allows them to address the market’s expectations by developing the new-generation LEAP, already selected by the world’s leading aircraft manufacturers to power their new single-aisle jets.
ENERGIZING THE MARKET

In many parts of the world, short and medium-haul flights reflect business growth and rising GDP, resulting in a strong increase in passenger traffic on point-to-point routes up to about 3,000 miles (5,000 kilometers). This is the largest and most dynamic segment in commercial aviation, with some 20,000 new aircraft to be delivered over the next 20 years, according to Snecma’s market studies. It is also a highly competitive market for operators, who have to maximize their load factor and number of cycles, while reducing fuel consumption and the time aircraft are on the ground. To support the business growth of these operators, engine manufacturers have to deliver a very economical, reliable product, backed by quick, complete support services that reduce operating costs and maximize return on investment.
SNECMA AND GE, TEAMING UP FOR SUCCESS

Sneca and GE teamed up in this market segment as early as 1974, creating an equally-owned company to develop a revolutionary aircraft engine in the 18,500 to 35,000 lb of thrust class. Today, CFM International is the world’s leading supplier of engines for single-aisle mainline commercial jets (over 100 seats). Nearly 28,000 CFM56 engines have been delivered to date, and the CFM56 is widely acknowledged as the most reliable engine of its generation. This all-time best seller mainly powers the single-aisle jet families offered by Boeing (737-300 to 737-900) and Airbus (A318 to A321). In 2008, GE and Sneca extended their unique partnership until 2040 and expanded its scope to include services. This decision clearly reflects the long-term commitment of GE and Sneca to meeting the specific needs of each customer. To provide real local support worldwide, CFM draws on the complementary technical, geographic and human resources of the two parent companies’ support services and MRO networks, and on the unparalleled skills of their employees.

(1) The CFM International partnership covers the thrust range from 18,000 to 50,000 lbf.
(2) At April 30, 2015

Complementary capabilities, integrated product

CFM engines are developed and produced according to a clearly defined, highly effective workshare organization, with each partner fully responsible for their own part of the jet engine: GE is in charge of the core, and Sneca the low-pressure section (fan, low-pressure compressor and turbine), accessories and exhaust nozzle. Each partner has its own development resources, assembly lines and test facilities, and puts together half of the engines produced each year. Sneca and GE also split responsibility for sales and CFM support according to assigned zones around the world.

CFM responsibilities

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<th>Commercial zones</th>
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<td>A CFM56-powered aircraft takes off somewhere in the world every 2 seconds</td>
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Best sellers, generation after generation

LEAP engines have already been chosen to power new single-aisle commercial jets by the world’s leading plane-makers. Airbus chose the LEAP-1A for its new A320neo, Boeing chose the LEAP-1B as the exclusive powerplant for its 737 MAX, and Comac of China chose the LEAP-1C as the sole Western engine on its C919. At the end of April 2015, the LEAP order book already stood at more than 8,900 engines (including commitments).

LEAP: BEST-IN-CLASS TECHNOLOGIES

The new LEAP engine, developed by CFM to power new-generation single-aisle jets, features the best technologies from the two partners. Snecma, for example, has developed the fan blades and case using an advanced 3D woven composite, based on the RTM (resin transfer molding) process. These blades offer higher performance than conventional metallic blades, because of significant weight savings, greater robustness and a virtually maintenance-free design. Other contributions from Snecma include 4th generation 3D aero design and the use of new alloys, such as titanium aluminide (TiAl). Because of this array of innovative, yet mature technologies, the new-generation LEAP engine will meet the needs of both aircraft manufacturers and operators. When it enters service in 2016, the LEAP will reduce fuel consumption and CO₂ emissions by 15% versus the previous-generation of engines (before the LEAP), while also decreasing NOx emissions by 50% and significantly reducing noise, in compliance with Chapter 14 standards. Largely meeting regulatory and environmental requirements, now and in the foreseeable future, this eco-friendly performance also lowers the engine’s operating costs.

At April 30, 2015, orders had been placed for more than 8,900 LEAP engines.
DISPATCH RELIABILITY

Snecma calls on its OEM skills and expertise to deliver a comprehensive slate of support services to airlines, other operators and leasing firms, either through CFM or via our own EngineLife® package of support services. These services cover the entire life cycle of each engine, from service entry to dismantling, and from on-wing maintenance to “by the hour” support contracts, designed to enhance operations and reduce costs. Snecma handles CFM support services in its commercial zone. In particular we operate a Customer Support Center open 24/7, a dedicated website (Customer Web Center), and a training center offering more than 150 different programs. For maintenance, repair and overhaul (MRO) services, Snecma deploys a worldwide network comprising eight engine maintenance shops and 12 world-class centers of excellence in parts repair. As part of our comprehensive offering, we are also developing innovative service packages based on the analysis of flight data, and high-added-value consulting services.
CFM at a glance

NEARLY 28,000 CFM56 ENGINES DELIVERED TO DATE (APRIL 30, 2015)

MORE THAN 13,000 CFM56 AND LEAP ENGINES ON ORDER, EQUAL TO 8 YEARS OF PRODUCTION

NEARLY 550 CUSTOMERS WORLDWIDE

LEAP HAS WON NEARLY 70% OF THE NEXT-GENERATION SINGLE- AISLE MAINLINE JET ENGINE MARKET
Snecma (Safran) is a major partner on most of GE’s large turbofan engines, contributing our expertise in design and performance improvement. A specialist in the high- and low-pressure compressors for this type of engine, Snecma also provides MRO services for the modules under our responsibility, worldwide.
A STRONG GROWTH MARKET

The steady increase in intercontinental passenger and cargo traffic has driven the strong growth of the long-haul widebody aircraft market. Snecma’s own market studies show a requirement for about 8,000 new aircraft over the next 20 years, which will in effect double the fleet. The major challenge for operators is to reduce aircraft fuel consumption while maximizing dispatch reliability, thus minimizing the number of late or cancelled flights, which carry a cost penalty. Large turbofan engines such as the GE90, powering the Boeing 777 family, or the GP7200 for the Airbus A380, were specifically designed to meet these requirements. Snecma is a major GE partner in this market segment, with different stakes in the GE90, GP7200, GEnx, GE9X and CF6-80 engines.
Snecma contributes its latest innovations in fans, compressors and turbines to all of these engines. We are in charge of the design and production of key modules such as the high- and low-pressure compressors on GE90 engines (giving us a 23.7% stake in this program). We also take responsibility for the development and certification tests on these modules, and we have installed a test cell that can handle very large turbofan engines. For the new GE9X, the exclusive engine that will power Boeing’s new 777X long-haul widebody twin, Snecma is contributing its expertise in 3D woven RTM composites, by designing and producing the fan case. Through CFAN, our equal joint venture with GE, Snecma also makes the composite fan blades for the GE90 and GE9X. We are also the exclusive provider of MRO services for the compressors on the GE90, and the high-pressure compressor on the GP7200, while supplying the associated tools.

Snecma calls on its technical expertise, industrial capabilities and worldwide network to provide a complete range of operator services, including 24/7 engine support, and by-the-hour support contracts. We also deploy a network of dedicated service reps at airlines operating the GE90, to meet their specific requirements.

Snecma contributes its latest innovations in fans, compressors and turbines to all of these engines.
GE90, the most powerful aero-engine in the world

The GE90 is the most powerful commercial aircraft engine in the world. It is available in two versions, for different models of the Boeing 777. The GE90-94B entered service in 1996 and develops 94,000 lb of thrust. It powers the Boeing 777-200 and the 777-200ER (Extended Range). The GE90-115B entered service in 2004 and develops 110,000 to 115,000 lb of thrust. It powers the Boeing 777-200LR (Longer Range), 777-300ER and 777 Freighter.
To meet the specific needs of the regional aviation market, Snecma (Safran) developed and produces the new-generation SaM146 propulsion system through PowerJet, a 50/50 joint company with Saturn. The SaM146 turbofan entered service in April 2011, and has since demonstrated exceptional dispatch reliability and adaptability to all operating environments. At the same time, Snecma is conducting preliminary studies to develop a new family of turboprop engines that would address the demanding operating cost requirements of this market segment.
COMPLEMENTARY GROWTH

Regional aviation is reaping the benefits of medium and long-haul traffic growth, since a large part of the routes handled by these smaller planes (less than 100 seats) involves linking medium-size cities to hubs in major cities. Over the last decade, this trend has also led to the development of new regional aircraft, mainly in the 70 to 90 seat class, that provide point to point service over shorter distances, or replace more-expensive mainline jets during off-peak hours.

SaM146, THE NEW STANDARD IN REGIONAL JET PROPULSION

In the regional aviation market, availability, reliability and low operating costs are imperative, because these aircraft are real “frequent fliers”. The SaM146 is an integrated propulsion system that was purpose-designed to meet these requirements. It was developed and is produced by Snecma and NPO Saturn through their 50/50 joint company, PowerJet. Optimized for the new-generation Superjet 100 regional jet, the SaM146 covers a thrust range from 15,400 to 17,800 lbf. Its design is derived from that of the best-selling CFM56 commercial turbofan, and it also incorporates the latest Snecma technologies, in particular 3D aero design. Because of these technologies, plus the small number of stages, the SaM146 offers significant advantages over other engines in its thrust class in terms of fuel consumption, environmental footprint and maintenance. Since entering service in 2011, the SaM146 has posted an exceptional dispatch reliability rate of 99.99%, while adapting to all operating environments, and posting maintenance costs up to 20% less than engines in its class. The SaM146 is available in two versions, the 1S17, rated at 17,300 lb of thrust, and the 1S18, rated at 17,800 lb of thrust, for the Longer Range and Business Jet versions of the Superjet100.
PowerJet offers all Superjet 100 operators a complete range of dedicated support services for the SaM146, under the PowerLife™ label. Drawing on the complementary capabilities of Snecma and Saturn, PowerLife™ features a single-point-of-contact for each customer, the dedicated PowerJet Customer Support Center (CSC), a 24/7 hotline, and a team of service reps located near operators around the world. PowerLife™ also deploys two MRO centers, certified to Part 145, spare parts distribution centers, a data and documentation center accessible online, and complete customer training services, through two training centers, in France and Russia.

Building on its expertise in commercial aero-engines, Snecma teamed up with Russian counterpart NPO Saturn to develop the SaM146, a turbofan purpose-designed for regional jets.
The SaM146 at a glance

- **SAM146**: A family of engines rated at 15,400 to 17,800 lb of thrust
- More than 200,000 flight-hours since service entry in 2011 (April 30, 2015)
- Engine dispatch reliability exceeding 99.9% after two years of revenue service
- Maintenance costs up to 20% less than other engines in the same class
RESPONSIVENESS & AVAILABILITY

With the new Silvercrest® engine, Snecma (Safran) is reshaping the propulsion landscape in the business aviation market. This new-generation turbofan was designed for large-cabin, long-range bizjets, in the super-midsize segment, and will offer unrivaled performance in terms of fuel consumption, reliability and environmental footprint. Drawing on Snecma’s long experience as a manufacturer of both commercial and military engines, the Silvercrest® addresses the major expectations of business jet owners and users: speed, range, availability.
TARGETING A PREMIUM MARKET SEGMENT WITH STRONG GROWTH POTENTIAL

Following a long period of growth, the global business aviation market was heavily hit by the economic crisis that has affected most of the world since 2008. However, the upper-end of this market, including the large, long-range, super-midsize segments, has been relatively spared. Both customer surveys and Snecma’s own studies show that this market should post a dynamic recovery, with projections for the delivery of 8,000 new aircraft in the next 20 years.

While the United States is still the leading business aviation market by number of aircraft in service, over the last five years more than half of all orders have come from other parts of the world, especially Asia, South America and Russia. This trend indicates strong potential for purchases in the super-midsize class – the target market of Snecma’s Silvercrest® engine.

HIGHER, FASTER, FARTHER...

Snecma launched the development of the Silvercrest® turbofan in 2010, based on its successful test of a core demonstrator. Our aim is to reshape the propulsion system landscape in the new-generation large-cabin, long-range business jet market. Rated at 9,500 to 12,000 pounds of thrust, Silvercrest® delivers the performance expected of these machines, in particular reaching high cruise altitude as quickly as possible to avoid the restrictions of commercial traffic. In addition to higher cruise speed, Silvercrest® reduces fuel consumption by 15% versus today’s engines in the same thrust class, thereby extending range and decreasing operating costs. Furthermore, the engine offers hefty margins in relation to the most demanding current and upcoming regulations for emissions (CO₂, NOx) and noise – up to 20 EPNdB less than Stage 4 standards.
Silvercrest® calls on **Snecma’s 40 years of experience in commercial aero-engines and sustained R&D investments over many decades.**

**THE BEST OF SAFRAN**

Designed to set the standard in this thrust class, the Silvercrest® engine reflects Snecma’s 40 years of experience in commercial engines, with the CFM56 family, and our broad technological expertise in military and rocket engines. It calls on state-of-the-art development methods and tools, plus decades of extensive Research & Technology investments by Snecma and parent group Safran in engine architecture, compressors, combustors, turbines and materials. Silvercrest® also combines Snecma’s acknowledged expertise as an aero-engine manufacturer with the skills of fellow Safran companies, including Turbomeca, which designed the centrifugal stage of the high-pressure compressor, Techspace Aero for the low-pressure compressor, or booster, Safran Electronics  (Sagem) for the FADEC engine control unit, and Aircelle for the nacelle and thrust reverser.
One of the most prized qualities in any business aircraft is dispatch reliability – will the plane be ready to go when you are? The Silvercrest® engine offers considerable advantages in this area, by drawing on proven developments for mainline jets. Reliability is designed into each and every component, and the engine features an exclusive performance and health monitoring solution. This system, dubbed ForeVision™, also analyzes and transmits data during the flight, including diagnostics and maintenance recommendations if needed. Right from the initial design stage, dispatch reliability is an integral part of the Silvercrest® DNA.

Snecma has also set up a premium support network, with skilled staff manning Customer Hubs in Dallas, Texas, to cover the Americas, near Paris, to cover Europe, the Middle East, Africa and India, and in Singapore to cover the Asia-Pacific. These service centers will offer replacement engines and equipment, spare parts, a network of repair providers, on-call MRO «Engine teams», and technical experts, allowing them to provide fast, comprehensive support for all customers in their region.
Our overriding objective at Snecma (Safran) is to deliver high-performance, reliable and flawless engines to our customers, right on time. We continuously invest to enhance our capabilities and optimize our production organization and supply chain. To give our customers the solutions that best meet their needs, whether original equipment or MRO services, we focus on enhancing the efficiency of our organization, processes and management methods, and delivering world-class technologies and capabilities, both in-house and at our suppliers.
SIX STATE-OF-THE-ART CENTERS OF EXCELLENCE

Snecma’s production operations are organized in six centers of industrial excellence (CIE), which take charge of the detailed design, engineering, production – or purchase – and support of parts under their responsibility. These centers encompass all of the state-of-the-art human and material resources needed to manufacture an aircraft engine: rotating parts (compressor and turbine disks and shafts, and blisks, or integrally-bladed disks); compressor blades (fan and compressor blades, guide vanes); turbine blades (high- and low-pressure turbine blades, nozzle guide vanes, rings); chambers and structures (cases, combustors); composite parts (3D woven RTM composite parts for the LEAP fan module: blades, case, platform and shims); accessories and equipment (engine equipment, bearings, wiring harnesses, etc.).

GLOBAL SUPPLY CHAIN

The backbone of Snecma’s production organization is an ensemble of three large plants in the greater Paris area, Gennevilliers, Evry-Corbeil and Villaroche. With a total workforce of more than 9,000, these three plants can handle the entire manufacturing process, from forging and casting to final assembly and testing of engines. Snecma’s other production facilities, located in France, the United States, Mexico, India, China and Russia, plus all partners in the global supply chain, send their parts and subassemblies to Villaroche in France, Querétaro in Mexico and Suzhou in China, where the main modules are assembled. These modules are then shipped to the engine assembly lines in Villaroche – except for half of the low-pressure modules on the CFM56 (fan, compressor and turbine), which are sent to GE’s assembly lines in the United States. Safran’s procurement strategy is based on in-house production (Snecma or other Safran companies) of all complex high-value-added parts, along with structural partnerships with small and medium-size companies that have mastered key technologies, and a global network of constantly monitored subcontractors, selected for their proven skills.

Composite materials for lighter engines

Reducing weight is one of the best ways to increase engine efficiency. For the new LEAP engine, Snecma developed fan blades and cases made of a 3D woven composite using the RTM (resin transfer molding) method. This innovative technology provides weight savings of nearly 1,102 lbs per aircraft, compared with conventional fans. Snecma counts on two new plants to produce these parts, in Commercy, eastern France, and in Rochester, New Hampshire in the United States.

Printing 3D parts for Silvercrest®

Snecma’s Evry-Corbeil plant deploys laser additive manufacturing, more popularly known as 3D printing. This process uses a numerically-controlled laser beam to melt a metallic powder and build up even complex parts layer by layer, in a virtually finished state. While increasing part strength, this process also significantly cuts production cost, reduces cycles and the quantity of raw materials needed, thanks to eco-design, and also supports the recycling of raw materials. Snecma is already using the additive manufacturing process to make high-pressure compressor guide vanes for the Silvercrest®.
Snecma is one of the few engine manufacturers to have mastered forge and foundry techniques (including equiaxial, columnar and single-crystal solidification), which play a critical role in ensuring the metallurgical quality of the most highly stressed parts. We have installed specialized machinery in the Gennevilliers plant to handle stamping, circular rolling, thermomechanical treatment and isothermal forging, including an 80-ton counterblow hammer, two circular rolling mills (200 and 565 tons) and a 4,000-ton hydraulic press. Other advanced techniques in the Snecma portfolio include multi-channel cooling, and the deposition of ceramic-based thermal coatings, which protect turbine blades against extreme temperatures.

On the machining side, the Corbeil plant features over 400 major machines, including 300 with numerical control (NC). The plant deploys a number of advanced production technologies, including inertial friction welding, electromechanical machining, laser welding, drilling and cutting, plasma projection and high-speed machining.

ALL OF SnecMA’S COMMERCIAL ENGINES ARE ASSEMBLED AT Villaroche, WHICH TURNS OUT SOME 750 CFM56 ENGINES PER YEAR. THE ASSEMBLY OPERATIONS ARE ORGANIZED IN TWO PULSE LINES, CAPABLE OF ROLLING OUT FOUR CFM56 ENGINES A DAY. THESE LINES, THE RESULT OF A TWO-YEAR Lean-Sigma PROJECT, HAVE REDUCED ENGINE ASSEMBLY TIME BY 30%, TO JUST TWO AND A HALF DAYS. EACH LINE COM普RES FIVE STATIONS TO ATTACH MODULES, SUBASSEMBLIES AND ACCESSORIES, CULMINATING IN A DELIVERY CENTER WITH SEVEN STATIONS TO PREPARE ENGINES FOR ACCEPTANCE TESTS, FINAL INSPECTIONS AND PACKAGING BEFORE SHIPMENT TO CUSTOMERS.

The Villaroche plant has all the facilities needed for production testing, including three acceptance test rigs for the CFM56, one of which is also used for the CF6-80. It also deploys three development test rigs, which can be used for acceptance tests as well, including one for the Leap and one for the GE90 (one of the two largest indoor test cells in Europe), along with repair test benches qualified for after-sales support. Villaroche will ramp up to a production rate of 900 LEAP engines per year in 2020.
Snecma deploys a global maintenance, repair and maintenance (MRO) network, operating directly or via CFM, with facilities in Europe (France and Belgium), North America (Mexico), North Africa (Morocco) and Asia (China), plus parts repair centers and spare parts distribution centers. The MRO facilities offer a total capacity of 450 shop visits (major engine overhauls) per year. They have over 30 active certifications, and provide overhauls for all CFM56 models, the SaM146, compressors on the large GP7000 and GE90 engines, and soon the LEAP engine and the Silvercrest®.

Making maximum use of Lean-Sigma precepts, Snecma continuously modernizes and improves the organization of our MRO facilities. The Querétaro shop in Mexico, a model for new-generation facilities, is organized around a pulse line for engine disassembly and reassembly, to optimize takt time, and an automated warehouse along with an RFID system to track all parts.
As a leading aircraft engine manufacturer, innovation is in our DNA. Snecma (Safran) invests continuously in research, technology and development. And we deploy a full array of resources – the latest technologies, open organization, proven methodologies, experts network, world-class test facilities, etc. – to develop innovative engines that combine performance, economy and environmental-friendliness, for the greater benefit of all customers.
TECHNOLOGY, AT THE HEART OF SNECMA’S STRATEGY

More than 2,600 people at Snecma work solely on research, technology and development. They design innovative, economical and environmentally-friendly propulsion systems for aircraft manufacturers and operators around the world. To stay at the cutting edge of technology, and meet the current and future needs of the aviation market, Snecma invests in research, technology and development. Snecma’s R&D teams work on different strategic research objectives, including all components that are critical to aircraft engine performance: fans, high- and low-pressure compressors and turbines, combustors, engine architecture and integration, composite and metallic materials, etc. The overriding aim of this research is to meet customer requirements, resulting in a number of innovations that offer concrete benefits: 3D woven composite fan blades which are light, strong and maintenance free; lean burn combustors, which reduce fuel consumption, while meeting the most stringent environmental standards; ceramic matrix composite (CMC) turbine blades that stand up to extreme temperatures, and other blades made of ultra-light alloys, such as titanium aluminate (TiAl).

Standing out through innovation

Snecma applies a proactive intellectual property policy to sustain our market leadership and protect critical technologies, drawing on a portfolio of more than 16,000 patents. We regularly file for more than 450 new patents every year. Our contributions further enrich the technology heritage of Safran, which is one of the leading companies in France for the number of patent filings.

RESEARCH, PARTNERSHIPS, ENVIRONMENTAL PROTECTION

Snecma contributes to sustainable air transport at several levels: through reduced fuel consumption, of course, one of our primary research objectives, but also by working on other ways of reducing carbon dioxide (CO₂) and nitrogen oxide (NOx) emissions, as well as cutting noise. These efforts are reflected in our participation in European research programs such as Silence(R) and OpenAir to reduce noise; Newac and Clean Sky to improve aircraft environmental performance; and studies on sustainable biofuels.

More generally, we carry out a number of research programs in partnership with national organizations such as CNRS (scientific research) and ONERA (aerospace research), universities and our counterparts in the aerospace industry. These programs cover key subjects, such as mechanical engineering methods (Maia), noise reduction technologies (Iroqua), aerodynamics, aerothermodynamics and aeroelasticity (Haida), and advanced combustion concepts (Inca). Snecma is also a major player in Safran’s own Sparcs programs, which aims to identify potential disruptive technologies that could be used on future-generation propulsion systems in the 2030-2050 timeframe.

Tomorrow’s engines

Snecma is studying various design concepts for tomorrow’s engines, in a drive to achieve significant reductions in fuel consumption – 25 to 30% less than the previous LEAP generation of engines. One of the main concepts being studied is the counter-rotating open rotor (Cror) engine, being developed as a technology demonstrator via the European research initiative Clean Sky. Through the Sustainable and Green Engine (SAGE) Integrated Technology Demonstrator (ITD), Snecma is overseeing the SAGE2 project, which aims to test an open rotor engine in pusher configuration (aft fan) starting in mid-2016.

Another concept being studied by Snecma is the ultra-high bypass ratio (UHBR) turbofan engine. The main structural parts of the fan module will include lighter and stronger composite parts. A demonstrator, UHPE, is scheduled for ground tests in 2021 as part of the Clean Sky 2 program, and will be used to validate these new technological building blocks and their integration in a UHBR architecture.
Managing continuous improvement

Continuous improvement applies to all areas of Snecma. It is based on recognized methods, such as Lean, Six Sigma and Impact 8D, and aims to improve efficiency, competitiveness and performance. Since 2007, Snecma has built up a network of trained and certified experts to deploy our Lean-Sigma continuous improvement program. This network comprises about 15 Master Black Belts, 200 Black Belts and 1,100 Green Belts (April 30, 2015). Managers are also offered special training courses to make them more aware of their own role in driving the success of the Lean-Sigma approach.

All of these methods, first deployed in production, engineering and quality, are now being extended company-wide. To optimize the deployment of Lean-Sigma, training is pooled within Safran and coordinated by Safran Corporate University. Green Belt training combines classroom study, e-learning in particular, and practical exercises using the ‘model factory’ concept. With these new tools and methods, Snecma was able to train 300 new Green Belts in just one year. A new introductory White Belt training course, teaching all employees the fundamentals of Lean-Sigma, is also being deployed.

TOP-FLIGHT DEVELOPMENT TOOLS AND METHODS

Snecma deploys the resources and organization needed to support all of our engine programs and the people working on them. For instance, we have set up centralized development platforms for the new engines LEAP and Silvercrest®, uniting all design staff working on a given program to stimulate discussions and creativity. In turn, these teams work with the specialized design departments in our industrial centers of excellence, which handle production engineer-ing, in particular to ensure that designs are compatible and producible! These teams can call on our knowledge management system, or our in-house network of experts, with cutting-edge expertise in their respective disciplines, shared with younger engineers and technicians. All developments are organized according to proven scheduling methods, based on meeting predefined milestones.

Snecma’s design departments deploy state-of-the-art tools – 3D modeling, computer-aided design, digital models, etc. – and powerful computation codes to simulate aerodynamic, mechanical, combustion, aerothermodynamic and other key performance factors. These powerful tools help us develop innovative concepts, plus new technologies and services, while also reducing development times and costs.

OUTSTANDING TEST FACILITIES

Snecma deploys more than 100 test rigs for engine development and qualification, guaranteeing outstanding reliability right from service entry. The Villaroche plant offers three engine development test stands and 15 component test benches, all among the best in the world. The Istres test center in southern France provides an open-air test cell, and operates flying testbeds, such as the Gulfstream GII that will be used for Silvercrest® testing. A second open-air test cell is available in Rybinsk, Russia, and Snecma can also call on Techspace Aero’s engine test cells in Belgium, along with the simulated altitude test facility offered by French defense procurement agency DGA’s engine test center in Saclay, the only one of its kind in Europe. This huge volume of test data is crunched by our design departments, to validate new technologies in terms of performance and operability, as well as checking critical phenomena such as distortion, vibration and temperature right from the development phase – all factors that impact an engine’s service life and cost of ownership.
Research & Innovation at a glance

2,600 research, technology and development specialists

100 test rigs of all sizes, for complete engines and components

Tomorrow’s engines aim to reduce fuel consumption by 25% to 30%
SNECMA, A PIVOTAL ROLE IN THE SAFRAN ECOSYSTEM

Our engines incorporate the best technologies from across Safran, including nacelles, electronics, wiring and materials. New developments at Snecma also benefit from Safran’s advanced research efforts. Year after year Safran deploys extensive human and financial resources to develop breakthrough technologies, with tomorrow’s engines being a primary focus.
SNECMA INCORPORATES THE BEST TECHNOLOGIES FROM THROUGHOUT SAFRAN

Research & Technology
drives Excellence & Competitiveness

Snecom also works closely with Safran Tech, the corporate Research & Technology center. To reduce development costs on our upcoming products, we incorporate the latest technological advances from Safran:

- Modeling and simulation of aerodynamic, thermal, mechanical, acoustic and combustion processes,
- Ceramic matrix composites (CMC),
- Expanding use and second generation of organic matrix composites (Safran Composites research center),
- Sensors and data processing (big data, etc.).
SNECMA, THE MULTIDISCIPLINARY ENGINE MANUFACTURER

In addition to our commercial aircraft engine business, Snecma (Safran) also makes military engines (we are one of the few companies in the world capable of designing and producing a jet fighter engine from A to Z) and rocket engines for both launchers and satellites.
MILITARY ENGINES

Snecma offers propulsion solutions for combat aircraft (the M88 engine powering the Rafale, and the M53 powering the Mirage 2000), training aircraft (Larzac, for the Alpha Jet) and military transports (TP400 turboprop, via Europrop International, for the Airbus A400M).

In fact, we design, develop, produce, sell and support the engines powering 20 different types of aircraft deployed by armed forces in 40 countries. More than 4,500 Snecma engines are currently in service, clearly demonstrating our technological expertise and competitive advantages, including a heritage of more than 60 years as a manufacturer of military jet engines.

SPACE ENGINES

Snecma designs, develops and produces propulsion systems and equipment for launchers, satellites and space vehicles. As prime contractor for the cryogenic propulsion systems on Ariane launchers (using liquid hydrogen and oxygen propellants), we were also chosen to develop the propulsion systems for the cryogenic upper stages of the next-generation Ariane 6 launcher. Snecma is the world’s second leading liquid rocket propulsion company.

All of Snecma’s launcher cryogenic propulsion operations will be folded into the new joint company, Airbus Safran Launchers, which took over management responsibility for these programs on January 1, 2015. Snecma is also the European leader in electric propulsion systems (Hall effect plasma thrusters) for satellites. We supply propulsion systems and/or thrusters based on this technology to leading satellite manufacturers, meeting their requirements for orbital transfer and stationkeeping.
Safran is a leading international high-technology group and Tier-1 supplier of systems and equipment for aerospace, defense and security. Operating worldwide, Safran has 69,000 employees and generated sales of 15.4 billion euros in 2014. All Safran employees, from forge and foundry operators to researchers in the mathematical morphology lab, are united by a single overriding aim: to achieve industrial excellence that drives customer success.
SAFRAN, A WORLD LEADER IN ITS CORE MARKETS

Safran is one of the world’s leading suppliers of systems and equipment for the aerospace, defence and security markets. Comprising a number of companies, Safran has 69,000 employees in nearly 60 countries and posted sales of 15.4 billion euros in 2014. Working alone or in partnership, Safran holds world or European leadership positions in its core markets, including commercial aircraft engines (in partnership with GE), landing gear, helicopter flight controls and biometric technologies. Safran’s international reach enhances its competitiveness and underpins industrial and commercial relations with leading prime contractors and operators, while ensuring fast, local service anywhere in the world.

SAFRAN’S THREE CORE BUSINESSES

**Aircraft engines and equipment.** Safran develops, produces and sells engines and subassemblies for civil and military airplanes and helicopters, ballistic missiles, launch vehicles and satellites. It also provides a wide range of systems and equipment for airplanes and helicopters.

**Defense electronics.** Safran operates in the optronics, inertial navigation, electronics and safety-critical software markets. It provides a complete range of opticron and navigation systems, optical equipment and other products for all armed forces branches worldwide.

**Security.** Safran operates in the global security market, offering cutting-edge solutions to meet the changing requirements of people, businesses and governments. These solutions are based on multibiometric technologies, smart cards and secure ID and travel documents.

Snecma at a glance

2014 SALES: 6.5 BILLION EUROS

EMPLOYEES*: MORE THAN 15,000

35 OFFICES AND FACILITIES WORLDWIDE

Safran at a glance

2014 SALES: 15.4 BILLION EUROS

EMPLOYEES*: 69,000

IN NEARLY 60 COUNTRIES

R&D INVESTMENTS: 13% OF THE SALES

* at Dec. 31, 2014.
KEY MISSIONS, KEY TECHNOLOGIES, KEY TALENTS

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