



2,315

Active patents,
utility models and designs



1,161^{FTE}

Persons employed
on R&D activities



100%

Plants with IATF 16949
quality certification





Creating and testing

cutting-edge technologies
and materials



Creating and testing cutting-edge technologies and materials

6.1 Designing innovation

The constant evolution of transport vehicles is driving Brembo’s Research and Development activities, which have always focused on finding the best braking system design to ensure the safety of vehicles of the future.



The work supported by the Group covers all brake system components (caliper, disc, pad, suspension, control unit) and guide Brembo in testing revolutionary solutions that can improve the comfort and environmental sustainability of products, as well as the application of a design that can combine functionality, comfort, durability and aesthetics. Therefore, the aim of the Group’s research and development work is to:

- ▶ **increase braking system performance**, while ensuring maximum reliability and improving comfort through solutions that can reduce braking action noise, vibrations and harshness;
- ▶ **prolong the life of Brembo’s products**, while minimising disc and pad wear;
- ▶ **reduce the environmental impact** resulting from the use of vehicles in terms of greenhouse gas and particulate emissions into the air, through the reduction of the weight of Brembo’s products and the control of the dispersion of braking-related dust, thus contributing to combating the climate change;

- ▶ **enhance the style content** so as to offer products that can interpret concepts of prestige and elegance, thus becoming new status symbols.



2,315

active patents, utility and design models

filed by the Group since it was founded

Brembo’s capacity to innovate and exploit its own expertise as a strategic lever for maintaining its technological and commercial leadership at global level can also be gauged by the patents filed by the Group over time: 2,315 patents divided into 459 families have already been registered in the world in little more than fifty years since its foundation. In 2018, 47 patents and utility and design models were filed, in addition to 43 filed the previous year and 42 in 2016. In 2018, Brembo also registered five new brands.

Brembo and the Chinese market: collaboration focused on innovation

During the event “Italy – China Science, Technology and Innovation Week 2018” the Popular Republic of China’s Minister for Science and Technology, Wang Zhigang, visited the Kilometro Rosso Science and Technology Park. Together with the company’s top management Minister Wang visited the exhibition corridors of the Group’s headquarters, where he was also able to see an example of virtual reality through a 3D visor

and the first “In-Wheel Drive” application developed by Brembo, namely a 100% electric zero-emissions vehicle.

This meeting highlighted the close collaboration established over the years between China and Brembo. This alliance is aimed at promoting both major investments in research and continual development of technology in many fields, from social issues to climate change.

6.2 Awards for innovative ideas of employees

Brembo values the contribution to innovation of all teams and reinforces the spirit of collaboration within the Group, by rewarding ideas that have enabled major improvements and

progress to be made in different areas including quality, process or product innovation, cost reduction, increased productivity and simplified processes.

BREMBO Excellence Awards



Every year Brembo uses the Excellence Awards to reward the new solutions presented by Group employees. Said awards are structured as follows:

► **Best Idea**, which promotes ideas for improvement in the production and office area; from 2017, there will be a particular focus on innovative ideas in the fields of Sustainability and Digital Factory;

► **Best Improvement Plant e Best in Class Plant**, which respectively reward the plants that have produced the most significant improvements and the best performances in terms of quality, production system efficiency and human resources organisation within the plant.

Innovative ideas in the larger areas of Sustainability and Digital Factory have been given particular emphasis with the introduction of the “Sustainability” and “Digital Factory” special mentions.

Participation in the Excellence Awards is open to individual employees or groups of employees from all of the Brembo sites.

BREMBO Innovation Awards



The Innovation Awards recognise the best ideas relating to the following business areas:

- product;
- systems production process;
- disc production process.

These annual awards are also accompanied by the Brembo **Monthly Innovation Prize**, which every month recognises the best projects developed by Group employees.

In 2018, **60 ideas were presented**, comprising 37 product ideas and 23 process ideas: the latter regarded both the systems and the discs. Out of all those submitted, **awards were given to 47 ideas**: 31 product ideas and 16 process ideas. In 2018, Brembo allocated a budget five times higher than that of 2017 for awards for employee ideas, confirming the importance that the Group attributes to the innovation and improvements that these projects can bring.

Following on from the increase in patent applications due to Brembo personnel's ideas, from 2018 onwards all new patent applications will automatically be submitted to the Innovation Awards competition.



The main areas that reflect the Group’s capacity to develop new generation brake systems are as follows.

Discs and calipers



With reference to cast iron discs, during 2018 Brembo continued its research into defining and consolidating parameters for improving the comfort characteristics of the brake system and the methodologies for the disc fluid-dynamic calculation. The Group also continued with studies researching new geometries to enable significant mass reduction and improvement in disc performance, also in environmental terms. The year 2018 also saw the Group engaged in developing and testing new non-conventional solutions to be applied to cast iron discs and the new generations of “light” discs through the study of forms, materials, technologies and surface treatments designed to meet the needs of the new generation electric drive vehicles.

Regarding commercial vehicle applications, Brembo continued to develop, in collaboration with Daimler, a new light disc solution that reduces weight by up to 15%, thanks to the combination of two different materials. In particular, it is due to this solution that Brembo has been chosen as the brake disc supplier for all the new generation rear-drive cars produced by the German manufacturer. In addition, the new “light” disc has also been tested successfully by other leading manufacturers such as Jaguar, Land Rover and Tesla.

With reference to the motorbike sector, the Group has continued to develop composite material discs for road use through the definition of usage limits and the fine tuning of machining processes. In addition, the first testing phase for new disc materials was completed during the year, with the aim of reducing their weight and increasing their performance, with positive results being produced by the bench tests.

Regarding the racing world, which also includes Formula 1, as well as other competitions, work continued on developing new generation brake discs and systems and on improving the performance of the innovative Carbon/Carbon pad.

Research activities in the motorbike field, MotoGP class, covered the new brake calipers and new hydraulic system designed to reduce front caliper retraction. In addition, Brembo has tested a new amplified caliper with anti-drag in the Superbike category.

Pads



The structure dedicated to the study and production of brake pads, called **Brembo Friction**, is now a well established, stable reality, in constant expansion and focused on continual product improvement in accordance with the company philosophy of innovation and technological development. The friction materials, which are today increasingly flexible and designed to meet the different needs of individual customers, are the result of a specific reactive response made possible by the synergy of the work carried out between the R&D department and all the other Brembo departments. One example is the joint effort to develop new friction materials suitable for the production of pads for electric parking brakes or to be paired with new applications that involve the use of discs that are much lighter than standard but offer a high level of heat and mechanical resistance. Research into innovative friction materials also covers the development of new environmentally friendly solutions that have an increasingly lower impact on the environment.

Brembo’s capacity to achieve significant results in all areas where the Group is committed to product and process innovation is the result of:



1,161 People
(Full Time Equivalent) engaged in research and development activities



More than 19 years
of refining the **Brembo Project Development System** methodology which structures phases, roles, responsibilities, controls and tools for the innovation

6.3 The results of innovation: some distinctive products

	<p>The Flexira™ compact caliper, the result of the innovation and technological development stimulated by motorsport competitions, represents a new high-performance aluminium caliper concept, which overcomes the limit of the reduced space available inside the wheel, typical of compact cars. The technology applied to the Brembo fixed compact caliper was conceived and developed so that it could be inserted in tight spaces, maintaining the typical functionality and performance of a fixed caliper, but at the same time having similar dimensions to those of a floating caliper. The objective was achieved using aluminium as the reference material, gravity cast in a special alloy through shells; steel inserts have been added only to the outside of the caliper which increase the mechanical strength and reduce the axial bulk of the caliper. The end result is that this solution, patented by Brembo, ensures a significant reduction in mass compared with the cast iron floating calipers normally used on compact cars. This reduction in mass, with a view to environmental sustainability, also reduces fuel consumption and as a result polluting emissions, whilst at the same time increasing the vehicle's dynamic efficiency and reducing moments of inertia. The introduction of Flexira™ has thus enabled Brembo to combine dimensional optimisation with light weight and design, in line with Brembo's values of form and substance.</p>
	<p>The B-M6 brake caliper, a 6-piston aluminium monobloc presented in 2018 at the Speciality Equipment Market Association (SEMA) show in Las Vegas, represents the new innovative solution conceived by Brembo to increase overall performance during the braking phase of all sports sedans, ensuring a constant braking power in intensive use conditions. As with the other calipers in the B-M family, the B-M6 monobloc is also produced thanks to the innovative 4D technological casting process, which allows Brembo to bring a product to market that combines performance and design, thanks to a highly efficient architecture and a unique style.</p>
	<p>The GP4-MS caliper is Brembo's first monobloc machined from solid, developed for MotoGP, also made available for road use. Destined to become the new benchmark for the High Performance range for road motorbikes, the innovative GP4-MS caliper is produced starting with an aluminium monobloc machined from solid through the use of a topological optimiser, software resulting from Brembo's 40 years of victories in the premier World Championship class. The entire process ensures exceptional rigidity, unprecedented lightness and less deformation at high temperatures.</p>
	<p>With the introduction of the 17Rcs and 15Rcs short-stroke radial master cylinders Brembo is widening the RCS Short Stroke family with the aim of meeting the needs of all types of motorbike in an optimal and personalised way, with even more modular braking. The 17mm version is conceived and designed to best meet the needs of a growing number of vehicles that use brake calipers having 30mm diameter pistons, whilst the 15mm version has been developed to ensure optimum versatility both for single-disc applications and for motorbikes with floating caliper and dual disc.</p>



The **electric parking brake (EPB) system**, presented by Brembo at the 67th IAA Nutzfahrzeuge, the major European event dedicated to the world of commercial vehicles, replaces the parking brake usually actuated manually from a mechanical lever in the vehicle cab. The international market is welcoming this solution with great enthusiasm because it simplifies the vehicle assembly phases and layout. The commercial vehicle driver is the main beneficiary of this system, as it provides more room in the cab, improved ergonomics and less cognitive effort. As this is a safety critical system, in other words it is able to manage increasingly more complex functions, Brembo has dedicated particular attention to compliance with current legislation. The EPB has obtained ISO 26262 certification, the standard that regulates the use and functional safety of electrical and electronic systems in vehicles. The control software has, by contrast, been developed in accordance with the most stringent Automotive Spice quality standards, the process model conforming to the requirements laid down by ISO 15504.



The new spheroidal cast iron **ECS (Electric Combined Sliding) brake calipers** are the innovative solution conceived by Brembo for commercial vehicles that combines the service brake function and the integrated electro-mechanical parking brake function. This innovative match combines the traditional mechanical competences with the emerging functionalities made available by electronics. Built to withstand the stresses and loads typical of these vehicles, the ECS calipers are integrated in the vehicle's electronic stability control system (ESC). Thanks to this solution, Brembo is confirmed as one of the few brands on the market that can operate with system logics, being able to benefit from continual testing on the various components that determine vehicle safety.



The Electric Drum in Hat is a “duo-servo” brake with a special electro-mechanical actuator, designed to ensure the braking of commercial vehicles up to 8 tonnes in weight. Patented by Brembo, this actuator represents one of the jewels in the crown in the research, development and testing of brake systems for commercial vehicles. The Electric Drum in Hat is integrated in the vehicle's electronic stability control (ESC) system and ensures the same functionalities as ECS brake calipers. In addition, if the EPB parking system fails, the EDIH allows the vehicle to move thanks to the actuator's manual release.



The **XTRA brake pads** represent Brembo's new solution conceived to maximise the advantages of the Aftermarket range of drilled and slotted discs. The new pads are based on an innovative mix consisting of more than 30 different components studied in the Kilometro Rosso's Friction laboratory. This material is distinguished by a high friction coefficient which in turn translates into decisive and stable braking both at high and low temperatures. All this without compromising on the product's mileage, and also assuring greater driving comfort.

Innovation serving the mobility of the future

The automotive market is on the brink of one of the most important revolutions in its history, which could radically alter the concept of the car and its use. A profound transition as a mark of the new electric drive systems, autonomous driving and integration of different vehicle systems, where the car is increasingly more able to carry out independent actions and provide assistance to the driver in real time. In particular, over the next few years we will witness a sharp increase in cars fitted with hybrid and electric motors in response to the new European regulations. In fact, it is estimated that over the next three or four years hybrid cars could represent about 40% of the vehicles in circulation and electric cars could reach a threshold of 10% of the total.

This is a revolution for which Brembo has been preparing for almost twenty years, due to an ever greater focus and investment spending on electric braking system research. During the year the Group has developed and presented the Brake By Wire system in this direction. This will enable the vehicles of the future to have braking electronically controlled using sensors and control unit, developed on mechatronic bases. The new brake system will also be able to communicate with all the vehicle's other systems and particularly the electric motors, allowing effective use of 'regenerative' braking, typical of these new motors.

In particular, Brembo's Brake By Wire system will provide car drivers with increasingly higher safety standards, thanks to a significant reduction in stopping distances compared to a traditional system, and unprecedented driving comfort, the result of the system's capacity to ensure braking that can automatically adapt to the vehicle's load conditions, whilst maintaining constant stopping distances.

The advantages of the Brake By Wire system do not end with benefits in terms of safety, performance and comfort for the driver, but also extend to the topic of environmental sustainability. On the one hand, integration with the regenerative

systems optimises energy use in hybrid and electric cars; on the other, in the traditional combustion engine car it reduces the phenomenon known as 'residual torque', caused by intrinsic and unwanted friction between disc and pad outside the braking phase. This causes the car to brake, albeit imperceptibly, increasing its fuel consumption and as a result its emissions. This phenomenon is already minimised by Brembo's traditional fixed hydraulic calipers but is further reduced thanks to the Brake By Wire system, which actually allows CO₂ emissions to be reduced.

The first important results for Brembo in the field of future vehicles are also being received from the racing sport world dedicated to single-seater cars and electric motorbikes. In fact, during the year Brembo became the exclusive supplier of the brake system complete with carbon discs and pads for the French team Spark Racing Technologies (SRT), the sole producer of the single-seaters used in Formula E. The premium product in this area is the new Formula E Caliper resulting from in-depth research into lightness and aerodynamic performance to achieve top performance. This research has also led to the definition of identity-making, dynamic and sporting aesthetics that have featured in the ADI design Index. This is the annual publication of ADI (Association for Industrial Design) which includes the best Italian designs entering production during the year.

In addition, Brembo has officially presented the brake system to be used on all the Energica motorbikes in the next MotoE Championships, the single-brand full electric competition that will be raced over 5 European circuits in the 2019 World Championships. The new brake system includes the "T Drive" brake disc, created from the experience gained in Superbike and MotoGP, the GP4-PR front monobloc caliper, again derived from MotoGP and the Z04 Pads, already used in Superbike championship races, in the SuperSport Championships and in Moto2.



6.4 Listening to customers for product improvement

Brembo works to improve its products through collaboration and daily contact with customers who manufacture vehicles fitted with Brembo braking systems. It does this to understand and anticipate their future needs and promote joint development of new solutions in yet-to-be consolidated technological areas.

It is just as essential for the company to keep a constant dialogue with end-users of the vehicles fitted with Group products, so we can understand the extent to which Brembo solutions meet their expectations and which are the aspects that can be improved further, especially with regard to perceived quality and comfort.

Thus in this regard, the annual analyses of data relating to issues encountered by drivers in certain key markets during brake use are important. To conduct these analyses the Group uses the “Initiative Quality Study” and “Vehicle Dependability Study” monitoring research, published by Jdpower. These studies cover drivers in the first few months after buying a new vehicle, as well as those using vehicles from one to three years old, and reveal the main braking system issues.

In addition to monitoring the quality and comfort perceived by users of Brembo solutions, the Group also involves end customers in its processes to develop new products. For example, new design concepts for the composite disc were presented during various trade fairs — amongst the most

important for 2017 the Frankfurt IAA, NAIAS, MIMS in Moscow and Auto Shanghai — and visitors were asked to choose which one they preferred. Likewise, during the local aftermarket fairs, meetings are organised with distributors to hear what their mechanics have to suggest. In 2017, initiatives also took place involving top universities, designed to engage students in experimental workshops. One example of this is the Digital LAB Brembo “Internet of Brakes: braking system innovation.”

During 2018, Brembo also took part in the “Ad Impresa Docet” series of meetings, organised by the School of Design, in collaboration with the Design Department of the Milan Polytechnic university, Polidesign and ADI, an event that offers the opportunity for dialogue and discussion amongst design students, businesses and professionals in Italy. On this occasion Brembo portrayed itself as a company in which product design has enabled it to create the foundations for its competitive advantage, sharing the main challenges overcome over the years to transform a project into a successful product.

Other important opportunities for making contact and engaging with the Group’s clients include its Tech Days, such as the ones held in Brazil, designed to reveal ‘another side’ of Brembo, which differs from the one clients usually encounter, highlighting everything that goes into making Brembo a global leader in braking systems.



more than **1.5 million fans**

for the Brembo brand Facebook page, who have left more than 3.7 million likes



about **310,000 fans**

for Brembo’s Instagram profile



more than **26,500 followers**

for Brembo’s Twitter profile



about **77,000 followers**

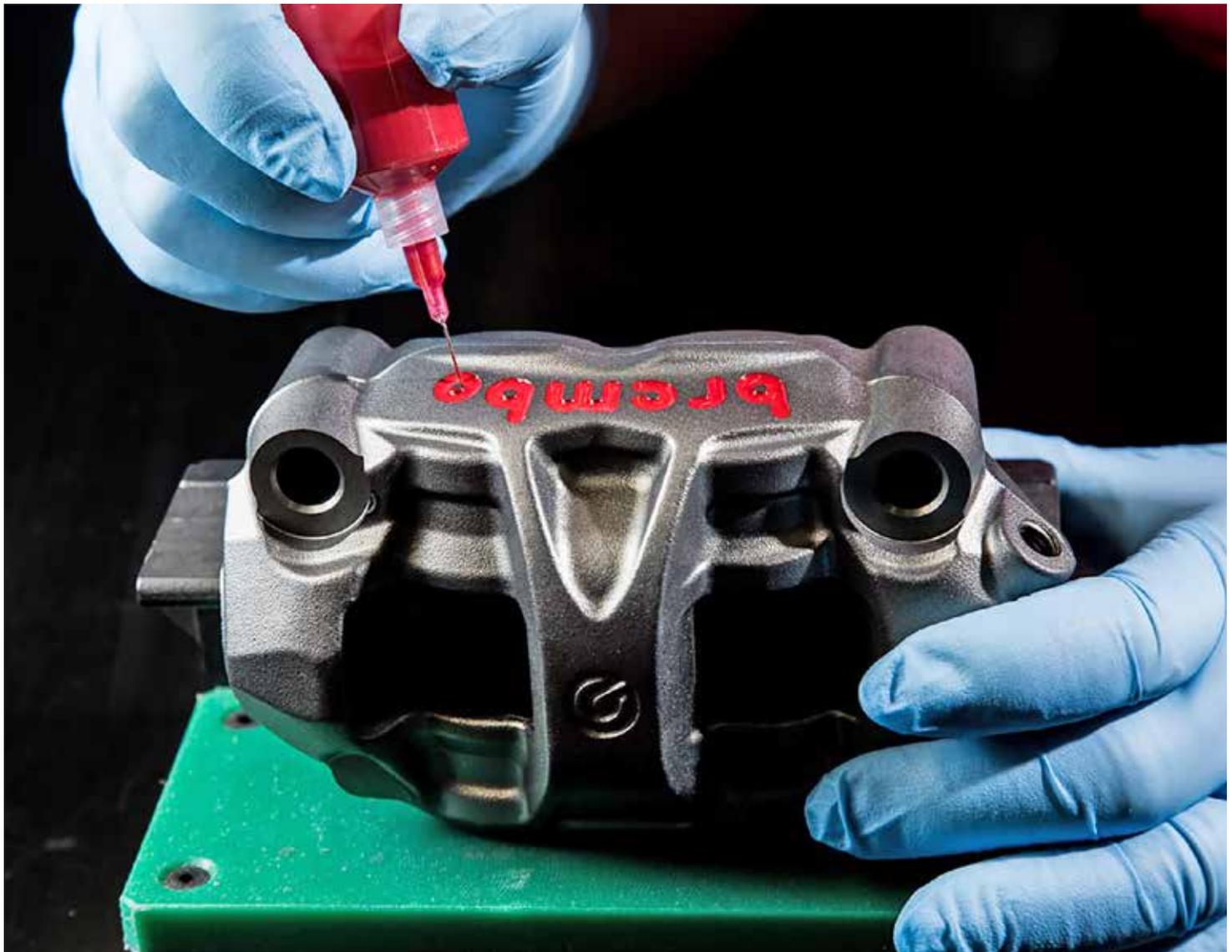
for Brembo’s LinkedIn profile

The Group is also working to constantly develop the digital channels for contacting and communicating with its customers and end users. The Group's corporate website is important in this area. Over the year it recorded more than 4.5 million visitors, up by about 20% compared to 2017. It should be emphasised that the website's visitors are more and more 'mobile', since almost 4 out of 5 visitors used a smartphone or a tablet to connect to the site.

Finally, Brembo is active on the main social media (Facebook, Instagram, LinkedIn and Twitter) within which the company

publishes a large amount of content conceived for the various public segments and optimised to be used in the best way on the different networks. During the year, the Group reported excellent performance on these channels as well, with a general growth in engagement on the 4 main channels, with more than 8 million interactions.

Brembo's presence also continued to grow on WeChat, the most popular network in China, and on the other Chinese social platforms such as the microblogging platform WeBo and the video hosting channel Youku.





6.5 Partnerships to improve the environmental impact of products

One of the prime objectives of Brembo product innovation is to reduce environmental impact, linked especially to the production of raw materials used, the generation of particulates during braking — harmful for human health — and greenhouse gas emissions caused by vehicles that can be reduced also by limiting the brake systems' weight.

In a perspective of open-innovation, and to improve the effectiveness of research in these areas, the Group encourages collaboration, through networks and joint work projects, with other players in the automotive sector, Research Centres and Universities both at Italian level (where the Group works closely with organisations including the Milan Polytechnic and the Universities of Padua and Trento) and at international level (where Brembo continues to partner with the Royal Institute of Technology in Stockholm).

Brembo subscribes to various coordinating organisations that promote industrial research in the automobile field, including AIRI (Italian Association for Industrial Research), ATA (Technical Automobile Association), Automotive SPIN Italia, CAAR (Automotive Cluster of Aragon Region) and the Lombardy Mobility Cluster.

The main joint research projects in which Brembo participates are described below:

► **LOWBRASYS**: acronym for “Low Environmental Impact Braking System”, this three-year project began in the second half of 2015 as part of the Horizon 2020 scientific research and technological innovation programme. It involves Brembo in the role of coordinator of a consortium of 10 partners from the industrial world — including Ford, Continental Teves, Federal Mogul and Flame Spray — and research institutions including: Ostrava Technical University, Stockholm's Royal Institute of Technology, Trento University's Department of Industrial Engineering, the European Commission's Joint Research Center and the Mario Negri Institute for Pharmacological Research in Bergamo. The challenge is to develop a new generation of technologies, materials and measures to improve the impact of vehicles on health and the environment through an innovative braking system that can halve the emissions of micro and nano particles. To date, the first results of the project have highlighted the possible

reduction of about 30% of particulate matter generated by braking systems, through the implementation of next generation discs and new friction materials; similar results have been reached through the implementation of an in-vehicle smart dashboard designed to teach more sustainable braking styles to drivers. Lastly, the project has shown that it is possible to obtain a further 20% reduction of emissions by using the new Brake By Wire system.



Learn more

LowBraSys Project

► **REBRAKE**: financed by the European Union and coordinated by Brembo together with the Royal Institute of Technology of Stockholm and the University of Trento, it is the first project relating to the production of braking systems that allow a reduction in the emissions of particulates during the braking phase.

Launched in 2013 with the objective of improving the skills of Brembo's research team through partnerships with Italian and international Universities, the project concluded in February 2017. It contributed to the production of 30 scientific articles, featured at around 30 events and was widely cited in the media. Thanks to this project, two researchers from the Brembo team achieved a PhD. The skills gained will be applied in numerous projects over the coming years.

► **LIFE-CRAL**: launched by the European Union in July 2016 and set to end in December 2019, this project is coordinated by Brembo and aims to develop a production line, in the pre-industrial phase, that will allow aluminium and magnesium components to be produced, starting with recycled or highly impure materials, whilst at the same time maintaining the product's end quality. The use of secondary aluminium, i.e., arising on the recycling process, avoids the energy consumption required to prepare aluminium, by saving 97% of CO₂, as well as the emissions of polluting gases released in the magnesium casting process. The first pilot production line was introduced, whilst plant verification and improvement activities are still in progress.

- ▶ **EQUINOX:** european research project in which Brembo is a partner. The project aims to identify possible alternatives to critical raw materials included in the list drawn up by the European Union. The project focuses particularly on replacing stainless steel in brake systems since the elements required for its production, such as nickel and molybdenum, are deemed to have limited availability. Brembo is developing a new large-scale industrial process to replace stainless steel by 2019. This process uses an aluminium-iron alloy, which is used only in small market niches at the moment. This change would also allow materials to be used that have better environmental performance since they can be more easily recycled than stainless steel.
- ▶ **COBRA:** this is a research project for the development of a new type of material for brake pads, steered by Brembo and co-financed by the European Commission. It aims to develop a pre-industrial process for the production of pads whereby organic origin binders can be substituted with cement binders, with the same finished product performance, allowing a significant reduction in both water and energy consumption, estimated at 88% and 95%, respectively.
- ▶ **LIBRA (Light Brake):** launched in 2015, this project aims to develop brake pads using a material capable of replacing steel in the composite material backing plate, reducing pad weight by 50%. In addition to the light weight, advantages include faster brake pad production times and a reduction in CO₂ emissions. The results achieved as soon as in the first year of research and development have confirmed

the soundness and competitiveness of this approach. This project has attracted the attention of several companies in the automotive sector.

- ▶ **ECOPADS:** this is an international research project to develop new copper-free brake pads, with excellent brake performances and lower polluting emissions. In this project Brembo works in partnership with the Trento University and the Stockholm Royal Institute of Technology (KTH).
- ▶ **EU-LIVE:** this is an R&D project carried out by an international consortium made up of 12 companies, including Brembo. The project is funded by the European Union and aims at finding sustainable solutions for future mobility by developing the concept of an L-category urban vehicle with lower noise and lower pollution emissions. In the consortium, Brembo is the specialised company tasked with the braking system and In-Wheel Motor development and integration into the wheel end, equipped with units with regenerative capacity during deceleration phases.
- ▶ **IMPROVES:** this is a pilot project aimed at creating brushless motors based on permanent magnets (PMM) for braking systems, traction and energy recovery. Brembo is the lead partner of the project in which other partners are Magneti Marelli, the Milan Polytechnic University, the Bergamo University and PMI members MD Quadro, eNovia, Peri, Mako-Shark and Utp Vision. The project is also aimed at integrating product and process innovation, by designing a new production line exploiting the potential of digitalization and IOT to produce future electrical motors.

REBRAKE

€ 2,061,000

allocated by the European Union for this project. Brembo is Project Coordinator
www.rebrake-project.eu

LOWBRASYS

€ 9,465,000

budget for the project, 8% of the costs are financed by Brembo, which is the Project Coordinator
www.lowbrasys.eu

LIFE - CRAL

€ 3,327,000

budget for the project, 42% of the costs are financed by Brembo
www.cralproject.eu

COBRA

€ 3,825,000

budget for the project, 43% of the costs are financed by Brembo
www.cobralifeproject.eu

EQUINOX

€ 4,678,000

budget for the project Brembo works in collaboration with 11 international partners
www.equinox-project.eu

LIBRA

€ 2,987,140

budget for the project, 50% of the costs are financed by Brembo



6.6 Creativity and method: ensuring product safety

Over the past few years, Brembo has promoted constant innovation and improvement of its production processes by researching cutting-edge solutions that can enable the Group to meet the many difficulties of integration and direct management of all the braking system's main production phases, starting with raw material processing in the foundries, moving through product machining and assembly, and then ensuring that products are promptly distributed in the various geographical areas where the Group's customers are located.

Following a preventive and proactive approach, Brembo is committed to applying the voluntary technical standards that

national and international standards bodies develop to define in detail how to produce excellent products and align production processes with best practice, guaranteeing safety, quality, respect for the environment and reliable performance. All Brembo products have to pass controls and checks designed to ensure their quality and safety, following a logic of ongoing improvement which makes an essential contribution to increasing the ability to meet all requirements and to improving process efficacy and efficiency, both within the Group and throughout the supply chain. From this standpoint, every problem identified and resolved for a specific product is then extended, on the basis of a "lesson learnt" approach, to the entire Brembo product range, where applicable.

The Road Safety Award

Dekra, one of the leading global organizations specialising in mobility and training, with a presence in over 50 countries and more than 35,000 employees, has awarded Chairman Alberto Bombassei with the first Road Safety Award. The prize is bestowed on entrepreneurs who over the past few years have contributed significantly with their companies to improving roads safety. The Chairman received the prize on 30 October upon the occasion of the Milan #FORUMAutoMotive.

The seven requirements assessed for choosing the award winner are:

- The development of a significant action in road safety research.
- The creation of products that have improved and contribute to road safety.
- Innovation as a fundamental criterion for road safety.
- Use of procedures to ensure workplace safety.
- Attention to young talents.
- The theme of road safety training.

The tests



During the development and technical approval stage, each product is subject to tests, carried out in different operating conditions.

These are tests designed to define product quality, performance and efficiency and are performed in type-approved laboratories, as well as on the road and racetrack. This process follows a rigorous sequence that includes: static bench tests, dynamic bench test cycles and then on-road tests. These three steps are needed to ensure that the products meet the relevant requirements, to identify any discrepancies with the quality standards pinpointed during the design phase and to test the braking systems in operating conditions similar to actual usage conditions.

The static bench tests represent the moment when design, testing and production come together; in order to check that design requirements are met, the prototypes are subject to load, pressure and braking torque cycles, superior to those physically applicable on the vehicle in various ambient conditions in terms of temperature, humidity and corrosion.

The dynamic benches, by contrast, are used to replicate vehicle dynamics through a combination of mass and speed. The checks carried out regard efficiency, functionality and resistance, and also use loads that are greater than operating ones in accordance with appropriate safety coefficients. To reduce



development times, these benches, designed by Brembo, operate independently 24/7 thanks to sophisticated control systems. They are able to simulate all worldwide type-approved circuits for the various categories of cars and motorbikes, as well as the main alpine descents for any vehicle type.

Comfort is also tested on dynamic benches and is measured based on three characteristics defined in the acronym NVH — Noise Vibration Harshness: the lower these three elements, the more silent and vibration-free the braking.

In addition, Brembo has a roller bench for cars, motorbikes and heavy goods vehicles, where vehicles can reach 250km/h at temperatures between -30 and +40C° (-22 and 104°F).

This is a test booth which simulates road tests in all conditions, from snow to wet roads to extreme speeds. However, it is the final on-road vehicle tests that allow Brembo to achieve excellence.

In fact, the products approved on the various benches are mounted on car prototypes supplied by the manufacturers. An internal team, consisting of expert inspectors, carries out all the tests necessary for testing brake system performance, comfort and durability.

The inspectors trained by Brembo have a broad-spectrum profile that allows them to cover tasks ranging from prototype assembly to data analysis, and thereby provide a subjective assessment supported by the measurements carried out.

The tests carried out include “superfading”, which involves a suitable braking sequence, from high speed to speed kept at zero in full load conditions, the subjective comfort and feeling assessment, carried out by drivers who have an in-depth knowledge of the vehicles and products, and the efficiency tests on wet and dry terrain.

Training on the Butterfly system

Given the importance that the Butterfly system holds for Brembo, the Quality Department, with the support of the Brembo Academy, designed the first BPDS training course conceived and taught by certified internal teachers. The main objective of this project is to train new people recruited for

Partnership with Regulatory Bodies

- ▶ The Brembo Group is associated with the **Italian Standardisation Body (UNI)** and complies with the technical standards of the **British Standards Institute**.
- ▶ The Group also works with the **National Unification Commission for the Automobile** which, in the framework of UNI federated bodies, assists with defining technical standards and instructions for production, testing, the correct use and maintenance of vehicles, motor vehicles, operating machines and related components so as to improve their safety and reliability.
- ▶ Brembo also participates as an expert member on functional safety in the joint **working group in technical commission TC22/SC3/WG16** appointed to improve standard WG 16 ISO:26262 regarding the functional safety of electrical and electronic systems in motor vehicle production.

The entire test system falls within the solid Project Management (BPDS - Brembo Project Development System), known as “Butterfly”. This management system is based on Project Management, a structured method that, focusing on the principles of coordination and control, enables to develop and follow a new project in all phases of its evolution. By planning and managing specific inspection moments (so-called “gates”) and handling any recovery plans, the Butterfly system makes it possible to verify the suitability and completeness of the activities carried out, guaranteeing that the mass-produced products fully comply with the set requirements.

platform roles and who are not familiar with this methodology. At the same time, Brembo intends to highlight the strategic nature and importance of this process for the entire company population operating in development platforms. A first training session took place at the end of 2018.

FMEA/FMECA



100%¹³
of production plants
are IATF 16949 certified

To ensure maximum safety and quality of its products, Brembo adopts a preventive and proactive approach enabling the company to anticipate any problems and criticalities along the entire production cycle and take preventive correction measures. In detail, during the **design and development phase**, the Group carries out product and process FMEAs/FMECAs to identify in advance the weaknesses and critical issues that could compromise product reliability and safety and define the necessary improvements and priority measures to be taken before the product enters into production. FMEA methodology is used, in particular, to identify product and process characteristics having a potential impact on end-user safety, so that these characteristics can be managed and controlled systematically throughout the entire production chain (product development, internal process and supplier process). These elements represent a fundamental part of Brembo's quality management system, compliant with **IATF 16949:2016** technical specification.

This system, characterised by Guidelines common to all the Group's production sites, allows best practices to be transferred from one plant to another, as well as all the production sites to be managed with the same standards and quality indicators. Like other management systems, in newly opened sites the quality management system is implemented when production gets underway and certification audits are normally carried out around twelve months after the plant is commissioned.

Quality monitoring process



Brembo has established a structured internal and external quality monitoring process, which therefore also involves clients and suppliers. In detail, product quality and safety is monitored at all the Group's plants, by using specific indicators that are set

out annually by the Quality Department as part of the Quality Plan, which also sets yearly quality objectives.

From an internal standpoint, the most important indicators involved are those regarding waste; from an external standpoint, indicators regarding complaint monitoring and the number of defective items sent out to clients are key, both as regards their level of criticality (in terms of inconvenience for the client) and severity (in terms of their impact on end-user safety). Brembo also monitors any product recalls from the market, or customer's notifications of non-compliance with the pre-defined qualitative standards. The application of these indicators also extends to the monitoring of product quality and safety made by the suppliers. Should these indicators reveal situations that diverge from the established objectives, action plans are immediately put in place to restore compliance.

Activities guaranteeing product authenticity



For the Group, safeguarding the safety of those who buy and use Brembo equipment means promoting initiatives aimed at countering product illegal counterfeiting activities and fraud in the distribution channels. The sale of counterfeit braking systems may represent a source of high risk for the end user due to the importance of the braking system as a safety component in vehicles. In fact, it is not uncommon that counterfeit products are found to be extremely dangerous because they are not made with controlled materials and are inadequately tested in the production phase.

The main tool developed by Brembo to counter the sale of non-original products is the **"anti-fraud card"** which allows customers to easily check if their purchase is really "Made in Brembo". The anti-fraud card is delivered inside a sealed bag in the packing of the product purchased and gives a unique identification code, which — once entered on the website www.original.brembo.com together with the card number, component type and country of purchase — allows its authenticity to be checked. If the check fails to give a positive outcome, the purchaser is invited to enter further information to enable the Group to start investigations about the origin of the counterfeit part. The card also contains the quality control document — another

¹³ The Zaragoza site is ISO 9001 certified. By 2019 the Escobedo cast iron foundry is expected to obtain the IATF 16949 certification.



tool for confirming product originality — whilst an external seal guarantees that the purchaser has received the product intact from the factory.

The anti-fraud card is currently available for the Brembo High Performance and Brembo Racing lines, with reference to the following products: Sports discs, Rally discs and GT kits. For motorbikes, the initiative covers: calipers, discs, brake/clutch cylinders and replacement levers.

The collaborations established by the Group over the years with public institutions, public security authorities and customs control authorities are fundamental in Brembo's fight against the production of and illegal trade in counterfeit products. In this context, Brembo's collaboration with OLAF - European Commission Anti Fraud Office continued during the year to prevent the growing presence of counterfeit products. Moreover, the Group has carried out numerous operations in collaboration with the local authorities in China and Taiwan which led to the closure of laboratories and shops that

produced and sold counterfeit Brembo-branded products. In 2018, Brembo launched specific activities in collaboration with Thailand local authorities to combat counterfeiting. In particular, the Group has involved local port officials in three training sessions, with the aim of supporting them in identifying and recognizing counterfeit Brembo products. The activities carried out in collaboration with the local authorities have led to 19 anti-fraud operations in China and Thailand and to the removal of over 29,000 non-original Brembo components from the markets of these countries.

Lastly, regarding the online sales channels, the Group is engaged in monitoring the main e-commerce sites with the aim of reducing the number of counterfeit Brembo products sold on digital platforms. Thanks to these activities, in 2018, Brembo was able to remove more than 48,000 counterfeit product offers from e-commerce platforms, block over 15,000 pages and fraudulent accounts on the main social networks and identify 745 websites using the Brembo brand illegally.

Eureka: a software to tackle and manage product criticalities

“Eureka” is the new software that will enable Brembo to revolutionise the management of all product issues, both in the development phase and for products that have already entered the mass production phase. This is an innovative project developed by Quality Management, ICT Management and Technical Management, as well as Advanced R&D, in collaboration with inter-departmental and interdivisional teams and some sites. Eureka is a tool intended to support those who have to face any critical product issues by conveying all the relevant information in a single container. The new software will not only allow to understand the underlying causes in a more structured and faster way, but it will also enable the plants to more easily share solutions, by making such information available to all the people involved at the various Brembo offices. The problems, whether internal to Brembo or reported by the client, can then be managed by the relevant teams

using a common problem solving methodology. Thanks to Eureka it will also be possible to view similar cases that have already occurred at other sites and to know in real time how and by whom they have been solved. The goal is to use shared knowledge to preventively manage potential problems, prevent the occurrence of the same problem at other plants and / or on similar products. Eureka, combines under the same name two basically ‘twin’ software, one dedicated to products under development (Eureka Development) and one to series products (Eureka Production). Finally, the new system will allow real-time reporting of problems underway and how they are being managed, resolution times and compliance with the pre-set deadlines, providing a brief overview of the issues underway. From January 2019 the software will be officially released and integrated into all Brembo plants, starting from the European ones.