

Michelin Truck Tires Press Kit

EuroSatory Exhibition (June 16-20, 2014)

**Michelin invents the “anti-landmine” tire for military vehicles
capable of traversing minefields**



With this major innovation, Michelin is reaffirming its commitment to all-terrain mobility in extreme conditions.

Michelin is going further to support its customers as well as civilian and military users by developing a unique network and services offering.

Lastly, the company is enhancing its MICHELIN X-Force tire range with a new, more fuel-efficient tire version, the XZL2.

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To summarise

When working with partners as demanding as the armed forces, Michelin has a duty to stretch the limits of its traditional role as a tire supplier to provide all-inclusive mobility support.

The armed forces know that innovation is part of the Group's DNA and that the partnership will include a comprehensive, unique offering of end-to-end project services, from tire design to in-field testing.

Today, Michelin is unveiling the "anti-landmine" tire, a product designed to meet the needs of the French Army and the defense systems manufacturer MBDA. As a materials specialist with extensive experience in building tires that perform at very low pressure, Michelin has engineered the anti-landmine tire to exert less ground pressure than a man's footfall – when fitted to a vehicle weighing over 7.5 tonnes! Capable of clearing safe pathways through minefields without setting off explosions, the anti-landmine tire is a major mobility innovation.

With the same level of rigor, the Michelin Group has reworked its range of all-terrain Truck mobility solutions. Its MICHELIN X-Force tires are now available in four different tread designs, including the new fuel-efficient XZL2 version. Available in sizes ranging from 16 to 21 inches, the MICHELIN X-Force lineup has also been extended to include specific sizes for machines such as the German-Dutch Boxer and French VBCI armored fighting vehicles. In addition to these military applications, the MICHELIN X-Force tire range brings the same level of all-terrain mobility performance to the leisure, emergency services and competition Truck tire segments.

Being a global player in mobility means being able to provide the armed forces with much more than just tires. The Michelin Group is doing just that by mobilizing its research and development prowess on its partners' behalf, backed by an extensive network of more than 6,600 researchers on three continents and an annual R&D budget of over €640 million. The same spirit of sharing applies to its test tracks and expert developers and testers. In this way, Michelin can undertake projects far upstream with its partners – both manufacturers and armed forces – to jointly develop vehicles and mobility solutions capable of traversing the most difficult terrain. Michelin is able to work closely with its partners in a wide variety of areas ranging from technical engineering to subjective testing. This comprehensive approach is strategically unique among manufacturers, and it's what makes the Michelin experience so valuable to its partners.

Codename LX PSI 710/75 R 34: the MICHELIN anti-landmine tire pushes back the limits of mobility in extreme conditions.

**Key points
to
remember**

Minefields represent the world's greatest threat to land mobility.

To meet the needs of the French Army and defense systems manufacturer MBDA, Michelin has developed a low-pressure tire – the MICHELIN "anti-landmine" tire – capable of carrying a specialized vehicle over mine-ridden terrain.

Inflated to 0.3 bar of pressure, the tire allows the vehicle to move across minefields while exerting less pressure on the ground than a human being.

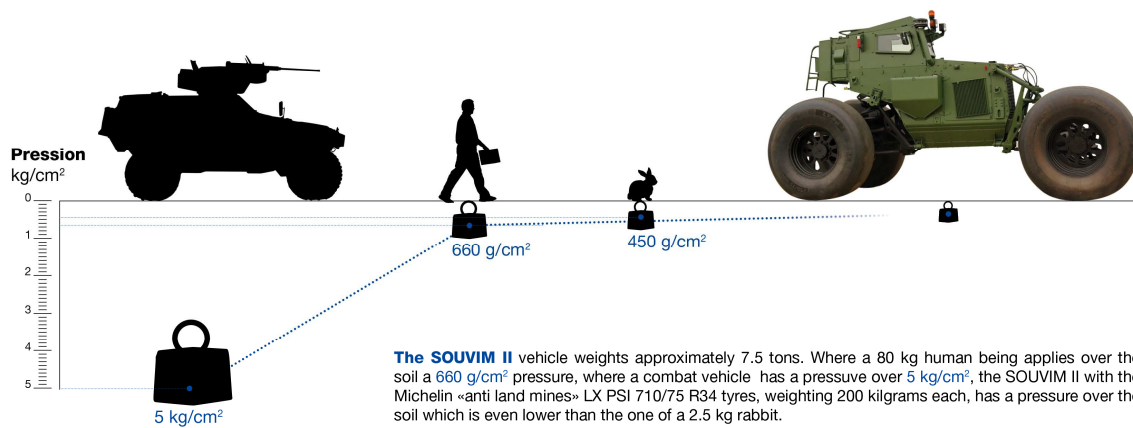
The MICHELIN anti-landmine tire perfectly illustrates Michelin's commitment to contributing to more sustainable mobility through constant research and innovative technology expertise.

To meet the needs of the French Army and the defense company MBDA, Michelin has done the impossible: enabling a specialized vehicle, the SOUVIM II mine clearing system, to move across minefields without triggering detection systems. This major innovation came into being thanks to the Michelin Group's powerful research and development program, backed by an extensive network of more than 6,600 researchers and an operating budget of over €640 million dedicated to enhancing mobility. Security, rescue, evacuation and supply operations are now feasible in mine-ridden areas as a result. Following delivery of the SOUVIM II vehicles for testing in 2013, Michelin's LX PSI 710/75 R 34 anti-landmine tires passed every "stealth" test with flying colors, thereby earning original equipment certification for the SOUVIM II.

A standard armored reconnaissance vehicle exerts a ground pressure of 5 kg/sq.cm. Equipped with MICHELIN LX PSI 710/75 R 34 anti-landmine tires, each weighing 200 kg, the roughly 7.5-tonne SOUVIM II vehicle applies a ground pressure of just 360 g/sq.cm. That's less than a 80-kg walking human, which exerts about 660 g/sq.m of ground pressure per footfall, and – for anecdotal purposes – even less than a 2.5-kg rabbit, which applies 450 g/sq.cm to the soil.

MICHELIN «ANTI LAND MINES»

LX PSI 710/75 R 34

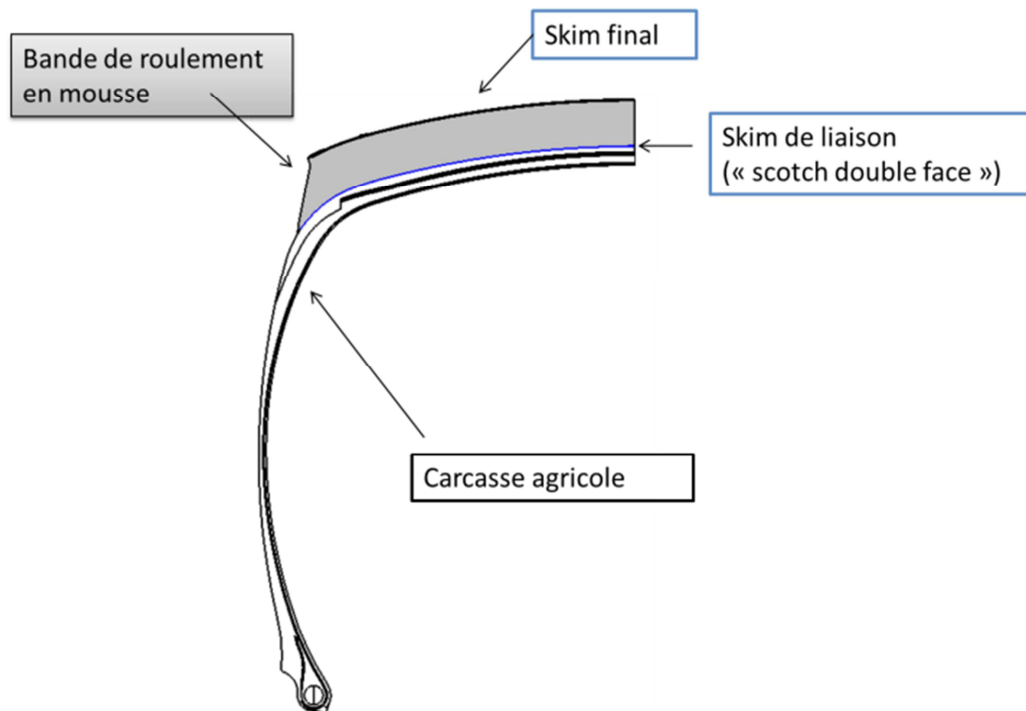


This makes it possible to demine paths of up to 150 km in length per day at an average speed of 20 km/h. MICHELIN anti-landmine tires enable the SOUVIM II to maneuver over flat landmines without being detected and can deform around the tops of conical landmines without activating them.

The product of ten years of research and development, this technological feat is the crowning achievement of Michelin's unique tire industry expertise. The MICHELIN anti-landmine tire is made entirely by hand by extremely experienced line operators, according to a complex process.

The main technical challenge is to manually build and affix a wide, 10-cm thick, foam band on a casing derived from Michelin's agricultural tires. The casing is capable of functioning at very low pressure, so as to apply the longest possible footprint. The foam material is extremely difficult to shape and work. The thick foam band is then covered with a fine rubber film called "skim" to enhance protection and grip.





Bande de roulement en mousse : foam tyre tread.

Skim final : final skim.

Skim de liaison (scotch double face) : liaising skim with double face tape.

Carcasse agricole : carcasse from AG tyres.

In this way, the MICHELIN anti-landmine tire is able to move the SOUVIM II forward at a record-low pressure of 0.36 bar.

The MICHELIN X-Force tire range for enhanced all-terrain Truck mobility

Key points to remember

Traveling a distance of 100 km after being punctured by 5 bullets: the MICHELIN X-Force tire lives up to the challenge.

In this way, whether on a mission or in a training exercise, MICHELIN X-Force tires guarantee the mobility of the armed forces even in the most difficult circumstances.

The new MICHELIN X-Force tire range comes in four different tread designs, including a new XZL2 version for rocky and sandy terrain. The robustness of these tires and the strength of their casing makes the MICHELIN X-Force range the benchmark all-terrain mobility solution.

Not just for the armed forces, the new MICHELIN X-Force range meets every all-terrain Truck mobility need. Whether in the deserts of Dakar, on long-haul expeditions or in support of civilian and emergency services, the MICHELIN X-Force tire is available in sizes ranging from 16 to 21 inches.

The majority of military trucks in Europe are equipped with MICHELIN X-Force tires.

All-terrain mobility is a much more complex challenge to master than traditional road mobility. This is because a balance must be achieved between several conflicting requirements. The tire casing plays a critical role in this. If a tire is to travel over loose soil such as mud or sand, necessarily inflated to very low pressures in order to ensure traction, it needs a flexible casing to prevent damage. However, the casing has to be robust enough to withstand abrasions and other shocks caused by the landscape, such as sharp rocks or thorns that border the path. Similarly, wide open tread patterns enhance traction over difficult terrain whereas road safety and speed limits call for more closed tread patterns.

Reconciling the irreconcilable and satisfying contradictory specifications is part of the mission of the Michelin Group's Technology Center researchers, a network of 6,600 people spread across three continents who work continuously to create the materials and tires of the future.

This explains how Michelin is also able to create specific tire sizes to support its customers' needs to develop new vehicles. For example, Michelin developed MICHELIN X-Force tires in the special 395/90 R 560 and 415/80 R 685 sizes to equip the French Army's VBCI infantry fighting vehicle and the similar Boxer vehicle used by the German and Dutch armies.

These tires were made to order to meet very specific road and all-terrain handling requirements in line with exacting specifications.

Patented technology

These tires have the advantage of evenly distributing tension in the casing with their TR (*Tension Répartie*) bead design – based on a similar technology developed for the MICHELIN vertical anchorage tire that propelled the Bugatti Veyron to speeds of 400 km/h – ensuring an exceptionally strong tire-rim connection and a degree of flexion enabling them to run flat. Mounted on bespoke rims, the tires were designed in close cooperation with defense vehicle manufacturers based on a common set of specifications. Patents have been filed by Michelin for the TR technology.

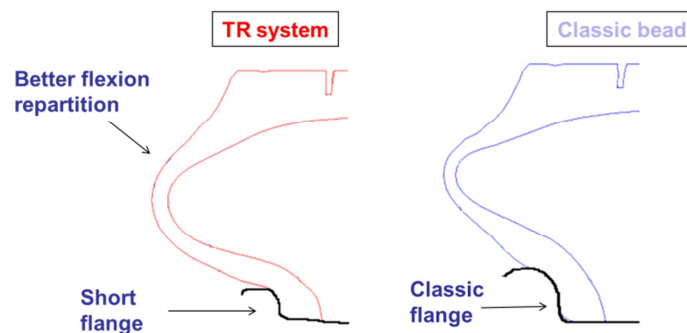


XML

LE **MICHELIN X FORCE XML** POUR ENGINES MILITAIRES VBCI ET BOXER



The MICHELIN X-Force XML tire for the VBCI and Boxer military vehicles



Highly rigorous certification testing

Before they can be launched on the market, MICHELIN X-Force tires have to pass a series of very rigorous tests, including road safety tests according to NATO-approved protocols, breaking energy tests to determine puncture resistance, and aging resistance tests. The materials used in military equipment have to demonstrate exceptional robustness. For example, the bead wires on a MICHELIN X-Force 14.00R20 XZL+ tire are strong enough to carry the weight of more than five African elephants from one end. That's the equivalent of over 20 tonnes!

Then, to be certified to equip military vehicles, the tires sometimes have to pass a run-flat test simulating circumstances in which a military vehicle needs to be returned to safety following an attack, in compliance with FINABEL A.20.A. standards established by a coalition of the French, Italian, Dutch, German, Belgian and other European armies. The test evaluates a vehicle's ability to keep going for about 100 km after one of its tires has been punctured by five bullets, three in the sidewalls and two in the tread.

In the simulation, the collapsed zero-pressure tire has to travel resting on an internal support ring. Subjected to extreme flexion, friction, stretching and heat build-up, with component temperatures exceeding 130°C, its every design feature is pushed to the absolute limit of performance.

In these extremely demanding conditions, the MICHELIN X-Force tire clearly demonstrates the Group's technological superiority. According to recent tests¹, a competing premium brand product disintegrates after 27 km and 36 minutes, leaving the vehicle and crew at a standstill, whereas the MICHELIN X-Force can travel for more than 97 km over three hours, preserving the safety of the soldiers and their equipment.

Part of the secret is in the casing

Building a tire that can withstand air pressure variances of over 6 bar on alternating road and loose soil driving surfaces, while guaranteeing the safety of all crewmembers regardless of the conditions, is a major feat that can only be accomplished by deploying leading-edge technology.

Whereas the sizes and load carrying capacity of MICHELIN X-Force tires logically place them in the Truck tire family, they stand apart for their distinctively designed casing and tread. A very flexible, yet resistant network of several kilometers of steel cords allows the casing ply to function at very low to zero pressure, while the overall structure nevertheless remains supple enough to tolerate high deformation ratios.

Michelin's responsibility is to guarantee sustained tire performance across the board over the long term. That's why, from design to delivery, MICHELIN X-Force tires undergo a strict control process guaranteeing that level of quality. For example, each newly cured tire is meticulously inspected for uniformity; line operators check for irregularities in appearance and measure any imbalances or runout. The tires are subjected to X-rays and ultrasound

¹ In-house Michelin test.

tests to ensure that they have been manufactured to perfection. MICHELIN X-Force tires don't leave the plant unless they meet the most rigorous quality criteria.

Because the Michelin Group upholds such high standards for its tires, users can count on them for guaranteed mobility. This is particularly important in the case of military vehicles, which can be kept in storage or rarely used for many years before being deployed on a mission. In this common situation, ground-level ozone and UV rays can become a tire's worst enemy. Here too, Michelin's technology serves up the best solution for its customers. During the curing process, Michelin simulated 15 years of aging in its MICHELIN X-Force range and in competing brands, then subjected the tires to various stresses on a mechanical wheel. The MICHELIN X-Force tire proved to have three times more endurance than its leading premium competitor in terms of distance.

Rigor, experience and know-how are what make the MICHELIN X-Force brand the preferred partner of military ground forces.

The MICHELIN X-Force range meets every all-terrain mobility need

An armored fighting vehicle, a fire engine, a cross-country rally truck, an Unimog truck on an adventurous family world tour and an emergency gas and power utility vehicle providing natural disaster relief all have one thing in common: the need to get where they're going without fail. Ranging from 16 to 21 inches and weighing from 40 to nearly 200 kg, the MICHELIN X-Force tire range covers every possible all-terrain mobility need, supporting vehicles in a wide variety of environments thanks to a combination of attributes:



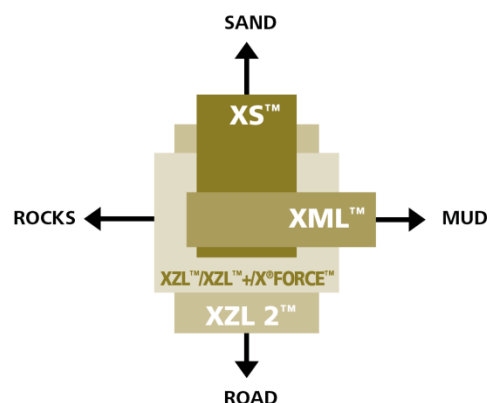
The MICHELIN X-Force Range



- **Tires suited to tire pressure monitoring:** Featuring a unique casing design, MICHELIN X-Force tires can function across a wide range of pressures. This makes it possible to achieve a flotation effect, by increasing the size of the contact patch, or carry heavy loads and move at speed, as required.
- **Multi-purpose tires:** Rarely equipped with tire pressure controls, fire engines and gas and power utility vehicles are used in extremely varied conditions, including on roads and forest tracks, humid or wet environments. They need to be as versatile as possible, and MICHELIN X-Force tires ensure their mobility requirements are met.
- **High-performance tires:** For civilian use, MICHELIN X-Force tires are certified to perform at speeds of up to 90 to 110 km/h. However, there are some cases where the speed required is much higher. For example, cross-country rallies may have speed limits of 130 to 150 km/h depending on competition rules, and emergency airport vehicles, which are often extremely heavy and loaded with large quantities of water, sometimes need to move at 160 km/h. At the Dakar Rally, where all-terrain grip and strength requirements are at their most demanding, MICHELIN X-Force tires perform marvelously well. In 2014, they captured their 32nd victory out of a total of 34 competitions. More than 70% of the participating teams choose MICHELIN X-Force tires.
- **A commitment to responsible mobility:** The new MICHELIN X Force XZL2 tire demonstrates excellent rolling resistance, lowering by 20% the coefficient offered by the previous XZL/XZL+ range, to deliver significant fuel efficiency gains. Its performance is enabled by the use of special rubber compounds that help to reduce fuel consumption in military vehicle fleets.

The MICHELIN X-Force tire lineup includes a variety of tread patterns suited to the full range of all-terrain usage needs. Depending on the type of terrain, the grooves need to be designed to different depths according to the level of grip or flotation desired.

- MICHELIN X-Force XML: for exceptional mobility on muddy terrain.
- MICHELIN X-Force XS: the must-have tire for the desert and sandy ground.
- MICHELIN X-Force ZL: the benchmark for all-terrain versatility and the preferred tire of cross-country rally teams.
- MICHELIN X-Force XZL2: a multi-purpose tire that improves fuel efficiency.



The mobility requirements for extreme conditions are as complex as they are multi-faceted. Michelin meets them all with its new MICHELIN X-Force range.



Michelin Military Value Proposal: Comprehensive all-terrain mobility support

Much more than just a tiremaker, the Michelin Group is a provider of comprehensive mobility support. In the all-terrain segment, the Group has set up an expertise unit in Europe dedicated to military mobility, complementing a similar unit created in the United States several years ago. In addition, Michelin is leveraging its R&D resources on behalf of its customers to enable better military mobility.

A stronger team of experts in Europe

The Michelin Group recently strengthened its Truck tire business in Europe with a new unit dedicated to tires for all-terrain military use. The goal is to provide customers and equipment manufacturers with broader usage expertise and an enhanced mobility and services offering.

In this way, armies in every European country can now directly contact a local technical expert with any questions they may have about their military mobility needs. This close-to-the-customer network is supported and led by a dedicated European team that was created two years ago. Combining logistics, marketing, sales and R&D expertise, the team guarantees customers the best possible conditions for obtaining Michelin off-road tires.

Following the example of the MICHELIN Challenge Bibendum sustainable mobility competition, which is a dynamic platform for thinking about the future shape of mobility, the European team is preparing its own military mobility innovations for the future, notably through the organization of inter-army colleges inaugurated in 2013.

Calling all Michelin R&D capabilities to support all-terrain mobility

To bring its tires to their current level of off-road and military performance, Michelin has acquired very advanced wheel assembly expertise within its R&D centers. The tiremaker has also developed testing and measurement resources that are often unique in Europe.

These sometimes little known world-class resources and expertise have now been made available to customers and manufacturers, and position Michelin as a key player in the process to improve military mobility.

A broad palette of services is provided, including training, tests, vehicle assessments, road handling simulations and test track rentals:

- Driver safety training and vehicle handling assessments for all-terrain and military vehicle users, army vehicle testers, manufacturers, etc.
- Military vehicle tests and handling assessments.
- Definition of subjective and objective mobility test protocols, mainly for loose soil/surface types, i.e. mud, snow and sand.

- Dynamic vehicle testing, with the installation of onboard equipment and a trial run over a measurement pit (the only one of its kind in Europe), and static vehicle testing, with test benches capable of carrying axle loads of up to 12 tonnes as well as torsional stiffness benches.
- Supply of technical data to help simulate road handling and thereby speed the upstream phases of the vehicle design process.
- Handling simulations using software.
- Test track rental: several dozens of kilometers of road and all-terrain surfaces are available to customers at test tracks located in Ladoux near Clermont-Ferrand, France and in Almeria, Spain. The extreme driving conditions at the Almeria facility make it possible to perform extensive heat and dust tests all year round.

The Michelin Military Value Proposal is a complete package of services and expertise dedicated to the mobility needs of the armed forces.

Interesting to know

Michelin all-terrain Truck mobility solutions in facts and figures

0.8: the amount of pressure, expressed in bar, to which MICHELIN X-Force tires were deflated on Gerard de Rooy's truck in order to cross the sand dunes at the 2014 Dakar Rally and take victory.

1: the thickness, in millimeters, of the "skim" covering the MICHELIN "anti-mine" tire.

4: the number of tread designs available in the new MICHELIN X-Force tire range.

5: the number of African elephants than could theoretically be lifted by the impressively robust bead wire on the MICHELIN X-Force XZL+ 14.00 R 20, i.e. about 20 tonnes.

5.7: the variation in pressure, expressed in bar, that a MICHELIN X-Force tire can withstand on its travels, from 2.3 bar on loose soil to more than 8 bar under a heavy load.

10: the thickness, in centimeters, of the foam band affixed to the surface of the MICHELIN "anti-landmine" tire.

12: the number of trucks equipped with MICHELIN X-Force tires that crossed the finish line consecutively in the Dakar Rally 2014 ahead of all other competitors.

12: the axle load, in tonnes, of a military vehicle that can be sustained by a test bench at Michelin's Ladoux research center.

32: the number of times that trucks equipped with MICHELIN X-Force tires or previous Michelin tire lineups have won the Dakar Rally.

70: the percentage of teams that chose to use MICHELIN X-Force tires to start the 2012 Dakar Rally.

150: the maximum speed, in km/h, reached by competition trucks fitted with MICHELIN X-Force tires when cross-country rally rules allowed it. They are identical to street tires which, for civilian use, are certified to perform at speeds of up to 100 km/h.

200: the weight, in kilograms, of a MICHELIN LX PSI 710/75 R 34 "anti-landmine" tire, which can traverse minefields without setting off any explosions.

(Over) 640: the amount, in millions of euros, that Michelin allocates to research and development each year.

900: the amount of horsepower developed by Kamaz trucks equipped with MICHELIN X-Force tires in the Dakar Rally.

1957: the year when Michelin developed the first tires dedicated to all-terrain mobility in extreme conditions, designing the MICHELIN XS to equip the Berliet T truck for an expedition across the Sahara. Its contributions in this area have steadily evolved, now taking the shape of the MICHELIN X-Force range.

6,600: the number of people currently working in Michelin's R&D teams to fine-tune the tires of today and tomorrow.

Michelin Group: Milestones

For more than a century, MICHELIN has dedicated all its expertise and innovation to enhancing mobility for motorists around the world.

1889: Founding of **Michelin et Cie**.

1891: Michelin files its first patents for removable and repairable tires.

1895: Michelin introduces **Éclair**, the first car to be fitted with pneumatic tires.

1898: Birth of **Bibendum**, the Michelin Man.

1900: First **MICHELIN guide** published.

1905: Introduction of the **Michelin *semelle*** tread with hobnails to improve tire grip and durability.

1910: First 1/200,000 scale Michelin **road map** published.

1913: Michelin invents the **removable steel wheel**.

1923: First **low-pressure car tire** (2.5 bar).

1926: Michelin creates its first **Green Guide for tourists**.

1930: Michelin files a patent for the **integrated tube tire**.

1938: Michelin launches **Metalic**, the first truck tire with a steel casing.

1946: Michelin invents the **radial tire**.

1959: Michelin introduces the first radial tire for earthmovers.

1979: The Michelin radial tire wins the Formula 1 championship.

1981: The MICHELIN Air X is the first radial aircraft tire.

1989: Michelin launches the first online travel itinerary service, on France's Minitel teletext network.

1992: Launch of the fuel-efficient MICHELIN ENERGY™ tire.

1993: Michelin invents the new C3M tire manufacturing process.

1995: The US space shuttle lands on MICHELIN tires.



1996: Michelin invents the vertically anchored PAX System tire.

1998: The first Michelin Challenge Bibendum, the world's leading clean vehicle event.

1998: The Michelin Man's 100th birthday.

2000: Michelin Man voted best logo of all time by an international jury.

2001: Michelin brings to market the world's largest earthmover tire.

2003: Launch of MICHELIN brand automotive accessories.

2004: New corporate signature introduced: **"Michelin, a better way forward."**

2004: Launch of the MICHELIN XeoBib, the first agricultural tire that operates at constant low pressure.

2005: Michelin provides tires for the new Airbus A-380 aircraft - Launch of the MICHELIN Power Race, the first dual compound racing tire approved for road use.

2006: Michelin revolutionizes truck tires with MICHELIN Durable Technologies.

2007: Launch of the new MICHELIN ENERGY™ Saver tire, which reduces fuel consumption by nearly 0.2 liters per 100 kilometers, thereby lowering carbon emissions by almost 4 grams per kilometer.

2008: Introduction of the new MICHELIN® X® ENERGY™ SAVERGREEN truck tire.

2009: 100th edition of the MICHELIN guide France.

2010: Market launch of the MICHELIN Pilot Sport 3 and MICHELIN Pilot Super Sport tires.

2012: Launch of the MICHELIN Primacy 3 tire in Europe.

2012: European launch of two new high-performance winter tires, the MICHELIN Pilot Alpin and MICHELIN Latitude Alpin.

2013: Launch of new low rolling resistance truck tyres, the MICHELIN X Line Energy.

Michelin Group: Key Figures

Founded:	1889
Production base:	67 production sites in 17 countries
Number of employees:	111,200 worldwide
Research and development:	More than 6,600 persons working in Research and Development and located in Europe, North America, South America and Asia
2013 R&D budget:	Over €600 million
Annual output:	171 million tires produced, over 13 million maps and guides sold in more than 170 countries, and 1.2 billion itineraries calculated by ViaMichelin
2013 net sales:	€20.2 billion

An extensive portfolio of brands covering all market segments: Michelin, BFGoodrich, Kleber, Uniroyal, Warrior, Kormoran, Riken, Taurus, Tigar, Pneu Laurent, Recamic, Michelin Remix.

More than 3,500 proprietary and franchised outlets in 29 countries: Euromaster in Europe and TCi in the United States; TyrePlus in Asia, the Middle East, Russia, Australia and Mexico; Michelin Commercial Service Network in the United States; and Michelin Truck Service Center in Asia, the Middle East and Algeria.



