Brief history and range of current business

We were incorporated on September 1, 1945 as a public limited company under the Indian Companies Act VII of 1913 as Tata Locomotive and Engineering Company Limited and we received a certificate of commencement of business on November 20, 1945. Our name was changed to Tata Engineering and Locomotive Company Limited on September 24, 1960, and to Tata Motors Limited on July 29, 2003. Tata Motors Limited is incorporated and domiciled in India. We commenced operations as a steam locomotive manufacturer. This business was discontinued in 1971. Since 1954, we have been manufacturing automotive vehicles. The automotive vehicle business commenced with the manufacture of commercial vehicles under financial and technical collaboration with Daimler-Benz AG (now Daimler AG) of Germany. This agreement ended in 1969. We produced only commercial vehicles until 1991, when we started producing passenger vehicles as well. Together with our consolidated subsidiaries we form the Tata Motors Group.

In June 2008, we acquired the Jaguar Land Rover business from Ford Motor Company. Jaguar Land Rover is a global automotive business, which designs, manufactures and sells Jaguar luxury sedans and sports cars and Land Rover premium all-terrain vehicles as well as related parts, accessories and merchandise. The Jaguar Land Rover business has internationally recognized brands, a product portfolio of award-winning luxury performance cars and premium all-terrain vehicles, brand-specific global distribution networks and research and development capabilities. As a part of our acquisition of the Jaguar Land Rover business, we acquired three major manufacturing facilities located in Halewood, Solihull and Castle Bromwich and two advanced design and engineering facilities located at Whitley and Gaydon, all in the United Kingdom, together with national sales companies in several countries.

In September 2004, we became the first company from India’s automotive sector to be listed on the New York Stock Exchange. Our ADSs are traded on the NYSE under the symbol “TTM”. Our Ordinary Shares and ‘A’ Ordinary Shares are traded on the BSE under the codes 500570 and 570001, respectively, and the National Stock Exchange of India Ltd., or NSE, under the symbols “TATAMOTORS” and “TATAMTRDVR”, respectively.

We offer a broad portfolio of automotive products, ranging from sub-1 ton to 49 ton GVW, trucks (including pickup trucks) to small, medium, and large buses and coaches to passenger cars, including the world’s most affordable car—the Tata Nano, premium luxury cars and SUVs.

We have a substantial presence in India and also have global operations in connection with production and sale of Jaguar and Land Rover brand passenger vehicles. We are the largest commercial vehicle manufacturer in terms of revenue in India and among the top six passenger vehicle manufacturers in terms of units sold in India during Fiscal 2015.

We operate six principal automotive manufacturing facilities in India: at Jamshedpur in the state of Jharkhand, at Pune in the state of Maharashtra, at Lucknow in the state of Uttar Pradesh, at Pantnagar in the state of Uttarakhand, Sanand in the state of Gujarat and at Dharwad in the state of Karnataka. We also operate three principal automotive manufacturing facilities in the United Kingdom through our Jaguar Land Rover business: at Solihull and Castle Bromwich in the West Midlands and at Halewood in Liverpool. Jaguar Land Rover also manufactures its models in India (in the Pune plant) and China with its joint venture partner, Chery Automobile Company Ltd. Our Jaguar Land Rover business also includes an engine manufacturing centre at Wolverhampton in the West Midlands, where, in Fiscal 2015, it began to build the new family of Ingenium engines. Jaguar Land Rover also has two advanced design and engineering facilities located at Pune, India, Whitley in Coventry and at Gaydon in South Warwickshire, United Kingdom.
We have expanded our international operations through mergers and acquisitions and in India we have made strategic alliances involving non-Indian companies in recent years.

Through our other subsidiary and associate companies, we are engaged in providing engineering and automotive solutions, construction equipment manufacturing, automotive vehicle components manufacturing and supply chain activities, machine tools and factory automation solutions, high-precision tooling and plastic and electronic components for automotive and computer applications, and automotive retailing and service operations.

Tata Technologies Limited, or TTL, our 72.32% owned subsidiary, is engaged in providing specialized engineering and design services, product lifecycle management, or PLM, and product-centric IT services to leading global manufacturers. TTL’s customers are among the world’s premier automotive, aerospace and consumer durables manufacturers. TTL had 14 subsidiary companies and one joint venture as at March 31, 2015.

TML Distribution Company Limited, or TDCL, our wholly-owned subsidiary, was incorporated on March 28, 2008. TDCL provides distribution and logistics support for distribution of our products throughout India. TDCL commenced its operations in Fiscal 2009.

Our wholly-owned subsidiary, Tata Motors Finance Limited, or TMFL, was incorporated on June 1, 2006, with the objective of becoming a preferred financing provider for our dealer’s customers by capturing customer spending over the vehicle life-cycle relating to vehicles sold by us. In India, TMFL is registered with the RBI as a Systemically Important Non-Deposit Taking Non-Banking Financial Company, or NBFC, and is classified as an Asset Finance Company under the RBI’s regulations on NBFCs. In Fiscal 2015, TMFL has acquired 100% shareholding of Rajasthan Leasing Private Ltd, which subsequently changed its name to Tata Motors Finance Solutions Private Ltd, an NBFC registered with the RBI. On June 4, 2015, Tata Motors Finance Solutions Private Ltd was converted into a public limited company, named Tata Motors Finance Solutions Limited or TMFSL. TMFSL will focus on the used vehicle financing business.

Our wholly-owned subsidiary, Tata Motors Insurance Broking and Advisory Services Limited, or TMIBASL, is a licensed Direct General Insurance Broker with the Insurance Regulatory and Development Authority of India that operates in the Indian market and has plans to branch out globally to seek additional business opportunities. TMIBASL commenced business in Fiscal 2008 and provides end-to-end insurance solutions in the retail sector with a focus on the automobile sector. TMIBASL offers services to various OEMs in the passenger vehicle, commercial and construction equipment markets, including to us.

As at March 31, 2015, our operations included 72 consolidated subsidiaries, 2 joint operations, 3 joint ventures and 18 equity method affiliates, in respect of which we exercise significant influence. As at March 31, 2015, we had approximately 73,485 permanent employees, including approximately 45,488 permanent employees at our consolidated subsidiaries and joint operations. Our Registered Office is located at Bombay House, 24, Homi Mody Street, Mumbai 400 001, India.
Business Overview

We primarily operate in the automotive segment. Our automotive segment includes all activities relating to the development, design, manufacture, assembly and sale of vehicles including financing thereof, as well as sale of related parts and accessories. The acquisition of the Jaguar Land Rover business has enabled us to enter the premium car market in developed markets such as the United Kingdom, the United States and Europe as well as in emerging markets, including China, Russia and Brazil. Going forward, we expect to focus on profitable growth opportunities in our global automotive business, through new products and market expansion. Within our automotive operations we continue to focus on integration and synergy through sharing of resources, platforms, facilities for product development and manufacturing, sourcing strategy and mutual sharing of best practices.

Our business segments are (i) automotive operations and (ii) all other operations. Our automotive operations include all activities relating to development, design, manufacture, assembly and sale of vehicles including financing thereof, as well as sale of related parts and accessories. We provide financing for vehicles sold by dealers in India. The vehicle financing is intended to encourage sales of vehicles by providing financing to the dealers' customers and as such is an integral part of our automotive business. Our automotive operations segment is further divided into Tata and other brand vehicles (including financing thereof) and Jaguar Land Rover.

We produce a wide range of automotive products, including:

- **Passenger Cars:** Our range of Tata brand passenger cars include the Nano, a micro, the Indica, the Vista, the Zest and the Bolt, which are compacts and the Indigo eCS and the Manza, which are mid-sized, in the sedan category. We have expanded our passenger car range with several variants and fuel options designed to suit various customer preferences. Our Jaguar Land Rover brands have an established presence in the premium passenger car category under the Jaguar brand name. There are four car lines currently manufactured under the Jaguar brand name, including the F-TYPE two-seater sports car coupe and convertible (including all-wheel drive derivatives), the XF sedan (including the Sportbrake and all-wheel drive derivatives), the XJ saloon, and the new XE sports saloon, which commenced sales in May 2015.

- **Utility Vehicles:** We manufacture a range of Tata brand utility vehicles, including the Sumo and the Safari, which are SUVs, the Xenon XT, a lifestyle pickup, the Tata Aria, a crossover, and the Venture, a multipurpose utility vehicle. We offer two variants of the Safari: the Dicor and the Storme. We also offer a variant of the Sumo, the Sumo Gold, and launched the new Movus in May 2014, which is an entry level UV. There are six car lines under the brands of Range Rover and Land Rover in the premium all-terrain vehicles categories: the Range Rover, Range Rover Sport, including the Range Rover Sport SVR, the Range Rover Evoque (available in 5-door and coupe versions), Land Rover Discovery, including the Discovery 4 which features 7-seat capacity, the Discovery Sport and the Defender, which will cease production in Fiscal 2016.

- **Light Commercial Vehicles:** We manufacture a variety of light commercial vehicles, including pickup trucks and small commercial vehicles. This includes the Tata Ace, India’s first indigenously developed mini-truck, with a 0.75 ton payload with different fuel options, the Super Ace, with a 1-ton payload, the Ace Zip, with a 0.6 ton payload, including a CNG variant launched in Fiscal 2015, the Magic and the Magic Iris, including an electric variant, both of which are passenger variants for commercial transportation developed on the Tata Ace platform, and the Winger. In addition, we introduced a new generation of Ultra LCV trucks, including the Ultra narrow cab, in Fiscal 2015. We also offer the City Ride and Starbus ranges of buses.

- **Medium and Heavy Commercial Vehicles:** We manufacture a variety of medium and heavy commercial vehicles, which include trucks, tractors, buses, tippers, and multi-axled vehicles, with GVWs (including payload) of between 8 tons and 49 tons. In addition, through Tata Daewoo Commercial Vehicles Co. Ltd., or TDCV, we manufacture a wide array of trucks ranging from 215 horsepower to 560 horsepower, including dump trucks, tractor-trailers, mixers and cargo vehicles. Our Prima line of trucks is aimed at its customers in India and South Korea, and we have extended the Prima line by offering Prima LX and multi-axle truck variants. We expect to gradually export our Prima products to other countries such as South Africa, Russia, the other South Asian Association for Regional Cooperation countries, the Middle East and various countries in Africa. We also offer a range of buses, which includes the Divo Coach, the Semi Deluxe Starbus Ultra Contract Bus and the new Starbus Ultra.

- **Defence vehicles:** Tata Group company whose relationship with India’s defence and security forces is synonymous with that of the group is Tata Motors. India’s largest automobile company (subsidiaries include Jaguar Land Rover), with consolidated revenues of almost $35 billion in 2012-13, is strategically moving from the logistics vehicle segment into the combat vehicle segment.
Tata Motors has been associated with country’s Defence forces since 1958. Over 100,000 vehicles have been supplied to Indian Military and Para-Military forces so far. Tata Motors Defence Solutions cover the complete range of logistics and tactical vehicles. Current range of products for Defence and security forces includes Tata Armoured Safari, Tata Light Armoured Vehicle and Tata Light Armoured Troop Carrier, Mine Protected vehicle and Light Armoured Multi Role vehicle. High Mobility vehicle such as Tata 1623 (6x6), Tata 2038(6x6) and Tata 3138(8x8) are being well received by Defence. We also manufacture Shelters, Containers on 4x4, 6x6 and 8x8 platforms for Missile, Rocket Launchers and Command Post.

Tata Motors has now entered into tactical, combat support vehicles by introducing Duty High Mobility All Wheel Drive Multi Axle Military Vehicles. Tata Motors has supplied the multi-axle vehicle 8x8 to the Indian Air force and to LRDE Qty 06 Nos & 03 Nos respectively. The TATA 8x8 & 6x6 have also been also been supplied to RAFAEL, Israel for the SPYDER Missile System for the Indian Air force. Tata Motors has also developed and trial evaluated the 8x8 prototype at VRDE for the BrahMos programme. The acceptance trial was undertaken by the trial team comprising reps from R & DE (E), VRDE, MAG 14 (rep of Army) MSQAA, CQA & BrahMos. The schedule of trials was in conformance to the GSQR and the Extended Acceptance Test was completed in five (05) phases. This was carried out and was a success due to the active support received from BrahMos.

TATA 8x8 is also under trial evaluation for the MHC Crane application for the Indian Army and is presently at VRDE, Ahmednagar for the DGQA Evaluation after successful completion of User Trials.

Tata Motors has also developed the Wheeled ICV Kestrel (a joint design and development project between TML and VRDE (DRDO indigenously developed armoured fighting vehicle which has passed not only the mobility and blast tests, but also the flotation tests with flying colours. Through the WhaP (a joint design and development project between TML and VRDE (DRDO) program, Tata Motors has gained an unmatched understanding of armoured fighting vehicle technology and is possibly the only existing armoured land systems development capability outside of government owned entities in India.

The ICV weighs 22.5 to 26 tonnes depending on the configuration and it’s powered by a Tata Cummins diesel engine that makes 600 bhp (608 PS). Tata refuse to share the torque figures but claim it’s quite high. This can carry up to 10 soldiers and a crew of two. Seats for the troops are equipped with an energy attenuating mechanism that shields them from the effect of blasts. The seats actually move and absorb the impact of the initial blast as well as the secondary slam down of the vehicle, reducing the severity of injuries to the spine and brain. In the style of the Russian army, the seating for soldiers is back to back, allowing them to use the 4 gun ports on each side.

The amphibious propulsion employs rear mounted twin water jets that do not require any preparation before entering water. Only the Anti-Surge Vane is raised to ensure water flows over the roof. The platform can achieve 100 kmph on land and 10 kmph in water. With all-terrain ability and a powerful engine, this can also cross a trench of up to 2 metres width and vertical obstacles as high as 0.7 metres. It also has an on-board winch to enhance off-road ability. In combat mode, the driver shuts his hatch and utilises multiple cameras with day and night vision to steer the ICV. When in water, he also has three periscopes to aid him.

The platform is 7.8 metres long, 2.95 metres wide and 2.28 metres tall. It uses a GPS system for navigation and can be fitted with UHF, VHF or HF wireless systems for communications. As its modular, the platform can accommodate different variety of weapon stations and a one man or two man turret (for all calibres) depending on its application requirements. It can be armed with a 30 mm remotely operated cannon, a single 7.62 mm co-axial MMG (medium machine gun) and an automatic grenade launcher. In addition, it’s capable of being fitted with an anti-tank missile station with two fire and forget missiles.
The TML Wheeled ICV (Kestrel), a platform now in trials, takes Indian Army’s combat power to the next level

Wheeled Infantry Combat Vehicle (Kestrel)

Background

- The Kestrel represents the leading edge of wheeled 8X8 Infantry Fighting Vehicles. Combining the unique mobility, inherent high level of protection & the latest turret technology with advanced communication systems.
- The ICV variant presents state-of-the-art capabilities to face current battle field requirements.
- Key areas of application are ICV, APC, CBRN recce, Ambulance, Mortar Carrier, ATGM carrier

Technical specifications

- Mobility
  - Cummins ISXe 600HP EURO III Water cooled Compression Ignition, Turbocharged, After-cooled Diesel engine
  - Max Engine output: 600 HP @ 2000rpm
  - Max Torque: 2400 Nm @ 1500-1700 rpm
  - Max Speed: 100 kmph
  - Gross Vehicle Weight: 22500 kg (Amphibious) to 26000 kg
- Protection
  - Ballistic Protection: Modular from STANAG I to V
  - Blast Protection: upto STANAG III
- Crew Capacity
  - Driver + 11 Configuration
- Maintainability:
  - Proven, reliable and easy to maintain indigenous TATA Aggregates
  - Lowest Life cycle cost

TML’s ICV success is a result of more than 10 years of product & competence development in the armored vehicle segment
Other Armoured vehicles

**Armoured Personnel Carrier (MPV) – 4X4**
This personnel carrier is an anti-mine protector, counter-insurgency life-saver that offers all-round protection. It has armour and bullet-resistant glass, its V-shaped armoured undercarriage offers optimum underbelly and under wheel protection from landmines.

**Tata Armoured Safari**
It is manufactured using state-of-the-art armouring technology that minimizes penetration areas and offers maximum protection. Its comfortable interiors with plush seating and vibration-free suspension offer enhanced comfort levels. It has superior features including hand grenade protection for underbelly.

**Tata Sumo Armoured Vehicle**
It makes a great patrolling and escort vehicle. Strategically placed firing ports and observation/rescue hatch offer a 360° field view. The vehicle has a spacious cabin, factory fitted climate control windscreen and offers high mobility due to higher engine power and torque.

**Tata Light Armoured Troop Carrier**
It is the mobile fortress that cracks down on insurgent activity with deadly accuracy and efficiency. Its rotating gun turret enables 360° defence against enemy. Its Run Flat Tyre system allows the vehicle to move with great efficiency and the air-conditioned interiors ensure cool comfort for 8 troopers plus driver and co-driver.

**Range Rover: Defender Series**
For over 60 years Land Rover has been at the fore-front of developments and innovation in all-terrain vehicles. As well as distinctive, supremely capable, civilian vehicles, Land Rover has established a trusted position as rugged vehicle supplier of choice for the security and defence sectors in many countries across the globe. Land Rover Defence Vehicles have seen service the world over and demonstrated their exceptional blend of dependability and capability in some of the toughest, most hostile conditions on earth.

Our Land Rover Armoured Vehicles programme offers the discreet, independently verified, B6 armouring of the world renowned Range Rover and Discovery products. Perfect for the discerning close protection (CP) or law enforcement customer.
Other Defence Platforms

**Troop Carrier**
- Tata LSV
- Tata LPTA 713
- Tata SD 1015
- Tata LPTA 1623

**Water Tanker**
- Tata LPTA 715
- Tata SD 1015

**Trucks & Tippers**
- Tata SD 1015
- Tata LPA 713
- Tata LPTA 1623

**Specialist Vehicles**
- LPTA 1623 6X6
- LPTA 1623 4X4
- LPTA 2038 6X6 or High Mobility Vehicle

**Military Buses:**
Tata Motors Military Buses have high degree of maneuverability and protection that is enhanced with special comfort features for movement of troops in paramilitary vehicles.

**Tata Winger**
The Tata Winger is available in four variants, one of which is CNG operable. Other available variants are troop carrier, ambulance, and bus

**Buses**
- Tata LP 410
- Tata LP 712
- Tata LP 1512

**Tactical Vehicles:**
Tactical Vehicles from Tata Motors are designed to support the tactical manoeuvre of combat operations. It includes light specialist vehicles, UN vehicles, specialist vehicles like high mobility vehicle 6x6 & and high mobility vehicle 8x8, trucks & tippers, etc.

**Ambulance**

**Bus**
Organization Capabilities

Research and Development Infrastructure

Over the years, we have devoted significant resources towards our research and development activities. Our research and product development costs are attached in Appendix 1. Our research and development activities focus on product development, environmental technologies and vehicle safety. In India, our Engineering Research Centre, or ERC, established in 1966, is one of the few in-house automotive research and development centers in India recognized by the Government of India. The ERC is integrated with all of the Tata Motors Global Automotive Product Design and Development Centers in South Korea, Italy and the United Kingdom. In addition to this, we leverage key competencies through various engineering service suppliers and design teams of its suppliers.

We have a new passenger car electrical and electronics facility for the development of hardware-in-the-loop systems, labcars and infotainment systems to achieve system and component integration. We have an advance engineering workshop, with a lithium-ion battery module, for the development of electric vehicle and hybrid products. We have a crash test facility for passive safety development in order to meet regulatory and consumer group test requirements and evaluate occupant safety, which includes a full vehicle-level crash test facility, a sled test facility for simulating the crash environment on subsystems, a pedestrian safety testing facility, a high strain rate machine and a pendulum impact test facility for goods carrier vehicles. This facility is also supported with computer-aided engineering infrastructure to simulate tests in a digital environment. Our safety development facilities also incorporate other equipment that we believe will help improve the safety and design of our vehicles, such as an emission labs engine development facility, a testing facility for developing vehicles with lower noise and vibration levels, an engine emission and performance development facility and an eight post test facility that helps to assess structural durability of M&HCVs. In addition, we are installing a new engine noise test facility and transmission control unit which we expect will aid in powertrain development. Other key facilities include a full vehicle environmental testing facility, material pair compatibility equipment, corrosion test facility, heavy duty dynamometers and aggregate endurance test rigs.

Our product design and development centers aim to create a highly scalable digital product development and virtual testing and validation environment, targeting a reduction in product development cycle-time, improved quality and the ability to create multiple design options. Global design studios are key part of our product conceptualization strategy. We have aligned our end-to-end digital product development objectives and infrastructure with our business goals and have made significant investments to enhance our capabilities, especially in the areas of product development through computer-aided design, computer aided manufacturing, computer-aided engineering, knowledge-based engineering, product lifecycle management and manufacturing planning. In specific engineering review processes, such as digital mock-up and virtual build and validation, we have been able to provide capabilities for reduced time and increased quality in product designs. The design IP is managed through a product lifecycle management system, enabling backbone processes, and we have institutionalized “issue tracking” work-flow based systems in various domains to manage them effectively.

We have begun developing a technology platform for small electric vehicles with a GVW of one ton or greater with the National Automotive Board, SIAM and other OEMs. In addition, our research and development activities also focus on developing vehicles that consume alternative fuels, including CNG, liquefied petroleum gas, bio-diesel, compressed air and electricity. We are continuing to develop green-technology vehicles and are presently developing an electric vehicle on a small commercial vehicle platform. We are also pursuing alternative fuel options such as ethanol blending. Furthermore, we are working on development of vehicles fuelled by hydrogen.

We are also pursuing various initiatives, such as the introduction of premium lightweight architecture, to enable our business to comply with the existing and evolving emissions legislations in the developed world, which we believe will be a key enabler of both reduction in CO2 and further efficiencies in manufacturing and engineering.

We have implemented initiatives in vehicle electronics, such as engine management systems, in-vehicle network architecture and multiplexed wiring. We are in the process of implementing electronic stability programs, automated and automatic transmission systems, telematics for communication and tracking, anti-lock braking systems and intelligent transportation systems. We have implemented new driver information technologies and high performance infotainment systems with IT enabled services. Likewise, various new technologies and systems including hybrid technologies that would improve the safety, performance and emissions of our product range and are being implemented in our passenger cars and commercial vehicles.

We are developing an enterprise-level vehicle diagnostics system with global connectivity in order to achieve faster diagnostics of complex electronics in vehicles in order to provide prompt service to customers. We are also developing prognostic data collection and analysis for failure prediction to the end customer. Furthermore, our initiative in telematics has spawned into a fleet management, driver information and navigation systems, and vehicle tracking system using global navigation satellite systems.
systems. We intend to incorporate Wi-Fi and Bluetooth interfaces in our vehicles to facilitate secure and controlled connectivity to third-party IT enabled devices.

Advanced engineering

The TMETC Advanced Engineering (AE) department leads much of the technology development, across all vehicle functions, for introduction in future Tata Motors products. It also undertakes collaborative R&D projects with partners in the automotive industry with co-funding from UK Government and EU bodies.

TMETC’s AE department leads many of the AE projects for Tata Motors’ Engineering Research Centre (ERC), where the R&D teams are fully integrated into a common portfolio of technology development.

More specifically, the TMETC AE activities cover the following portfolio:

- Technology roadmap’ definition and maintenance for Tata Motors’ ERC
  - Innovation and technology screening of external and internal technology ideas and inventions
  - Innovation management and ‘embryonic research’ scheme
  - AE projects portfolio delivery, including collaborative projects
  - Intellectual Property Rights (IPR) generation and management

An overview of the technology roadmap is shown above to illustrate a typical 3-horizon technology development strategy and the key components and technologies being developed or applied. A strong emphasis on low carbon technologies is essential to the development of competitive and cleaner future automotive products.

This forward-thinking approach means that the TMETC AE department has become the Centre of Excellence for Tata Motors in technologies such as electric vehicle technologies (EV), hybrid systems (HEV) development and validation, fuel cell (FC) systems and vehicles, advanced infotainment and telematics, and control systems and embedded systems development.

Under the AE projects portfolio, there are typically 40-50 technology development projects running in parallel with approximately 100 initial assessments of innovative technologies.

Delivering technologies for the vehicles of the future, and linking particularly with Tata Motors’ HorizoNext strategy, TMETC’s major technology focus areas in AE are:

Advanced vehicle & drivetrain development:
TMETC’s AE department coordinates cross-department projects to develop advanced drivetrain technologies to meet future legislative and customer requirements. Significant expertise has been developed in the following areas and systems:

- Advanced transmission and hybrid systems
  - Focused on technology development and validation
  - Design, analysis, verification and validation capabilities

- Dynamic systems modelling and simulation
  Physical modelling in support of technology development

- Drivetrain control system development
  - Software in the loop through to rapid prototyping
  - Industry standard CAE capabilities: MATLAB, Simulink, Stateflow

- Embedded Systems
  - Platform & process and tool development
  - Automatic climate control ECU development
Design

The TMETC design studio is one of three Tata Motors global design centres that together make up Tata Motors Design, the other two being Trilix Srl, located in Turin, Italy and the Pune design studio in India.

The TMETC design studio plays a pivotal role in the creation of design concepts of future Tata Motors passenger vehicles, part of TMETC’s role as Tata Motors’ Advanced Product Creation Centre for the next generation of passenger vehicles. Under the leadership of Pratap Bose, a London Royal College of Art Alumnus and Head of Design for TMETC’s design studio and for Tata Motors Design, Tata vehicle design has grown in stature, and the design DNA of future Tata brand vehicles will be of world class standard.

The 60 member strong TMETC Design team has attracted talented Chief Exterior and Interior Designers, with significant experience gained with other OEMs and design agencies. It continues to attract and develop talented designers from the London Royal College of Art (RCA) and the Coventry University School of Automotive Design, both regarded as world class institutions.

The TMETC Design team is equipped with world class tools and techniques to enable it to deliver world class designs, some maintained internally and others in partnership with key partners and suppliers. Typically these include:

- 2D Sketch and Photoshop
- Photo real 2D rendering
- Sketch modelling 3D in Alias
- Proportion/volume modelling in Alias
- Milling (foam/clay/ureol)
- Rapid prototyping (SLA/SLS/3D printing)
- Clay modelling
- Hard modelling
- Trimming (design properties)
- Scanning
- Production surfacing Alias
- Production surfacing ICEM
- Painting
- Photo real visualisation from Alias data
- Animation
- Film production
- Colour materials and finish design
- Colour materials and finish maturation

Product Engineering

The Product Engineering function is TMETC’s core engineering capability, having by far the largest headcount. The Advanced Engineering department is an essential part of the Engineering function to ensure that teams at different stages of the innovation chain are well integrated. Product Engineering includes the key engineering functions and departments for a full vehicle development capability, more specifically:

- Programme Management
- Body, Trim & Craftsmanship
- Vehicle Integration, which includes:
  - Chassis systems
  - Thermal systems and aerodynamics
  - NVH
- Packaging, Safety & Regulations
- Electrical & Electronics
The Product Engineering departments work together with Design and Manufacturing Engineering to deliver projects in a matrix structure, which is linked to mirror organizations within Tata Motors and other customers. Areas of competency include:

- **Concept layout** - Clay model feasibility, from blank piece of paper design to using customer platform and carry over components, plus the generation of target setting documents, product design specifications, initial bill of design, and bill of process.
- **Body stiffness** - Optimised using global and local modal performance. Driving up global body modes, for both trimmed and untrimmed models, using the latest CAE tools ensures a lightweight, stiff, robust, and durable structure.
- **Weight** - Employing the principle of 'right material in the right place' through the use of new materials and moulding concepts. Choosing the right material is based on customer constraints, market constraints and market availability to give optimum material selection at the right cost.

**Vehicle Integration**
TMETC's Vehicle Integration department is responsible for the design, analysis and development of chassis systems and dynamics, aerodynamics, climate control & passenger comfort, powertrain cooling & vehicle thermal management, and vehicle & powertrain refinement NVH.

Combining all of these integration disciplines together enables TMETC to deliver a fully integrated solution by carefully balancing vehicle performance and design attributes.

The Chassis & Dynamics team is responsible for the design and development of vehicle chassis systems from concept through to production level solutions. Advanced CAE simulation software tools are applied to evaluate the dynamic characteristics of vehicles. Chassis components and systems are designed to global engineering standards and to ensure all attribute targets are met.

The Aerodynamics team evaluate and manage the airflow around the vehicle and its effect on vehicle stability, fuel economy and speed. Working closely with the Design team, the aerodynamicists use results from CAE and scale model testing to influence the shape of key features of a vehicle during the initial design phase.

The Climate Control team designs and develops the vehicle heating, ventilation and air conditioning systems to ensure that passengers are kept comfortable in all climates. The Vehicle Thermal engineers are responsible for designing and developing systems to manage the heat generated by the engine, gearbox and exhaust. The teams utilize CAE software and conduct vehicle testing in climatic facilities and in territory in order to optimise these systems.

The NVH team is responsible for the delivery of vehicle and powertrain refinement and sound quality throughout engineering programmes. The latest CAE software and test systems are applied to evaluate and develop components and solutions so as to meet defined attribute targets in both the virtual and physical domain.

**Powertrain (Engines & Transmissions)**

The TMETC Powertrain engineers have extensive experience in transmission and driveline design, development and calibration. This experience has been gained working within vehicle manufacturers, tier1 suppliers and engineering consultancies.

The Powertrain department is particularly experienced in the design, development and validation of all transmissions types for conventional, hybrid and electric passenger cars. It offers support to its clients with transmission selection and powertrain matching, and is supported by a full service vehicle engineering
capability, with skills in all areas of transmission design, analysis, packaging, and test and development. Design and development processes are aligned with niche low volume or high volume manufacturing methods.

The CAE team has access to world class simulation tools and high calibre computing resources, allowing them to perform a complete range of engine and vehicle simulations thus optimising engine designs with regard to power, weight and durability.

**Manufacturing Engineering**

The Manufacturing Engineering department provides a simultaneous link with the Design and Product Engineering teams to provide manufacturing feasibility inputs, process development and facility specifications from the beginning of concept creation and feasibility studies through to Engineering Sign-Off (ESO) and up to start of production.

The TMETC Manufacturing Engineering team also works directly with Tata Motors' manufacturing teams to enable a smooth transition of the product development into the manufacturing process at the various Tata Motors plants.

Manufacturing skills in the department span the complete spectrum of automotive manufacturing, with key members of the department having between 10 and 30 years' experience with vehicle OEMs and Tier1 suppliers. These principally cover:

- Total manufacturing systems from planning concept through to full industrialization
- Manufacturing Engineering to provide manufacturing feasibility inputs, process development and facility specifications to Design and Product Engineering teams
- Quality and supply chain to ensure quality standards and customer requirements are achieved for both in-house activities and within the supply base
- Launch of new products and facilities with specific focus on quality maturation and stabilization of the manufacturing processes, essential for robust industrialization

The breadth of the Manufacturing Engineering department's capabilities and expertise has grown in recent years and has contributed to the delivery of significant projects in the last 3-4 years. More specifically:

**Manufacturing Engineering expertise**

- Manufacturing feasibility for product integration
- Manufacturing techniques (lean principles)
- Root cause analysis
- Process development

*Industry standard tools are used by the Manufacturing Engineering team, such as:*

- Vis mock up for DMU applications
  - Creation of DMU to drive validation of the build sequence
- Catia V5
  - Validation of engineering data to provide inputs for digital validation

**Manufacturing facility planning capabilities**

- Digital simulation and virtual planning
- Facility planning, installation and start up
- Development of jigs and fixtures

Digital tools to support such work are used, in particular:

- Delmia Quest (facility planning)
  - Creation of conceptual layouts and simulations of throughput to establish capacity constraints and process bottlenecks, based on initial volumes and estimated cycle times
- Delmia DPE (process development)
  - Process sequence creation - inputs of DMU
  - MBOM Output - developed from assigning EBOM to the process sequence
  - Process sheet creation

**Prototype build and product manufacture capabilities**

- Press panel feasibility
- Body In White (BIW) part sub assembly and BIW body assembly
- Paint technology
- Trim and final assembly techniques
- Powertrain manufacture
- Launch management
- Manufacturing leadership and management

**Tata Motors' Testing Facilities**

Pune - India's first full vehicle crash test facility, capable of conducting all types of frontal, side and rear impact tests. The facility is accredited by TUV (European certification agency), as per European standards.

India's only pedestrian test facility capable of conducting all types of pedestrian tests. Asia's first semi-anechoic chamber is based out of Tata Motors, Pune. The facility provides accurate noise measurements of vehicles simulated under various speed and road load conditions, in order to study the acoustic behaviour of vehicles and identify noise sources.

India's only full vehicle climate test facility from small car to intercity bus. BSR (Buzz, Squeak and Rattle) testing, to improve interior noise of vehicles, helping in improvement of engine insulation, refinements in power train, body and suspension design. Steering Robot to apply inputs to a vehicle's steering system for testing transient handling behaviour on the test track, or for evaluating the steering system itself, allowing wide range of steering inputs.

The Full Environment Test Facility (FVETF) provides year-round capability to carry out vehicle development work from -40 to +56 degrees Celsius with humidity, solar, wind speed and road load simulation. The Suspension Parameter Measuring Machine (SPMM) measures the suspension characteristics that are used to define a vehicle's ride and handling performance, helping an engineer to quantitatively understand the various suspension parameters directly or indirectly influencing customers' perception of the vehicle capabilities.
Vehicle modelling and simulation capabilities at Tata Motors, at Pune and Jamshedpur

Tata Motors has a vast history of design and R&D led capability development. There are significant capabilities that exist across the firm and the relevant capabilities are listed below:

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Modelling/Simulation Capability</th>
<th>Statement of Capability</th>
<th>Expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tracked Armored Vehicle Modelling</td>
<td>Tata Motors has already in the past worked on the virtual development and of the a tracked armoured platform This work gives us a head start in the development of the new FICV</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Wheeled Armoured Vehicle Modelling</td>
<td>Tata Motors has developed and proven the Wheeled ICV in partnership with VRDE The platform has undergone flotation, mobility and firing trials witnessed by the top officials of the Indian Army</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Vehicle Dynamics Tracked Vehicle</td>
<td>Tata Motors has Vehicle dynamics simulation capabilities and has already simulated the a tracked armoured platform</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Vehicle Dynamics Wheeled Vehicle</td>
<td>Though the development of the Wheeled ICV, Tata Motors has simulated and trailed the platform Tata Motors has the confidence to deliver this</td>
<td></td>
</tr>
</tbody>
</table>
### 5 Turret durability testing

To prove assembly Gun turret mounting on vehicle hull through bearing (sleeve ring) and assess durability life of turret assembly by simulating field condition subject test was carried out. This set up can also be used on making a right fixture simulating static load, momentum and recoil forces as well.

### 5 Handling simulation

Expertise developed over the last five decades in the field of handling will be applied to the development of the FICV.

### 6 Ride Simulation

Vehicle ride simulation models the ride quality and comfort of the passengers and driver. Tata Motors has extensive experience in the optimization of quality of ride and this expertise will be applied to the FICV.
Load Simulation

Load analysis is critical to assess the mobility capability of the platform on the predicted terrains at the expected combat loads.

Components/Sub-systems Simulation

Sub-component level testing for life and performance to ensure the quality and reliability of the components on the platform.

Simulation of Vehicle Structure Response and Occupant Injury During Blast

Simulation of vehicle structure integrity and personnel safety/injury simulations. Capability to simulate damage on person/body part and on vehicle sections individually.
<table>
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<tr>
<th>Page</th>
<th>Section</th>
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<tbody>
<tr>
<td>10</td>
<td>Ballistics - Simulation</td>
<td>For simulating armour penetration against different levels of threat</td>
</tr>
<tr>
<td>11</td>
<td>IED &amp; Fragment - Simulation</td>
<td>IED simulation and live testing experience exists based on the delivered platforms like the MPV and the Wheeled ICV (Kestrel)</td>
</tr>
<tr>
<td>Page</td>
<td>Description</td>
<td>Details</td>
</tr>
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<td>------</td>
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</tr>
<tr>
<td>12</td>
<td>Ballistic Testing as per STANAG &amp; Measurement</td>
<td>Armour plate testing experience exists based on multiple platforms delivered including the MPV, the Wheeled ICV (Kestrel), armoured sumo &amp; safari and other vehicles.</td>
</tr>
<tr>
<td>13</td>
<td>Material Characterization testing for blast / ballistics</td>
<td>Testing capability for armour material characteristics in conditions including, but not limited to, high strain, shock, pressure, and drop.</td>
</tr>
<tr>
<td>14</td>
<td>HVAC bench system testing</td>
<td>A test facility to evaluate automotive HVAC system performance at system level by precisely controlling ambient conditions around the AC compressor &amp; condenser and of air temperature and humidity content entering the HVAC unit.</td>
</tr>
</tbody>
</table>
Manufacturing Infrastructure

TML has production facilities in Pune, Jamshedpur, Lucknow, Sanand, Pantnagar and Dharwad in India. These facilities are equipped to produce various vehicle platforms.

Jamshedpur: The Jamshedpur facility, Tata Motors’ first, was established in 1945 to manufacture steam locomotives. It led the company’s foray into commercial vehicles in 1954. It has been modernized through the decades, with a particularly intense scale in the last 10 years and has led the company's evolution into a manufacturer of global repute.

The state-of-the-art Engine Factory manufactures the Tata 697/497 naturally aspirated and turbo charged engines, with a capacity of supplying up to 200 engines per day. The Vehicle Factory's main assembly line rolls out one truck every 5 minutes. Two other lines are dedicated to the Prima range, Multi-axle, special purpose vehicles and for meeting the requirements of the defence sector. The plant manufactures Tata Motors’ entire range of medium and heavy commercial vehicles, including the Tata Prima, both for civilian and defence applications - over 200 truck variants, ranging from multi-axle trucks, tractor-trailers, tippers, mixers and special application vehicles.

Besides India, these vehicles are sold in South Africa, Russia, Myanmar, the SAARC region and the Middle East. On February 19, 2013, Jamshedpur Plant rolled out its two millionth truck. The chassis frames are supplied by the Frame Factory, which is equipped with a 5000 Ton Siempelkamp press to manufacture frames up to 6.2 metre wheel base.

The fully equipped Foundry supplies high-grade SG Iron Castings and is rated as one of the highly automated foundries in the world. It manufactures all critical automobile castings, viz. Cylinder Block, Cylinder Head etc. Its sophisticated Kunkel Wagner High Pressure Moulding line has a rated production capacity of 90 moulds/ hour. The melting shop has Medium Frequency Induction Furnaces for melting and Channel Furnaces for holding while the pouring is done by a Channel Press Pour coupled with a Steam Inoculation Dispenser. The core shop has a state-of-the-art Cold Box Machine, making four cores per minute. It has sand and metallurgical laboratories.

TML Drivelines Limited was established on March 13, 2000 as a subsidiary of Tata Motors by taking over operations of Tata Motors’ erstwhile Axle and Gearbox Divisions. It is currently the market leader in medium and heavy commercial vehicles axles in India with an installed capacity of over two lakh axles per annum. TML Drivelines Limited has proven skills in manufacturing axles from component level to assembly & testing. As one of the most modern forging set-ups in the country, the Forge is equipped with the 40,000 mkg Beche Hammer and state-of-the-art presses from Kurimoto of Japan.

Pune: The Pune unit is spread over two geographical regions- Pimpri (800 acres) and Chinchwad (130 acres). It was established in 1966 and has a Production Engineering Division, which has one of the most versatile tool making facilities in the Indian sub-continent. It houses a Vehicle manufacturing complex which is one of the most integrated automotive manufacturing centres in the Country producing a large variety of individual items and aggregates. It is engaged in the design and manufacture of sophisticated press tools, jigs, fixtures, gauges, metal pattern and special tools, as well as models for the development of new ranges of automobile products. Its capabilities have enabled Tata Motors to introduce new products and improve existing ones without resorting to imports of dies or fixtures.

The Passenger Vehicle Division in ‘K’ block executes the entire process of car manufacture over five shops - the engine shop,
the transmission shop, press and body shops, paint shop and the trim and final assembly shop. The shops are fully automated ensuring that there is minimal chance for error in the manufacturing processes.

State-of-the-art, press shop technology sourced from renowned manufacturers like Erfurt, Weingarten, Schuler, Fago. Header press capacity of 1200 to 2000 tonne, enable to press challenging styling shapes. These presses are equipped with automatic blank washing & oiling facility. The state-of-the-art welding facility, developed from German line builders like Kuka, HLS & Nothelfer is designed to be flexible enough to handle 8 models simultaneously. The capacity is 1900 bodies on 3 shift basis, with cycle time ranging from 54 to 90 seconds. State-of-the-art "Final Vehicle Assembly Line" with a cycle time of 67 seconds and production capacity of 1000 vehicles per day on a 2 shift basis. The manufacturing process is based on TQM World-class Quality Philosophy.

Industry experts rate the fully automated Foundries at Chinchwad and Maval among the best, worldwide. The Iron Foundry at Chinchwad produced 29334 Tons of high precision castings in 2012-13 while the Iron Foundry at Maval produced 10646 Tons of spheroidal Iron castings in 2012-13. These include Cylinder Blocks, Cylinder Heads, Gear Box Housing, etc. The Aluminium Foundry at Chinchwad produced 4292 Tons of casting mainly Cylinder heads required for PVBU and FIAT.

**Lucknow** - Tata Motors Lucknow (TML-Lucknow) is an important production facility of Tata Motors Limited, which was established in 1992 to meet the growing demand for Commercial Vehicles in the Indian market. Fully Built Vehicle business (FBV), which is one of the fast growing areas of business, is also head quartered here. This plant rolls out commercial vehicles & is specialized in the designing & manufacturing of a range of modern buses which includes Low-floor, Semi Low-floor, and High Deck & CNG Buses. Lucknow plant also specializes in integral bus manufacturing & has recently commissioned JV Company, Tata Marcopolo Motors Ltd. in the premises. The facility boasts of state of the art facilities like the Paint Shop, BIW Shop and the TCF factory with automated lines have been benchmarked with the best in the world.

**Pantnagar** - The Company has set up a plant for its mini-truck Ace and the passenger carrier Magic (based on the Ace platform) at Pantnagar in Uttarakhand. The plant began commercial production in August 2007. This is the company's fourth plant, after Jamshedpur (commercial vehicles), Pune (commercial vehicles and passenger vehicles) and Lucknow (commercial vehicles). The plant is spread over 953 acres, of which 337 acres is occupied by the vendor park.

State-of-the-art facilities include weld shops, paint shops, engine and gear box shops and assembly lines. The Company has invested over Rs. 1,000 crores in the plant. Vendors for the vehicle have made additional investments to set up their plants in the vendor park adjoining the plant. The operation has generated about 7500 direct and indirect jobs in the plant, among vendors and service providers in the area.

**Sanand** - Tata Motors' plant for the Tata Nano at Sanand, in Ahmedabad district of Gujarat, marks the culmination of the Company’s goal of making the Tata Nano available to hundreds of thousands of families, desirous of the car a safe, affordable and environmental friendly mode of transport. The capacity of the plant, to begin with, will be 250,000 cars per year to be achieved in phases, and with some balancing is expandable up to 350,000 cars per year. Provision for further capacity expansion has also been incorporated in this location.

Built in a record time of 14 months starting November 2008, the integrated facility comprises Tata Motors’ own plant, spread over 725 acres and an adjacent vendor park, and spread over 375 acres, to house key component manufacturers for the Tata Nano.

In line with latest world-class manufacturing practices, the Tata Nano plant has been equipped with state-of-the-art equipment. They include sophisticated robotics and high speed production lines. Conscious of the critical need of environment protection,
the plant has energy-efficient motors, variable frequency drives, and systems to measure and monitor carbon levels. These are supplemented with extensive tree plantation, sustainable water sourcing through water harvesting and ground water recharging and harnessing solar energy for illumination.

**Dharwad** - Tata Motors’ Dharwad Plant, located on the Pune- Bangalore highway around 425 km northwest from Bengaluru, became operational on “Founders Day” 3rd March 2012. This is the latest green field project by Tata Motors being commissioned for production of Ace Zip. Dharwad plant in a record time rolled out 15,000 Ace Zip’s in first year of operations.

In line with world-class manufacturing practices Dharwad Plant has installed most advanced technology which includes robotics, automated line with Automated Guided Vehicles and ultramodern manufacturing systems and practices. The Plant has a high capacity paint shop which brings perfect harmony between plant and conveyor equipment with RoDip technology.

Plant is spread over an area of 400 Acres. It has an installed capacity of 90,000 vehicles annually. Dharwad Plant is the one of the first plant in automobile industry to obtain Platinum Rating by Indian Green Building Council and it also holds the ISO 14001 and ISO 50001 Certification for Environment Management System and Energy Management System respectively. Dharwad Plant was awarded with ‘State Level Safety Award’ for development, implementation and practicing of sustainable safety culture in its location.

**International** - Through subsidiaries and associate companies, Tata Motors has operations in the UK, South Korea, Thailand, South Africa and Indonesia. Among them is Jaguar Land Rover, acquired in 2008.

In 2004, it acquired the Daewoo Commercial Vehicles Company, South Korea’s second largest truck maker. The rechristened Tata Daewoo Commercial Vehicles Company has launched several new products in the Korean market, while also exporting these products to several international markets. Today two-thirds of heavy commercial vehicle exports out of South Korea are from Tata Daewoo. In 2006, Tata Motors entered into joint venture with Thonburi Automotive Assembly Plant Company of Thailand to manufacture and market the company’s pickup vehicles in Thailand, and entered the market in 2008. Tata Motors (SA) (Proprietary) Ltd., Tata Motors’ joint venture with Tata Africa Holding (Pty) Ltd. set up in 2011, has an assembly plant in Rosslyn, north of Pretoria. The plant can assemble; semi knocked down (SKD) kits, light, medium and heavy commercial vehicles ranging from 4 tonnes to 50 tonnes.

The manufacturing capabilities are supported by Internal Operations & Systems to enable optimized operations and systems through ESM, Kaizen, IT support, SAP, e-Procurement, e-NPI, BSES, TML and other Standards, e-connectivity Interface for Suppliers, Dealers & Customers, strategic sourcing

Supply chain is managed though the latest tools and techniques with a state-of-the-art ‘Siebel’ e-CRM package, Dealers and Vendors network management systems, VCM/SRM and on-line customer and channel partner information.