Research Paper

Intelligent Tyres at CEAT Ltd.

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Research Objective

Cars are getting smarter. Smart, connected services, and the data that results from them, will be very important in next few years, for consumers, car makers and tyre manufacturers. The research focusses on technology developments in the space of intelligent tyres and bring out recommendations to evolve differentiated value proposition for CEAT Tyres Ltd. for Indian market.

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About CEAT Tyre Company

CEAT Tyres is one of India's leading tyre company with over 50 years of presence with revenue over $1Billion. It produces a wide range of tyres for cars, trucks, buses, tractors etc. It has 4500+ dealers, 500+ exclusive CEAT franchisees. In addition, there are 7 manufacturing facilities in India. There products are sold with a strong brand recall in over 100+ countries.

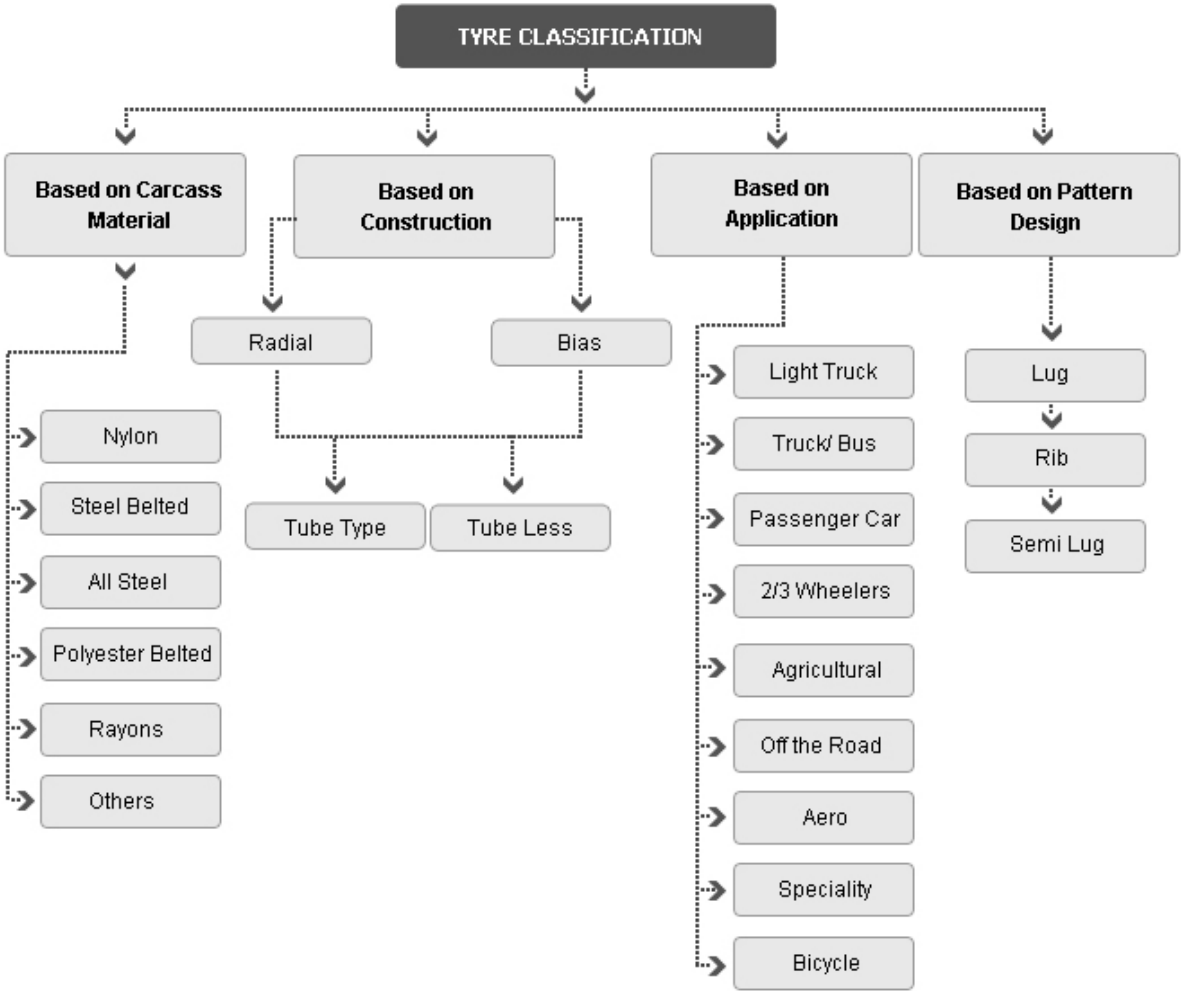
CEAT Research & Development centre

- 1984: Technical Collaboration with Yokohama (10 Years)
- 1991: Exclusive R&D center at Mumbai
- 1994: Joint Venture with Goodyear (4 Years)
- 2011: State-of-the-art R&D facility set up at Vadodara, India
- 2016-18: Phase-2 R&D expansion (18 Million USD)
- 2017: European Technical Centre close to Frankfurt, Germany

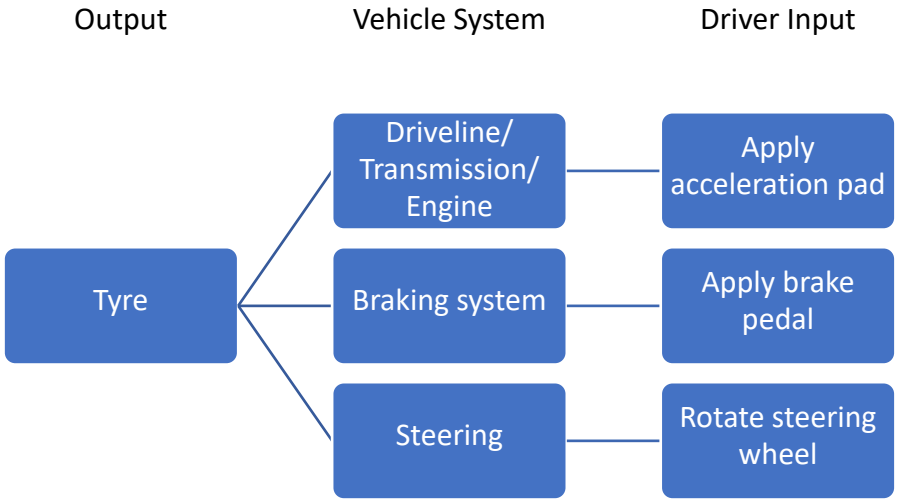
European Technical Centre

Understanding Tyres as product

Classification of Tyres



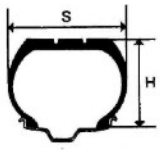
Tyre as a component in car



Primary functions	Original Equipment (OE) Requirement
• Provide Mobility • Carry Load • Directional Control • Absorb Shocks	• Ride Comfort, Noise comfort • Safety • Grip • Life/Durability • Cost

Tyre Nomenclature & sidewall markings - Passenger Cars

185/60 R14 82T MILAZE TL	CEAT : Manufacturer's name MILAZE : Name given to the pattern



- 185 : Normal section width of the tyre (SW = 185 mm)
- 60 : Aspect ratio or series (H/S = 0.60)
- R : Radial construction
- Z : Speed range (used till 1991) (in this case above 240 km/h)
- 14 :Nominal interior diameter of the tyre in inches
- 82 : Load Capacity Index (82 =475 kg)
- T : Speed Category Symbol (T = 190 km/h)
- TL : Tubeless

Tyre Tread Pattern - Based on season of usage



SUMMER	Winter	All Season
• Groove angle mostly straight • Both Direction/ Asymmetry • Cannot be used in Snow	• High sipe density • Uni-Directional pattern • Suitable for Snow /Ice • High noise during summer	• Assymetry/ Directonal • Can be used both in summer & mild snow • Not suitable for extreme Ice • Sipe density lower than winter tire

Tyre Tread Pattern- Based on terrains



Rough	All Terrain	High Way
• Block Pattern • Sharp groove angle • Rugged Shoulder • High NSD • Cut & Chip resistance	• Block Pattern • Sharp groove angle compared to H/T • Stiff Shoulder blocks • Good cornering stability must	• Predominantly Rib pattern • Good ride comfort • Low RR

Context for the Research

Cars are getting smarter – as is transport generally. Smart, connected services, and the data that results from them, will be one of the major battlegrounds over the next few years, both among car makers and their technology partners. Cars are massive data points, in terms of how they're performing, how they're being used, and how they relate to the organisations that manage them – and the world around them.

It's not just tyre manufacturers that are looking to reinvent the wheel with new smart tyres. Microsoft has announced that it intends to spend $5 billion on IoT programmes over the next four years, the software giant also revealed that an Indian start-up, Tyre Express, is using its Azure IoT Hub cloud service as the foundation for its service for fleet operators.

As per Microsoft, the new IoT platform helps monitor tyre performance in real time, to help customers take suitable action and improve operational efficiency, reduce costs and improve profitability. It also noted that operating a vehicle with tyre pressure 20 percent below the correct pressure can increase fuel consumption by 5-10 percent, and reduce tyre life by 15-20 percent.

That's important, because for fleet operators, tyre costs typically come second only to fuel costs. A technology that delivers both longer tyre life and better fuel efficiency – as well as greater safety – isn't likely to fall flat with fleet-operating companies.

Tyres of the future ...

- Are connected – a tyre that communicates vital information wirelessly to the car and its driver
- Have smart sensors
- Are electrified - a tyre that uses its own, self-generated air and electricity to optimize driving performance
- Are autonomous – a tyre that monitors and adapts its own air pressure automatically, as needed
- Are reliable - a tyre that keeps on rolling, under all conditions

Hence it is important to study and participate in tyre manufacturing & IoT ecosystem to be part of future automobile revolution. Even today many car manufacturers have started investing in this ecosystem and are offering different solutions.

The research therefore focusses on working with R&D of CEAT Tyres Ltd to benchmark technology developments so far in this space of intelligent tyres and bring out recommendations to evolve differentiated value proposition for CEAT Tyres Ltd.

Secondary Research

Study of technology with Global players in Tyre industry

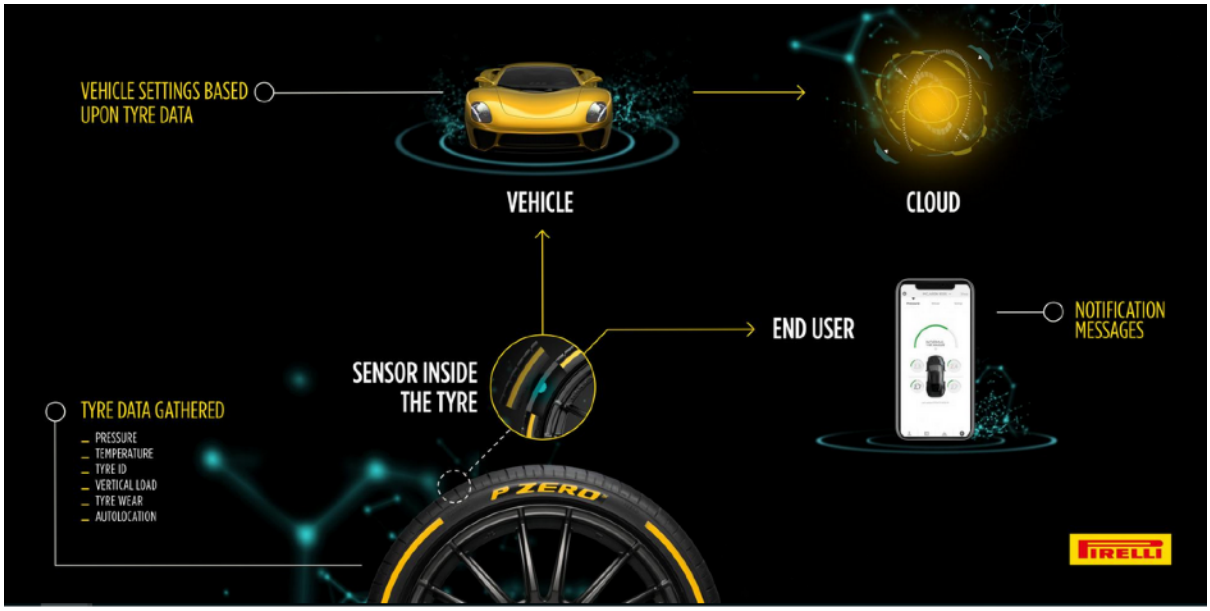
A) Pirelli Tyres

The Pirelli Conesso System uses a set of sensors mounted in a tire's tread groove and an on-board sensor located in the inner wall of the tire that transmits tire performance information pressure, temperature, and load data to a receiver unit in the car. The Ceramic Sensor embedded into the car transmits tire performance information via wireless dongle to the cloud as well. This is turn in turn communicates with the smartphone app and, via a wireless-dongle to the Pirelli cloud. The latter enables the system to store historical data to offer real-time analytics regarding tire consumption, residual mileage, maintenance status, and potential breakdowns. The sensor weighs only a few grams and has no effect on the actual tyre performance. The sensor data is also run through prediction algorithms that make estimates about the state of the tire, captures driving behaviour, ambient weather and road conditions as well as additional factors, and send them to each driver's personal app, with any warnings delivered via a special alert.

Connesso recognises the identification code of each tyre, measuring its pressure and temperature even when the car is standing still. It also supplies information about the vertical static load, how worn the tyre is and how many kilometres have been run on it. A future version will provide an estimate of the number of kilometres still remaining. The system can also act as a pressure meter while the tyre is being inflated, giving the driver exact readings without having to wait for the tyres to cool down.

Alerts via your smartphone, the system can warn you when the pressure of one or more tyres is too low or when the wear limit is close to being reached. Additionally Connesso is connected to auto body shops and tire-distributors to have advance visibility into their current inventory of P-Zero tyres. In both cases, the app is able to identify the tyre workshop that's closest and has availability. It then allows the driver to set up a one-tap appointment to carry out any necessary maintenance, or for a tire replacement cutting down on waiting times. In either case, it contributes towards predicting the end-of-life and pre-empting any incidences related to tire failures. In a future update, Connesso will add a remote function that will let you activate tyre maintenance and replacement from a distance, when you're away from your car

Inferring change in circumference of the car from tire rotations, as an indicator of wear and tear. Based on distribution gathered from track testing runs, Pirelli uses Weibull distribution to estimate remaining useful miles left in the tire and send advance alerts to the driver via a mobile app. The sensor data is run through prediction algorithms that make estimates about the state of the tire, captures driving behaviour, ambient weather and road conditions as well as additional factors.



The Cyber Car is intended as original equipment, designed to work with integrated on-board systems. Under normal conditions, by reading a tyre's "identity card" (the tyre ID) the vehicle can alter its set-up in order to make the drive safer and more comfortable. In challenging conditions, the system informs the driver, through the carmaker's interface, about standard operating parameters of the tyre, such as vertical load, temperature and pressure, which allows timely intervention and activate systems such as ABS and stability control, if the pressures are wrong. Tyre maintenance becomes an easier job, thanks to specific information about tread wear and how the tyres should be seasonally rotated.

B) Continental Tyres Ltd.

Today's TPMS sensors, mandatory in many countries and offered as standard equipment in most new cars, already provide the information you need to maintain the perfect pressure. But what about the other aspects of tyre health that often remain invisible until it's too late? Smart sensors will keep an eye on them.

Tyre tread grips the road as you drive and is vital in maintaining traction and controlling the vehicle, particularly in wet weather. Smart sensors will let you know when the tread is so low that the tyres should be replaced.

Tyre temperature often increases before a blowout, giving an indication that something is wrong. Smart sensors will also warn you of temperature changes, indicating moisture (snow, rain, ice) or other hazardous road conditions.

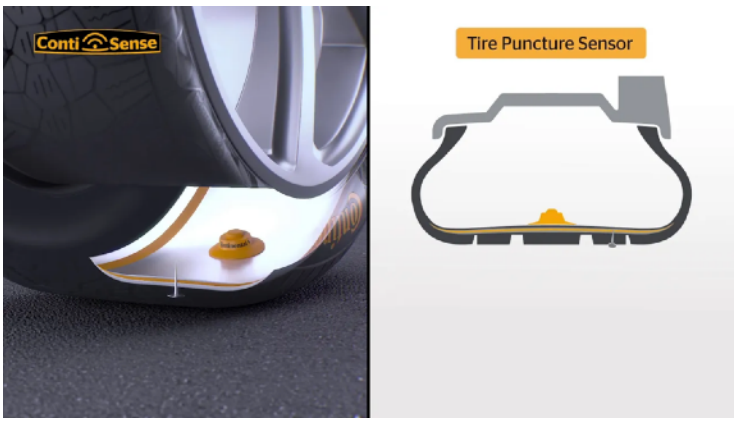
Tyre failures like small punctures can be a big pain, especially if a slow leak goes undetected for too long. Smart tyre sensors will alert you immediately, preventing further damage to the tyre and minimising the risk of accidents, thus drastically improving automotive safety.

<u>Intelligent tyre sensors</u>

Reduce repair and maintenance costs, provide a more comfortable ride, minimise wear and tear & Maximise fuel efficiency

ContiSense™ tyre sensors

ContiSense™ detects a puncture, ContiConnect™ transfers a warning to the system.



Continental C.A.R.E Pressure Proof technology

Tyres that are just as smart as the autonomous, electrified car will monitor their own air pressure – and top it up as needed.

Continental C.A.R.E Pressure Boost technology

Continental C.A.R.E™ is a new tyre technology for the fast-approaching era of electric, connected and autonomous driving. For you, that simply means your tyres will care for

themselves, so you don’t have to. Car owners and drivers will receive real-time notifications on tread depth, possible damage, and tyre temperature, while sensors continuously analyze data and immediately transmit information.

C.) JK Tyre

JK Smart Tyre provides real time information about the health of the tyres through smart sensors. The introduction of TREEL Sensors is the first such high-tech move towards creating a Smart Tyre in Indian markets. Smart tyre technology helps to monitor various parameters of tyres that directly or indirectly affect other parts of the vehicle and therefore help maintain overall health of vehicle.

Tyre Pressure Monitoring Systems (TPMS) offered by TREEL Sensors monitors the tyre's vital statistics, including pressure and temperature. These sensors are one of a kind technology-based tool geared towards smart monitoring and maintenance of tyres.

TPMS technology will capture data relating to tyre pressure and temperature through advance algorithms and enable alerts in case of pilferage of tyres as and when they are demounted from vehicles. These data will show the co-relation between tyre pressure and temperature and will help in predicting tyre life.
The patter of the data will provide insights of the wear pattern on tyres, helping to predict cases of puncture or burst probability in real-time. This technology can also define threshold operating conditions, generating real-time alerts for maintaining the right tyre pressure.

The information collected by this smart monitoring system will be relayed on a real-time basis to the vehicle owner’s smartphone via Bluetooth on to a mobile application, allowing for early detection of issues and deployment of timely preventive measures. It provides an enhanced value proposition to vehicle owners, particularly fleets, by reducing their operational costs. This keeps tyres safe and hence reduces the risk of accidents. Healthy tyres help reduce fuel consumption and other maintenance requirements.

The Smart Tyre technology is compatible with cars, bikes and trucks/buses.

It is available in three variants for cars- Smart Tyre Sensor Car Kit: Valve, MTrac Smart Sensor Car & Truck Kit: Valve and MPower Smart Sensor Car Kit: Valve. Similarly, it is available in two variants for bikes- Smart Tyre Sensor Bike Kit: Belt and MTrac Smart Sensor Bike Kit: Belt.

Analysis & findings

Parameter	Continental	Pirelli	JK Tyres
Technology	Cloud technology used for data transfer.	Cloud technology used for data transfer.	Cloud technology used for data transfer.
Design	Circular shape	Circular shape	Valve shape
Tyre size list	Can be used in any sizes. As it is not size specific	Available for selected sizes.	No relation with tire size, as it is kind of smart valve.
Outputs	Temperature pressure & puncture detection	Temperature, pressure, wear nature	Temperature & pressure
Cost	NA	NA	5000 approx.
Type of cars	Available for all cars	Available for sports cars	Available for all cars
Placement	Placement on tire inner liner	Placement on tire tread & inner liner	Placement on valve
Product availability in India	No available	Not available	Available in India
Sensor image			

Recommendations

Parameter	Recommendations for CEAT Tyres
Technology	All the competitors are using cloud technology as this is latest technology and helps in accessing data in real time. So, for CEAT Tyres, cloud technology would be best for data transfer and data access.
Design	Mostly companies are using circular shape. Reason of using circular shape is less stress concentration in circular shape. So, recommendation would be CEAT should go with Circular shape or can go with any other shape after studying stress concentration.
Tyre size list	Tyre should be available in all sizes to increase market visibility.
Outputs	From above research it was found that mostly companies are giving basic parameters like pressure, temperature and wear related information. To be market leader CEAT should come up with extra output features which are listed below: 1. Information related to tyre contact patch 2. Information related to tyre alignment 3. Information related to tyre failure 4. Real time information regarding tyTyrere use. 5. Real time notification on mobile app for all above parameters. 6. Provide information related to road surface temperature and road surface nature.
Cost	On cost front it should be optimised and should not exceed more than normal tyre.
Type of cars	Should be available for all type of cars. Also, modifications can be done for providing specialization for sports cars and cars enthusiastic persons.
Sensor placement in tire	Sensor should be placed on inner liner as it will be safe from impact coming from road.

Additional recommendations	CEAT should use this Tyre as an opportunity for EV vehicle and should look possibility for synchronization with autonomous vehicle. As looking into future this can be a good business opportunity.

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