The challenging world of new tyre development tests

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Mehmet Koral has 40 years of experience in tyre industry. He started career at Lassa Tire Manufacturing, Izmit, Turkey (now BRISA). Koral has worked for BRISA Technology division for 22 plus years. He retired in 2003 and has been a consultant for several companies in China, India, Russia and the Republic of Tatarstan. He also helps well-known tyre manufacturing machinery companies from Europe, USA, China, and Japan. He has participated in performance improvement tests, OE tyre approval tests, road, and field tests, standard and regulatory tests both indoors and outdoors. He participated actively in ETRTO (European Tire and Rim Technical Organisation). He also served as the Chairmen of the UN ECE Tires S/C for Turkey about ten years.

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By Mehmet Koral

The point, or better area of contact, of the tyre with the road is in fact a surface. When the tyre is inflated onto a rim, and installed at a vehicle properly, the weight of the vehicle applies a certain vertical load for each tyre and rim assembly.

The safe and reliable driving of any vehicle is a resultant of the vehicle, its tyres, and the road and the driver interaction. It is a dynamic interaction between these variables and the climatic conditions in the environmental climate. Each may affect the safety of the travel and transportation differently e.g. dry road, wet road in the rain, snow and ice on the road in winter. We should better remember that the only contact area of vehicle is the contact patch (footprint) of the tyre and its response to everchanging road conditions. Driving uphill, driving downhill, taking curves along a travel are among them.

It is important to understand the tyre behavior before we start development of a tyre, and related tests to be applied indoors- on the drum, and outdoors- on the roads and test tracks.

In order to be able to analyze the forces and moments which are acting on a vehicle tyre, especially during cornering, we need to define an **axis (coordinate) system**. Since the wheel can move in three directions, we need a 3-D coordinate system. The most common one being the tyre axis system defined by the **Society of Automotive Engineers (SAE)** and by ISO (International Organization for Standardization).

The SAE standard which defines the tyre axis system and terminology is **SAE J670 – Vehicle Dynamics Terminology.**

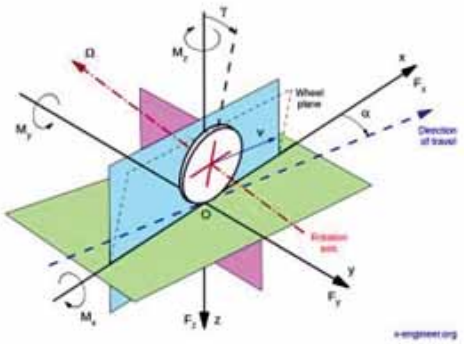


Figure: Tyre axis system and terminology defined by SAE standards (right-hand road wheel)

Who needs tyres?

Who needs and initiates a request for a specific tyre of a specific vehicle? Vehicle manufacturers.

It is not a secret that there are vehicles that do not need a driver today. However, we did not hear yet about a vehicle on the ground roads that runs without tyres!

All ground vehicles need tyres-one way or another. Pneumatic tyres or not, low profile or not. Textile belted or steel belted tyres or not. All steel

tyres or not? Simply because, without their tyres all vehicles are stationary machines only-they cannot move.

When does the development of a new tyre start, **where** does it start from? **How** does it deserve allocation of company resources for its development, testing indoors, testing outdoors, and for its production; money, manpower, machinery, material, time and technology concerted efforts of a large team of experts? It is initiated by the definitive needs in a certain segment of a vehicle market is agreed and signed by the Vehicle and Tyre manufacturer managements.

Tyre needs of today; there are new vehicles, with new tyre sizes imported and running on domestic roads. They have original tyres mounted under them as they are imported.

That fires the enthusiasm of local tyre manufacturers in the domestic market. Why? Due to the international partnerships worldwide, these new tyres are imported and sold in domestic market at start.

Tyre needs of tomorrow; domestic tyre manufacturers closely follow up of the imported vehicles be it a car, truck, light truck, or a giant off the road vehicle. Searches for the imported vehicle trends, and projections of the tyre sales needs of 2-3 years later are made. These indicate to the tyre needs of tomorrow in the market.

Tyre needs of today and tyre needs of tomorrow bring forward new tyre needs to be understood and put this need into a perspective of the company investment plans.

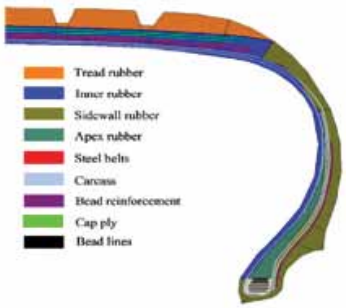
These findings are reviewed and used as a criterion to develop a new tyre, or not by the Tyre Company management. Sometimes it is decided to start development, because new projects bring eye-opening discoveries, they become new technologies and new technologies become new products to give better performance, more safety and greater economic benefits for the society and the providing Tyre company.

Development process for tyres.

How does the story of tyre development start, where does it tart from?

Due to the international trade, and due to partnerships established worldwide, the tyres may be imported and sold in domestic market. However, usually domestic tyre manufacturers closely follow up the imported vehicles; be it a car, truck, light truck, or a giant off the road vehicles. They estimate about tyre needs of 2-3 years later.

Tests applied during the design and development of a tyre

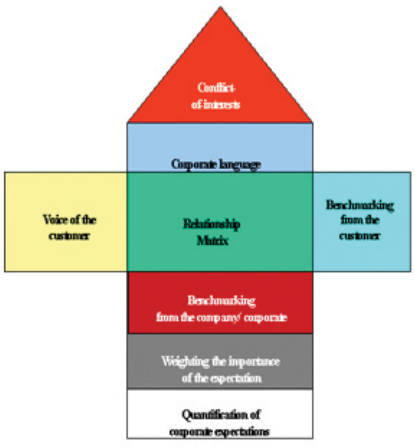


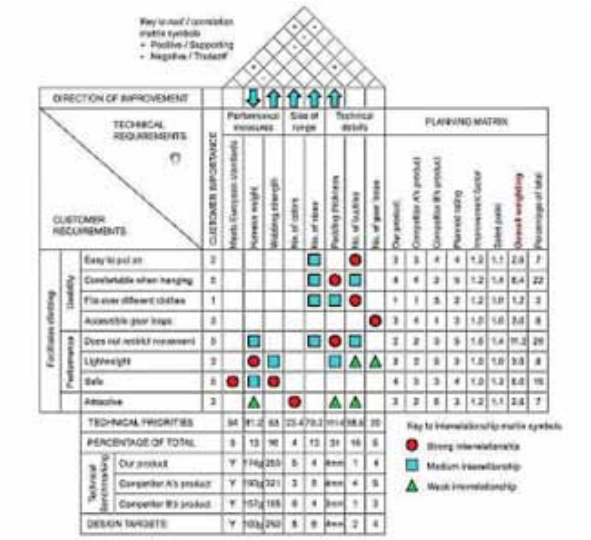
How long does it take to start from the scratch of pattern exercises to the tyre released for Warehousing, Shipment, and Sales in the market? 2-3 years normally.

Who takes care of all the detailed and sometimes tedious work to develop a new tyre?

A new tyre may be a new size for an existing tread pattern; it is then called "size expansion". It is relatively faster to complete. There is observed some active critic of the pattern expanded to cover a new tyre size. In such a case, it may be later understood that one property of the tread pattern for the new size is became bad. e.g. ride comfort, uneven wear, vibration and enveloping power of that tyre.

A new tyre may be a brand-new tread pattern for the market introduction. For such cases it is a must to employ the principles of the Quality Function Deployment (QFD. QFD methodology starts with listening to the customer (understand and learn her requirements), listen to his preferences in the competitor's tyres, and (make Benchmarking for your new tyre), then make deployment of the design to your manufacturing capabilities at production, complete any missing part in these series of deployment matrix, this will be a whole learning process together with Design, Engineering, Production, Production Planning, Marketing and Sales teams.





Some Tyre companies calls this as Tyre Project Marketing Review (TPMR) when they start the project.

Based on real life examples, this right approach does not perform, the ownership of the project is shifted to participating other groups. Management ownership loosens. The limiting factor is here the duration of the process, if it is not managed closely time is lost, resources are wasted. Release target of the new tyre project is lost. To eliminate such loses Process Ownership methodology is the approach to implement.

QFD also includes intensive works of competitor tyres, both construction and compounding is re-engineered and a Dimensional Standard Specification is created for that tyre; pattern, outside diameter, section width, s-depth, void-to rubber ratio, branding, its positioning according to tyre standards (e.g. ETRTO-European Tyre and Rim Technical Organisation head office in Brussel, EDI (Enginering Design Information) reference books of ETRTO for Tyre Design Engineering).

Its position in the other Tyre Standards and Regulations e.g. DOT (Department of Transportation, FMVSS (Federal Motor Vehicle Safety Standards) in the US is also cross checked and learned.

If that new tyre for an OEM customer, manufacturer of target vehicle may be contacted, consulted, and worked together if they look for another tyre as OEM part for that vehicle. If it is so, then a series of the tests and evaluations defined by the vehicle manufacturer is applied both indoors and outdoors at their proving grounds, and country roads, or private proving test grounds. Usually, the vehicle manufacturers have their own vehicle proving grounds, and sometimes they may utilize proving grounds closer to their manufacturing sites.

Some example can be mentioned as Renault OEM approval tests in the Monthlhery Racing Circuit (Autodrome) near Paris, for FIAT it may be the Valelunga Test track near the Balocco proving ground of FIAT. Toyota used her Proving Grounds in Japan for approval tests. Hyundai uses her Test Tracks in Korea. This is a well implemented approach by many OEM (Original Equipment Manufacturers).

These PG testing is usually accompanied by the ride comfort testing in the vicinity of the proving grounds.

Vallelunga Test Circuit near Rome is utilized by FIAT in Italy.

In Turkey, for example, the country roads are used for Ride comfort testing, highways are used for maneuverability tests. Ride and handling tests are done in the Korfez test track in Kocaeli, and sometimes it is done in the Formula 1 Test Track near Istanbul.

In recent years, Petlas tyre manufacturing has invested and built a Test Track near its plant in Kırsehır central Turkey. Two professional test drivers who are closely worked with the Tyre design engineers makes joint tests and make design review meetings based on the Ride and Handling results. Important to mention that these test pilots are involved in tyre and vehicle tests in the vehicle manufacturer's country together with their test drivers. **This is called as a calibration test for the test drive of the tyre and vehicle test drivers.** This shared experience, in a sense, is a mutual training of each test pilot to make similar test acts and make similar grading of the tyre and car joint behavior. They are calibrated first then they make pre-selection tests before they submit test tyres to OEM.

On the course of development do you expect a little excitement. There may be more than you imagine.

• Trials of a new compound?

• Designing, developing a new tyre that is lighter in weight, but has longer tread wear life?

• Low in rolling resistance (RR) but safe in wet performance?

• Low in pass by noise, but high in ride comfort, and very good in ride and handling-maneuverability?

• A tyre that is better in cut and chip resistance? Yes, but how about stone retention? How about tear and cut resistance?

• Safe in snow and ice, but also have a longer tyre wear life?

• Does it complete the ECE R30, or ECE R54 testing by the accredited labs? Does it carry an official approval number marked on the sidewall of that tyre?

• ECE R30 tests and marking approval number on the sidewall? ECE R54 tests and marking ECE R54 approval number on the on the sidewall?

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Tyre dimensions and tyre branding concerns are similar but not the same in every market.

Many discussions on the branding of sidewall? Depends on the market you are going to sell that tyre. In Europe ECE Regulations are necessary and enough. In the USA market it is different rules and regulations for the same tyre. DOT, FMVSS, UTQG regulations are valid and they must be met by your tyres.

In European ECE Regulations you must complete successfully tyre tests indoors by accredited test labs, apply with these test results to governmental bodies, get an approval number, mark that number on your mold for that tyre. Then every single tyre has an official approval number on the sidewall, and you may ship and sell it in every European country.

In the US there are Tyre rules and regulations too. However, you are not forced to get your tyre tested by accredited test labs, get that result, apply to an authorized body, then receive an official approval number... this is not a process that you have to follow. and regulations are issued and every tyre manufacturer know about them.

What is the skid depth when it is a new tyre?

What is the skid depth after 6, 12...36 months, is its skid-depth above the legal limit of 1.6 mm or not?

I hear your question “how do I know the residual skid depth at that stage?

It is already marked along the circumference of a tyre at least at four points, you may see it from outside at upper sidewall area near the shoulder.

When you get a closer look at near that marks, you may see the small triangle marks. Then check in the grooves of the tread at that point, you may easily find a 1.6mm high spots in the grooves.

Also, the used tyre changes its appearance in the tread area. Some kerfs are worn out. All grooves and voids becomes shallower upon use and wear.

Is this tyre developed for OEM (e.g car manufacturer in domestic market, or a car manufacturer in the export markets? Who is going to evaluate it and technically homologize it for a model of a model of a car as original equipment for that car model? What will be the total weight of it? What will be the price? What will be the Rolling Resistance of that tyre? What will be the Pass By noise limits ? what will be its wet brake performance? How about the tread wear resistance? It is for the USA there are special rules for all.

In European markets there are certain performance, and branding criteria to be met.

In a more larger European areas ECE regulations must be met and this must be based on the data created by accredited Tyre Test centers. In Europe it may be TUV in Germany, it may be an accredited Test center where you can make tyre tests, submit data state officials and get a ECE R30 number, brand it on the tyre mold. That way every single tyre cured carries this number. Tyre designing, manufacturing and selling become more and more regulated already. Trend continues. ■