TIRE INDUSTRY RESEARCH Global Tire Intelligence report

June 2024 edition: Date: 31 May 2024

Compiled by Shaw Information Services trading as Tire Industry Research

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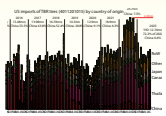
Opinion & commentaries:



News and intelligence

About this publication

This document has been prepared in response to demands from the global tire community for insight into all aspects of the global tire industry value chain.

As the tire industry transforms, increasing numbers of people in the tire industry do not have a multi-decade history in this business. This report is for them, and for the more experienced.

Everything in the report is completely independent. All our revenue comes from subscriptions. Our only loyalty is to the readers. So we have to offer reliable and insightful analysis.

About the author. This report is compiled by David Shaw. David publishes widely on his own website and LinkedIn about the tire industry. He has a 30-year track record reporting on the global tire industry at the highest levels. He publishes influential newsletters; offers a weekly news service and manages conferences globally.

For more information see http://TireIndustryResearch.com

 TIRE INDUSTRY RESEARCH

Virtual tire development

Virtual tire development gets more realistic

Developing a tire in a virtual environment is challenging, but once the challenges are (mostly) overcome, the benefits can be huge. The industry is now at the stage where the challenges are being overcome and a few tires have been designed from scratch with zero physical prototyping.

What this means is that the virtual tire models are now realistic enough to perform development with no physical prototypes models – in limited circumstances. But there is a lot of work to do before every tire can be developed with no physical prototypes prior to production.

Keen observers of the tire business will have noticed that Pirelli, Michelin Goodyear and others have announced the purchase and use of new driving simulators. This is a critical step on the road to zero-prototype development. And a big investment. A DiM250 simulator costs around USD5mn. On top of that, it makes sense to create a dedicated building and offices and computing power.

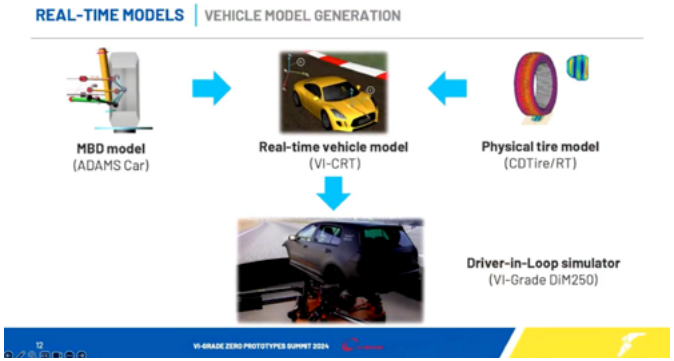
It is possible to develop a tire purely in the computer, without using a driving simulator, but that ignores the haptic – subjective and heuristic – responses of the tire and the driver.

The point of the driving simulator is to give a professional driver the opportunity to drive the car-and-tire combination and give feedback on how the tire 'feels' as it is being driven, as well as more qualitative data such as lap times and stopping distances.

The driving simulator allows that phase of the test cycle, without the time and expense of creating a physical model.

It brings together a model of the car and a model of the tire and a model of their dynamic responses in a computer and then links that to a virtual road.

Not only that, but the interior of the simulator can be re-arranged to match a specific vehicle cabin interior and layout of controls. Putting all these together, the test driver can apply power and brakes and steering and the system will respond as if it were a real physical set-up.



So the purchase of a driving simulator is one of the final steps in a tire maker's journey on the road to virtual tire development.

The investment indicates that the tire maker has developed a good model of the tire dynamic response and has enough demand for virtual testing that it no longer makes sense to hire a simulator from a consultancy like MIRA, Multimatic or IDIADA, and that the tire maker is working with clients who operate similar equipment.

As the number of tires and variants and the degree of customisation to specific vehicles increases, we expect to see the top tire makers buying more such driving simulators.

Just as tire makers started building proving grounds in the period from 1950 – 2010, and then moved to indoor testing tracks, we think future growth will be in driving simulators, rather than physical test tracks, for any tire maker that is interested in developing tires for a vehicle maker. It's just possible that the glory days of outdoor test tracks may be coming to an end.

Meanwhile, outside the top-10 tire makers, other tire makers that want to become established suppliers to the vehicle makers are developing their own modelling skills and developing their simulation experience using consultancies. Their next step will be to buy a driving simulators. When they do that, observers might realistically conclude that internal demand for virtual testing has exceeded the threshold for availability and costs that external consultancies can provide.

The driving force in all of this is to accelerate development times. And reduce cost. It costs a great deal of money and time to create a few sets of tires and then transport them and a team of test drivers and technicians to a test track (where the weather might not be ideal).

Gaining the trust of the drivers

There is a common myth that drivers prefer to drive real cars on real tracks, but that is beginning to change. Mahmoud Shaker at Bosch said the turning point is often when a driver first drives a real car on a real track, and then moves to the simulator to drive the simulated version, and the driver discovers that the feel of the car (and tires and brakes) and the lap times are almost identical. "Sometimes you just need one situation where they have seen that with simulation, they have reached the same results. And afterwards, they are connected to simulation and would like to use it even more."

Getting started on simulations

One of the topics addressed at the conference was on how to bring new companies into the eco system, especially if they have little experience of simulations. The more experienced panellists shared their experiences of getting involved in simulations.

Marco Malagò (Ferrari) said that one of the issues that everyone struggles with is confidentiality. "For sure confidentiality is the main question that we are facing today. The other thing is like I think methodological approach."

He added, "we collaborate with different suppliers, it's really important that there are some basics that are shared and understood by everyone. In particular, the importance of providing reliable model in advance of the physical components. Our models depend on suppliers who know exactly and in detail the component itself to make a first accurate validation of their system." What can be frustrating from an OEM standpoint, he said, "is that there is a perception from suppliers sometimes to say, yeah, OK, I'll give you the model. And then they don't spend enough time to properly check if the model that they are providing to us is accurate or not."

However, some suppliers put proprietary knowledge inside their models, "we know that there are some specific suppliers that have their own know-how and they would like to keep their specific model approach confidential. And that's absolutely fine for us."

He said that the issue is more that if multiple suppliers are contributing their own models of different parts of the system, but if one of those models is inaccurate, then it affects all the other suppliers and slows down the whole project.

Rutger Uil said that when the same conference was held in Udine in 2019, things were very different. "I think we see a clear increase in what we can do. I think the road to zero prototypes is now real. We are not there yet. I think also with the right partners, so finding the right partners that can help you in bridging that gap, that is one of the challenges that really evolved over the past year."

The panellists were then asked what they would say to companies who are not yet into simulating tire performance.

Marco Malagò Said, "they have to understand that the zero prototype goal is definitely a challenge. It will be tough to get from three physical prototypes to zero. But the approach of reducing the design space with this approach is absolutely crucial."

Mahmoud Shaker from Bosch said, "just do it. It's a state of the art. Everybody needs it in the development. Just choose the right partners, the right people to help you with it; Just do it."

Virtual tire development

While it costs a lot to develop the models and to buy the simulator, once that knowledge is in place, the rate of tire development can accelerate.

Furthermore, most vehicle makers – not just the premium marques – now expect to work with their tire suppliers on virtual development, as a way to speed up the development process.

The challenge up to now has been that the simulations have not been representative of the experience of driving a real car and tire.

At the recent VI-Grade meeting in Udine, Italy, a series of speakers from car makers, tire makers, consultants and suppliers of driving simulators and software, all confirmed that the experience in a simulator is now a close match to the experience on a real test track.

Marco Malagò at Ferrari (a former Goodyear tire development engineer) said that there is a queue of test drivers waiting to use the simulation equipment – especially when the weather on the test track is not ideal.

One of the key developments is that the different players in the value chain are working very closely together.

That includes the vehicle makers; the suppliers of modelling software; tire makers; suppliers of suspensions and brakes and the manufacturers of driving simulation makers and even road digitisation processes.

Current state of the art

The current state of the art is to build the models of the tires – for existing tires and future products – and to test those tires in the virtual equipment, but in parallel to test physical tires on the test track. The crucial step is to compare the actual result with the simulation, both in terms of instrumented response and in terms of test driver experience.

This is known as validating the tire model. With a validated model, tire developers can have confidence that the tires they develop in the computer and test in the simulator will behave well on a real vehicle.

This is still unusual, but everyone involved in the process can see that the accuracy of the simulations is advancing very rapidly and that the range of products where zero prototyping is possible is set to expand quickly in time-scales of months rather than years.

In a few cases, the simulation is good enough to move forward to customer acceptance and homologation without a physical prototype.

Where the simulation differs significantly from the physical response, the engineers have to find out why the differences exist. That might be the resolution of the model; or it might be a deliberate compromise to speed up the calculations, or it might come from a poor simulation of the suspension geometry or even from an unrealistic representation of the tire model, for example.

The point is that where the simulation does not represent accurately the actual vehicle/tire/road behaviour, that discrepancy might come from a wide range of different origins, and it is necessary for the different players to cooperate to identify and then remove such discrepancies.

Furthermore, as this is a developing science, there needs to be standardisation. And within that standardisation, those tire makers who have invested heavily in making more accurate models do not want to release the results of that effort to rivals who may not have invested so much time and effort.

It is something of a delicate balance, but the overwhelming message from Ferrari, Goodyear, MIRA and others at the Udine event was that this is definitely the future; any tire maker has to get involved, or they will be left behind with longer development times and higher expense in the mid-term.

Rutger Uil, lead engineer at tire simulation at Goodyear in Luxembourg, said Goodyear has already developed one (just one) tire and had it accepted by a customer without building any prototypes.

Giti starts down the simulation road

Of the presentations involving tire makers, Giti showed that it is still early in the process. In a joint presentation, Karthik Tharani Singh, A Giti motorsport engineer, presented alongside Mariano Carpanelli, senior multi-body simulation engineer from Horibo-Mira.

The project was about Giti seeking to validate certain aspects of its tire models in MIRA's DIM250 driving simulator.

Giti has an office within the MIRA proving ground, and has been using the tracks for physical testing for some time. Carpanelli said, "in the past months, our collaboration has gotten an entirely new spin as we've started helping them moving forward along the zero prototype path."

He continued, "In order to propose the simulators as a valid alternative to physical testing, we had to make sure that our customers could experience exactly the same tracks and the surfaces that they have been using on our site for a long time. So we had all our major tracks and surfaces, laser scanned, and VI-Grade made accurate digital twins for us."

The scope of the project, said Carpanelli, was to make it possible for Giti to bring its professional test drivers on the DiM 250 and replicate the same kind of subjective assessment that they would usually do in a physical car on the MIRA proving ground.

Singh said, "our ambition as Giti Tyre is to be more prominent in the European market space as a reliable partner to our OEM customers, and also be innovative and open up our capabilities in the ever-changing world of requirements to make future automotive products."

He said that the project started, "So that we can have fewer hardware loops. Probably zero is still far away, but maybe we start with fewer hardware loops, and we start doing the iterative methods in the virtual side. And of course, a big thing in using that is to also bring in the human in the loop. And that's why driving simulators come into play."

He said, "What we particularly wanted to focus on in this particular project was to understand the subjective side of things on a driving simulator. And of course, we did not want to go through the entire set of the requirements, because that would be hard. So we started with dry lateral subjective handling.

This is a very limited set of characteristics in the tire design world, but the scope of the project was to see if the engineers could simulate the performance of a tire in this one dimension, and if the test drivers could gain something useful from the different designs.

"So in terms of requirements, we had to go out and build some tires to test it on the real prototype car. As well as, of course, we needed to measure them on a Flat-Trac. As well as use our FEM techniques to measure to create models for two specifications."

Giti also had to develop the characteristics of the tire to feed into the MIRA equipment, so that the drivers would have a good comparison between physical tires and the virtual environment.

Singh concluded, "what was interesting is that the subjective comments from the drivers matched with our expectation of what such a spec change should do, as well as a trend-wise performance characteristic." He said the strange thing was that very quickly, the drivers forgot they were in a simulator. Martin Gibson, manager of Giti's test centre test engineer) said, "I left impressed what we imagined we'd achieve in, say, five years, 10 years we've actually achieved in one year. So hand in hand, that helps us with our sustainability targets. That will have a huge impact on what we do. Surprisingly, it doesn't take that long to get used to it. Once you've got somewhat acclimatised to it, it's surprising how quickly you can start to get fully immersed in it."

He said the next step we want to explore more into the higher dynamics part of it. Try to use the simulator for a bigger array of the specification sheet, which will include ride as well in the future.

Virtual tire development

Next steps

Once the models are validated, there is another step. The industry is only now working out that brake suppliers do not build detailed tire models, even though the braking performance depends on the tire as much as the brakes. Equally, tire makers do not build accurate braking models. So the aim is to bring everyone together to build a digital twin of the vehicle dynamics that incorporates engine performance; suspension dynamics, braking dynamics and tire dynamics. Building such a digital twin would enable more rapid and more comprehensive development cycles among different suppliers as well the by the vehicle maker.

Ferrari's Malagò said, "I think there is still some way to go because we are bringing a really high-level model from suppliers, but from my experience, we are still not in the phase of providing a full integrated model that brings together all these high accurate model. But I think in two years' time, I think we will have some use case that we can show up that it will work."

Collaboration across participants

In the tire industry, we have been hearing more and more about the need for collaboration between customers, suppliers and others, but the theory is often different from the publicity spin. In the tire simulation world, however, collaboration really is the name of the game.

It's also an area where there is most mobility between tire engineers and the vehicle makers. Former tire engineers go to work with vehicle makers and vice versa, so there is more cross-fertilisation of ideas among the different participants than in other parts of the tire development process.

Marco Malagò at Ferrari said his company has a clear task to deliver a special product to our customer. And to do so, he said, "we need to get our suppliers on board." He continued, "I keep saying to them is not only coming at the right time with the right product, but to embark on the same journey of sharing the same understanding and same kind of methodologies and communication protocols or methodologies to get there not only with the physical product, but with a model that can allow us to develop our product ahead of time, long before having the real prototype that you can see on the pictures and on the web."

He said it is becoming clear that the key suppliers are going in the same direction and are adopting similar sub-systems and models of suspension and tire behaviour. The implication is that those suppliers who do not follow this path will not be suppliers for much longer.

The industry appears to be standardising on FTire as the modelling package; VI-Grade as the driving simulator.

There are issues around specific Non-Disclosure Agreements, but the days of a vehicle maker and OE tire supplier each developing a different proprietary tire dynamics model appear to be over.

Mahmoud Shaker, Vehicle Dynamics Team Leader & Simulation Expert, Bosch Engineering at Bosch Engineering said, "the collaboration between automotive OEMs and suppliers is basically the state of the art. We can see it today in a lot of the projects. But I see that this will intensify in the future because we can all see that the trend is toward zero prototype or fewer prototypes."

He added, "Like Marco [Malagò] mentioned, we need to be ready to integrate our sub-models into the simulation environments, be able to speak all the languages that the OEMs are speaking, and be ready on the technical side to integrate our models into their environments and also support them in the simulation activities.

But also, as a tier one supplier, it is important that we are using it internally for our own development, for our own release and development processes in order to be faster on the market."

He noted that multiple suppliers are working on their own systems within this OE-led environment. "A very interesting point is

Goodyear develops a tire with zero prototypes

Goodyear presented a paper alongside IDIADA in which they discussed the development of a new tire for the Mahindra Inglo platform. It was done with zero prototypes – so far the only zero prototype project at Goodyear.

The Mahindra Inglo platform is a completely new electric platform, and the development project started only at the end of 2022.

Rutger Uil, Vehicle Dynamics Engineer – T&PS Product Development at Goodyear Luxembourg, said, "Mahindra approached us to develop this new electric vehicle platform. And there were some challenges: a very short time to market.

So there was a short development time. As well as the requirements for the electric vehicle that we had to develop without any physical prototype availability."

He said, "From Goodyear's side, we were basically responsible for the virtual tire development, as well as the modelling and assessment of the virtual prototypes. And the role and responsibility of IDIADA was developing the platform architecture, as well as the development validation. That was done both on the driving simulator and with their other virtual evaluation capability."

Uil said, "we have already performed two loops of prototype tuning for this platform. So we have both the virtual development, but we also have the validation results to present today."

He said The platform will be applied to five different products each with different requirements. We have from family SUVs with seven seats up to Coupé style SUVs, which have completely different kind of requirements. We have different sizes of batteries. And also, we have different power train configurations with single and dual motors. So we have a wide range of products, which also means a wide range of requirements and a wide range of different constraints.

The traditional approach to tire development is that the actual prototype vehicles are set up with the latest steering, brake, and suspension components. And then the tire supplier provides physical prototypes that can be tested subjectively on the proving grounds. In this case, said Uil, "we set up the driving simulator with the latest vehicle component configuration via real-time models. And in addition, we developed virtual tire candidates that professional test drivers could evaluate by performing a complete subjective evaluation in virtual scenarios."

He said much of this testing was carried out at IDIADA. A key benefit is that IDIADA and Goodyear both have DiM250 driving simulators by VI-Grade, so that it was very easy to exchange files to integrate updated virtual models with no difficulties or re-engineering of the code or the configuration of the simulator.

Uil said, "We wanted to evaluate limit handling stability, as well as the character. This was performed on the (virtual) dry handling circuit. We also did steering feel, cornering confidence, and lane change stability. We also did comfort. We did some, trials also for comfort assessment, so primary body motion, suspension, shake, and impact forces."

To sum up, he said, "The first conclusion is that we have seen appropriate improvement and a good progression of the performance in the virtual loops in which the vehicles has been tested. And we were able to finally find a good match between the tire performance and the vehicle performance. And the other good positive thing is that we were able to see a good agreement between the objective APIs that we have seen on the virtual vehicles and the ones that we have seen on the track, giving confidence that we were actually capable to predict properly the behaviour of the vehicle in the real world."

Uil added, "the same thing also applies to the subjective feeling of the drivers. They were able to really perceive the car as something they already recognised from the tuning on the simulator. And these provide us good confidence that this process can be applied in a very consistent way in many different projects. "

Virtual tire development

also the inter-supplier communication, because at the end of the day, we cannot really simulate the brake system alone. We need, for example, a tire. So it would be also very interesting if we kind of break the bureaucracy in getting the models working together and be faster and more maybe a little bit standardised in the exchange of the models."

Goodyear's Rutger Uil said, "it is important that we can work with accurate and detailed models, that is to say both vehicle models, but also sub-component models to be able to develop our products really with the latest and best specification." He added, "if we want to do more virtual prototyping, this collaboration aspect with the OEM, but also with subcomponent suppliers, will become more important."

As a consultant offering the use of a driving simulator on a contract business, Michael Naylor, Simulation Team Leader, Horiba MIRA said, "we're working with lots of different OEMs and different supplies, we're seeing the different approaches that are being used, but I think it still comes back to having that common language so that when we work between those different areas, we're getting the most from it."

He said the whole point of the virtual development cycle is speed. So if different partners need to spend time translating one model to make it work with another, then all the benefits of speed are lost. He said part of MIRA's role is to speak with different clients and steer them towards a consistent model and development environment that will help everyone to speed up their development cycles.

The panel moderator then asked about specific benefits of collaboration. Marco Malagò said that the Vi-Grade meeting brought together people from different countries with different languages and cultures, but everyone is speaking English. It is the same, he said, in the world of simulations. "Everyone needs to speak the same language if the collaborations are to move forward quickly. He said, "The need of squeezing the development time now is crucial."

He continued, "it's just that the complexity of our vehicles is continuously increasing, and development time is continuously decreasing." One of the best ways, he added, to increase the speed of development, "is to lose all the logistics time or time lost in preparing prototypes, transforming prototypes, building the prototypes. And at least in the very first iterations, focus on the simulation. So just send a file via email, and then you have the newest update. And that's basically how we should be working or partially working today."

He concluded, "the last 5% of the performance can still be done on the vehicle, but everything else can be done in the simulation and accurately in the simulation. And that if we really reach this equation, we have had a very big step ahead in our process."

Rutger Uil from Goodyear answered the same question thus: "everyone is talking about reducing development time. So that is definitely a clear benefit. For a tire manufacturer, the virtual models help us to understand the whole system. That helps us to develop our products really to the full car and control system early on, I think it's really a benefit of the virtual approach." He added that working with many different car makers means that Goodyear has to be flexible. He added, "what we clearly see at these events is that everyone is heading in that direction."

Naylor from Mira said, "I think it's bringing everyone together, but it's also sharing the skills that we have. There's no point having a team of people at an OEM and a supplier and a consultancy all performing the same role. I think actually it's about being able to share that knowledge and get the most out of it."

He said that one of the barriers for smaller tire makers is the cost of buying a driving simulator. However, there are consultancies – like MIRA – that offer the equipment on a rental basis and this offers a relatively low-cost and low-risk route into the world of simulation. MIRA's Michael Naylor said, "we've got the simulator, we've got the tools, people can come and use it, and then we've got that experience of using it regularly. We're getting a lot of the new start-ups and new suppliers as the vehicles get more and more complex."

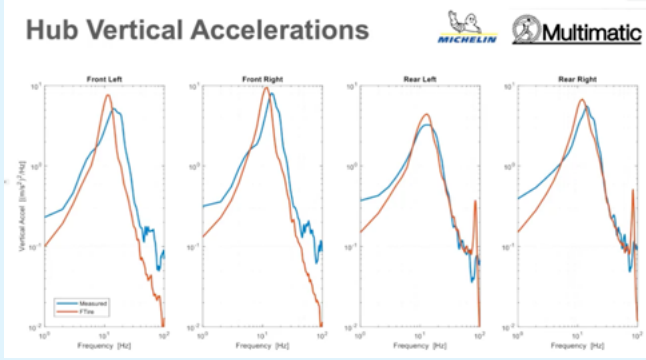
Michelin adapts Sport Cup 2R for Ford GTD

In a presentation by Multimatic, Tony Yardley described a project carried out with Michelin in which the team sought to match the Ford Mustang GTD super-car to the Michelin Pilot Sport Cup 2R and validate an FTire model against real-world performance. That enabled Michelin to customise the tire to the Mustang.

Like IDIADA and Goodyear, both Multimatic and Michelin run DiM250 driving simulators, and that made it easy to change the models and update to the latest version of the dynamic model.

One of the limitations of the system was that the FTire model used only 60 segments around the belt. This did not allow for fine resolution of the dynamic response. Yardley said, "And ideally, we'd like to run more. As the computing improves, we would run more and get higher fidelity, [At present,] we are actually trading off a little bit of NVH performance."

Much of the presentation focused on comparing the simulated predictions against real-world test results – validating the model.



Yardley said, "Shown here (lower left) is kind of the structural performance of the loaded and unloaded radius versus how it varies versus speed."

This is, he said a very good fit.

Then testing the tire on a Flat-Trac using a belt with a cleat. Again, the simulation was accurate up to around 150Hz, but after that, the simulation diverged from the real test.

Yardley then showed the contact patch as the tire went through extreme manoeuvres.

Yardley said, "The basic picture here was that at low speed, the match is really very good. And then as the speed increases, the difficulty of matching that contact patch increases considerably because the time that the contact patch is actually touching the ground is very short. And that relates back to our 60 segments in the belt." If we could have more segments, said Yardley, "we would be able to reproduce it to a higher speed." Multimatic engineer, Michael Caradonna then showed the results of its simulation in the DiM250, using a high performance car on a poorly-maintained Michigan residential road.

He said, "And that would more accurately reproduce the shake that we were experiencing in real life. This [road geometry data] is all generated from a point cloud scan, and the location of the road, and also some close-ups of the sections that create a lot of the shake. Kind of the buckling of the concrete slabs create a lot of these really aggressive shake motions.

Caradonna said that it was necessary to use a single core (of the computer) dedicated to each tire. "The biggest addition to running it real time was to have one core dedicated per tire. Nothing else on that core."

Overall, Multimatic said the correlations were good, but they needed some improvement, and with better models, some of these issues would go away.