CDTire – Reinventing the Tire with Simulation

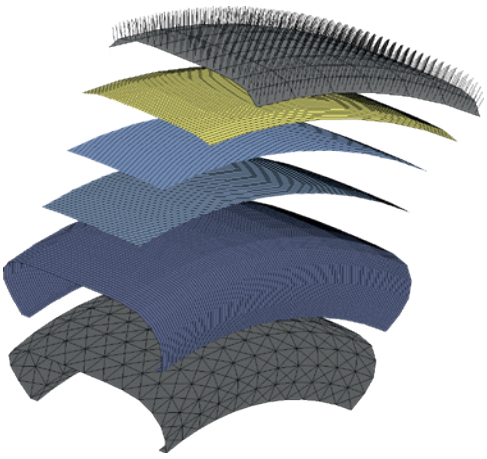
The tire modeling software has long been an integral part of the product range in the field of "Mathematics for Vehicle Engineering". In an interview with Dr Manfred Bäcker, head of the "Tire Modeling" group, we wanted to find out the unique selling points of CDTire:

CDTire is a tool for the simulation and development of tires. What does it do and who works with it?

Historically, tire simulation models such as CDTire were first used by the automotive industry. They were needed to enable full vehicle simulations on digital (measured) test tracks in the virtual vehicle development process in order to obtain statements about comfort, operational stability and driving dynamic properties of a development status early in the development process and to further improve it. The tire industry, on the other hand, uses detailed tire models, which, however, are not applicable due to their very high computational simulation cost. Moreover, they are not readily made available to third parties, i. e. not even to customers in the vehicle industry, because they also contain design details which are regarded as proprietary know-how. That is why the automotive industry has always has always been dependent on tire models developed outside the tire industry. Because of the demand for low computational cost, these very much simplified models were inferior to the finite element (FE) models of the tire industry.

And this is where CDTire comes into action?

Exactly! With the CDTire model generation, developed between 2010 and 2012, we have provided simulation models of tires for the first time that are accepted and used as development tools in both the automotive and tire industries. The key to this success is a model framework which simulates tire geometry and structure with similar accuracy as the tire industry's FE models – but at hundred times the computational speed.



CDTire/3D: Functional layer concept

What does CDTire do in the virtual pre-development of tires? What do the individual process steps look like?

Since CDTire/3D is suitable for all applications from driving dynamics to comfort to "Noise Vibration Harshness", the software suite allows evaluations for these development criteria at a very early stage. In addition, since 2018, we have established a new method for the subjective evaluation of tires on driving simulators in cooperation with the tire manufacturer Goodyear via corresponding pilot projects with vehicle manufacturers such as Maserati. For this, we use the real-time capable CDTire/

Realtime, which is derived from CDTire/3D. This innovation is so important because the subjective evaluation of a tire by professional test drivers is still the pinnacle of the development process: Only their OK releases the tire. However, this usually requires many iterations and a corresponding tire prototype must be produced in each iteration. Vehicle prototypes must also be available, of course. The goal is to complete 90 percent of this time-consuming and cost-intensive process on the driving simulator using virtual tire and vehicle prototypes, so that ideally only the final acceptance has to take place on the real test track. This can save immense costs and development time.

What were the biggest challenges in software development in recent years?

We have consistently designed the new generation of CDTire as a "multi-physics tool". Thus, the actual structural mechanical tire model has been extended in recent years by a thermodynamic model (CDTire/Thermal) for the simulation of temperature propagation within the tire and also by a model for the air flow within the tire – the so-called cavity model. These different physical sub-models require a high degree of modularity in software development and also pose a challenge to the numerics of the overall model, because the structural model, temperature model and internal air model naturally interact with each other. The overall model thus becomes a so-called "multi-scale model". The computational step sizes of the sub-models are on different scales and must be coordinated against each other to achieve good overall performance. The modularity and extensibility in the sense of a multi-physics tool with simultaneous high computing speed is the greatest challenge.

CDTire contains a whole family of tire models that are used by both tire and vehicle manufacturers. What new properties will be considered in CDTire in the future?

We achieved the greatest development progress and at the same time the greatest success in attracting new customers by adding the dynamic inner air model. The new application allows a good prediction quality for full vehicle simulations in a frequency range up to 300 Hz. Pilot users were Audi and Maserati, which we were able to win as customers. In the near future, the prediction quality is to be further increased by linking the tire model to a flexible rim model. Furthermore, CDTire is to be extended for the "Air-Borne Noise" application. Here, we simulate the transfer of structural vibrations of the tire surface into the outside air and their feedback via the body into the vehicle interior.

More information at www.itwm.fraunhofer.de/cdtire_en

Contact

Dr. Manfred Bäcker
Team leader "Tire Modeling"
Phone +49 631 31600-4249
manfred.baecker@itwm.fraunhofer.de