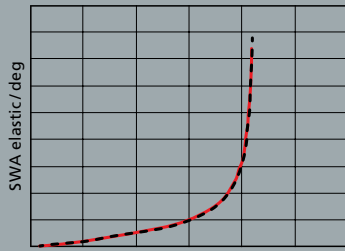
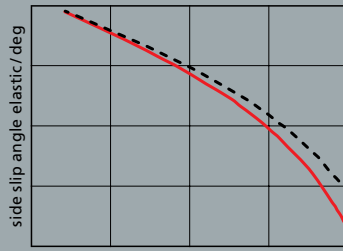


Simulation results

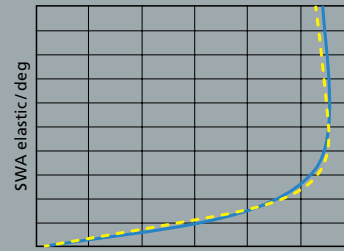


steering wheel angle vs. lat. acc.

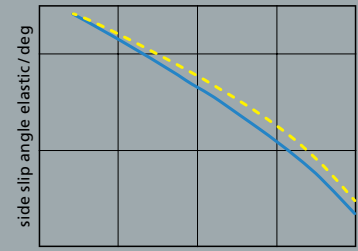


sideslip angel vs. lat. acc.

Experimental results



steering wheel angle vs. lat. acc.



sideslip angel vs. lat. acc.

1

CDTIRE/3D: MODELLING TIRE VARIATIONS

1 *Qualitative comparison of tire size variation: 235/60 R 18 both axles (red/blue straight lines) vs. 235/55 R 19 front and 255/50 R 19 rear axle (black/yellow dotted lines).*

Simulation tools can shorten the time it takes for a product to reach series production with no loss in quality. Above all, they speed up the concept phase. Our department works together with various car manufacturers to improve the accuracy of simulation results in the early stages of development. Currently, a very promising new technology known as “morphing” is providing automotive manufacturers with access to data on many possible tire and wheel sizes in the earliest stages of planning – including, especially, some that do not yet physically exist.

The handling and performance of a passenger car is very dependent on the selection of tires. A new method uses the CDTire/3D model to predict the characteristics of a tire without having a physical prototype. Among the questions that arise in the early stages of development are the choice of tire and rim size, the optimal tire pressure, how much does changing tire specifications help in achieving the stated goals and how important is the vehicle itself.

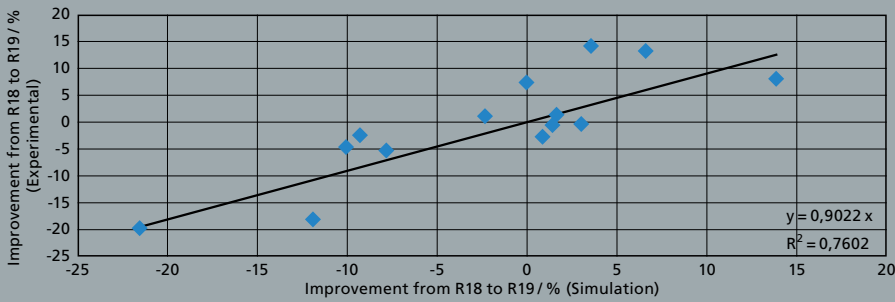
Geometric description of the tire

Fraunhofer ITWM develops the tire model CDTire/3D, which is used by the automotive industry in comfort, durability, and vehicle dynamics studies. A shell based discretization method combines the functional layers of a tire (like the cap plies, steel belts, and carcasses – each having defined material parameters), with their respective geometries. Modeling the elastic component for each fiber reinforced layer includes a nonlinear part that results from different tensile and compressive behaviors. The geometric description permits large deformations.

Separating material and geometric characteristics

The design assistant uses pressurized cross sectional geometry to parameterize the tire based on the construction properties of the functional layers. In effect, because the model strictly separates material and geometric properties, our method is able to modify an existing tire based on nominal specifications.

Our morphing algorithm adapts the geometric description and weight distribution of the reference tire to the specifications (tire width, tire cross section, rim diameter and width), without changing the material properties. For example, a 225/45 R17 (x7.5) tire size can be transformed into a 235/40 R18 (x8).



2

Internal pressure variation

The importance of tire inflation pressure as a factor influencing tire performance characteristics must also be mentioned. The compressed air acts as a force on the innerliner of the tire and puts a strain on the structure, in particular, the load bearing elements of the spiral layers (steel belts, carcass and cap plies). The CDTire/3D tire model can apply gas pressure to the entire inside of the tire (using various gas models such as the ideal gas equation or the compressible Euler equation), to accurately describe and predict how is effected not only by size changes to an existing tire and rim, but also by variations in the internal pressure.

This method is used in the early stages of tire development – from a base tire – to study different tire and rim sizes. The prerequisite for this approach is that the materials, construction, and profile all remain the same.

Comparison of simulation and result

Our evaluation compared the predictions about varying tire size with the experimental results for the typical criteria of driving dynamics. The results showed only small differences between measured and predicted vehicle behavior (see Figure 1). The method is also useful in cases where not many measurements are available. Figure 2 shows the measured and simulated percentage improvement for each criteria used by a luxury vehicle manufacturer to assess vehicle handling. As is clearly shown, the predictions always reflect the same tendencies.

Morphing engineering in tire development has proven successful and its continued use in the future is assured. Planning for future projects includes a study of minor changes to the materials and construction.

2 Comparison between simulated and measured improvement of key performance indicators when switching from 18" to 19" wheels

