Automated Correlation of **Door Sag Simulation** Using **MSC Marc**

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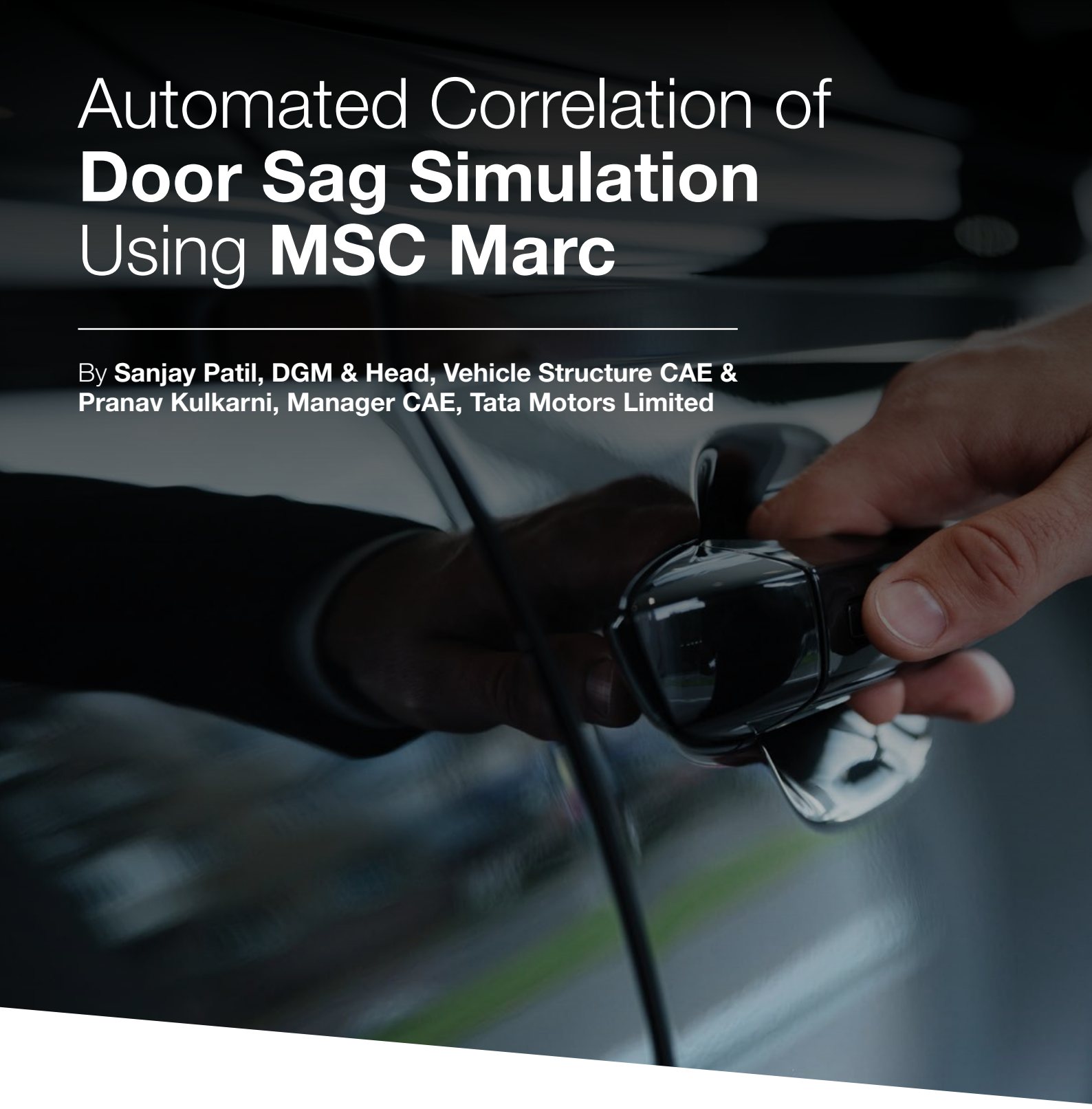

Tata Motors Limited is headquartered in Mumbai, India and is a multinational automotive manufacturing company as well as a member of the Tata Group. Its products include passenger cars, trucks, vans, coaches, buses, sports cars, construction equipment and military vehicles.

Tata Motors was established in 1945 and has since grown to be a $42 billion a year company with over 60,000 employees worldwide delivering over 9,000,000 vehicles per annum. Tata Motors has auto manufacturing and assembly plants in six locations across India, as well as in Argentina, South Africa, Great Britain and Thailand. It has R&D centres in India, South Korea, the UK and Spain. Tata Motors includes the English premium car maker, Jaguar Land Rover (JLR), and the South Korean commercial vehicle manufacturer, Tata Daewoo.

Figure 1: Examples of door sag in automobiles

In any form of car manufacturing, 'door sag' (see Figure 1) is the term given to the permanent deformation of door assemblies due to the manufacturing process not functioning correctly. Door misalignment is an age-old problem that has evolved with time. The automotive industry, for a long time, has witnessed the negative impact of this problem on customers. Hence, with increasing customer expectations the automotive industry has become proactive in addressing this challenge.

Door sag challenge leads to two deleterious effects: increased door closing effort, and ineffective door sealing that leads to water seepage and extra cabin noise. In order to check for permanent deformation in car doors, non-linearities need to be considered during FEA simulation and this requires the use of non-linear solvers for design simulation such as MSC Marc. Door sag is both a complex and scalable problem and it needs to be checked for all the underlying causes: geometric non-linearity, material non-linearity and contact non-linearity.

At Tata Motors, we have developed a tried and proven computer-aided engineering simulation process for predicting door sag that is shown in Figure 2. However,

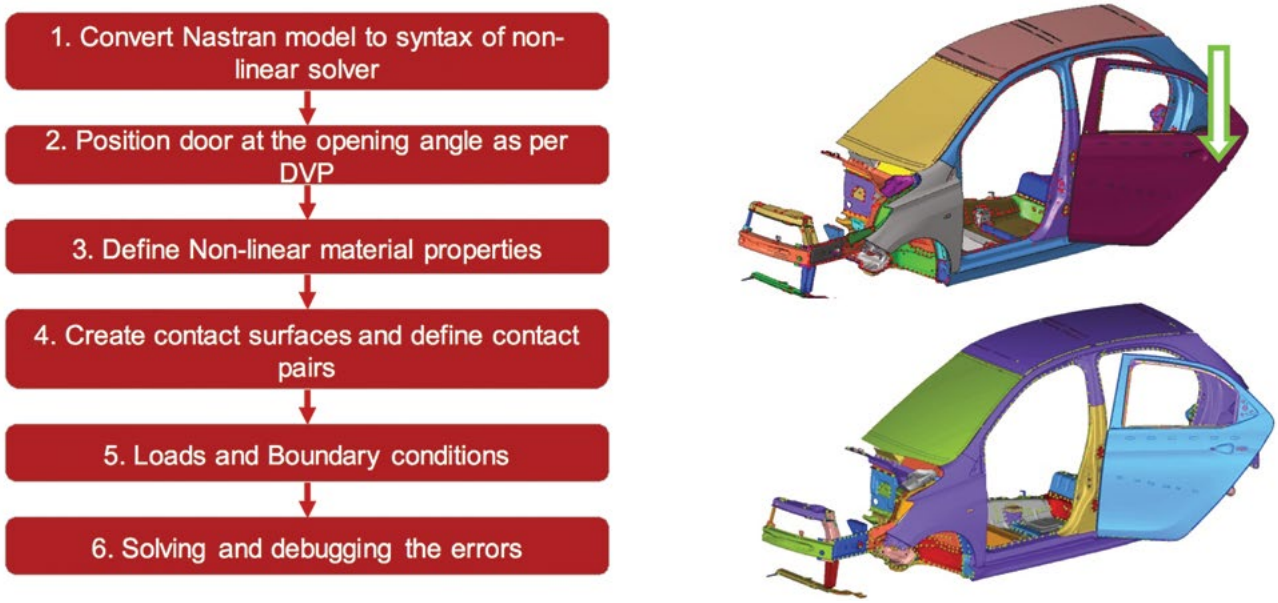

Figure 2: Door sag simulation process in Tata Motors

with the existing solver the door sag simulation was taking 1 working day per simulation cycle which was causing delays in our workflows. We decided to use MSC Marc with its preprocessor, Mentat, but we also wanted to automate the model building activities to speed up the design process. Hence, we used our existing Nastran Linear analysis deck to set up the door sag model so there was no need to use any other pre-processor than the existing one, Hypermesh. We defined the loads and boundary conditions in Hypermesh and all the boundary conditions in one collector. The point load for Door Sag should have ID 104 and for applying gravity only on the door we created a dummy force with all the nodes of the door with ID 105. We then specified the Property ID for defining the contacts in a variable input file (see Figure 3) and finally we specified the non -linear material ID and Table ID to create non-linear materials.

The Marc template automation approach we devised allowed us to create contact bodies, a contact table, non-linear materials and Load cases with all the required parameters; Gravity, Loading and Unloading. We could therefore create a non-linear Job with all necessary parameters to make the job solvable without debugging and convergence errors. This meant that we were able to do the simulation four times faster (see Table 4 and Figure 4) and at least double our existing simulation productivity. The predicted results with Marc were also within 1-5% difference to our existing approach which was acceptable.

This automated correlation of door sag using MSC Marc therefore enables us not to have to learn a new tool, take less solution time and effectively have less cost per simulation because Marc is available within our Masterkey tokens. The automated design

	Existing Solver	Marc	% Difference
Model Set Up Time	10 Hrs	2 Hr	80
Solution Time	5 Hrs	2.5 Hrs	50
Elastic Displacement	9.50 mm	9.6 mm	1
Permanent Set	0.04 mm	0.038 mm	5

Table 1: Door sag simulation times and numerical predictions with our existing solver versus MSC Marc

Figure 3: HM table for Door Sag and resultant template

verification plan (DVP) execution ensures robustness of our process and the quality of our results. Because this takes less solution time overall, many more iterations can be run for optimization of door sag performance in the same amount of time as before.

Partners in Success

With MSC team, our equation is more akin to 'work-in-progress' because they are proactive in working with us in sorting out issues and not just when there is a problem or a challenge, as such.

In A Nutshell

Door Sag simulation results with MSC Marc were similar to our existing proven solver approach.

However, with reduced solution time in Marc, program development cycle timelines were met by leveraging our Masterkey license tokens. The automation of our preprocessing activities eliminated the need for learning of Mentat in this case and reduced the burden of defining contact pairs.

In future for Multi-Disciplinary Optimization of Closure assemblies, the use of Marc will be explored and a similar approach will be extended to simulation of other projects including oil canning, denting, control pedal mounting strength, rubber and suspension simulations among others using Marc. In so doing our FEA Analysts can focus better on result interpretation and design recommendations instead of spending time on preprocessing activities.

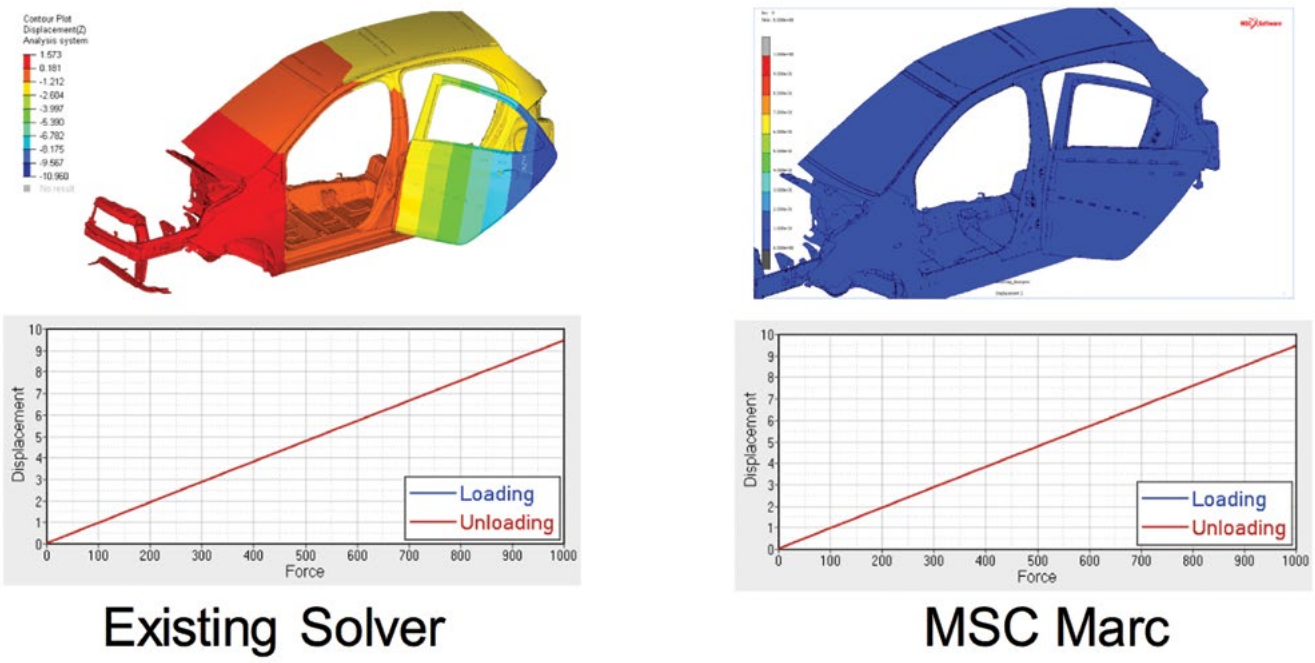

Figure 4: Door sag predictions for the existing solver and MSC Marc for loading and unloading