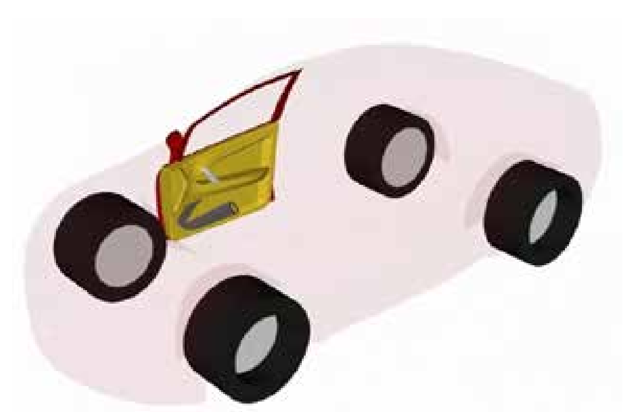
# Case Study: Standard Profil and Bias Engineering

## Co-Simulation Helps Win Order to Supply Seals for a New Model Vehicle

### Overview

The amount of effort required to close the doors of an automobile is critical to the consumer's perception of its quality. If too high a closing velocity is required, the customer may have a negative impression of the car and the potential also exists for an unpleasant noise to be created by closing the door. The goal for most automobile manufacturers is to require a relatively low effort to close the door while at the same time meeting weather sealing and acoustic insulation requirements.

The seal has a major effect on the velocity required to close an automotive side door. The initial seal Profil must also deform as it engages the body panel to avoid defects such as wrinkles and deformation. Building seal prototypes is expensive and time-consuming so Standard Profil has for several years used MSC Software's Marc nonlinear finite element analysis software to simulate the behavior of seals during door closing. The seal is modeled using hyperelastic material properties. The simulation predicts the quasi-static forces involved in closing the door per unit length of seal that contribute to the door closing force. The simulation also predicts the ability of the seal to appropriately fill the gap between the car door and the adjoining body panels.



**Adams-Marc co-simulation helps predicting door closing effort**

**“Throughout the co-simulation, the dynamic behavior of the door is calculated by MSC Adams and resistance of the seal is calculated by MSC Marc. The accurate results of the co-simulation were provided to our customer and helped win the order to supply seals for a new model vehicle.”**

Dr. Tuncay Yuksel, Design Director, Standard Profil

## Challenge

A Standard Profil customer asked if it would be possible to simulate the complete door closing process and predict the initial velocity required to close the door. The door closing is a result of the complex interaction between different components of the door design, such as the latch, weather seal, energy loss due to air-binding effect, the inclination of the hinge axis, check-link, etc. The air-binding effect refers to the fact that as the door is closed it pushes air inside the vehicle. If the windows and other doors are shut, this increases the pressure inside the vehicle which in turn offers resistance to further closing of the door. The check-link is a device that holds the door open at several positions for the purpose of preventing the door from closing on an occupant while the vehicle is on a grade. The check-link has several grooves that generate resisting torque to the door closing and so must be considered in simulating the door closing event.

## Solution

Standard Profil contracted with Bias Engineering to perform the door closing simulation. The large displacements involved in the door closing process require multibody dynamics simulation. “We selected MSC Software’s Adams multibody dynamics software because of its robust solver and the parametric capabilities of its graphical user interface,” said Hunkar Yurt, Simulation Engineer for Bias Engineering. “In addition, Adams allows the user to create user-defined subroutines for calculating applied forces to the system. This capability is very useful when calculating the resistance due to the air-binding effect.”

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The latch was modeled as a force element at the latch location that changes with the displacement of the striker, the part of the door that contacts the latch, with respect to the latch. The hinge friction was modeled by applying a 3.7 Nm static torque on the door about the hinge axis in the opposite direction of the movement. The air-binding effect was modeled modelled analytically using a 1D approach based on a treatment found in published literature. The resulting torque was calculated by a user-defined subroutine and applied as a torque element on the hinge axis. Engineers used Adams design evaluation tools to set up a designed experiment that determined that the minimum velocity needed to close the door was 820 mm per second.

Bias engineers then went one step further and used the recently introduced Adams-Marc co-simulation capabilities to increase simulation accuracy by calculating the seal forces and deflection in real-time as opposed to relying on the approximation provided by the CLD. This is believed to be the first co-simulation has ever been used to simulate automotive door closing. Adams runs a dynamic analysis and then feeds its results to Marc. Marc interpolates the Adams results to catch up and passes the results to Adams which extrapolates them in taking the next step. Finally, Bias engineers created an Excel interface that enables users who are not familiar with Adams or

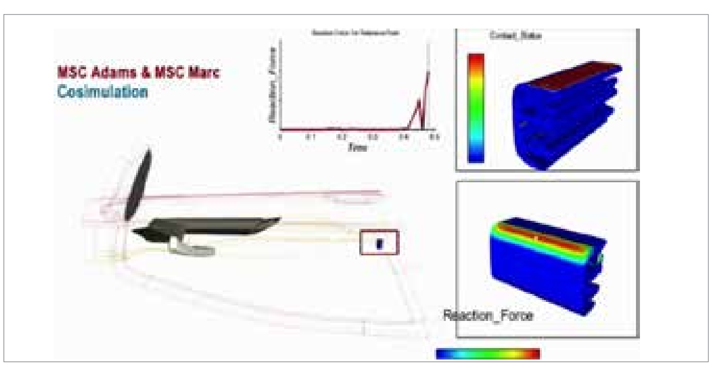
### Key Highlights:

**Product:** Adams

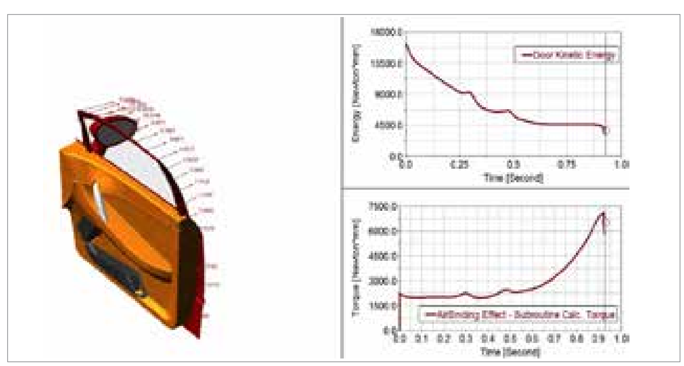
**Industry:** Automotive/ Automotive Supplier

**Benefits:**

- Adams-Marc cosimulation helps the engineers accurately evaluate the amount of effort required to close the doors, which is critical to the consumer’s perception of its quality
- Co-simulation helps MSC customer to win order to supply seals for a new model vehicle
- Users can now simulate new seal designs in much less time and at a lower cost than physical prototyping.




Marc model of seal



Adams Model of door

Marc to easily perform dynamic analysis by inputting certain parameters. "Throughout the co-simulation, the dynamic behavior of the door is calculated by MSC Adams and resistance of the seal is calculated by MSC Marc," Yurt said. "With this approach, we believe that, entire seal can be modelled in more detail for closing effort calculation."

## Results/Benefits

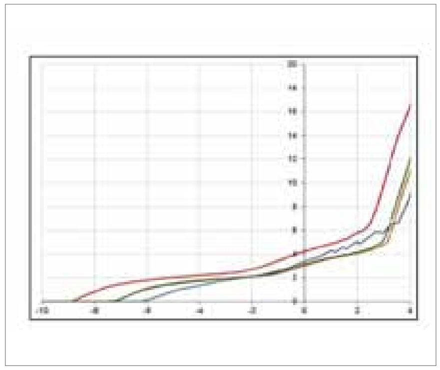
"The results of the cosimulation were provided to our customer and helped win the order to supply seals for a new model vehicle," said Dr. H. Tuncay Yüksel, Design Director for Standard Profil. "Now that the simulation process has been developed it will be possible to simulate new seal designs in much less time and at a lower cost than physical prototyping. This will make it possible to evaluate more design alternatives to improve door closing performance as well as reduce the time and cost of the product development process."

## About Standard Profil

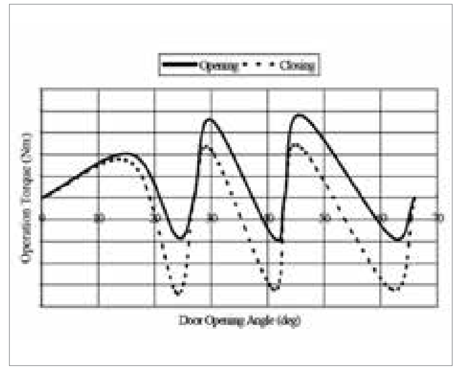
Standard Profil is Europe's second largest automotive sealing supplier. The company produces hood seals, windshield seals, glass run channels, trunk seals, body mounted seals/door mounted seals, waist belts, convertible header shields, and rocker panel seals. Standard Profil was founded in 1978 and is headquartered in Istanbul, Turkey. The company has manufacturing centers in Düzce, Manisa, Bulgaria, Mexico, South Africa, China, Spain and Morocco. It also has JV in India, and the Russian Federation. In addition it is represented by R&D centers in Germany, France, Italy and USA.

## About Bias Engineering

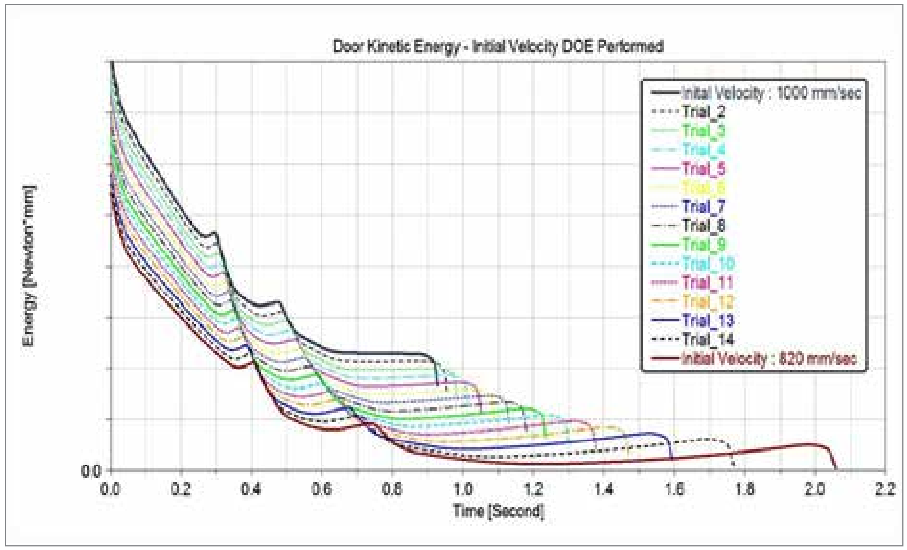
Bias Engineering provides engineering services in Turkey including computer aided engineering solutions and test and measurement systems and sensors. Bias engineering also designs and builds custom machines mainly for the defense and manufacturing industries.



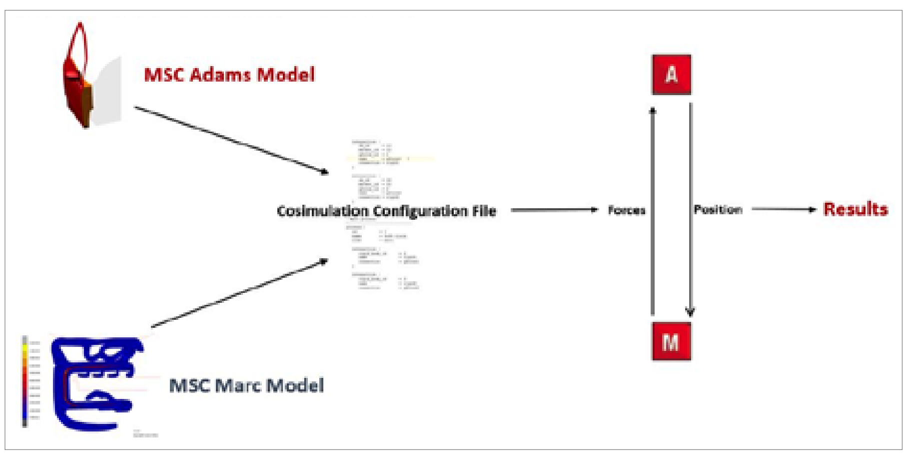
Compression load diagram of seal generated by Marc




Torque generated by check-link




Designed experiment determines minimum closing velocity




Adams-Marc co-simulation increases simulation accuracy

For more information on Adams and for additional Case Studies, please visit **www.mscsoftware.com/adams**

**Corporate**
MSC Software Corporation
2 MacArthur Place
Santa Ana, California 92707
Telephone 714.540.8900
**www.mscsoftware.com**

**Europe, Middle East, Africa**
MSC Software GmbH
Am Moosfeld 13
81829 Munich, Germany
Telephone 49.89.21093224
Ext.4950

**Asia-Pacific**
MSC Software Japan LTD.
Shinjuku First West 8F
23-7 Nishi Shinjuku
1-Chome, Shinjuku-Ku
Tokyo, Japan 160-0023
Telephone 81.3.6911.1200

**Asia-Pacific**
MSC Software (S) Pte. Ltd.
100 Beach Road
#16-05 Shaw Tower
Singapore 189702
Telephone 65.6272.0082