



# Renault uses ESI's PAM-COMFORT to virtually design a new car seat

## THE CHALLENGE

- Validate a new production seat model with simulation
- Evaluate all comfort issues related to an automotive seat (manufacturing, occupant seating, occupied seat vibration transmissibility)

## THE STORY

*“The models and methodology developed with PAM-COMFORT enable the computation of predictive results, using only physical parameters and without any tuning of filtering. This good correlation between simulation and test results confirms the ability to assess the riding seat comfort in a full virtual process.”*

Jérôme Makala,  
Head of Comfort and Safety Research  
Department, Renault Group.

## THE BENEFITS

- Provide predictive and highly accurate results using Finite Elements
- Build a fully virtual preliminary design of a new seat and validate it with simulation
- Save on development costs and time
- Meet production targets

Automotive OEMs increasingly take into account seat comfort, as it's become an important criterion in the customer's purchase decision. Seat comfort is of first importance in the daily use of a car, no longer limited to driving on bumpy roads or over long distances.

Renault uses PAM-COMFORT, ESI's solution for Virtual Seat Prototyping, in a new approach for numerical evaluations of the automotive seat comfort. Virtual Seat Prototyping consists of several chained steps ranging from seat manufacturing to static occupant seating and occupied seat NVH (Noise, Vibration and Harshness), where the stresses resulting from each step are communicated to the next one. Chaining is a necessary requirement to accurately predict the behavior of the seats under numerous loading conditions (trimming, dummy loading, various human anthropometries, and vibrations) and for various design changes (materials and shape).

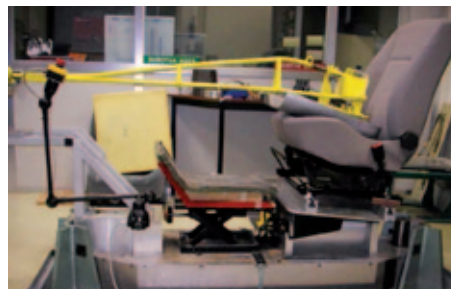
The aim for Renault was to provide predictive results, including realistic mechanical seat modeling and a successful description of the materials' complex dynamic behavior. To do so, Renault's engineers built a detailed Finite Element (FE) model of one of their existing car seats using PAM-COMFORT and simulated its complex mechanical behavior, with non-linear materials, large deflections of the foam blocks and springs. This allowed them to assess the dynamic seat comfort in a full virtual process.

## DYNAMIC COMFORT TESTING

As part of the process of designing a new car seat, Renault runs a dynamic experimental test of seat transmissibility with a static weight. Helping to evaluate the seat frequency response, this test informs them of how the seat contributes to the vertical acceleration filtering of the car. It is used to improve and validate the seat design.

In order to characterize the dynamic seat comfort, the test can also be performed with human subjects and with dedicated dummies.

Renault's goal here was to replace some of these physical seat transmissibility tests with numerical simulation.



Experimental set-up and Finite Element model with PAM-COMFORT.

## SEAT AND VIBRATION MODELING

Renault simulated the experiment named the “Lead Buttock” mannequin test, which consists of a dynamic test of seat transmissibility with a static weight, in order to obtain the seat frequency response, meaning the amplification ratio between the seat sliding rail acceleration and the vertical acceleration of the dummy.

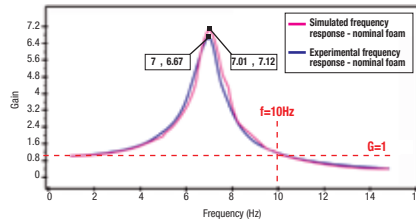
The Lead Buttock test was simulated using PAM-COMFORT. First of all, the seat was modeled and assembled, in a detailed and realistic way: seat component materials were characterized and added to the model in order to inform their non-linear behavior. Springs were fastened on the seat metallic frame, and supported the polyurethane cushion foam. The seat was then trimmed with the cover, the fabric part of the seat, and the resulting equilibrium was computed.

The computation of vibration transmissibility was then divided in two phases. First, a static phase where the dummy was seated and where the equilibrium was computed to precisely know the stress and strain states of the various parts of the seat. This enabled improved accuracy for the second, dynamic phase where a vertical acceleration signal was applied to the seat rail to obtain the seat dynamic transmissibility at the interface with the dummy.

## SEAT DYNAMIC TRANSMISSIBILITY

The seat dynamic transmissibility test was done using a middle class production seat, with two variants characterized by different foam stiffness, taking into account the manufacturing dispersion: one nominal configuration and one softer foam.

Computed results had a very good level of correlation with physical testing. Indeed, the computation time was about twenty hours with a four processors cluster (DMP4), and a frequency range of 1-15Hz.



Seat frequency response function with static weight - nominal foam

**Renault successfully completed its first fully virtual preliminary design of a new seat using PAM-COMFORT. In addition, as they were very satisfied with the results obtained with PAM-COMFORT, Renault began to transfer this methodology to their seat providers and to Nissan.**

To find out more about ESI's Seat Prototyping Solution, visit: [www.esi-group.com/pam-comfort](http://www.esi-group.com/pam-comfort)

*"This simulation input can truly be considered as an **ultra realistic model**, since it allows the simulation of the whole complex mechanical phenomena of the seat, the non-linearity of the materials, the large displacements of the cushion foam and springs, as well as the effect of the cover trimming."*

*"Using PAM-COMFORT, within a short period of time, and with few resources, we were able to deliver a new seat design meeting our objectives"*

Jérôme Makala, Head of Comfort and Safety Research Department at Renault Group

## ABOUT RENAULT

Renault S.A. (Euronext: RNO) is a French automaker producing cars, vans, buses, tractors, and trucks. The strategic alliance with the Japanese automaker Nissan in 1999, makes currently Renault the world's fourth largest automaker. Established in 1898 by the Renault brothers, the company is well-known for numerous revolutionary designs, security technologies and motor racing. Headquartered in Boulogne-Billancourt, France, Renault also owns the Romanian automaker Automobile Dacia and the Korean automaker Renault Samsung Motors. Renault vehicles are distributed worldwide, especially in Europe, Middle-East and Africa, South-America and Asia. For further information, visit [www.renault.com](http://www.renault.com)

## ABOUT ESI GROUP

ESI is a world-leading supplier and pioneer of digital simulation software for prototyping and manufacturing processes that take into account the physics of materials. ESI has developed an extensive suite of coherent, industry-oriented applications to realistically simulate a product's behavior during testing, to fine-tune manufacturing processes in accordance with desired product performance, and to evaluate the environment's impact on product performance. ESI's products represent a unique collaborative and open environment for Simulation-Based Design, enabling virtual prototypes to be improved in a continuous and collaborative manner while eliminating the need for physical prototypes during product development. The company employs over 750 high-level specialists worldwide covering more than 30 countries. ESI Group is listed in compartment C of NYSE Euronext Paris. For further information, visit [www.esi-group.com](http://www.esi-group.com).



[info@esigroup.com](mailto:info@esigroup.com)

**BENELUX & SCANDINAVIA**  
**ESI Group Netherlands**  
Radex Innovation Centre  
room 4.57  
Rotterdamseweg 183 C  
2629 HD Delft  
The Netherlands  
T. +31 (0)15 268 2501  
F. +31 (0)15 268 2514

**CZECH REPUBLIC & EASTERN EUROPE**  
**MECAS ESI**  
Brojova 2113/16  
326 00 Pilsen  
Czech Republic  
T. +420 377 432 931  
F. +420 377 432 930

**FRANCE**  
**ESI France**  
Parc d'Affaires Silic  
99, rue des Solets - BP  
80112  
94513 Rungis cedex  
France  
T. +33 (0)1 49 78 28 00  
F. +33 (0)1 46 87 72 02

**GERMANY**  
**ESI GmbH**  
Mergenthalerallee 15-21  
D-65760 Eschborn  
Germany  
T. +49 (0)6196 9583 0  
F. +49 (0)6196 9583 111

**ITALY**  
**ESI Italia**  
Via San Donato 191  
40127 Bologna  
Italy  
T. +39 0516335577  
F. +39 0516335578  
F. +39 0516335601

**SPAIN**  
**ESI Group Hispania**  
Parque Empresarial Arroyo de la Vega  
C/ Francisca Delgado,  
11 - planta 2ª  
28108 Alcobendas (Madrid)  
Spain  
T. +34 91 484 02 56  
F. +34 91 484 02 55

**SWITZERLAND**  
**Calcom ESI**  
Parc Scientifique  
EPFL / PSE-A  
1015 Lausanne-EPFL  
Switzerland  
T. +41 21 693 2918  
F. +41 21 693 4740

**UNITED KINGDOM**  
**ESI UK**  
1 Robert Robinson Av.  
The Magdalen Centre  
Oxford Science Park  
Oxford OX 4 4GA  
United Kingdom  
T. +44 (0) 1865 784 830  
F. +44 (0) 1865 784 826

**ESI Group**  
**Headquarters**  
100-102 Avenue de Suffren  
75015 Paris  
**FRANCE**  
T. +33 (0)1 53 65 14 14  
F. +33 (0)1 53 65 14 12

### AMERICAS

**USA**  
**ESI North America**  
32605 W 12 Mile Road  
Suite 350  
Farmington Hills, MI  
48334-3379  
USA  
T. +1 (248) 381-8040  
F. +1 (248) 381-8998

**USA**  
**ESI North America**  
6767 Old Madison Pike  
Suite 600  
Huntsville, AL 35806  
USA  
T. +1 (256) 713-4700  
F. +1 (256) 713-4799

**SOUTH AMERICA**  
**ESI South America**  
Av. Pedrosa de Morais,  
1619 cj.312  
São Paulo  
SP CEP 05419-001  
Brazil  
T./F. +55 (011) 3031-6221

### ASIA

**CHINA**  
**ESI China**  
Room 16A,  
Base F Fu Hua Mansion  
No. 8 Chaoyangmen  
North Avenue  
Beijing 100027  
China  
T. +86 (10) 6554 4907  
F. +86 (10) 6554 4911

**INDIA**  
**ESI India**  
Indrakrupa #17, 100 feet  
ring road  
3rd phase, 6th block,  
Banashankari 3rd stage  
Bangalore 560 085  
India  
T. +91 98809 26926  
F. +91 80401 74705

**JAPAN**  
**Nihon ESI**  
5F and 16F Shinjuku Green  
Tower Bldg. 6-14-1,  
Nishi-Shinjuku  
Shinjuku-ku, Tokyo 160-0023  
Japan  
T. +81 3 6381 8490 / 8494  
F. +81 3 6381 8488 / 8489

**KOREA**  
**Hankook ESI**  
157-033, 5F MISUNG  
bldg., 660-6,  
Deungchon-3Dong,  
Gangseo-ku,  
Seoul  
South Korea  
T. +82 2 3660 4500  
F. +82 2 3662 0084

**SOUTH-EAST ASIA**  
**ESI Group South-East Asia**  
12, Jalan Dato Haji Harun,  
Taman Taynton, Cheras  
56000 Kuala Lumpur  
Malaysia  
T. +60 (12) 6181014