VIRTUAL SEAT SOLUTION

Virtual Evaluation of Seat Performance using ESI's Virtual Seat Solution

TACHI-S

Global Seat System Creator
TACHI-S Co. Ltd.
Test Engineering Department
CAE Evaluation Section

01 | About TACHI-S

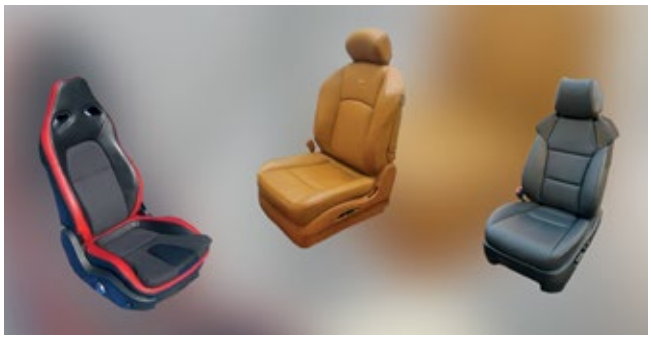
Technical Monozukuri Center.

TACHI-S, an independent car seat maker, does everything from developing to producing automotive seats. They offer car seats, as well as seat components, to domestic and foreign car makers alike. Some of these car makers include: Nissan Motor Co., Ltd., Honda Motor Co., Ltd., Toyota Motor Corporation, Hino Motors, Ltd., UD Trucks Corporation, Isuzu Motors, Ltd., Mitsubishi Motors Corporation and Zhejiang Geely Holding Group Co., Ltd.

More than half a century since its establishment in 1954, TACHI-S has been making car seats, which provide reliability and inspiration. In recent years, to deal with diverse demands from users all over the world, globalization is in progress by establishing new production bases around the world, such as Asia, North, Central and South America and Europe.

02 | About the Car Seat

A car seat is a key component of the car's interior which connects humans with vehicles and there are high levels of expectation related to its appearance and performance. The seat must be designed and produced to satisfy a wide range of requirements such as comfort, feel of touch, maneuverability, ergonomics through seat adjustments and armrest, safety requirements, product durability, and reduction of vibration to mitigate driver fatigue in long haul driving.



Various seat designs.

03 | Seat Composition

The basic structure of a seat is typically composed of a metallic frame, urethane cushions, and trim cover. It is completed with assembled parts such as a seat back, seat cushions, a headrest to support the head, recliners to adjust the seat angles, and seat rails to adjust front and back position.

There are various types of seats and the design of each seat depends on the car category and the related expected options.

For example, in a luxury model vehicle, real leather is used for the trim cover and a high quality of wrapping, similar to a sofa, is expected. For rear seats, various seat configurations could be requested. In a minivan for example, the rear seats could fold down to free load space on demand or they could be used to accommodate additional passengers.

Seat structure.

Mr. Takagi,
Test Engineering Department
General Manager

Why are Seats for Sports Cars so Hard?

"A sports car is expected both to improve driving performance and, at the same time, be stylish. Therefore, a low center of gravity, low vehicle height, and weight saving are essential. For these reasons, seats have to be thin and light. At the same time, stiffness is required to hold the driver in place while, for example, on a winding road that may impose high centrifugal forces on the driver. For these reasons, seats for sports cars are usually stiff and firm.

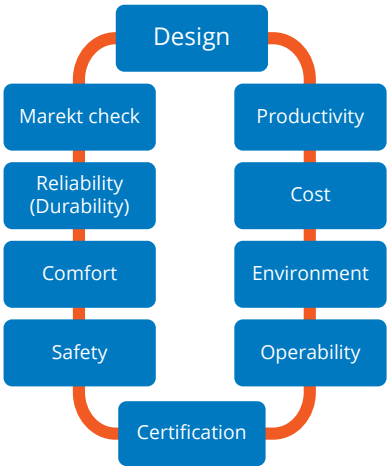
Additionally, stiff seats have the advantage of propagating the vibration to feel the road conditions. That is why seats for sports cars are different from seats for luxury cars, which are soft and spacious. Of course in both cases, safety is very important as the seat design plays a key role in buying intention."

TACHI-S's sport-type seats are high quality and at the same time meet all of the required specifications.

04 | Seat Development Challenges and the Decision to use Virtual Seat Solution

Once the requirements from the car makers are received, seat manufacturers start planning the design development steps to meet the specifications.

Automotive seat manufacturers face continuous challenges. The number of seat models and variants multiply with local market specifications, while shorter development cycles are required. At the same time, the requirements and level of expectations regarding vehicle safety grow every year. TACHI-S is an independent car seat maker working for major Japanese and foreign automotive OEMs. To respond to the increasing sophistication of seat safety, TACHI-S, who implemented ESI's multi-domain simulation software Virtual Performance Solution since 2010 for crash simulation and more, decided to start using ESI's Virtual Seat Solution



Innovation with virtual seat prototyping to shorten development cost and time

VPS simulation results.

When a car manufacturer develops a new model, it performs crash safety performance tests on cars occupied by crash test dummies. The dummy's injuries are assessed after each collision. This New Car Assessment Program (NCAP), originated in the United States in 1979, and corresponding tests have since been defined locally in Japan (JNCAP) and Europe (Euro NCAP).

These NCAP tests are published as a yardstick for car safety and test results can even impact insurance rates in some countries. Requirements evolve continuously. In recent years, a new set of tests has been introduced in NCAP to

assess the performance of seats in relation to whiplash and the risk of associated neck injuries in low severity rear impacts.

To deliver the expected safety to the user, Tachi-S decided to review its process and systematically perform virtual whiplash performance tests in order to evaluate potential neck injury accordingly to the JNCAP protocol.

In iterative successions of operations such as Design leading to Trial manufacturing, allowing Testing, requiring Design Modification, TACHI-S has also reviewed and updated its processes in other domains so as to improve performance

Trim manufacturing trial.

Reducing the Number of Prototypes and Cost

"Before the use of CAE in crash and occupant safety analysis, seat makers, like TACHI-S, performed several analytical calculations and experimental tests to check how the seat fulfilled standard requirements.
At TACHI-S, we have successfully reached greater design targets, fulfilled safety requirements, and improved overall quality in trial phases by adding Virtual Seat Solution into our seat development process. Because there are more than 300 mechanical elements in one seat, designing the seat using virtual seat prototyping at the early stage has greatly shortened the development time."

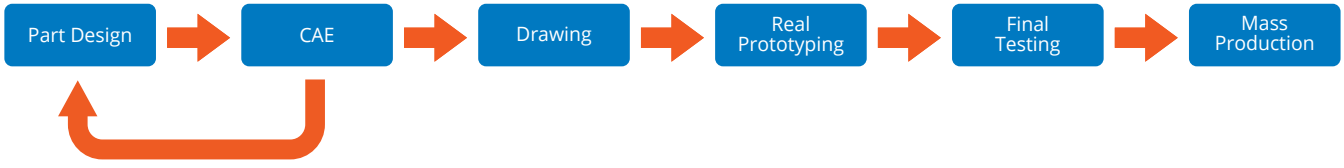
Mr. Inoue,
Manager of CAE Evaluation Section,
Test Engineering Department, TACHI-S

Before using virtual prototyping

Long development time and considerably high testing costs were needed in the trial phase.

After using virtual prototyping

Development time and testing costs are reduced by the use of virtual prototyping.



05 | A Practical Case: Seat Design to Reduce Whiplash Injury

Reducing whiplash injury in a collision is a crucial requirement in seat design. Recently, JNCAP released a testing program to decrease neck injury during a rear end collision. Following the prescribed rear end collision tests, an injury value is calculated based on acceleration and loading on the head and neck. Seats can receive a rating of one to five stars, five stars being the best.

Seat manufacturers are required by the car makers to obtain a high predictability of injury value.

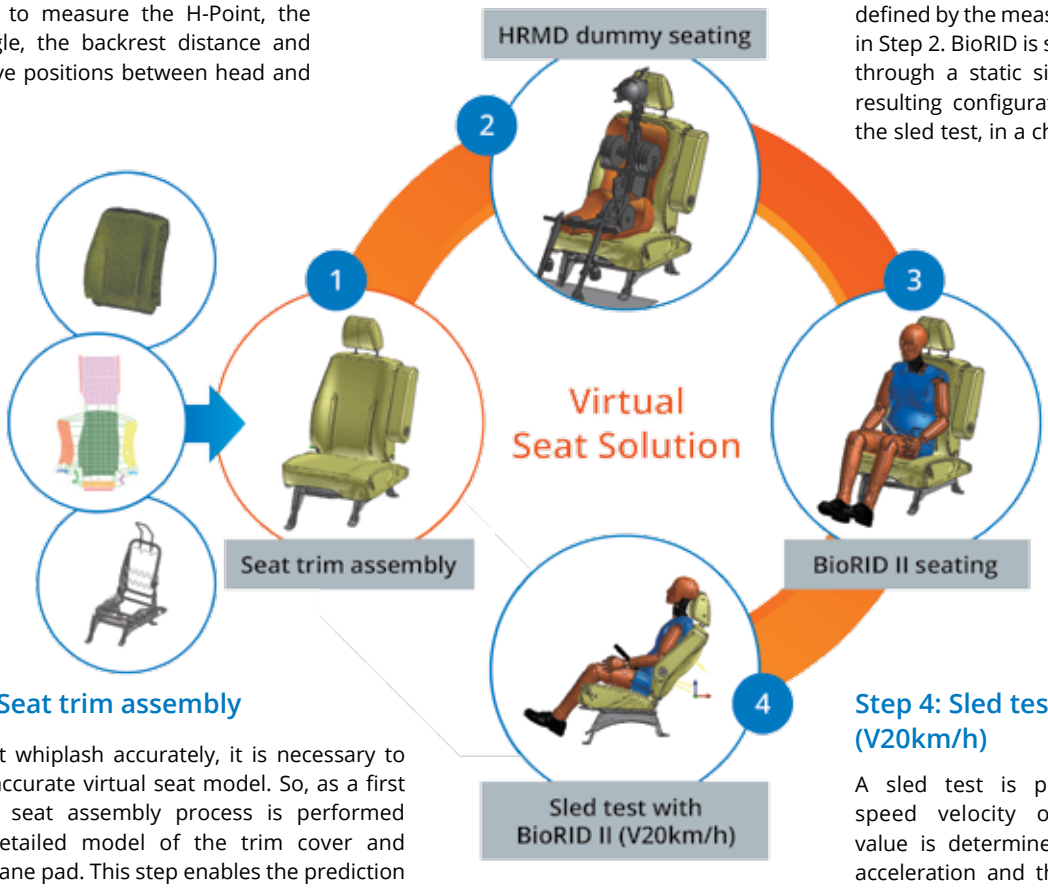
TACHI-S used Virtual Seat Solution to evaluate neck injury value according to the JNCAP protocol. The following flow chart illustrates the process followed by TACHI-S teams; from predicting seat model assembly to evaluating the seat's static and dynamics performances. These steps include the seating of an H-Point dummy equipped with a Head Restraint Measuring Device (HRMD) followed by the seating of a BioRID II crash dummy.

Step 2: HRMD dummy seating

In the second step, the HRMD dummy is seated to measure the H-Point, the torso angle, the backrest distance and the relative positions between head and headrest.

Step 3: BioRID II seating

The initial posture of the BioRID II is defined by the measurements carried out in Step 2. BioRID is seated and positioned through a static sitting simulation. The resulting configuration will be used for the sled test, in a chained process.



Step 1: Seat trim assembly

To predict whiplash accurately, it is necessary to have an accurate virtual seat model. So, as a first step, the seat assembly process is performed with a detailed model of the trim cover and polyurethane pad. This step enables the prediction of the internal stresses in the trim cover and polyurethane pad that appear during the seat assembly process. Once completed, the dummy's sitting posture and the H-Point can be accurately predicted.

Step 4: Sled test with BioRID II (V20km/h)

A sled test is performed at a low speed velocity of 20 km/h. Injury value is determined by measuring the acceleration and the load on the head and neck of the BioRID II dummy. A score is then calculated.

Virtual and real sled test with BioRID II.

Chaining of Seating and Sled Test

"Seat crash performance must be evaluated with the occupant seated in a realistic position. Being able to predict the exact sitting posture of the dummy with ESI's Virtual Seat Solution, has improved the accuracy of crash and safety prediction. It is a big step towards decreasing the number of real prototypes we have to build and test."

Mr. Okano,
Manager of CAE Evaluation Section,
Test Engineering Department,
TACHI-S

06 | Producing a Seat Using Virtual Seat Solution and Future Possibilities

Visualization of the production process

"It's important to see the production site when you simulate using CAE in order to understand the kind of processes and issues that exist. Procedures which go smoothly in the computer may not be the same or work as well at the production site. Assembly workers may stretch the outer material to cover cushions or strike it to straighten out wrinkles. By seeing the production processes, you can visualize a wide variety of possible production complications in your head, even when you are working at your desk. Being able to visualize the production site is very important, not only for CAE engineers, but also for ESI, which develops Virtual Seat Solution. I am happy to continue sharing my knowledge of manufacturing with ESI."

Improving Predictability with the Use of Considerably more Detailed Seat Models

"By using Virtual Seat Solution there will be more possibilities in seat design with more detailed seat models. But there should be a right balance between the level of detail of the model and the time spent for calculation and building of the model. ESI is supporting us to improve this predictability and the use of optimized detailed seat models."

Mr. Inoue,
Manager of CAE Evaluation Section,
Test Engineering Department, TACHI-S

Pour-in-Place Foam

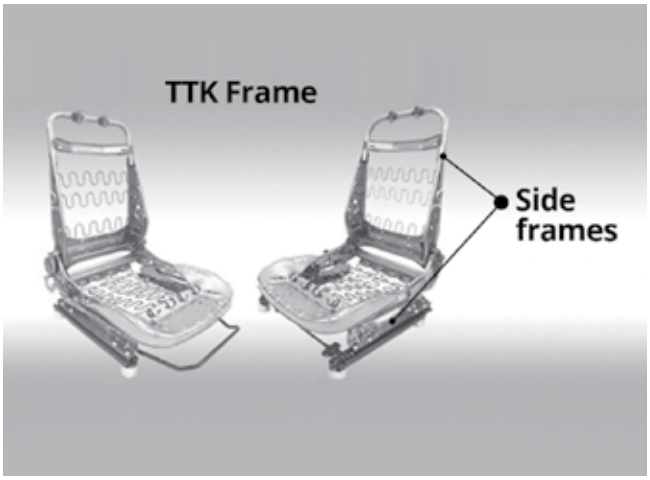
Seat Assembly

07 | Next Generation Frame: TKK (TACHI-S Teian Kokkaku)

TACHI-S announced in 2012 a new standard frame, the "TTK frame", which is safe, lightweight, and compact and offers exceptional versatility for various types of car seats. It is available to car makers around the world.

Background of the conception of the standard seat frame

Seats are required to have a dedicated function and performance, depending on the type of car. Before, each frame was designed to answer each requirement and specification previously discussed. But the TKK frame, providing the basic framework including all kinds of function and performance, enables manufacturers to make a variety of car seats by changing only one part of the total structure. For example, the part for manual seating adjustment is different from the one for power seating adjustment. Previously, a different side frame (pictured in the diagram below) was designed for each seat. But now that we have standardized the side frame, we no longer need separate parts.



TTK Frame: specifications for manual and power seats.

The TKK frame has succeeded in reducing manufacturing time and cost by providing a standard frame which deals with various seat configurations respectively, by changing only one component of the total seat structure.

08 | Working on Seat Design and Development

Comments from Mr. Uchino, Engineer in the CAE Evaluation Section, Test Engineering Department:

"The first thing that catches your eye as you open the car door is the seat, which is why its design is very important. Another reason it's so important is because it is one of the car components that the driver is in constant contact with. This is what makes it worth doing this job and I want to produce the best car seat with a high degree of credibility.

When I imagine that there are drivers sitting on a seat which I took part in the design of, not only in Japan but overseas, I am really proud of myself.

I feel satisfied when seats go through design and testing, become manufactured and are sent on the market. When I happen to see a seat in daily life I can't help following it with my eyes.

From now on, I'd like to focus on safety and comfort and continue to contribute in the making of good seats."

Mr. Uchino,
Engineer CAE Evaluation Section, Test Engineering Department,
TACHI-S

May thanks to the team at Tachi-S for their time in making this story possible.