Engineering Initiatives and Application Case Studies of Driving Simulator Technologies in the Mazda–S&VL Collaboration

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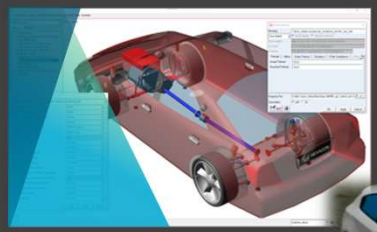
Agenda

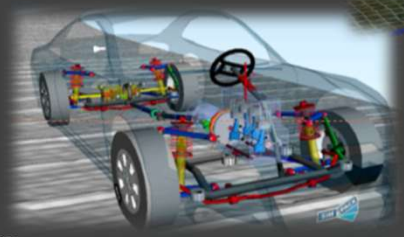
- S&VL Business
- Mazda–S&VL Technical Collaboration
- Recent Research Topics of S&VL
- Driving Simulator Application for Body Development
- Mazda's Philosophy
- Challenge / Value
- Development Steps and Example
- Summary

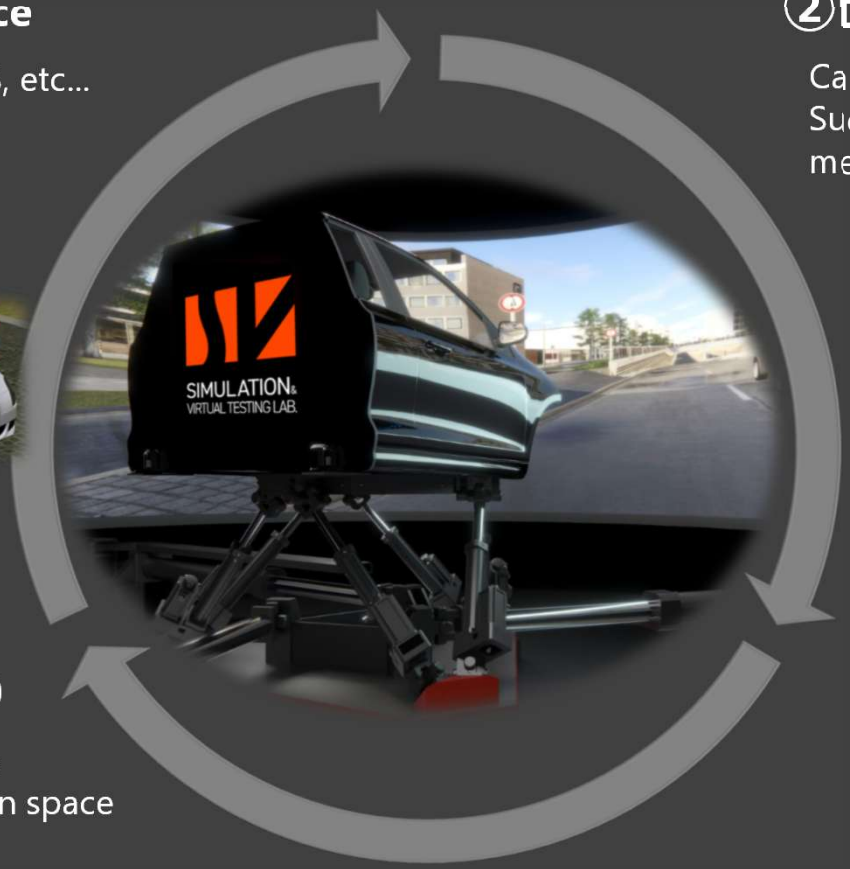
S&VL Business: One-Stop Driving Simulator Services (DiM300)

①Real-Time modeling service

VICRT, Carsim、Simpack RT、ADAMS, etc...







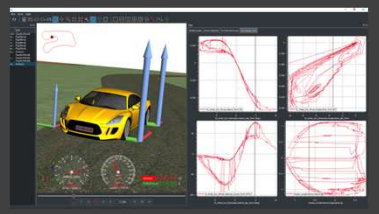
②DiM300 operation service

Carrying out total operation of DiM300
Such as model checking cueing and measurement.

VI-GRADE

③Technical consulting

Analyzing the testing results and propose how to improve the performances



④Testing service by DiM300

Provides total test facilities include DiM300, office space and relaxation space

Mazda–S&VL Technical Collaboration

- Mazda and S&VL agreed in October 2025 to collaborate on digital and human-centric technologies for next-generation vehicle development.
- Responding to shorter development cycles and the rapid shift toward simulation-driven, model-based engineering.
- S&VL, equipped with the advanced DiM300 driving simulator, provides high-fidelity human-in-the-loop virtual testing.
- Through joint research and technical collaboration, the partners aim to accelerate innovative vehicle development with enhanced safety and comfort.

Recent Research Topics of S&VL

Driving simulators (DS) offer high reproducibility and safe testing conditions, making them well suited for research on human perception and feelings. Below are the human research–related devices owned by our company.

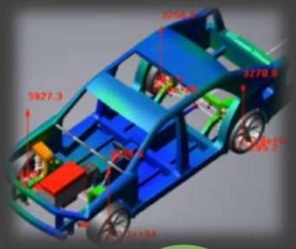
Steering Wheel Grip Force Sensor
Measurement of the driver's tension level and research on its use as an interactive device.

Varjo XR-4　Focal　Edition
Research on factors affecting immersion and their application to HMI development.

Blueskeye AI B-Automotive
Capture facial skin movements on video and analyze them with AI to estimate the driver's feeling.

Driving Simulator Application for Body Development

1: Checking Vehicle Model



Model check and confirm RTF
If needed, reduced # of DOFs
or improve the model

2 :Preparation of Driving Test Scenario

Propose and develop
test scenarios that meet
customer requirements.

1 → 2 → 3 → 4 → 5

3 :Verification

Adjust the cueing
together with the
customer's driver, and
check the scenarios.

4 :Testing

Conduct tests together with the
customer, and collect the driver's
subjective feedback and objective data.

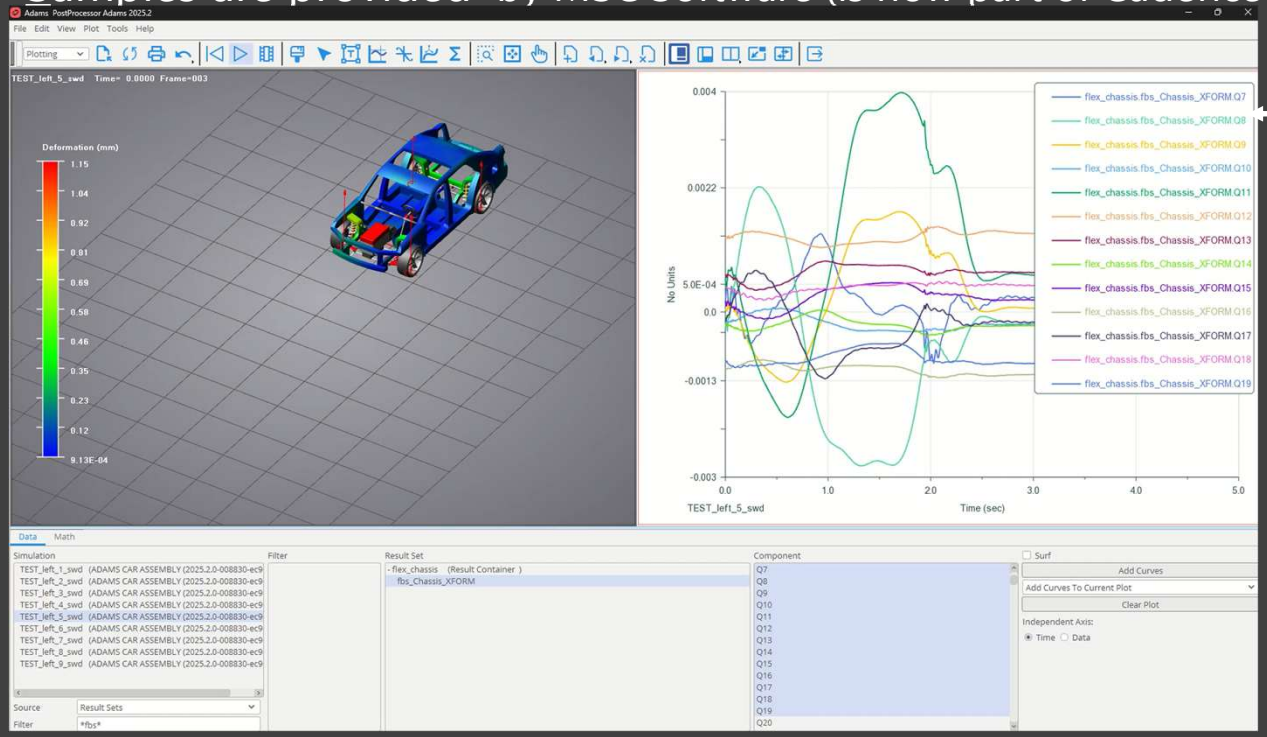
5: Data Analysis

Based on the collected data, conduct
analysis with the customer and
propose improvements to vehicle
performance.

Driving Simulator Application for Body Development

How to reduce RTF when using flexible bodies in Adams.

Samples are provided by MSC Software (is now part of Cadence Design Systems)



Mode #

Modify Modal ICs ...

	Natural Frequency	Enable
1	-7.8168806795E-05	
2	-6.0648842918E-05	
3	-4.1751736717E-05	
4	-2.8014417694E-05	
5	2.7982507163E-05	
6	3.7011042878E-05	
7	36.3768844604	*
8	38.9458732605	*
9	45.5921707153	*
10	50.1027908325	*
11	51.6534576416	*
12	58.623752594	*
13	60.9107017517	*
14	64.2746963501	*
15	66.6403884888	*
16	68.8988723755	*

- Import the flexible body model (MNF) into Adams
- Check mode shapes and frequencies
- Remove modes not affecting the target phenomena
- Optimize the RTF
- Run offline calculations
- Compare with the original model and verify no differences

Identify areas for improvement by conducting subjective evaluations before body design release.

OUR PHILOSOPHY: Human-Centered

- **DEVELOPMENT PHILOSOPHY**
  Strong culture of Model-Based Development

- **PRODUCT PHILOSOPHY**
  Human-centered
  - Revitalize human life through driving
    Key value: Sense of accomplishment and Personal growth

CHALLENGE: Subjective evaluation in real world

- **HUMAN-CENTERED?**

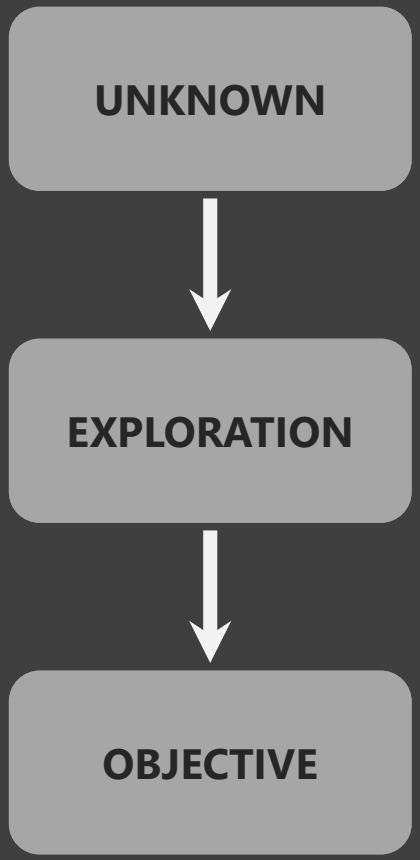
  Activates physical and cognitive capability
  Driver involvement is essential

  REQUIREMENTS
  ✓ Drive with confidence
  - Safety at all times
  ✓ Behave as intended
  -intuitive vehicle response

- **CHALLENGE**

  Extensive subjective evaluation with in-vehicle
  because underlying mechanisms are not fully understood
  e.g. Vehicle dynamics vs Human sense

VALUE: Bringing Subjective Evaluation into Simulation



➢ CURRENT LIMITATION

Subjective evaluation with physical prototypes
- Costly and limited coverage
- Conservative design is forced
  due to limited understanding of underlying mechanisms

➢ WITH DRIVING SIMULATOR

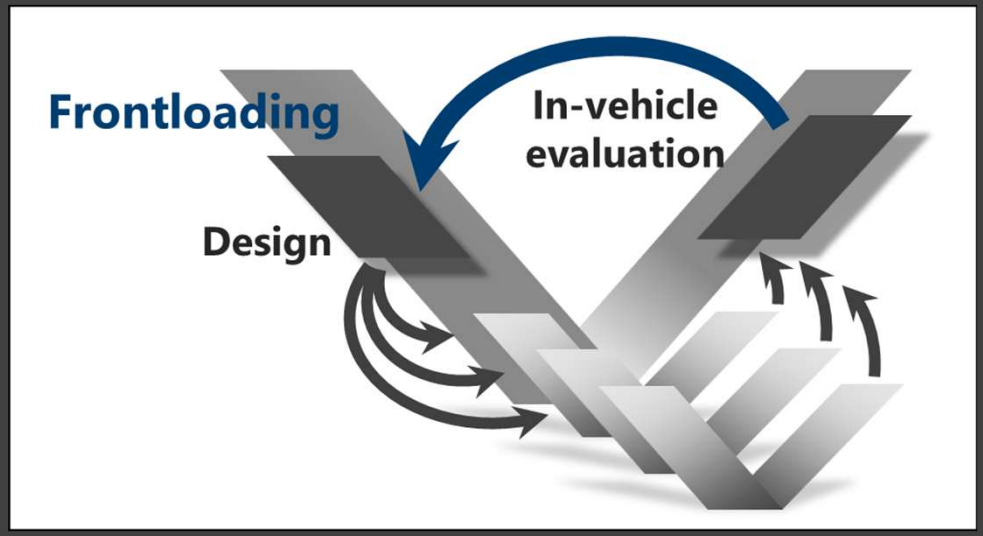
Enable design exploration
- at early phase without physical prototypes

Controlled experiments
- for target clarification and human analysis

TOWARD ZERO PROTOTYPE

Step1. EXPLORATION
-Virtualize and upstream

Step2. OBJECTIVE
-Subjective perception to Objective

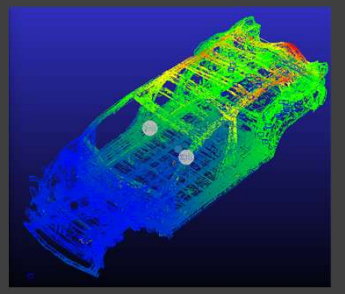


→ **Two examples using DiM300 for vehicle dynamics**

STEP 1: EXPLORATION Virtualize and Upstream

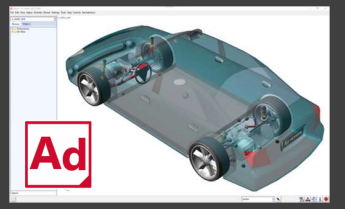
APPROACH

Perform subjective evaluation in simulation
Front-load requirement alignment and function allocation



EXAMPLE

Body stiffness design:
- derive structure requirements from vehicle dynamics
- Vehicle model: Multi-Body Dynamics (Adams Flex)

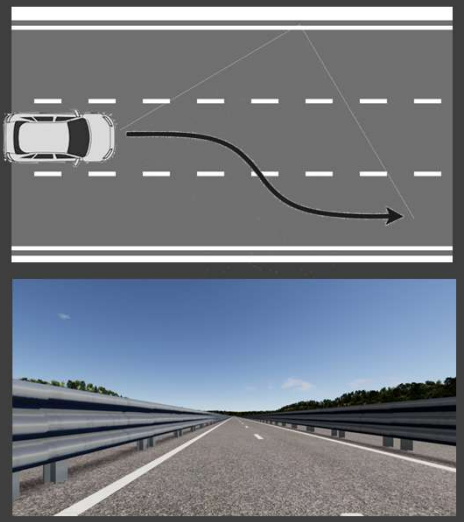


IMPACT

Less conservative design for underlying mechanism not understood
Reduce rework, cost, and effort by fewer physical iterations
Increase evaluation coverage beyond real-world constraints

STEP 2: OBJECTIVE Subjective to Objective

- **APPROACH**
  - Convert driver perception into objective
  - Define tolerance ranges through controlled testing
- **EXAMPLE**
  - ADAS lane change controller calibration:
    - objective + perceived controllability
    - Vehicle model / Control model: Simulink
- **IMPACT**
  - Quality/performance improvement by objective metrics
  - Cross-vehicle / platform development with consistent targets
  - Strategic design across projects
    - scalable, reusable, commonized



SUMMARY

Driving simulator enables
the transformation of subjective evaluation through simulation

STEP 1 (Exploration)

Move subjective evaluation upstream
→ Less conservative design + better efficiency

STEP 2 (Objective)

Translate subjective into objective targets
→ Strategic design and Vehicle-less development

■ Outcome

DS strongly contributes to vehicle-less development