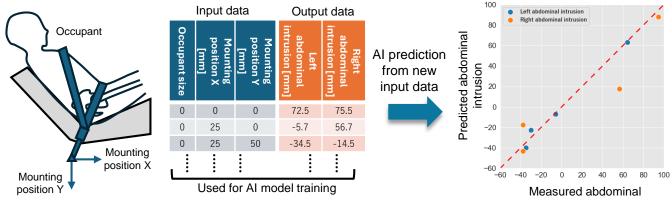


## CAE Surrogate Modeling and Optimization with Multi-Sigma<sup>®</sup> -Advancing Safe Vehicle Design for Diverse Occupant Body Sizes

# Multi-Sigma<sup>®</sup> constructed a surrogate model from CAE crash simulations to derive optimal safety device configurations while accounting for diverse occupant body sizes.

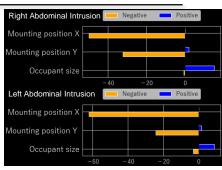
#### 1. Surrogate modeling for injury prediction using Multi-Sigma®

Using only 14 crash simulation cases, Multi-Sigma<sup>®</sup> successfully created a surrogate model for predicting abdominal injury risk in small-statured adult female and male occupants in suboptimal seating positions. This model demonstrated high accuracy despite limited data.



### 2. Leveraging factor analysis to highlight key contributors to injury risk Intrusion

Factor analysis showed that a lower and more forward seat belt mounting position reduces the risk of excessive abdominal injury, even in poor posture scenarios. Additionally, small female occupants were shown to have a higher risk of abdominal injury than average male occupants under the same design conditions.



#### 3. Optimizing safety configurations for body size variation

30 100 Multi-Sigma® optimizes design under Abdominal Intrusion (mm) Injury Risk Area 20 constrained inputs. In this case, body type -80 was fixed due to higher abdominal injury 10 risk in small female occupants and seat 60 0 belt position was limited to 0-40 mm. -10 Within these limits, the model identified a 40 design that minimizes injury risk. The red Initial position -20 Optimization 20 Direction area in the figure shows the abdominal -30 Left intrusion zone, clarifying design boundaries. Optimized position 40 -20 -10 -40 -300 10

(Note 1) Data source: Saito, H., Pipkorn, B., and Lubbe, N., "Understanding the Influence of Seat Belt Geometries on Belt-to-Pelvis Angle Can Help Prevent Submarining," SAE Int. J. Trans. Safety 10(2):463-481, 2022, <a href="https://doi.org/10.4271/09-10-02-0017">https://doi.org/10.4271/09-10-02-0017</a>. (Note 2) Surrogate model trained with 14 samples, validated on 4 samples

(Note 3) Body types defined as: 0 = average male, 1 = small female (Note 4) Abdominal injury index = max belt intrusion above the ASIS (anterior superior iliac spine)

AlZOTH inc. provides a range of Al services, including Multi-Sigma®, Al consulting, experimental condition optimization support, and contract research and development. Multi-Sigma® is a cloud-based Al software designed for research and development, significantly reducing experimental workload and enabling researchers to discover innovative solutions to real-world challenges with minimal experimental datasets.

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Right Abdominal Intrusion (mm)