Stochastic Simulation of Crash Structures

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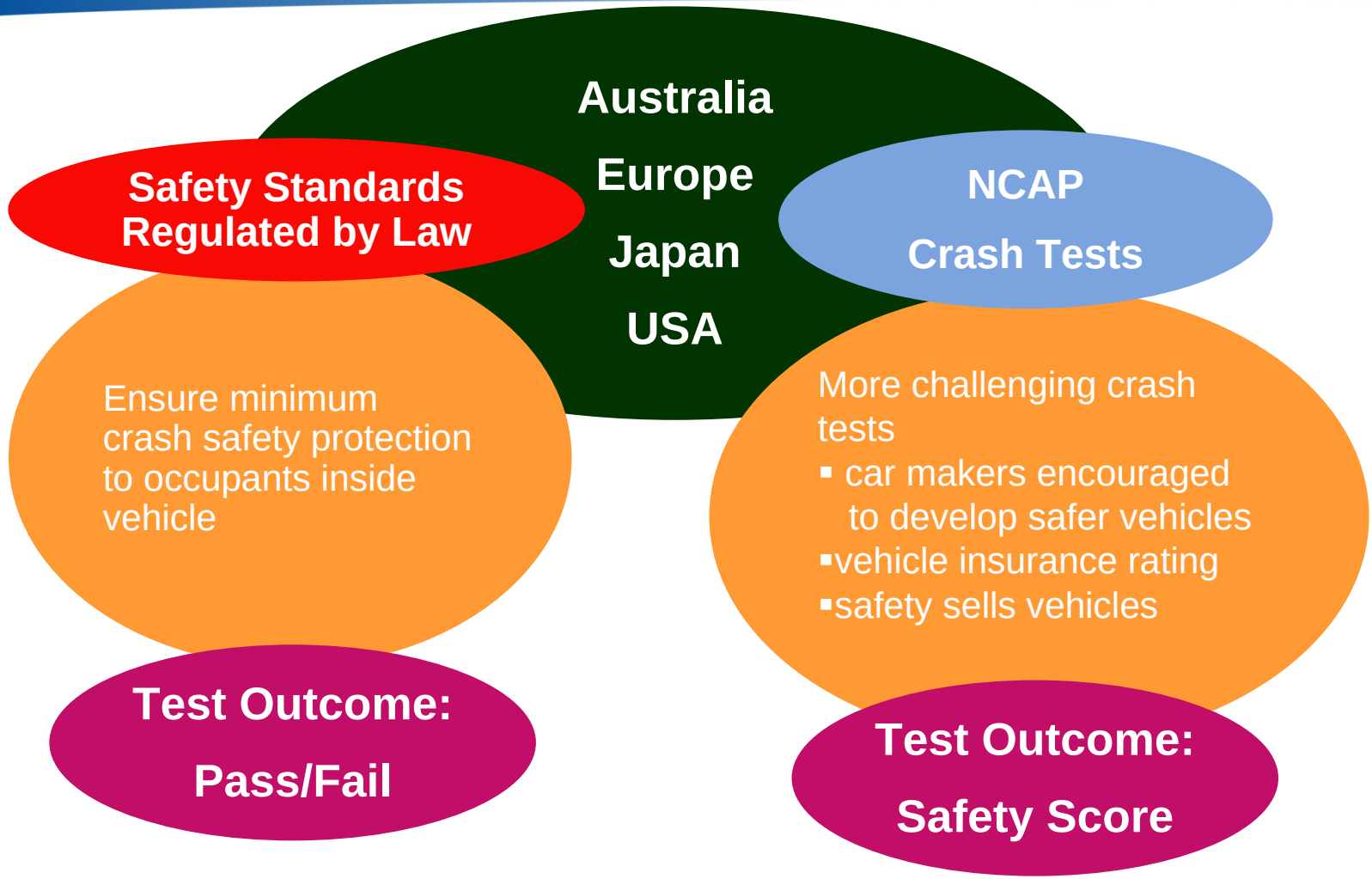
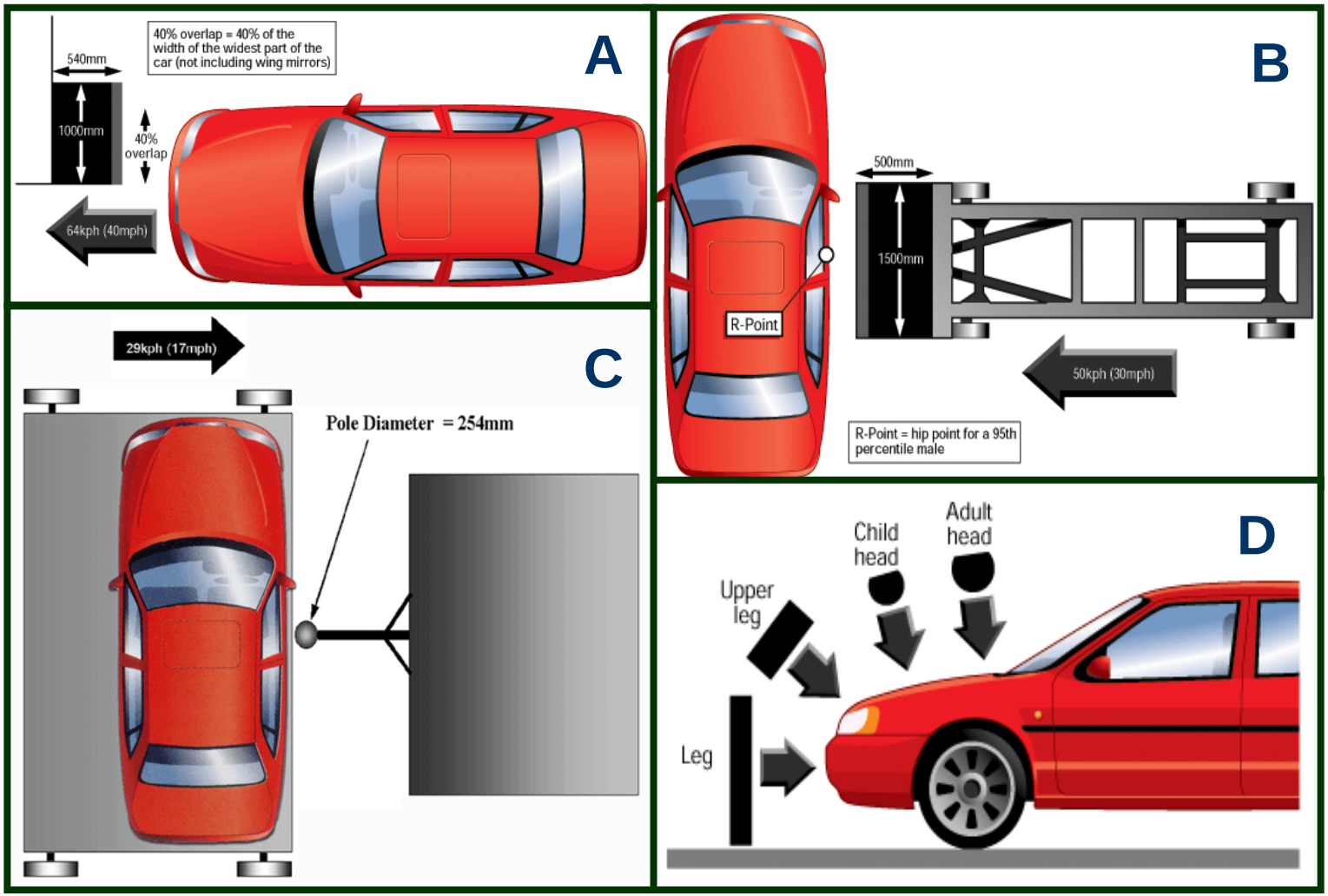
Materials Characterisation and Simulation Project

Project Partners

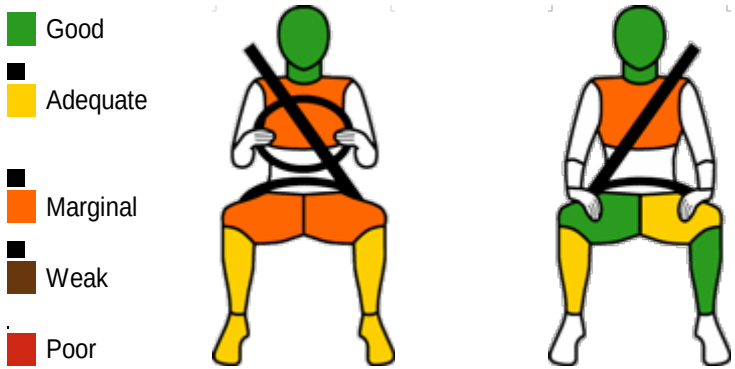
Crash Test Requirements



NCAP Crash Test Procedures



NCAP Crash Test Drivers



Test dummies for front and side impact contain sensing equipment to measure forces, accelerations and displacements during crash tests

The measurements relate to injury criteria e.g. HIC, chest acceleration and rib displacements. A scored is assigned using a star rating which is published for public viewing on NCAP websites

Example of NCAP Crash Test Results

a. Example of Low NCAP Score (c.2003)

Adult occupant rating ★★☆☆☆
Pedestrian rating ★☆☆☆

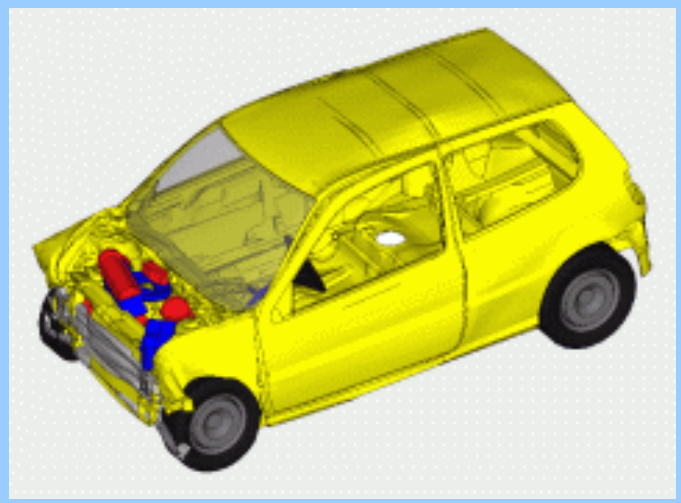
Test Scores:
Front **4 (25%)**
Side **14 (78%)**
Pedestrian **4 (11%)**

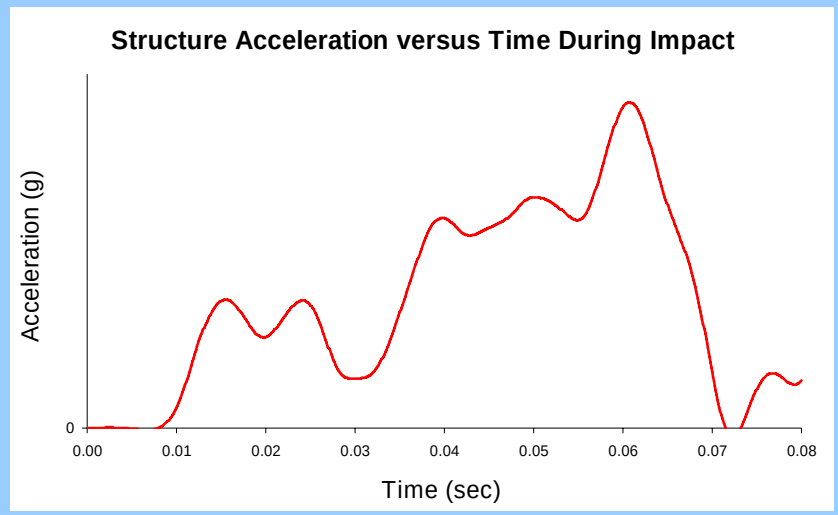
b. Example of High NCAP Score (c.2003)

Adult occupant rating ★★★★★
Pedestrian rating ★★☆☆

Test Scores:
Front **15 (94%)**
Side **18 (100%)**
Pedestrian **10 (28%)**

Virtual Crash Testing





Protection:

- Good
- Adequate
- Marginal
- Weak
- Poor

NCAP SCORE

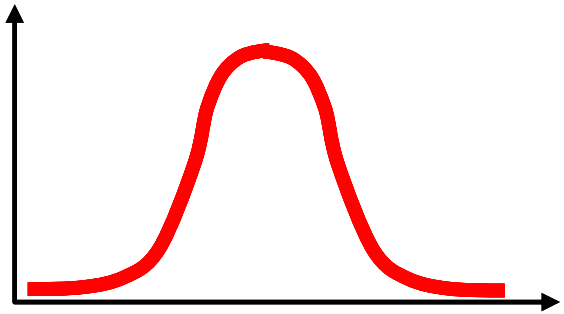
Typical Engineering Tolerances

Typical structural property and noise factors variations;

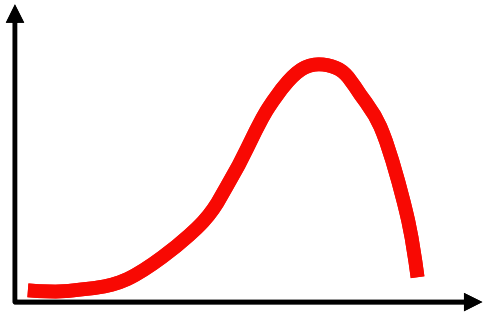
	Description	Range	Distribution Model Applied
Structural Properties	Materials	+/- 10%	Uniform?
	Gauges	+/- 10%	Uniform?
	Joints	+/- 20%	Skewed ?
	Manufacturing effects	+/- 10%	Skewed ?
Boundary Conditions	Barrier angle	+/- 1 deg	Normal
	Impact velocity	+ 3%	Normal

Modelling Variability

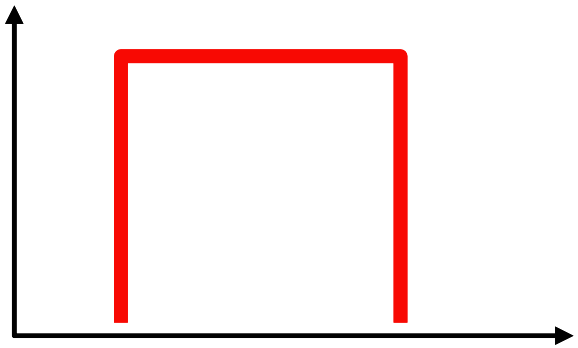
Typical parent distribution models;



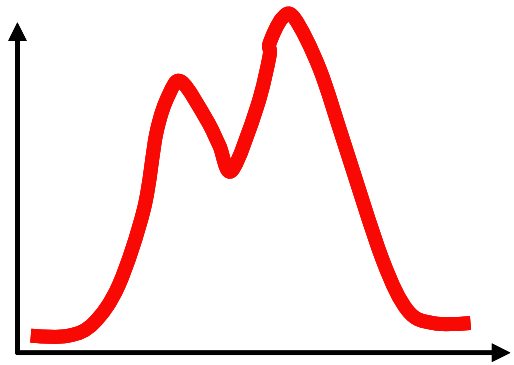
Normal Distribution



Skewed Distribution

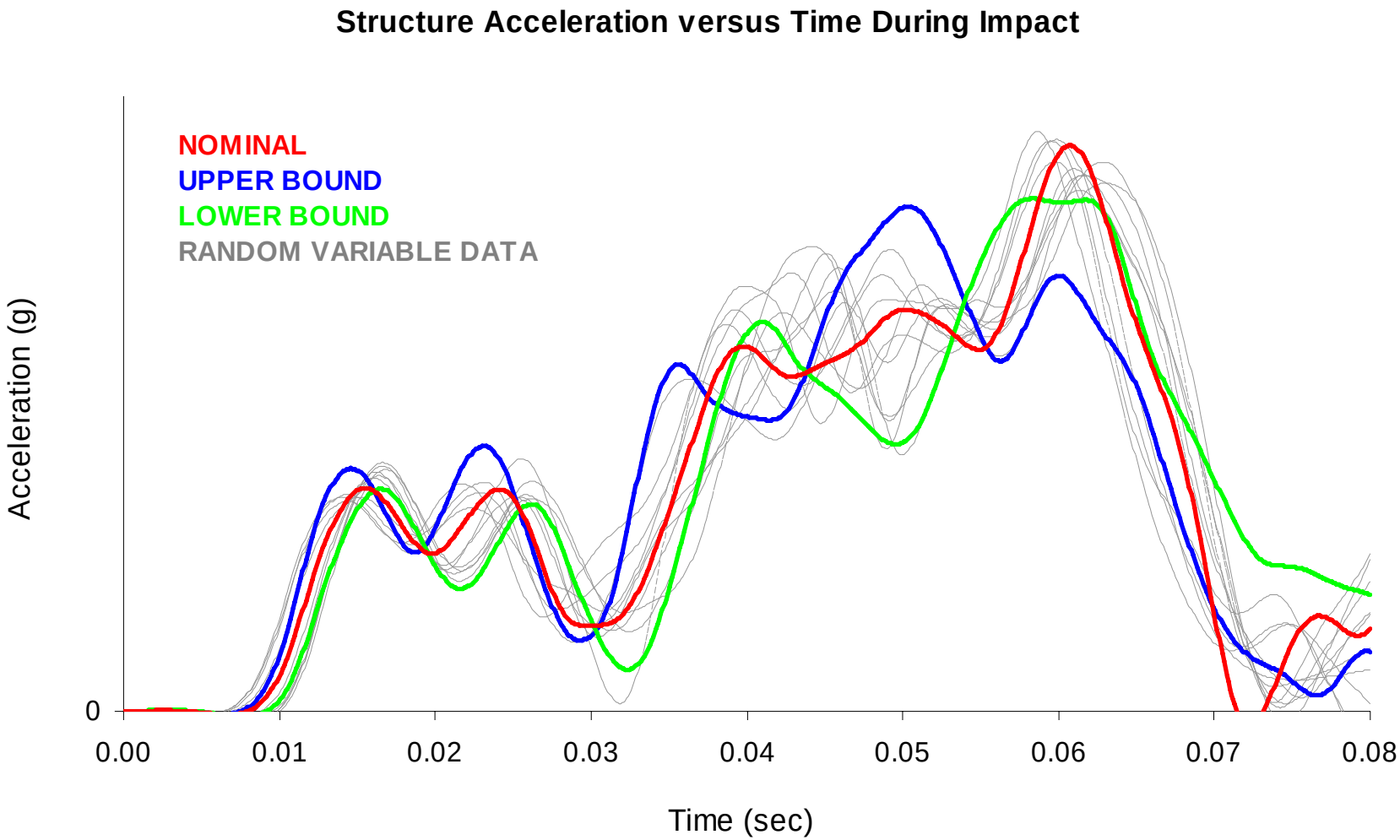


Uniform Distribution

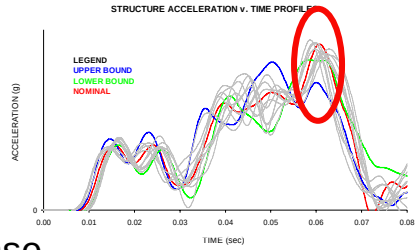


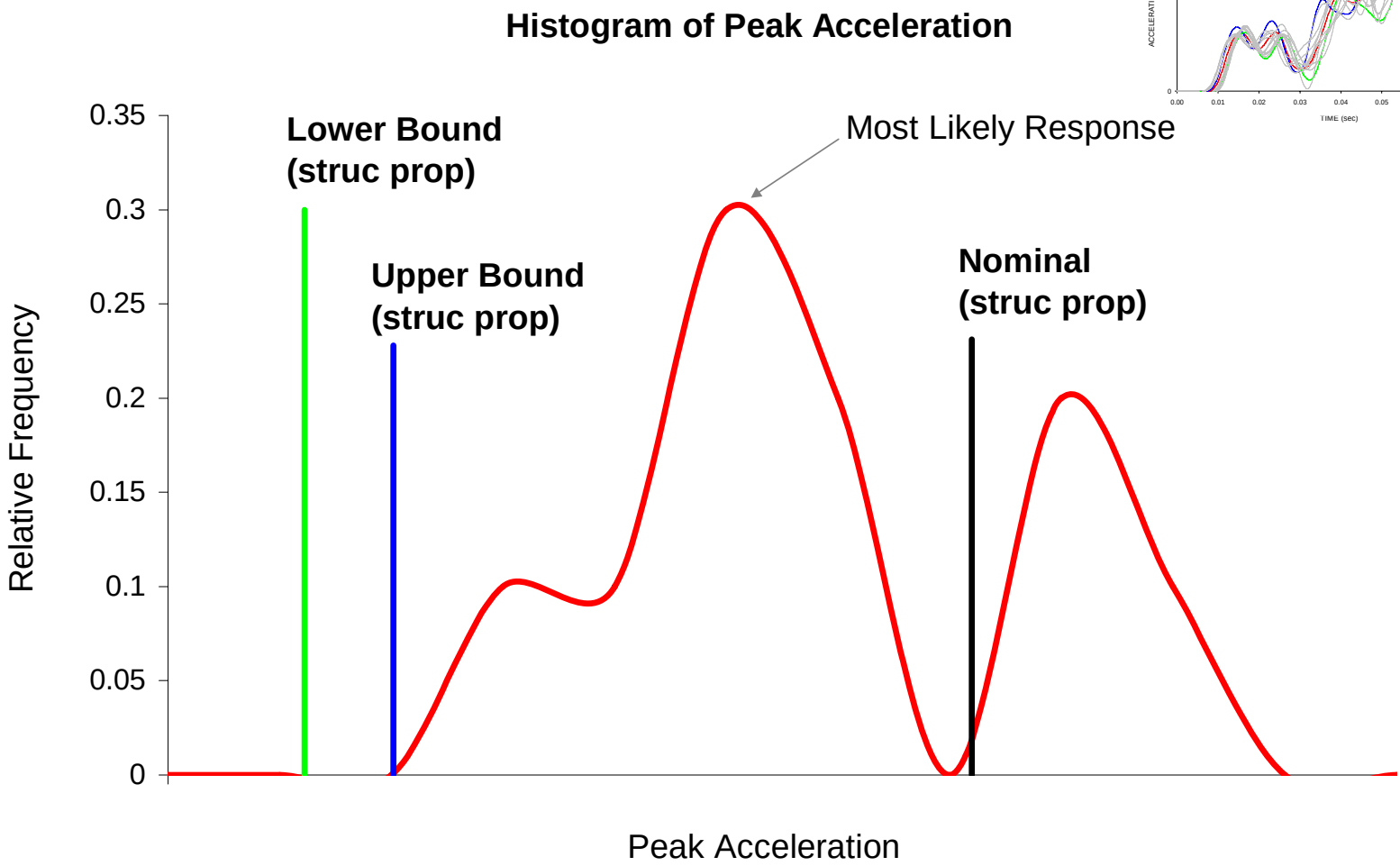
Bi-modal Distribution

USNCAP Performance Variability

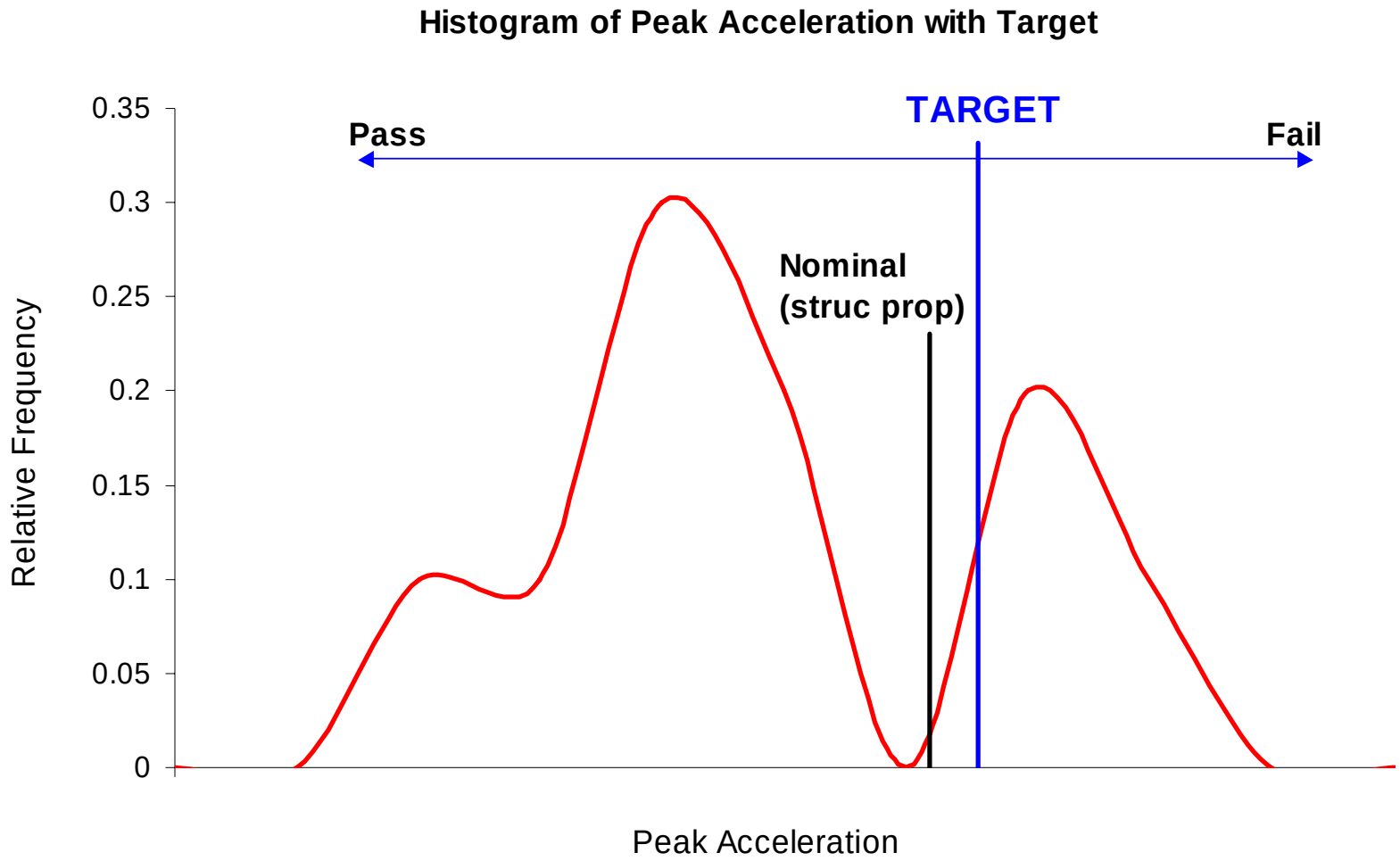


Characterising Performance Variability

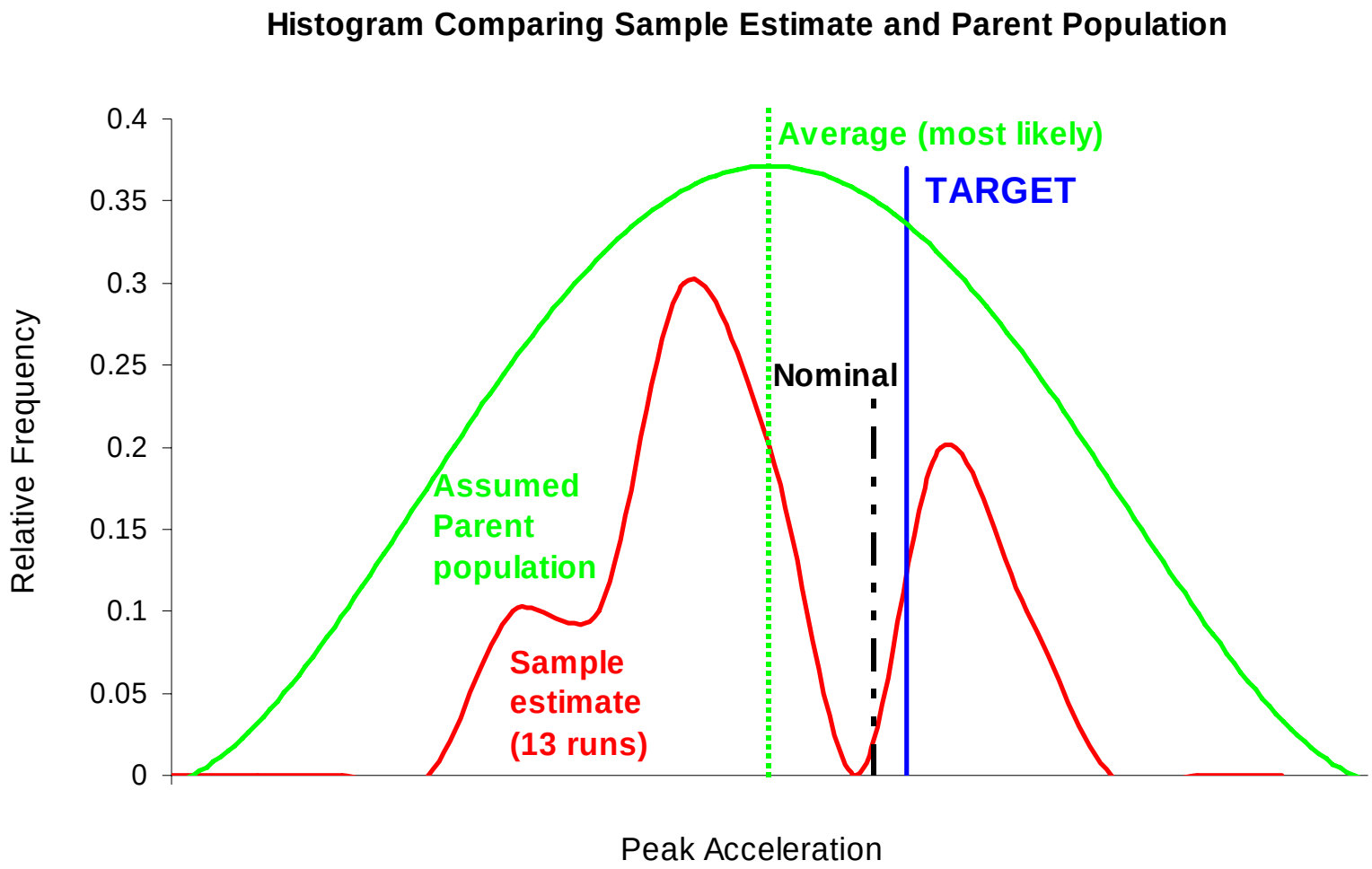




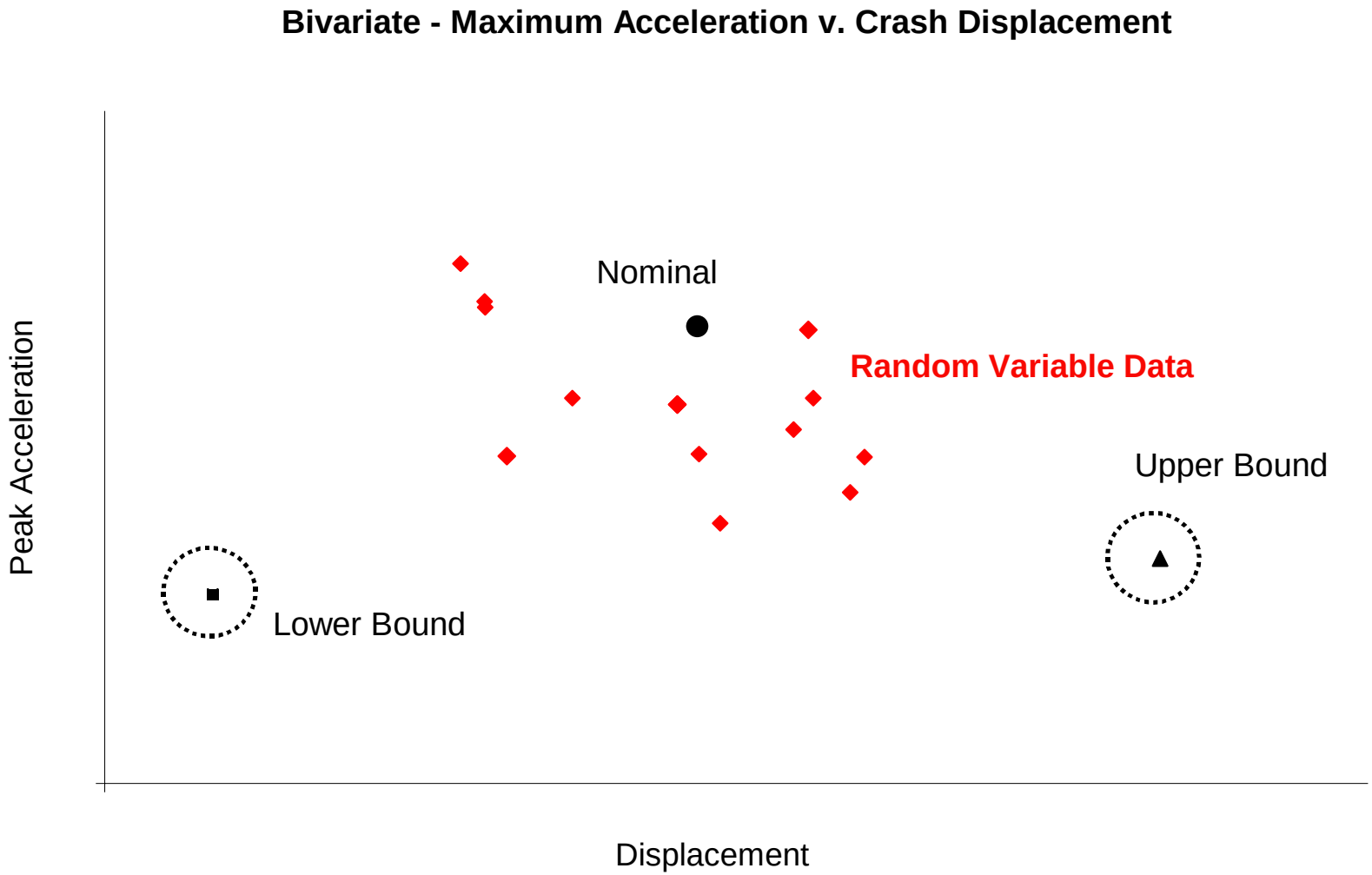
Performance Variability & Relationship to Target



Sample Estimate of Performance Variability



Univariate v. Bivariate



Investigate Suitability of Structural Design Metric

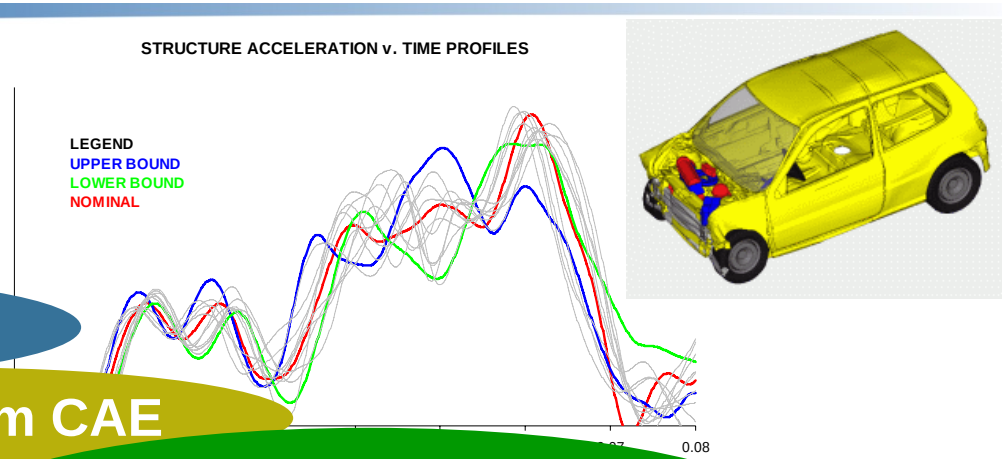
Define random variables in crash structure

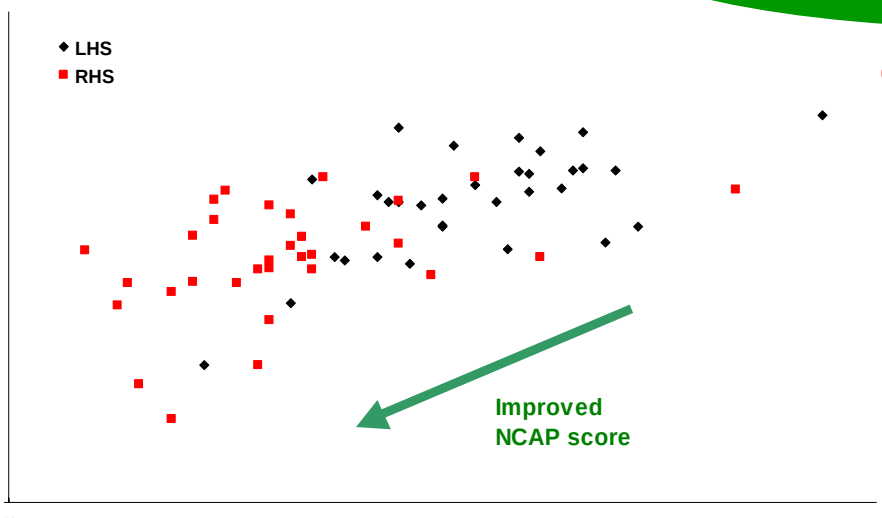
Submit to CAE

Output from CAE

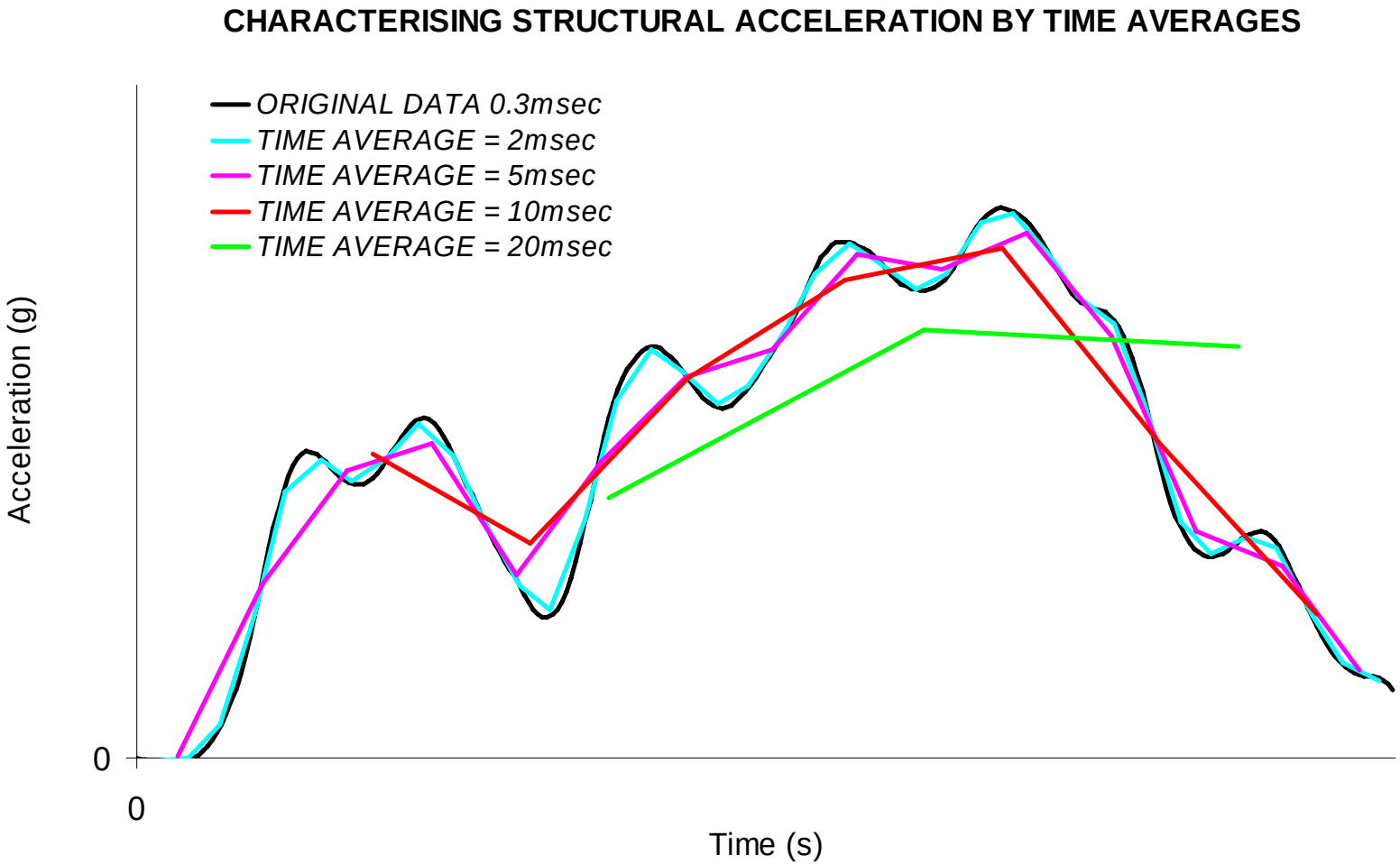
Input to occupant model

Output from occupant model

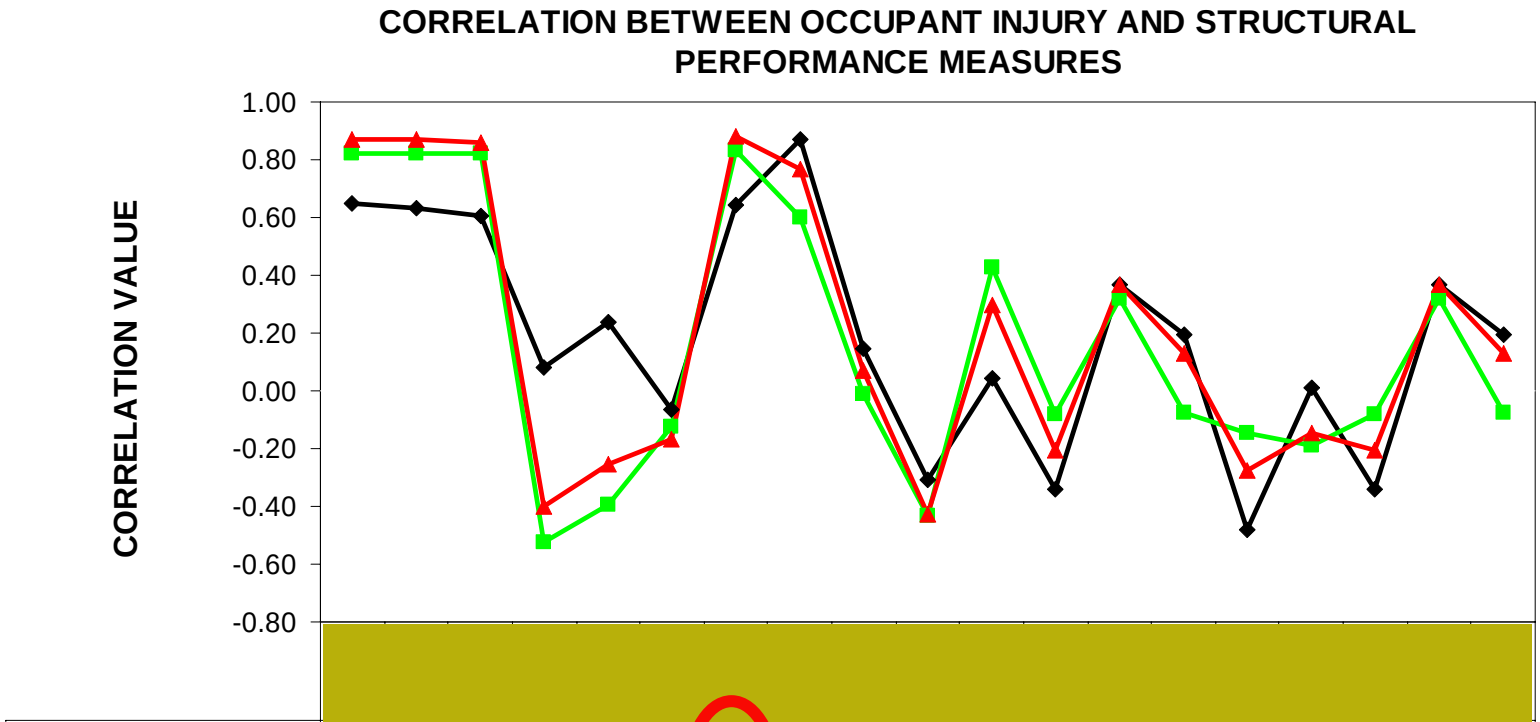




Characterise Structural Performance



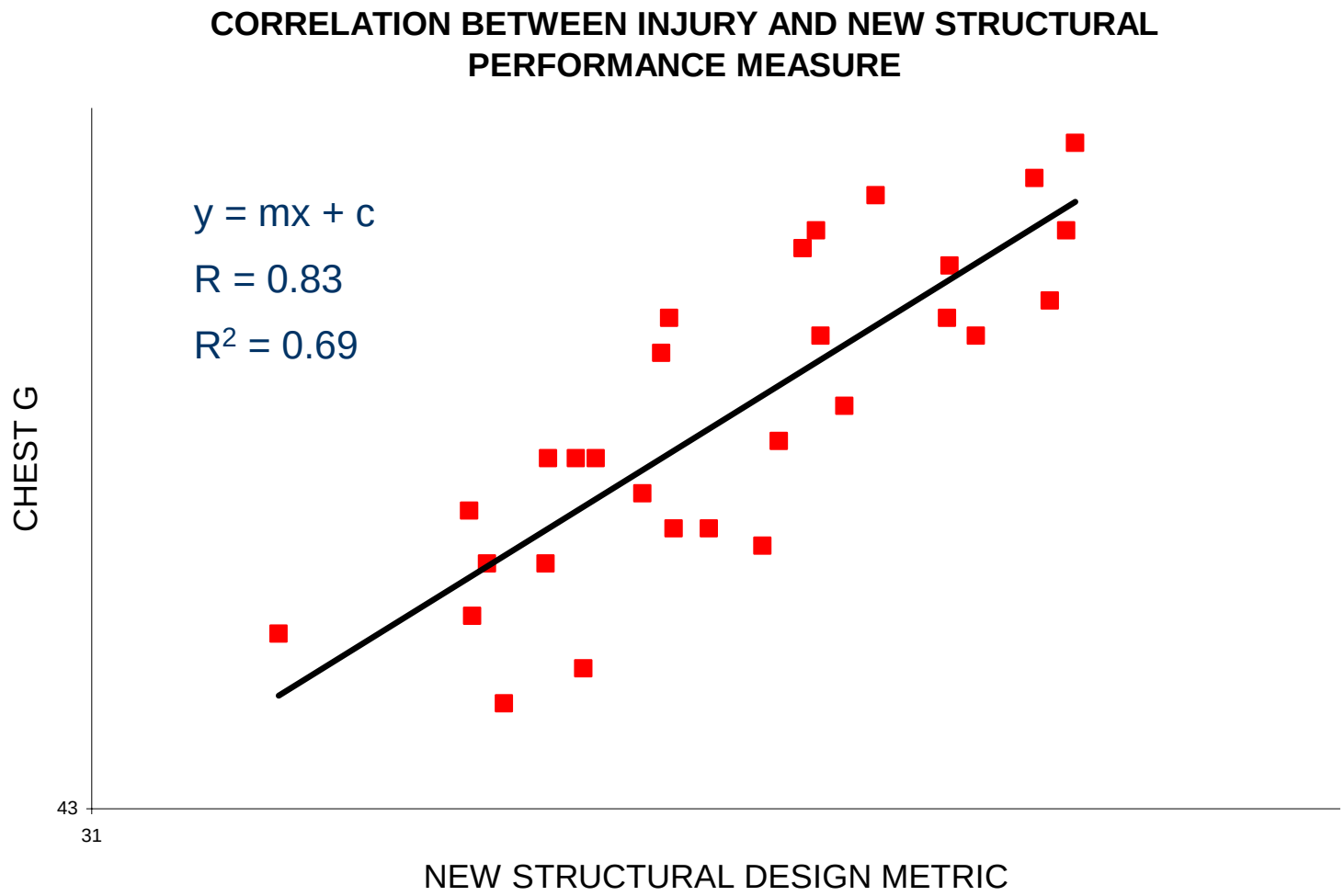
Validate New Structural Design Metric



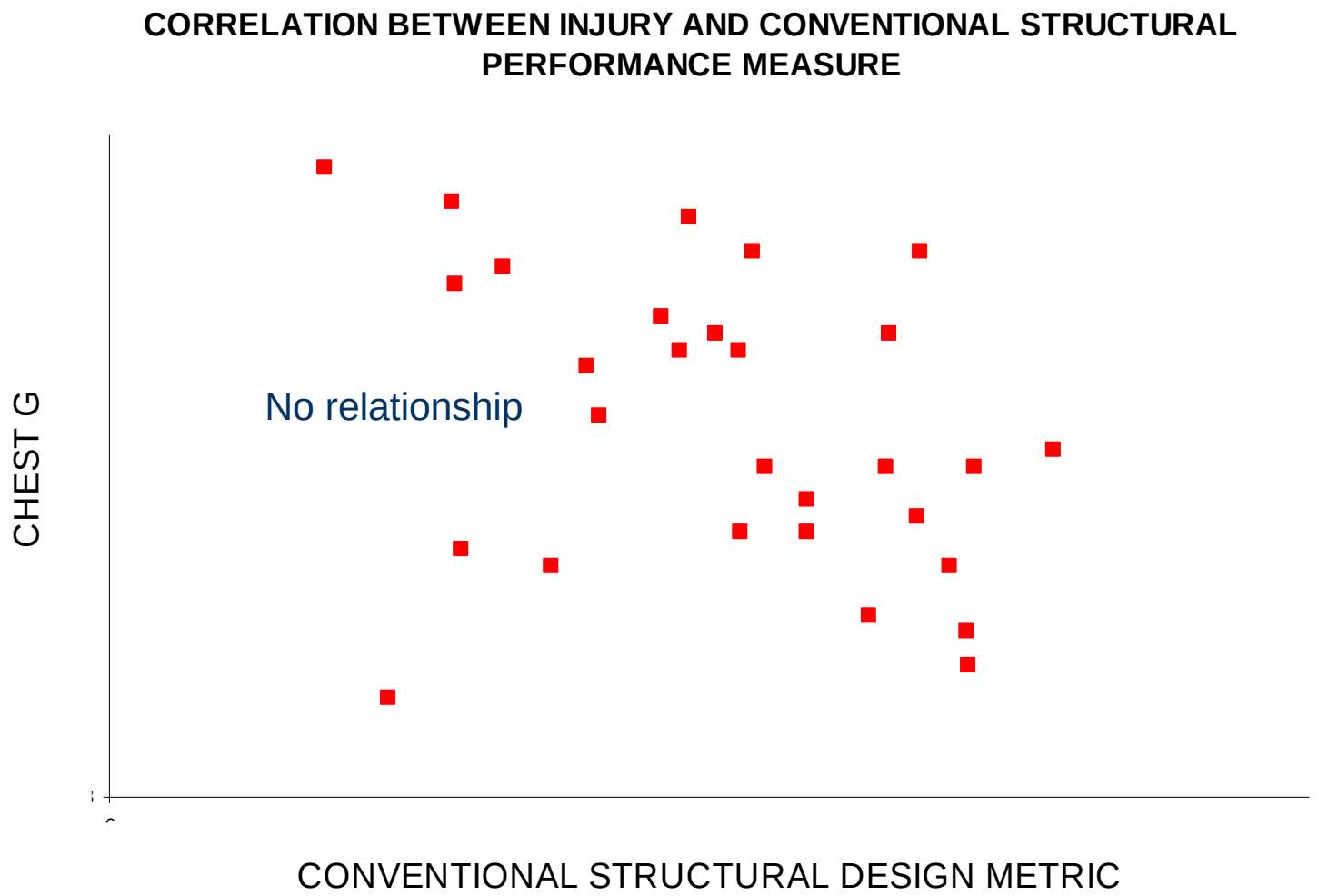
LHD HIC 36.0	0.65	0.63	0.60	0.08	0.24	-0.0	0.64	0.87	0.15	-0.31	0.04	-0.34	0.37	0.19	-0.48	0.01	-0.34	0.37	0.19
LHD CHEST ACCEL (g)	0.82	0.82	0.82	-0.53	-0.39	-0.1	0.83	0.60	-0.01	-0.43	0.43	-0.08	0.32	-0.07	-0.15	-0.19	-0.08	0.32	-0.07
LHD P.COMBI(%)	0.87	0.87	0.86	-0.40	-0.26	-0.1	0.88	0.77	0.07	-0.42	0.30	-0.21	0.37	0.13	-0.28	-0.14	-0.21	0.37	0.13

Structural Performance Measures

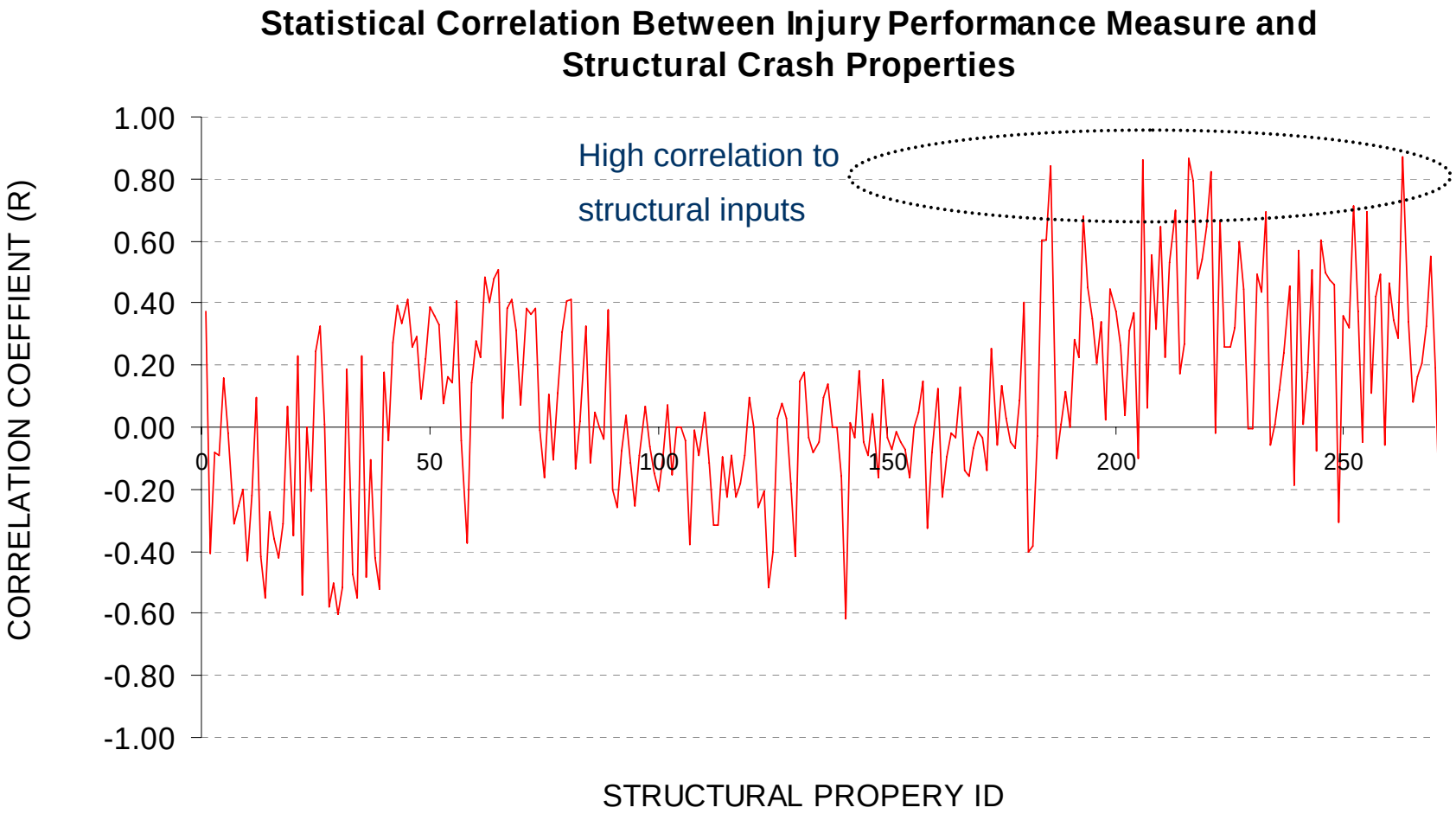
Check Sensitivity of New Structural Design Metric



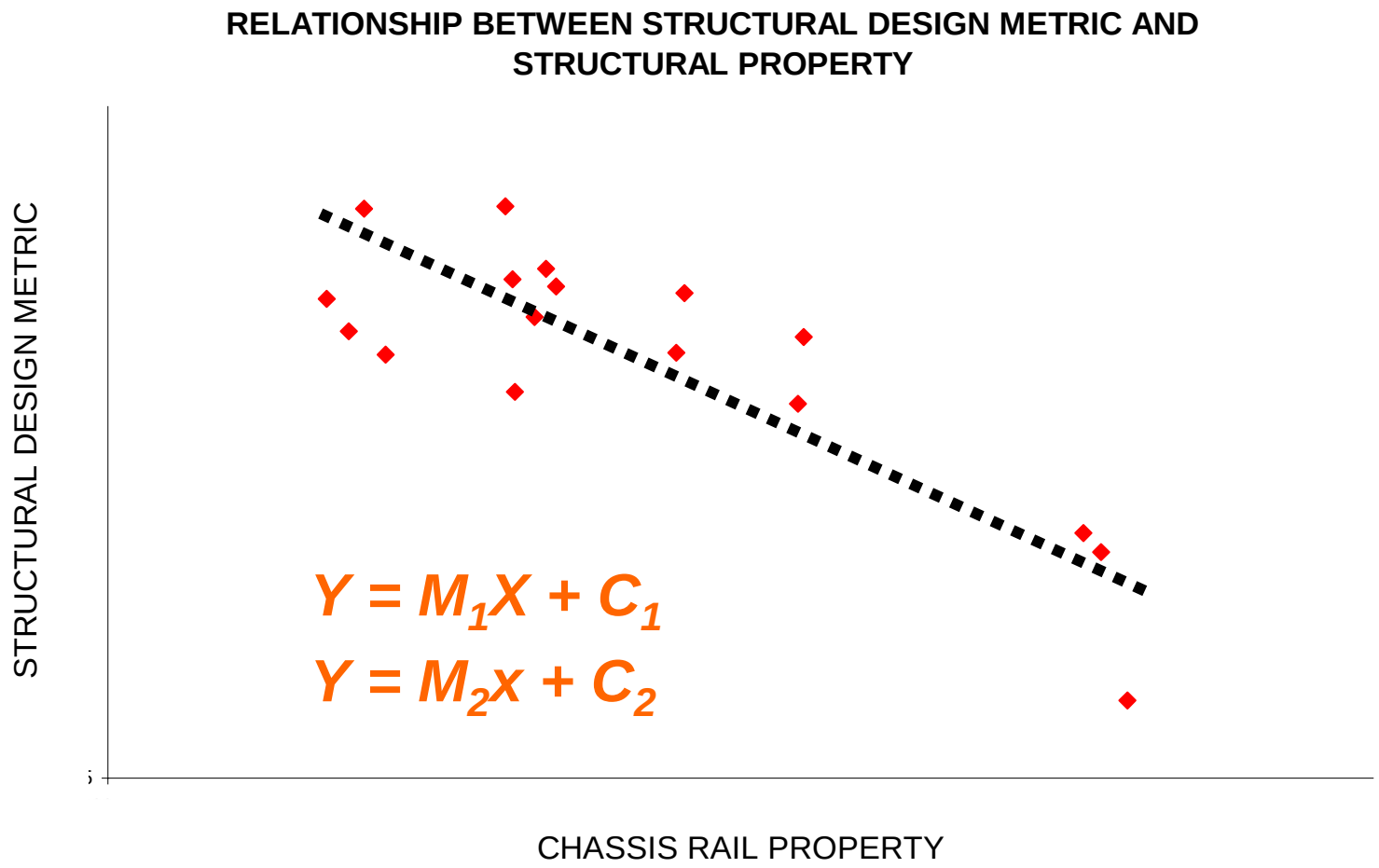
Conventional Structural Design Metric



Correlation Between New Structural Design Metric and Structural Properties



Establish Transfer Function Between New Structural Design Metric and Structural Properties



Establish Likely Performance Modes and Dependencies