Multidisciplinary Optimisation and the Design for 6 Sigma
An Executive Summary

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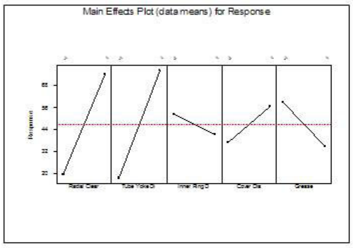
Abstract

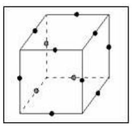
Restraint system components are currently designed to carry out very specific functions and are inherent parts of design involving multi disciplinary aspects such as EuroNCAP, USNCAP, FMVSS208. Their development and analysis expose the designer to a series of unknown parameters from several sources such as material properties, environmental and operational conditions. Therefore the qualification and quantification of these inherent sources of design uncertainties becomes very important.

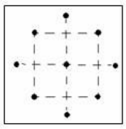
This paper focuses on the methodology development and application of a multidisciplinary design optimisation, robustness in choosing and designing a restraint system for meeting vehicle targets for USNCAP and FMVSS208 crash scenarios for both driver and passenger simultaneously. The methodology used is based on the 6-sigma principles. This paper also include a Calibration of the kinematics response of the airbag is achieved by defining the activity as an optimisation problem. The objective being to minimise the error between the experimental test and numerical simulation curves. Once calibration has been achieved, a unique robustness assessment is performed, which utilises the optimisation technology used in the calibration exercise. The approach efficiently quantifies the quality of the numerical model to achieve successful calibration. The numerical model is assessed against a sigma quality level of ±3? thus identifying the most efficient way to control the variation to achieve the required quality level.

Characterise Phase Or Sampling Methods

Determine relationships between certain key factors (noise and control).





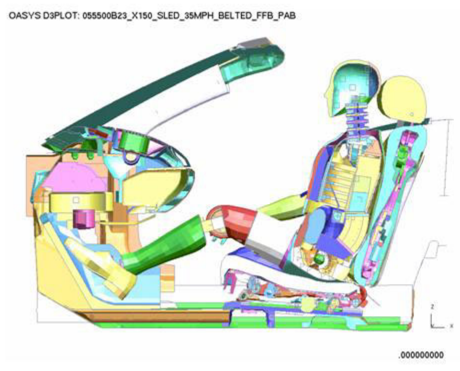


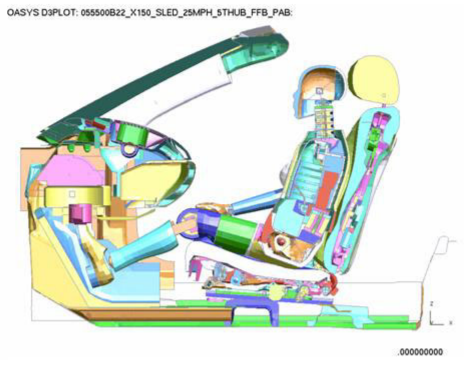
Full or partial factorial DOE.

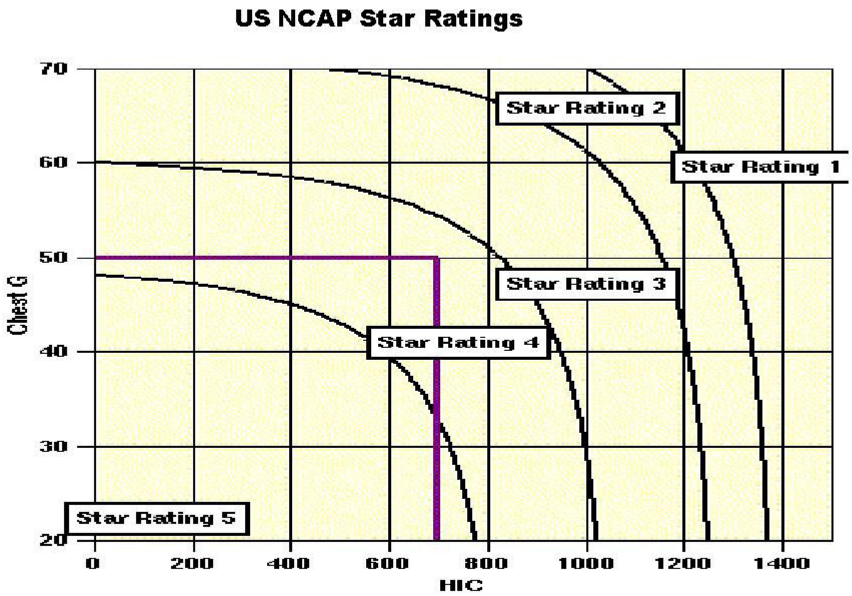
- Latin Hypercube
- Generic Algorithms
- **Stochastic Method**
- Response Surface Method

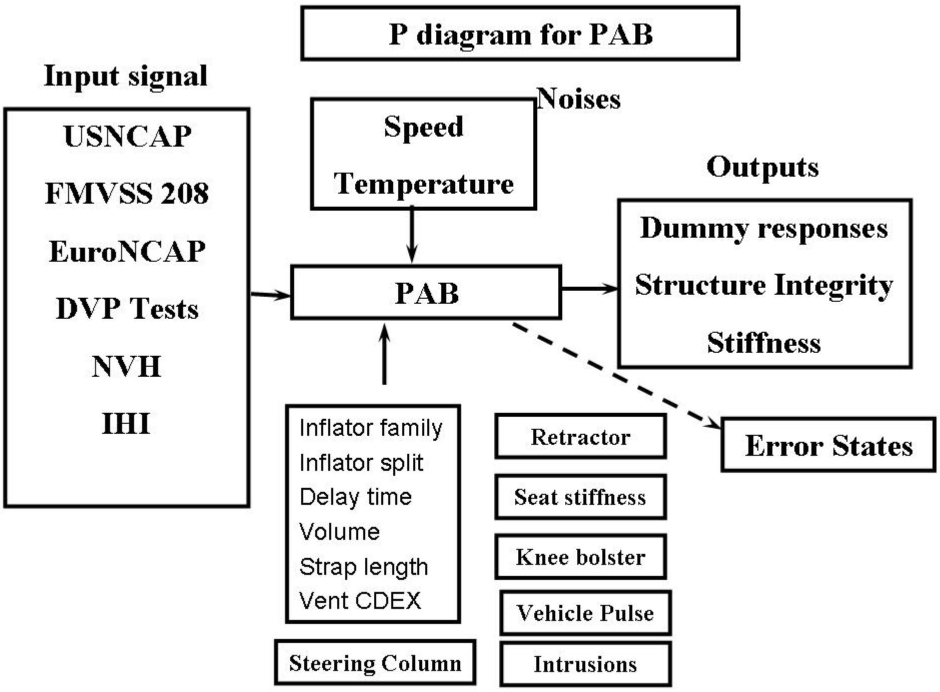
Optimisation and Robustness

Model set up






US NCAP Star Ratings
Star Rating 1
Star Rating 2
Star Rating 3
Star Rating 4
Star Rating 5
Chest G
HIC
70
60
50
40
30
20
0
200
400
600
800
1000
1200
1400


P diagram for PAB
Input signal
USNCAP
FMVSS 208
EuroNCAP
DVP Tests
NVH
IHI
Speed
Temperature
Noises
Outputs
Dummy responses
Structure Integrity
Stiffness
PAB
Inflator family
Inflator split
Delay time
Volume
Strap length
Vent CDEX
Steering Column
Retractor
Seat stiffness
Knee bolster
Vehicle Pulse
Intrusions
Error States

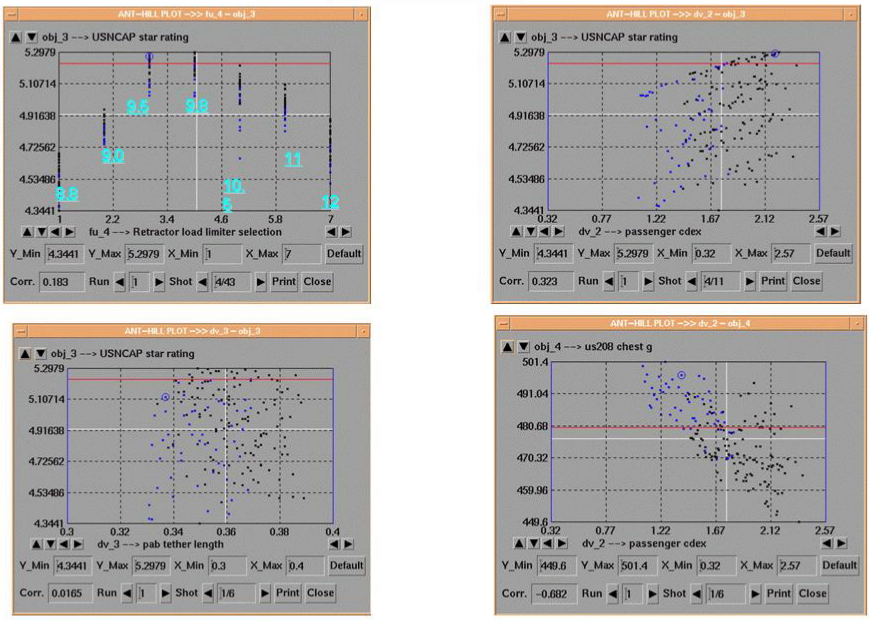
Variables used

	Initial value (proposed)	Minimum	Maximum
PAB	Inflator family PPI-3-2-3 Inflator split 60/40 Delay time 15 ms Volume 115 litres Strap length 376 mm Vent CDEX = 2.094	Same family 60/40 5 ms 115 litres No strap 0.32	Same family 70/30 20 ms 115 litres 400 mm 2.57
DAB	Inflator family Dual Tab1 Inflator split 200/140 Delay time 10 ms Vent CDEX 1.751	Same family 200/140 5 ms 0.6	Same family 225/160 20 ms 2.2
Retractor	9.5 mm diameter torsion bar	8.8 mm	12.00 mm

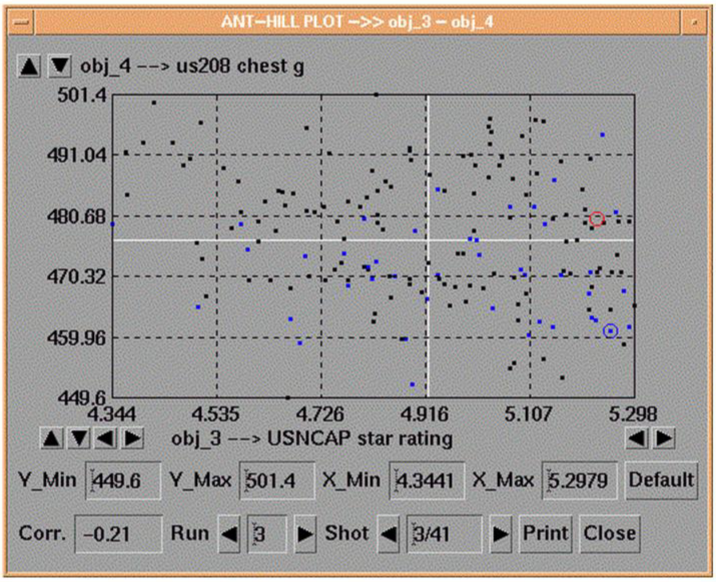
TARGETS

	Target
USNCAP: Driver & passenger	5 star rating 90% confidence Chest g < 36.6 g HIC < 445
Unbelted 208: Driver & passenger	Chest g < 48 g HIC < 700

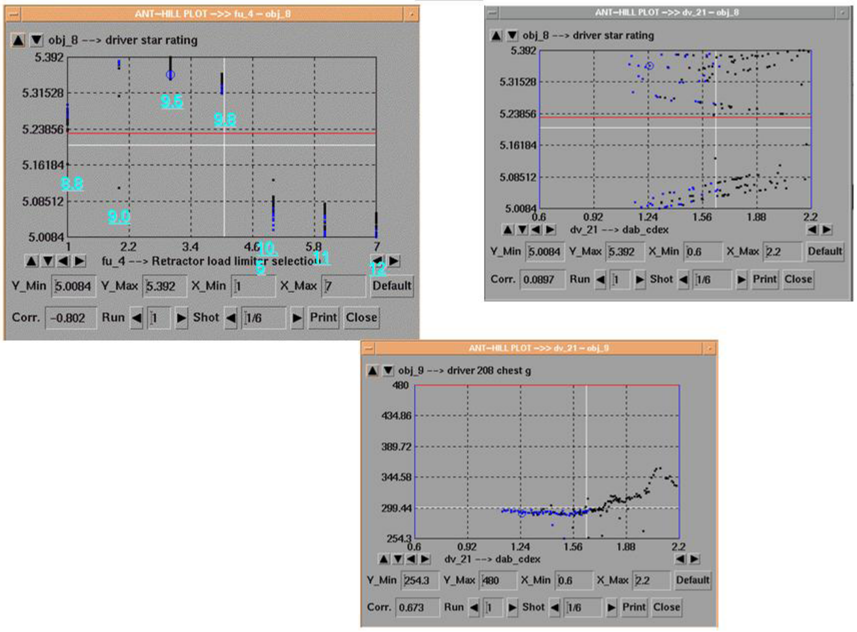
Current PAB



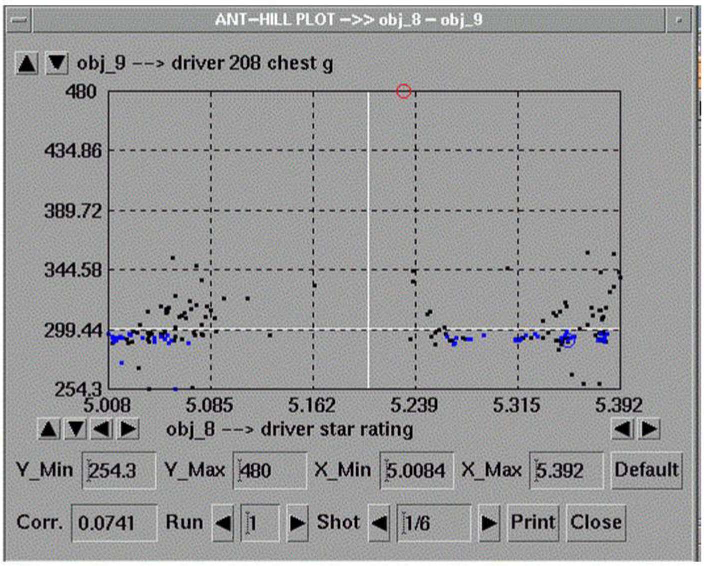
PAB Trade Off



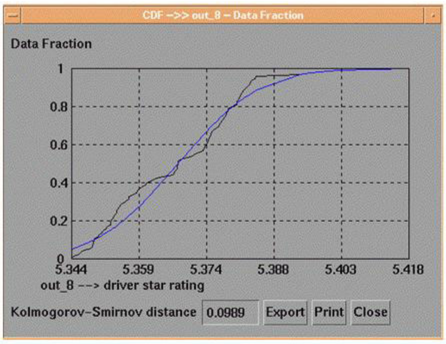
DAB



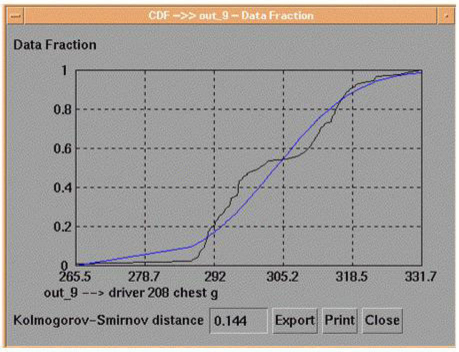
DAB Trade Off



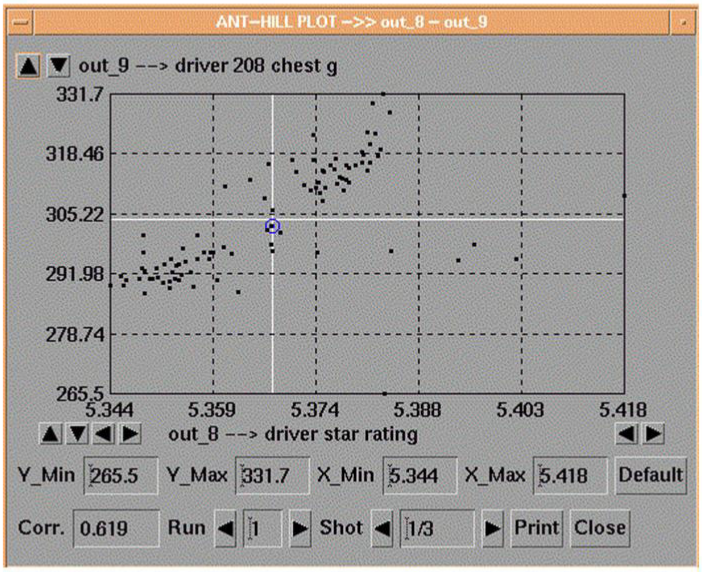
DAB Star rating Confidence



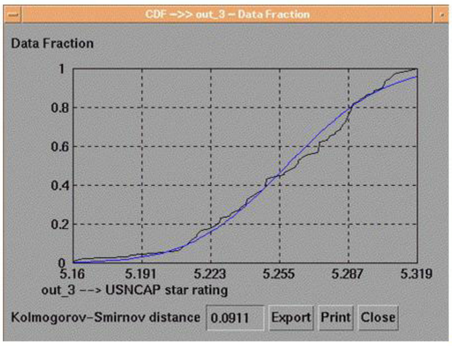
DAB 208 Confidence



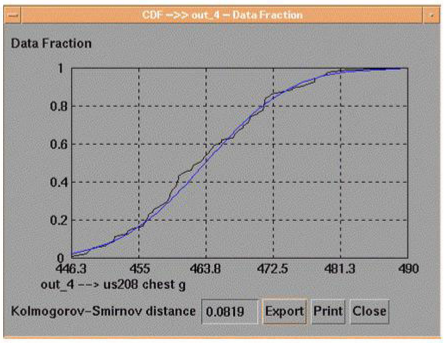
DAB Robustness



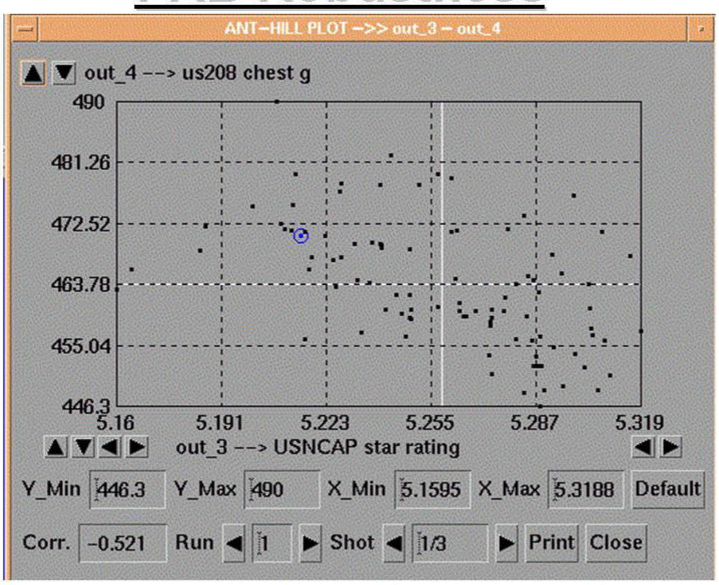
PAB Star rating confidence



PAB 208 confidence



PAB Robustness



DFSS analogy DCOV