










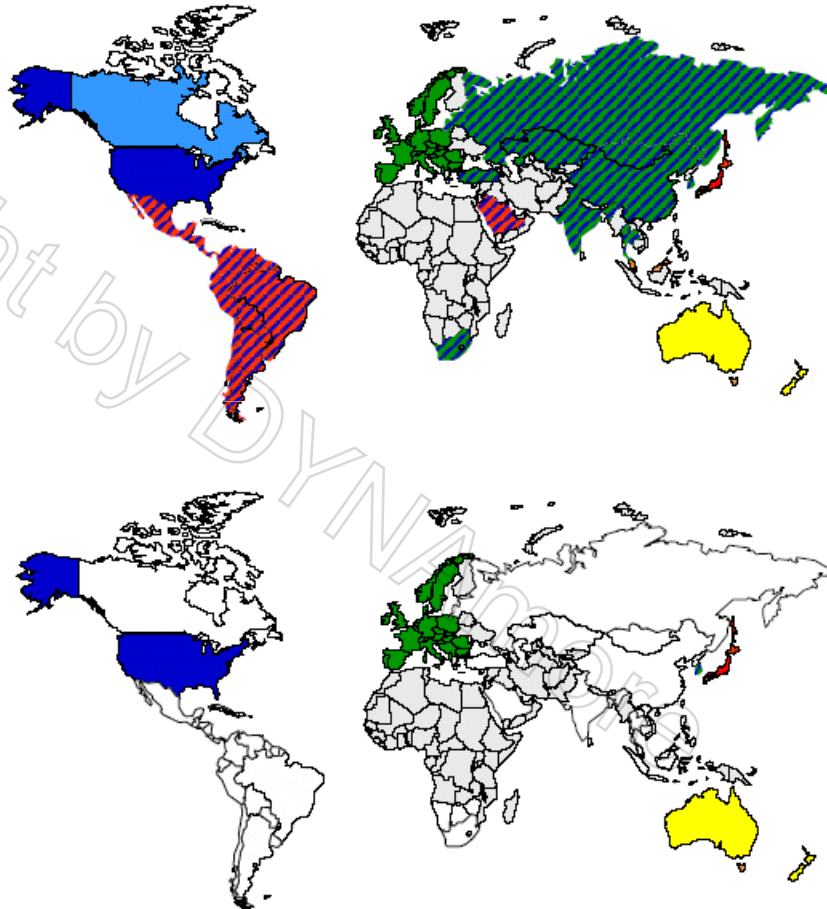
Early Design Validation of Vehicle Interiors for FMVSS 201 using IHIT and LS-DYNA

Arun Chickmenahalli International Automotive Components
Suthy C. Sivalingam ESI North America
Thomas Weninger, ESI-Group, Germany

Worldwide regulation

-  FMVSS (US)
-  CMVSS (Can)
-  ECE/EU
-  Mixed FMVSS/Local
-  Mixed ECE/Local
-  ADR (AUS)
-  TRIAS (J)

-  US-NCAP (US)
-  Euro-NCAP (EU)
-  J-NCAP
-  A-NCAP



FMVSS 201 regulation and procedures

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

LABORATORY TEST PROCEDURE
FOR
FMVSS 201

Occupant Protection

10. DEFINITIONS

INSTRUMENT PANEL AREA TO BE INVESTIGATED

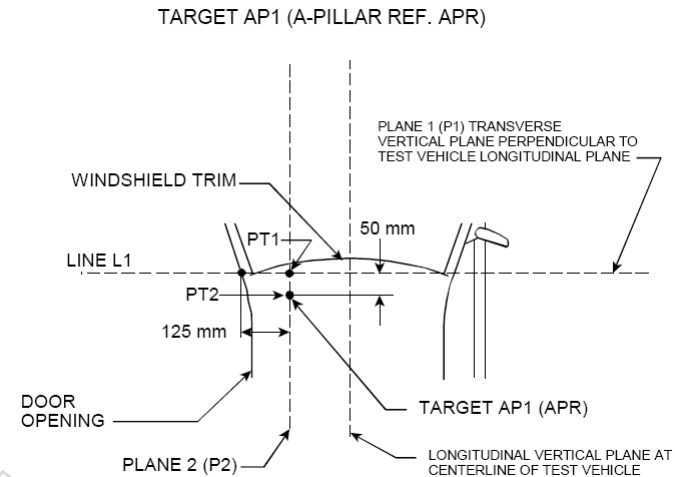
Area of the instrument panel NOT excluded by the following (see Figure 1):

- Console assemblies
- Areas less than 5 inches inboard from the juncture of the instrument panel attachment to the body side inner structure
- Areas closer to the windshield juncture than those statically contactable by the head form with the windshield in place
- Areas outboard of any point of tangency on the instrument panel of a 6.5 inch diameter head form tangent to and inboard of a vertical longitudinal plane tangent to the inboard edge of the steering wheel
- Areas below any point at which a vertical line is tangent to the rearmost surface of the panel

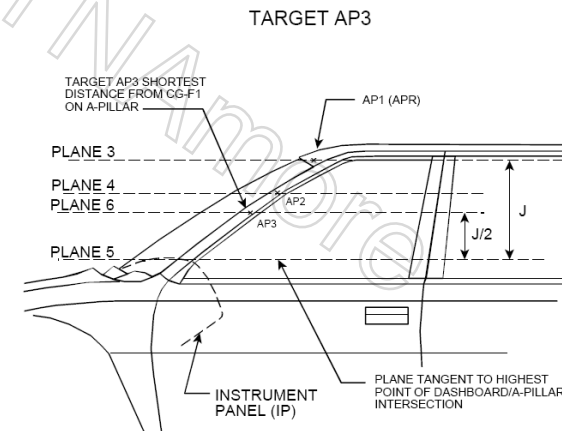
EXCLUDED AREA

FIGURE 1

<http://www.nhtsa.dot.gov/staticfiles/DOT/NHTSA/Vehicle%20Safety/Test%20Procedures/Associated%20Files/TP-201-02a.pdf>



Target Point Variation due to reach-ability issues



Head Impact Zone Variation

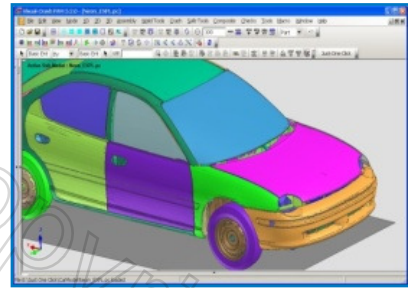
Challenges in FMVSS 201 Simulation

- Time consuming manual calculation of target points
 - 1 hour to complete one target point in average
 - Nearly 70 target points on left and right side of the vehicle
 - New components requires complete re-calculation
- Learning and interpreting the FMVSS 201 regulation
- Human errors in measurement procedure
 - Wrong reference point invalidates the dependent points
- CAE engineers use measured target points
 - Value of CAE not fully explored
- Alternatively, target points are defined in CAD models during design

ESI holistic approach



CAD based Model

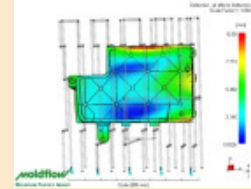


Compute Model

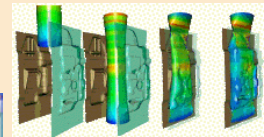


Virtual manufacturing and assembly

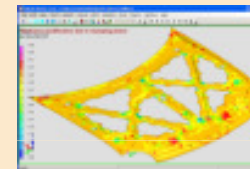
Optimization Loops



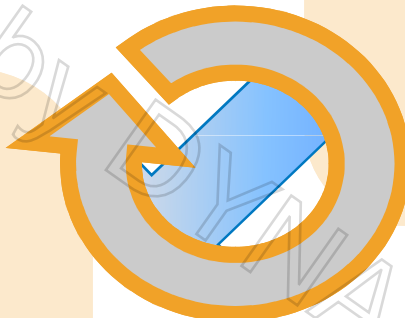
Warping



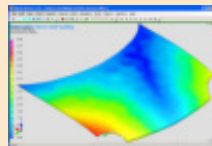
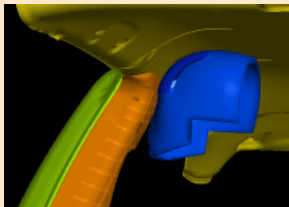
Molding



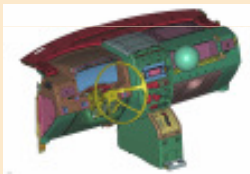
Stamping



HI 2



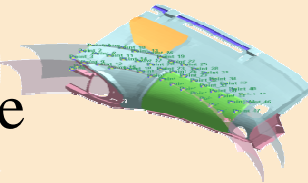
Stiffness Wind load



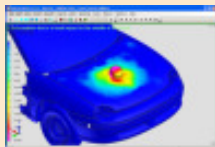
HI 1

Virtual Performance

Optimization Loops



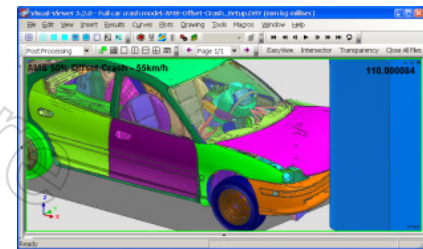
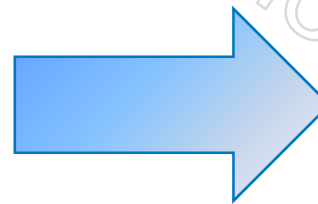
Target Zone



Pedestrian Prot.



Front Impact



Full virtual prototype

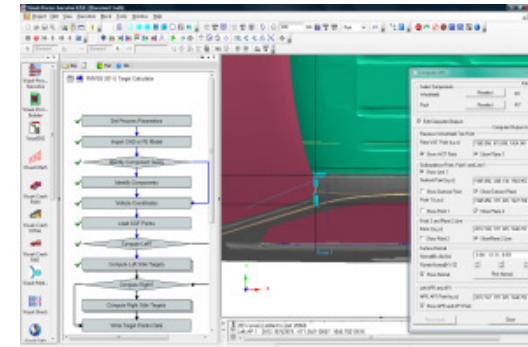
- Integrated CAE system for Crash / Save / NVH
 - Managed compute model for all major vehicle CAE disciplines
 - Automatic definition of discipline relevant compute models
 - Sidecrash vs. Frontcrash model
 - Automatic update of geometry, material or connection information
 - Compare variants, projects and results
 - Generate reports and Web documents

- FMVSS 201
 - Calculation of HIT Table
 - Headform positioning
 - Simulation
 - Report

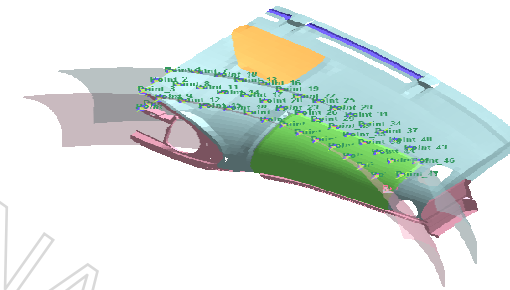
- Example VisualDSS IHIT tools for integrated FMVSS 201 simulation

Overview IHIT Tools

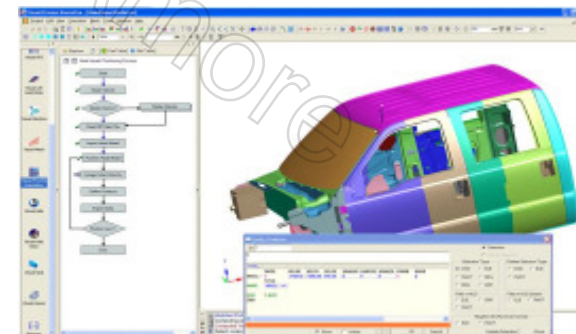
- Upper Interior Targets Locater
- Instrument Panel Targets Locater
- Contactable Robustness Points and 12 mph Zone Locater
- Simulation Model Setup for LS-DYNA, PAMCRASH, ABAQUS and RADIOSS
- Simulation Report Generation



Upper Targets Locater



IP Targets Locater



CAE Model Setup

"Visual-Safe IHIT software developers worked closely with OEMs to have a software that accurately calculates target locations consistent with practical application of the Safety Standard. The automation saves time and eliminates inconsistent application of the targeting procedure."

-- Robert (Bob) Armitage,
Head Impact Technical Specialist, Ford Motor Company, USA

"With the use of Visual-Safe IHIT, we have been able to improve turnaround time from 3 weeks to 1 week on interior head impact. Target points, zone, approach angles, impactor / headform positioning in the FEA model and report generation are automatically done by using this software."

-- Arun Chickmenahalli, FEA Manager, International Automotive Components, USA

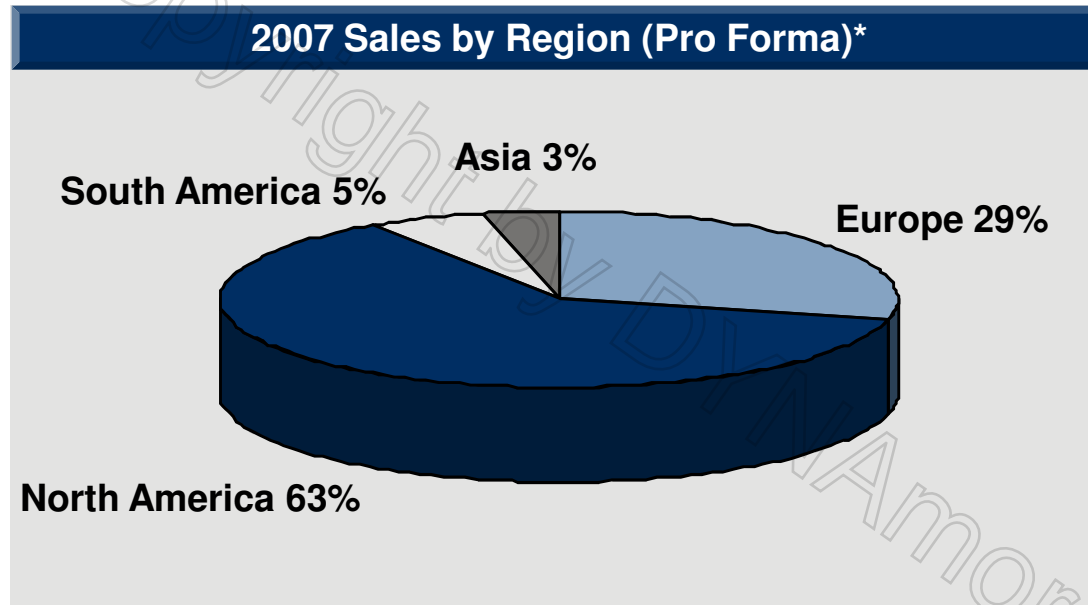
Automated Approaches Using VisualDSS

Arun Chickmenahalli
CAE Manager



IAC Global Summary

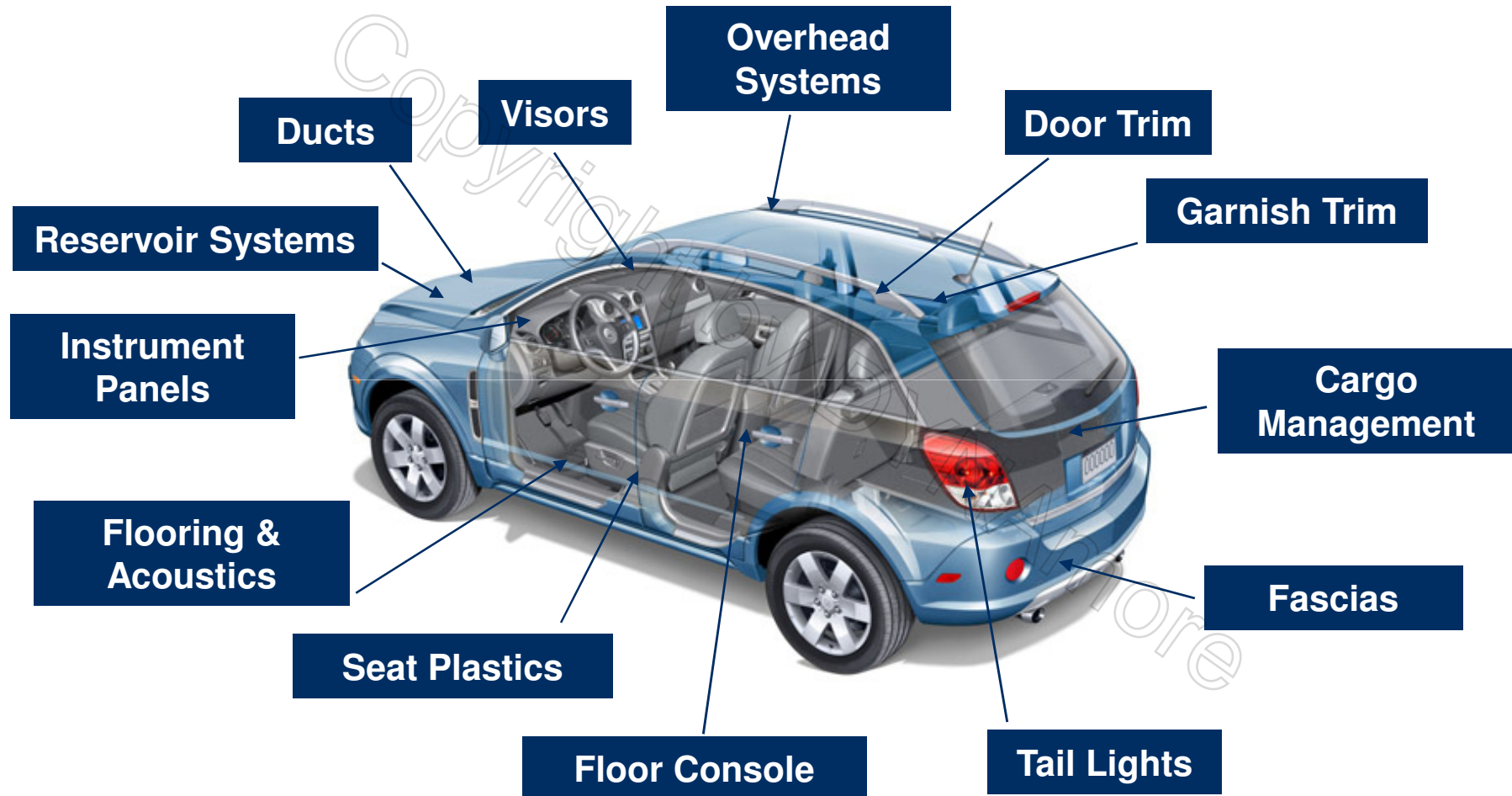
- Globally, IAC Group has 73 manufacturing facilities in 17 countries with more than 25,000 employees and \$5 billion in sales



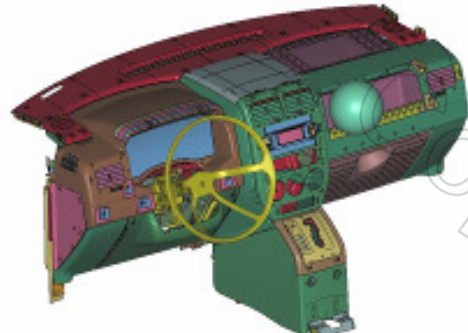
**#13 largest N.A. supplier on the 2008 *Automotive News* supplier
#1 position on *Plastics News*' 2008 N.A. injection molders list.**

*Based on Pro Forma Financials

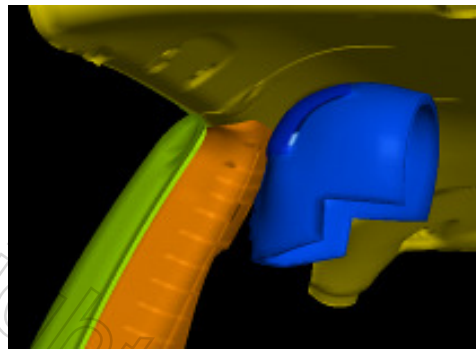
Global Product Portfolio



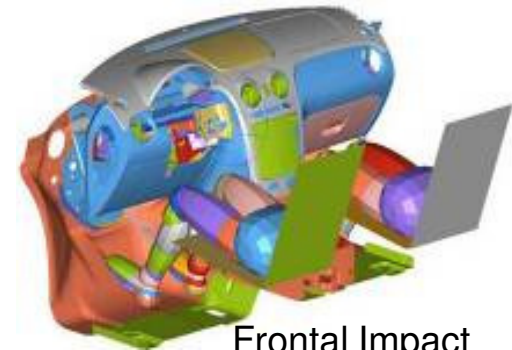
Up-Front Virtual Computer Aided Engineering Capabilities



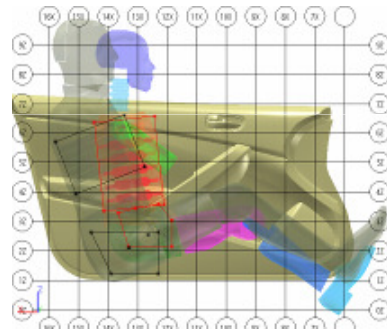
Head Impact on IP



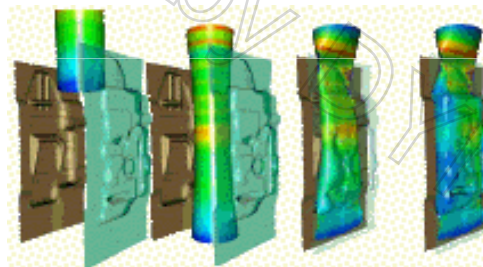
Upper Interior Head Impact



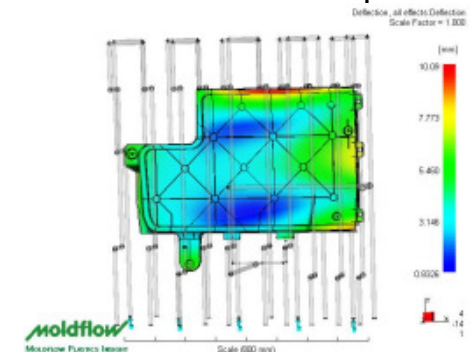
Frontal Impact



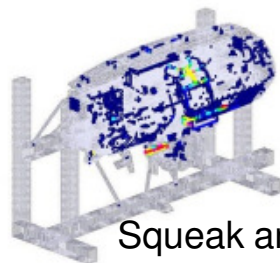
Side Impact



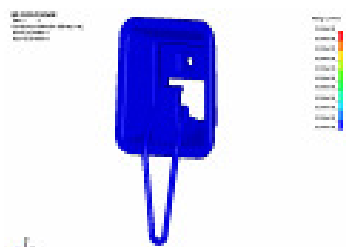
Blow Molding



Injection Molding (Fill, Cool & Warp)



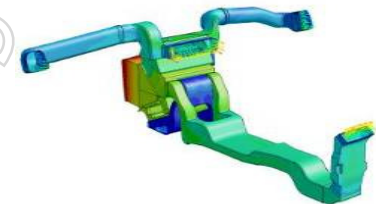
Squeak and Rattle



Thermal and Creep



Durability and Fatigue

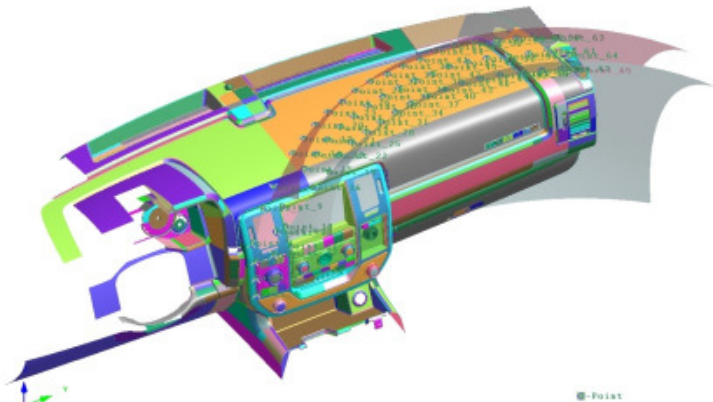


Duct Air Flow

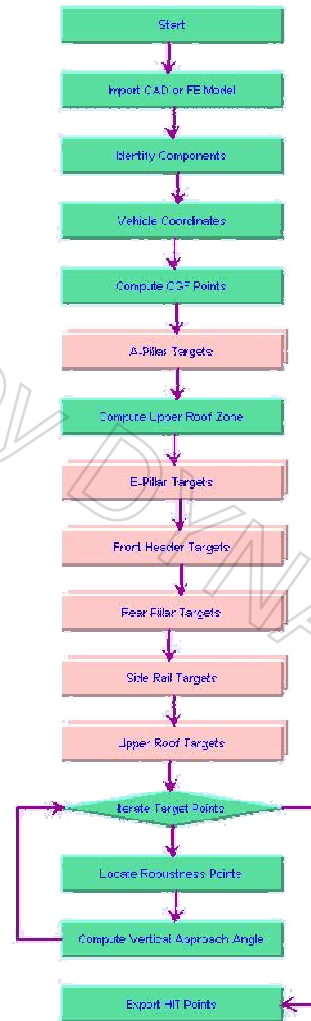
IP Head Impact Automation: Impact Zone and Targets



Typical Inputs from an OEM



Automated Zone and Targeting at a Studio released A surfaces for Instrument Panels



Zone Identification

HT Data

Name	Tx	Ty	Tz	Pick	Position M...	Veloc...	Beta	St R	Dys Fi	Compute
Point_1	1765.81	88.74	1407.13	Pick	Element No...	12.0	52.18	0.2	8.1	Compute
Point_2	1816.58	88.74	1401.06	Pick	Element No...	12.0	50.32	0.2	8.1	Compute
Point_3	1872.71	88.74	1407.03	Pick	Element No...	12.0	49.48	0.2	8.1	Compute
Point_4	1795.66	119.74	1428.59	Pick	Element No...	12.0	52.88	0.2	8.1	Compute
Point_5	1795.33	119.74	1424.26	Pick	Element No...	12.0	50.88	0.2	8.1	Compute
Point_6	1842.72	119.74	1416.26	Pick	Element No...	12.0	49.82	0.2	8.1	Compute
Point_7	1781.32	169.74	1429.56	Pick	Element No...	12.0	52.88	0.2	8.1	Compute
Point_8	1762.28	169.74	1425.98	Pick	Element No...	12.0	49.86	0.2	8.1	Compute
Point_9	1823.82	169.74	1418.24	Pick	Element No...	12.0	47.84	0.2	8.1	Compute
Point_10	1886.13	219.73	1428.03	Pick	Element No...	12.0	51.8	0.2	8.1	Compute
Point_11	1745.74	219.74	1426.76	Pick	Element No...	12.0	49.8	0.2	8.1	Compute
Point_12	1885.2	219.74	1421.14	Pick	Element No...	12.0	47.73	0.2	8.1	Compute
Point_13	1885.41	289.74	1428.13	Pick	Element No...	12.0	52.1	0.2	8.1	Compute
Point_14	1727.82	289.74	1427.36	Pick	Element No...	12.0	49.82	0.2	8.1	Compute
Point_15	1780.32	289.74	1421.15	Pick	Element No...	12.0	46.95	0.2	8.1	Compute
Point_16	1853.28	219.7	1429.77	Pick	Element No...	12.0	52.15	0.2	8.1	Compute
Point_17	1765.8	219.73	1427.36	Pick	Element No...	12.0	49.59	0.2	8.1	Compute
Point_18	1778.38	318.74	1422.57	Pick	Element No...	12.0	46.81	0.2	0.1	Compute
Point_19	1650.97	368.69	1429.08	Pick	Element No...	12.0	51.96	0.2	0.1	Compute
Point_20	1710.23	368.73	1426.85	Pick	Element No...	12.0	49.48	0.2	0.1	Compute
Point_21	1769.47	368.74	1422.51	Pick	Element No...	12.0	46.8	0.2	0.1	Compute
Point_22	1641.53	418.67	1428.44	Pick	Element No...	12.0	52.2	0.2	0.1	Compute
Point_23	1702.62	418.72	1426.34	Pick	Element No...	12.0	49.64	0.2	0.1	Compute
Point_24	1763.71	418.74	1422.02	Pick	Element No...	12.0	46.85	0.2	0.1	Compute
Point_25	1640.66	468.66	1427.55	Pick	Element No...	12.0	52.26	0.2	0.1	Compute
Point_26	1702.21	468.72	1425.37	Pick	Element No...	12.0	49.67	0.2	0.1	Compute
Point_27	1763.78	468.74	1420.89	Pick	Element No...	12.0	46.85	0.2	0.1	Compute
Point_28	1630.63	518.63	1426.72	Pick	Element No...	12.0	52.82	0.2	0.1	Compute
Point_29	1697.15	518.71	1424.57	Pick	Element No...	12.0	50.08	0.2	0.1	Compute
Point_30	1763.72	518.74	1419.66	Pick	Element No...	12.0	47.09	0.2	0.1	Compute

Show/Hide Zor Add Point OK

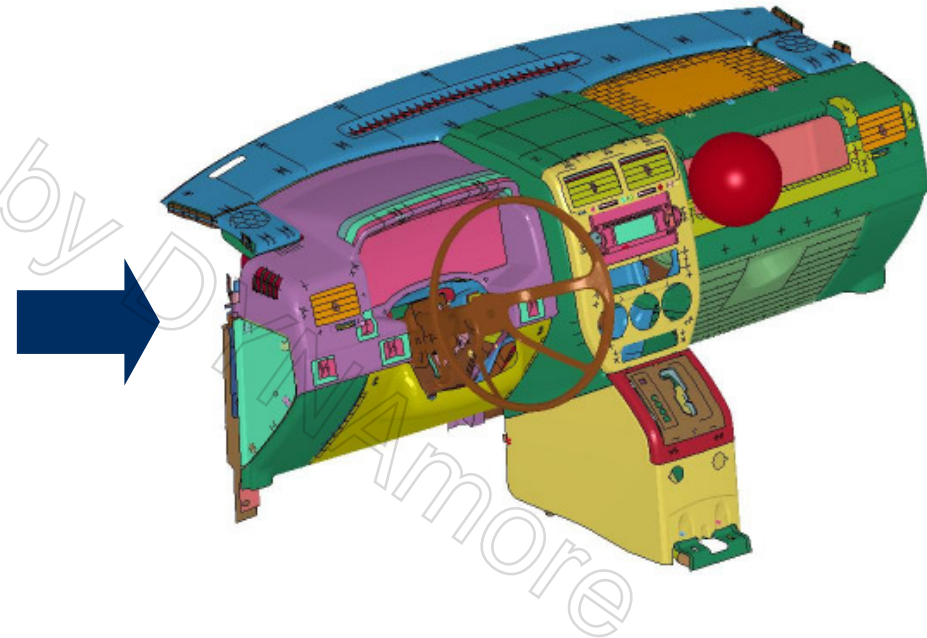
IP Head Impact Automation: Automated Positioning in CAE

Zone Identification

-HT Data

Name	Tx	Ty	Tz	Pick	Position M...	Valo	Bits	St Fr	Dyn Fr	Compute
<input checked="" type="checkbox"/> Point_1	1755.81	68.74	1427.13	Pick	Element No...	12.0	52.18	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_2	1815.59	68.74	1421.06	Pick	Element No...	12.0	50.32	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_3	1873.71	68.74	1407.03	Pick	Element No...	12.0	48.48	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_4	1726.66	118.74	1428.89	Pick	Element No...	12.0	52.08	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_5	1785.37	118.74	1424.25	Pick	Element No...	12.0	50.09	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_6	1843.72	118.74	1416.35	Pick	Element No...	12.0	48.02	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_7	1701.32	168.74	1429.86	Pick	Element No...	12.0	52.08	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_8	1762.29	168.74	1425.98	Pick	Element No...	12.0	49.86	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_9	1823.02	168.74	1419.34	Pick	Element No...	12.0	47.54	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_10	1686.13	218.73	1430.03	Pick	Element No...	12.0	51.9	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_11	1745.74	218.74	1426.76	Pick	Element No...	12.0	49.6	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_12	1805.2	218.74	1421.14	Pick	Element No...	12.0	47.17	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_13	1665.41	268.71	1430.13	Pick	Element No...	12.0	52.1	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_14	1727.92	268.74	1427.36	Pick	Element No...	12.0	49.62	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_15	1790.32	268.74	1422.15	Pick	Element No...	12.0	46.95	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_16	1653.38	318.7	1429.77	Pick	Element No...	12.0	52.15	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_17	1715.9	318.73	1427.36	Pick	Element No...	12.0	49.59	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_18	1778.38	318.74	1422.57	Pick	Element No...	12.0	46.81	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_19	1650.97	368.69	1429.08	Pick	Element No...	12.0	51.96	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_20	1710.23	368.73	1426.85	Pick	Element No...	12.0	49.48	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_21	1769.47	368.74	1422.51	Pick	Element No...	12.0	46.8	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_22	1641.53	418.67	1428.44	Pick	Element No...	12.0	52.2	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_23	1702.62	418.72	1426.34	Pick	Element No...	12.0	49.64	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_24	1763.71	418.74	1422.02	Pick	Element No...	12.0	46.85	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_25	1640.66	468.66	1427.55	Pick	Element No...	12.0	52.26	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_26	1702.21	468.72	1425.37	Pick	Element No...	12.0	49.67	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_27	1763.78	468.74	1420.89	Pick	Element No...	12.0	46.85	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_28	1630.63	518.63	1426.72	Pick	Element No...	12.0	52.82	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_29	1697.15	518.71	1424.57	Pick	Element No...	12.0	50.08	0.2	0.1	Compute
<input checked="" type="checkbox"/> Point_30	1763.72	518.74	1419.66	Pick	Element No...	12.0	47.09	0.2	0.1	Compute

Show/Hide Zor Add Point OK



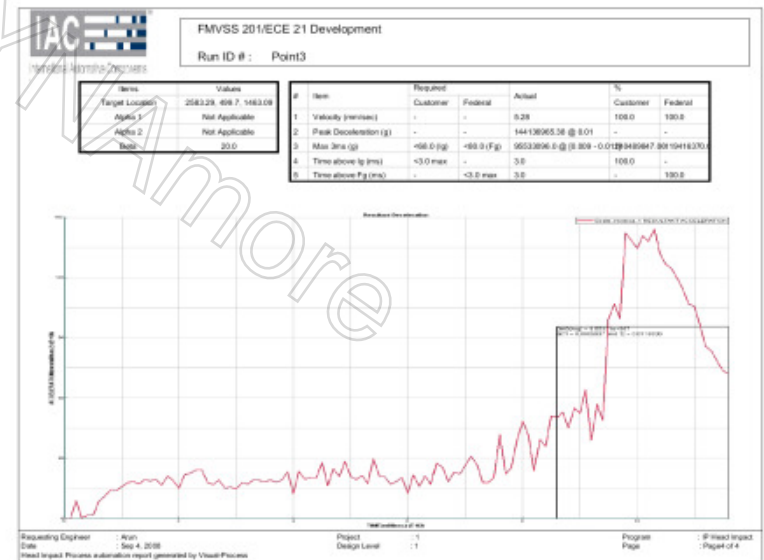
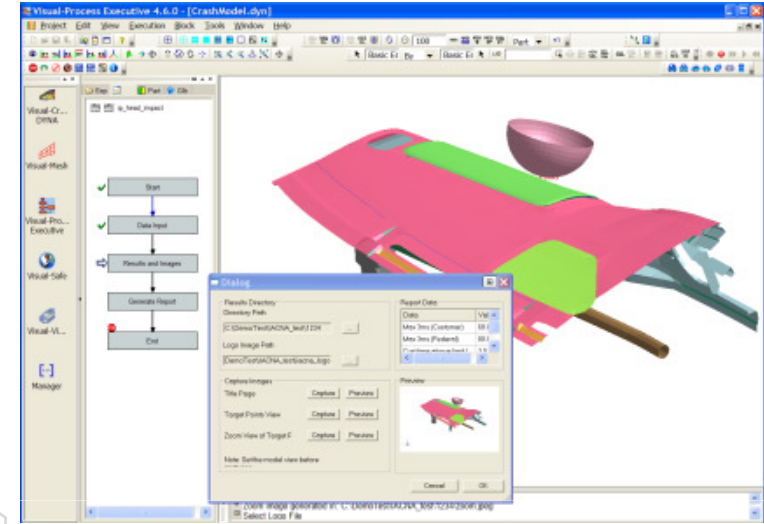
IP Head Impact Automation: Automated Report Generation

Automated report generation in Html, PowerPoint or PDF formats.

Create reports for each domain with standard content

Automatically create reports which compare different variants of different projects

Basic building block for knowledge database



Benefits

- **Time and Cost Savings: Reduction of turn around time from 3 weeks to 1 week for an Instrument Panel Head Impact project**
- **The Analyst's time can be utilized for other projects**
- **Less potential for human error**
- **Systematic and organized data management**
- **Helps the global offshore centers to be in par with the parent centre in a short period of time.**
- **Work can be started in the beginning of the product development cycle.**
- **One input file for all the IP head impact simulations**
- **This tool can also be used for upper interior head impact**

Challenges and Recommendations

- **Ease of use needs some improvement**
- **Adopt online training for simple editing of the software to meet the user needs**
- **Robustness study module should be a part of the standard package**
- **Simple flow charts for better understanding of the process which should eliminate specialized training.**



Questions ?

Copyright by DYNAmore



Pls visit our booth for more information

Thomas Weninger
ESI Group

Thomas.Weninger@esi-group.com