

*Welcome*

## **Participants of 3<sup>rd</sup> AAI Summit**



**Overview of functions and strengths of  
AUTOMOTIVE RESEARSH ASSO OF INDIA (ARAI)**

*Presentation by*

**Neelkanth V. Marathe**

**Senior Deputy Director & Head – Power Train Engineering**

**3<sup>rd</sup> AAI Summit  
Hotel Novotel Impact, Bangkok**

***3<sup>rd</sup> December 2014***



- **About ARAI**
- **Functions of ARAI**
- **R&D divisions – Business portfolio, facilities and projects**
- **Certification divisions – Business portfolios and facilities**
- **Closing Remarks**

## **Automotive Research Asso of India (ARAI) Pune**

<b>Establishment</b>	<b>: 1966</b>
<b>Location</b>	<b>: Pune, INDIA (150 km south-east of Mumbai)</b>
<b>Manpower</b>	<b>: 600+</b>
<b>Facilities</b>	<b>: 12 divisions – Powertrain, Emissions, Safety &amp; Homologation, Passive Safety, Vehicle Evaluation, Materials, Automotive Electronics, NVH, CAE, Structural Dynamics, Calibration, Post Graduate Academy, Forging Industry Division</b>
<b>Offices</b>	<b>: China, Korea and Chennai</b>
<b>Investments</b>	<b>: USD \$ 60 Million</b>
<b>Accreditations</b>	<b>: ISO 9001, 14001, OHSAS 18001 &amp; NABL ( ISO/IEC 17025)</b>

## Automotive Research Asso of India (ARAI) Pune



## Government of India

### **MORTH**

Ministry of Road  
Transport &  
Highways

### **MOHI&PE**

Ministry of Heavy  
Industries & Public  
Enterprises

### **MOEF**

Ministry of  
Environment &  
Forests

**Ministry of  
Consumer Affairs**

### **DGFT**

Director General of  
Foreign Trade

**State Ministries**

## Standardization

### **CMVR-**

**Technical Standing  
Committee**

**Automotive Industry  
Standards Committee-AISC**

**Standing Committee on  
Emission Legislation – SCOE**

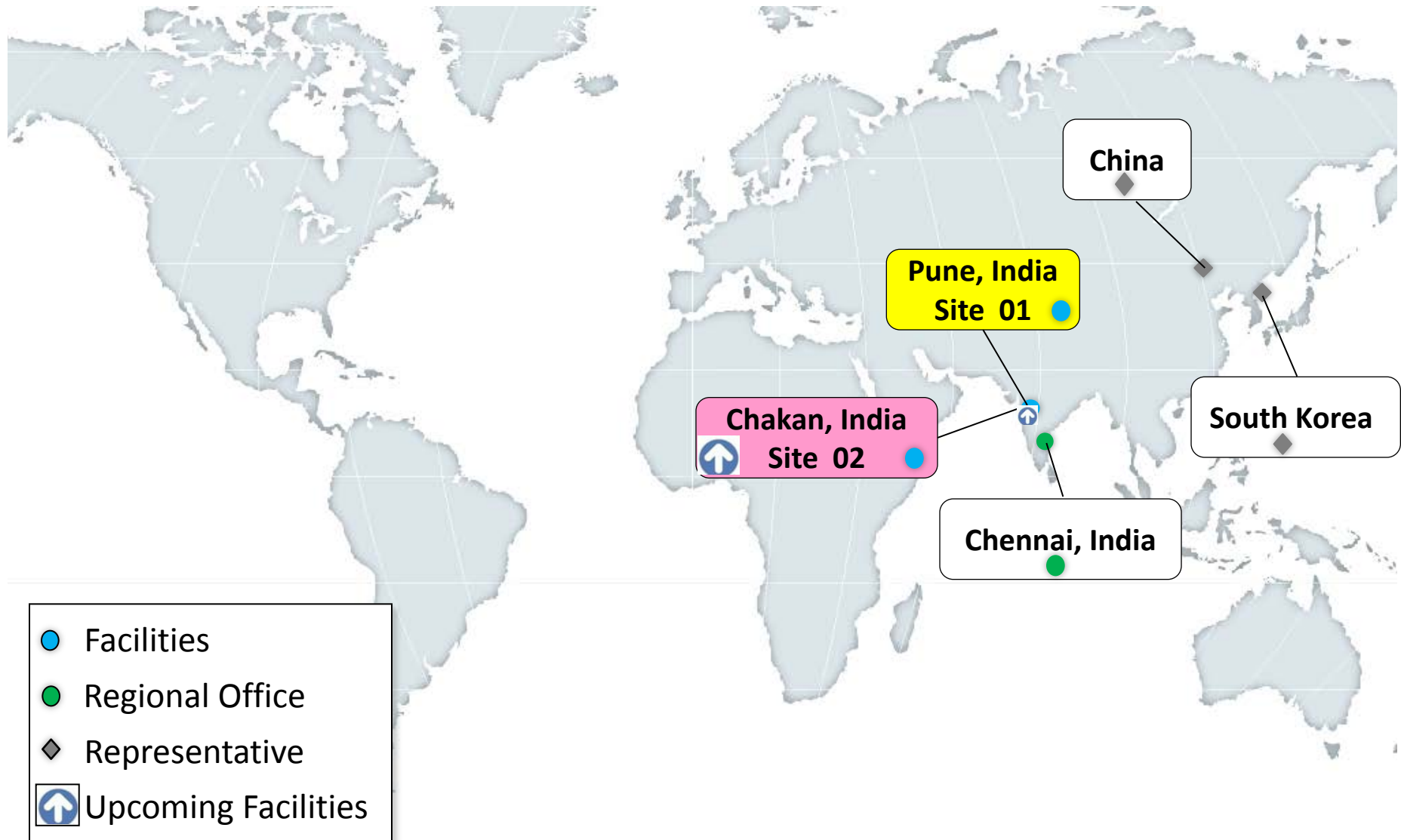
**Bureau of Indian Standards  
– BIS**

## Type Approval / Certification Agencies

### **ARAI**

**Automotive Research  
Association of India**

**Other testing  
agencies identified  
by Govt. of India**



**1970**

**Testing House**

**2010**

**Testing + R&D House**

**1970 – 1980**

**Focus Area**

**Facility  
Establishment**

**1981 – 1990**

**Focus Area**

**Testing  
Competency**

**1991 – 2010**

**Focus Area**

**Technology  
Development**

**> 2010**

**Focus Area**

**Research**

**Tools**

**Experience**

**Expertise**

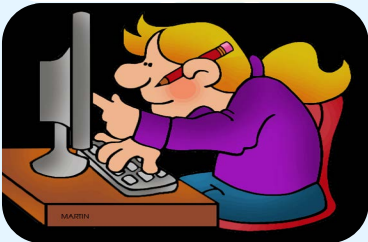
**Knowledge**



**R&D: Automotive Industry Projects,  
National Interest Projects and Internal R&D Projects**



**Certification Testing / Homologation**



**Assisting Government of India  
in Formulation of Regulatory Standards  
and Harmonization of Regulations**



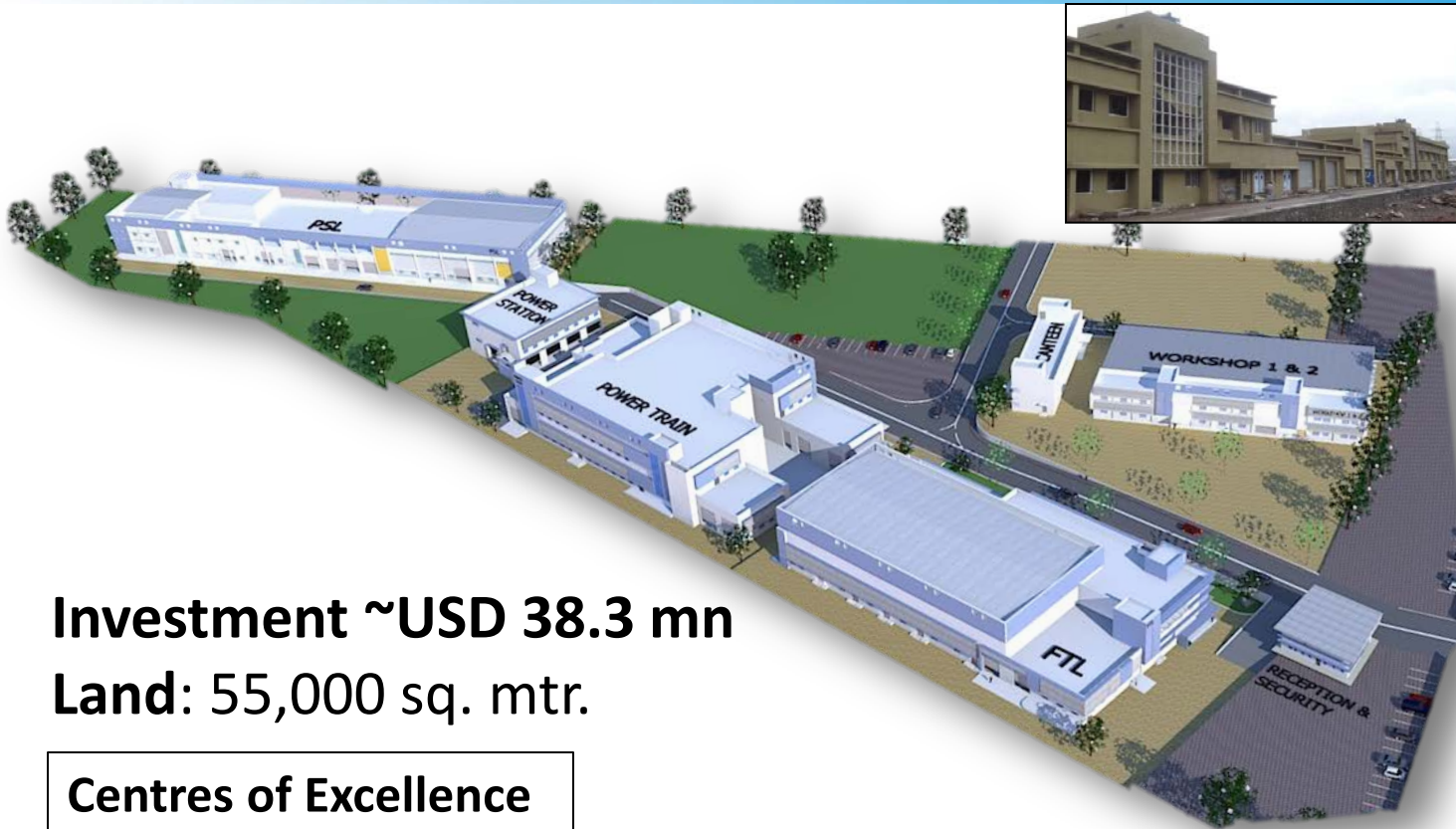
**Education and Training**



**Consulting Services**



- Full Vehicle and engine testing and approval
  - 2 wheelers / 3 wheelers
  - Passenger cars
  - Commercial vehicles / buses
  - Agricultural Tractors / Construction Equipment
  - Battery operated Vehicles
  - CNG / LPG Retrofitment Vehicles
- Diesel / Petrol / CNG / LPG engines for emission certification
- Pollution Under Control (PUC) equipment
- Certification of Safety Components
- Export Homologation



**Investment ~USD 38.3 mn**

**Land: 55,000 sq. mtr.**

## Centres of Excellence

- **Powertrain**
- **Fatigue**
- **Materials**

## Other Areas:

- **Passive Safety**

***Facilities will be Operational by April 2015***





- Powertrain and Transmission
- Automotive Electronics
- Automotive Materials
- Structural Dynamics

- ◆ Homologation and Certification
- New Services
- Knowledge Initiatives

## TECHNOLOGY DRIVERS:

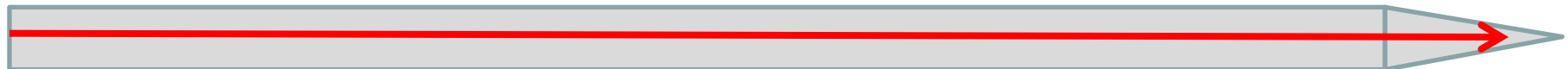
Fuel economy  
Low emissions  
Weight reduction  
Ride comfort  
Vehicle stability & Handling  
Reduced road damage  
Cost Efficient

30% Fuel reduction

20% Weight reduction

- Powertrain
- Vehicle Structure/Dynamics
- NVH

- Safety
- Electronics
- Light Weight Materials



2010

2013

2015

2020

- Hybrid Electric Vehicle Technology Development in Phase I (2010-2020)
- Light Weight Passenger Bus Technology Development in Phase I (2010-2020)

**Technology drivers:**

- Fuel economy
- Low emissions
- Ride comfort
- Vehicle stability
- Handling
- Safety & Light weight construction

- Continuously variable transmission (CVT)
- 3 cylinder CI/GDI/CNG(4-cylinder)
- Electric Power Pack
- Electric Power steering
- Traction control
- Active Head Restraint
- Composite materials
- Networking
- Advanced Lighting

- NVH Program
- Road vehicle interaction
- Virtual simulation
- Vehicle Integration

- Emergency brake assist
- Ceramic coatings
- Adaptive cruise control
- Accelerator Force Feed back pedal(AFFP)
- Smart foams
- Transmission control unit
- Active Suspension
- Airbags
- Steer by wire

Transmission/Chassis system/NVH

Transmission/Chassis system/NVH

*Phase I*

*Phase II*

*Phase III*

Safety/Structure/Electronics

Safety/Structure/Electronics

2010

2013

2015

2020

2025

**Hybrid Electric Vehicle**



**Technology drivers:**

- Fuel economy
- Low emissions
- Weight reduction
- Ride comfort
- Vehicle stability
- Handling
- Reduced road damage
- Cost Efficient

30% Fuel reduction

20% Weight reduction

- Electric drive propulsion system
- Air Suspension
- Traction control
- Advanced High strength steel (Body & chassis)
- Advanced Lighting
- Electronics

- NVH Program
- Road vehicle interaction
- Virtual simulation
- Vehicle Integration

- Synthetic fuel engine(DME)
- Advance combustion engine
- Emergency brake assist
- Adaptive cruise control
- Active control of structural vibrations
- Smart foams
- Auto pilot( GPS)
- Transmission control unit & Engine modifications
- Active Night Vision
- Infotainment

Transmission/Engine/Chassis system/NVH

Transmission/Engine/Chassis system/NVH

*Phase I*

*Phase II*

*Phase III*

Safety/Structure/Electronics

Safety/Structure/Electronics

2010

2013

2015

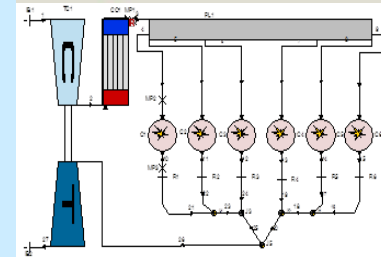
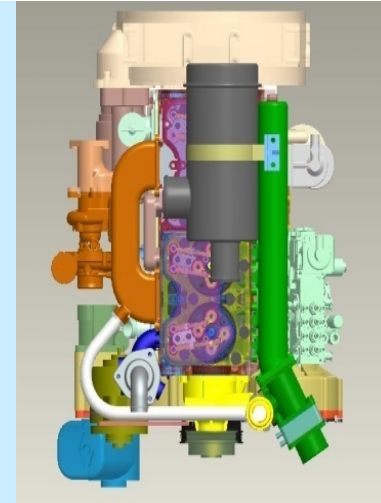
2020

2025

**Light Weight Passenger Bus**

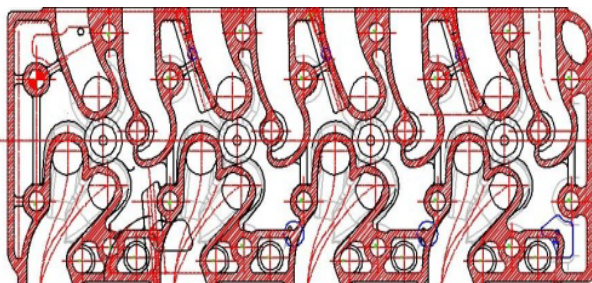
- **R&D divisions**  
**Business portfolio, facilities and projects**

- **NEW ENGINE DESIGN and DEVELOPMENT** (*Paper concept to Prototype*)
- **DESIGN UPGRADATION OF EXISTING ENGINES**
- **PERFORMANCE UPGRADATION OF EXISTING ENGINES**
- **COMBUSTION & EMISSION IMPROVEMENT**
- **AFTER TREATMENT OPTIMISATION**
- **SPECIFIC POWER (BOOSTING) & FUEL ECONOMY IMPROVEMENT**
- **LAYOUTING & ENGINE SUB-SYSTEM DESIGN**
- **ALTERNATE FUEL ENGINES – CNG, LPG, HCNG, Dual-Fuel ....**
- **FEASIBILITY STUDY REPORTS**
- **ENGINE FAMILY DEVELOPMENT**
- **BENCHMARKING**
- **FRICTION AUDIT AND REDUCTION SOLUTIONS**
- **NVH & WEIGHT OPTIMISATION, PACKAGING**
- **DURABILITY TESTING**



## New Competency Areas:

- HCCI combustion development
- Hydrogen – CNG blended fuel engines
- Dual Fuel CNG – diesel engines
- CNG injection
- High power density engines
- Engine downsizing
- Hybrid power train development





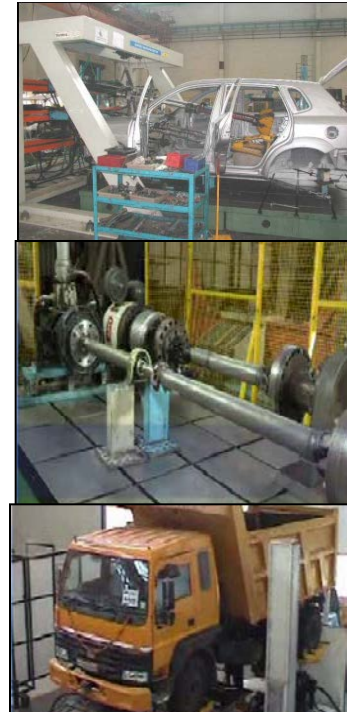
## New engines designed and developed by Power Train Engineering division of ARAI



### Facilities

Transient dynamometers (450 kW mx), Eddy current dynamometers (580 kW mx), Emission analysers, Full and partial flow Particulate systems, Port flow bench, Friction motoring test bench, combustion measurement, gas exchange study, valve train and chain dynamics measurement, oil consumption, Thermal shock tests  
Known Commercial design and analysis software, ARAI developed design software, CAE, FEA and CAD facility, port flow box machining

- Vehicle design / development for durability / reliability / comfort
- Service load data acquisition on Indian roads
- Compressing vehicle development time
- Laboratory / virtual simulation
- Correlation of Indian roads to proving tracks
- Design and development of suspension using Hardware-in-Loop technology



## Facilities

- 2500 LPM, 210 Bar, Hydraulic Power-Pack
- 80 Rectilinear Actuators (Force Capacity up to  $\pm 250$  kN)
- 2 Rotary Actuators (Torque Capacity up to  $\pm 22.6$  kN-m)
- 196 Channels of simultaneous data acquisition
- Multi-axis Shaker Table
- 22 Channel Controller
- Pulsator
- 6000 kgf Electro-dynamic Shaker with Environ Chamber

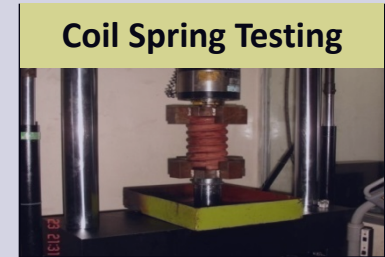




## Simulation



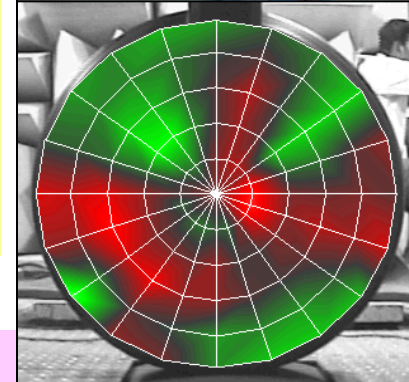
## Component Level Testing



## Seat Development & Certification Testing



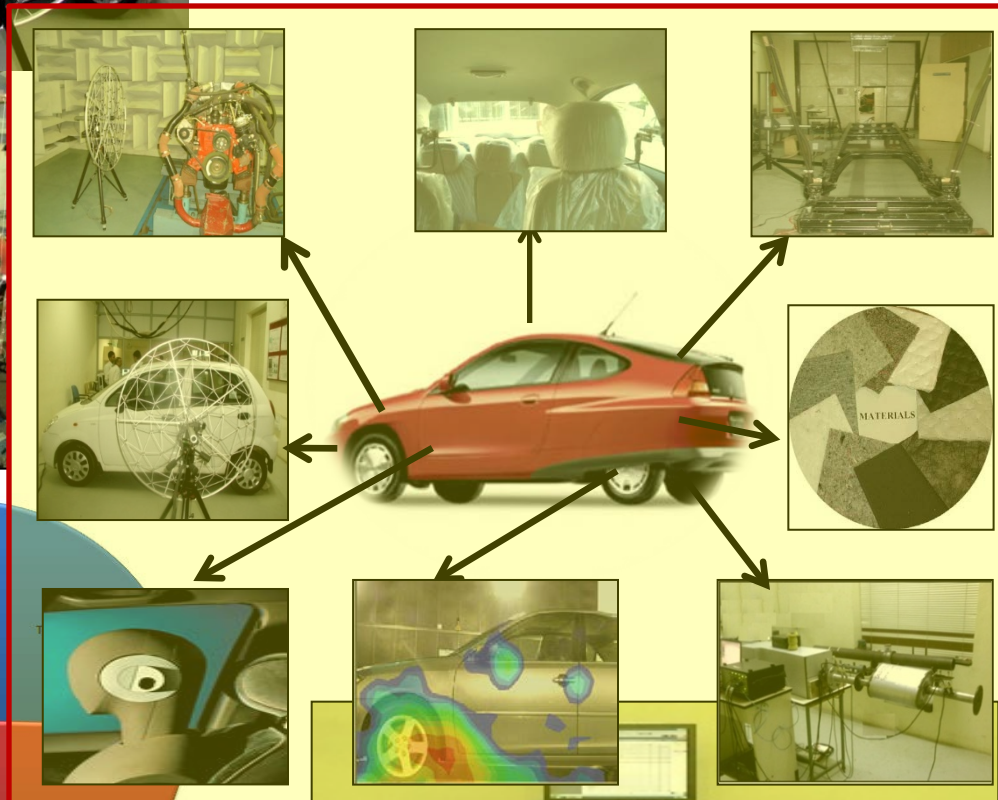
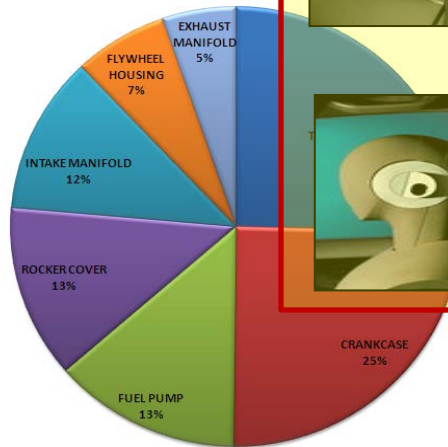
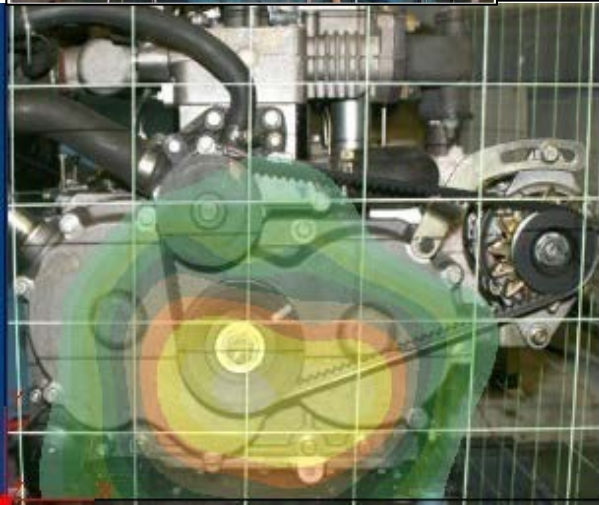
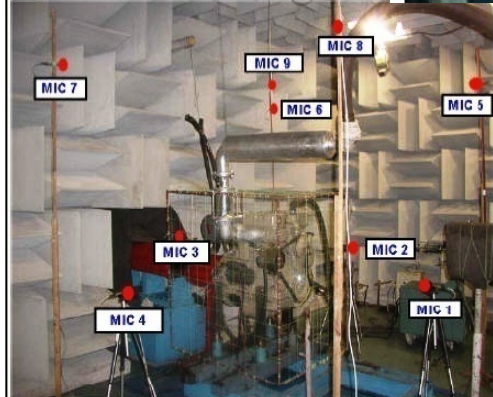
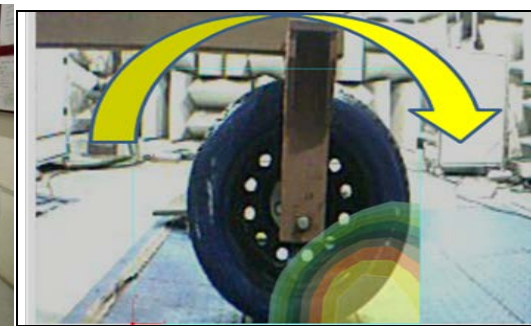
- Sound Power evaluation and understanding of engine NVH
- Sound Intensity Mapping, Ranking and Contribution Analysis
- Transient Acoustic Holography
- Linear and Torsional Vibration measurement of the Powertrain
- Pass-by Noise Measurement
- Interior NVH Assessment
- Tyre NVH Evaluation
- Noise & Vibration Mapping
- Identification of Prominent Noise Sources
- Effectiveness of Engine & Body Mounts
- Effectiveness of Silencer & Intake system
- Effectiveness of Acoustic Treatment



## FACILITIES

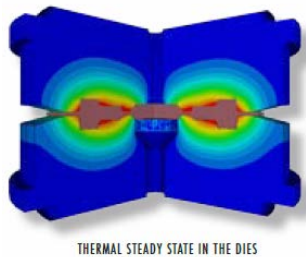
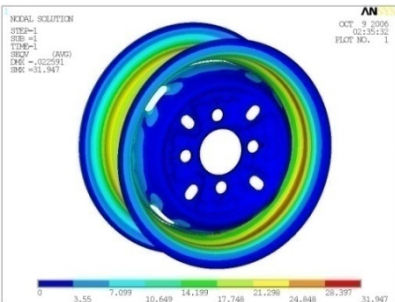
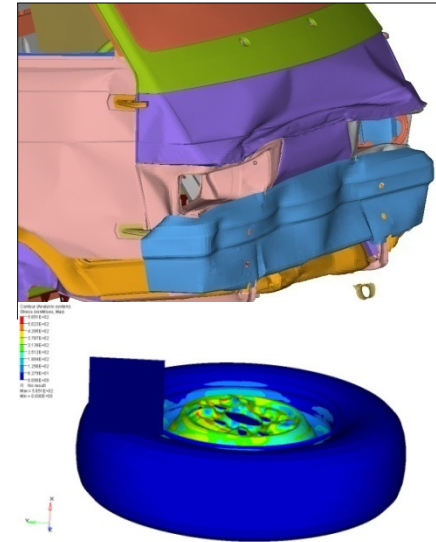
- Hemi-anechoic chamber meeting ISO : 3745 requirements
- Engine dynamometers of 70 and 400 KW capacities
- Chassis dynamometer(70 kW) for testing 2,3 and 4-W
- Two adjacent reverberation chambers of volume 110 m<sup>3</sup> and 80m<sup>3</sup>
- Test rigs for characterization of acoustic materials
- Test rig for determination of Transmission Loss of Silencer



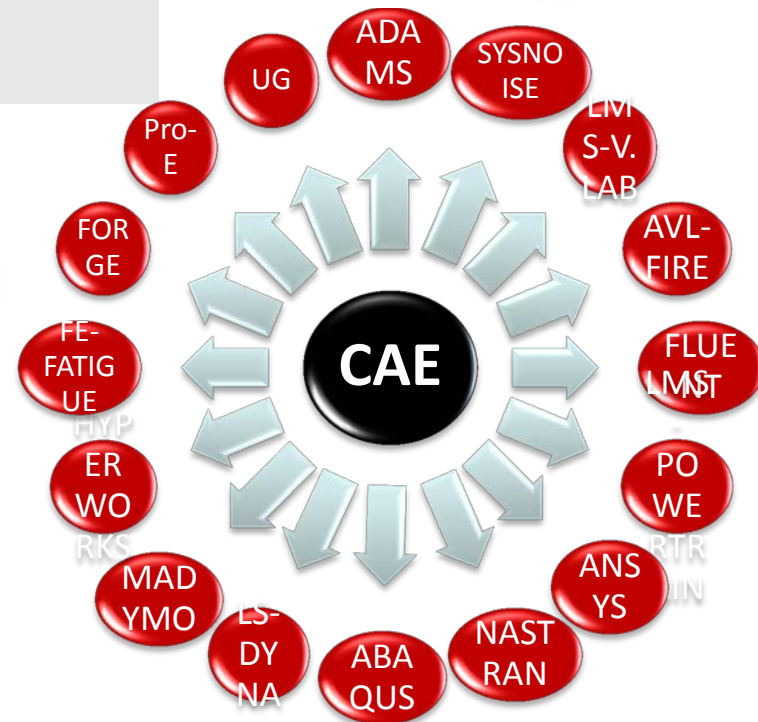
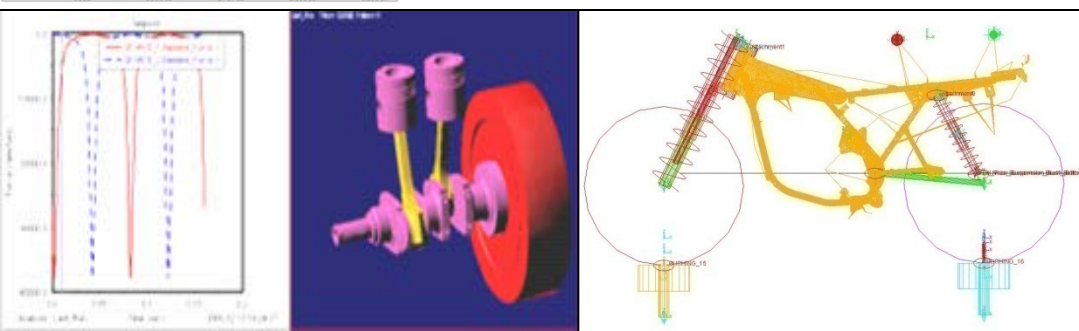


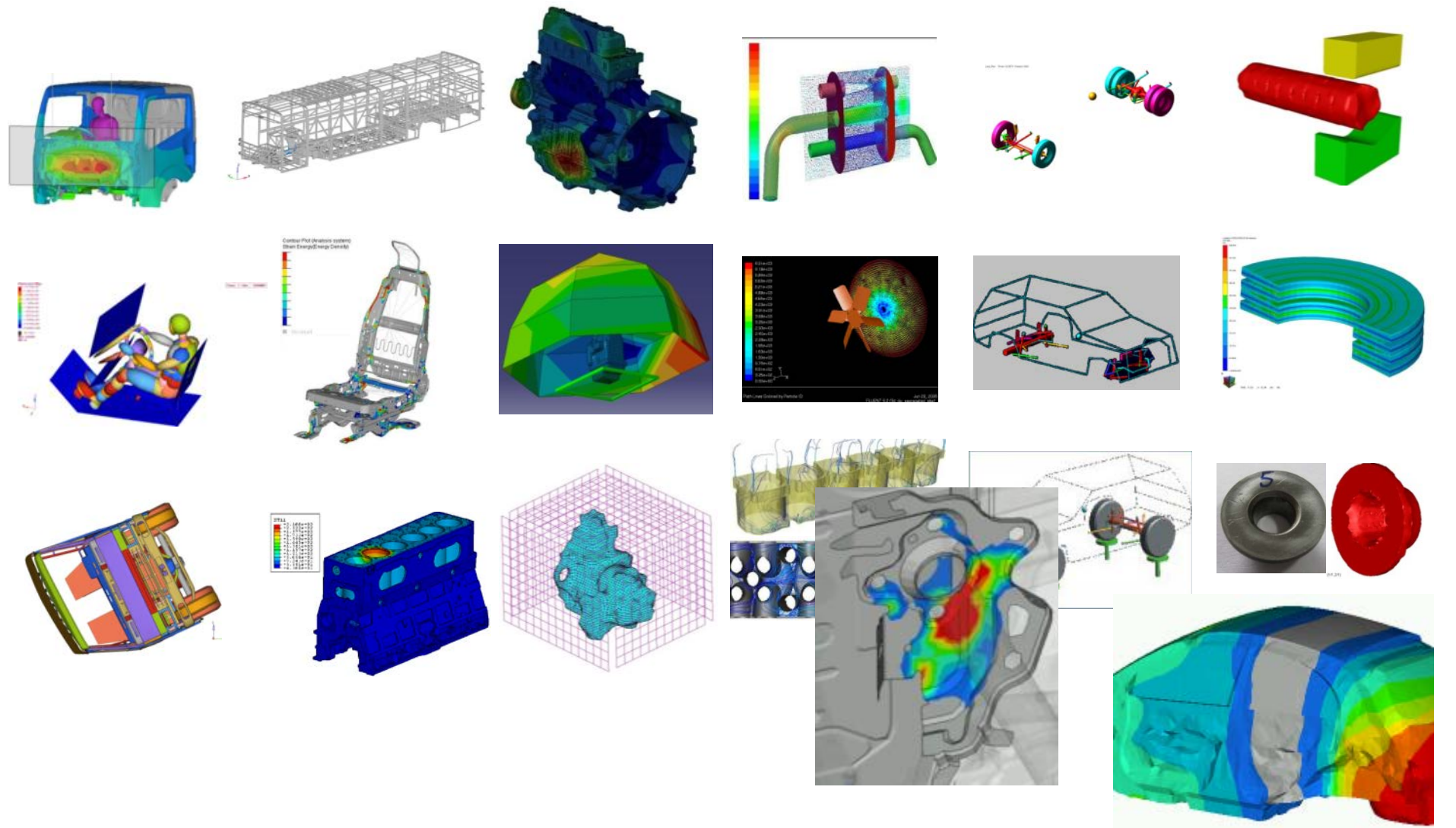


- Design optimization of structures using static, thermal, dynamic and fatigue analysis techniques & experimental validation techniques
- Simulation & analysis of structures using multi-body dynamics
- Simulation of vehicle crash & evaluating crash-worthiness including occupant safety
- End-to-end solutions using multi-attributes optimization
- Forging simulation



**FORGE**  
2009 CLUSTER





## Model Based Design for ECU Control Strategies

- Rapid Prototyping (RPT) for ECUs (Powertrain , Chassis, Networking.... )

## Development of Engine & Safety related Automotive Embedded Systems

- 8 bit / 16/32 bit, CAN/LIN, Hardware & Firmware

## Evaluation of Automotive Electronic Systems

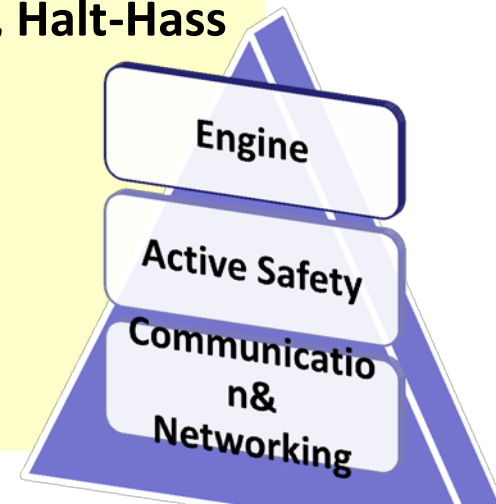
- EMI-EMC, Thermal Shock, Temperature + Vibration, Altitude, Halt-Hass

## ECU Calibration on HIL & Vehicle

- In Lab & Vehicle calibration
- Emission & OBD

## Development of Test Instrumentation

- CDCS / Saarathi /EDACS / GDACS / VDACS
- Test Cell Automation / DDC / AC Engine Dynamometer



Small Engine Fuel Injection ECU



## FACILITIES

- Code Warrior, MATLAB, Simulink, State Flow, Multisim, LabView,
- Development boards / In-circuit debuggers for 8-16-32 bit controllers
- Test, calibration and analysis tools
- E-Cal for small gasoline vehicles, INCA, Control Desk
- Simulator for engine and safety controls
- Bus analysis system for CAN / LIN
- Rapid prototyping platforms



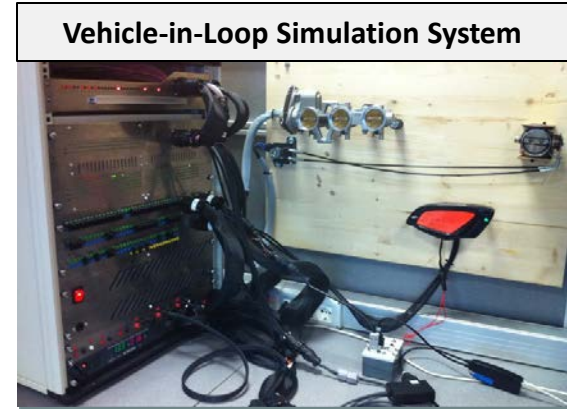
# Facilities – Automotive Electronics



**Chassis Dynamometer with Emission Analyzer & Dilution System**



**AC Engine Dynamometer**



**Vehicle-in-Loop Simulation System**



**High Speed Data Acquisition System**



**GTEM**



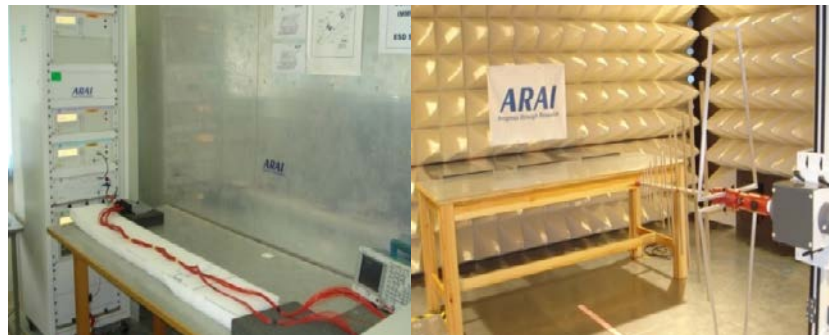
**Accelerated Life Testing (HALT)**



**Thermal Imaging Camera**

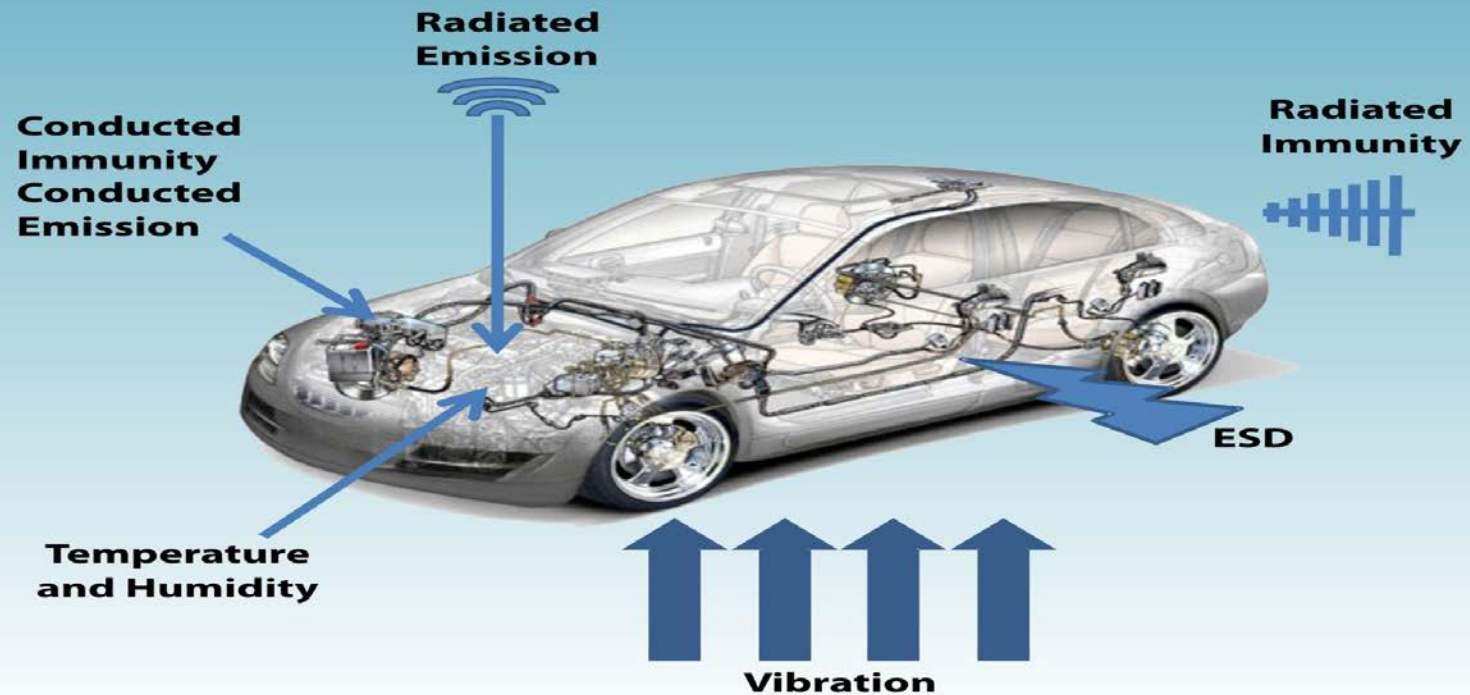


**Hardware-in-Loop (HIL)**



**Conducted and Radiated Immunity Tests**

# EMC & Environmental Development Solutions



- Customer Requirement
- Formulation of Test plan as per International or OE standard.



- Developmental test iterations for EMI/EMC and Environmental Test
- Analysis of test Results.



- Design Optimization and Modifications



- Pre-compliance testing



- Compliance testing for Indian/European /OE approvals

**NABL ACCREDITED Test Facility**

## Small Engine Fuel Injection ECU

- Up to 2-Cylinder engine operation
- Adaptability and calibration facility for various range of sensors and actuators
- Diagnostics handling of Sensors, output drivers, interlocks and decision of MIL
- Fuel Consumption / Mileage Calculation
- Ignition Switch, Side Stand switch as Interlocks
- On-board programming
- K-line based communication algorithm, Scalable to upgrade to CAN
- Limp Home on sensor faults
- Expandable RF-Receiver Module to interface with Keyless transmitter and TPMS



- **Certification divisions**  
**Business portfolio, facilities and projects**



- Domestic and Export Certification / Homologation of all types of vehicles and engines ( Diesel, gasoline, LPG, CNG, Ethanol, blended fuels, etc ) :
  - ✓ 2W, 2W, Passenger car, LMV, Utility Vehicles, LCV, HCV – Bus & Truck
  - ✓ Agricultural Tractor, CEVs, Genset, other off-road equipment
- Evaluation of Oil Fuels and Lubricants
- Evaluation of additives & Devices
- Assessment of advanced Emission Control Technologies
- Durability Assessment
- Ambient Air Quality Monitoring
- Source Apportionment and Emission Factors for in-use vehicles
- Study of Unregulated pollutant emissions
- Study of nano particles and their speciation ( from engine exhaust )
- Emission measurement system Certification

## Emission Test Facilities ( Pune Site 01)

- Chassis Dynamometer test facility for 2 Wheelers
- Chassis Dynamometer test facility for 3 Wheelers
- Chassis Dynamometer test facility for 4 Wheelers
- Chassis Dynamometer test facility for Buses & Trucks
- VT/VV SHED Facility for Gasoline 2W/ 3W/ Cars
- PM Conditioning & Weighing Chamber
- PM Conditioning & Weighing Chamber
- Engine Dynamometers for Automotive/ CEV/Tractors
- Nano Particle Facility for Euro- V /Euro VI

Engine Dynamometers  
for Automotive/ CEV/Tractors



Chassis / Vehicle Dynamometer

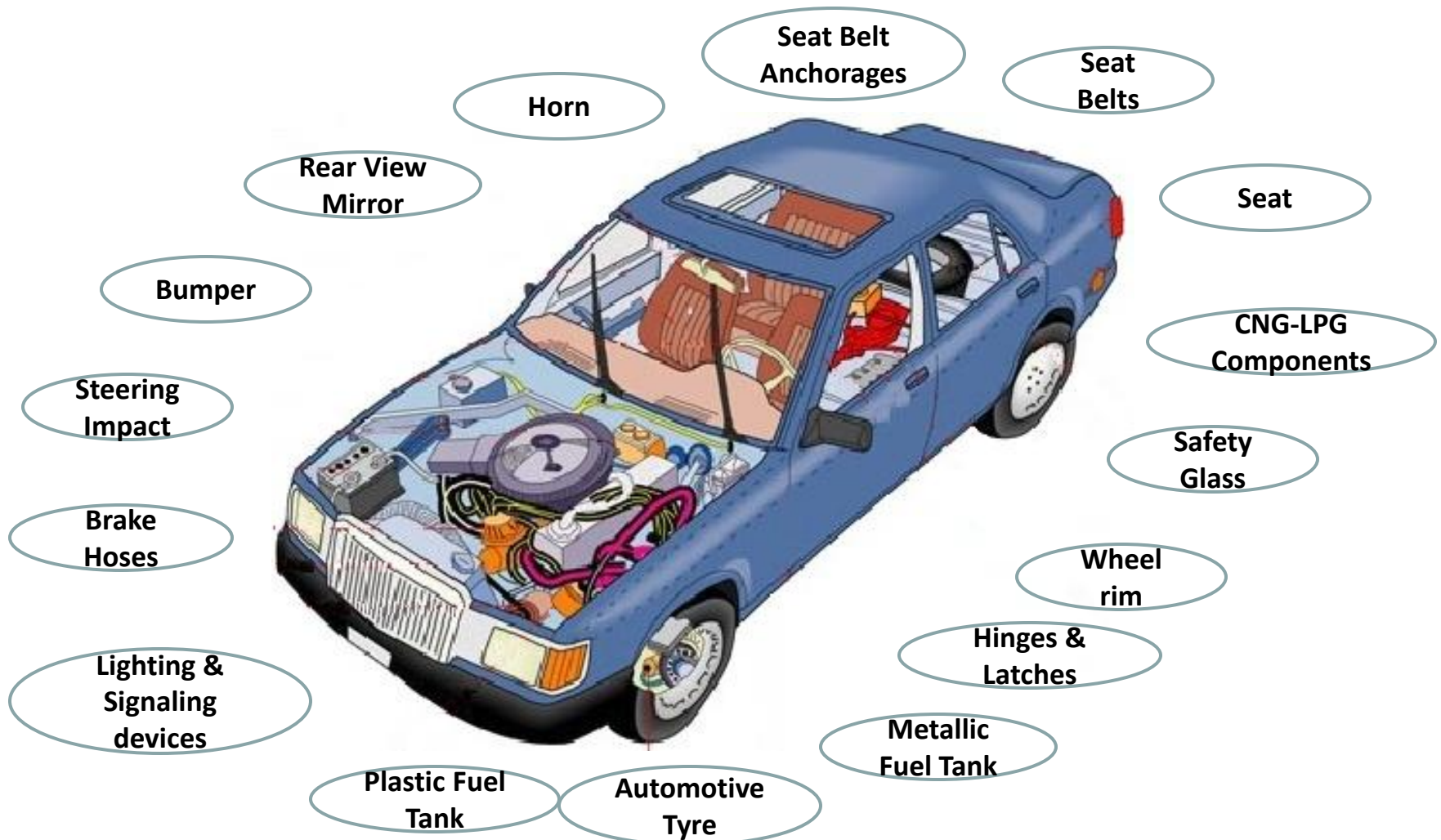


4 X 4 Chassis Dynamometer

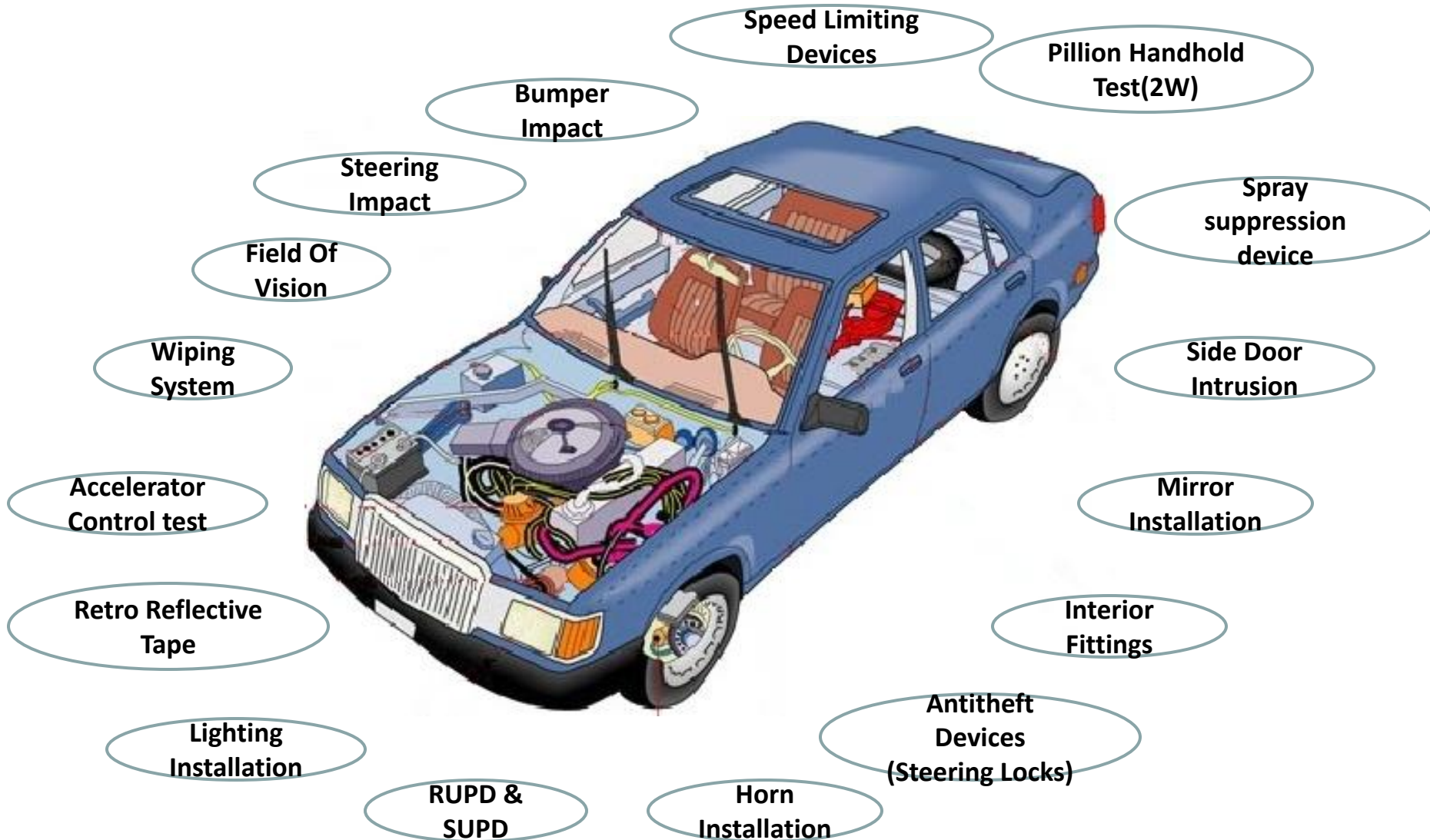
## Upcoming Test Facilities at Chakan (Site 02)

- Transient Engine Dynamometers with Full Flow Dilution Tunnel (220 kW & 500 kW)
- 4 X 4 Chassis Dynamometers for Emissions
- Climatic 4 X 4 Chassis Dynamometer with Solar Simulation
- 4 X 4 Chassis Dynamometers for Mileage Accumulation
- SHED for Gasoline Evaporative Emissions

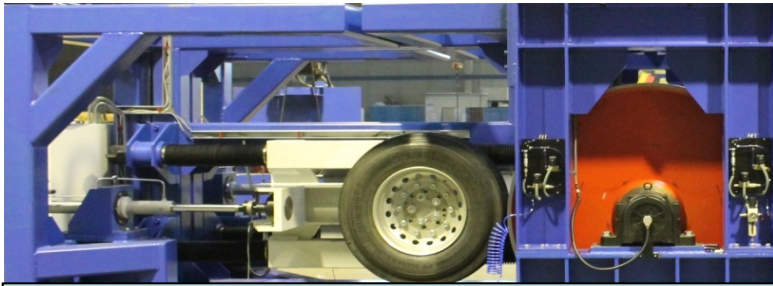
## Safety Critical Components in a vehicle



## Vehicle level / Vehicular System level tests



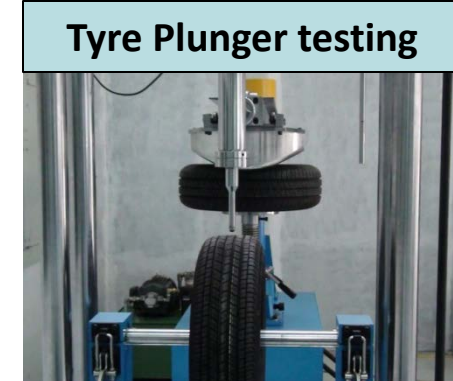




**Four Station Tyre Endurance Test Facility**



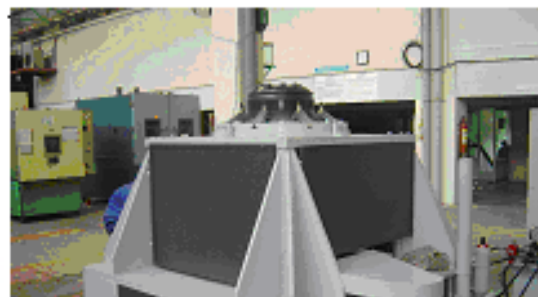
**Brake Hoses Hot Impulse Test Facility**



**Tyre Plunger testing**



**Radial Fatigue Test Rig  
for Wheel Rims**



**Cornering Fatigue Test Rig  
for Wheel Rims**



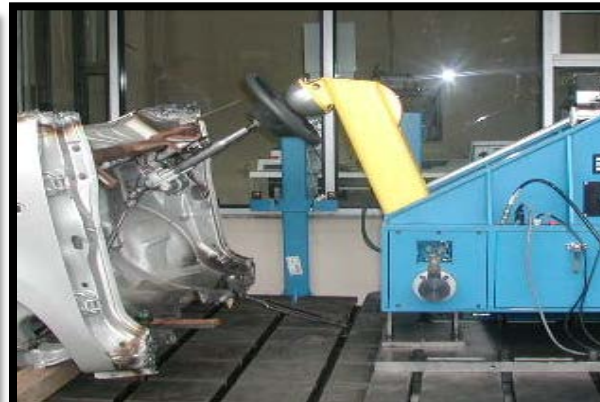
**Weather-O-Meter**



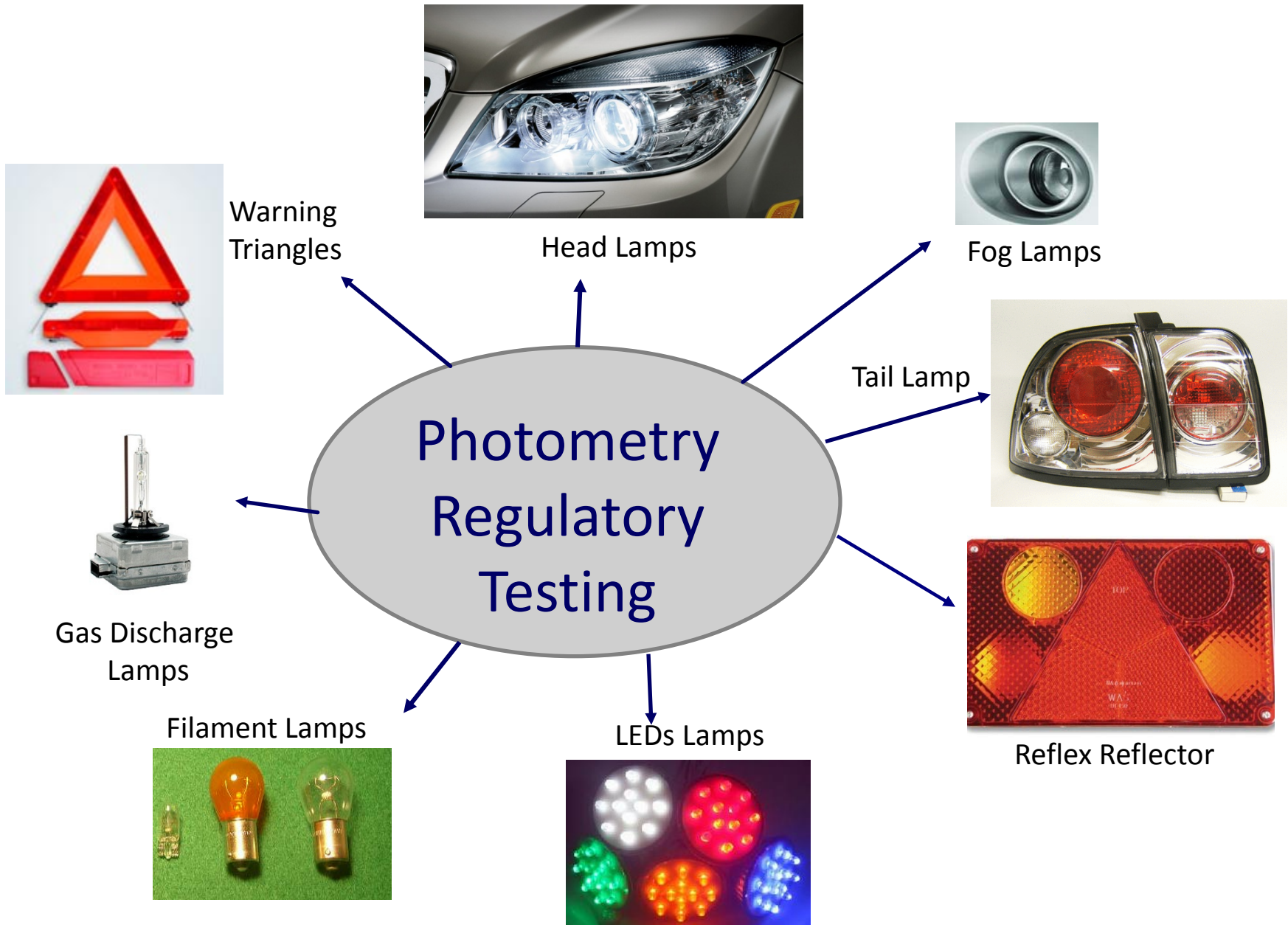
**Side Door Intrusion**



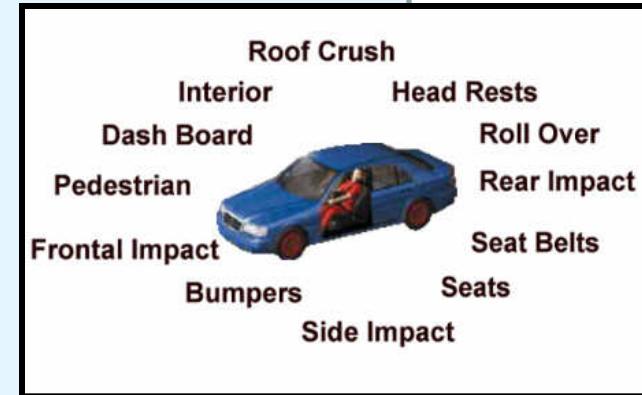
**Velocity Generator for Body Block Impact Test and Head Form Impact Test**



**Photo Gonio-Meter**



- Protection of occupant in the event of frontal collision (Offset frontal)
- Protection of occupant in the event of Lateral Collision
- Requirements of vehicle in head-on collision
- Rear End Collision
- Testing of Child Restraint System
- Testing of Pedestrian Protection
- Safety Belt Assemblies
- Safety Belt Anchorages
- Seats, Their Anchorages and Head Restraints
- Evaluation of Steering Column Displacement against Front Collision
- Rear and Lateral Under Run Protection Devices
- Interior Fittings
- Tyre Ripper Testing
- Road Restraint Testing





## Crash Test Facilities



**Offset Frontal Test**



**Side Impact Test**



**Pendulum Impact Test**

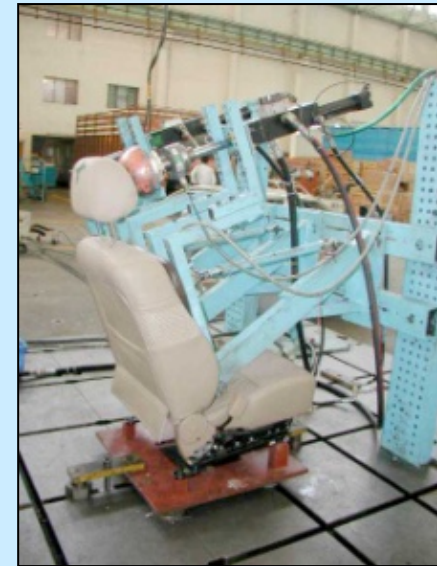


**Bus Roll over Test**



**Rear end Impact Test**

## Test Facilities – Seats, Seat Belts, Seat Anchorages and Head Restraints



## Crash Dummy Facilities







**Steering Column Displacement  
against Front Collision**



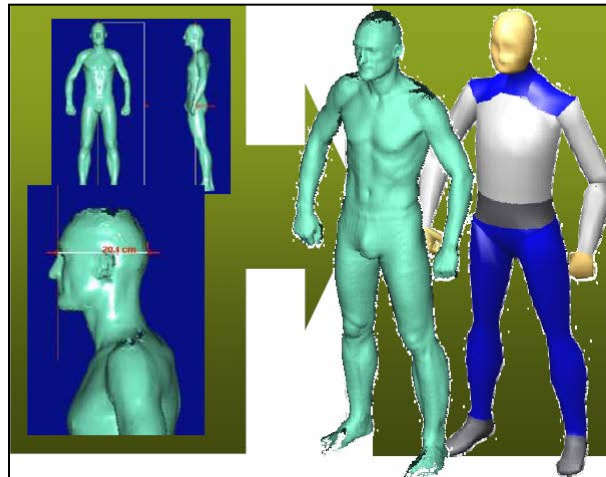
**Rear and Lateral Under Run Protection  
Devices against Front Collision**



**SLED Facility**



**Facility for Testing of Child  
Restraint Systems**



**3-D whole Body scanner for  
Anthropometric Measurements**



**Tyre Ripper Test Facility**

## Winter Testing of Vehicles

At sub zero temperatures (up to -30 deg C) under collaboration with Invest in Sweden, for assessment of:

- Cold start ability
- HVAC
- Wiping performance (Visibility)
- Brake testing
- Fuel and Oil studies
- Study on vehicle performance braking, steering, stability, power and acceleration



## Fire Safety / Fire Avoidance Testing

- Under collaboration with SP Technical Research Institute for assessment of:
- Engine Compartment
- Exhaust system
- Electrical system
- Fuel tank and Fuel line layout
- Air conditioning
- Under body inspection
- Retarder and Brake system
- Aging and maintenance



- Vehicle Benchmarking study

- Vehicle Stability and Handling tests

- Vehicle Assessment as per International Standards, viz SAE, ECE, ADR, NZS, FMVSS, ISO etc.
- Assessment of special purpose vehicles – Medical Mobile Units (MMUs), Mobile Computer Vans (MCVs)





**Data Acquisition System  $\mu$  EEP 12**



**Portable Weather Station**



**Noise Level Meter**



**Speed Measurement  
Sensor**



**Oscillographic  
Recorder**



**Vbox-II System**



**Data Logger**



**Wheel Pulse  
Transducer (WPT)**



**8 Channel Data  
Acquisition System DAS 3**



**Towing Dynamometer**



## Certification / Homologation Testing (2 wheelers / 3 Wheelers / Four Wheelers / Agricultural Tractors / Construction Equipment Vehicles / Special Purpose Vehicles)

### Dynamic Trials

- Maximum Speed
- Brake Test (including ABS)
- Acceleration Test
- Fuel consumption test
- Pass-by Noise Test
- Interior Noise test
- Speedometer Calibration
- Coast Down
- Cooling performance
- Range test
- Hood Latch Test
- Handling / Stability Test



Maximum Speed



Pass-by Noise Test

### Static Trials

- EMI
- Static Brake Test
- CMVR Compliance Verifications
- Dimensional Verifications
- Installation Checks for Safety
- External Projections of Vehicles
- Tell Tales and Symbols
- Arrangement of Foot Controls



Brake Test with ABS



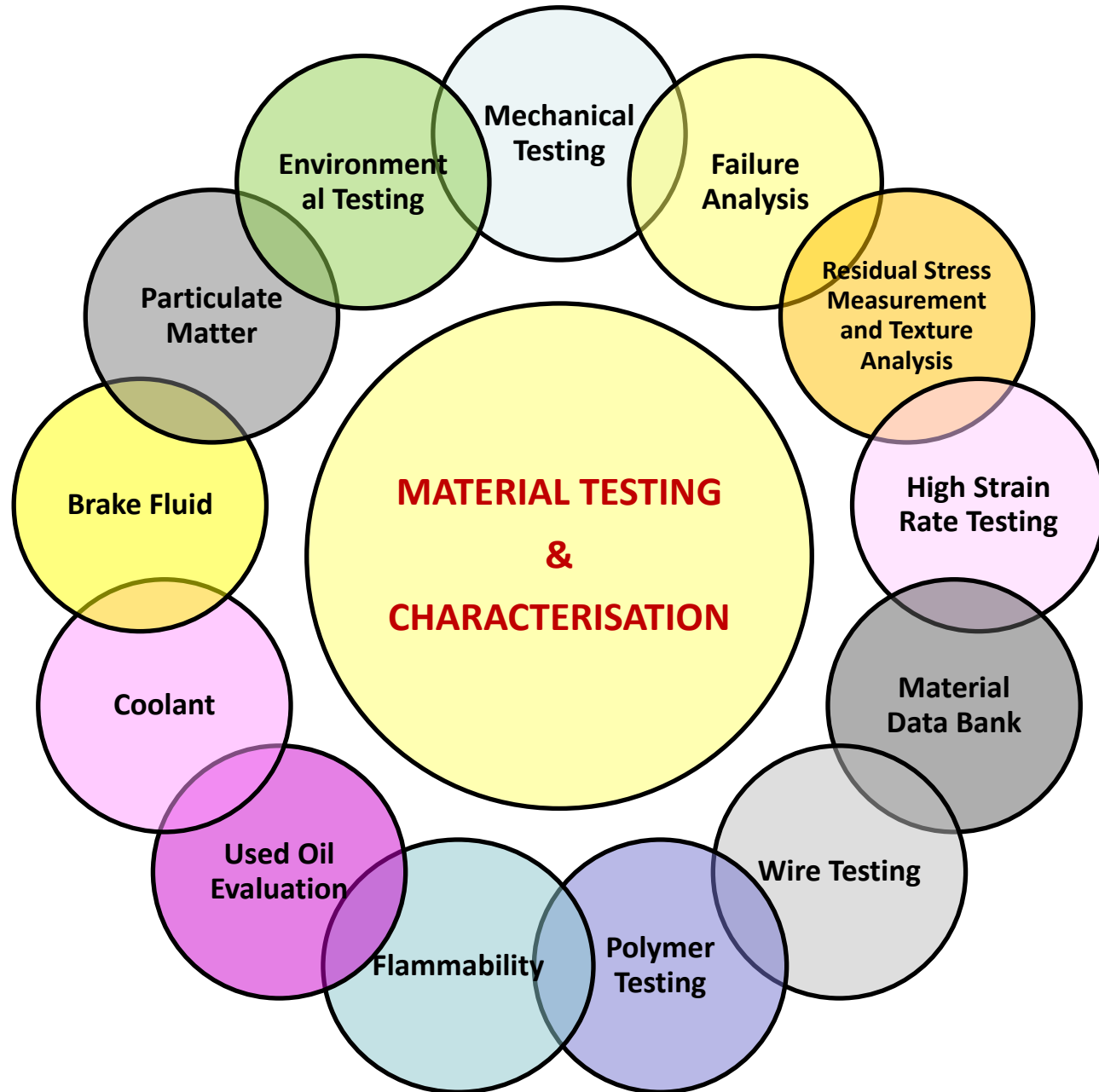
Steering Effort Test



Gradeability Test



Steering Circle Test





**Universal Testing  
Machine**



**Environmental Scanning  
Electron Microscope**



**Circulating Coolant  
Corrosion Test Rig**



**X-Ray  
Diffractometer**



**High Strain Rate  
Machine**



**UV Testing Facility**

- **Closing Remarks**

**ARAI is an independent R&D and Testing Institute in India offering its services to domestic and global automotive and allied industries in different areas covering :**

- **New product development**
- **Product testing and evaluation**
- **Product certification**
- **Framing draft regulations / standards**
- **Education to engineers / Technicians**

- **ARAI will be pleased to closely associate with all Research Institutes, Universities and Automotive and component industries from ASIA region with an aim to strengthen regional competencies : one of main objectives of the AAI Summits.**
- **WMTC test cycles for motor cycle application was evaluated by ARAI.**
- **ARAI is working deeply with WP29 groups for harmonization and globalization of standards.**
- **ARAI will also be pleased to share its experience in framing the draft regulations in the areas such as fuel efficiency, emission and safety.**



**Invites you to SIAT 2015 Conference and EXPO**

**14<sup>th</sup> Symposium on International Automotive Technology (SIAT)**

 <p><b>Symposium on International Automotive Technology 2015</b> Towards Safer, Cleaner &amp; Quieter World... 21-24 January 2015, ARAI, Pune, India</p>					
					
■ <b>SIAT 2015</b> ■ 21-23 January 2015		■ <b>SIAT EXPO 2015</b> ■ 21-24 January 2015		■ <b>TECHNOLOGY THEATRE</b> ■ 24 January 2015	

**ARAI Campus, Pune, INDIA**

**Thank you**  
**dear AAI Summit Participants !!!**

**Looking Forward to working together,**  
**Working for each other .....**

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