ए आर ए आई ARAI Progress through Research **Update**

Transformation towards Progressive Mobility

Design, Development and Testing Services at ARAI

Azadi Ka Amrit Mahotsav

G20 भारत 2023 INDIA

January-March 2025

New Capabilities / Development / Conferences / Seminars

- **Making of an Integrated E-Axle based Powertrain for EV, HEV and FCEV – An efficient way of Electrification**
- **Electro-Mechanical Design and Development of Electric Motors for Mobility based Applications**
- **Innovative Methodology for Testing Cooling Modules in Heavy Commercial Vehicles and Buses**
- **TG: Technovuus Engagements Update & Establishment of RADAR Scenario Emulator for Virtual Validation of RADAR Based ECU Controls under Digital Twin Lab**
- **Test facility for Measurement of Extractable/Leachable Ionic contamination level on the surface of printed boards and assemblies by Ion Chromatography**
- **Seminar on General Lighting "Emerging Smart Trends in General Lighting" - 29th January 2025**
- **International Conference on Advanced Powertrains for Mobility and Power Generation Applications: 7th & 8th March 2025**
- **ARAI Journal of Mobility Technology (Volume 5, Issue 3, July-September 2025)**

❑ Making of an Integrated E-Axle based Powertrain for EV, HEV and FCEV – An efficient way of Electrification

Rise in greenhouse gas emissions, which is resulting into ozone layer depletion and global warming effect, is alarming to control CO_2 emissions by drastically reducing fossil fuel consumption of the vehicles. This need has already started trend towards extreme downsizing and down speeding of Internal Combustion Engines (ICE) for making them highly efficient. However, to address present greenhouse effect along with exponential decay of fossil fuels, there is a need to achieve CO_2 emissions less than 100 g/km or to achieve practically zero carbon footprint using an alternate powertrain.

Electrification is one of the promising solutions, which is three-fold in present situation. The first level of electrification comes in the form of Hybrid Electric Vehicle (HEV) technology followed by Battery Electric Vehicles and Fuel Cell Electric Vehicles as second and third level of electrification, respectively. In all these technologies a common thread is running in the form of an efficient electric drivetrain.

Use of E-Axle based powertrains in EV, HEV and FCEV offers additional complimentary benefits apart from other technology options described above. E-Axle based powertrains offer flexibility in generating three variants of vehicle using one electric drivetrain architecture, viz. making EV, HEV & FCEV. Compactness, modularity, scalability, flexibility along with efficient cooling system management and control over active current losses due to use of bus bars, which have implicit advantages of E-Axle based powertrains.

Two major challenges need to be addressed and resolved while designing E-Axle based powertrains by doing concurrent vehicle engineering. This is mainly due to increased unsprung mass that needs to be handled by suspension system and exposed electric drive components to excitation loads more than 5g.

By proper layouting for effective vehicle mass distribution and required CG location, which is essential from overall vehicle dynamics, more space can be offered by E-Axle based powertrains by increasing battery energy density for getting more electric range in case of BEVs. This add-on space benefit extends help in packaging of hydrogen fuel cell integrated with batteries having power cells in case of FCEVs. Thus, E-Axle based powertrains prove to be most modern way of making EVs, HEVs and FCEVs.

To cater to this emerging need, ARAI has designed range of E-Axle based Powertrains as OE and Retrofitment solution for vehicles having GVW in the range of 1.5 to 5 Tons. Out of these solutions for 1.5 Ton GVW vehicle is physically developed which is tested and validated for road worthiness trails viz Range, Max Velocity, Gradeability and durability while running for approx. 1 lakh kilometer on road.

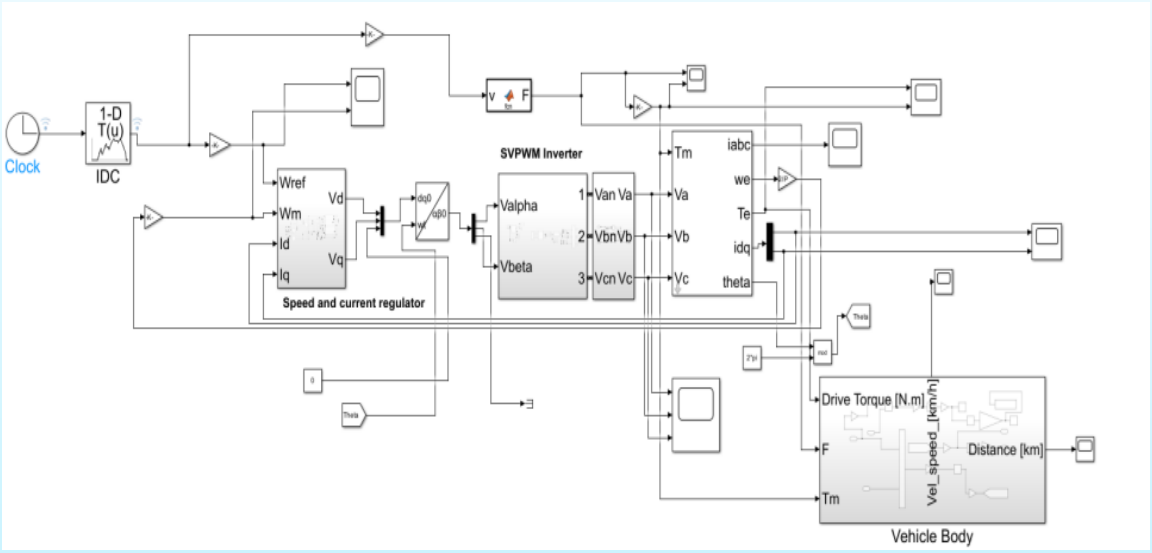


Fig. 1: Equation Driven High Fidelity Based Mathematical Model of Electric Vehicle's DriveTrain

Model based simulation approach is used to develop first for predicting existing Diesel Engine based vehicle performance and then predicted results are validated against experimental results for cycle trace, fuel consumption and other vehicle performance related parameters. Later, High-Fidelity Mathematical model (Refer Fig. 1 & 2) is used, which is completely equation driven and developed from concept for predicting Induction and PMSM motor's performance coupled with complex Indirect Field Orientation control algorithm.

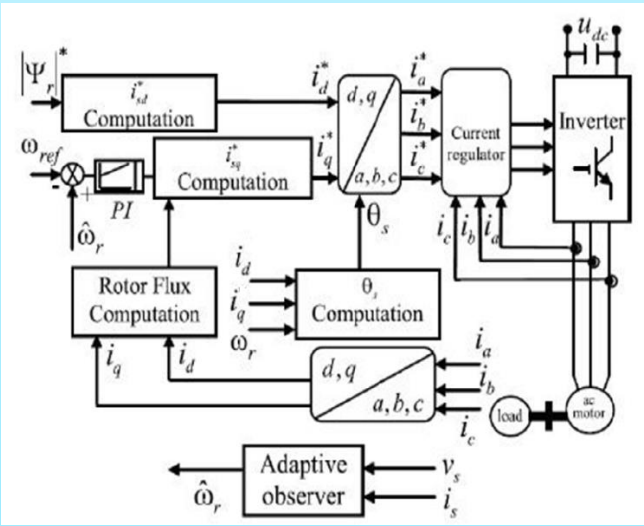


Fig. 2: Indirect Field Orientation Control Algorithm coupled with PMSM Plant Model

This model is used for characterization of motor's peak / continuous power & torque performance, efficiency mapping, sizing of gear train including differential gears, specification finalization of 3 phase, 2 level, 6 leg, half bridge inverter, DC-DC converter, OBC, MCU, BMS, VCU, PDU, Battery pack, Cooling system for motor and battery, sensors & wiring harness and dashboard cluster to achieve required range and other target vehicle performance parameters. Using finalized specifications of electric and mechanical drivetrain components, prototype E-Axle based version of vehicle is built for validation and testing trials (Refer Fig. 3).

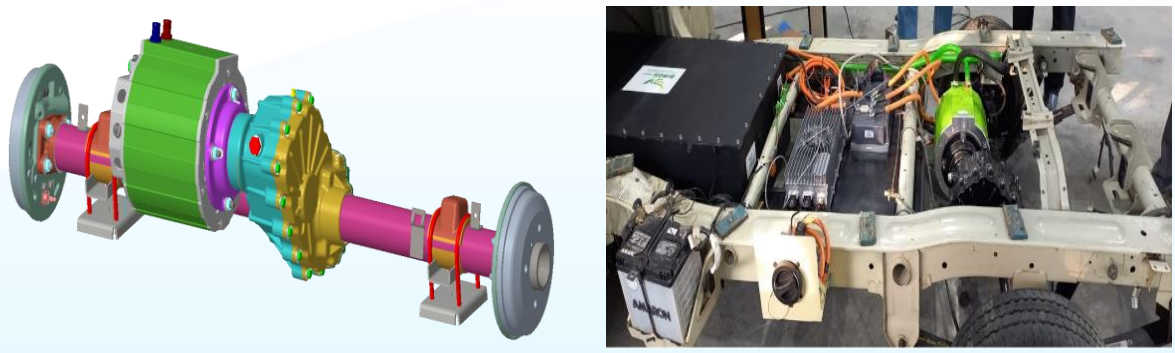


Fig.3: Indigenously Developed E-Axle Based Powertrain for Small Commercial Vehicle

Table 1 shows brief performance achieved with fitted ARAI developed E-Axle Powertrain for vehicle having GVW as 1.5 Ton.

Sr. No.	Performance Parameter	Achieved Value	Remarks
01	Range	130 km in Single Charge	Range obtained with GVW on road mix of city, highway and having gradients
02	Max Velocity	60 km /hr	Max speed can go up to 80 km /hr
03	Gradeability	15.5 degrees	Retained the base vehicles gradeability with obtained GVW
04	Acceleration	14.5 s for 0 to 60 kmph	Retained the base vehicles acceleration obtained with GVW

Table 1: Achieved Vehicle Performance Parameters using E-Axle Based Powertrain

Fig.4 shows fleet of vehicles, which is running on road with GVW and has logged cumulative running of 60,000 km without any mechanical, thermal and electrical issues.

Fig. 4: Fleet of SCV (1.5 Ton GVW) Running with Retrofitted E-Axle Powertrain

On similar lines, design of E-Axle based powertrains for 2.5,3.5 and 5 Ton GVW Vehicles is ready and in the process of making prototype for testing and validation purpose.

❑ Electro-Mechanical Design and Development of Electric Motors for Mobility based Applications

In order to meet the target of achieving minimum 30% electrification by end of 2030, there is need to to work in all aspects of product development in the area of electric drive train which will be economical, affordable, flexible, durable and reliable. To achieve this the only answer is to promote indigenisation supported with local available resources and raw material to avoid further geo political and geo graphical challenges.

Major components viz. Battery, Bi directional inverters, DC DC converters, PDU, MCU, BMS, VCU, Motors, Dashboard, Sensors and wiring harness makes a complete Bill of Material (BOM) which essentially need to get developed with the approach mentioned above for increasing the penetration of E Mobility not only in on-road segment but even in off highway, defence, railway, marine and in aviation sectors. Hence its essential to design these products from concept apart from manufacturing and assembly in India.

Considering this need ARAI have developed competency in the area of electro mechanical design of motors viz induction and PMSM motors to start with which will get followed by Switch Reluctance Motor for Mobility based Applications and have started demonstrating in various used cases. However, efforts are going in the direction to bring value addition in the conventional design topology and processes to handle the above-mentioned requirements and challenges. Three used cases are mentioned here in brief which will be the futuristic technology options to offer having certain unique technical advantages over present one.

Case Study No. 1 - Making of PMSM electric motor with wet rotor concept for coolant pump

Design and development of PMSM electric motor with wet rotor concept for coolant pump for EV application is carried out where electromechanical design of motor has been made from clean sheet. Most of the electric motors used in coolant pump are BLDC motors. However, considering advantages in terms of efficiency and performance, PMSM is used in place of BLDC motor for the application under consideration.

By knowing the max coolant flow and corresponding pressure head needed to be delivered by water pump for cooling of battery, motor and inverter of EV, constant / peak power, torque and operating speed of motor is estimated. Once these specifications and packaging boundary conditions known, various design iterations are carried out mainly to improve power to weight ratio, efficiency over the speed range and to reduce cogging torque and torque ripple. This is achieved by doing extensive optimisation of various design parameters such as number of poles, stator & stack geometry, air gap, type of magnet, calibration factors for iron and mechanical loss etc. Considering the typical application where rotor is in contact with coolant, special focus has given on design of low reluctance path between stator and rotor poles. The performance of e-motor is analysed for no-load and steady state conditions. The optimized design is manufactured and simulation results are compared with experimental results. During experimentation Motor Electromagnetic Torque and Speed is controlled by giving variable PWM input to MCU through VCU to obtain various flow rates as per demand from the coupled water pump. Fig.1 shows simulation driven process which is used to optimise an integrated design of PMSM with water pump to meet target specifications.

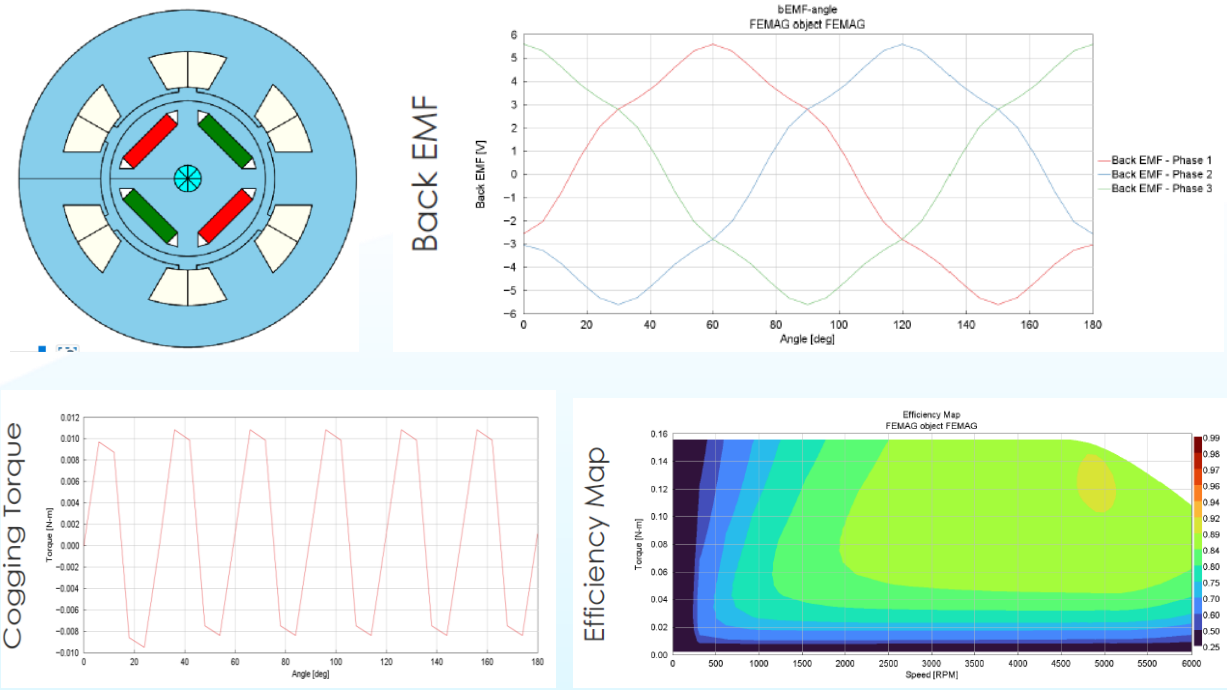


Fig. 1 Simulation Driven Product Development Process - Making of PMSM with Wet Rotor

Two prototypes of PMSM having rated power as 80 & 40 Watts are made based on the optimised design and evaluated extensively for its performance and durability by using special tailor-made test rig for doing validation trails of electric water pumps. Fig.2 shows prototype of PMSM coupled with water pump along with cut section to reveal more details.

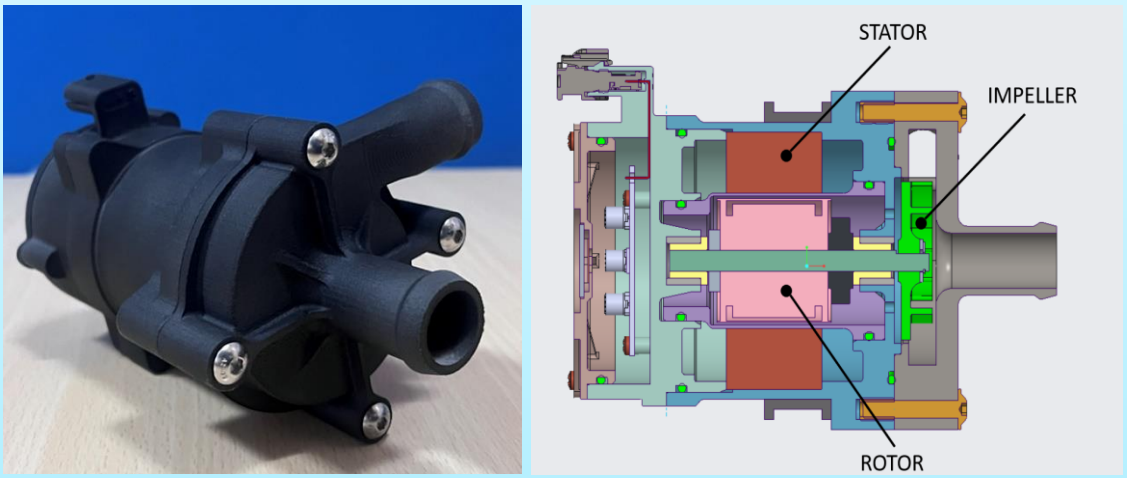


Fig. 2: Integrated PMSM with Water Pump for Electric Vehicle Cooling System

Case Study No. 2 - Design and Development of Conventional and 3 in 1 E-Axle powered with PMSM

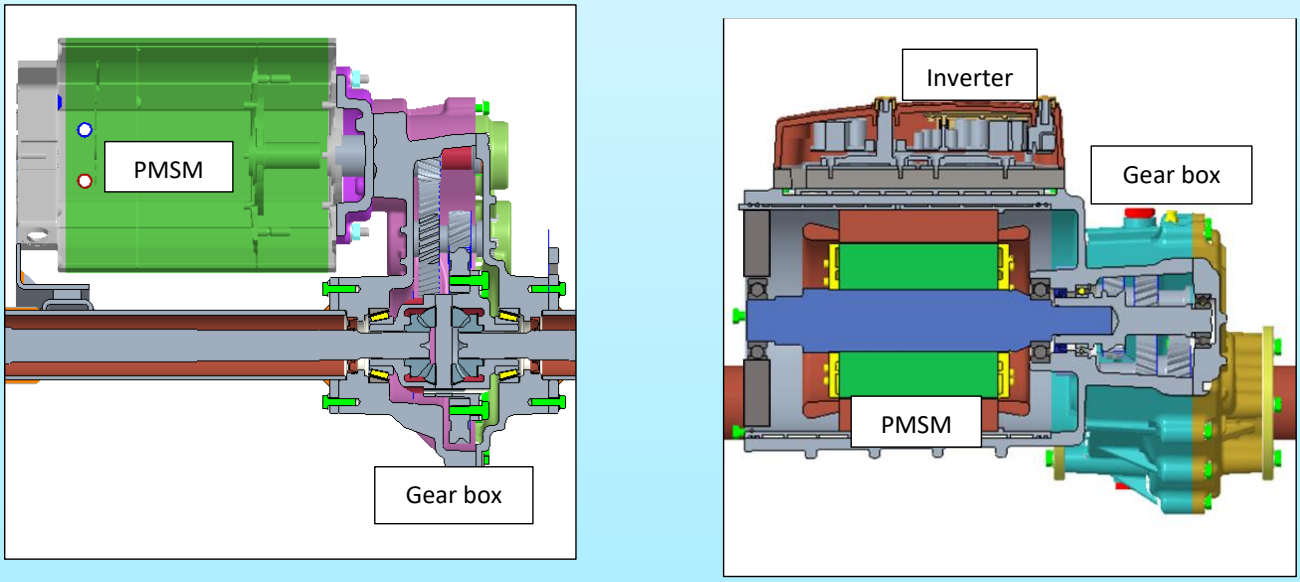
ARAI have designed and developed Conventional E-Axle-based powertrain as OE and retro fitment solution for range of CV's having GVW in the range of 1.5 – 5 Tons. Out of this, one prototype of E Axle based powertrain is implemented into base ICE vehicle having GVW 1.5 Ton to make it electric vehicle (Refer Fig.3).

After converting base diesel vehicle to the electric vehicle, performance trails were conducted on the road for validation purpose. Major targets viz. Range, Max Velocity, Gradeability and Acceleration are met up to the expectations. Later further four number of vehicles driven in the city which has accumulated total mileage of 100000 kms till date without any electrical and mechanical issues.

Fig.3 : Design and Development of Conventional E-Axle for SCV

Compactness, modularity, scalability, flexibility along with efficient cooling system management are the implicit advantages of E Axle based powertrains. These advantages further get multiplies if we go for 3 in 1 (gearbox + Stator housing + Inverter) architectures which are predominantly used in independent suspension-based vehicles. This type of architecture offers control over active current losses due to use of bus bars in place of using high voltage wiring harness.

ARAI has completed design of such 3 in 1 E axle for rigid axle version where an integrated PMSM is designed from concept with the similar approach explained in Case study No.1. Fig.4 shows comparison of cut section of conventional and 3 in 1 design for the same vehicle configuration where prototype of conventional E Axle is produced and validated. Prototype making of 3 in 1 unit is under development stage. Later it will get evaluated for similar validation trails used for validation of conventional E Axle based powertrain.



Conventional E-axle

3 in 1 type of E-axle

Fig. 4: Comparison of Conventional and 3 in 1 E Axle based Powertrain for SCV Application

Case Study No. 3 - Making of Light Weight, High Speed Induction Motor

ARAI is in the process of developing light weight, high speed induction motor which will be a parallel solution to PMSM which have dependency on rear earth magnet material. PMSM type performance is possible achieve with this new design due to light weight casted aluminium rotor as one of the design features responsible for the same.

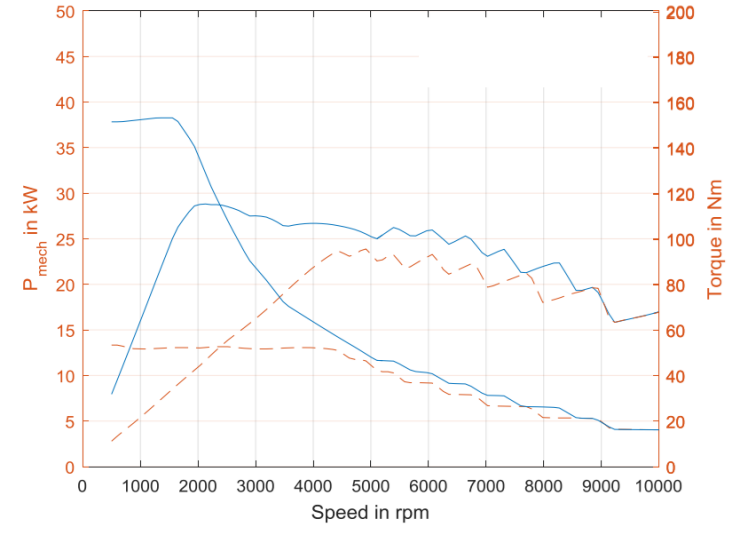


Fig. 5: Target Performance Curve – Light Weight High Speed Induction Motor

Fig. 5 shows target performance for meeting with light weight, high speed induction motor for SCV application. It is aimed to achieve motor efficiency above 90% for wider speed range. Developed motor will be an ideal candidate for SCV & LCV's with either mono motor E axle or with Twin Motor E axle-based version.

❑ Innovative Methodology for Testing Cooling Modules in Heavy Commercial Vehicles and Buses

Background:

Cooling module is a critical component in heavy commercial vehicles and buses, ensuring that the engine and other vital systems operate within optimal temperature ranges. Efficient cooling is essential to prevent overheating, which can lead to engine failure, reduced performance and increased maintenance costs. However, testing these cooling modules in a laboratory setting poses significant challenges. Traditional testing methods often fail to replicate the complex, multi-axial forces experienced in real-world conditions, making it difficult to validate the design accurately and efficiently.

Challenges in Accelerated Testing:

Replication of Real-World Conditions: Simulating the exact conditions that cooling modules face in the field, including varying temperatures, pressures and mechanical stresses is complex.

Time Constraints: Accelerated testing methods must compress the equivalent of years of wear and tear into a much shorter timeframe without compromising the accuracy of the results.

Resource Intensive: Traditional methods can be resource-intensive, requiring extensive instrumentation and set up.

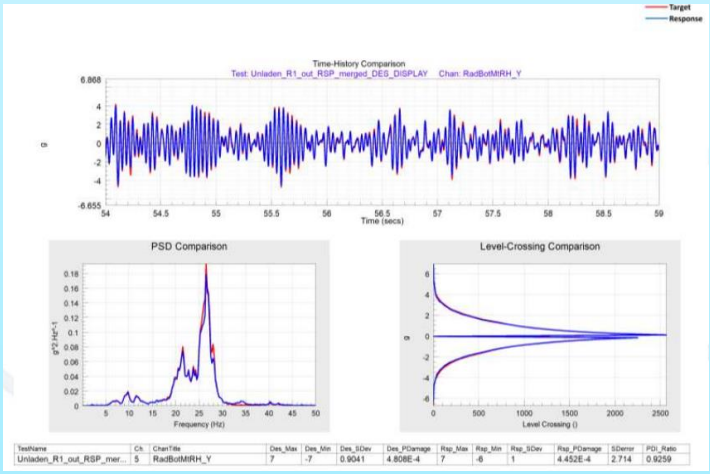
Innovative Multi-Axial Test Setup by ARAI

ARAI's Structural Dynamics Lab (SDL) has developed innovative multi-axial test set up to address certain challenges. This set up uses real-time field data to validate cooling modules under conditions that closely mimic actual operational environments. Tests can be conducted with actual circulation of coolant, maintaining necessary temperature and pressure, ensuring high degree of accuracy and reliability.

Key Advantages

- **Accelerated Durability Testing**: The innovative setup significantly reduces testing time, allowing for faster validation of cooling module designs.
- **Real-World Correlation**: Utilizing actual field data ensures that the test conditions closely match real-world scenarios, improving the reliability of the results. Simulation of real-time field data can be replicated and compare in terms of statistical, spectral & damage parameters with close math with 90% to 95% of target data.
- **Continuous Operation**: The facility operates in three shifts, 24 hours a day, six days a week, maximizing testing throughput.
- **Proven Methodology**: The test methodology has been validated through multiple successful projects, demonstrating its effectiveness and reliability.
- **Experienced Team**: ARAI's team of experts has extensive experience in delivering complex testing projects, ensuring high-quality results.
- **Comprehensive Services**: The lab offers a full suite of services, including instrumentation, Road Load Data Acquisition (RLDA), in-lab simulation, drive file creation, and durability testing, all under one roof.

This innovative approach by ARAI represents a significant advancement in the field of cooling module testing, providing manufacturers with a reliable, efficient and accurate method to validate their designs and ensure durability and performance of their products in real-world conditions.



❑ TG: Technovuus Engagements Update & Establishment of RADAR Scenario Emulator for Virtual Validation of RADAR Based ECU Controls under Digital Twin Lab

TechNovuus is a collaborative eco-system for enabling indigenous technology, innovation and solution development through an open innovation and technology development platform. TechNovuus facilitates development of solutions for challenges related to mobility, while gradually expanding to other sectors like Defense, Aerospace, Telecommunications, Railways, etc., providing an impetus to the Government of India's Make in India and Aatmanirbhar Bharat programs.

TechNovuus Internship Program

Technovuus has facilitated more than 290 students to gain industry experience through this internship program since its inception.

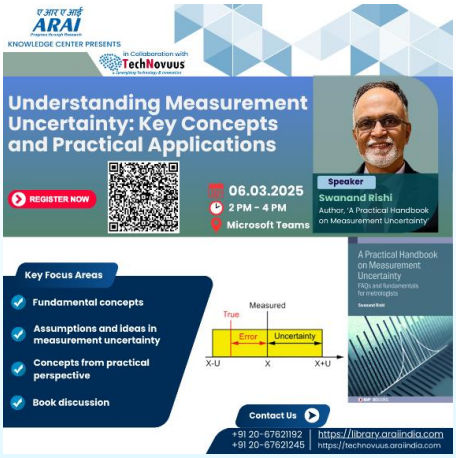
Each student has been individually selected based on their unique skills by different departments within ARAI to work on live projects. This tailored approach ensures that students can contribute effectively to ongoing projects while gaining valuable hands-on experience in their respective areas of expertise.

Technovuus Webinar Series

ARAI-Technovuus celebrated National Start-Up week from 10th to 16th Jan 2025 with Start-Up संगोष्ठी, a Webinar Series for Start-Up New Entrant, Students and Enthusiasts. This series had Sudeep Ambare, CEO- AMTIF, who spoke on the topic "Skills for Start-Ups" followed by session by Umesh Rathod, Manager, Indovation Centre, Western Region, Maharashtra and Goa for the AICTE's - Ministry of Education - Innovation Cell. He spoke on "Viksit Bharat: Future Trends in Automotive Industry". The third session was on "Perfecting Your Investor Pitch: Tips and Techniques for Innovators and Entrepreneurs in the Mobility Sector" by Ankit Machhar, Director-Ecosystem, Wadhwani Foundation. Close to 200 participants attended these webinar sessions and interacted with the experts. It was decided to keep this series live looking at the responses from the participants. Accordingly, the next session was successfully completed on 21st February 2025, which had Amey Vaze, Managing Partner & Consultant, SWANHANS Technology Consultancy LLP, as the speaker, who spoke on "Market Needs, Idea Generation and Systematic Scaling of the Solution".

ARAI Knowledge Centre - Kothrud in collaboration with ARAI-TechNovuus, organized next webinar as a part of the collaborative series on "Understanding Measurement Uncertainty: Key Concepts and Practical Applications" on 6th March 2025. This webinar was open to professionals, researchers, students, faculty, engineers in the field of automotive research and other scientific disciplines. It was especially relevant for those who were curious about the fundamentals of measurement uncertainty and its evaluation.

The author also discussed the key aspects of the book. The webinar was led by the expert, Mr. Swanand Rishi, Scientist F, Electronics Test & Development Centre (ETDC), Pune & Author of the book titled "A Practical Handbook on Measurement Uncertainty: FAQs and Fundamentals for Metrologists". At the end of the session, participants had clear understanding on measurement uncertainty.



Establishment of RADAR Scenario Emulator for Virtual Validation of RADAR Based ECU Controls under Digital Twin Lab:

With the introduction of ADAS features in vehicles, the sensing elements play a major role in how accurately the controls work. With the regulations also being in draft stage viz. AIS 162 (Advanced Emergency Braking Systems), AIS 186 (Blind Spot Information Systems), AIS 187 (Moving Off Information Systems), AIS 188 (Lane Departure Warning Systems), more emphasis is placed on virtual validation techniques. The sensing elements for ADAS includes RADAR, Camera, GPS – INS Systems, LiDAR and Ultrasonics. For effective virtual validation, the sensing elements need to be brought inside the LAB to validate the different False Positives and False Negatives scenarios. Also, for a thorough validation of L2+ ADAS, the vehicle needs to be driven for a large number of kilometres, which may not be possible on Roads or on Test Tracks. Hence the virtual validation techniques are indispensable when it comes to ADAS validation.

ARAI has established a state-of-the-art RADAR Over the Air Scenario Emulator for enabling virtual validation of RADAR based control Systems. The RADAR is housed inside an anechoic chamber to make it free from interferences. The RADAR Echoes are being generated by the antennae which is being controlled by the virtual Simulation running on the Real-Time Environment. The Antennae are motorised to exactly emulate the angle of arrival of the echoes to the RADAR. The RADAR Housing has vertical motion to accurately emulate the elevation angle.

Fig. 1: RADAR OTA Scenario Emulator

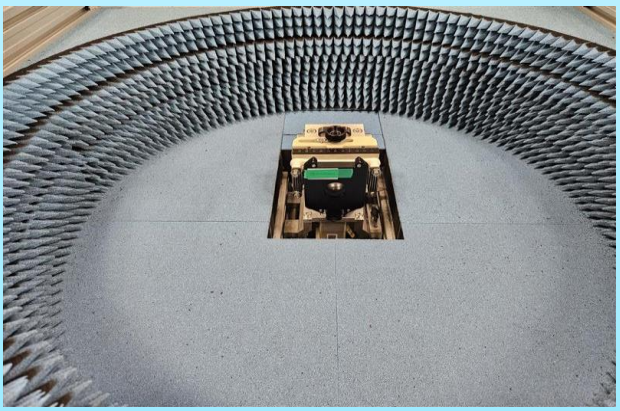


Fig.2: Inside View

Following are the high-level capabilities of the RADAR Scenario Emulator.

Bandwidth	5 GHz
Frequency Range	76-81 GHz
Range	5.6 to 299m
Speed	+-500Km/h
No of Targets	2

The Simulation environment can also replicate the real-world open scenario data captured using the vehicular data acquisition systems. These data can then be curetted, processed and digitized and used in simulation environment in conjunction with the RADAR Scenario Emulator. Thereby the virtual validation ensures the validation of the RADAR and control systems on real world Indian Scenarios in Digital Environment.

Fig. 3: Real world Data

Fig. 4: Digitized Real-world data

Applications:

- RADAR characterization
- Validation of RADAR based control systems like AEB, ACC.
- Validation using real world data specifically for Indian use cases.

❑ Test facility for Measurement of Extractable/Leachable Ionic Contamination Level on the surface of printed boards and assemblies by Ion Chromatography

Ions such as chloride, bromide, fluoride, nitrite, nitrate, sulphate, phosphate, lithium, sodium, ammonium, potassium, calcium and magnesium, if present in the material or product, are considered as sources of ionic contaminants and can have detrimental effects on quality, safety and performance.

ARAI has established a test facility as per IPC-TM-650 for measurement of extractable ionic contamination, which is crucial for various industries, including pharmaceuticals, electronics and environmental science. Accurate measurement of ionic contamination ensures compliances with regulatory standards and helps maintain integrity of the products and processes. Fig. 1 explains the source and effects of ionic contamination.

Fig. 1: Sources and Effects of Ionic Contamination

The process involves extracting these ions from sample matrix and quantifying them using analytical technique such as Ion chromatography. A few examples of PCB samples are shown in Fig. 2.

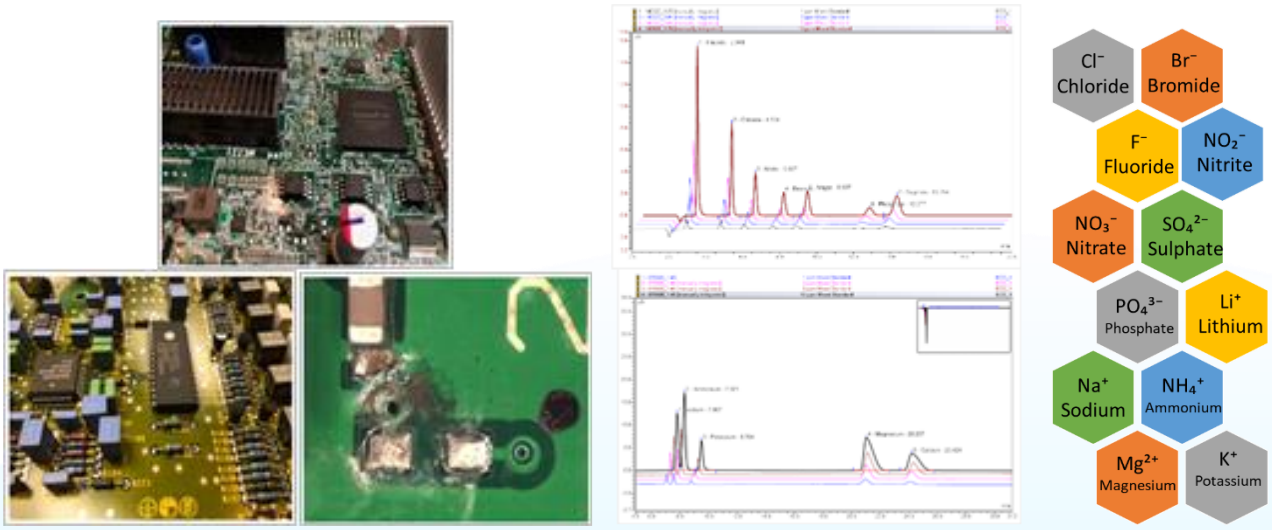


Fig. 2: Analysis of Printed Circuit Board / Assembly for Ionic Contamination

Ion contamination testing will not only identify contaminants but form the type of the contaminants, sources of its introduction can be known. This helps in taking control measures during manufacturing process to avoid the same.

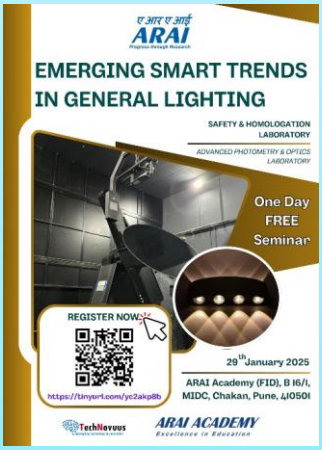
Evaluation of ionic contaminants prevents electrical failures due to ionic residues, improves product longevity and performance, ensures cleanliness and quality assurance in manufacturing.

❑ Seminar on General Lighting "Emerging Smart Trends in General Lighting" - 29th January 2025

Safety and Homologation Lab, ARAI Academy and TechNovuus jointly organized "Seminar on Emerging Smart Trends in General Lighting" on 29th January 2025 at ARAI-FID, Chakan. The objective of this seminar was to facilitate knowledge sharing on the advancements in general lighting technologies, explore upcoming trends and discuss the challenges currently faced by the industry.

Drawing on ARAI's extensive experience in optical measurements, ARAI has set up state-of-the-art facilities for testing general lighting systems. As a part of the seminar, participants were offered exclusive lab visit to the newly commissioned Advanced Photometry and Optics Laboratory at ARAI-HTC, Chakan, providing insights into the capabilities and innovations integrated into the facility.

The seminar was inaugurated by Shri S. D. Rane, Head & Director – BIS, Pune along with Shri A. A. Badusha, Sr. Deputy Director; Ms. M.S. Jambhale, Sr. Deputy Director; Dr. B. V. Shamsundara, Sr. Deputy Director and Ms. J. M. Kirve, Deputy Director.



Over 70 delegates and 12 speakers from various fields of general lighting, including lamp manufacturers, Designers, Architects, Associations, Academicians, etc. were a part of the event.

Eminent speakers from the general lighting area shared their valuable knowledge in their presentations on the topics such as importance of dark night sky, mitigating challenges evolving lighting technologies, LED lighting in Indoor and outdoor lighting, connecting solutions for simplifying the outdoor lighting installations, future of LED Lighting: Innovations and Trends.

Panel discussions on the following two emerging areas, viz. Incorporating Energy Efficiency in Lighting and Trends of Smart Lighting – Industry Viewpoint, were arranged during the Seminar

Following the completion of all technical sessions, a guided visit to Advanced Photometry and Optics Laboratory at HTC, Chakan was organized for all delegates and speakers. The visit provided first hand insight into the cutting-edge testing capabilities and infrastructure developed by ARAI on optics laboratory, which includes general lighting.

The feedback received from speakers as well as delegates was overwhelmingly positive and encouraging. The seminar successfully fulfilled its objective of fostering knowledge sharing, enabling meaningful exchanges between industry experts, and effectively showcasing ARAI's advanced capabilities and facilities at ARAI-HTC, Pune.

❑ International Conference on Advanced Powertrains for Mobility and Power Generation Applications: 7th & 8th March 2025

This Conference was jointly organized by ARAI, SAEINDIA Western Section & BOSCH Global Software Solutions Pvt. Ltd. at The Hotel Orchid Balewadi.

Dr. Sushil Ramdasi (Deputy Director, In-charge -Powertrain Design, ARAI) was the convener & Mr. Dattatraya R. Kurade (General Manager, Mobility strategy, Pune, Bosch Global Software Technologies Pvt. Ltd.) was the co convener of the conference.

Mr. Sudeep Dalvi (Senior Vice President & Director-Technical, Toyota-Kirloskar Motors) was the Chief Guest of the conference.

The said conference was a groundbreaking event aimed at exploring cutting-edge advancements in automotive technology. It brought together renowned experts, industry leaders, and researchers to discuss the latest trends in powertrain technology.

With a focus on sustainable and advanced technologies such as EURO VII readiness, electrification, hydrogen fuel cells, and powertrain optimization, the conference showcased insightful keynote speeches, engaging panel discussions, and detailed technical sessions.

The conference covered challenges due to upcoming Euro7 emission norms, Hydrogen ICE and Flex Fuel technology, making of an efficient & cost effective Conventional / E Axle based drive trains for EV's, Advances in Motors and motor controllers (IM / PMSM / SRM), Power Electronics, MCU, BMS, Battery, Charging Technology, Hydrogen Fuel Cell Electric Vehicle Technology for Mobility & Power Generation Applications, Strong Hybrids / Series Hybrids / Range Extender Based Hybrids, etc.

Highlights of the Conference:

There were total **15 technical presentations**, **09 Keynote addresses** and **2 Panel discussions** conducted in which an eminent personality from top organizations were participated. Around 100 industry professionals from various industries attended this event and appreciated the technical contents presented and discussed over two days.

Following is the brief summary of points presented and discussed during presentations and panel discussions.

ICE Based Powertrains for Mobility & Power Generation Applications (EURO VII / H2 ICE & Flex Fuel):

- The challenges and cost implications of EURO VII implementation along with strategies for compliance
- The future of powertrains beyond EURO VII regulations
- The future trends in power generation technologies viz ICE and Fuel Cell based
- India Specific Alternate Fuel Based Powertrain Technology & Government Initiatives, Rules, Regulation & Testing Infrastructure
- Breakthroughs in emission measurement technology for EURO VII and beyond
- Toyota's experience in pioneering alternative fuels and global trends in hydrogen adoption
- Advancements in hydrogen and flex fuel injection technology
- Fuel Injection Systems for Hydrogen ICE and Flex Fuel Engines
- Multifuel Pathway for India and Honda's perspective towards Ethanol Blending

Penetrating Electrification in Commercial Vehicles:

- Readiness and acceptance of electrification in mass transportation based on facts and figures
- Indigenisation of E-Mobility from an Indian Perspectives
- Physics Based Models to XiL Controls Development for xEV's
- An Indigenous, Efficient and Non-interruptive Supply Chain & Eco-system for all kind of EV's for Indian Market
- Complimenting Product Development Process by use of Advanced Testing Solutions (EV & H FCEV)
- Advances in Motor Controller & Power Electronics Technology
- Digital Twinning for V &V and Calibration of xEV Control Units
- Advances in Motor Technology
- Mahle's Perspective and Technology Readiness in xEV & Flex Fuel Based Powertrains
- Updating on PLI, Rules, Regulations and Certification of Electric Vehicles, Systems & Components
- Sodium Ion Battery Technology for EV's and its Readiness for Mass Implementation

Promoting hydrogen Fuel Cell & Electrolyser technology with due consideration for making viable Business Case

- Bosch Readiness for Migrating towards E Mobility (EV & HFCEV)
- Accelerating EV & Hydrogen FCEV Technology from an Indian Perspective
- Innovative Based Solutions for Hydrogen Electrolysers and Fuel Cell Technology

We thank our Eminent Speakers, Sponsors, and Participants for participating in this wonderful conference.

We congratulate Dr. S. S. Ramdasi (Convener), Mr. Dattatraya R. Kurade (Co-Convener) for successful conference.

Glimpses of the conference:







❑ ARAI Journal of Mobility Technology (Volume 5, Issue 3 July-September 2025)

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