

MOBILITY ENGINEERING

AUTOMOTIVE, AEROSPACE, OFF-HIGHWAY

A quarterly publication of **SAE** INTERNATIONAL and **SAE INDIA**

SsangYong Tivoli

Mahindra & Mahindra aims to make European inroads



Uncertainty quantification

A must for next-generation simulation tools

Oil-pump sizing

Options for low friction and power consumption

Future Indian aviation

Traffic growth and improved infrastructure to raise perceptions

Volume 2, Issue 4

December 2015

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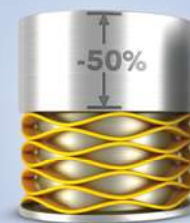
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Connecting in Frankfurt

Last month saw the biennial IAA (Frankfurt Motor Show) rise to new heights with 219 world premieres and 1103 exhibitors from 39 countries. Check out our extensive coverage at <http://bit.ly/1NFiKQ9>. A significant show within the show addressed the megatrend of connectivity with the theme “Mobility Connects.” The dedicated exhibit called New Mobility World held over 180 exhibitors and 46 production and prototype cars.

The connected car is becoming a prime mobile communication platform with rapidly evolving business models and opportunities. According to the **VDA**, the German auto industry association, one quarter of all new cars have an Internet connection, and two years from now, the figure will be 80%. The German automotive industry alone will invest €16-18 billion over the next 3-4 years in connected and automated driving R&D.

The large German suppliers, **Bosch**, **Continental**, and **ZF**, among others demonstrated how connectivity and automation can vastly improve road safety and passenger convenience in the future.

Bosch exhibited connected car technology that can see ahead—further than any sensor, and with much more up-to-date information than any map—to navigate around traffic jams, accidents, and construction zones. The company says its electronic horizon technology will make automated driving safer and hybrid vehicles will know when to convert braking energy into electricity to extend their range. The technology can also regulate particulate filter regeneration based on route data. The electronic horizon’s navigation software will know that an urban area is approaching and could charge its battery in preparation to pass through a full-electric, zero-emissions zone.

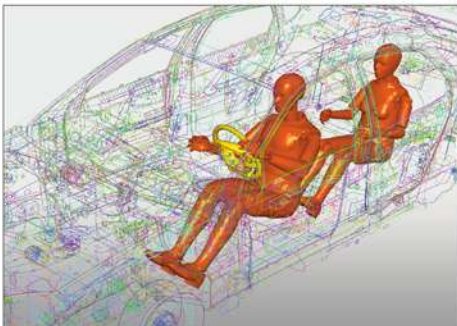
Continental showed a test vehicle with adaptive cruise control combined with elements of its similarly themed dynamic eHorizon technology.

The Connected Enhanced Cruise Control test vehicle combines the accuracy of road maps from **Here** and vehicle sensor data on such things as lane-keeping, routing, curve radius, road slope, and traffic congestion. It effectively enables the vehicle to “see” around corners. Aggregation and analysis of the data provided from various sources is performed by a scalable backend platform created in cooperation with **IBM**.

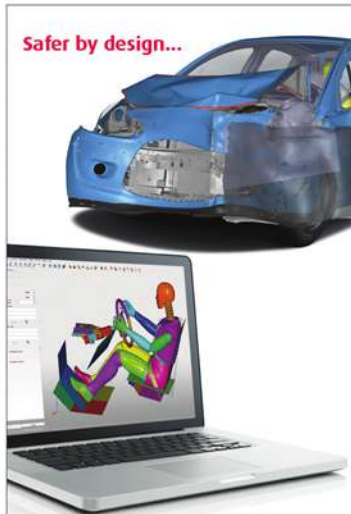
The new **ZF/TRW** combination exhibited its first joint development effort in the all-electric and connected ZF Advanced Urban Vehicle, which has semi-automated functions intended to enhance comfort/convenience, safety, and efficiency. Its PreVision Cloud Assist function, like the other two companies’ offerings, provides Internet connectivity to aid maximum range and driving safety by storing data in the cloud on vehicle position, current speed, and lateral and longitudinal acceleration. If the driver follows the same route again, the assistance function can throttle back torque early on before entering the bend without mechanical braking. All of which not only protects the vehicle’s battery and braking system, but also provides greater safety particularly on blind corners.

These three highlights were only a tip of the iceberg of connected vehicle technology from Frankfurt—and for good reason. The connected car market, just for services, is predicted to be worth \$40 billion by 2020, according to new market research from ReportsnReports.com titled Connected Car Ecosystem: 2015 - 2030—Opportunities, Challenges, Strategies & Forecasts. The growing proliferation of embedded in-vehicle connectivity and smartphone integration platforms has made connected cars one of the fastest growing segments of the Internet of Things market, according to researchers. Keen to establish recurring after-sale revenue streams, all major automotive OEMs and their supplier partners are investing in connected-car programs.

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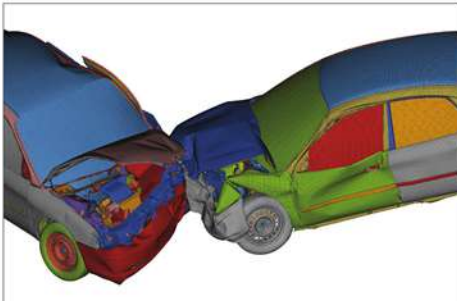
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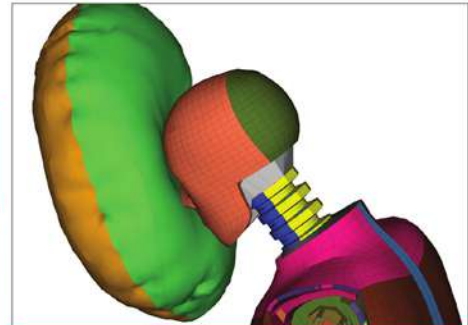
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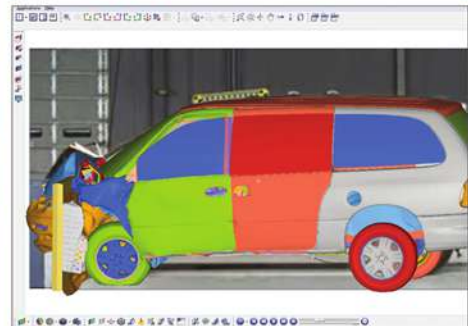
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FOCUS

An action-packed quarter

At the outset, it gives me immense pleasure to share with you that our illustrious past President, Dr. Pawan Goenka, has been recognized by FISITA, the International Federation of Automotive Engineering Societies, for the most coveted and prestigious Medal of Honour. The fact that he is the first Indian and one of the very few Asians to be chosen for the award distinguishes him as an acknowledged leader of the automotive industry in the global arena. Dr. Goenka will be conferred with this award in the FISITA World Congress in Korea in 2016.



Dr. Aravind Bharadwaj
President, SAEINDIA

It has been an action-packed and eventful quarter between July and September for SAEINDIA as events and activities took place in such quick succession with high-voltage publicity.

ITEC INDIA 2015, organised for the first time in India in collaboration with IEEE-IAS, was a remarkable success. Honourable Minister for Department of Heavy Industry and Public Enterprises, Shri. Anant Geete, inaugurated the event and flagged off the electric car rally. He also dedicated the Lithium Project for corporate city mobility in the form of electric cars. He launched Virtual Electra, a design and development competition for engineering students, signifying the intent of the government and industry to usher in electric mobility in the country. As a fitting finale, Mr. Rajan Wadhwa, President and Chief Executive, Truck & Powertrain, Head - Mahindra Research Valley,

announced in his valedictory address that the second edition of ITEC INDIA would be held in Pune in collaboration with ARAI in 2017.

In July we had the first webinar program on Vehicle Dynamics by Dr. Thomas Gillespie, an internationally renowned expert on the subject. This was held at Amrita University Coimbatore and was webcasted live in six different locations in the country and was attended by over 44 faculty advisors and 450+ students. The participants had live interactions with Gillespie, making the program a huge success.

In the last week of July, Dr. Richard Greaves, President of SAE International, visited India and attended a unique program on "Engineer an Entrepreneur" conducted by SAEINDIA Southern Section, and interacted with industry leaders in the Blue Ribbon CEO Conclave held in Chennai on "Deployment of EV opportunities." This was followed by a one-day conference in Bangalore on "Make in India: Transformational Driver for Aerospace and Defence Industries," which was attended by policy makers from the government, industry leaders from aerospace domain, and scientists from defence laboratories and departments.

Dr. Greaves visited Pune and attended a program under the off-highway vertical followed by a leadership enclave networking with the industry leaders. It was also a joyous occasion when Greaves inaugurated the new office of SAEINDIA Western Section in the industrial belt of Pune, endearing SAEINDIA closer to the mobility community. He also took part in the SAE Foundation Awards ceremony in Delhi and announced an endowment of \$10,000. The interest from the proceeds will be used to recognize and reward the best contribution in the aerospace domain. On behalf of SAEINDIA, I would like to take this opportunity to thank Dr. Greaves for this generous donation to SAEINDIA Foundation.

In continuation to the First Policy Deployment Meeting held at Lavasa, Pune, last year, the second edition was successfully held at Damdama Lake near Gurgaon on 12th and 13th September 2015. An action plan for taking SAEINDIA to the next growth trajectory was finalized and a task force has been formed for the short-listed priorities to ensure execution in a time bound manner.

The highlight of the Annual General Body Meeting held in September was the lively interactions with the energetic audience. The fact that there was a large number of members participating in this meeting for the first time bodes well for the future of our society since active members/volunteers are the key for SAEINDIA to meet our growth objectives.

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SUPRA SAEINDIA 2015 held in Chennai



Teams line up for the endurance test event at SUPRA SAEINDIA 2015.

SUPRA SAEINDIA 2015 was an exciting design competition conceived to instill and harness talent, honing the skills of engineering students from all over India. Students from various colleges form teams and create a virtual design, build a prototype, and test their own Formula-type racecar. The project fuels the exuberance of the youth by providing teams a platform to test their mettle, giving them pragmatic exposure to real-world challenges faced in industry. The event happened from 16th to 19th, July 2015, at MMRT (Madras Motor Race Track) in Chennai.

The challenge for the participating engineering students is to constantly innovate and bring about changes for reduction in weight, fuel economy, and increased transmission efficiency. The students are guided and mentored by industry professionals and faculty advisers who are imparted training and guidance by technical experts of SAEINDIA.

The 4th edition of SUPRA SAEINDIA was inaugurated at the hands of Mr. Subu D. Subramanian, MD and CEO, **Hinduja Tech Limited** on 16th July 2015 at MMRT. 2200 engineering students in 110 teams competed to design a Formula prototype car. Nearly 100 judges from mobility industries as well as motorsports came to judge the talent of the SUPRA participants.



Key stakeholders kick off the endurance test.

SUPRA SAEINDIA 2015 Winners

RANK	TEAM NAME	COLLEGE NAME
OVERALL		
1	INVINCIBLES	KRISHNA INSTITUTE OF ENGINEERING & TECH.
2	TEAM HAYA	PES INSTITUTE OF TECH.
3	HERMES RACING	KIIT UNIVERSITY
BEST PIT AWARD		
1	HERMES RACING	KIIT UNIVERSITY
BEST GIRL PARTICIPATION AWARD		
1	UNNATHI B PAI (FORCE IKSHVAKU)	THE NATIONAL INSTITUTE OF ENGINEERING
BEST TEAM AWARD WITH GIRL PARTICIPATION		
1	TEAM ARYANS	GOVERNMENT COLLEGE OF ENGINEERING
INNOVATION		
1	TEAM ROAD RUNNER	NIT ROURKELA
GO GREEN		
1	TEAM HAYA	PES INSTITUTE OF TECH.
FUEL ECONOMY		
1	HERMES RACING	KIIT UNIVERSITY
CAE AWARD		
1	VAMOS AUTOCROSS	SINHGAD ACADEMY OF ENGINEERING
2	TEAM PVPIT	PADMABHOOSHAN VASANTDADA PATIL INST. OF TECH.
COST AWARD		
1	GS RACERS	S.G.S.I.T.S INDORE
2	FORCE IKSHVAKU	THE NATIONAL INSTITUTE OF ENGINEERING
PRESENTATION AWARD		
1	INVINCIBLES	KRISHNA INSTITUTE OF ENGINEERING & TECH.
2	VELOCE 4.0	VISHWAKARMA INSTITUTE OF TECHNOLOGY
ENGG. DESIGN AWARD		
1	TEAM OCTANE RACING	COLLEGE OF ENGINEERING PUNE
2	TEAM PVPIT	PADMABHOOSHAN VASANTDADA PATIL INST. OF TECH.
ACCELERATION AWARD		
1	VELOCE 4.0	VISHWAKARMA INSTITUTE OF TECHNOLOGY
2	VAMOS AUTOCROSS	SINHGAD ACADEMY OF ENGINEERING
SKID PAD		
1	INVINCIBLES	KRISHNA INSTITUTE OF ENGINEERING & TECH.
2	VELOCE 4.0	VISHWAKARMA INSTITUTE OF TECHNOLOGY
AUTO CROSS		
1	TEAM HAYA	PES INSTITUTE OF TECH.
2	INVINCIBLES	KRISHNA INSTITUTE OF ENGINEERING & TECH.
ENDURANCE		
1	INVINCIBLES	KRISHNA INSTITUTE OF ENGINEERING & TECH.
2	HERMES RACING	KIIT UNIVERSITY

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News



Team Invincibles won overall first place at SUPRA SAEINDIA 2015.



The organizing team for SUPRA SAEINDIA 2015.

Speaking on the occasion, Mr. Prashant K. Banerjee, Convener, SUPRA SAEINDIA 2015 and Head of Homologation and Product Evaluation, **Tata Motors Ltd.**, said, "It gives us great satisfaction to see that over the years teams are maturing, which is now showing in some of the very impressive prototypes that they have brought here. We hope this event will continue to enable these bright, young engineers to discover their passion for automotive engineering and motivate them to choose it as their career."

About 91 teams registered on the first day and underwent static tests and dynamic tests. Finally only nine teams qualified for the endurance test.

The Event came to an exciting close on 19th July afternoon. Mr. C. V. Raman, Executive Director, Engineering Research, **Maruti Suzuki India Limited**, was the

Chief Guest of the Valedictory Function. Ms. Rashmi Urdhwashe, Director, **ARAI**; Dr. Aravind S. Bharadwaj, President, SAEINDIA and Senior Vice President, Advanced Technology and Services, Automotive & Farm Equipment Sectors, **Mahindra & Mahindra Ltd.**; Mr. Prashant K. Banerjee, Convener, SUPRA SAEINDIA 2015 and Head, Homologation and Product Evaluation, Tata Motors Ltd.; Mr. Sirish Vissa, Technical Committee Chair, SUPRA SAEINDIA 2015 and Head of **Volkswagen Motorsport India**; and other office bearers and members of SAEINDIA were present on the occasion.

Mr. C. V. Raman said, "We had first collaborated with SUPRA SAEINDIA in 2011 for this competition to encourage budding talent in motorsports and engineering. To conceptualize, design, fabricate and run a Formula prototype car from start to finish provides an immense

amount of hands-on experience. Being the market leader, Maruti Suzuki has always paid extra attention to engineering and we will continue with our initiatives to provide students the right kind of exposure to further polish their engineering skills. I believe that there is an abundance of talent pool in our country so I hope to see more students participating and gaining as much experience as possible from these events to develop their abilities from the opportunities that lie ahead."

Maruti Suzuki India Limited is and has been the Title Sponsor of the event right from the first edition. Other sponsors include **BPCL**, who have offered to exhibit these vehicles at their network across the country, **Altair**, **ANSYS**, **ARAI**, **Bosch**, **Continental**, **Viper Hobbies**, **Roots**, and **Canara Bank**.

Mr. Bibhu Kumar, Officer, CDS EVENTS, SAEINDIA

Gillespie gives international seminar on vehicle dynamics



Participants at SRM, Chennai—coordinated by EEB member Prof. Leenus and supported by Prof. Bhaskar Sethupathi.

The first international seminar on vehicle dynamics by Dr. Thomas Gillespie was held July 9th to 11th, 2015. The event was held for the faculty advisors at **Amrita University**, Coimbatore and was transmitted live to six locations for students, including **PSNA** (Dindigul), **SRM** (Chennai), **PES** (Bangalore), **MVSR** (Hyderabad), **MIT** (Pune), and **KIIT** (Bhubhaneswar).

The members of the Engineering Education Board (EEB) Prof. P.B. Joshi, Prof. Kannan Rajendran, and Prof. Leenus were the coordinators at Pune, Dindigul, and Chennai and the Division chairman of Hyderabad Dr. G. Padmanabham along with Dr. Gururaj. T supported the initiative at Hyderabad.

The EEB contacted KIIT for hosting it at Bhubhaneswar with Prof. Isham coordinating the program. The live streaming was done by using A-view, a software developed by **Amrita** and used extensively by **IIT Bombay** for their E-learning and MOOC initiatives, and technical support was rendered by the e-learning initiatives team from Amritapuri and Coimbatore. About 450 students and faculty members attended the program.

The event was inaugurated by Dr. Aravind Bharadwaj, President of **SAEINDIA**, through Skype and was streamed live to all the six locations. Gillespie answered questions live from the various locations. The feedback from this program was very encouraging and EEB will be planning further programs with domain experts.

Dr. S. Thirumalini, Chair, EEB SAEINDIA

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India holds first International Transportation Electrification Conference



Lighting up the ceremony by Chief Guest Shri. Anant Geete.



Dr. Aravind S. Bharadwaj, President, SAEINDIA, addresses iTEC INDIA 2015.

iTEC INDIA 2015, the country's first International Transportation Electrification Conference, was inaugurated by Shri. Anant Geete, Honorable Minister of Heavy Industries & Public Enterprises, Government of India, on August 27, 2015. The three-day (August 27-29, 2015) conference held at Le Royal Meridien (Chennai) was jointly organised by SAEINDIA and the Institute of Electrical and Electronics Engineers (IEEE) Industry Applications Society (IAS). The main focus of the conference was "Electrified Mobility through Holistic Ecosystem Solutions."

Shri. Ambuj Sharma, Patron of the Steering Committee for iTEC INDIA 2015 and Additional Secretary, Department of Heavy Industries, Government of India; Dr. Aravind S. Bharadwaj, President, SAEINDIA and Senior Vice President, Advanced Technology and Services, Automotive & Farm Equipment Sectors, Mahindra & Mahindra Ltd.; Dr. David Schutt, CEO, SAE International; Dr. Tomy Sebastian, President Elect, IEEE IAS and Director of Motor Drive Systems, Halla Mechatronics; and Mr. N. Balasubramanian, Chairman, Organizing Committee for iTEC INDIA 2015 and Deputy Vice President, Product Engineering, Renault Nissan Technology & Business Centre India; and other members of iTEC INDIA 2015 committees were present on the occasion.

iTEC INDIA 2015 was supported by

the Department of Heavy Industry, Government of India under Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, a part of the National Electric Mobility Mission Plan (NEMMP) 2020, Confederation of Indian Industries (CII), Society of Manufacturers of Electric Vehicles (SMEV), Society of Indian Automobile Manufacturers (SIAM), Automotive Component Manufacturers Association (ACMA), and SAE International.

Shri. Anant Geete said, "The growth and adoption of hybrid electric vehicles will be a major component of the government's FAME India scheme. These vehicles will reduce CO₂ emissions and fuel consumption, in turn positively impacting the foreign exchange situation in the country, since 90% of our crude oil is imported. India is unique and there are huge cost and environmental challenges. Solutions which work abroad, may not work as is in India. iTEC INDIA 2015 provided the opportunity to deliberate on these technical challenges and come up with solutions required for India's future."

iTEC INDIA 2015 also saw the launch of the "Lithium" Project. Lithium is the world's first service provider with a 100% zero emission electric car fleet for corporate transport. Lithium provides an integrated transport management system for corporations including a fleet of connected cars manned by

trained and certified drivers and supported by qualified professionals, working in the backend. A display of the latest electric vehicles was showcased during iTEC INDIA 2015, highlighting the Nissan Leaf, Mahindra Reva e2o, etc. among others.

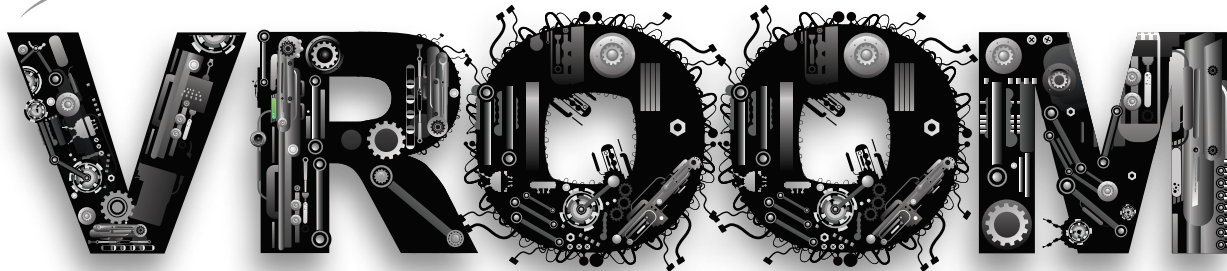
"The Government of India had formulated the FAME - India scheme and allocated Rs. 795 Crores for the years 2015 - 2017. This scheme will focus on four areas namely, technology development, demand creation, pilot projects and finally charging infrastructure," Shri. Ambuj Sharma said.

Speaking at the kick-off event, Dr. Aravind S. Bharadwaj said, "The Government of India has set the challenging goal of achieving 6-7 million sales of hybrid and electric vehicles year on year from 2020 onwards. While monetary incentives and investments are important to realize this ambition, technology innovation and advancements are even more crucial at this stage to shape the growth trajectory of Electro Mobility adoption in the country."

In his speech, Dr. David Schutt complimented SAEINDIA for organizing the First International Transportation Electrification Conference in India with IEEE IAS and assured the support of SAE International in carrying out such trend-setting programs as Electric Mobility, which is going to occupy a significant place in mass mobility in the future.

Dr. Tomy Sebastian said, "Cooperation

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Panel Discussion L to R: Mr. Deepangshu Sarmah; Mrs. Hemalatha Annamalai; Mr. Asit K. Barma; Mr. Basavaraj Garadi; and Dr. Chalasani Rao.

of SAE whose focus is on mobility systems and IEEE which is the largest professional association for the advancement of technology focused on electrical and electronic technologies is probably the most efficient way to address the technical challenges associated with the integration of electrical technologies into automotive systems.”

Mr. N. Balasubramanian said, “Individual mobility of the future will be greener, intelligent and partnership oriented. India has opportunities both as a manufacturer as well as an early adopter of hybrid and electric technology. iTEC INDIA 2015 is being organized to encourage sharing of knowledge, best practices and case studies, both technological and organizational, to propel India’s fledgling Electro Mobility Industry.”

Balasubramanian expressed his gratitude to Ministry of Heavy Industries, government of India, for having supported in conceptualizing this first of its kind conference in India. He also thanked the delegates and the participating companies for coming together for the conference.

The conference addressed technical interests related to the electrification in the transportation sectors including but not limited to, electric hybrid vehicles, plug-in-hybrid vehicles, aeronautical, railroad and off-road vehicles. iTEC INDIA 2015 also had an array of papers across different topics. In addition, the event was comprised of panel discussions, short courses and tutorials, presentations, exhibits, electric vehicle displays, and ride and drives. About 80 technical papers

were presented at the conference by participants from seven countries.

The conference covered topics including power electronics and electric motor drives, electric machines, sensors and actuators, battery and battery management systems, electric, hybrid electric, and plug-in-hybrid vehicles, electric vehicle system architectures, smart grid, electrical infrastructure and V2G, autonomous vehicles, V2V communication and ICT, fuel cell applications in transportation, and electrical systems and components for sea, undersea, air, rail and space vehicles.

The three-day conference featured an exceptional line-up of speakers including Dr. Mahesh, Illinois Institute of Technology; Mr. Patric Mccarren, ED, IEEE IAS, USA; Mr. Michael Poznanski, CTO, **Volkswagen** India; Mr. Naritomo Higuchi, **Honda** R&D, Japan; Mr. Brian McMurray, Director, **General Motors**; R.K. Shenoy, Sr. VP, **Robert Bosch**; Mr. Stevan Dom, Manager, **Siemens**; Mr. Wensi Jin, **MathWorks**; Mr. Mahesh Babu, COO, **Mahindra e2o**; Mr. I.V. Rao, Executive advisor, **MSIL**; Dr. Chalasani Rao, Director (Ret.) General Motors; and Mrs. Rashmi Urdhwareshe, Director, **ARAI**.

The event was sponsored by the Department of Heavy Industries, Bosch, Maruti Suzuki India Ltd (MSIL), Siemens, Automotive Research Association of India (ARAI), Ansys, Altair, Continental Automotive Components India Limited, and MathWorks. The various exhibitors who exhibited the event are Comsol Multiphysics Pvt. Ltd, Automotive Test Systems (ATS), Autocar Professional,



Dr. Mahesh Krishnamurthy, Illinois Institute of Technology, delivers the keynote address.

Autotech Review, Lohia Auto Industries, Mahindra Reva Electric Vehicles Pvt. Ltd, TVS Motor Company, St. Peter’s University, and Satyam Venture Engineering Services Pvt. Ltd.

The conference also featured a young professional program where students and young professionals got an opportunity to discuss issues and opportunities with industry and academic leaders and entrepreneurs, moderated by Prof. Akshay Rathore.

Dr. Rajan Wadhwa, Chief Executive and President of Truck & Power Train Division, and Head of Mahindra Research Valley at Mahindra & Mahindra Ltd., was the Chief Guest of the valedictory function and stated that the iTEC India 2015 Conference also offered an excellent platform for exhibitors to showcase their products, technologies, and services to the important players of the mobility industry. It also provided OEMs and suppliers a perfect venue to display and demo the advanced technologies in their vehicles so the tech-savvy audience could touch, feel, and live the experience. The conference has channelized innovative minds from the global automotive community to congregate and exchange ideas. Going forward, innovative design concepts will lead the way toward sustainable, safe, and connected vehicles, in line with ever-changing customer demands and loyalty.

Wadhwa also announced that the 2nd iTEC INDIA will be organized in August 2017 at ARAI Campus in PUNE, India.

Mr. R. Srinivasa Raghavan, Dy.Manager - Projects, SAEINDIA

ELECTRA event focuses on electric vehicle technology



Team Taiyo Zen from Hindustan University, Chennai won first place at Virtual ELECTRA.



Judges and organizing team of ELECTRA SAEINDIA.

SAEINDIA is pleased to announce that the society is taking up a new initiative to promote technologies that support eco-friendly vehicles in India.

ELECTRA SAEINDIA will focus on electric vehicle technology exploration and evaluation for students of the engineering institutes all over India. This event provides a real world engineering challenge for SAEINDIA student members that reflects the steps involved in the entire process including design and engineering, production, marketing, and endurance testing of an electric vehicle.

The Virtual ELECTRA - a first edition for ELECTRA SAEINDIA took place on 28th of August 2015 at Le Royal Meridien, Chennai. The Rule Book of ELECTRA SAEINDIA was launched by the Honorable Minister of Heavy Industries Shri. Anant Geete.

According to Dr. S. Thirumalini, Chair, Engineering Education Board, SAEINDIA, the ELECTRA SAEINDIA competition is a great idea to entice students to work in emerging technologies since India has a mission plan to promote the manufacture and usage of electric vehicles. Participating students will have the ability to think ahead in terms of the requirements for an EV ecosystem since the requirements are



Team Drag Demons from Sri Krishna College of Engineering Technology, Coimbatore took second place.

unique and solutions need to be innovative.

14 teams registered and 9 participated in the Virtual ELECTRA event with Team Taiyo Zen from Hindustan University, Chennai taking first place. Team Drag Demons from Sri Krishna College of Engineering Technology, Coimbatore took second place.

Mr. Bibhu Kumar, Officer-CDS Events, SAEINDIA

Kamalakkannan wins Ralph Teetor Award

Mr. K. Kamalakkannan, Associate Professor and HOD, Department of Automobile Engineering, has been working at Hindustan University for nearly a decade. As a faculty member, he is a backbone of India's first UG syllabi in Automobile Engineering specialization with Motorsports Engineering. He is a faculty advisor for Baja, International Baja, and FSAE in his institution. His ability to impact students has awarded him to obtain from Indian Baja 2012 'The



Dr. K. Kamalakkannan.

Dronocharya' and Best Faculty Advisor (2011) by SAEINDIA Southern Section.

He was instrumental in obtaining the prestigious AICTE -RPS(C) titled "Design & Development of Three Wheeler for Physically Challenged" and acted as its principal investigator.

He was one of the members selected for attending Faculty Induction Education Program (FINE) organized by the Off-Highway Board of

SAEINDIA, supported by John Deere, Pune for 15 Days.

He has obtained his UG degree in Automobile Engineering from Bharathiar University, Coimbatore and PG degree in Engineering Design from Anna University, Chennai.

His research work involves Semi-active Suspension System for All terrain Vehicles and he has published in four international journals and three international conferences.

He is also an active member of SAEINDIA Southern Section.

Blue Ribbon CEO Conclave focuses on electric vehicle deployment



Lighting the function by Dr. Richard Greaves.



Discussion by Mr. Karthick, Ashok Leyland; Ms. Farhana, Vodafone; Mr. Mahesh Babu, Mahindra Reva; Dr. Aravind S. Bharadwaj, M & M.



Mr. G. Vijayan; Mr. Pawan Kumar; Mr. J.K. Krishnamurthy; Dr. R. Mahadevan; Mr. Murli Iyer; Dr. Richard Greaves; and Dr. Aravind S. Bharadwaj.

In India, the penetration of Electric Vehicles (EVs) in urban areas depends on the acquisition and ownership costs as well as quality of and accessibility to charging infrastructure. The government should work toward developing an environment that encourages the private sector to create charging infrastructure in the country. Another important focus to boost the EV market should be on batteries that typically constitute up to half of the vehicle cost and weight. The government should support research activities to develop innovative and low-cost batteries, recycling and reuse of batteries, etc. For example, the NEMMP 2020 (National Electric Mobility Mission Plan) focuses on battery cells and Battery Management System (BMS) technology as a priority.

Hence, a lot needs to be done by both the government and OEMs to revive and rebuild the Indian EV industry. EVs have been on the global radar of governments

and OEMs, however, the scenario of roads filled with electrically operated cars still seems distant. According to the 2015 Global Automotive Executive Survey, by 2020 less than one in 20 vehicles is expected to be equipped with electrified powertrains, which may be dominated by full or partial hybrids. The plug-in hybrid and battery EVs are expected to capture a smaller portion of the pie, followed by fuel cell electric cars that have the least share. By 2020, only 0.01% of cars are expected to be equipped with fuel cells i.e. about 16,000 units per annum.

With this backdrop, the Automotive Board of SAEINDIA conducted the second edition of Blue Ribbon CEO Conclave in Chennai on July 27th at ITC Grand Chola, Chennai during the visit of Dr. Richard Greaves, President of SAE International. Mr. Murli Iyer, Executive Global Advisor, SAE International, accompanied the president. At this Conclave, 20 CEOs and heads of business from OEMs

and vendor partners were present to show their continued support to SAEINDIA and share their thoughts and experiences about “Deploying EVs: Innovative Opportunities For Indian Automotive Industry.”

The entire discussion was not limited to, but covered four major aspects: innovations in the e-mobility architecture for India, development of e-vehicle, development of talent base, and infrastructure and supply chain for e-mobility. M/s ALTAIR Engineering Private Limited sponsored the entire event. The Conclave began with auspicious lamp lighting by Dr. Richard Greaves followed by the opening address by Dr. Aravind Bharadwaj, President, SAEINDIA.

The interesting presentations provoked interaction and constructive suggestions on how we should hasten in creation of supporting infrastructure and encourage mass mobility by public transportation such as electric/hybrid buses. Battery management and fuel cells will have to become user friendly and the state governments should play a proactive role by introducing tax incentives to make acquisition attractive for the next generation.

Malls, cinemas, and public places should create charging facilities and overnight charging should make the vehicle mobile during the day. In the estimated six to seven million electric/hybrid vehicles on the road by 2020, 60 to 70% would be two-wheelers and if achieved, it could be a game changer in the automobile scenario.

Mr. D. Seshadiri., Sr. Dy. Director-Marketing, SAEINDIA

SAENIS Efficycle focused on lightweight technologies



Inauguration of SAENIS Efficycle 2015.



Participants at the registration desk for SAENIS Efficycle 2015.



Teams presenting at SAENIS Efficycle 2015.

The 6th edition of SAEINDIA Northern Section (SAENIS) Efficycle 2015 event was organized as “Efficycle - Lightweight Season” with the theme “Using lightweight technologies to make lighter, durable, and highly efficient cycles but without compromising safety.” The event was conducted in two locations: Ghaziabad for the first round and Indore for the second.

The first round of SAENIS Efficycle 2015 event was conducted at KIET, Ghaziabad from 4th to 5th July 2015. 59 teams participated and there were five judging panels of four judges each from companies including **MSIL, ICAT, ABB Electric, Lumax, NSCT, SPX ClydeUnion Pumps, IOCL** etc.

Shri. Atul Garg, Management Trustee, KIET; Dr. S.P. Mishra, VC-Dev, **Sanskriti University** and Advisor, **Krishna Group**; Shri. U.D. Bhangale, Sr. GM, ICAT and Convener Efficycle 2015; Dr. Reji Matahi, Chief Research Manager, IOCL and Co-convener, Efficycle 2015; and Dr. K.L.A. Khan, HOD, Mechanical, KIET were present during the inaugural ceremony. After the lamp lighting ceremony, Shri. U.D. Bhangale welcomed all the participants, faculty advisors, and judges from the automotive industry. Dr. S.P. Mishra and Shri. Atul Garg enlightened the participants with their motivational talks. The event proceeded with the students briefing and judges briefing by Mr. Jitendra Singh Gaur, Technical Committee Coordinator, in which the evaluation procedures were explained

to the participants. Judges were briefed about the rulebook criteria, evaluation parameters, etc.

On the second day of the first round, the participants were briefed and the presentations were made as per the schedule. After all the presentations, the valedictory session was organized. The judges’ efforts were recognized by the organizing committee and Shri. U.D. Bhangale presented the “Certificate of Appreciation” and mementos to all the judges on behalf of SAENIS and the whole organizing committee. The event concluded with the vote of thanks by Convener Shri. U.D. Bhangale.

The second round of SAENIS Efficycle 2015 event was conducted at CDGI, Indore from 11th to 12th July, 2015. 84 teams participated and there were six judging panels of three judges each from companies namely MSIL, ICAT, Lumax, IOCL, **John Deere, Volvo Eicher Commercial Vehicles, Mahindra 2 Wheelers, and NATRAX** (under NATRiP) etc.

Shri. K.S. Jairaj, Registrar, **CDGI**; Mr. D.R. Phalke, HOD Mechanical, CDGI; Shri. U.D. Bhangale, Sr. GM, ICAT and Convener Efficycle 2015; Dr. Reji Matahi, Chief Research Manager, IOCL and Co-convener, Efficycle 2015; Mr. S. Saifee, Sr. Manager, Mahindra 2 Wheelers; and Mr. Ashit Jha, GM, MSIL, were present during the inaugural ceremony. Lighting the lamp, Shri. U.D. Bhangale welcomed all the participants, faculty advisors and judges from the



Bird's eye view of the valedictory function at SAENIS Efficycle 2015.

automotive industry. Mr. K.S. Jairaj and Mr. S. Saifee enlightened the participants with their motivational talks. The event proceeded with the students briefing and judges briefing by the Technical Committee and M/s Siemens conducted a separate session. The students were then informed about the CAD/CAE practices.

On day two of the second round, the participants were briefed and the presentations were made as per the schedule. The judges’ efforts were recognized by the organizing committee and Shri. U.D. Bhangale (Convener), Shri. Jitendra Malhotra (Co-convener), Dr. Reji Mathai (Co-convener), and Prof. C.N.S. Murthy (Dean, CDGI) presented the “Certificate of Appreciation” and mementoes to all the judges on behalf of the chairman, SAENIS, and the whole organizing committee. The event concluded with the vote of thanks by Convener Shri. Jitendra Malhotra.

SAEINDIA

News

Written test added to Virtual Baja SAEINDIA



The entire Virtual BAJA SAEINDIA 2016 team.

The two-day virtual round of BAJA SAEINDIA 2016 was conducted on the 10th and 11th of July 2015 at **Chitkara University**, Chandigarh. About 370 teams participated in the event from all the parts of our country.

A written test was added to this event from this time onward as an evaluation criteria with equal weightage to both written test and presentation. There were about 60 industrial experts and the Organizing Committee (OC)

supported this All Terrain Event (ATE) as judges and panelists.

The event was started with the auspicious lamp lighting by Dr. K.C. Vora, **ARAI**, and Mr. P.S. Nitish, **M and M**, and they shared their thoughts on this occasion. It was then followed by a student briefing about the entire event. Ms. Srishti Prasad, **UIET**, Punjab was awarded a cash prize of Rs 5000 for suggesting the theme of "Passion to Podium" for BAJA SAEINDIA 2016.

One of the highlights of this event was the launch of the first edition of "BAJACME" – BAJA SAEINDIA newsletter by all the dignitaries of this event. The initiative, taken up by the BAJA SAEINDIA Alumni Committee, is the passionate adventure of the world of BAJA and off-roading.

Chitkara University, the host of the event, arranged a cultural extravaganza on day two for all the attending team members, judges, OC Members, and Alumni Committee members. The students of Chitkara University performed a skit and ended with an energetic dance performance, where all judges and OC Members were invited on the stage to perform with the Students.

During the valedictory speech, Mrs. Madhu Chitkara, Vice Chancellor of Chitkara University, expressed her pleasure in hosting this event and similar events in the future. Mrs. Chitkara and other dignitaries from Chitkara presented the judges, OC Members, and Alumni Committee members with a token of appreciation.

Off-highway Leadership Enclave looks at smart cities



Inauguration of the SAEINDIA Off-highway Leadership Enclave.

The SAEINDIA Off-highway Board organized a day program on Leadership Enclave in Pune on 30th July 2015 with the theme "Role of Off Highway Industry in Smart Cities and Digital India."

The highlight of the event was the panel discussion by eminent leaders from the off-highway industry on the theme and



Dignitaries of the function.

a speech by **SAE International** President Dr. Richard Greaves.

Dr. Greaves and Mr. Murli Iyer, Executive Global Advisor, SAE International, talked about the role of SAE in building off-highway industries and thereby making smart cities for the future. They also spoke about the SAE Foundation and SAE International's commitment to help take these and newer initiatives ahead along with the Off-highway Board.

A vote of thanks was proposed by Mr. Amar Variawa, secretary SAE Off-highway board, and it was followed with a networking dinner.

Inauguration for SAEINDIA Western Section office



Dignitaries present at the SAEINDIA Western Section office inauguration.

The SAEINDIA Western Section (SAEIWS) office was inaugurated by Dr. Richard Greaves, President SAE International in the presence of Dr. Aravind Bharadwaj, President SAEINDIA, and Mrs. Rashmi Urdhwarshre, Chairperson, SAEIWS and Director, ARAI, on 31st July 2015, Pune.

The event flow was as follows:

- Welcome address by Mrs. Rashmi Urdhwarshre, Chairperson, SAEINDIA WS
- Student perception about SAEINDIA by Mr. Pratik from MIT, Pune
- Address by Mr. Murli Iyer, Executive Global Advisor, SAE International
- Address by Dr. Aravind Bharadwaj, President SAEINDIA
- Introduction of Dr. Richard Greaves, President SAE International, by Mr. Narahari P. Wagh, Secretary, SAEIWS
- Inauguration of SAEIWS office and inaugural address by Dr. Richard Greaves
- A vote of thanks by Mr. G. Vijayan, Deputy Director General, SAEINDIA

The event was followed by the lunch at Sayaji Hotel for all dignitaries.

Training programs conducted for AWIM Master Teachers



New innovative thought seen at the SAEINDIA Western Section AWIM Master Teacher Training Program.



Participants of the SAENIS AWIM Master Teacher Training Program.

SAEINDIA Western Section in association with ARAI and sponsors **Eaton Technologies**, John Deere, and **Cummins India** conducted A World In Motion (AWIM) Master Teacher Training Program (MTTP) on 31st July for teachers from various schools from Pune and volunteers of sponsoring companies. AWIM is a competition for school students of 5th and 6th Standard who work as a team, applying scientific design concepts and exploring the principles of laws of motion, inertia, force, momentum, friction, air resistance, jet propulsion, etc. to create moving vehicles like skimmer and balloon-powered JetToy cars. Mr. Saurabh V. Chitnavis, Mr. Manoj Girhe, and Mr. Rahul Gujar, along with conveners of AWIM Pune Olympics 2015, Mr. Kiran Patil, Ms. Mrunmayee Pujari, and Mr. Yatin Jayawant conducted the training. Teachers and volunteers from Pune City as well as some Mumbai and Chandigarh volunteers attended the training.

Then on 22nd August 2015, SAENIS inaugurated the AWIM 2015 chapter by successfully conducting the MTTP at Mapple Emerald for Delhi NCR region.

Mr. Alok Jaitley, Vice Chairman Student Competition, SAENIS and Convener, AWIM SAENIS, and Mr. Rakesh Sood, Vice Chairman Student Activities, SAENIS and ex-convener, AWIM SAENIS, were present and made the program a success.

Over 77 schools from Delhi, Gurgaon and Faridabad along with volunteers from **IGDTUW, Jamia University, DTU, NSIT, and NIEC** participated in the event.

Both the Skimmer and JetToy sessions were simultaneously conducted. The sessions started with a brief introduction of the trainers, teachers, and volunteers. Following the brief, motto, and significance for today's building intellectuals, the fabrication of JetToy and Skimmer finally began. Post lunch, innovation was at its peak during fabrication time and

various tips and suggestions were constantly rendered by the trainers.

Sails of different shapes and areas for Skimmers were tested for various categories i.e. maximum distance, accuracy, directional stability, weight carrying capacity, and more. Conclusions were drawn upon the observations with different designs and graphs. JetToys were experimented with different size nozzles and balloon inflation diameters for categories like maximum time, maximum speed, maximum distance, accuracy, and weight carrying ability.

College leaders and industrial volunteers were making their respective toys and gave a healthy competition to the volunteers during testing, taking out time from their jobs of managing the whole event. The presentation round gave an opportunity to the teams to discuss and share their ideas on how to market their toys.

SAEINDIA Foundation gives annual awards in New Delhi



Awarding the young women of the engineering profession.



The Life Time Achievement Award is presented to Dr. B. Bhanot.

The Third Annual Awards function of the SAEINDIA Foundation was held on 3rd August, 2015, at India Habitat Centre, New Delhi. The awards were given to recognize and motivate young women engineering students, working professionals, SAEINDIA section champions, institutions, and to honor our gurus and mentors for their contribution to mobility at large. Mr. Vijay Chhibber, Secretary, Ministry of Road Transport and Highways, was the Chief Guest, and Mr. Ramesh Suri, President, **ACMA**, and Chairman, **Subros Limited**, was the Guest of Honor. Dr. Richard Greaves, President, SAE International, was the Special Guest at the occasion.

Mr. R. Dayal, President, SAEINDIA Foundation, welcomed the guests and explained the activities of the Foundation and the objective of the SAEINDIA Foundation Awards. From this year onward, the "Corporate Award" has been instituted to award corporations/

universities/associations for their outstanding contribution in promoting SAEINDIA activities. More than 120 invitees and guests from the industry, government, academia, and media attended the Annual Awards function.

Mr. Vijay Chhibber delivered the keynote address. His talk was inspirational and motivating for all who were present. He started with paying homage and observing silence as a mark of respect to ex-president, the late Dr. Abdul Kalam. He focused on road safety and reminded that it was the responsibility of all stakeholders to work toward minimizing casualties happening on Indian roads. He appreciated the efforts of the SAEINDIA Foundation in awarding the students, faculty members, and professionals from the industry. He further shared and emphasized that students are the building blocks of the nation and any step taken in the improvement of their skill would definitely provide the

right path for the nation's development.

Mr. Ramesh Suri also appreciated the efforts of SAEINDIA Foundation in recognizing students, faculty, and corporations for their contribution in the field of mobility. He assured greater participation by ACMA in all activities related to SAEINDIA.

Dr. Richard Greaves praised the activities of SAEINDIA during his visit and interaction at all sections. He was keen to promote aerospace engineering in India and announced a donation of USD \$10,000 to the SAEINDIA Foundation for providing recognition to extraordinary efforts put in the field of aerospace.

Mr. Murli Iyer emphasized the support of SAE International to SAE activities in India and shared that next Board meeting will be held in India. A vote of thanks was delivered by Mr. I V Rao, Past Chairman, SAENIS. He summarized the event and thanked the contributors who had contributed for the awards and for the function event.

Aerospace Board organizes CXO Conclave



The SAEINDIA Aerospace Board organized the CXO Conclave 2015, which was well attended by CXOs of various aerospace companies.

The president of SAEINDIA, Dr. Aravind Bharadvaj, gave an introduction on SAEINDIA and its activities. It was then followed by Dr. Bala Bharadvaj highlighting the type of memberships to be availed like diamond, platinum, and gold for the companies/industries. This event was organized in the Le Meridien hotel Bengaluru on 4th September 2015.

The CXO Conclave was followed by an impressive presentation on the Aerospace Board and its activities since its formation in December 2009.

Dr. Bala Bharadvaj listed options to become a patron member to develop a strong ecosystem for advancement of the aerospace community of professionals.

SAENIS hosts Presidential Policy Deployment Meet

SAENIS hosted the Presidential Policy Deployment Meet 2015-2016 at the Gateway Damdama, Gurgaon, Haryana from 12th to 13th September 2015.

Forty five delegates from SAEINDIA, sections, and various operating boards attended the two-day conference. Various priorities, issues, and improvements ideas were discussed during the meet.

Six teams were formed to discuss and decide actionable ideas for the most important priorities of SAEINDIA. These were:

- Proposal for improving membership
- Meeting and exposition board's future role
- Training contents
- Training delivery



Executives at the Presidential Policy Deployment Meet 2015-2016.

- Restructuring SAEINDIA office and infrastructure
 - SAEINDIA branding
- The Meet concluded with the SAEINDIA Managing Committee (MC)

meeting where the actionable items of the above six teams were put up as resolutions and guidance/approval of the MC was accorded to work on them further for implementation.

Aerospace Board organizes “Make in India” conference



“Lighting the lamp” during the inauguration of the conference. (From Left: Mr. Javaji Munirathnam, Dr. Richard W. Greaves, Mr. Sudhir Kumar Mishra, Dr. Bala K. Bharadvaj, and Mr. Murlil Iyer.)

SAEINDIA Aerospace Board organized a conference titled “Make in India: Transformational Driver for Aerospace & Defence Industry” on 29th July 2015 at Sterlings Mac Hotel, Bangalore, under the leadership of Dr. Bala K. Bharadvaj, Chair, SAEINDIA Aerospace Board and Leader of Engineering & Technology, Boeing India. Dr. Richard Greaves, President SAE International and Meggitt PLC’s CTO Emeritus, delivered the Presidential Address and Mr. Sudhir Kumar Mishra, Chief Executive Officer and Managing Director of BrahMos Aerospace, was the Chief Guest at the conference.

The main objective of this conference was to unravel the challenges and myths about the “Make in India” theme for the Indian Aerospace & Defence Industry and lay the road map for the future. This event was well organized and brought Aerospace & Defence leaders from the government, industry, and academia to one platform to network and to share their experiences and success stories for the benefit of



During the inauguration of the conference. (From Left: Mr. M. Parvez Alam, Dr. Bala K. Bharadvaj, Mr. Sudhir Kumar Mishra, Dr. Richard W. Greaves, and Mr. Javaji Munirathnam.)



Snapshot of delegates of the conference.

the aerospace fraternity in India.

Senior leaders from Boeing, Airbus, GE Aviation, Honeywell, Safran, UTAS, ISRO, DRDO, HAL, Godrej Aerospace, L&T Aerospace, Infosys, Data Patterns, and KPMG spoke on the challenges and opportunities posed by the “Make in India” campaign, which can be a transformational driver for the aerospace & defence industry.

Industry NEWS

Magna recognized by Mahindra for modular frame

Magna International Inc. has received the Best Product Development Performance Award from its customer Mahindra for a new ladder frame used across multiple vehicle platforms. The award was presented at Mahindra's Supplier Conference in Warsaw, Poland, and recognizes Cosma International, Magna's body and chassis operating group, for the design, engineering, and development of the frame for Mahindra's Scorpio SUV and other vehicle platforms.

The complete design, engineering, and development of the Scorpio ladder frame was done at Magna's product development and engineering centers in Bangalore and Pune.



Mahindra awarded the complete re-engineering of the Scorpio chassis frame to Magna, which proposed and engineered a modular frame that can accommodate multiple vehicles and variants, and developed a manufacturing process to make the frames on a flexible assembly line. The company's localization strategy has been optimized for the Indian market, and performance has been improved to meet and/or exceed the mass and safety requirements.

The complete design, engineering, and development of the frame was done at Magna's product development and engineering centers in Bangalore and Pune. Activities included product design, CAD, CAE, and advanced manufacturing. Manufacturing of the frames was launched in 2014 at Magna's body and chassis plant in Pune, where nearly 45,000 chassis frames for Mahindra have been produced to date. The stamping, welding, and assembly facility is a 279,000-ft² (25,900-m²) building with more than 450 employees.

"We are thrilled to receive this award from our valued customer Mahindra, particularly because it recognizes our full product development capability—from design and engineering to validation and production," said Swamy Kotagiri, Magna's Chief Technical Officer.



Magna also developed a manufacturing process to make the frames on a flexible assembly line. Its localization strategy has been optimized for the Indian market.

India to operate advanced Apache and Chinook helicopters

The India Ministry of Defence has finalized its order with Boeing for production, training, and support of Apache and Chinook helicopters that will enhance India's capabilities across a range of military and humanitarian missions. India will receive 22 AH-64E Apache attack helicopters and 15 CH-47F Chinook heavy-lift helicopters—both the newest models of those aircraft.

"This is a milestone in Boeing's expanding commitment to India," said Pratyush Kumar, President, Boeing India. "This acquisition enhances the Indian Air Force's capabilities and offers us an opportunity to further accelerate 'Make in India.' Large sections of the Chinook fuselage are already manufactured in India and discussions are ongoing with our Indian partners to make Apache parts."



The India Ministry of Defence has finalized an order with Boeing for 22 AH-64E Apache attack helicopters and 15 CH-47F Chinook heavy-lift helicopters. The contracts provide for production, training, and support. (Boeing photo)

The Apache is a multi-role attack helicopter. The AH-64E variant, which is also flown by the U.S. Army, features enhanced performance, joint digital operability, improved survivability, and cognitive decision aiding. The CH-47F Chinook is an advanced multi-mission helicopter operated by the U.S. Army and 18 other defense forces. The Chinook has proven its ability to operate in the range of conditions that typify the Indian subcontinent, according to Boeing, including delivering heavy payloads to high altitudes.

"The Apache and Chinook represent the best of high-performing technologies that will modernize India's defense capabilities," said Dennis Swanson, Vice President, Defense, Space & Security in India. "We look forward to delivering the newest Apache and Chinook to our customers and remain focused on delivering on its commitments to the Indian Air Force and India's Ministry of Defence."

Stanadyne diesel products to improve off-highway emissions

Stanadyne, a U.S.-based global fuel injection systems designer and manufacturer, recently introduced its new EcoForce line of fuel-system components designed to improve fuel economy, performance, and emissions of off-highway diesel powertrains in India, China, and emerging markets. The EcoForce product



The EcoForce diesel product line from Stanadyne helps make engines cleaner and more efficient, reducing particulate emissions by about 50%.

line is targeted for the below 50-hp (37-kW) diesel engine market for agriculture, construction, and industrial applications. Below-50-hp engines make up more than an estimated 80% of India's off-highway market, according to Stanadyne, making them a major contributor to particulate emissions.

"The EcoForce product line helps make engines cleaner and more efficient, reducing particulate emissions by approximately 50% and enabling improved performance for off-highway applications," said Stanadyne CEO David Galuska.

EcoForce products are aimed to support India and China, two markets that comprise roughly 50% of all global tractor sales in 2014. These markets are expected to grow at a compound annual growth rate of 5-7%, the supplier notes. Slated to start production in the second half of 2016, EcoForce products will be manufactured at Stanadyne facilities in India and China. The company is currently working with strategic partners in both countries to bring initial end-user products to market.

LyondellBasell expands presence in India's automotive plastics

LyondellBasell recently acquired SJS Plastiblends Pvt. Ltd., advancing its position in India's expanding automotive market. LyondellBasell announced in August a definitive agreement to acquire SJS, a polypropylene (PP) compounds manufacturer located in

Aurangabad, Maharashtra, India. "This acquisition underscores our strategy of investing in growth projects that provide a competitive advantage in targeted markets and a strong return on assets," said Bhavesh (Bob) Patel, CEO and chairman of the management board of LyondellBasell.

The Aurangabad compounding plant has an annual production capacity of approximately 12,000 t (13,225 ton). In addition to the already existing product lines, the facility will produce LyondellBasell's Hostacom glass fiber-reinforced, mineral filled and unfilled colored grades as well as Hifax high impact thermoplastic olefins. These products are used in the manufacture of automotive parts and other applications. LyondellBasell has supplied the Indian market through imports and tolling arrangements since 2009.



The Aurangabad facility will produce LyondellBasell's Hostacom glass fiber-reinforced, mineral filled and unfilled colored grades as well as Hifax high impact thermoplastic olefins. Toyota's Auris model (pictured), for example, features instrument panels produced using LyondellBasell's Hostacom resins. (Toyota photo)

WABCO India expands software engineering capabilities for CVs

WABCO has opened a new 65,000-ft² (2790-m²) facility in Chennai, India, that will enable the company to significantly expand its software engineering and shared services capabilities. WABCO plans to further leverage its talent in India and expand its software engineering capabilities to support the local design of new products and systems for emerging

markets as well as to contribute to the global development of advanced technologies for commercial vehicles (CVs). Since 2010, the company has more than doubled its software-engineering talent pool in India to nearly 250 and anticipates enlarging its team by an additional 150 engineers over the next five years.



Jacques Esculier (right), WABCO Chairman and Chief Executive Officer, and WABCO India Country Leader P. Kaniappan (left) inaugurated a new Software Engineering and Business Services Center in Chennai, India. The company plans to expand its software engineering capabilities to support the local design of new safety and efficiency technologies for commercial vehicles in emerging markets.

The new facility also will accommodate WABCO's business services team of approximately 110 professionals. The team is dedicated to continuously improving the cost effectiveness and efficiency of the company's business operations worldwide. The team is expected to deliver advanced information technology solutions and continuous business process optimization based on leading international standards.

"We will further leverage WABCO India's superb talent pool and cost efficiency to support and differentiate the development of advanced technologies to help improve the safety and efficiency of commercial vehicles around the globe," said Jacques Esculier, WABCO Chairman and Chief Executive Officer. "WABCO India is also taking a primary role in our efforts to drive efficiency and business process improvements across the company to continuously lower cost."

TECHNOLOGY

Report

AUTOMOTIVE POWERTRAIN

Tenneco unveils emission-control solutions for Euro 6c



Tenneco's double-swirl mixer is designed for Euro 6c diesel aftertreatment.



In a cutaway view of the double-swirl mixer, urea injection takes place in the small space between the oxidation catalyst and SDPF.



Tenneco's oval gasoline particulate filter is designed for packaging in confined spaces to meet the requirements of Euro 6c.

Euro 6c emissions limits will present a number of challenges for light duty engine emissions, both gasoline and diesel when the regulations come into force in September 2017. One significant hurdle is speeding light-off of diesel selective catalytic reduction (SCR) catalysts.

In current systems it can take up to 10 or 12 minutes currently for a diesel SCR cat to reach its light-off temperature. This is determined to an extent by the packaging of the exhaust aftertreatment system.

In a current Euro 6b system the diesel particulate filter (DPF) may be the first aftertreatment device downstream of the engine, with a separation of 50 to 60 cm (19.6 to 23.6 in) between the rear of the DPF and the front of the SCR cat. Under Euro 6c, the light-off time would have to be shortened to between three to four minutes. The same will apply to US Tier 3

regulations, which will require a light off time of two minutes or less. Reducing the distance between the SCR and DPF to around 10 cm (4 in) could help.

The problem then is that neither the DPF nor the SCR cat is close enough to the engine to ensure that both have reached the required working temperature in the required time interval.

Tenneco's solution, on display at the 2015 IAA Frankfurt Show, is to combine the two devices in one. In this case the DPF is treated with an SCR coating.

Double-swirl does it

"That is what we call an SDPF, an SCR coated DPF," explained Frank Terres, Executive Director, Core Science, Advanced Engineering and Hot End Development, Tenneco Clean Air.

"If you move the SCR portion into the DPF, you also need to move the dosing point to the gap between the diesel oxidation cat (DOC) and the SDPF," noted Terres. "Normally there is 1 cm between those two substrates but now you need to increase this gap because you need to dose in this small gap. Every centimeter is a pain because you have package constraints. So you give your few centimeters, maybe less than 10 cm and the whole processing of the urea additive that you inject needs to be done in this small cavity."

Processing means injection, atomization, evaporation, hydrolysis and transforming into ammonia and then distributing everything homogeneously on the SDPF—a challenge, he admitted.

Tenneco has developed a solution to the problem of mixing the urea solution with the exhaust gases in such a small space. The company's new double swirl system is able to promote the mixing even in a very compact mixing zone such as in the SDPF.

"We generate a swirl and inject the urea, then have a controlled contact of the fluid droplets with the wall, where they can evaporate," he explained.

In addition to the shortened light-off time from a cold start, the new European Real Driving Emissions (RDE) test also presents challenges. "You need to have a system that performs under all realistic driving conditions," Terres noted. The urea injector is positioned in a much hotter area of the catalyst system than on previous designs.

Tenneco also uses the urea supply to cool the injector by circulating the flow from the tank to the injector and back. This ensures that the urea temperature in the injector is around 40°C despite the high surrounding temperature of the exhaust system.

There may be insufficient space for an in-line DOC/SDPF design. In this case some form of parallel design would

be necessary. This might involve connecting the diesel oxidation catalyst directly to the turbocharger, with the SDPF in parallel to it. A step-shaped mixer offers the same functionality as the mixer in the in-line system.

New oval GPF fits tight spaces

Tenneco also launched its oval-shaped gasoline particulate filter (GPF) at Frankfurt, anticipating the EU Euro 6c regulations, which will introduce a particulate number standard for direct injection gasoline engines from 1 September 2017. Euro 6c will also introduce a new test cycle for all EU engine testing. The oval shape has been designed so that it can fit into spaces where a cylindrical shape might not fit.

“The challenge for us is that the substrates used in a GPF have a higher porosity than a diesel filter and as a result they are more fragile,” said Terres. “That makes the whole canning process very challenging.”

Tim Jackson, Tenneco’s Executive Vice President Technology, Strategy and Business Development, explained the thinking behind the development of the GPF.

“Let’s optimize the engine for fuel economy and CO₂ emissions and let’s use the affordable aftertreatment to clean up the remaining emissions,” he said. “Let’s not sacrifice CO₂ and fuel economy to meet criteria [emissions]. Now that all the continents are faced with CO₂ reduction goals, I think that message resonates a little stronger.”

The GPF is a self-regenerating device, unlike diesel particulate filters, which need to reach a particular operating temperature for regeneration to take place. The GPF is a continuously regenerating device. Tenneco has devised two ways of packaging it. The unit can either be included in addition to the existing three-way catalyst or the three-way catalyst coating can be applied to the GPF substrate to form what Tenneco terms a four-way catalyst.

“Because of the better flow characteristics in this filter, the efficiency of the gaseous pollutants conversion is much better, so you could make the total volume smaller and reduce the amount of precious metals used,” noted Terres.

John Kendall

OFF-HIGHWAY POWERTRAIN

FPT plans engines for complex market

Expected in 2019, the impending European Stage V emissions regulations for off-highway engines will remain top of the agenda for FPT. EU regulators will limit both particle number, or PN, as well as tighten the existing particle mass limits. Stage V also reduces NO_x, HC, and CO limits.

While these are stringent, it is also true that the EU market governed by Stage V is only a small part of the global market, according to Federico Gaiazzi, Vice President of Marketing & Product Management for FPT Industrial. Sharing his views with *Off-Highway Engineering*, Gaiazzi noted that these EU regulations may well affect how regulators approach their own national needs in other parts of the world. Gaiazzi believes it is likely that emissions regulations and fuel quality restrictions imposed in other countries will tighten in response to the EU actions.

This means FPT will need to upgrade global engines to use similar advanced technologies needed for the EU market. “While working toward the anticipated emissions standards, FPT is looking at solutions that will continue to increase engine efficiency and reduce total cost of ownership, which is why we will not be deviating from our long-term high-efficiency selective catalytic reduction [HI-eSCR] only strategy,” he said. This technology, according to Gaiazzi, frees FPT’s engines from using exhaust

The current BTE of the FPT Industrial range of engines achieve approximately 46%, according to Federico Gaiazzi. Shown is FPT’s C13 two-stage construction engine.



gas recirculation (EGR) in medium- and heavy-duty applications, simplifying the engines and reducing costs.

He predicts that the next generation of FPT’s HI-eSCR aftertreatment solution will incorporate a diesel particulate filter (DPF) integrated on the SCR. Part of the SCR catalyst will be replaced by the DPF in this solution to avoid impacting the aftertreatment layout. This is a technology that is reportedly efficient in meeting both particle mass and PN emissions. In general, these combined SCR and DPFs reduce packaging and make it easier to manage the temperature needed for the SCR (See “The Complicated Future of Off-Highway Engines,” OHE, August 2015).

“The HI-eSCR system was originally developed at FPT’s R&D Center in Arbon, Switzerland, and was the first maintenance-free aftertreatment system, achieving NO_x reductions of more than 95%,” he said. Observations from others in the industry note that newer SCR technologies could achieve 97–98% efficiencies in reducing NO_x, a key enabler in eliminating EGR.

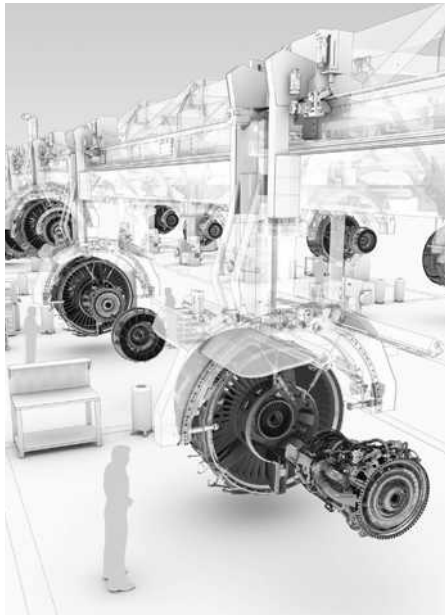
When asked what were the most important advanced technologies for achieving better fuel efficiency and total cost of operation, his answer reflected a broad perspective.

“No one technological area will create a breakthrough in improving fuel consumption or performance in engine development,” he said. The key is increasing an engine’s brake thermal efficiency. “It is a challenge with no quick-fix technological breakthroughs on the horizon; instead, progress will be the sum of improvements to several aspects of the engine.”

These include the optimization of combustion and air handling, reduction of power losses, the introduction of smart auxiliaries, and waste heat recovery in the exhaust line, as well as energy management controls in the engine, its related systems, and all elements of the vehicle that influence its fluid usage.

Bruce Morey

New pulse lines for LEAP engine production



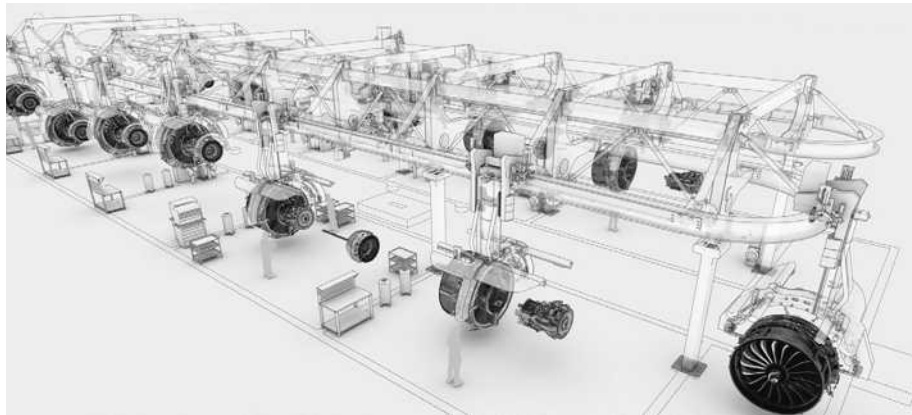
Engine movements on the pulse lines will be managed by touchscreens and an overhead handling system featuring a “swing cradle” that enables rotating the engine around the horizontal axis (a proprietary Snecma process), so staff won’t have to work at heights.

During the recent Paris Air Show, French engine manufacturer **Snecma** announced significant investment in a new assembly facility to meet the unprecedented level of customer demand for the new LEAP engine, which is being developed as part of the **CFM** partnership with **GE** to power the latest re-engined versions of the **Boeing 737** and **Airbus A320** families and the new Chinese **COMAC 919** airliner.

At the time of the announcement, before another flood of 500+ orders were declared at Paris, there were already more than 8900 orders and commitments for the new engine, a year before entry into service.

The new LEAP is already the world’s best-selling new engine, while it is still under development, in the history of aviation. The challenge facing the engine manufacturers, and everyone else down through the supply chain, is how to produce enough units to satisfy what has grown to a backlog of well over 12,000 new aircraft.

Even with aircraft output at Boeing and Airbus heading toward 50 airframes every month, and possibly rising even



The positioning of components and subassemblies on the engine will use the latest laser projection and virtual reality assistance systems, while operators will use connected tools and other advanced devices. The design of these pulse lines involves operator feedback and can accommodate recommendations.

higher, the need to supply the new generation engines (from **CFM** and **Pratt & Whitney**) that make these 150-seat airplanes so popular has become a priority, certainly in the case of the LEAP engine, which is the sole source powerplant on the 737 Max family.

As a result, Snecma is preparing its supply chain and industrial capabilities for an unprecedented production ramp-up.

The LEAP’s predecessor, the CFM56, saw its production gradually rise over a dozen years to an annual rate of nearly 1600 engines. The LEAP faces a much more daunting challenge, since it is aiming at an annual production rate of more than 1800 engines as early as 2020, in just four years. In line with the assigned workshares in the joint French/U.S. company, Snecma is responsible for the final assembly of half of all engines made by CFM, with this assembly being handled by Snecma’s Villaroche plant near Paris.

To meet this huge challenge, Snecma is to build two new assembly lines dedicated to the LEAP, alongside the two existing CFM56 production lines. These new pulse lines will stretch 60 m long and 20 m wide (about 200 x 65 ft), and each line will offer a capacity up to 500 engines per year. They will be able to assemble all three versions of the LEAP: the LEAP-1A for the Airbus A320neo, the LEAP-1B for the Boeing 737 MAX, and the LEAP-1C for the Comac C919. These two lines will be up and running by January 2017 and early 2018, allowing

Snecma to assemble up to 1000 engines/year at Villaroche—the equivalent to over four engines every day.

The two current CFM56 pulse lines, commissioned in 2009, had already enabled Snecma to reduce engine assembly time by 30% and the two new LEAP assembly lines will extend this initiative, while adding a number of innovations.

For example, engine movements will be managed by touchscreens, and an overhead handling system featuring a “swing cradle” that enables rotating the engine around the horizontal axis (a proprietary Snecma process), so staff won’t have to work at heights. The positioning of components and subassemblies on the engine will use the latest laser projection and virtual reality assistance systems, while operators will use connected tools and other advanced devices.

The design of these pulse lines involves operator feedback and can accommodate recommendations. It is expected that this will significantly enhance the comfort and efficiency of operators at the various workstations throughout the production and assembly process. The new additions to the plant will allow for a third LEAP assembly line if this is eventually needed to increase production capacity even further. The GE partners in CFM are also expanding their own LEAP production facilities in the U.S. at West Lafayette, IN, which will see a new line open before the end of this year.

Richard Gardner

OFF-HIGHWAY INTERIORS

Webasto engine-off cooling keeps off-highway cabins comfortable

The new **Webasto** Polar Cab TS engine-off cabin cooling system provides on-demand cooling during downtime, resulting in fuel savings, reduced idle time, increased productivity, and operator safety and comfort.

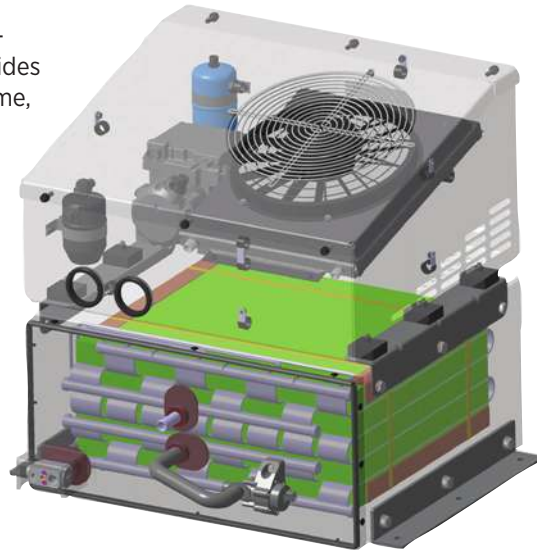
Polar Cab TS engine-off cooling features a patented storage core with a series of aluminum micro-channels that route R-134a liquid refrigerant around a graphite honeycomb substrate that's impregnated with water. The substrate is capable of storing cold energy at an extremely high efficiency, according to Webasto. This cold energy is transferred to the cab for on-demand cooling via an air handler, which measures 19.3 x 6.3 x 18.5 in (490 x 160 x 470 mm) and weighs 18 lb (8 kg).

The core and charge unit is 26.0 in (660 mm) wide, 26.4 in (670 mm) deep, and 28.4 in (720 mm) tall, and weighs 330 lb (150 kg).

The system has a cooling capacity of 1.3 kW (4450 BTU/h). The Polar Cab TS does not require any additional batteries and consumes very little power, according to Webasto. Technical specifications show that for engine-on charging, charge amp draw is 50 Amp nominal (45 Amp compressor and 5 Amp condenser). Engine-off discharging is 7 Amp nominal (5 Amp blower and 2 Amp coolant pump).

The system can be fully recharged within 3 h. According to a company spokesperson, the TS 24-V system holds cold stored energy with static discharge rate of 10% per 24-h period at 130°F ambient temperature. Field testing and climate chamber test have substantiated 90 min of engine-off cooling at 110°F ambient temperature, under full sun load.

"Engineering challenges included finding the right balance between performance and size/volume of the system," the spokesperson shared with SAE Magazines. "Webasto engineers committed to provide a system that is adaptable and easy to install on a variety of machines. Due diligence was exercised by the team to ensure that the product performs in the severe



Webasto's Polar Cab TS engine-off cabin cooling system features a patented storage core with a series of aluminum micro-channels that route liquid refrigerant around a graphite honeycomb substrate impregnated with water.

off-highway environment."

Polar Cab TS has been in development for two years including extensive field testing with customers under extreme climactic conditions: high humidity, high heat, dust, and dirt. Testing has been performed on machines in the southern regions of California, Arizona, Texas, and Mississippi as well as in North Carolina and Michigan in the U.S. The technology has been used in the on-highway market for 10+ years, according to Webasto.

"Designing products with operator safety and comfort in mind is a big part of our business plan at Webasto," said Dr. Rolf Haag, Webasto Thermo & Comfort North America President and CEO. "Webasto products provide operators an opportunity to reduce machine hours, scale down fuel costs, lease payments, and lower annual maintenance costs."

Webasto offers Polar Cab TS as an aftermarket kit, which includes the thermo storage core, electrical compressor (24-V), condenser with fan (24-V), air handler, wire harness, and miscellaneous hardware needed for installation. The system can be installed at the dealership on new equipment as well as on existing equipment.

Ryan Gehm

OFF-HIGHWAY ELECTRONICS

Case shifts to enhanced communications, LEDs

Case IH has enhanced its electronic features and functions, adding ISOBUS Class 3 capabilities and beefing up its Advanced Farming Systems (AFS) communications technology. In a broad product rollout, the company also increased its use of LEDs and improved fuel economy by reducing shift times and employing a variable vane cooling fan.

Case IH beefed up its Optum and Steiger tractor lines and unveiled new balers and other implements at the recent Farm Progress Show in Decatur, IL. The company also rolled out its LB4 series large square balers, which offer an ISOBUS Class 3 enabled Feedrate Control system. When paired with a range of hay and forage tractors that offer this control technology, the baler uses ISOBUS Class 3 commands to control the tractor's forward speed.

"This can provide 9% better productivity for the baler," said Leo Bose, AFS Marketing Manager, Case IH. "If the producer has a total mix ratio, the system can adjust when it sees variables and create the same level. Based on the load level, it can bring in the stuffer to add more hay or it can determine it's time to make a new bale."



The Optum tractor uses an ISOBUS Class 3 link to communicate with LB4 balers.

TECHNOLOGY Report

Case IH also updated its AFS Connect telematics technology. A new modem provides connections to CDMA (Code Division Multiple Access) and GSM (Global System for Mobile) networks, automatically switching to the system with the best signal. The system's new two-way file transfer lets users move yield maps, prescriptions, or guidance lines from the machine to the portal and vice versa.

A new Multiswath capability takes a step toward autonomy, working in tandem with AccuGuide for improved guidance line patterns such as maneuvering around field obstacles such as standing water. Two-way communications let remote personnel manage the equipment.

"Sometimes the operator in the field will feel conditions warrant settings at one level," Bose said. "But a technician with a total view of the machine, who sees updates every minute and looks at the most recent incoming grain samples, may determine that another setting will yield better results."

LED lighting is becoming more commonplace as new systems emerge. The Steiger and Optum tractors offer a number of white lamps that conserve power and improve light output.

"LEDs operate at about a quarter of the power, which lets you go to a smaller alternator or add more systems," Kaiser said. "In the field, LEDs don't have the glare that HID lighting has. Lighting is becoming more important as we go to more 24/7 farming."

Case IH also detailed some powertrain advances. For example, the Steiger line's cooling system and transmission were both improved.

"The Steiger has two cooling systems," said Mitch Kaiser, Steiger Tractor Marketing Manager. "The second water cooler is electric, which helps give the engine 13% more low-end lugging power."

Tom Dean, Marketing Director, described the transmission upgrade. "We've upgraded to a power shift transmission that has 20% faster response, which reduces parasitic loss. When operators shift between forward and reverse, shifts are 40% faster."

Terry Costlow

AEROSPACE ELECTRONICS

Signal compression technology enables E-Fan's flight, potential enhanced 'black box' possibilities



V-Nova's PERSEUS data compression technology enabled HD video telemetry for Airbus's E-Fan technology demonstrator's crossing of the English Channel. With its 74-km flight from Lydd, England to Calais in France in July, the E-Fan became the first all-electric two engine aircraft taking off by its own power to successfully cross the English Channel. (Airbus)

V-Nova Ltd. demonstrated the capabilities of its PERSEUS data compression technology for aerospace applications as part of Airbus' all-electric E-Fan technology demonstrator aircraft's flight across the English Channel.

During the flight, PERSEUS enabled up- and downstream HD (high-definition, 720p 25 frames/sec) video telemetry over standard, publically accessible 3G mobile networks, with a more than 80% bandwidth reduction compared to traditional technology under similar conditions, said V-Nova.

This made it possible to transmit terrestrial HD video to the cockpit, and allowed personnel aboard the chase aircraft and on the ground to view the E-Fan's flight progress, as offline content and camera feeds from the crossing were down-linked, encoded, and distributed in real time via 3G networks to Android- and iOS-connected devices.

"Streaming HD-quality live video over existing 3G networks under demanding 'real-life' aerospace conditions is completely new," said Dr. Jean Botti, Airbus Group Chief Technical Officer. "There are significant opportunities for this technology to support the aerospace industry's digital transformation."

PERSEUS provides high-quality, high-compression encoding and decoding of data—at significantly faster speeds and the same or lower latency than traditional technology—using commercial-off-the-shelf (COTS) hardware.

The successful video telemetry for

E-Fan's flight demonstrated a wide range of potential aerospace industry uses for the PERSEUS technology, including transmission of high-quality video content between the ground and aircraft, the handling of flight-critical data for trend monitoring and aircraft optimization, wireless distribution of in-flight entertainment throughout commercial jetliner cabins, and other potential bonuses.

"PERSEUS' effective data compression also opens opportunities for additional services, such as an 'enhanced or virtual' black box that could store more data, or provide real-time critical information via the cloud," said Eric Achtmann, V-Nova Executive Chairman & Co-Founder. "Another possible application could be for continuous live video observation of the cockpit or cabin for security purposes, with this hierarchical software enabling users to adjust the level of video quality and bandwidth required 'on-the-fly' as situations evolve."

PERSEUS has been developed and tested over the past five years within an open innovation, interoperable coalition of over 20 global industry leaders, including **Broadcom, Dell, Encompass, Hitachi, Intel, Sky Italia, TataSky, VisualOn, and WyPlay**, to name a few. The PERSEUS software currently is offered in the form of bundled hardware, embedded software, codec plugins, and silicon IP.

Jean L. Broge

AUTOMOTIVE ELECTRONICS

Delphi says 48-volt mild-hybrid systems could offer 15% CO₂ reductions

Delphi believes that 48-volt mild hybrids could offer significant CO₂ reductions and driver benefits for cars in the future. Speaking at the IAA 2015 (Frankfurt Motor Show), Christian Schäfer, Global Director of Advanced Electrical and Electronic Architectures at Delphi, told *Automotive Engineering* that there are several drivers for the technology that were not present 15 years ago.

“The main driver is the carbon dioxide threshold of 95 g/km fleet average in 2021 across the European Union,” he said. “The idea is that we have a mild hybrid, so we don’t need high-voltage on all cars because it is too expensive to implement. We would have 48-volts, especially in the low segment, up to C-segment cars. Then we could have a belt-driven starter/alternator and can use it as an e-boost if you don’t have a rear drive unit, so the alternator is an electrical machine to boost the combustion engine.”

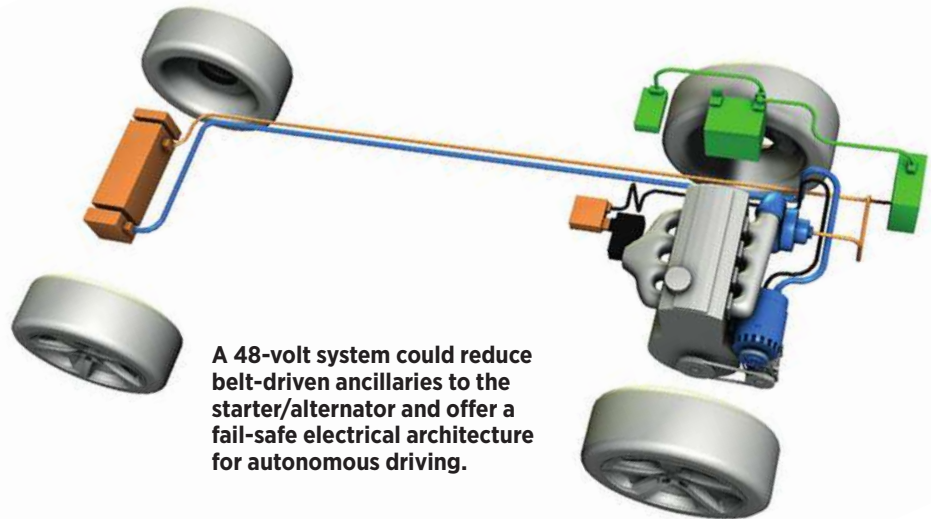
Delphi envisages that the car would start with electric propulsion for the first 100 m (328 ft) of movement.

Regenerative braking would be the main path to reduce CO₂ emissions, reckoned Schäfer.

“From our experience and our discussions with European OEMs, we have seen between 7 and 10 percent reductions in CO₂ emissions from the current test fleet with today’s 48-volt alternators, which have a nominal power of between 10 and 12 kW. For the next generation with up to 20 kW, we expect that we could increase the CO₂ reduction to 15%.”

Besides the CO₂ reduction potential of 48-volt systems, Delphi sees other reasons to switch to the higher voltage electrical architecture. Some systems, such as dynamic chassis control, would impose a high power load on the car. “You would have high current peaks, so you can’t do it with a 12-volt system,” said Schäfer.

In addition, the aim of many vehicle OEMs, according to Schäfer, is to remove all belt-driven ancillaries from the engine with the exception of the alternator. This would mean that all these systems—such as the HVAC compressor, power steering pump, and coolant pump—would be driven electrically from the 48-volt system.



A 48-volt system could reduce belt-driven ancillaries to the starter/alternator and offer a fail-safe electrical architecture for autonomous driving.

“With the belt, you have a lot of friction; for instance on the highway, you have the highest speed on the power steering pump, but you don’t need it,” said Schäfer. Then power steering could be an “on-demand” electrically driven system. “That’s another way you can reduce CO₂ emissions by a small amount.”

The penalty charges that would be imposed on manufacturers who might struggle to comply with the 2021 EU CO₂ emissions average could at least be offset by fitting a 48-volt system. From the discussions that Delphi has already had, between 20 and 70 percent of all hybrids will be produced with a 48-volt mild-hybrid system. The company thinks that it is a reason why the growth in battery-electric vehicles is not as strong as was expected in 2009 and 2010. “You can reach about 60 to 70 percent of the targets with around 30 percent of the cost,” said Schäfer.

Delphi is already working on the electrical components that would be required for a 48-volt architecture. This includes a 3-kW DC/DC 48/12-volt converter.

“The important thing is that it is a bi-directional device, producing 3 kW from 48 volts where the alternator is, to the 12-volt side to support the battery and all the comfort functions, bulbs, and traditional equipment,” explained Schäfer, “But to make a jump start possible from a 12-volt car to a 48-volt car, we have a boost mode as well to transform 1 kW nominal power from 12- to 48-volts.” Delphi will produce the device

with both air and liquid cooling options.

Other electrical components include waterproof 48-volt electrical connectors that meet the highest waterproof and vibration-resistant standards. Delphi also plans to introduce color-coding for 48-volt systems to warn users that this is not a 12-volt system. The suggestion is that 48-volt systems should be coded blue.

Delphi expects to begin production of a 48-volt electrical distributor in 2016 that will provide a 40-amp output. A smart 48-volt distributor, incorporating a semi-conductor MOSFET fuse, is already in development, with production planned for 2017.

“Smart fusing is the only chance to detect all failure modes which could occur on a 48-volt and 12-volt board,” said Schäfer. This would include electrical arc detection, because it could be too dangerous to use conventional electrical melting fuses.

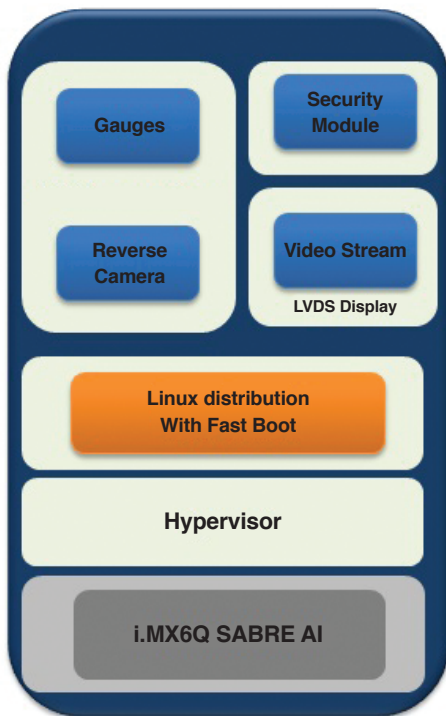
An algorithm is used to detect arcing. “We have to distinguish [between] ‘good arcs’ and ‘bad arcs,’” said Schäfer, “The good arcs are the relays. If a relay is open, there is always an arc for around 2 ms. If we have more than 10 ms, we would switch off and then only the dedicated path and not the complete 48-volt system.”

A 48-volt architecture in combination with 12-volt system also offers a level of electrical redundancy for future autonomous driving systems, where a failsafe system would be required.

John Kendall

ELECTRONICS

Functional safety and info security – no two ways about that

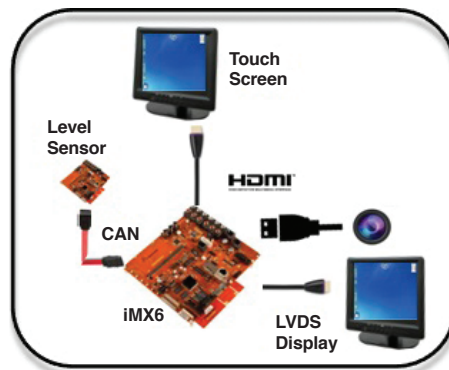


Schematic representation of the deployment of proposed safety system.

The hacking of **Fiat Chrysler's Jeep Cherokee** set off a flurry of activity in the automobile security space, and everyone was quick to point fingers at the infotainment system that was the source of the intrusion. With as many as 1.4 million cars recalled, the cost of this successful intrusion was pretty high, to say the least.

The standards for safety and security, however, are empirically divided. We have functional safety standards in **ISO 26262** and information security standards in **ISO 27001:2013**. In the Cherokee incident, the infotainment system and the vehicle's braking systems met standards but were deemed not "non-compliant" because of the intrusion. The other areas of vulnerability identified were the onboard diagnostic (OBD) ports and over-the-air (OTA) updates.

So where was the problem? It was finally concluded that the vulnerability was with respect to adherence to the data security standards as governed by **ISO 27001:2013** instead of an infotainment weakness. However, the situation is that the infotainment system was hacked and the vehicle's control systems were handed to the hacker on a platter.



Schematic representation of the deployment of proposed safety system.

Whether the non-conformance was for **ISO 26262** or **ISO 27001:2013**, the important part is what was eventually compromised. It was the safety of the driver, passengers, and potentially other motorists on the road that would have been ultimately affected by the intrusion.

The investigation revealed that infotainment systems with open ports are not mature enough to reject commands from unauthenticated sources and hence vulnerable to intrusions. In an earlier era, hackers could send rogue voltages and damage printers that were connected to the victim. Today, printers and other devices that are connected to the computer have circuitry that prevents damage caused by rogue currents coming from the wrong source.

This is rather similar to how hackers used the ability of the infotainment port to "listen and accept commands." The question that end-users would like to ask is this: just like modern computer printers and peripherals, shouldn't we also secure critical processes of an automobile from rogue commands being executed out of the ordinary? Whether done genuinely or maliciously, when the possibility of the commands resulting in a hazard is high, the need for security against intrusion is paramount.

However, an OEM needs to be able to ask simple questions such as for the brakes:

- Should the system allow the brakes to be disabled when the engine is on?
- Even more so, should the brakes be allowed to be disabled when the automobile is in motion?
- Most so, should the brakes be allowed to be disabled at all?

For the throttle, the questions are:

- Should throttle control be allowed by any other device but the gas pedal?
- Even if it were allowed, shouldn't it take permission from the driver, such as with a voice or code activated command from the driver?
- Even so, should there not be a feature to override this from behind the steering wheel?
- Should all critical commands be encrypted?

Compromising the safety of the passengers and motorists in the immediate surroundings is not something that automotive manufacturers, or for that matter, regulators, can pass off as a standoff on standards. Whether it was a nonconformance with respect to **ISO 27001** or **ISO 26262**, the result was a potential hazard. Fortunately, this event unfolded under controlled circumstances as opposed to any actual exploitation of such vulnerabilities, which will be anything but controlled.

The debate about the sharing of responsibility between system security and information security continues, and it is still unclear, which of the two should be responsible for what type of intrusion. The road ahead is, however, very clear: there will be an increasing sharing of risk and responsibility of intrusion prevention. From an end-objective perspective, there will be either an overlap or convergence in **ISO 26262** and **27001** conformance requirements.

In the future, instruments and automobile systems will require self-validation of commands. To achieve this, they would require a certain degree of analytical ability programmed into them, to help differentiate a malicious command from a genuine one.

QuEST Global's automotive team is working with some Tier 1 vendors and OEMs to help them to address and solve some of these challenges and ensure fool-proof conformance to all safety standards meeting the needs of the automobile industry of the future.

Dinesh Dholeh, Strategic Initiatives Leader, Automotive, QuEST Global, and C Damodaran, Strategic Initiatives Leader, Embedded Systems and Electronics, QuEST Global wrote the article for *Mobility Engineering*.

OFF-HIGHWAY BODY

Deutz-Fahr tractor debuts industry-first Hella LED light package



The Deutz-Fahr 7250 Warrior is equipped with 14 new Hella Module 70 LED Generation IV worklights. Each LED module has three multichip LEDs and is rated to 2470 lumen, consuming just 30 W of energy.

Deutz-Fahr collaborated with Hella to develop an industry-first LED light package for its line of 7 Series tractors. The Deutz-Fahr 7250 Warrior is equipped with 14 new Hella Module 70 LED Generation IV worklights, which in addition to close- and long-range illumination also offer a special extra-wide illumination, allowing for homogeneous light distribution across the work area. The tractor is the first in the market to incorporate this latest-generation LED light package.

For the first time, LED output is on par with that of xenon in this compact design, according to Stefan Maierhofer, the Worklights Program Manager at Hella Fahrzeugteile Austria GmbH, where the company develops and produces its worklights. Equipped with three high-performance multichip LEDs, the Module 70 LED is rated to 2470 lumen and consumes just 30 W of energy.

“By comparison, the Module 70 LED Generation 3 only generated 800 lumen and the halogen version just 1100 lumen. With the xenon version it is possible to achieve the same light output as with the fourth generation, but due to its power supply unit it is not possible to offer the same compact housing,”

Maierhofer shared with SAE Magazines.

With a diameter of 80 mm (3.15 in), the Module 70 LED is particularly suitable for installation in tight spaces, said Maierhofer.

The 7 Series of Deutz-Fahr is already equipped with the previous version of the Module 70 LED; for the special-edition Warrior, the company decided to equip the tractor with the latest version.

Hella launched the first version of the Module 70 LED in 2005 with 170 lumen.

The Module 70 Generation IV is a standard worklight—not a customized specific solution, Maierhofer pointed out. A multifaceted reflector ensures homogenous lighting of the work area. Available for special applications, the extra-wide illumination uses a highly-diffusing cover lens. All illumination variants have a symmetrical configuration, allowing the headlamp to be upright or pendant mounted.

The black lamp housings are made of aluminum and incorporate cooling fins to dissipate heat from the high-power LEDs. The electronics of the Module 70 LED are “multi-volt compatible,” capable of operation with a 12- or 24-V power supply. The module’s integrated electronics protect it in case of a



The Module 70 worklight for close-range illumination.



The Module 70 worklight for long-range illumination.

polarity inversion and ensures constant brightness, even when operating voltage fluctuates between 9 and 33 V. Temperature sensors protect the lamps from overheating.

“LED lighting is very similar to daylight,” Carl Brown, President of Hella Inc. in Peachtree City, GA, said in a statement. “It helps to combat fatigue by allowing equipment operators to distinguish colors more easily after dark.”

LEDs offer high color temperatures of around 6500 Kelvin. The LED worklights have a design life of up to 60,000 h with constant lighting performance, according to Maierhofer, and thus are maintenance-free.

Other manufacturers also have specified the fourth-generation of Module 70 worklight, but the tractors have not had start of production yet, he shared. The Module 70 is already available for the aftermarket.

Other applications for Generation IV include agriculture and construction machines, municipal vehicles, vehicles for commercial use, and transport vehicles. It is also available in a marine version, one that can be used as a “rear driving lamp,” and another one as a high beam (used for agricultural or special-purpose vehicles).

Ryan Gehm

TECHNOLOGY Report

AUTOMOTIVE CHASSIS

Hyundai enhances NVH with 2016 Tucson's re-engineered suspension—including 'world first' dual-member damper housing



Front and rear suspension setups for the 2016 Hyundai Tucson are 20% stiffer than the outgoing model's.



The new Tucson features a "world first" integrated dual-member rear wheelhouse design using AHSS (orange = 100 kg/mm², or 980 MPa; red = hot-stamped steel). Also shown is the hydraulic rebound bump stop. (Ryan Gehm)

No area of the third-generation Tucson crossover utility vehicle was left untouched by Hyundai engineers, but particular attention was placed on re-engineering the chassis for improved ride and handling, and importantly, better NVH (noise, vibration, and harshness) characteristics.

Not surprisingly, the 2016 Tucson platform is larger than the previous generation's; however, engineers focused on improving width and wheelbase for greater ride comfort and linear stability, according to Mike O'Brien, Vice President, Corporate and Product Planning, Hyundai Motor America (HMA).

"We have a full lineup of CUVs, so having the biggest one in the segment

is not the best because people that buy in this area of the market focus more on maneuverability and parking," O'Brien said. "So instead we focused on getting the best width that we could, at 72.8 in, and also the best wheelbase at 105.1 in, which gives a sense of stability."

Compared to the 2015 model, the new Tucson is 1.1 in (27.9 mm) wider, with a 1.2-in (30.5-mm) increase in wheelbase. The front and rear overhangs were increased "in smaller proportion," centering more of the Tucson's mass within the wheelbase for better handling response and control. The CUV is 3 in (76 mm) longer overall than the outgoing model, at 176.2 in (4475 mm).

To enable the suspension refinements

to be more effective, Hyundai engineers focused on increased use of advanced high-strength steels (AHSSs) and what O'Brien called "advanced aero-space-based, high-strength adhesives." The entire Tucson body and chassis is more rigid, using 51% AHSS—greater than 60 kg/mm² (590 MPa)—compared with 18% for the former model.

"Another thing that we've done, very similar to what we did with Genesis, is to use a tremendous amount of high-strength adhesives," said O'Brien. "We went from no adhesives—just a welded structure on our outgoing model—to now over a football field in length of adhesives [335 ft (102 m), to be exact]. Not only does this help in body strength, but also in NVH by isolating noise better than just welding."

The result of such efforts is a 48% improvement in body rigidity.

'World first' mounting structure

One area that benefits from the employment of AHSS is a "world's first" shock-absorber mounting structure for the 2016 Tucson. The CUV employs a dual-reinforcing panel rear wheelhouse design, which optimizes panels that are prone to vibration, resulting in a 109% increase in rigidity, reduced road noise levels, and ride and handling improvements. Traditional designs employ only one reinforcement.

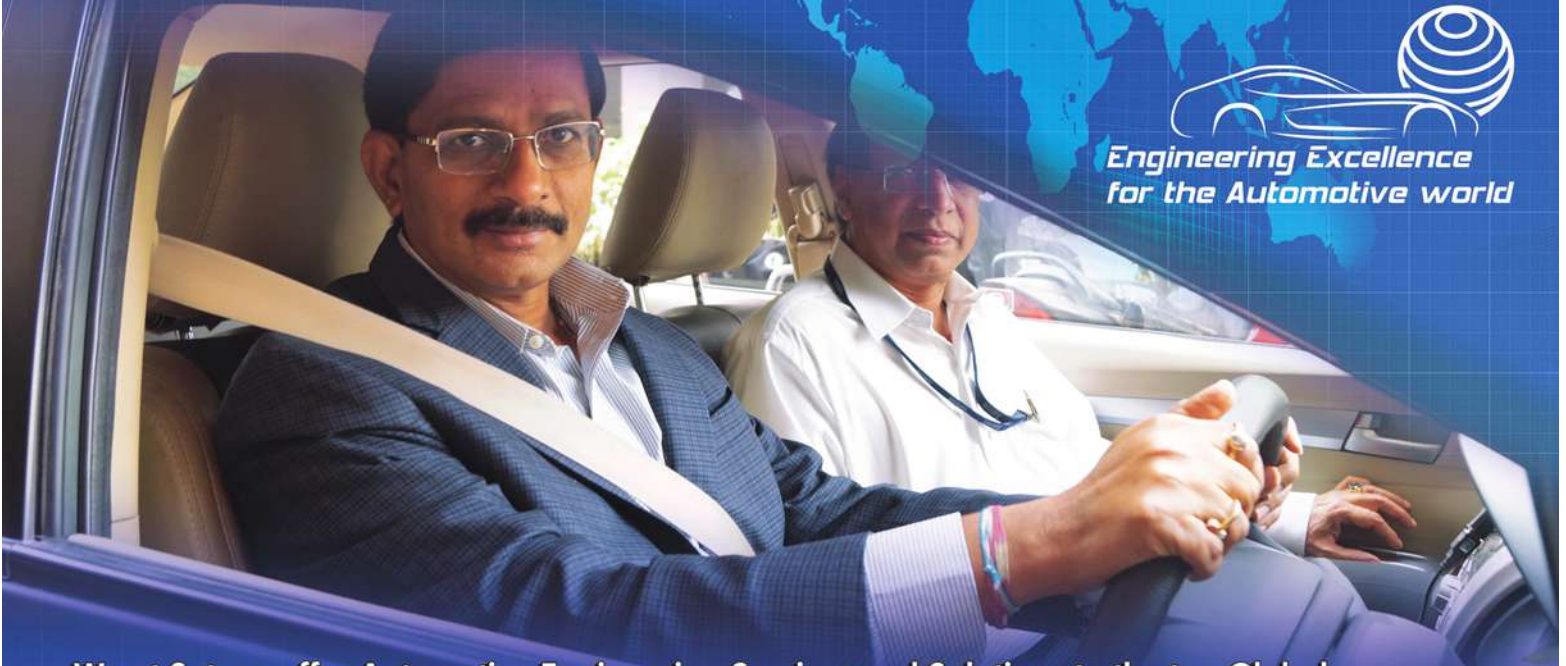
"Hot-stamped steel is the highest stiffness steel we use. Generally it is used for crash [protection], but we also use it for the [integrated dual-member rear wheelhouse] structure," said Chahe Apelian, Senior Manager of Vehicle Evaluation - Chassis & NVH, Hyundai America Technical Center, Inc., as he gave *Automotive Engineering* a walk-around of the Tucson body-in-white cutaway.

"In terms of the rear suspension towers, it's to make the attachments stiff enough to where we increase the envelope of tunability of the shock absorbers," he continued. "Once the body becomes stiff to the point where it deflects very little, all the energy from the road is absorbed by the shock

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I wish all the Automotive Engineering Professionals a very successful career in the automotive business !

Rao S. Vadlamudi
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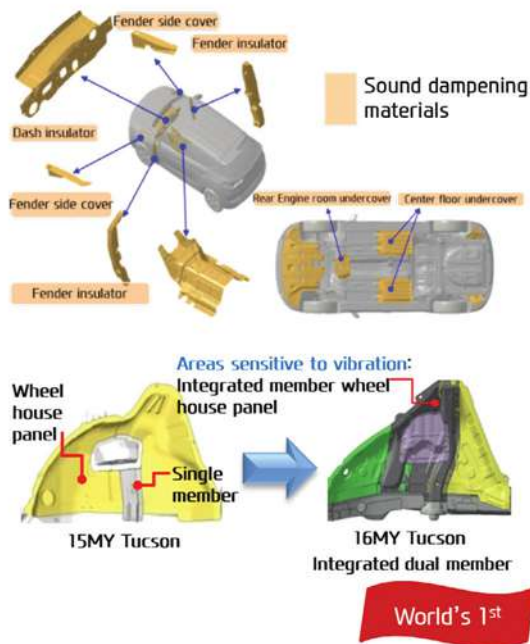
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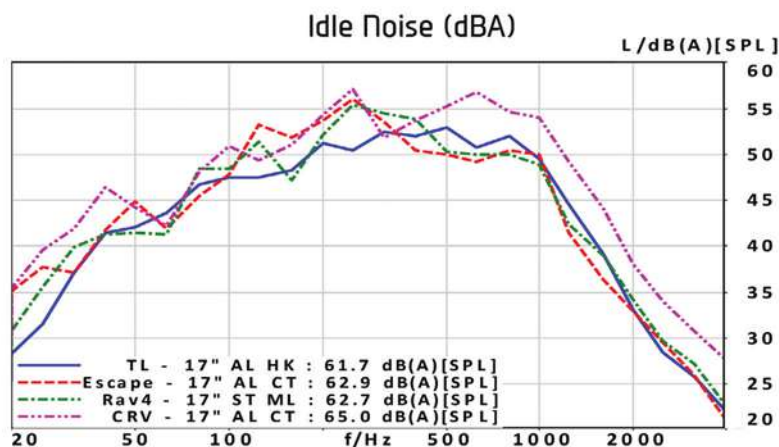
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TECHNOLOGY Report



Item (dBA)	Tucson	RAV4	CR-V	Escape
Wind Noise	67.2	68.6	70.2	67.9
Road Noise	65.5	66.4	68.6	68.3
Idle Noise	61.7	62.7	65.0	62.9



Hyundai Motor America

HMA Internal Competitive Evaluation: Wind Noise (Smooth Road @ 110 kph) / Road Noise (Coarse Road @ 60 kph)

Hyundai engineers' focus on chassis and NVH enhancements paid off in internal testing of noise levels.



Hyundai's Chahe Apelian next to the Tucson BIW. Note the hot-stamped steel piece (red) that sandwiches the damper, resulting in a 109% increase in rigidity, reduced road noise levels, and ride and handling improvements. (Ryan Gehm)

absorber and that's a tunable variable." Apelian pointed out the spring seat on the underside of the BIW wheel well, comprised of 100 kg/mm² (980 MPa) HSS and hot-stamped steel; "on the other side, we sandwich it with another piece of hot-stamped steel, so it's all bracketed in and takes all the forces right here."

Engineers in Korea began working on the solution since the previous generation, according to Apelian, after identifying the rear suspension mount as an area that needed improvement. HSS being a "core technology" for Hyundai, its employment for this application made sense, he said.

"The part sizes aren't very big; it's not

like we're using a whole rocker," he explained. "It's a laser-focused application, so it minimizes cost but gives us the biggest bang for the buck...You could do it with normal steel, but then you start adding more weight."

Though the overall solution is heavier than the previous single reinforcement, Apelian noted that "all of the other solutions would be higher weight...to achieve this much stiffness and this much ride improvement."

Other NVH enhancements

Another area targeted for NVH improvements was the subframes, which are fully isolated, front and rear. "The platform is basically a derivative of the Sonata platform, and we carried over those," he said. "The body stiffness is critical to making sure those subframes work, so that the handling doesn't degrade, and also for managing the 19-in tires, making sure they work with the whole system."

The 19-in tires are one size larger than the previous-generation's available 18-in tires.

Front suspension is a MacPherson strut design, with coil springs, gas-filled shock absorbers, and a 24.7-mm (0.97-in) stabilizer bar. The rear suspension is an independent, multi-link design, now with dual lower arms for both front-wheel and all-wheel-drive models, for

optimal ride comfort and body control. Overall, front and rear suspension setups are now 20% stiffer than the outgoing Tucson's.

Suspension bushings are now composed of a higher-damping synthetic rubber that is 30% stiffer for smoother ride characteristics when compared with conventional rubber.

"The front suspension was completely redesigned," O'Brien said. "We went to a four-point bushing setup for better rigidity and better noise isolation. Probably more importantly we've gone from a conventional rubber bump stop that basically has that very harsh feeling when you hit the limit of the suspension travel, to instead a hydraulic rebound spring stopper that manages that last bit of suspension travel much more comfortably."

To help lower wind noise, aerodynamics have been improved to 0.33 Cd, a 0.02 lower coefficient of drag than the former Tucson.

Based on Hyundai's internal tests at its R&D center in Ann Arbor, MI, the new Tucson has achieved better road noise (65.5 dBA), idle noise (61.7 dBA), and wind noise (67.2 dBA) measures than **Toyota RAV-4**, **Honda CR-V**, and **Ford Escape**—"the result of our extra effort in terms of NVH and road noise isolation," said O'Brien.

Ryan Gehm

AEROSPACE MATERIALS

NASA pursues coatings that reduce bug debris to improve aerodynamics

NASA recently tested non-stick coatings on Boeing's ecoDemonstrator 757 that could eventually help aircraft become more fuel efficient by reducing insect residue that creates a surprising amount of drag.

NASA and Boeing engineers spent about two weeks in Shreveport, Louisiana, testing non-stick wing coatings designed to shed insect residue and help reduce fuel consumption. Researchers with the Environmentally Responsible Aviation (ERA) Project assessed how well five different coatings worked to prevent insect remains from sticking to the leading edge of the airplane's right wing.

Because most insects fly relatively close to the ground, NASA explained, the 757 made 15 flights from the Shreveport Regional Airport that each included several takeoffs and landings. Shreveport was chosen in part because of its significant bug population, and the crews worked around storms and winds to ensure the bugs would be present.

"One of the five coating/surface combinations showed especially promising results," said Fay Collier, ERA Project Manager. "There still is a lot of research to be done, but early data indicated one coating had about a 40% reduction in bug counts and residue compared to a control surface mounted next to it."

Bug residue causing drag has long been a challenge for the aviation community, according to Mia Siochi, Senior Materials Scientist at NASA's Langley Research Center in Hampton, Virginia.

"Laminar aircraft wings are designed to be aerodynamically efficient," she said. "If you have bugs accumulating, it causes the airflow to trip from smooth or laminar to turbulent, causing additional drag. An aircraft that's designed to have laminar wings flying long distance can save 5-6% in fuel usage. Surprisingly, all you need are little bugs that trip the flow and you lose part of this benefit."

Prior to development and testing of the non-stick coatings, the researchers studied bug chemistry and what happens when an insect hits a surface at a high velocity.

"We learned when a bug hits and its body ruptures the blood starts undergoing some chemical changes to make it stickier," said Siochi. "That's basically



NASA materials scientist Mia Siochi and systems engineer Mike Alexander, from the agency's Langley Research Center in Hampton, VA, and Boeing technician Felix Boyett count insect residue on the right wing of Boeing's ecoDemonstrator 757 aircraft following a flight test in Shreveport, LA. (Credit: NASA Langley/Paul Bagby)

the survival mechanism for the bug."

Materials scientists then turned to nature—lotus leaves, in particular—to create the right combination of chemicals and surface roughness in the test coatings, Siochi added.

"When you look at a lotus leaf under the microscope, the reason water doesn't stick to it is because it has these rough features that are pointy," she explained. "When liquid sits on the microscopically-rough leaf surface, the surface tension keeps it from spreading out, so it rolls off. We're trying to use that principle in combination with chemistry to prevent bugs from sticking."

The best-performing coating is an epoxy with fillers—this is all Siochi, through the Langley communications team, could share about its make-up. "Our materials scientists can't say more until the patent process is complete," the spokesperson relayed.

Engineers at Langley developed and tested more than 200 coating formulations in a small wind tunnel, then took a number of those to flight on the wing of a NASA jet. They selected the best candidate non-stick coatings to fly on the ecoDemonstrator, while a team comprised of experts from NASA, Boeing, the U.S. Department of Transportation, and University of California-Davis identified the best location for testing.

Where does the project go from here? "We are talking with possible industries about commercialization," according to the spokesperson. "Any product applications would be up to industry and aircraft manufacturers."

Ryan Gehm

AEROSPACE MATERIALS | MANUFACTURING

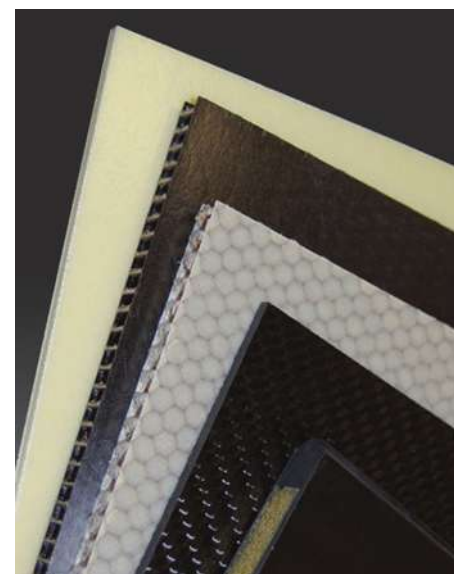
TRB turns composites focus to aerospace sector

TRB Lightweight Structures Ltd. recently released an aerospace-grade lightweight honeycomb composite panel designed for interior applications, expanding the application areas for its range of composite flat panels.

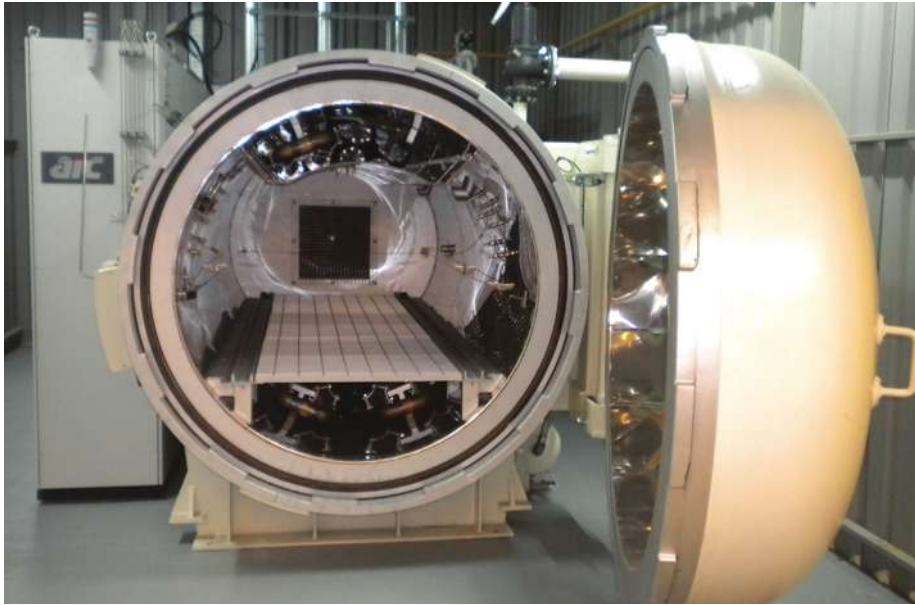
Cellite 840 panels are manufactured from woven glass with a phenolic resin and a Nomex honeycomb core, bonded with high-performance adhesive. The woven glass prepreg skins are 0.5 mm thick. Standard panels are 2500 mm wide (± 4 mm) by 1250 mm long (± 3 mm). Other panel sizes are available upon request, the Cambridgeshire, U.K.-based company notes. Overall thickness is per customer request, ± 0.25 mm.

The new design extends the range of TRB's composite flat panels, which have been used for years to manufacture bonded assemblies, lightweight structures, and composite components for rail, defense, marine, and motor-sports industries.

This product development builds on TRB's recent AS9100 (BS EN 9100) aerospace accreditation, adding to the IRIS (International Railway Industry Standard) and ISO 9001 certifications



Cellite 840 panels from TRB are manufactured from woven glass with a phenolic resin and a Nomex honeycomb core, bonded with high-performance adhesive.



TRB's new autoclave system for the manufacturing of high-performance composite components is 3 m long and has pressure capability of 10 bar at 250°C.

already in place. AS9100 is an industry-recognized standard of quality and risk management for the aerospace and defense industry aimed at improving service standards and product reliability.

Obtaining AS9100 is part of TRB's long-term strategic investment in the aerospace sector, both in the U.K. and globally. Additional new capacity and capabilities in the design and manufacture of composite materials have been made over the past year to help secure new business. Recent investments for manufacturing composites include the procurement of a new 3- x 1.5-m autoclave system.

"As specialists in the design and engineering of lightweight composite solutions, we enjoy the challenges that the aerospace industry provides," said Richard Holland, Managing Director of TRB. "Obtaining AS9100 now allows us to extend our expertise as an end-to-end service provider further into the heart of this demanding industry, as well as improving our service to existing customers in aerospace and defense.

"In the last 12 months, in addition to putting in place additional composites capabilities, we've been on a journey that has seen us implement many improvements across the business to raise quality and drive down costs," Holland continued. "A key focus on production efficiency means that we are now able to offer significantly reduced lead times. As a result, we're

currently in the process of negotiating new contracts with a number of aerospace customers, and we expect more to come on board now that we are AS9100 approved."

Procured in June 2015, the new autoclave system for the manufacturing of high-performance composite components is 3 m long and has a process mass including tooling of up to 500 kg. The vessel is designed to meet the requirements of PD 5500 with a design pressure capability of 10 bar at 250°C.

The autoclave system complements TRB's existing range of machines for composite manufacture that includes ovens, computer-controlled multi-day-light heated platen presses for high-performance material bonding, and a 4000-ft² ISO 14644 class clean room.

"The autoclave system is an important step in the continued development of our business," said Andrew Dugmore, Sales Director at TRB. "[It] enhances our current in-house capability, ensuring we maintain control of costs, lead times, and quality."

He added, "This has resulted in new contracts for key customers including the manufacture of a complex, lightweight backing structure for use in an RF Mock-Up of a new microwave instrument for **Airbus**, and a complete carbon-fiber floor system for a high-performance racing yacht for **Green Marine**."

Ryan Gehm

OFF-HIGHWAY SIMULATION

Advanced simulation aids heavy-truck aerodynamics

There is more pressure than ever on heavy-truck engineers to find and create significant improvements in fuel economy and reduce tailpipe greenhouse gas (GHG) emissions. This is being driven primarily by two factors. First, customers are looking for ways to improve their business model by reducing fuel consumption. Diesel fuel prices in the past few years have been volatile, ranging from \$2.931/gal (Sept. 6, 2010) up to \$4.159 (Feb. 25, 2013) and back down to \$2.561 (Aug. 24, 2015), according to U.S. Retail Diesel Price data from ycharts (http://ycharts.com/indicators/us_diesel_price), showing the need to be prepared for possible upswings in fuel costs of 50% or more. Additionally, regulations are driving fuel-economy improvements and GHG reduction to unprecedented levels.

To compound the challenge of these customer and regulatory pressures, the low-hanging fruit for these gains is already long gone. Aerodynamic enhancements have historically offered the biggest opportunity, but finding significant improvements today requires a shift in testing and development to be efficient and successful, and new advancements in CFD may be the key. The aerodynamic challenge with heavy trucks is that they're pulling a brick-like shape that has a flat wall at the end. The closing of the airflow at the end of that brick creates a wake, and inside that area is extremely low pressure that pulls on the surface, creating about 40% of the pressure drag of the entire tractor and trailer. Pressure drag is about 90% of total drag on a truck and trailer combination, thus, a key target for refinement.

Exa Corp. has been working with several truck and component manufacturers in the heavy-truck industry, and has shown how its CFD software, PowerFLOW, can evaluate and quantify small changes without expensive and time-consuming prototype builds or wind tunnel testing. PowerFLOW also offers an Optimization Solution, which uses algorithms to test hundreds and even thousands of variations, literally

overnight, between a baseline design and end parameters set by the engineering team.

Designs can be morphed quickly using CFD, and unlike physical testing where the design has to be modified for the consecutive tests, users can easily and accurately return to the baseline. Additionally, wind tunnels cannot accurately address how the moving road surface and spinning tires affects airflow; this is critical now as many opportunities for aero improvements—skirts, under-vehicle panels, and wheel covers—are parts of the tractor and trailer that are close to the pavement.

Exa recently worked with **Laydon Composites** on a trailer skirt solution that explored which design would provide optimum results. In addition to looking for the best aerodynamics to enhance fuel economy, the team also found that with the right design they could achieve **U.S. EPA SmartWay Elite** status without a boat tail. This can have large operational and cost advantages for a fleet.

“Anyone can put a fairing under the trailer and get a 2-5% improvement,” said Doug Hatfield, Managing Director, Heavy Vehicles, Americas, at Exa. “We developed one with extensive simulation and achieved a 9.3% improvement in fuel economy.”

Even with improvements in fuel economy through the optimized design of a trailer fairing, Exa believes there are more opportunities. Simulation provides insight into the airflow so engineers have more control to influence it. For example, through simulation and analysis, better integration of the airflow under the truck



Exa recently worked with Laydon Composites on a trailer skirt solution that explored which design would provide optimum results. The result of extensive simulation was a 9.3% improvement in fuel economy, and achieving U.S. EPA SmartWay Elite status without a boat tail.

and trailer combination can be achieved to maximize the fuel-economy gain. Already popular in Europe, there is more talk in the U.S. about matching truck and trailer systems for better aerodynamics, but it would require fleet homologation to make it more realistic for the U.S. business model.

There are also aerodynamic opportunities with active grille shutters, which are becoming common in passenger vehicles. Active grille shutters allow more airflow for cooling, but can close (forcing airflow around the engine compartment instead of through it) when not needed. Exa has found that closing off the grille to airflow results in about a 1% improvement in fuel economy overall with current design of tractors, and that there's potentially a 3-5% gain on the table if the tractor design is optimized to make use of active grille shutters. This would require a paradigm shift in tractor design and manufacturing. Vehicle manufacturers may be

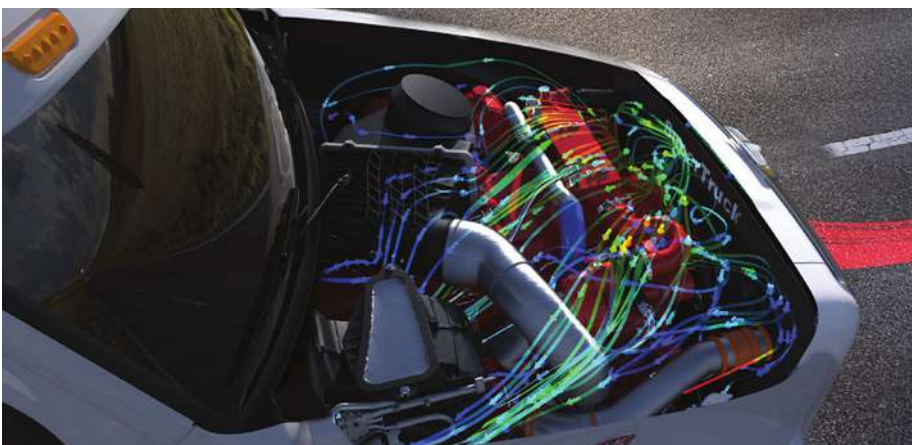
more willing to embrace these shutters as pressure for improvement from customers and regulations increase.

Even without active shutters, with simulation software it is possible to explore the front-end design to reduce the frontal area but still provide what's needed for cooling. There are opportunities with trucks designed for specific routes to optimize the front-end design to balance airflow for cooling and reduced frontal area for cooling. For example, today all trucks are designed for worst-case heat scenarios: pulling full GVWR (combined gross vehicle weight rating) at a grade at ambient temperatures above 100°F (38°C). But if the customer will never operate the vehicle in those extreme conditions, then it will never need that much cooling capacity, and the front-end design could be swayed to favor aerodynamics.

It also will be interesting to watch as technology for self-driving trucks evolves. Truck platooning, for example, presents an interesting mix of opportunity for fuel-economy improvement and unique cooling challenges. The rear trucks in a draft will have better fuel economy, but it will have increased cooling needs. Exa has already done simulation work on platooning and found significant gains in fuel economy with 50 ft (15 m) of following distance even without unique aerodynamic design.

While the future has many variables, one certain thing is that utilizing advanced simulation tools for development and testing will be critical to efficiently identifying the next wave of fuel-economy improvements.

Cole Quinell on behalf of Exa Corp. wrote this article for SAE Magazines.



Complex underhood airflow management is key when determining proper cooling of critical components. Through simulation, truck manufacturers can evaluate and design efficient airflow and cooling for various situations such as drafting/platooning virtually. (SuperTruck image courtesy of Exa/Peterbilt/Cummins.)

OFF-HIGHWAY TESTING

LiuGong builds commitment to R&D into new China hub



The Global Research and Development Center opening in June at Liuzhou will be housed by a team of LiuGong employees, each of whom will share the company's collective approach to design and manufacturing. The company says its team of well over 1000 engineers will have expertise spanning just about every key element of construction machinery.

At Intermat, LiuGong announced that it was in a 60-day countdown before its new Global Research and Development Center opened in June. LiuGong, founded in 1958, currently directs close to 5% of its total sales revenue into R&D year-on-year, with an investment of over €61 million (~\$68 million) in 2014 alone.

"For LiuGong to continue our growth path, we need facilities that enable our design and engineering teams to innovate and utilize the technologies that will drive the future of our machines," said David Beatenbough, Vice President of LiuGong and Project Lead for the new Development Center.

Development began in Liuzhou, China, in 2013 and the accumulated investment in the project since then has reached €40 million (\$45 million). The facility spans 110,000 m² and includes a 22,000 m² office complex for about 1200 engineers, a test center, a prototype center, seven laboratories, and three design studios, including a virtual reality studio.

Liuzhou—also home to the company's global headquarters—will be the new hub that will provide direction to LiuGong's three other R&D facilities in India, Poland, and the U.K. One of the main objectives of the new center will be to encourage greater interaction between the R&D facilities, streamlining information exchange and resource utilization.

Most important, the new center will be the focal point for the development of engineering talent within LiuGong, considered a key target at LiuGong. The new complex has several specialized training laboratories that will focus on testing and optimizing all aspects of machine performance, such as structural design, materials science, electronic and hydraulic efficiency, cooling, vibration, and noise. The laboratories will allow accelerated endurance testing as well as a wide variety of performance testing.

"From a personal point-of-view, it is the most complete facility that I have had the opportunity to work in," said Beatenbough. "It gives us the platform to be competitive with any construction equipment manufacturer in the world."

At Intermat, Beatenbough, even considering the state-of-the-art equipment in the laboratories, seemed particularly enamored of the office space, which has been designed "with gathering and meeting places to facilitate interactions between engineers," he said. "The space will have different kinds of rooms for different kinds of meetings, for energetic engineers eager to learn."

Co-locating experts from many disciplines will allow better exchange of ideas, and help with one of the new design center's primary missions—that of evaluating future technologies, and



"We want to bring highly-skilled people to LiuGong whose primary outlook is to teach and inspire their colleagues in their specialties," said David Beatenbough, Vice President of LiuGong and project lead for the new center. "I am not interested in bringing in an engineer just to design a better excavator; I want to hire an engineer that designs a better excavator in a way that educates and hones the skills of their fellow employees."

future trends within the industry. LiuGong believes that the center will enable a fundamental change for the better in how it approaches R&D.

In terms of expectations for the research center, "We want to bring highly-skilled people to LiuGong whose primary outlook is to teach and inspire their colleagues in their specialties," said Beatenbough. "I am not interested in bringing in an engineer just to design a better excavator; I want to hire an engineer that designs a better excavator in a way that educates and hones the skills of their fellow employees."

Beatenbough believes that within just a few months of moving into the new center "our customers will begin to feel the impact of optimized R&D, and I can confidently say that within a very few years there will be technologies and products from LiuGong that will advance the industry."

The facility's initial focus will be to undertake major R&D and testing for LiuGong's lines of wheel loaders, excavators, and graders. One of the first projects will be the completion of R&D and testing for the second-phase models of H Series wheel loaders. In 2014, LiuGong held nearly 9.7% of the global market share in wheel loaders and nearly 17.5% share domestically.

Jean L. Broge

AEROSPACE SIMULATION

Dassault Systèmes on everyone's side with 3D visualization for cabin design

Dassault Systèmes announced just prior to the Paris Air Show the launch of "Passenger Experience," what it describes as a new aerospace and defense industry solution experience that features high-end 3D visualization technology for customized aircraft cabins.

As Pierre Marchadier, Vice President, Public Relations, Corporate Communications, and Global Events, Dassault Systèmes, told *Aerospace Engineering* at the Paris Air Show, "The passenger is the last bastion to conquer in the aerospace industry."

And he meant it in the best way. Indeed, throughout the show the talk to the press conferences seats, if not the talk on the street, was very focused on the passenger, and not just stretching versions of planes already flying like the A380 to fit more of them in. Instead, it's about connecting them and, if possible, making it seem like they're the only ones on the plane through a customized experience, such as allowing them to preorder food, or starting off a movie on flight B exactly where they left off on flight A. It's also about comforting them.

There have been many technological advances in the industry since nearly every plane flying today went into production, and "there are still lots of planes to produce," said Marchadier. And if not finally, then at least intently, passengers have become part of the conversation as aircraft modernization and the retirement of thousands of aircraft over the next decade have led to a strong build cycle in the industry. That fact in particular has spurred innovation in cabin personalization and passenger comfort as "an effective tool" for OEMs, completion centers, suppliers, and airlines to differentiate themselves and bring back flyers.

Based on Dassault Systèmes' 3DEXPERIENCE platform, Passenger Experience uses 3D visualization technology and interactive content to transform engineering data into visual 3D design, marketing, and sales applications that address all aspects of the cabin design experience—from initial customer interaction and design validation and verification, through to



Based on Dassault Systèmes' 3DEXPERIENCE platform, Passenger Experience uses 3D visualization technology and interactive content to transform engineering data into visual 3D design, marketing, and sales applications that address all aspects of the cabin design experience.

Real-time cabin configuration and immersive cabin validation capabilities enable quick turnaround time on design configurations, reduce engineering changes, and ensure that the final product meets expectations before a physical prototype is created.



marketing campaigns. "We think of ourselves as strategy partners as opposed to software suppliers," said Marchadier.

Passenger Experience automates cabin completion processes with essential intelligent "building blocks" capturing rules, regulations, and manufacturing knowledge to automate cabin interior design, development, and delivery.

Real-time cabin configuration and immersive cabin validation capabilities enable quick turnaround time on design configurations, reduce engineering changes, and ensure that the final product meets expectations before a physical prototype is created.

Different forms of training and visualization content, including web-based courseware, interactive game-based

training and fully immersive 3D visualization, increase training efficiency and minimize time out of the field for cabin crews and aircraft on the ground.

"Allowing aircraft customers to experience their choices as they make them, to appreciate the beauty, effect, practicality, feasibility, cost, and benefit in real time as they make these choices, is a key goal for Passenger Experience," said Michel Tellier, Vice President Aerospace & Defense Industry, Dassault Systèmes. "There is a competitive advantage in bringing maximum harmony between the interior while it is being specified and what will be delivered, and ultimately marketed, to the private or commercial passenger."

Jean L. Broge

TECHNOLOGY Report

AUTOMOTIVE TESTING

Millbrook's latest sound advice to the auto industry



UK independent vehicle test, validation, and engineering services provider, **Millbrook**, is considering introducing acoustic holography as the next step in the further development of its new noise-measurement systems.

"Able to support the latest automotive technologies including electric and hybrid vehicles, our newly commissioned system provides a great opportunity to introduce more advanced test methods to reduce NVH, test to regulatory requirements, and facilitate investigation and development into improvements in vehicle refinement," said Millbrook's Principal Engineer, Ravi Bal.

He explains that the new system is ideal for (but not limited to) sound source localization and contribution analysis. Engineers will be able to measure acoustics and vibration inside a vehicle and sync it with data recorded outside, conducting a variety of objective measurements in a repeatable test environment.

The system that it replaces had been in service for 20 years, stated Bal: "Although everything was digital, there were limitations for efficient and thorough data analysis. So we have made a substantial investment in new equipment—both hardware and software—to expand on our test capability and to introduce more advanced test methods."

The update has seen an advance from a two-channel setup to a 16 channel: "So we are looking at the introduction of

acoustic holography, essentially an acoustic camera that can visually indicate sound sources and highlight potential problem areas. This requires multiple microphones built as an array, so our 16-channel capability allows us to do exactly that, with potential scope to improve spatial resolution by increasing the number of microphones used."

Together with other upgrades, including Millbrook's dynamometers, investment in its Portable Emissions Measurement System (PEMS), and increased capability within its test department, the new noise system provides the opportunity to test, investigate, and develop "way beyond" basic regulatory requirements, stressed Bal.

Millbrook's work on noise was enhanced in 2012 with the introduction of an ISO 10844:2011 specification noise test surface, providing an advanced facility for investigating and understanding vehicle noise: "Whilst the anticipated update to European legislative type approval requirements did not go ahead as predicted in 2014, Millbrook remains at the forefront of the latest technology for test and development of noise solutions."

Global noise test level

Efforts to introduce a global regulated legislative level are still under discussion, but it is difficult to say when the next

legislative date will be.

Bal regards European pass-by limits on noise as being "fairly stringent." They apply to all vehicles, including high-performance cars that are applicable to the European Community Whole Vehicle Type Approval (ECWVTA) framework directive. There is a fixed test procedure—ISO 362—first established in 1981, which was revised this year. Currently, though, the European regulatory standards use a 1998 version.

He explained: "With regard to high-performance cars, the market requires they have the 'right' exhaust note for their type—we all do! The current Type Approval test method varies according to the power output of the vehicle category and transmission type of the vehicle.

"As an example, a car with power output of 100 kW and manual transmission (categorized M1 by Millbrook), is tested in second and third gears at an entry speed of 50 km/h. At a specific point, designated Line AA, the car is accelerated on a "wide open" throttle for 20 m and then the accelerator is lifted. In second and third gears, a mathematical average is applied to the results and that must be below the limit applied to that particular class of vehicle. It should be considered for the majority of modern vehicles, that with



Ravi Bal says Millbrook is considering acoustic holography as part of its new noise measurement system.



Millbrook has increased its investment in its Portable Emissions Measurement System (PEMS).

electronic throttles, when a driver presses the accelerator pedal he is not making the vehicle's speed increase but merely requesting that it should go faster. The limit is 74 dB(A)."

However, for test vehicles with a power output greater than 140 kW (and other stipulations), it is required to enter the test zone with only third gear selected, which typically tends to be quieter (lower engine speed than in second) but is given a 1 dB provision for its class, consequently raising the limit to 75 dB(A), which is a challenge.

The market emergence of electric and hybrid vehicles has brought a new dimension to noise testing. Bal explained: "We regard dB figures of mid to high 60s as the norm for these vehicle types based on our experience, and we attribute most of this to tire noise, with tire manufacturers required to declare the sound pressure generated by the tire—although this is tested via a different methodology to the whole vehicle."

Reducing tire noise in electric vehicles increases the need to consider an artificial approach—warning systems for pedestrians. This is another aspect of noise testing. Bal wants to see limits that require minimum sound pressure levels at key frequencies: "These key frequencies should be established using data relating to a person's perception of sound, i.e., can they hear it over a typical background noise? Therefore, creating a noise that is more than a constant drone, and distinguishable as an electric vehicle." With a typical ambient noise level of around 46 dB, the situation of Millbrook's noise site is conducive to achieving accurate measurement data.

Surface test

Although Millbrook has a control surface test area (ISO 10844), coupled with



Siemens technology is used for Millbrook's new noise measurement system.

measurement equipment applicable to ISO 362 that can be used as a point of reference, tire test noise per se is not part of Millbrook's work, but Bal says the possibility is under discussion. Potentially, it would involve a large investment and, again, varying standards across the world would present complications: "The European tire regulation R 117 has four elements: wet grip, rolling resistance, snow performance, and noise. We can assess noise by using a test trailer but it is quite an involved program. The tires have to be loaded to a set percentage of their maximum permissible load carrying capacity."

If Millbrook did move into tire noise testing, it would also want to enter the other three categories, too. Bal added: "Rolling resistance is relatively straightforward, but wet grip would require further investment. We work in collaboration with **Test World**, the winter vehicle and tire test facility in Finland." It facilitates access to snow all year round.

Bal hopes Millbrook will eventually test whole vehicle noise levels, embracing vehicle body structure, contact patch, aerodynamics, and powertrain contributions.

But he wants to see any new test regulations created via a different procedure: "At present, the perception is that legislators decide what is going to be required, but if a more pragmatic approach could be agreed, taking into consideration OEM and suppliers' views at the earliest stage of decision making, a more appropriate conclusion for the industry could be reached."

Stuart Birch

AUTOMOTIVE MANUFACTURING

Comau enters the small-robot segment with Racer3

Small robots are beginning to handle tasks inside automotive production facilities that require human-like dexterity.

"The primary reason for smaller robots gaining traction in the automotive industry, especially in the assembly area, are advances in end effector technology (the device at the end of a robotic arm), tactile sensing capabilities, and overall precision," said Alex Shikany, Director of Market Analysis for the **Robotic Industries Association (RIA)** in Ann Arbor, MI.

Improved sensor technology is making it safer for humans to work alongside robots, according to Jeff Burnstein, President of RIA, who adds, "This so-called 'collaborative robot' movement is the hottest area of robotics today, and many of the collaborative robots are smaller robots."

Comau recently unveiled its Racer3, a compact robot with the same precision and repeatability of the company's large industrial robots used in the automotive manufacturing environment.

"The Racer3 is not the spot-welding robot, for sure. I think there are a lot of areas in automotive—beyond the body



Comau's Racer3 is a new, high-speed compact articulated robot. "We had a missing product in our portfolio, and we're trying to fill that," said Comau Robotics' Mathias Wiklund.

TECHNOLOGY Report

shop where you do not see a high-density of robots—where the Racer3 can be used,” Mathias Wiklund, Chief Operating Officer of Robotics for Comau SpA, said in an interview with *Automotive Engineering* during a press event at the Castle of Rivoli in Italy.

Comau’s Racer3 can assemble small components, like powertrain parts.

“I think powertrain is an area where you have a tendency of investing in hard automation, instead of investing in flexible automation. And I think flexible automation becomes a need for the future,” said Wiklund.

While welding and paint shop tasks have been handled by large robots for several years, the trend toward using smaller robots for other automotive production duties is an emerging trend.

Said Shikany, “Advances in technologies are increasing the capabilities of these smaller, flexible robots, which opens up new automotive industry applications, such as dashboard assembly, engine and transmission handling, and cutting applications for softer materials.”

The six-axis Racer3’s primary applications are aimed at assembly, material handling, machine tending, dispensing, and pick and place. Racer3 has a 3-kg (6.6-lb) payload, and a 600-mm (23.6-in) reach.

Its 30-kg (66-lb) weight reflects the usage of aluminum and another light-weight alloy.

“There are a lot of new things with this robot that we did not have before. For instance, none of our big robots use magnesium. This robot has magnesium to make sure it is lighter and to make sure it is performing better,” Wiklund explained.

Designed to resemble a snake, the Racer3 can rotate into many positions. For example, it can assume a scissor shape, surpassing the flange at axis one. It also can close like a book, bringing the robot’s wrist toward the body in order to rotate the axis one at maximum speed.

According to Tobias Daniel, Head of Comau’s Robotics for Europe and the Americas, one of Racer3’s selling points is its speed (0.36-sec cycle time in prototype trials). “It is useful for automotive,” said Daniel, who points out that the Racer3 was specifically created for general industry sectors, including electronics, plastics, and metalworking.

Kami Buchholz

AEROSPACE MANUFACTURING

First Airbus A350-1000 wing goes into production in North Wales



Wings for the first A350-1000 jetliner are now under assembly process at Airbus’ Broughton, North Wales facility.



Assembly has commenced for the first A350-1000’s wings—which make the aircraft faster, more efficient, and quieter—at Airbus’ facility in Broughton, North Wales.

Airbus has begun the assembly process on the wings for the first Airbus A350-1000 in Broughton, North Wales. The A350-1000 wing has the same span of the A350-900 that is already in service, but 90% of the parts have been modified and the trailing edge has been extended to resize the wing for the additional payload and range.

Most of the A350 XWB’s wing is comprised of carbon-fiber composites, including its upper and lower covers. At 32 x 6 m, Airbus says the wing is the largest single part made from composites in use in civil aviation today.

The wings were designed and developed at Airbus’ facility in Filton, near Bristol, where a number of other systems are designed and tested including fuel systems and landing gear. The wing design includes several streamlined features, in particular droop-nose leading edge devices and new adaptive

dropped-hinge flaps, which increase the jetliner’s efficiency at low speeds. Also, the wings are capable of producing more lift and automatically handle loads across their surface—helping to reduce the aircraft’s drag and fuel burn.

On the A350 XWB wing, Airbus engineers combined aerodynamic enhancements already validated on the A380 with further improvements. To improve efficiency at higher speeds, the A350 XWB can deflect its wing flaps differentially, optimizing the wing profile and providing better load control. By intelligently controlling the wing’s moving surfaces using onboard computer systems, the wing will adapt while airborne—tailoring it for maximum aerodynamic efficiency in the various phases of flight. In essence, pilots will be able to use the flaps not only for takeoff and landing, but also while cruising to reduce wing drag.

Jean L. Broge



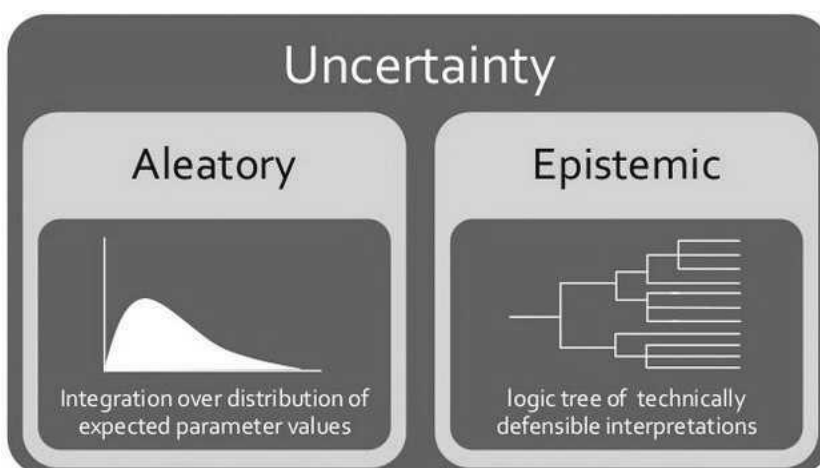
Uncertainty quantification

The technique is a must for next-generation simulation tools.

Today's CAE (computer-aided engineering) analysis tools are mature in terms of solving complex real-world problems. With growing industry expectations, next-generation system-level simulation tools will be armed with uncertainty prediction capability. Of course, there are challenges in implementing uncertainty quantification and propagation, but the ability to predict uncertainty would garner increased confidence on simulation predictions.

The plight of a 1D system analyst is summarized with Roache's famous statement: "No one believes the simulation results except the one who performed the calculation, and everyone believes the experimental results except the one who performed the experiment."

Simulation engineers struggle to convince engineering teams to believe in numbers along with real-world uncertainties. However, all real-world processes always come with associated uncertainty. While carrying out simulation, do we think of propagating measurement uncertainty to simulation predictions? Let's look at the basics to find the answers.

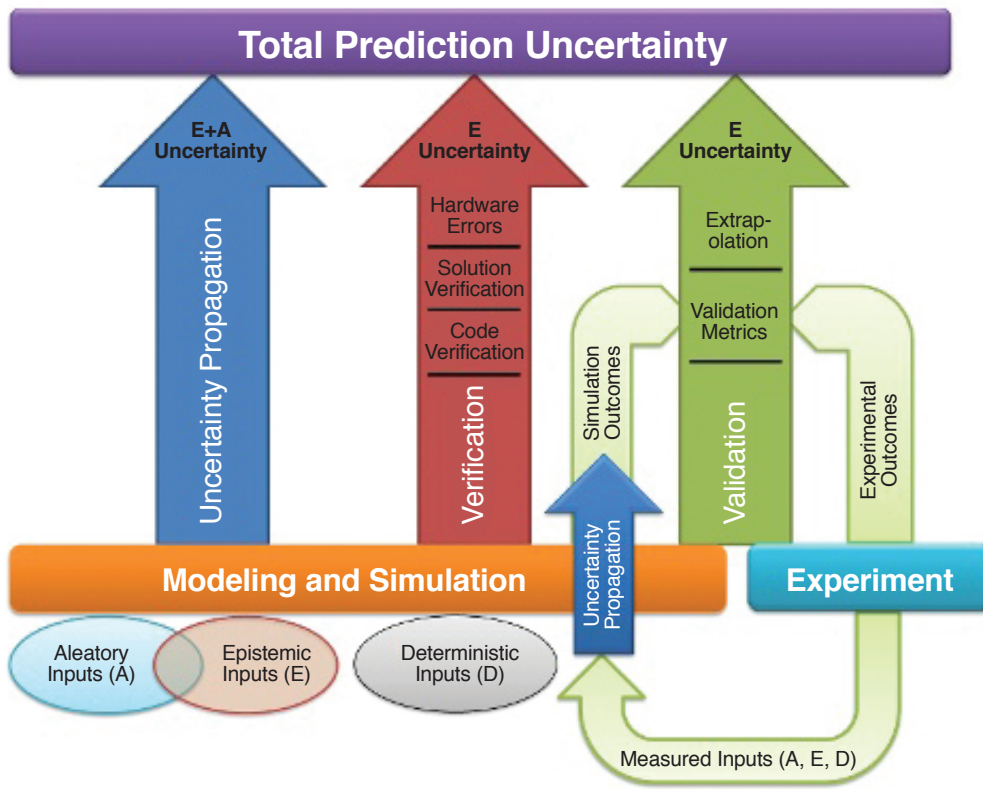


Types of uncertainty.

What is uncertainty?

Uncertainty is everywhere, but it does not necessarily mean risk. Error and uncertainty are different terms and cannot be correlated. Error is defined as "recognizable deficiencies of models or algorithms employed," whereas uncertainty is defined as "potential deficiency due to lack of knowledge." Therefore, the focus should be on managing uncertainty rather than complete eradication. For example, the main focus of an increasingly important discipline called Uncertainty Quantification (UQ) is uncertainty management instead of eradication.

There are two forms of uncertainty: aleatory and epistemic. Aleatory uncertainty (also called irreducible uncertainty) arises from the inherent variation associated with systems under consideration. The aleatory uncertainty can be represented by a finite number of random variables with some known probability distribution. The sources of aleatory uncertainty include both uncertainty in model coefficients and uncertainty in the sequence of possible events. Examples of aleatory uncertainty are material properties, operating conditions, manufacturing tolerances, etc. Aleatory uncertainty can be studied as noise analysis in mathematical modeling. This type of uncertainty should not keep engineers from carrying out simulation activities and should not decrease designer confidence in modeling. Established statistical models can



Uncertainty Quantification focuses on uncertainty management instead of eradication.

produce a range of scenarios and can be presented as “best-case, base-case, and worst-case” if needed.

More serious problems can arise for designers from epistemic uncertainty. This type of uncertainty represents any lack of knowledge or information in any phase or activity of a modeling process. Frequently, strong statistical information such as probability distribution function is not available. Experimental data needed to construct this information are expensive and consequently no data or only a small collection of data points may be available. In such cases “expert opinion” is used in conjunction with the available data to produce weak inferential estimates of parametric description, often in the form of lower and upper bounds. Designers of a system part, such as a Tier 1 supplier, deal with epistemic uncertainty as a core part of their process. Controlling it will depend on complete or simulated system data, which is where the use of robust computational tools is essential.

Why should we consider uncertainty quantification of simulation predictions?

Computational tools are increasingly used for designing and optimizing engineering systems, but can we have any confidence in their predictions? How certain, or uncertain, are we that the results will correspond to reality? UQ

simulation tools can answer these questions.

Any predictive simulation requires validated, computational tools, physical models, and quantified ranges and tolerances for all uncertainties. The objective of UQ is to provide bounds on computational results, just as they are provided with experimental results as uncertainties can arise from each of these inputs in the predictive simulation.

This calls for a fundamentally new approach for modeling focusing on bounds to simulation predictions. The traditional modeling approach is based on the idea of approximation: “say where the answer is” and then “try to minimize the bias.” The approach of bounding is exactly opposite: “say where you know the answer is not” and then “try to tighten the range.” Model validation and uncertainty quantification are closely associated. Model validation consists of performing thorough comparisons with experimental data, so as to ensure that the models accurately represent the reality. As real configurations are always associated with uncertainties, these uncertainties must be accounted for during validation.

Uncertainty quantification is not prevalent in today’s analysis process. The system analyst responsible for doing the modeling needs to communicate the uncertainty along with the predictions. The chief engineer who consumes the analysis results to make critical design decisions must demand this uncertainty range. Don’t just ask: “will my system meet the design target?” but also ask: “what conditions will make my system fail, and what are the chances of that happening?” ■



Ms. Angela Uppuluri, Director of Operations, and Mr. Hemant R. Khalane, Lead Systems Engineer, both of Computational Sciences Experts Group, wrote this article for *Mobility Engineering*.

Oil-pump sizing

Researchers from Hinduja Tech investigate options for low friction and power consumption.

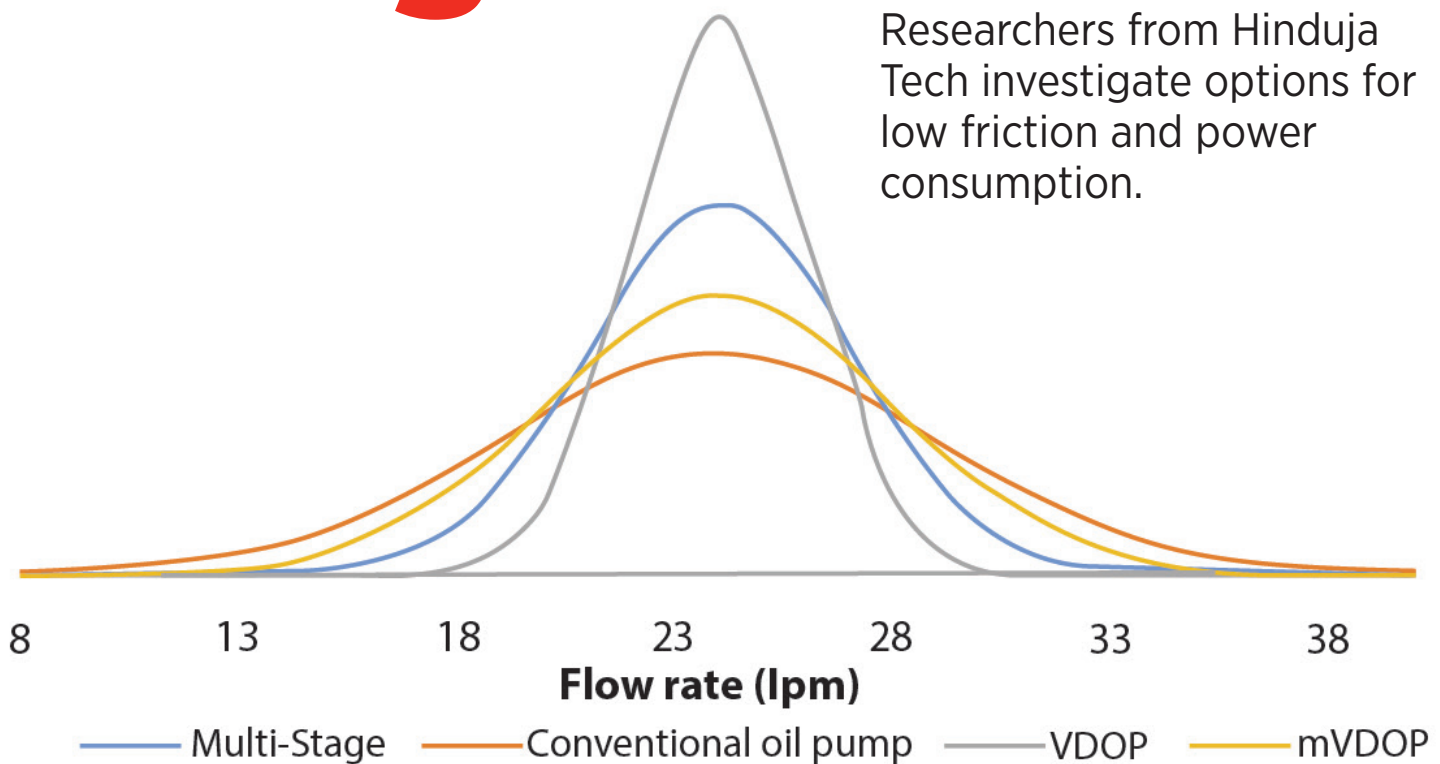


Figure 1: Flow distribution in various oil pump types.

Stringent emission norms are pushing OEMs to focus on making powertrains more efficient, making them look for all possible ways to reduce fuel consumption. The oil pump's contribution to accessory power loss of the engine is significant. Various OEMs have come up with different and new thought processes to counter power loss at oil pumps.

An effective lubrication system is necessary for an engine because of its tribology, hydraulic, and thermal functionality. A modern-day engine puts increased strain on lubrication systems due to additional components and higher thermal loads. The flow estimation for an oil pump is based on the flow requirement of the components in the system.

Conventional oil pumps are designed for high-temperature low-speed flow and pressure requirements. These methodologies tend to be simpler but lead to excess flow conditions at other operating points. Various technologies are implemented over the conventional oil pump design to improve overall efficiency.

Conventional oil pumps are of external gear or gerotor design. They are either driven directly through crankshaft, gear drive, or chain systems. Conventional oil-pump flow has a high level of variations/distribution in output. Figure 1 shows various distributions in different oil pump types. These distribution outputs are caused by linearity in flow increase with respect to rise in engine speed. An increase in flow overshoots the actual demand of the system leading to increase of pressure.

Variable displacement

A variable-displacement oil pump (VDOP), typically a solenoid actuated mechanical pump, employs a multistage pump strategy used by the OEMs and Tier 1s for power saving but are also market and cost driven. Another similar concept is a mild variable displacement oil pump. This contributes to power saving as well as counters the higher cost of VDOPs.

A variable-displacement oil pump addresses the problem of the conventional oil pump by keeping the output flow as close to system demand. VDOP lowers the variation in output by self-regulating the flow to the requirement of the system based on the feedback from the system. The feedback from the system is in pressure form. The pressure is picked up either at the outlet of the pump, in the gallery, or combination of both. The flow into the system is subsequently modified to meet the requirement. This reduces the overall system pressure and hence lowers power consumption.

Oil-pump sizing

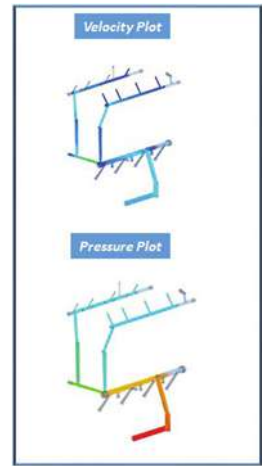
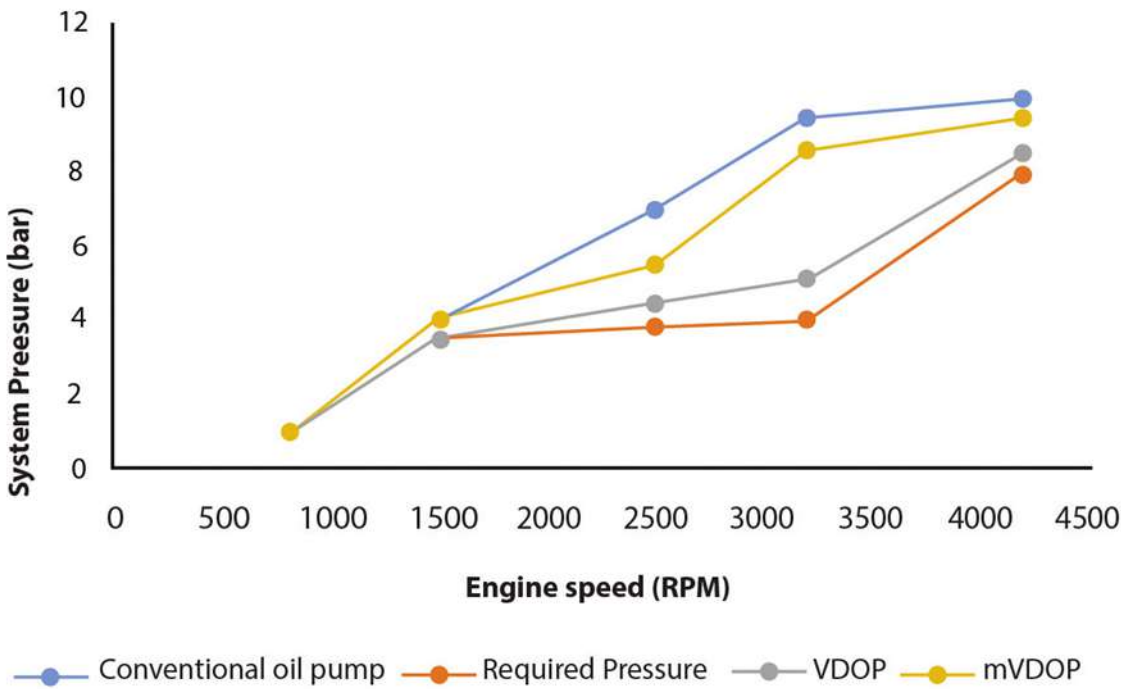


Figure 3: A CFD analysis of the oil passage.

Figure 2: System pressure various engine speed.

The flow regulation can also be achieved through the set pressure of the oil pump relief valve. The oil pump concept implemented is a two-stage oil pump called mild-VDOP (mVDOP). The two-stage setting of relief valve brings out a two-mode operation of the pump. The first stage takes care of the pressure surge during cold-start and high-speed operations. The second stage controls the flow during the cruise range of the engine. During the cruise condition, engine operation is stabilized. Conventional oil pumps have flow regulation set at a region beyond cruise region, leading to higher displacement from the pump into the system. Using mVDOP, the second stage of the oil pump relieves excess flow and lowers the system pressure. Thus, an advantage of power saving is achieved.

Case study

The operating condition of every component was evaluated in an mVDOP trial to define an overall system's definition. The pressure of the system was estimated based on the orifice diameters of the flow passages, pressure drop across filter, and other components of the system. Components considered in the system were oil filter, oil cooler, piston-cooling nozzle, HLA, and vacuum pump. The flow rates for these components were specified by the manufacturer.

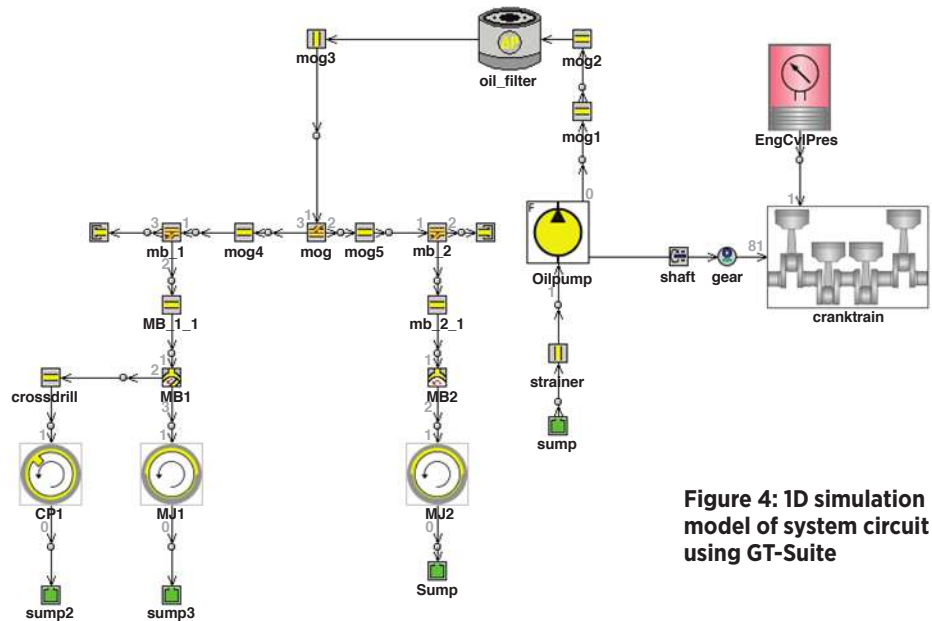


Figure 4: 1D simulation model of system circuit using GT-Suite

The pressure of the system was verified through CFD. Based on the results, orifice diameters were optimized for nominal restrictions. A 1D simulation model for the system was carried out through GT-Suite. The data were verified for a newly developed 1.0-L three-cylinder diesel engine. Thus, a concept of power saving oil pump was conceptualized, implemented, and validated, and the mVDOP was found to give an efficiency benefit of 3-4%. ■



Mr. R. Madhusudhan, System Engineer, Powertrain, and Mr. Meenakshi Sundaram, GM, Powertrain, both of Hinduja Tech Ltd., Chennai, wrote this article for *Mobility Engineering*.

The future of Indian

COMMERCIAL AVIATION



The growth in traffic that airport modernization has supported has also made a significant contribution to the local and national economies, while the improved infrastructure has been positive for the perception of India in the global market.

India, one of the fastest growing aviation markets in the world, currently ranks ninth, but is expected to become the third largest after the U.S. and China by 2020. Indian airport systems are poised to handle 336 million domestic and 85 million international passengers by 2020, from the current level of 121 million domestic and 41 million international passengers. According to International Air Transport Association's (IATA) Airline Industry Forecast 2012-2016, India's domestic air travel market would be among the top five globally, experiencing the second highest growth rate at CAGR of 13.1%.

Airbus has 196 of its commercial passenger aircraft flying in India, compared with Boeing's 160. Airbus has signed with Indigo for 250 planes and has an earlier firm order for another 180. It is likely that volumes over the next 10 years will increase to 516.

The nation's newest local carriers, the Tata sons' joint ventures, Vistara and Air Asia India, have both picked Airbus as their initial choice, while Boeing's visible backlog is much smaller at 59 planes, which include long-haul Dreamliners to Air India and Jet Airways BSE as well as narrow-bodied 737 Max planes to SpiceJet.

The government is working on rules that it says will make it easier for new airlines to fly abroad. The current rules say a carrier must have five years' experience of domestic flying and 20 planes would be allowed for overseas operations. The change in rules will likely create

demand for more kinds of planes in a market where 84% of the fleet consists of single-aisle aircraft. Boeing, which has made 50 of the 62 wide-bodied planes currently in the fleet of Indian carriers, is counting on growth in this segment to take on Airbus.

India does not have "genuine" low-cost carriers (LCC) as there are no budget terminals in the country. Low fares advertised by LCCs are mainly 90-day advance fares, and very few can actually plan their trips so far in advance. The government must make it easier for new airlines to fly abroad to counter their dominant role here. There is not much difference in spot fares of full service carriers (FSCs) and LCCs. India needs budget terminals that are efficient and from where all airlines, not just LCCs, can operate.

Gulf carriers are ruling Indian aviation. Flyers from here travel between India and the world through Dubai, Abu Dhabi, and other hubs in the Gulf.

Low-cost carriers have developed their value chain and strategies with a focus on cost reduction in comparison to network carriers who also focus on excellent customer service. Industry specialists and consumers both believe that LCCs have benefited the industry by providing low fares and made air travel affordable. LCCs need to select a need-based outsourcing to reduce their unnecessary operational costs. The advent of low-cost carriers has led to a rapid growth in the aviation market in India.

Today, LCCs have captured a majority share of the market. Globally, LCC growth is often associated with a boom in tourism, growth in air traffic, and increased frequencies to smaller cities. This is mainly because globally, LCCs have a totally different model, such as choice of routes, ticketing, check-in, passenger service, baggage rules, labor engagement, and aircraft configuration. Unfortunately in India, the LCCs have only a slightly better cost structure (primarily aircraft configuration, salaries), but they mirror FSCs on all other parameters. It's no wonder that the LCCs differ globally from FSCs is the choice of airport. Flying out of low-cost airports enables airlines to operate more efficiently and unbundle services, thus resulting in lower airport related costs (up to 13%).

Firstly, LCCs also prefer low-cost airports, as these are relatively

The future of Indian COMMERCIAL AVIATION



uncongested and free from ground and air traffic control delays. Lack of congestion and faster turnarounds enable LCCs to increase their productivity and lower their operational costs. Secondly, it would increase air connectivity to tier II and tier III cities, making these cities directly accessible without having to pass through major hubs like Delhi, Mumbai, and Bangalore. With significantly lower investments, both passenger and airline fees would be correspondingly lower. This can really spur the growth of international short-haul traffic from India. At present, the non-metro airports accounted for about 30% of the total air traffic, which was expected to rise to 45% in the next few years.

Currently, a passenger at Delhi airport pays Rs.600 as ADF (airport development fee) and Rs.1100 as UDF (user development fee) for international flights, whereas at Tiruchirappalli (Trichy) airport, the same passenger is charged only Rs.360 for UDF.

Air Asia initially operated to Delhi, Mumbai, Kolkata, Chennai, and Trichy, but later withdrew from Delhi and Mumbai airports, due to high airport charges, even as it introduced its third daily flight from Trichy, becoming the largest airline there. Consequently, Trichy airport today has 45% as many international passengers as Kolkata. Its international passenger traffic is over eight times its domestic passenger traffic.

The concept of low-cost airports/terminals is quite new in India, where the focus has always been on building huge state-of-the-art airports such as those in Delhi and Mumbai, with a good network of low-cost airports to provide direct point-to-point connectivity throughout the country. The government needs to ensure quick implementation of this idea, which would help boost tourism, increase economic development, as well as give a boost to the fortunes of LCCs.

Airports Authority of India (AAI) plans to invest Rs.1500 crore in the development of non-metro airports during the 12th plan. AAI is planning to develop 50 new low-cost airports across the country to cope with growing air traffic. The airports would come up on a public/private partnership model and the centre had earmarked Rs.100 crore for each airport. AAI said that the low-cost airports would be built over 10 years in an effort to reduce the cost of operation.

Meanwhile, huge losses have forced airlines to trim down operations and fly to fewer airports. Only 10 airports are profitable across the nation. Not many airlines want to experiment with new routes, especially to remote destinations. Today, most commercial airlines, except for the national carrier Air India, operate in sectors that register a high-load factor. According to AAI officials, commercial airlines in India currently fly to about 70 airports in the country, down from about 95-100 a few years ago.

Airlines are not interested in flying on routes that yield low-load factor and are loss making. Also, the cost of aviation turbine fuel (ATF) was quite high in the country with some states levying up to 30% Value Added Tax (VAT). The cost of operation of the airports and airlines has increased exceptionally and thus their economic viability is a major concern.

The AAI has initiated several steps to make the loss-making airports viable and profitable by development of cargo activities, enhancement of non-aeronautical revenue through revision of rates and awarding of contracts through master concessions, allowance of flying schools at nonoperational airports, and through encouragement of maintenance, repair and operations (MRO) activities. The effective weapon to earn revenue from low-cost airports is through MRO activities and by allowing commercial UAV (unmanned aerial vehicle) related activities such as training.

The growth in traffic that airport modernization has supported has also made a significant contribution to the local and national economies, while the improved infrastructure has been positive for the perception of India in the global market. AAI also needs support from the state governments to make available the required land. Though the government's plan to develop low-cost airports sounded ambitious, its success would largely depend on the financial condition of carriers. New airport infrastructure should be supported by realistic business plans and be linked to the regional airline strategy. Profitability is being delivered as a result of efficiency gains and improvements to the industry's structure. One illustration of this is that the average passenger load factor has increased by some 8% over the last decade.

Aviation is a team effort. Its fortunes and its ability to play this vital role are dependent on strong partnerships. In other areas, the industry faces strong headwinds. The future of Indian commercial aviation relies on profitable LCC routes supported by effective low-cost airports. With huge opportunities for the MRO sector, Indian commercial aviation will provide thousands of employment opportunities during the next decade. ■



**C. S. Karunakaran, Technical Officer,
School of Aeronautical Sciences,
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for Mobility Engineering.**

Driving EVs toward lower cost



The race is on to reduce battery and electric-drive systems costs while improving efficiency.

by Dan Carney

The Chevrolet Bolt EV due as a 2017 production model is the latest poster child for low-cost electric vehicles, but this camouflaged test mule isn't ready for beauty shots just yet.

Market penetration of electric vehicles has been limited by two significant constraints: driving range and purchase cost. These two factors are in fundamental opposition, because the most costly part of a battery EV is its battery. Make that battery larger to increase driving range, as **Tesla Motors** has done with the Model S, and the result is a retail price in the six-figure range.

Reduce the battery's size to hold down costs and the resulting driving range is unacceptably short. Indeed, despite progress on these issues, global EV sales will reach only 2.4% of all light-duty vehicle sales by 2023, predicts Scott Shephard, research analyst with **Navigant Research**.

The only way to overcome this situation is to drive down the cost of electric-drivetrain components. Major manufacturers are engaged on assaults on this paradigm, with new models such as the **Chevrolet Bolt**, expected to arrive as a 2017 model, coming to market amid claims of a 200-mi (322-km) driving range and a \$30,000 price tag (after government incentives).

"Plug-in EV markets are expanding rapidly, and are set to grow much more quickly as several major automakers are slated to introduce vehicles in the high-volume SUV segment," Shephard said.

Former **Volkswagen** CEO Martin Winterkorn told the German newspaper *Bild* that his company's Silicon Valley Electronic Research Laboratory is developing a smaller, cheaper battery that will give one of its cars a 300-km (186-mi) range. "It will be a quantum leap for the electric car," Winterkorn told the paper.

And Tesla is developing less-expensive vehicles than the Model S based on aggressive cost-reduction strategies. Its biggest bet is on its venture with **Panasonic** to build a Nevada "Gigafactory" which, Tesla

forecasts, will produce more lithium-ion cells in 2020 than the entire world made in 2013.

Nissan apparently agrees with the value in having large, integrated facilities located in the U.S. as a cost-control measure for electric vehicles. The company builds Leaf EVs and their batteries in Smyrna, TN, as part of its cost-saving strategy, according to spokeswoman Paige Presley.

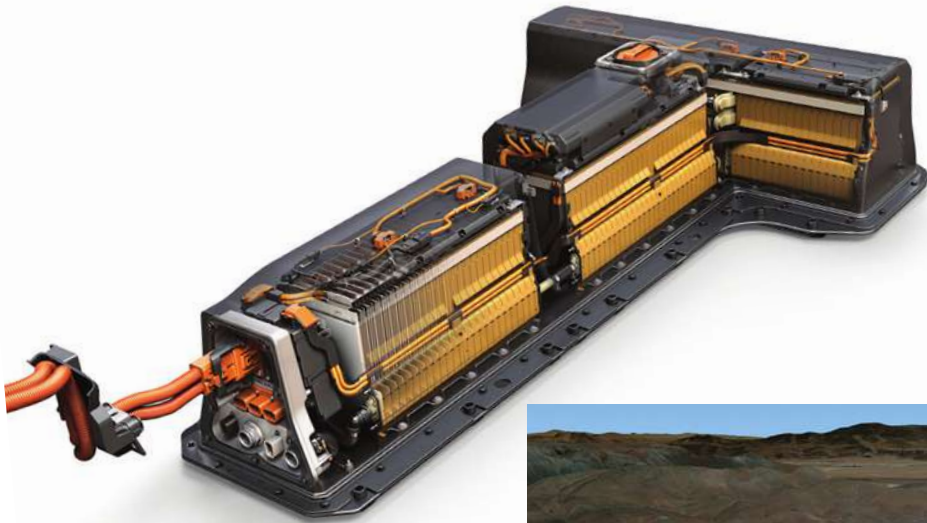
Battery-cell details

The Tesla Gigafactory's gigantic scale and integrated on-site manufacturing will slice the cost per kilowatt-hour for lithium-ion cells by 30%, Tesla predicts. To aid with that cost-reduction effort, the company has signed researcher Jeff Dahn, a professor at **Dalhousie University** in Canada.

Dahn's work has been supported by **3M** since 1996, but the chance to work directly on products that will go to customers was appealing, he said. "I wanted to try in some small way to help the Gigafactory and Tesla succeed even more," Dahn explained.

Today, Tesla sells its 10 kW-h Powerwall power backup and load-shifting battery array

Driving EVs toward lower cost



GM and LG Chem engineers were able to slash the number of lithium-ion cells in the battery pack of the 2016 Chevrolet Volt from 288 to 192, with corresponding savings in cost and space.



Tesla is banking on the sheer scale of its integrated Gigafactory to drive battery costs down from today's \$350/kW-h to closer to \$200.

for \$3500, revealing a price of \$350 per kW-h. If the Gigafactory's scale succeeds in reducing that cost by the 30% level claimed by Tesla, the price will be \$245 per kW-h. But even that is not enough of a cost-down.

"Everybody wants it below \$200, or even below \$100 would be a good thing," said Dahn.

So where is there room for improvement? It is in details, like the cost of the porous plastic separator membrane, he said. "The separator costs about \$1.50 per square meter when you buy it in huge quantity," Dahn reported. By comparison, a similar plastic film with no holes in it, costs about \$0.06/m² when sourced from the very cheapest Chinese suppliers, he pointed out.

"Somehow the process of putting holes in a separator raises the cost significantly," he said. So Dahn aims to seek low-cost ways to produce plastic films for separators with 50% porosity at a cost closer to 6 cents per m² than \$1.50.

Similarly, there are costly metals in lithium-ion batteries, such as the nickel and cobalt used in battery cathodes (positive electrodes), he said. "The more nickel and cobalt you can replace with manganese, the better the cost will get."

In contrast, however, there isn't likely to be

much opportunity for cost savings by refining the use of aluminum foil layers in the batteries. "We have a lot of experience making aluminum foil, so there is not much cost to come out of that," he said.

But a less-obvious avenue for savings is through improvements in battery durability. "Another way to think of cost reduction is, if you increase the battery's lifetime, you effectively reduced its cost. So that is one of the main areas we will focus on," Dahn added.

Chevrolet's dynamic duo

Chevrolet hasn't yet released the technical details of the Bolt, so we don't yet know how that car will achieve its ambitious targets. But the company has discussed the second-generation 2016 Volt, with its electric drivetrain.

The 2016 Volt's **LG Chem**-supplied lithium-ion battery pack contains 192 battery cells instead of the outgoing model's 288. So reducing the number of cells needed to do the job cuts the battery pack's cost correspondingly, and it also trims 30 lb (about 14 kg) from the pack as well.

"It would have been easy for us to tweak our existing battery to provide nominally improved range, but that's not what our customers want," said Larry Nitz, Executive Director of **GM** Powertrain's electrification engineering team. "So our team created a new battery system that will exceed the performance expectations of most of our owners."

That improved driving range stretches to 50 mi (80 km), in comparison to the old car's **EPA** rating of 38 mi (61 km) of electric-only driving range.

The company also made improvements in the Volt's electric motors. The two-motor drive unit is 5% to 12% more efficient than the old car's drive unit. Impressively, it also weighs 100 lb (45 kg) less. One of the



Mirai's fuel cell stack is half the size and 1/20th the cost of the stack that powered Toyota's previous FCV.



The EPA estimates that Toyota's Mirai fuel cell vehicle will be able to travel 312 mi on a full tank of hydrogen.

motors uses no rare-earth metals, while the other one uses far less of those metals.

And smarter programming lets the two motors work together in more driving scenarios, enabling the 2016 Volt to accelerate 13% more quickly to 30 mph (2.6 s) and 7% more quickly to 60 mph (8.4 s). All of these improvements can be expected to contribute to the Bolt's low-cost battery EV solution. (See <http://articles.sae.org/13666/> and <http://articles.sae.org/13831/>.)

Hydrogen solution

Another solution is to eliminate the large battery pack entirely, replacing it with hydrogen tanks to power a fuel cell, as in the new **Toyota Mirai** that has entered low-volume production for 2016. Getting rid of batteries is the true solution to low-cost electric vehicles, insists Matt McClory, manager of the fuel cell group at the Toyota Technical Center.

As with batteries, there is constant progress in the improvement of fuel cells, but fuel cells' improvement curve shows that they will be much more cost-effective for the foreseeable future, McClory said.

The latest advances in fuel cell production for the Mirai slashed the cost of its fuel cell to just 5% the cost of Toyota's previous fuel cell vehicle, which was built using a production Highlander. That far less costly fuel cell is also half the size of its predecessor. The improvements came in areas like

automation of the cell membrane handling and the cell stacking process in assembling the stack.

Fuel cells employ expensive platinum as a catalyst, but recent improvements have let Toyota cut the amount of that dramatically, according to McClory. In fact, the need for platinum in fuel cells should soon reach the level currently used in catalytic converters for emissions control in internal combustion vehicles. That means that global demand for platinum would not increase as fuel cells replace conventional cars, he pointed out.

And while fuel cells normally need a humidifier to keep their membrane moist, Toyota found a way to eliminate the added expense of that device, making Mirai the first production fuel cell vehicle without a humidifier, McClory reported.

Toyota, like all the companies working on fuel cells, has improved the fabrication techniques for making its carbon fiber hydrogen tanks, which also drives down cost. And because the Mirai is a smaller vehicle than the Highlander-based model, it needs only two of the 70-MPa (10,150-psi) tanks (instead of four on the Highlander) to provide satisfactory driving range.

In the Mirai's electric drive system, Toyota's cost-saving solution was to recycle as many components as possible from its high-volume hybrid models. That has meant using a voltage-boost converter to match the fuel cell's relatively low voltage with the higher-voltage motors from the company's production hybrids.

"That was still cheaper than developing a motor and inverter at the custom voltage of the fuel cell," he explained. Which is key, when cost is one of the primary obstacles to wider EV acceptance. ■

POWERING ON

Rolls-Royce's Chief Engineer discusses new technologies that inspire current R&D design and evaluation work as part of its strategic roadmap for future big commercial programs.

by Richard Gardner



The steady rise in demand for high-thrust, big-fan engines for new wide-body commercial airplanes continues to generate massive business, as the 2015 half-year results from **Rolls-Royce** demonstrated. But at the same time, underlying revenue and profits can suffer as demand falters on production that is transitioning to newer, but less mature engines, and as R&D investment increases to bring forward innovation that can safeguard future market share in due course. The company's civil aerospace order book has risen to \$103.6 billion and underlying revenue in this sector was up 2% in the first half of 2015, yet profits fell.

The airframe sector of the global commercial air transport market in the size category above 200 seats is totally dominated today by just two suppliers—**Airbus** and **Boeing**—and the engine market for these wide body passenger and cargo airplanes is in the hands of just three companies—**GE**, **Rolls-Royce**, and **Pratt & Whitney**, in that order of sales success. Profits from sales of the largest aero engines in production reflect their high value (more than a typical regional jet) and also, increasingly, the return from care packages that can offer lifetime maintenance and repair support, providing airline operators with an attractive alternative to traditional heavy investment in MRO contracts or in-house facilities and services.

But this is a very strategic sector, and to survive, let alone thrive, the big players have to be prepared to spend considerable sums on complex and challenging R&D programs to be in a position to bring new products to market in line with changing airframe needs. Getting this right is difficult to predict many years in advance and carries with it major commercial risks, but if the application of improved designs, materials, and production methods can deliver a new engine that will significantly increase operating efficiency, while improving reliability and environmental performance, then the rewards can more than compensate for the investment.

In reality, shareholders know that any company that just sits back and enjoys a long success run on a product without investing in its

replacement will eventually have no future. Managing the cycle so that today's revenues can produce profits while also off-setting the vital R&D expenditure that will bring forward the next generation of products is a corporate trial-by-strength challenge that only the biggest and boldest in the propulsion sector can afford to engage in. So long as they continue to be able to do this, however, then they can be assured that they will remain competitive.

Looking toward future technologies

No better example of such challenges is to be found than in the case of **Rolls-Royce** where its current profits have suffered as sales of the best-selling **Trent 700**, which powers the **Airbus A330**, have peaked and are now slowing down as more customers select its replacement, the **Trent 7000**, which is being developed for application on the upgraded **A330neo** (new engine option). This new engine is offering better all-round performance and so, understandably, customers are waiting for this latest product. At the same time, as the **Trent 700** nears the later stages of its delivery life cycle the aftermarket revenues are increasing.

But this market surge for the upgraded **A330** wasn't expected just a few years ago, as **Airbus** intended to replace the **A330** with the all-new **A350**, powered by the new **Trent XWB** engines. Although the company received a record number of orders for the new combination, you can't buck the customer. When a substantial

number of A330 operators and potential new ones told Airbus they wanted more A330s but could they please have some of the features from the Trent XWB in place of the Trent 700 (which was originally introduced in the early 1990s), Rolls-Royce responded with just that, which became the Trent 7000 and Airbus decided to launch the A330neo.

Rolls-Royce in recent years, as reported in SAE's *Aerospace & Defense Technology*, has been investing billions in highly innovative new technologies, materials, and production processes to safeguard and grow its market share (it wants a 50% slice of the big fanjet market) and now this is looking more and more likely to succeed as new information is revealed about the status of its new R&D programs.

In a post-Paris Air Show discussion, the company's Chief Engineer, Future Programs, Alan Newby, outlined how the new technologies in the Trent XWB family of engines were inspiring current R&D design and evaluation work as part of its strategic roadmap for future big fanjets aimed at delivery in the next decade.

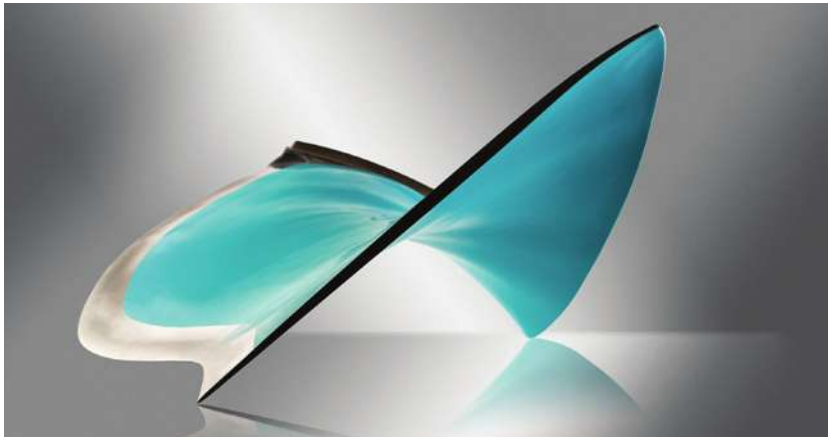
Newby said that the ongoing development work and associated test programs extended across a broad range of activities and involved many partners and specialist companies through the supply chain, as well as close cooperation with a cutting-edge innovation center in academia. This work has already led to the Trent XWB and 7000 models bringing new levels of fuel efficiency and low emissions and even lower noise levels into production products, and the future engines would build on this experience and incorporate a suite of new, even more advanced technologies that will have applications across the company's whole commercial aero engine portfolio.

The phased and very thoroughly tested nature of these programs meant that the risk element was being addressed at each stage and as the new features were integrated and evaluation proceeded, by the time the engines would be ready for the market they would already have achieved a high degree of maturity, even where they introduced game-changing improvements in performance.

The next development beyond the XWB and Trent 7000 and Trent 1000 would be the three-shaft Advance (for more detail, see April 2015 *A&DT*), which will introduce a new core architecture to re-define the workload split between the high- and intermediate-pressure compressors so that there will now be a two-stage HP and a one-stage IP turbine. The design will exploit new technologies to drive down component weight



Rolls-Royce's Trent 7000 being developed for application on the upgraded A330neo (shown is the -900) offers better all-round performance than the Trent 700 it replaces.



Using variable pitch CTi wide chord fan blades on future engines will save weight over all-metallic blades and could eliminate the need for a traditional thrust reverser system.

and system complexity. The engine will feature carbon titanium (CTi) fan blades and composite fan casings and advanced high-temperature technologies to deliver increased thermal efficiencies with an adaptive cooling system offering more intelligent engine controls.

A model future

Under its Vision 10 roadmap, Rolls-Royce is progressing demonstration programs for validation that will aim at exploiting the latest technology advances that will have an application in the near term, while its Vision 20 is concentrating on emerging technologies in the context of how the world, and markets, will change over a longer timescale. This twin approach is thus embracing both evolutionary improvements, Newby said, and also disruptive technologies. The company is studying development technology readiness levels that include issues relating to aspects of manufacturing, factoring in volume and quality needs, and also looking at supply chain capability at appropriate levels.

The main subject of the discussion, however, was centered on new information on the next Rolls-Royce program beyond the Advance, known as the UltraFan. This would use the same core architecture but with a new low-pressure fan system, and a power gearbox. Using variable pitch CTi wide chord fan blades will save weight over all-metallic blades and could eliminate the need for a traditional thrust reverser system, which would certainly reduce more weight and complexity.

According to Newby, the relatively slow-moving fan will be the key enabler on this engine, which will offer further improvement over the performance of the Advance design, and which translates into an efficiency improvement of 25% over the baseline Trent 700. The multi-stage



New technologies in the Trent XWB family of engines are inspiring current R&D design and evaluation work as part of its strategic roadmap for future big Rolls-Royce fanjets aimed at delivery in the next decade.

IP turbine system will feature high aspect ratio titanium aluminide/CMC aerofoils with advanced cooling features.

Rolls-Royce has invested in a large new fan blade facility in Rotherham, U.K., where it is using the latest materials and manufacturing methodologies for its new fan blades. It is situated alongside the Advanced Manufacturing Research Center at Sheffield University, which has become a center of excellence for innovative manufacturing, materials, and processes.

The word “optimized” comes up often. “With an extra-large fan engine, weight is always going to be an issue and so [Rolls-Royce] has looked at everything that might contribute to optimizing each major element in the design,” said Newby. “UltraFan brings together a lot of new technologies in its architecture.”

One example is a slim-line low-drag nacelle, which features a composite casing with embedded electrical connectors that eases assembly and saves weight. The planning effort for the development, testing, and future production of UltraFan can be seen in the investment with the company’s program partners in Germany. Rolls-Royce has teamed with **Liebherr Aerospace** in this new joint venture, which will develop a gear-box that can provide a range of efficient thrust settings. Test facilities are being built at Friedrichshafen and the first test items will start to be put through their paces next year.

Advanced virtual planning is being used via a high-fidelity 3D computer model that will incorporate every component and allow high-performance computing technology to generate high levels of confidence in every design aspect well before the first engine is built. This computer-generated model extends to the whole manufacturing process, including the factory layout, so that there will be unprecedented levels of situational awareness of the status of progress at every level and workstation, for the personnel who will manage and operate the assembly lines and the associated arrivals and departures of parts and modules integrated with the supply chain. This should greatly reduce the overall costs of manufacturing and assembly, and cater for variable production flows in the future.

The use of computer modeling is also bringing tremendous advantages as the additive manufacturing (AM) revolution starts to make 3D printing of components a new reality.

“We can now make complex structures through this process and new



Future Rolls-Royce engines will feature carbon titanium (CTi) fan blades and composite fan casings with other advanced high-temperature technologies to deliver increased thermal efficiencies.

methods of repair techniques are emerging,” said Newby. “Also, more embedded systems can be incorporated in the future, which can help save weight, time, and cost of assembly. We are still at the start of this particular revolution. The saving in time and weight (with big savings through reductions in waste materials) when producing some components by AM methods instead of casting or machining them is game-changing, with savings ranging from 30% upwards in manufacturing the same component by the new method.”

In summing up what he feels future programs may entail, Newby said, “We will see more integration between the aircraft and the engines, and maybe the distributed propulsion route, with a gas turbine generating power for electric fans distributed throughout the aircraft, but such aircraft are probably in the timeframe out beyond 2030.”

Asked about the current status of open rotor engines, he said that such powerplants could be developed through high bypass ratio ducted fans and developments following the UltraFan, but initial applications might be more likely on small business aircraft rather than large commercial airliners where there were still many practical difficulties with such designs. ■

HMIs extend beyond the cab



Telematic functions are being integrated into multi-function user interfaces.

by Terry Costlow

Engineers at FEV are helping OEMs combine telematics and HMIs.

Human-machine interfaces (HMIs) are evolving in multiple paths—they're becoming a more important product differentiator while also expanding their control functions outside the vehicle. As connectivity moves deeper into the mainstream, HMIs are being redesigned to make it easier for operators to utilize the broad range of features and functions that come with telematics.

Fleet operators who have utilized connectivity to gain information for some time seek improved techniques for making some of this data available to operators, while those new to telematics want a wealth of basic functions. Tool providers note that off-highway and commercial vehicle developers are using communication technologies to make vehicles safer and more productive.

"Automotive HMIs focus on infotainment; in off-highway and commercial vehicles, safety and operations are more important," said Manuela Papadopol, Marketing Director, **Elektrobit**, which makes HMI design tools. "HMIs with connectivity are now a key differentiator. Many of the instrument clusters are very graphical."

Handling communications from outside the vehicle is a logical extension of HMI capabilities. It highlights the central role that user interfaces play in making vehicles more useful and productive. HMIs play an important role throughout the vehicle's life cycle.

"The HMI is already the central communication hub in many off-highway vehicles today," said Christiana Seethaler, Product Development Director at **TTTech Computertechnik**. "Alternatively, it is also useful as a development and debugging interface during application development."

The tight link between HMIs and communication modules is following a common arc: once developers and users get comfortable with a few features, they start adding more functionality.

HMIs extend beyond the cab



Parker Hannifin and others are helping operators reduce downtime by providing insight into potential faults.

Many channels

Connectivity's swift journey from a high-end offering to a mainstream option is now evolving to include a range of communications interfaces. It's no longer uncommon for vehicles to have more than one outside link.

"Wireless connectivity options like Wi-Fi and mobile telecommunication options like GSM are becoming more prevalent in HMI devices as enablers for telematics solutions like remote assistance/maintenance and fleet management," Seethaler said.

While this data often flows from vehicles to operation centers, bidirectional links often let operators access the Internet or their management system. That makes it easy for them to get detailed information to enable educated decisions.

"Operators are no longer limited to radio weather reports," said Stephan Tarnutzer, Vice President, Electronics, **FEV North America**. "Someone on a tractor can run an app when it's raining to get information to help them decide whether to stop or continue planting seeds or spraying."

The role of connectivity will continue to expand as developers find more ways to utilize remote links. The continued growth of electronic controls and software means that more data can be accessed by letting communications modules transmit data gathered from a range of CAN buses.

"We expect to see increased use of software to feed data to telematics systems in off-highway equipment," said Kirk Lola, Business Development Manager, **Parker Hannifin** Electronic Controls Division. "Telematics allows for the owner to track machine usage and productivity, but also allows the service manager to view faults and performance to help reduce machine downtime."



HMIs in trucks and off-highway vehicles focus on safety and productivity. (Elektrobit)



Technicians at remote sites may soon be able to control some functions on vehicles, said Danfoss' Fauld.

Taking control

Currently, remote technicians can look at data from the vehicle, but they can't control the ECUs. That's expected to change. Specialists in operation centers may be able to control some functions. That capability may be extended to personnel carrying tablets or even smartphones.

"Depending on the robustness of the telematics solution, they might even have the option to make adjustments to the machine remotely or run automated functions such as remote upgrades or geo-fencing," said Kevin Faulds, Product Marketing Manager of Software Solution Services, **Danfoss Power Solutions**. "Bluetooth technology allows operators to connect a phone or tablet and get status reports or make adjustments to the system without actually needing to be near the machine."

Manual controls hold onto their popularity

Multiple flat panel displays are showing up in more and more cabs, with many of them featuring touch input technology. While touch is seeing significant growth, conventional knobs, buttons, and joysticks are evolving to remain relevant control technologies.

Versatility has become an important factor for the input devices used in cabs. Screens and controls alike must be capable of performing different tasks when vehicles are operating in different modes, such as transforming from infotainment to repair manual.

"Many drivers know how to fix things, so the systems need to give them information that will help them make repairs," said Manuela Papadopol, Marketing Director, **Elektrobit**. "Multi-function keys let operators control lights or radios at one time and drill down for more information when they need to fix something."

Touch input devices are inherently versatile, making them a popular technology for providing operators with versatility while not quite displacing many longstanding control technologies.

"Touchscreens are increasingly being used in off-highway equipment for operator input and menu manipulation," said Kirk Lola, Business Development Manager, **Parker Hannifin** Electronic Controls Division. "However, we see operators still prefer mechanical HMI devices such as joysticks and levers for the control of the essential machine functions like boom control and ground drives. The use of capacitive touchscreens isn't effective in cases where the operator needs to wear gloves."

Often, knobs can be used to let operators scroll through menu items on an LCD. These screens are often located out of the operator's reach. Knobs can be placed close to other manual controls, making it simple for people to shift from one control to another.

"Because operators are not always able to interact directly with a screen,

twist knobs allow them to make changes remotely," said Kevin Faulds, Product Marketing Manager of Software Solution Services, **Danfoss Power Solutions**. "Additionally, knobs allow for convenient page-scrolling, function-switching, or fine-tuned adjustments."



Joysticks from Parker meet ergonomic demands while providing many modes for control.

Joysticks are also letting operators do more tasks without removing their hands from one controller. As these manual devices evolve, comfort is becoming more important. Preventing issues like carpal tunnel syndrome is an increasingly important factor in designs.

"Joysticks have seen significant changes in the wide variety of handle designs that are available," Lola said. "This has allowed joystick providers to offer a handle design that fits the ergonomic requirements of the operator as well as the operational requirements of the application. In addition, more degrees of freedom of the joystick handle are being offered in a single joystick as well as mode selection in software that allows the same joystick to change operating modes when selected by the operator."

More commercial technologies like displays and touchscreens are expected to make their way into cabs. Most vehicle operators are quite familiar with tablets and smartphones, so it will be easy to convert screen control and manipulation techniques from consumer to off-highway environments.

"The biggest operator interface advances are ideas borrowed from the mobile devices industry," said Nick Keel, Group Manager for Automotive Applications, **National Instruments**. "Navigable menus, software hierarchy, and intuitiveness have all become significantly more important as the product complexity has grown. Software can now

offer significantly more functionality without making the user experience more difficult, because customers now have a predefined expectation about how their software should behave."

Terry Costlow



HMIs from TTTech provide many wireless connections.

Links between connected HMIs and CAN buses aren't the only new connections showing up in man-machine interfaces. Commercial technologies like USB and Ethernet are expected to move into the off-highway world.

"As the number of ECUs connected to the HMI increases, the required number of CAN interfaces also grows," Seethaler said. "In addition, USB and Ethernet interfaces become more and more important. USB is typically used for software updates (not only to update the software of the HMI, but also to use the HMI as gateway for updating the ECUs connected to the HMI device). Ethernet can be used as high bandwidth interface to ECUs like our HY-TTC 580 HMI, which features an Ethernet interface, or to connect Ethernet cameras."

Making it easier to update firmware in the field is a critical factor as software becomes more of a product differentiator. The ability to fix bugs or add new functions by simply reflashing memory in an ECU brings big benefits, so design teams are exploring many ways to simplify updating.

"OEMs are going more to Android and Linux-based systems that provide them with the ability to deliver upgrades," said FEV's Tarnutzer. "It's not mainstream, but it's being more widely supplied." ■

Global VEHICLES

SsangYong takes on European challenge with Tivoli



South Korean SsangYong Tivoli was designed in-house. Indian conglomerate Mahindra & Mahindra has a 73% stake in the company.



Shown at the 2015 IAA: SsangYong's Air concept.



CEO Paul Williams says the Tivoli is the “biggest thing to happen to SsangYong.”

“Tivoli is the biggest thing to happen to SsangYong,” said Paul Williams, CEO of SsangYong Motor UK.

It's a bold statement to make about a company that has had a long but sometimes commercially challenging history. But with the engineering and financial backing of India's Mahindra & Mahindra automotive conglomerate, it is now set on making meaningful inroads into the challenging European market, where aesthetics and engineering need to cohere convincingly to achieve real success.

So what has the South Korean built Tivoli got from design and technology aspects that make Williams so confident? “Firstly, we believe the crossover styling is unique—and it was done in-house. Now, people are saying, ‘My goodness, you're capable of doing this given what you have done in the past.’

“We have very high levels of engineering, with details including all-wheel drive, adaptive electric power steering (EPAS), efficient Aisin-supplied automatic transmissions, and a high-strength-steel (HSS) intensive architecture. We also offer an exceptional warranty for the Tivoli—five years limitless in the UK; a company can only do that if the vehicle has been screwed together well in the first place.”

Before joining SsangYong in 2007, Williams' career included posts with Nissan and Mercedes-Benz, and very senior executive positions expanding the presence of Kia, Mitsubishi, and Daihatsu in the UK.

Although SsangYong has a relatively modest presence in Europe, he believes Tivoli will prove the real pacemaker for the company, describing the company in Europe as a “challenger brand.”

Mahindra Motor Company's 73% stake in SsangYong has brought not only financial security but also a cross-fertilization of automotive engineering know-how together with shared manufacturing assets that make for required economies of scale.

Both the four-cylinder gasoline (e-XGi160) and diesel (e-XDi160) 1.6-L engines of the Tivoli are South Korean-designed. Produced in the company's new Changwon Plant, which began production in the fall of 2014 with a potential 300,000 units per annum capacity, the engine program was made possible by Mahindra's involvement.

“You don't necessarily need to invest

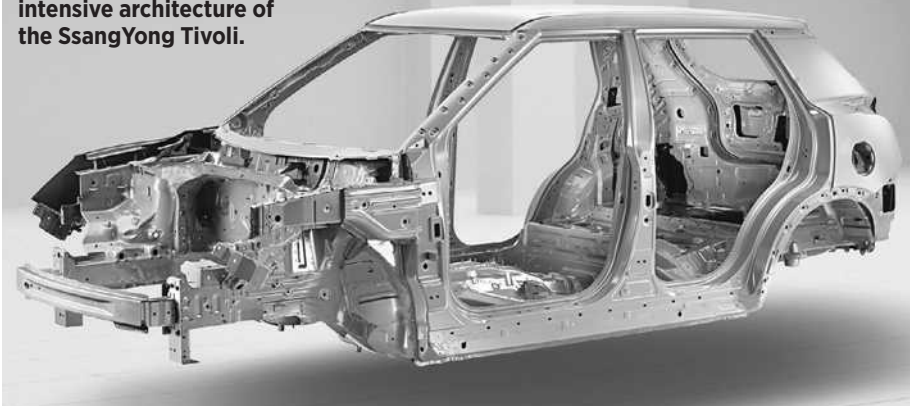
in a new engine plant given that there are plenty of alternatives, so SsangYong did consider sourcing from a third party but decided they wanted their own ‘home grown’ engines,” explained Williams. “And Mahindra wanted better engine technology for their future products and also needed size and scale. Therefore this is a long-term strategy with Mahindra that will see derivatives of the engines and use of the ‘know-how’ that is being created.”

The Tivoli's diesel produces 85 kW (114 hp) and 300 N·m (221 lb-ft) from 1500 to 2500 rpm. The gasoline engine's output is 94 kW (126 hp) at 6000 rpm with maximum torque of 160 N·m (118 lb-ft) at 4600 rpm. The diesel's CO₂ emissions' figure is 113 g/km in two-wheel-drive manual transmission form and 146 g/km as an auto. The gasoline gets 149 g/km with a stop/go facility, two-wheel drive, and manual gearbox, 167 g/km as an auto. Combined fuel consumption for the manual diesel is 4.3 L/100 km and 5.5 L/100 km for the auto.

The diesel uses a Honeywell turbocharger.

Transmission choice is six-speed manual or six-speed auto. Performance figures are relatively modest; the best 0-100 km/h (0-62 mph) for the gasoline car is 11.9 s (auto) and the same time for the manual diesel. Curb weight spans 1270 to 1465 kg (2800 to 3230 lb) depending on engine and specification. Best braked towing capacity is a high 1500 kg (3300 lb).

High strength steel intensive architecture of the SsangYong Tivoli.



In two-wheel-drive form, the Tivoli uses MacPherson front suspension and a live (torsion beam) rear axle, but gets a rear multi-link setup for the AWD version. The EPAS has Normal, Comfort, and Sport modes.

The three trim/equipment levels of the Tivoli—SE, EX, and ELX—provide a broad spread. SsangYong does not wish to be regarded as a “utility” brand, so the ELX specification includes “Diamond Cut” alloy wheels, smart instrument cluster, keyless start, parking sensors, privacy glass, automatic headlights, rain sensing wipers, GPS navigation system with 7-in touchscreen, rearview camera, and leather seating option. The ELX will be offered with AWD later this year.

Tivoli has been developed on a global basis for global markets; it will be available in both diesel and gasoline forms in the whole of Europe. Durability testing areas included Scandinavia for cold weather proving and Australia for hot, together with testing in China and South Korea.

“Our R&D center in South Korea is at Pyungtak, some 70 km from Seoul. We do not have a technical center in Europe—yet,” stated Williams. Demonstrating high quality standards is essential. Because the company has a long-established link with **Mercedes-Benz**, which supplied powertrains for the Musso SUV in the 1990s, SsangYong uses **Daimler** quality benchmarking levels, said Williams.

With regard to safety, the Tivoli has not yet been selected for assessment by Euro NCAP. “But the car was designed to meet high-level Euro NCAP requirements and has seven airbags as standard,” stressed Williams. “South Korea

has a test similar to that used in Europe, and the Tivoli has just received excellent results there.”

SsangYong (the name translates as “double dragon”) was established in 1954 and is South Korea’s oldest motor manufacturer. The company started by producing trucks, buses, and special purpose vehicles. It has always specialized in producing 4x4 vehicles, and in the 1980s developed them for international markets.

In 1997, Daewoo took a majority stake in SsangYong, and vehicles including the Korando (a diminutive of the words Korea-can-do!) and Musso were sold under the Daewoo brand name until 2001. In 2004 came a merger with **SAIC** (Chinese Shanghai Automotive Industry Cars).

More recently the SsangYong range expanded with the Rexton, Kyron, and third-generation Korando, the latter launched in 2010. A C-segment crossover, it was designed by Giugiaro and for the first time adopted monocoque construction.

Mahindra, which has its headquarters in Mumbai, bought its majority share in SsangYong in 2011.

While its latter products established the SsangYong name internationally, it is the Tivoli (as well as an Italian town, the name is also an anagram of “I love it”) that looks the most likely product to enhance its status.

Added Williams: “The Tivoli is entering a rising market sector and will have the effect of bringing the brand and its technology much further into people’s consciousness in Europe. But our other models remain; we will definitely not be a ‘one trick pony!’”

Stuart Birch

Cat pipelayers offer power and comfort to operators

Independent, variable-speed winches for the boom and hook provide precise control, and an enhanced counterweight system ensures a low center of gravity in **Caterpillar’s** new PL72, PL83, and PL87 pipelayers. A new ROPS (roll-over protection structure) provides added safety for both open and enclosed operator’s stations. The new, purpose-built Pipelayer cab is now pressurized and incorporates new operator-comfort and convenience features.

Cat says the new pipelayers were designed to offer the industry increased lift capacity, enhanced slope capability, ease of operation, and transportability. Rated lift capacity (at tipping point) for the PL72 is 90,000 lb (40,823 kg), 170,000 lb (77,111 kg) for the PL83, and 216,000 lb (97,972 kg) for the PL87. A non-suspended, elevated-sprocket undercarriage provides ample track-on-ground for added stability.

The PL72’s Cat C9.3 ACERT Tier 4 Final engine has a maximum power rating of



The enclosed cab option is new and designed by Caterpillar specifically for pipeline applications, allowing truck transport with the ROPS in place. The cab is fully sealed and supplied with filtered, pressurized air for a clean interior environment. Expansive glass surfaces allow unhindered visibility around the machine and into the trench, and a large skylight with sliding shade provides a clear view to the boom and block.

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The lightweight, durable boom of Caterpillar's new pipelayers features high-tensile-strength-steel construction and a narrow design that enhances visibility to the work area. Replaceable boom-mount bearings are designed for long life and easy service.



The new Cat pipelayers were designed to meet the demands of the pipeline industry for increased lift capacity, enhanced slope capability, ease of operation, performance, and transportability.

257 hp (192 kW), while the Cat C15 ACERT Tier 4 Final engine in the PL83 and PL87 has a maximum power rating of 363 hp (271 kW). The new models feature Cat's torque divider and electronically controlled 3F/3R powershift transmission.

The compact-profile winch assemblies for the new pipelayers feature oil-disc brakes to provide smooth operation and positive retention of boom and hook positions. The modular, pin-on design of the winches allows fast service in the field. Counterweight segments are contoured to provide optimum lifting performance and are extended hydraulically for efficient load balance and clearance. A new electronic kick-out switch for the PL83 and PL87 ensures that counterweights are retracted to the correct position.

The lightweight, durable boom features high-tensile-strength-steel construction and a narrow design that enhances visibility to the work area. Replaceable boom-mount bearings are designed for long life and easy service. The new PL83 and PL87 now use two booms in common, 24-ft (7.3-m) and 28-ft (8.5-m) configurations. The PL72 also features two booms, 20 ft (6.1 m) and 24 ft (7.3 m).

The short-profile block set enhances visibility to the work area and extends the working range of the boom. Heavy-lifting components include hook and boom blocks with sleeve bearings, forged hook

with latch, ductile iron sheaves, and heavy-duty frame structures pinned together for strength and durability.

Operator-comfort features on the pipelayers include a quieter cab, adjustable armrests, and heated/ventilated seat options. A dash-mounted LCD display provides onboard diagnostic information for the operator, allows operators to create individual profiles and operational settings, and provides access to multiple switch-controlled functions.

The available enclosed cab is new and designed by Caterpillar specifically for pipeline applications, allowing truck transport with the ROPS in place. The cab is fully sealed and supplied with filtered, pressurized air for a clean interior environment. Expansive glass surfaces allow unhindered visibility around the machine and into the trench, and a large skylight with sliding shade provides a clear view to the boom and block.

A low-effort joystick and a single-lever steering tiller places complete machine control at the operator's fingertips, including hook and boom, counterweight position, throttle, transmission, and steering. A planetary differential turns the machine by speeding one track and slowing the other to maintain full power to both tracks for added maneuverability in congested areas and for enhanced slope capability.

The new models are factory equipped

to accept a load-monitor indicator (LMI), with new hydraulic circuitry, integrated mounting hardware, and ready-mount power supply to facilitate installation. The LMI-ready system enables installation without opening the hydraulic system, thus preventing contamination.

Remote monitoring with the Cat Product Link system improves overall fleet management effectiveness, providing event and diagnostic codes, machine location, fuel level, idle time, working time, and other detailed information (including fault codes for not using seat belts) that is transmitted to the Cat secure web-based application, VisionLink.

For added job-site safety, a wide-angle rearview camera enhances visibility to the work area, and a standard operator-presence detection system allows the machine to idle when the operator is not seated, but locks out the powertrain to avoid unintentional movement.

To facilitate routine maintenance, hydraulic pressure taps allow quick pressure monitoring, and ecology drains for the radiator, hydraulic tank, engine, transmission, and main case add to service convenience and prevent spills. The radiator, charge-air cooler, and hydraulic oil cooler are packaged in a single plane, making cleanout easier, and the zero-speed, reversing hydraulic fan operates only as needed.

Jean L. Broge

HondaJet goes on show

The 4-6 seat HondaJet features an all-metal natural laminar-flow wing aerofoil with winglets, and a composite fuselage supplied by GKN, manufactured in the U.S.



An important element in its world tour was the participation of the new HondaJet at the European Business Aviation Convention and Exhibition (EBACE), held at Geneva, which was its first European appearance.

The new Japanese entry into this most competitive sector was part of a global sales and marketing initiative that has involved a series of launch events aimed at agents and potential customers for the 4-6 seat twin-engine light jet. This is a market that **Honda** has been keen to enter as its unique product features both an all-new airframe and jet engines manufactured by the same company.

Power comes from two new light-weight **GE** Honda HF120 turbofans of 2050 lb thrust each. In the well-equipped cockpit there is a **Garmin** all-glass G3000 avionics system with three 14-in landscape format displays and dual touch-screen controllers. There is an all-metal natural laminar-flow wing aerofoil with winglets, and a composite fuselage supplied by **GKN**, manufactured in the U.S.

A most unusual design feature of the aircraft is the rear, over-wing mounted engines, which have not been seen since the German VFW-614 in the late 1960s. This configuration is claimed by Honda to offer reduced aerodynamic drag, improved performance, and a very quiet cabin. At first glance the airplane looks like any other small jet in its class, but it is only when seen close up that the unusual engine positioning

becomes more obvious.

The HondaJet cabin interior has a “bigger on the inside than the outside” look with best-in class luggage space and legroom and multi-axis sliding passenger seats. The company has concentrated on fitting out the new bizjet with an attractive and comfortable interior with attention to detail, so that its small size does not result in an enclosed environment, yet includes all the passenger features that will be expected from discriminating customers.

Offering a blend of a modern specification with value-for-money (around \$4.5 million), HondaJet is still at the early stages of being seen as a major player in the market, up against such well established rivals as **Cessna**, **LearJet**, and **Embraer**, who all offer much larger product lines, as well as the entry-level and light jet niche in the business jet market. The HondaJet program has been underway for a long time—over a decade—and the company is now anxious to show that it has eventually emerged with a competitive product.

HondaJet has established a new global headquarters, final assembly plant, and customer service center at Greensboro, NC, which has a capacity to deliver up to 80-100 aircraft each year. So far, over 100 aircraft are currently on order and the company is very much hoping that the international exposure of the demonstrator aircraft will lift the sales momentum this year.

Richard Gardner

Honda shows radical Project 2&4

Honda sought to recapture some of the glory of its motorcycling and open-wheel-racing heritage at the 2015 Frankfurt Motor Show, introducing the Project 2&4, a tiny go-kart of a concept vehicle that marries the company’s MotoGP powerplant with a four-wheeled conveyance. Hence, two and four wheels of the project’s name.

Unfortunately, despite the company’s desire to exploit its powerful heritage with this concept, it said no more about the car during its introduction than was listed in the press release and company officials on the Frankfurt show stand declined to elaborate further.

What Honda’s release does say is that the Project 2&4 gets its motive force from a 999-cm³ V4 lifted from the company’s RC213V MotoGP bike. In this application it is tuned for 215 hp (160 kW) at 13,000 rpm, with 118 N·m (87 lb-ft) torque at 10,500 rpm, and power goes to the rear wheels through a six-speed dual-clutch transmission. Redline is 14,000 rpm.

Curb weight is 405 kg (893 lb), and the little concept is just a shade over 3 m (9.8 ft) long and 1.8 m (5.9 ft) wide. The driver’s seat is mounted on the left side of the car’s central spine. The car is finished in traditional Japanese racing white, with a rising sun atop the nose trailed by a red stripe, in homage to the RA272, Honda’s first Formula One race winner.

Though Honda declined to provide many details, Yogi Berra noted that “You can observe a lot just by watching,” and that is the case with the Project 2&4. The frame appears to be made of a combination of aluminum castings and extrusions and it creates a central section with the driver’s seat



The Honda Project 2&4 paint scheme evokes the company’s race-winning RA272 Formula One racer. (Dan Carney)

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outside the frame rails.

This leaves plenty of elbow room for the driver and improves ingress and egress over the contortions normally needed when sliding into or out of an open-wheel formula car with its cockpit contained within the frame.

Unlike the earlier Honda project Side-By-Side, which saw a motorcycle engine mounted alongside the driver's seat, the Project 2&4's engine and transaxle mount longitudinally behind the driver in conventional formula car fashion. A carbon fiber driver's seat is cantilevered on the car's left side, where a formula car's sidepod would normally be, and a beauty cover appears to conceal a lot of nothing on the right side, suggesting we could see the Project 2&4 with a passenger's seat mounted in the future.

The problem with production of such a design is that, even for racing rather than road use, the complete lack of side impact protection is likely to make the Project 2&4 nonviable. An extra large dead pedal with a large lip on the outside is the sole means of containing the driver's left foot in the car.

Simpson racing belts hold the driver in the seat, and a **Tilton Engineering** pedal array operate the throttle and dual master cylinder brake arrangement.

A flat-panel video display ahead of the steering wheel provides a video game-like array of race information, with a large analog tachometer in the center flanked by fuel level, water temperature, oil pressure and temperature, lap counter, lap timer, and a track-position indicator.

In lieu of conventional rearview mirrors, the display shows a video image from the rear-facing camera mounted on the trailing edge of the engine intake airbox and roll hoop.

The car wears **Ohlins** upside-down multi-adjustable aluminum bodied dampers at all four corners and 17-in **Bridgestone** Potenza street tires. The brakes are unbranded, but it sat adjacent to the RC213V-S, the company's new street-legal version of its MotoGP racer, and that had **Brembos** mounted conspicuously to its Ohlins forks.

Production, even for track-only use, may not be in the future for the Project 2&4, but Honda has released its most advanced racebike for sale to the public, so maybe in that spirit the 2&4 will reach enthusiasts' hands one day too.

Dan Carney

Komatsu America adds to intelligent machine lineup



An electronically controlled transmission on the D65PXi-18 locks up the torque converter to transfer engine power directly to the transmission, eliminating horsepower loss and cutting fuel consumption by up to 10%.



Komatsu America's D65PXi-18 intelligent machine control system allows automated operation from heavy dozing to fine grading, achieving up to 8% greater efficiency in moving material, based on start-to-finish grade testing of typical aftermarket machine control systems.

The long track, low ground pressure D65PXi-18 introduced recently by **Komatsu America Corp.** was designed specifically for functionality in soft or wet conditions, offering improved stability for finish grading applications. It is powered by a 217-hp (162-kW) SAA6D114E-6 Tier 4 Final emissions certified engine.

Highlights of the crawler dozer include next-generation intelligent machine control. "The machine senses blade load, minimizes track slip, and ensures operators get the most from every push," said Jason Anetsberger, Komatsu product manager. "We believe the difference in dozing efficiency between conventional machine operation and intelligent machine control technology is exceptional."

The intelligent machine control system on the D65PXi-18 allows automated operation from heavy dozing to fine grading, achieving up to 8% greater efficiency in moving material, based on start-to-finish grade testing of typical aftermarket machine control systems. By designing out blade-mounted sensors and components, operators no longer need to climb on the blade to install/

remove GNSS antennas, eliminating the need to care for electrical connections. Komatsu emphasizes that by getting rid of such cables, and the climbing and connections common with aftermarket systems, operators save 15 minutes at the start and finish of each day. A 30-minutes-a-day savings for 20 days a month is 10 saved hours per month.

An automatic gearshift transmission and lock up torque converter selects the optimal gear range depending on job-site conditions and load for maximum operation efficiency. This electronically controlled transmission locks up the torque converter to transfer engine power directly to the transmission, eliminating power loss and cutting fuel consumption by up to 10%.

D65PXi-18's ROPS (roll-over protection structure) certified, pressurized cab has wide, tall windows and properly sealed for increased visibility and less noise and dust inside the cab. The D65PXi-18 cab damper mounts isolate the cab from the machine frame, softening shocks and vibrations to the operator.

Jean L. Broge

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Q&A



“We’re not usually seeing the exact same part as we had it in InCar in a serial production vehicle; the technologies evolve,” said Timo Faath of ThyssenKrupp.

ThyssenKrupp explores steel innovations

InCar plus is the most extensive internal R&D project that ThyssenKrupp has ever undertaken. It encompasses the group’s interdisciplinary expertise to generate more than 40 individual solutions for cost-effective vehicle weight reduction without sacrificing performance, as well as the use of advanced manufacturing technologies that are validated and can be implemented with current processes. Another component is scalability, with modular lightweight design concepts that can be utilized across multiple platforms and vehicle programs. The project was initiated by developing an independent body-in-white structure to serve as a reference benchmark for the various body solutions. The reference structure is a representative upper midsize class vehicle that was derived through extensive comparative studies of bodies manufactured by various OEMs. With a lightweight index of 2.7, it surpassed its previous InCar reference structure that was developed in 2009, due to improved design and advanced material utilization. Timo Faath, General Manager Technology, ThyssenKrupp Steel North America, Inc., spoke with *SAE Magazines* about the InCar plus project and some of its promising technologies. Read more and view additional technical images at <http://articles.sae.org/14396/>.

One of the project’s innovations is a B-pillar featuring a new TriBond material. Can you talk about this development?

We have several different solutions for the B-pillar. Our reference structure is already a MBW 1500 tailored tempered (tt) solution. We’ve developed some hot-stamped solutions—one is MBW 1900 tt and the other is TriBond 1400, a pretty interesting new material development. And we also have some cold-stamped solutions—DP-K 700Y980T and DP-K 780Y1180T...TriBond is a material development; we don’t have it in serial production yet. It’s like a sandwich material. We take three slabs, to simplify it, stacked on top of each other and run them through the hot rolling mill, the cold rolling mill, annealing, and offer it as aluminized-coated. The only process that is added is that stacking up of the slabs. The slab in the middle is a conventional MBW 1500; the thin outer slabs are lower strength. What that does for us is...no cracks [in drop tower and 3-point bending tests], higher ductility with almost the same

strength level. When you look at the plain mechanical properties, the elongation is still defined by the core slab—it’s still 4.5-5% elongation. What’s really better for that material is the bending angle—for a conventional 1500 it’s about 65°, with the TriBond 1400 it goes up to 85°, and the TriBond 1200 it’s actually where the test ends at 135° bending angle. So this is the real highlight of that material...It is a monolithic material that can be stamped in a conventional hot stamping process—no process modifications necessary. So this is pretty exciting for us.

How does the new material compare cost-wise?

For a cost and weight comparison, our reference structure—the MBW 1500 tt B-pillar—weighs about 15.4 kg, and with our TriBond 1400 solution we were able to get the weight down to 14.1 kg. To be honest with you, it’s kind of difficult for us to do cost calculations on the material because it is not [in production yet]. We do see an increase compared to the conventional material [€38.80] just because we have an additional process step, but this may well go down a little [currently stated as €40.60]. So very attractive weight and slightly higher cost make the solution very attractive... We have a couple solutions [in InCar plus] where the weight reduction comes with reduced cost, just because you save material and material cost is the biggest portion of your part cost; that sometimes works in our favor. But it’s still attractive.

Any other possible applications for the material?

It doesn’t have to be a B-pillar. So we have a couple of different applications for that material. It will work for front rails as well...I showed a drop tower test of a front rail that looked very good. In today’s vehicles, you don’t use hot stamping for front rails because it’s not enough elongation in the part. But with TriBond we would actually have that option to use it in front and rear rails where deformation is required. That might actually be a better application than the B-pillars. But in B-pillars there’s a lot of expensive solutions out there—tailored tempering, tailor welded blanks, tailor rolled blanks—that are very complicated to control from a hot-stamping-process perspective. With the TriBond, you just throw it in your hot stamping press and you’ve got a ductile part.

You have also presented A-pillar and bumper concepts as part of InCar plus. Which of these technologies is closest to serial production?

That’s a tough one. Throughout the InCar project we tried to offer different serial production levels. Some of the solutions our customers can buy today. Some solutions are still under development. The reason why we do it like that is our customers—some of them work on next-generation vehicles, and some of them have a problem today with their serial production vehicle where they need a solution. So we’re trying to reach as many customers as possible. Generally speaking, hot stamping is a big topic for everybody, and we know there’s some OEMs trying to do it themselves [particularly] in Europe. Whenever OEMs invest in hot stamping, I don’t think they want to do it the conventional way—or follow what their suppliers already do for them—they want to come up with more sophisticated solutions. Some of the stuff [in InCar], tailored tempering being one of them, is very promising and I think we’ll see a lot more of that in the future in NAFTA; it’s already out there in Europe. Pretty much everything that we show [related] to hot stamping is very promising.

Ryan Gehm

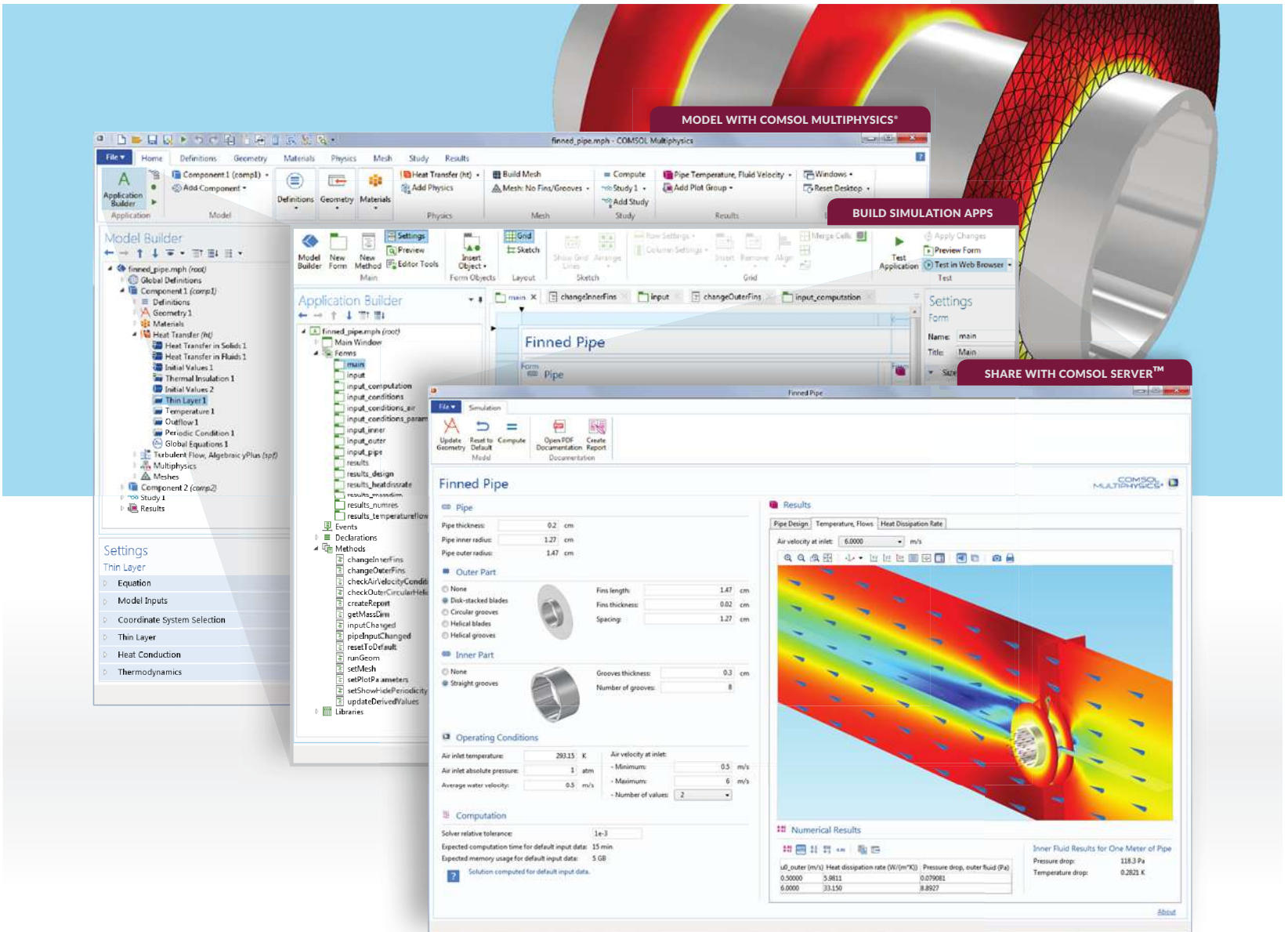
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