Ninth National Frontiers of Engineering Symposium

for Young Indian Engineers

5 - 7 June 2015 @ IIT Jodhpur

Agenda Book

Organized by

Indian National Academy of Engineering

Indian Institute of Technology Jodhpur

Dr. B. N. Suresh *FNAE, FAeSI, FASI, FSSI, MIAA*
President, INAE

In the last few decades, India has made significant advances on the technology front. Specifically, the country has joined the elite group of nations possessing indigenous capability to make satellites for variety of applications, launch vehicles, light combat aircraft, inter-planetary exploratory missions, intercontinental ballistic missiles, and supercomputers, thereby establishing India as a global hub for technological innovations. But, at the same time, the nation faces multiple challenges in the sectors, like healthcare, energy, water, waste management, internal security, and housing.

The National Frontiers of Engineering Symposium was launched by the INAE in 2006 as its flagship event. It brings together young engineers from companies, universities, and R&D Labs to discuss leading-edge research and technical work across a range of engineering fields. It is heartening to note that the *Ninth National Frontiers of Engineering Symposium (9NatFoE)* is being held at Indian Institute of Technology Jodhpur. The objective of the Symposium is to highlight and focus on the technology needs of the country so as to motivate the technological innovators to address the problems in the identified sectors. It is envisaged that the Symposium will give technologists impetus, reason, passion and encouragement to think out-of-the-box and find sustainable and effective solutions to challenges that are of utmost importance to the country.

The Symposium, no doubt presents a platform to the young innovators and engineering icons to come together to jointly address the technology challenges and work in unison to find wholesome solutions. The interactions during the Symposium will provide an opportunity and motivate the young engineer colleagues to work in tandem and analyse all facets of the challenges and arrive at effective solutions through generation of useful new ideas thereby addressing national technological challenges. The ultimate goal is to take these ideas and initiatives to the next level of commitment and execution to implement the technological solutions to national challenges.

I am confident that this event will provide an excellent opportunity to share ideas with bright, young and eminent engineers, and will catalyse the start of many new collaborative activities among the participants. I thank the organisers for their great efforts and wish the deliberations at 9 NatFoE a grand success in the achieving the objectives.

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॥ त्वं ज्ञानमयो विज्ञानमयोऽसि ॥

C. V. R. Murty
Director, IIT Jodhpur

India's need of the hour is manufacturing of products; for this, eye for detail is important. Young engineers need to be encouraged to *dream*, *go hands on* to work on their ideas, and *create products* from younger days to realise the urgent need of the nation; this early start is more likely to internalise this as a habit during their technology careers. Therefore, it is imperative that institutes of national importance, like *Indian Institute of Technology Jodhpur*, and umbrella engineering body of the country, the *Indian National Academy of Engineering*, provide platforms to the young engineering minds to:

(1) Encourage them to take to *technology innovation* as a formal activity;
(2) Facilitate them with potential collaborations with Institutes, Universities, R&D Laboratories and Companies that host *state-of-the-art laboratories* and *science & engineering facilities* to create the desired *technology products*;
(3) Broadcast the availability of the manpower with different specialisations distributed across the country; and
(4) Provide information on where financial support can be sought from, to give impetus to the process of *innovation*.

In line with this expectation, IIT Jodhpur is jointly hosting with INAE the *9th National Frontiers of Engineering Symposium* in Jodhpur during 5-7 June 2015.

We cordially invite you to the *Sun City* the Participants, Speakers, Session Co-Chairs and Symposium Co-Chairs of the 9NatFoE. Both the *themes of the Symposium* and the *weather* are hot!! But, the venue and stay should be comfortable. The schedule is very tight for the agenda proposed to be covered. One work that is crucial, but not listed formally on the *Program* of the *Symposium* is the preparation of the *White Paper* on the *Technology Grand Challenges* of the nation in focus during the Symposium. This document will stand as the base paper for paving the road ahead for the solving these technology grand challenges. We are hoping that you will give your best to prepare the first draft of the White Paper before leaving Jodhpur.

Welcome to IIT Jodhpur!!

C. V. R. Murty
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Arun Kumar Singh
Symposium Co-Chair (Academia)
9NatFoE

The *Indian Institute of Technology Jodhpur* in collaboration with *Indian National Academy of Engineering (INAE)* is proud to bring you the *Ninth National Frontiers of Engineering (9NatFoE) Symposium*. The *9NatFoE Symposium* is an attempt to draw attention towards the technology needs and challenges of India in four themes, namely *Arid Zone Technologies*, *Critical Technologies*, *Healthcare Technologies* and *Automotive Technologies*. The intent of the Symposium is *multi-fold*, including identifying and developing engineering leaders in the country. The format of the symposium encourages informal collective as well as one-on-one discussions among participants to generate useful new ideas that could culminate in technologies of national importance.

More than 40 participants from disparate fields are expected to participate and discuss collaborative work, the transfer of new techniques and approaches across fields, and also establish new contacts among the next generation of leaders in engineering. There will be total 18 talk including 2 Pre-Dinner talks by eminent engineers of India to the young engineers with a view to inspire and motivate them as well as get them to understand the realities of the engineering profession. Also, all participants will contribute towards a *White Paper* on one of the four identified technology themes.

On behalf of the *9NatFoE Organizing Committee*, I am honored and delighted to welcome all the participants to the *Ninth National Frontiers of Engineering Symposium*. I look forward to seeing you in Jodhpur!

Arun Kumar Singh

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Prafulla T. Dahiwade
Symposium Co-Chair (R&D Organisations)
9NatFoE

The *National Frontiers of Engineering (NatFoE) Symposium*, for Young Engineers, is the flagship event of the *Indian National Academy of Engineering (INAE)*. The purpose of this annual symposium is to create a forum where eminent and young engineering professionals from universities, industries and government labs presents and discuss on pioneering technical work, leading-edge research and challenges across a range of engineering fields of national importance. About 40 outstanding engineers under the age of 45 have been invited for this intensive two day symposium, to discuss technological challenges and current cutting edge research in the fields such as *Arid Zone Technologies*, *Critical Technologies* in *Defence and Space*, *Healthcare Technologies* and challenges in *Automotive Technologies*.

The *Symposium* will provide the platform to exchange the views, knowledge and ideas and hope to establish meaningful and fruitful collaborations between academia and industries. It is intended to facilitate cross functional interactions and networking between the participants from various domains of engineering. The idea is to explore the ways and means to overcome the *Technological Challenges* for achieving the national goal of making India self-reliant. Talks will emphasize on challenges and cutting-edge research in the disciplines highlighting the limitations of current state-of-the-art, and presenting ideas that could meet the technological challenges.

A panel discussion on "*How to increase the engagement of IITs in national Technology Mission?*", is expected to bring out new work domain and opportunities for the IITs to work in partnership with industry to take forward the laboratory research to the useful products. Overall, the *Symposium* will give impetus to explore the possibilities of collaboration and alliance between academia and industry to achieve the national goals.

I would like to thank the administration and staff members of *Indian Institute of Technology Jodhpur* who have put tremendous efforts for the organization of the *Symposium*. I look forward to seeing you in Jodhpur!

Prafulla T. Dahiwade

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The Symposium

The *National Frontiers of Engineering Symposium* was launched by the INAE in 2006 as its annual flagship event. It brings together about 40 outstanding engineers (ages ~30-45 years) from companies, universities, and government labs to discuss leading-edge research and technical work across a range of engineering fields. Convening engineers from disparate fields and challenging them to think about developments and problems at the frontiers of areas different from their own will leads to a variety of desirable results. These include collaborative work, the transfer of new techniques and approaches across fields, and establishment of contacts among the next generation of leaders in engineering. The format of the symposia encourages informal collective as well as one-on-one discussions among participants. Speakers are urged to focus their talks on current cutting-edge research in their disciplines to colleagues outside their field and to address questions such as: What are the major research problems and distinctive tools of your field? What are the current limitations in advancing your field? How might insight derived from other fields contribute to overcoming these limitations? Formulating and answering such questions involves surmounting the barriers imposed by the specialized terminologies and techniques that characterize different branches of science.

Past *Symposia* were organized at *IIT Delhi* (4-5 February 2006), *IIT Delhi* (31 March-1 April 2007), *IIT Madras* (24-25 October 2008), *IGCAR Kalpakkam* (16-17 September 2009), *Siksha 'O' Anusandhan University, Bhubaneswar* (3-5 August 2010), *IIT Hyderabad* (2-3 September 2011), *IIT Guwahati* (12-14 October 2012) and *IIT Gandhinagar* (5-6 September 2014). Each year a few disciplines are chosen as focus areas.

Format

The duration of the *Ninth National Frontiers of Engineering (9NatFoE) Symposium* will be 2 and a half days (starting the evening of 5 June 2015 and finishing in the afternoon of day 7 June 2015) conducted through evenings. There are three segments to the Symposium.

(a) Talks

It will consist of four sessions. The *9NatFoE* draws attention on the following four *technology challenges* of India:

1. *Arid Zone Technologies*
   (e.g., *Solar Energy, Water, and Green and Smart Buildings*)
2. *Critical Technologies*
   (e.g., *Defence Technologies, and Space Technologies*)
3. *Healthcare Technologies*
   (e.g., *Devices for Diagnostics and Treatment, and Therapeutics*)
4. *Automotive Technologies*
   (e.g., *Hybrid Transport, and Defense Transport Vehicles*)

Each session will consist of four talks of 30 minutes each followed by 10 minutes of discussion. Therefore, each session will take about 2 hours 40 minutes.

(b) Panel Discussion

It will be on: "*How to increase engagement of IITs in National Technology Missions?*"

The discussion is expected to focus on innovation eco-system problems and solutions, and policy changes required. The panelists will include some of the participants and some senior Fellows of INAE. This will be in the evening of day 2.

(c) Pre-dinner Talks

Two pre-dinner talks will be given by Distinguished Engineers of the country, one each in the evenings of 5 June 2015 and 6 June 2015. The topics will be:

1. *Space for National Development, and*
2. *Industry-Academia Interactions: Research Park at IIT Madras.*

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5 June 2015 (Friday)		
0600	1500	Arrival of Participants
1500	1530	Speed-dating
1530	1600	Inaugural Session
Session 1: ARID ZONE TECHNOLOGIES		
1600	1610	Overview by Session Co-Chairs : Rajasekar Elangovan (IIT Roorkee) *and* Bobin Mondal (Defence Laboratory Jodhpur)
1610	1650	*Solar Energy: Nanoparticle Applications in High Heat Flux Solar Collectors* : Himanshu Tyagi (Assistant Professor, IIT Ropar)
1650	1730	*Solar Photovoltaic (PV) and Concentrated Solar Power (CSP)* : Hem Raj Sharma (Vice President, Reliance Power Limited)
1730	1745	*Tea*
1745	1825	*Energy Disaggregation* : Kalpit V. Desai (Bidgely India Private Limited)
1825	1905	*Latent Heat Storage Device and Solar Energy Dispatchability* : Prodyut R. Chakraborty (Assistant Professor, IIT Jodhpur)
1905	1915	Concluding Remarks of Session Co-Chairs
Pre-Dinner Talk		
2000	2045	*Space for National Development* : B. N. Suresh (President, INAE, New Delhi)
Dinner		

6 June 2015 (Saturday)		
Session 2: CRITICAL TECHNOLOGIES		
0800	0810	Overview by Session Co-Chairs : Akshay Prakash (IIT Jodhpur) *and* : Trilok Kumar Saini (Defence Electronics Application Laboratory, Dehradun)
0810	0850	*Addressing Electronics Design Challenges of Aerospace System with Electronic Design Automation* : Anil Kumar Pandey (Expert Level R&D Engineer, Keysight Technologies)
0850	0930	*Multiband and Multifunctional RF Integrated Circuits and Systems* : Nagendra P. Pathak (Associate Professor, IIT Roorkee)
0930	0945	*Tea*
0945	1025	*MEMS based Sensors for Chemical & Biochemical Sensing Applications* : Nitin S. Kale (Chief Technology Officer, Nanosniff Technologies Private Limited)
1025	1105	*Development of an Ablative Thermal Response Model for Thermal Protection System Design of a High Speed Vehicle* : Rakesh Kumar (Assistant Professor, IIT Kanpur)
1105	1115	Concluding Remarks of Session Co-Chairs
1115	1130	*Tea*

Session 3: HEALTHCARE TECHNOLOGIES		
1130	1140	Overview by Session Chair : Nitin S. Kale (Nanosniff Technologies Private Limited, Mumbai)
1140	1220	*XrayTo3D-Tabplan3D:* *Software for Three Dimensional Surgery Planning using Conventional X-ray Images* : Vikas Karade (PhD Student, IIT Bombay)
1220	1300	*Lab on Chip Strategy for sensitive detection of Micro-organisms in Juice and Water Samples* : Shantanu Bhattacharya (Associate Professor, IIT Kanpur)
1300	1400	*Lunch*
1400	1440	*Medical Device Innovation: Biomedical Engineering and Technology Incubation Centre* : Rupesh Ghyar (Senior Research Scientist, BETiC, IIT Bombay)
1440	1520	*Rational Optimization of Therapies for Chronic Viral Infections* : Narendra M. Dixit (Associate Professor, IISc, Bangalore)
1520	1530	Concluding Remarks of Session Chair
1530	1600	*Tea*

Session 4: AUTOMOTIVE TECHNOLOGIES		
1600	1610	Overview by Session Chairs : Himanshu Tyagi (IIT Ropar) *and* Philip Jose (Tata Motors, Pune)
1610	1650	*Latest Testing Methodologies In Defence Vehicle Testing* : A. Kannan (Scientist C, Vehicle Research & Development Establishment, Ahmednagar)
1650	1730	*Status and Way Forward for Hybrid Technologies in Indian Automotive Sector* : Avinash Kumar Agarwal (Professor, IIT Kanpur)
1730	1810	*Technologies to Improve the Driving Factors of the Automotive Industry* : P. Sivakumar (AGM, Engineering Research Centre, Tata Motors)
1810	1850	*Advancements in Modelling of Sheet Metal Forming Process for Effective Design of Automotive Panels* : K. Hariharan (Assistant Professor, IIT Delhi)
1850	1900	Concluding Remarks of Session Co-Chairs

Pre-Dinner Talk		
2000	2045	*Research Park at IIT Madras* : M. S. Ananth (Distinguished Visiting Professor, IIT Bombay)

Dinner

7 June 2015 (Sunday)		
0830	1000	**Panel Discussion:** *How to improve engagement of IITs in National Technology Missions?* Moderators: *Symposium Co-Chairs*
1000	1030	Valedictory Function
1030	1100	*Tea*

Departure

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The Participants

Symposium Co-Chairs
Prafulla T. Dahiwade, Vehicle Research and Development Establishment, DRDO, Ahmednagar
Arun Kumar Singh, Indian Institute of Technology Jodhpur

Session Co-Chairs
Rajasekar Elangovan, Indian Institute of Technology Roorkee
Philip Jose, Tata Motors, Pune
Nitin S. Kale, Nanosniff Technologies Private Limited, Mumbai
Bobin Mondal, Defence Laboratory Jodhpur
Akshay Prakash, Indian Institute of Technology Jodhpur
Trilok Kumar Saini, Defence Electronics Application Laboratory, DRDO, Dehradun
Himanshu Tyagi, Indian Institute of Technology Ropar

Speakers
Avinash Kumar Agarwal, Indian Institute of Technology Kanpur
Shantanu Bhattacharya, Indian Institute of Technology Kanpur
Prodyut R. Chakraborty, Indian Institute of Technology Jodhpur
Kalpit V. Desai, Bidgley India Private Limited, Bangalore
Narendra M. Dixit, Indian Institute of Science, Bangalore
Rupesh Ghyar, Indian Institute of Technology Bombay
K. Hariharan, Indian Institute of Technology Delhi
Nitin S. Kale, Nanosniff Technologies Private Limited, Mumbai
A. Kannan, Vehicle Research and Development Establishment, DRDO, Ahmednagar
Vikas Karade, Indian Institute of Technology Bombay
Rakesh Kumar, Indian Institute of Technology Kanpur
Anil Kumar Pandey, Keysight Technologies, Gurgaon
Nagendra P. Pathak, Indian Institute of Technology Roorkee
Hem Raj Sharma, Reliance Power Limited, Pokhran
P. Siva Kumar, Tata Motors, Pune
Himanshu Tyagi, Indian Institute of Technology Ropar

Participants
Venkataramana Badarala, Indian Institute of Technology Jodhpur
Ashish Bora, Tata Motors, Pantnagar
Kaushal A. Desai, Indian Institute of Technology Jodhpur
Purunendu Ghosh, Birla Institute of Science & Research, Jaipur
D. K. Gupta, Defence Laboratory, Jodhpur
M. L. Meena, Defence Laboratory, Jodhpur
Brigadier Rajan Minocha (Retd.), Indian National Academy of Engineering, New Delhi
Vimal Mishra, Indian Institute of Technology Gandhinagar
Sanjay Mittal, Indian Institute of Technology Kanpur
Naran M. Pindoria, Indian Institute of Technology Gandhinagar
N. S. Prasad, Combat Vehicle Research and Development Establishment, Avadi
Rajaseeli Reginald, Combat Vehicle Research and Development Establishment, Avadi
Manvendra Sharma, Defence Laboratory, Jodhpur
Anish Upadhyaya, Indian Institute of Technology Kanpur
C. Venkatesan, Indian Institute of Technology Kanpur
G. Venkatesan, Combat Vehicle Research and Development Establishment, Avadi

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The Pre-Dinner Speakers

5 June 2015, 20:00-20:45

Space for National Development

B. N. Suresh, President, INAE

India's space program was started by *Dr. Vikram Sarabhai* with a vision to harness space technology for national development, while pursuing space science research and planetary exploration. Since its inception India's space program has focused on design and development of launch vehicles and related technologies for providing access to space, design and development of satellites and related technologies for earth observation, communication, navigation, meteorology and space science, and development of space based Applications for Societal development and Disaster Management Support. In recent years ISRO has also made significant efforts in research and development in space science and planetary exploration through its *Chandrayaan* and *Mars Orbiter missions*.

The *Indian National Satellite (INSAT)* system is one of the largest domestic communication satellite systems in Asia-Pacific region with nine operational communication satellites placed in Geo-stationary orbit. Currently operational communication satellites are *INSAT-3A, INSAT-3C, INSAT-3E, INSAT-4A, INSAT-4B, INSAT-4CR, GSAT-8, GSAT-10* and *GSAT-12*. The system with a total of 195 transponders in the C, Extended C and Ku-bands provides services to telecommunications, television broadcasting, satellite news gathering, societal applications, weather forecasting, disaster warning and Search and Rescue operations.

India has very diverse geo-climatic conditions with 7,516 km long coastline. To provide data and information required for efficient management of the country's natural resources, developmental planning and disaster management, ISRO has one of the largest constellations of remote sensing satellites in operation. Currently, eleven operational satellites are in orbit – *RESOURCESAT-1* and *2*, *CARTOSAT-1, 2, 2A, 2B, RISAT-1* and *2, OCEANSAT-2, Megha-Tropiques* and *SARAL*. The data from these satellites are used for several applications covering agriculture, water resources, urban planning, rural development, mineral prospecting, environment, forestry, ocean resources and disaster management.

Satellite Navigation service is an emerging satellite based system with commercial and strategic applications. To meet the Civil Aviation requirements, ISRO is working jointly with *Airport Authority of India (AAI)* in establishing the *GPS Aided Geo Augmented Navigation (GAGAN)* system. To meet the user requirements of the positioning, navigation and timing services based on the indigenous system, ISRO is establishing a regional satellite navigation system called *Indian Regional Navigation Satellite System (IRNSS).*

India has two operational launchers: *Polar Satellite Launch Vehicle (PSLV)* and *Geosynchronous Satellite Launch Vehicle (GSLV)*. A third launcher of higher payload capacity, *GSLV Mk - III*, is being developed. *GSLV Mk - III* is intended to launch satellites up to 4000 Kg into geostationary orbit and as a launcher for an Indian crew vehicle.

Speaker Brief Biography

Dr. B. N. Suresh obtained bachelors degree in *Science and Engineering* from *Mysore University,* and completed his masters studies from IIT Madras. He obtained a Doctorate with Commonwealth Scholarship in Control Systems from Salford University, UK. He joined *Vikram Sarabhai Space Centre (VSSC)*, Department of Space, Trivandrum, in 1969, and discharged several responsibilities as *Head (Control & Guidance Division)*, *Group Director (Guidance and Simulation Group)*, *Deputy Director (Avionics)*, etc., before taking over as *Director* of *VSSC* in 2003. He served in that capacity for 4½ years till end November 2007. As *Distinguished Scientist* and *Director* of *VSSC*, he provided the dynamic leadership for the development of launch vehicles and contributed significantly for the successful launches of ASLV, PSLV and GSLV. He played a crucial role in steering the

very complex *Space Capsule Recovery Experiment (SRE),* which involved several new and critical technologies. The module was flight tested successfully with perfect re-entry and recovery operations. Dr. Suresh took over as Founder Director for the *Indian Institute of Space Science and Technology (IIST)* at Trivandrum in 2007, and served for 3½ years till November 2010. Presently, Dr Suresh is *Vikram Sarabhai Distinguished Professor* at *ISRO HQ*. In that capacity, he is actively involved in *Mission Readiness Reviews (MRR)* for all launch vehicles of ISRO as *Chairman, MRR*. Also, he was *Distinguished Professor* at *IIT Bombay* and *MIT Manipal* for 4 years.

Dr. Suresh is a *Member* of *Board of Governors, IIT Madras*. He is a *Fellow* of several professional bodies, like *Indian National Academy of Engineering (INAE), Astronautical Society of India (ASI), Aeronautical Society of India (AeSI)* and *International Academy of Astronautics (IAA)* at Paris. Also, he is a *Fellow* and *Past President* of *System Society of India (SSI)*. He was Head of *Indian Delegation* for the *United Nations Committee* on *Peaceful Uses of Outer Space (UN-COPUOS)* at Vienna, Austria, during 2004-07. He was selected as *Chairman* of the prestigious *United Nations Scientific and Technical Committee* for the year 2006 by the Asia Pacific countries. This has been a unique distinction for India, as for the first time, a technical expert from a developing country was selected for this coveted post, since its inception 42 years ago. He was Co-Chair for the *International Programme Committee* and *Chairman* of the *Nation Planning Committee* for the *International Astronautical Congress* held at Hyderabad in 2007 with more than 2,500 delegates out of which 1,100 were foreign delegates.

Dr. Suresh has published more than 45 technical papers in prominent international and national journals, conferences and symposia. He has guided more than 450 technical reports on various technology developments at VSSC during his tenure of 38 years. He has co-authored a book *Integrated Design of Space Transportation System*. He has delivered several prestigious guest lectures like, *Ramanujam Memorial*, *Vikram Sarabhai Memorial*, and *Dr. Srinivasan Memorial* lectures.

Dr. Suresh has been conferred with several awards & honours, and prominent among them are *Dr. Biren Roy Space Science Design Award* from Aeronautical Society of India, *Agni Award* from DRDO for achieving self-reliance, *ASI Award* for contribution to space technologies from Astronautical Society of India, *Distinguished Alumni Award* from IIT Madras, *Ramanujam Award* by PSG Institute of Technology for System Engineering, *Technical Excellence Award* by Lions International, *Outstanding Achievement Award* from Department of Space, Government of India, *Lifetime Contribution Award in Engineering* by Indian National Academy of Engineering (INAE) for his significant contributions to space technologies, *National Systems Gold Medal* for lifetime contributions to large systems from System Society of India, *Aryabhata Award* the highest award by Astronautical Society for his invaluable contributions to aerospace developments, and *Big Kannadiga Award* by FM 93.7 Radio for Science in 2014. In recognition of his meritorious contributions to Science and Technology, the Government of India conferred on him *Padma Shri* Award during the year 2002 and *Padma Bhushan* during the year 2013. Also, Dr. Suresh received *Karnataka State Rajyotsava Award* for 2014 for S&T.

6 June 2015, 20:00-20:45

Research Park at IIT Madras

M. S. Ananth, Distinguished Visiting Professor, IIT Bombay

The university seeks unity in the great diversity around us whereas the industry thrives on differences to attain financial gains. The values in university and industry are not co-extensive; however, industry can play an important but limited role in education at the university. They can share empirical knowledge, and can serve as 'reality check' in teaching, can address professional student associations and also participate in joint-research projects. In return industry can get benefited significantly through their interactions with the university. The benefits are access to accumulated expertise (professors) in diverse disciplines at one location, access to young minds (viz. students) - a source of innovative ideas and access to well-equipped laboratories. For today's global economies the key drivers are innovation and entrepreneurship, these disciplines thrive in the vicinity of universities. For a university with an innovative and entrepreneurial culture, industry interaction is essential, as it leads to higher publication rates, more successful patenting, attracting larger grants, inputs for curricula/ 'reality check' on teaching , improved placement of graduates and access to specialized facilities in the industry. To achieve all these benefits there is a need to have research parks creating a conducive atmosphere where innovations thrive because of semi-formal interactions of faculty, students and experienced industry personnel.

The first such research park in India has come up at IIT Madras. IIT Madras *Research Park* is an independent company promoted by IIT Madras and its alumni and was incorporated under Section 25 of the Companies Act 1956. The IIT Madras Research Park facilitates the promotion of research and development by the institute in partnership with industry, assisting in the growth of new ventures, and promoting economic development. The IIT Madras Research Park assists companies with a research focus to set up a base in the park and leverage the expertise available at IIT Madras.

Speaker Brief Biography

Dr. M. S. Ananth graduated in *Chemical Engineering* from the *A. C. College of Technology* with a Gold Medal. He obtained the Ph.D. degree in Chemical Engineering in the area of *Molecular Thermodynamics* from the University of Florida, USA, in 1972. His research interests are in *Molecular Thermodynamics* and *Mathematical Modelling*.

He joined IIT Madras as a Faculty Member in the Department of Chemical Engineering in 1972. He has held various senior positions at the Institute, such as *Head of the Department*, *Dean (Academic Courses)* and *Dean (Academic Research)*. In December 2001, he assumed the charge of *Director* of IIT Madras, which post he held till 31 July 2011. Then, he served as a *Visiting Faculty* at the Department of Chemical Engineering at *Indian Institute of Science, Bangalore*, for a period of two years. Currently, he is a *Distinguished Visiting Professor* in the Department of Chemical Engineering at IIT Bombay. Also, he is Chairman, Board of Governors, of *Indian Institute of Information Technology Design and Manufacturing*, Kancheepuram.

Dr. Ananth was a Visiting Professor in *Princeton University* during 1982-83, and in *University of Colorado* during 1990-91. He was a *Visiting Scientist* in the *National Institute of Standards and Technology, Boulder, Colorado* during 1990-91, in *RWTH, Aachen, Germany,* during Summer 1983 and Summer 1999, and a *Visiting Thermodynamics Expert* in Aspen Tech, Massachusetts, USA, during Summer 1991.

He has several publications in international journals and is a referee for many journals in Chemical Engineering. He has been awarded the *Herdillia Prize* for excellence in basic research in Chemical Engineering by the Indian Institute of Chemical Engineers, and the *R. W. Fahien Alumni Award* for *Distinguished Professional Contributions* for the year 2003 by the Chemical Engineering Department of University of Florida, USA. He is a *Fellow* of *Indian Institute of Chemical Engineers* and the *Indian National Academy of Engineering*.

Session 1: ARID ZONE TECHNOLOGIES

Arid Zones offer three technology challenges, namely (a) utilizing the abundant solar energy, (b) addressing shortage of water, and irrigation (c) making habitat comfortable. Firstly, energy security of India requires judicious use of available conventional energy resources and efficient generation of energy from renewable energy resources. The Ministry of New and Renewable Energies, Government of India, has taken up the same as its technology development mission, with a special track on Solar Thermal Energies. Secondly, the Ministry of Water Resources, Government of India has been steadfast in addressing the severe shortage of water, especially in arid areas. The questions unanswered include availability, quality and distribution of water for regular needs. And thirdly, making habitat safe and comfortable remains a special challenge in arid areas. The availability of special materials and increased use of sensor technologies can help improve the living conditions, especially, in areas where maximum daytime temperature is above 50˚C for months.

Session 1: ARID ZONE TECHNOLOGIES		
1600	1610	Overview by Session Co-Chairs : Rajasekar Elangovan (IIT Roorkee) *and* Bobin Mondal (Defence Laboratory Jodhpur)
1610	1650	*Solar Energy: Nanoparticle Applications in High Heat Flux Solar Collectors* : Himanshu Tyagi (Assistant Professor, IIT Ropar)
1650	1730	*Solar Photovoltaic (PV) and Concentrated Solar Power (CSP)* *:* Hem Raj Sharma (Vice President, Reliance Power Limited)
1730	1745	*Tea*
1745	1825	*Energy Disaggregation* : Kalpit V. Desai (Bidgely India Private Limited)
1825	1905	*Latent Heat Storage Device and Solar Energy Dispatchability* : Prodyut R. Chakraborty (Assistant Professor, IIT Jodhpur)
1905	1915	Concluding Remarks of Session Co-Chairs

Nanoparticle Applications in High Heat Flux Solar Collectors
: Himanshu Tyagi, Assistant Professor, IIT Ropar

Majority of the present solar thermal systems are constructed using surface absorption-based absorbers, wherein solar energy is first absorbed by a selectively coated solid surface and then transferred to a working fluid through conduction and convection heat transfer. As a result, conversion of solar energy into thermal energy of the working fluid is not a very efficient process in surface absorption-based solar thermal systems. This problem becomes more pronounced in the case of concentrating solar collectors as the flux that must be transferred across this barrier increases. This problem can be reduced by allowing the incident solar radiation to interact directly with the working fluid without heating any other structures within the receiver. For such applications nanoparticle-laden fluids can be used in solar collectors which can directly absorb the sunlight. Moreover, the fact that the optical properties of metallic and semiconductor nanoparticles are dependent on their shape, size, and the surrounding dielectric media makes them easily usable for engineering highly solar selective nanoparticle dispersions at very low volume fractions. Based on the optical characterization and heat transfer analysis of nanofluid-based volumetric absorption solar thermal systems it is seen that these systems promise enormous potential in harnessing solar energy.

Solar photovoltaic (PV) and concentrated solar power (CSP)
: Hem Raj Sharma, Vice President, Reliance Power Limited, Pokhran

India's potential for generating renewable energy is huge,especially solar power. With growing realization in the government of how important it is to harness all available energy sources, the potential that always existed is now transfroming into reality. The key drivers are increased Government focus, recent regulatory initiatives promoting development of renewable energy sources such as Mandatory Renewable Purchase Obligations, revised tariff guidelines, generation based incentives and introduction of Renewable Energy Certificates (RECs). Reliance Power is investing in natural and renewable energy sources to help take the burden off our current dependancy on fossil fuels. Power generation from renewable energy sources will help mitigate green house gases and climate change issues. In the solar energy, Reliance Power is present both in the Photo-Voltaic (PV) and Concentrated Solar Power (CSP) segments. The company has successfully commissioned a 40 MW solar PV project in Pokharan, Jaisalmer, Rajasthan in March 2012. It also commissioned the world's largest compact linear Fresnel reflector (CLFR) based CSP project 100 MW in November 2014. It is expected that, of Reliance Power's total energy portfolio as much as ten percent will come from renewable energy capacities.

Energy Disaggregation
: Kalpit V. Desai, Lead Data Scientist, Bidgely India Private Limited, Mumbai

This talk will focus on "energy disaggregation", i.e. the task of energy consumption itemization, attributing consumption to different appliances without using plug level sensors. The knowledge of an accurate breakdown of energy consumed enables actionable insights, which can benefit both the power distribution companies ("discoms") and its customers. The disaggregation technology is now at the verge of being sufficiently mature to have a great impact on the energy landscape across varied geographies and demographics. The talk will include a peek into the information content in energy consumption data gathered at various intervals, examples of specific patterns that can be leveraged for disaggregation and provide insights into the diverse factors that affect the accuracy. I'll also cover various technological challenges for disaggregation, along with potential solutions. I'll also touch upon a few interesting applications that the disaggregation technology enables.

Latent heat storage device and solar energy dispatchability
: Prodyut R. Chakraborty, Assistant Professor, IIT Jodhpur

Heat storage systems utilizing latent heat of fusion for phase change materials (PCM) is an extremely potent method of storing thermal energy, since the storage of fusion enthalpy provides considerably high energy storage density involving nearly isothermal process. A wide variety of PCMs having wide range of melting temperature and heat of fusion are in existence to cater different operation requirements. Phase change materials such as paraffin and hydrated salts have been extensively studied and used for low and medium temperature range (below 120^{o}C) applications like - electronic cooling, building heating. Phase change materials with melting point ranging from 70-120^{o}C can also be considered as an effective heat storage material for continuous operation of food processing and water desalination process. On the other hand, PCM with melting temperature range 120-300^{o}C can be used as thermal storage for continuous operation of sorption refrigeration systems. The usage of latent heat based thermal energy storage using PCM for high temperature applications (above 300^{o}C) such as at high pressure steam generation or high pressure gas heating required to run steam or gas turbines, and process heating, is still at a conceptual level. Medium and high temperature solar thermal applications received considerable recognition as an attractive renewable energy resource during the past few decades. The major issue of all these applications being the intermittent nature of solar resource, continuous operation of such applications with reliable variation in power supply demands highly of an effective thermal storage device having high efficiency and low cost, and capable of operating at suitable temperature ranges required by specific applications. Although, thermal-energy storage device is considered to be one of the key components for successful implementation of most of the solar thermal based applications, it is yet to be considered as well developed. The development of such storage device involves addressing issues like transient nature of storage dynamics and associated design complicacies of heat exchanger, thermo-physical property degradation after moderate freeze and melt cycles, container and storage material compatibility (chemical as well as metallurgical), and chemical hazards. The aim of the presentation is to discuss the feasibility of using latent heat based storage devices for various solar thermal applications and associated challenges.

Session 2: CRITICAL TECHNOLOGIES

India's current requirements on defence are catered largely by imports, with about 60% of its defence requirements met through imports. The defence procurement has been a bone of discussion and debate. To promote indigenous development of needed defence technologies the Government of India through Defence Production Policy, 2011 and the MAKE procedure has given preference to 'Buy (Indian)' and 'Buy and Make (Indian)' over 'Buy (Global)'. The aim is to promote R&D in the industry with support from the government and the placement of orders (if R&D effort is successful) to make indigenous development more attractive and unambiguous. It is high time that strategies are understood and implemented by the stakeholders to make India self-reliant.

Session 2: CRITICAL TECHNOLOGIES		
0800	0810	Overview by Session Co-Chairs : Akshay Prakash (IIT Jodhpur) *and* : Trilok Kumar Saini (Defence Electronics Application Laboratory, Dehradun)
0810	0850	*Addressing Electronics Design Challenges of Aerospace System with Electronic Design Automation* : Anil Kumar Pandey (Expert Level R&D Engineer, Keysight Technologies)
0850	0930	*Multiband and Multifunctional RF Integrated Circuits and Systems* : Nagendra P. Pathak (Associate Professor, IIT Roorkee)
0930	0945	*Tea*
0945	1025	*MEMS based Sensors for Chemical & Biochemical Sensing Applications* : Nitin S. Kale (Chief Technology Officer, Nanosniff Technologies Private Limited)
1025	1105	*Development of an Ablative Thermal Response Model for Thermal Protection System Design of a High Speed Vehicle* : Rakesh Kumar (Assistant Professor, IIT Kanpur)
1105	1115	Concluding Remarks of Session Co-Chairs
1115	1130	*Tea*

Addressing Electronics Design Challenges of Aerospace System with Electronic Design Automation
: Anil Kumar Pandey, Expert Level R&D Engineer, Keysight Technologies

Over the past two decades, the Aerospace industry has been going through a gradual transformation driven by new technologies. The Aerospace and Defense Industry is at the forefront of development using cutting edge technology to ensure relevancy and ability to secure countries safety and survival. An ideal electronic design for the Aerospace should be reliable, flexible, and most of all is able to withstand extreme conditions such as stringent shock, vibration and wide operating temperature ranges; finally the system must be future-proof. Many factors must be taken in consideration when developing a system for this sector; these include the characteristics of the device with different technologies, environmental effect, fast design life cycle and overall cost of system.

EDA stands for Electronic Design Automation. As electronics become even more complex and pervasive, the EDA is more vital to the continued success of these complex designs. Electronics engineers engaged in the design of integrated circuits, systems on chip (SoCs), application specific circuits and other system's components. Electronic Design Automation (EDA) provides the critical technology to design electronics and other systems of aerospace that enable the fast and reliable design solution. Based on new aerospace design challenges, EDA has completely transformed the way that electronic engineers design, simulate and manufacture circuits. EDA tools are necessary to save time, reduce cost, and shorten design cycles, because they automate numerous tasks and provide feedback that enables designers to identify and correct design challenges before entering the costly prototype and manufacturing phase.

In this paper a typical remote sensing satellite system realization using latest technology of Electronic Design Automation is presented. This system contains multi-technology based T/R module, a complex large phased array antenna, multimode tracking system, high speed DSP board and high speed interconnects in backplanes to transfer data. Some latest EDA technology like interoperable process design kits (PDKs), multi-technology based System-on-Chip Design, hybrid electromagnetic simulation technique, powerful GPU computing, Power integrity and Signal integrity analysis are covered through these designs.

Multiband and Multifunctional RF Integrated Circuits and Systems
: Nagendra P. Pathak , Associate Professor, Indian Institute of Technology Roorkee

Radio Frequency (RF) represents electromagnetic spectrum from 9 kHz to 300 GHz. More than a decade back, RF systems had limited applications especially confined to defense and space research. There were major limitations due to high costs and lack of compactness which hindered its wide applications in different regimes. Since 2000 onwards, proactive research worldwide has addressed theses bottlenecks and its vast applications are being explored with very low cost, compact, efficient and viable RF systems in commercial, defense as well as space research. It is now considered a well proven solution to a wide range of research problems varying from telecommunications, medical, agriculture, civil engineering, food processing, disaster management issues and many more.
In the technical talk, brief description of RF system architecture, essential fundamental concepts and major design issues related to the development of future multiband and multifunctional RF integrated circuits and systems operating above 1 GHz would be considered. Some of our own circuits/ system designs along with other notable contributions available with the literature for upcoming applications would be discussed in detail.

MEMS based Sensors for Chemical & Biochemical Sensing Applications
: Nitin S. Kale, Chief Technology Officer, Nanosniff Technologies Private Limited

Since the late 1980s there have been spectacular developments in microelectro-mechanical (MEMS) systems, which have enabled the exploration of transduction modes that involve mechanical energy; and are based primarily on mechanical phenomena. While MEMS represents a diverse family of designs, devices with simple microcantilever architecture, or a microheater architecture, are especially attractive as transducers for chemical and biological sensors. As a result an innovative family of chemical and biological sensors has emerged that employ these MEMS devices. The first part of the talk deals with several important aspects of these devices, namely: (i) operation principles; (ii) fabrication; and (iii) applications. In the second part of the talk we discuss about our work in two critical areas: (i) Security & Surveillance; & (ii) Healthcare; where we have developed applications based on MEMS devices. The first application is an electronic nose, where we show how Piezoresistive Micro cantilevers & Micro heaters can be used to detect explosives, for e.g. RDX, TNT, PETN etc. The second application is a bioMEMS device, which detects cardiac markers that are released in the blood, after a person has a heart attack. It is visualized to be a Point-of-Care instrument; that can help physicians, in diagnosing a heart-attack event. Finally, we discuss about the instruments (Omnicant & Sensimer) that we have developed, to help students & researchers to experiment with micro cantilevers & micro heaters, and thereby understand their working.

Development of an Ablative Thermal Response Model for Thermal Protection System Design of a High Speed Vehicle
: Rakesh Kumar, Assistant Professor, Indian Institute of Technology Kanpur

A hypersonic vehicle goes through a severe aerothermodynamic environment during its ascent or descent flight, when a large fraction of its kinetic energy is converted to heat. The heat flux can vary from few hundreds to thousands of kW/m2 at peak heating conditions. At hypersonic velocities, the vehicle is surrounded by a flow of high temperature gas, which can be in a chemical and thermal non-equilibrium state. Such high heat fluxes require a reliable and robust thermal protection system (TPS) to preserve a payload and system from overheating. To this end, ablative materials are most widely used as thermal insulators for rocket engine nozzles and hypersonic vehicles. Use of such ablative heat shields have made possible the viability of reentry vehicles in the last few decades. Experimental studies under reentry conditions are rare and expensive. In this light, the development of an accurate thermal response code is important for the optimum design of TPS and for the safe and efficient operations of high speed vehicles. In this work, a generic one-dimensional thermal protection system material response model is developed and applied to study the thermal response of an ablative material like AVCOAT (used in Apollo missions) for a typical high speed vehicle. The complex processes of thermal and chemical ablation are modelled. The Direct Simulation Monte Carlo (DSMC) flow simulations were performed to estimate the heat flux onto the ablative TPS. To demonstrate the model, the temperature distribution and pyrolysis gases generation rate was computed at different times along a typical reentry trajectory, and compared with available data in the literature. A deeper insight into the flow physics close to the surface (due to interaction of pyrolysis gases with boundary layer flow) is brought into light. A very interesting case study is also carried out, wherein the effect of ablation on growth of a surface crack, is demonstrated.

Session 3: HEALTHCARE TECHNOLOGIES

Healthcare Technologies are listed amongst India's technology challenges. And, 2015 is an opportune time for undertaking a major effort towards Sensor Development and Embedded Systems Work to Synthesis medical science with engineering principles and to create devices that provide reliable and efficient methods of diagnosing and treating ailments.

Session 3: HEALTHCARE TECHNOLOGIES		
1130	1140	Overview by Session Chair : Nitin S. Kale (Nanosniff Technologies Private Limited, Mumbai)
1140	1220	*XrayTo3D-Tabplan3D:* *Software for Three Dimensional Surgery Planning using Conventional X-ray Images* : Vikas Karade (PhD Student, IIT Bombay)
1220	1300	*Lab on Chip Strategy for sensitive detection of Micro-organisms in Juice and Water Samples* : Shantanu Bhattacharya (Associate Professor, IIT Kanpur)
1300	1400	*Lunch*
1400	1440	*Medical Device Innovation: Biomedical Engineering and Technology Incubation Centre* : Rupesh Ghyar (Senior Research Scientist, BETiC, IIT Bombay)
1440	1520	*Rational Optimization of Therapies for Chronic Viral Infections* : Narendra M. Dixit (Associate Professor, IISc, Bangalore)
1520	1530	Concluding Remarks of Session Chair
1530	1600	*Tea*

XrayTo3D-Tabplan3D: Software for Three Dimensional Surgery Planning using Conventional X-ray Images
: Vikas Karade, PhD Scholar, Indian Institute of Technology Bombay

Conventional methods of 3D bone model reconstruction from CT scans deals with high radiation dose, cost and time. A 3D model generated from 2D X-ray images can be a useful alternative. Hence, a novel algorithm for 3D reconstruction from 2D X-ray images named as XrayTo3D was developed and tested. The algorithm involves reconfiguration of a template 3D bone shape to match it with the input X-ray images. The reconfiguration and matching is performed using self-organizing maps and Laplacian mesh deformation. The proposed reconstruction method was tested and benchmarked with the existing methods and showed better performance in acceptable range. The method was applied to 22 sets of simulated x-ray images of the distal femur shape. The method was also tested in practical conditions with real X-ray images as inputs. An acceptable range of reconstruction error of 1 mm and 1.2 mm with double and single X-ray images respectively, were obtained based on comparison with the corresponding reference models/ground truth. Computation time for the 3D bone modelling algorithm was less than a minute for each case.

Based on the XrayTo3D technology, a tablet/mobile device based 3D surgery planning software named as Tabplan3D was developed for knee surgeries. The software is being tested in a case study which included planning and simulation of tibial osteotomy surgery. The performance of the proposed 3D reconstruction method in practical situations, the software prototype and the case study demonstration proves that XrayTo3D and Tabplan3D can be used to solve real life surgical planning problems. XrayTo3D also has a lot of scope in scaling, performance improvement and many other futuristic applications.

Lab on chip strategy for sensitive detection of micro-organisms in juice and water samples
: Shantanu Bhattacharya, Associate Professor, Indian Institute of Technology Kanpur

The extremely low limit of detection (LOD) posed by global food and water safety standards necessitates the need to perform a rapid process of integrated detection with high specificity, sensitivity and repeatability. The work reported in this article shows a microchip platform which carries out an ensemble of protocols which are otherwise carried in a molecular biology laboratory to achieve the global safety standards. The various steps in the microchip include pre-concentration of specific microorganisms from samples and a highly specific real time molecular identification utilizing a q-PCR process. The microchip process utilizes high sensitivity antibody based recognition and an electric field mediated capture enabling an overall low LOD. The whole process of counting, sorting and molecular identification is performed in less than 4 hours for highly dilute samples.

Medical Device Innovation: Biomedical Engineering and Technology Incubation Centre
: Rupesh Ghyar, Senior Research Scientist, Biomedical Engineering and Technology

Biomedical Engineering and Technology (incubation) Centre, BETiC for short, is a multi-disciplinary multi-institution translational R&D project to facilitate rapid conversion of innovative ideas from expert surgeons into high-quality low-cost healthcare devices suitable for indigenous manufacture and use. Major objectives are to: (a) establish an integrated facility for medical device development, (b) develop selected medical devices representing different medical specialties and classes of risk, (c) rapid prototype, pilot manufacture and test the devices, (d) facilitate clinical trials, IPR and technology transfer to industry partners, and (e) identify, train and support biomedical innovators. During the project tenure of five years (2014-2019), a dozen different medical devices will be defined, developed and deployed in close collaboration with expert surgeons and entrepreneurs. The core team comprises three principal investigators and 11full-time researchers, supported by a number of co-opted faculty members as well as Ph.D, M.Tech and B.Tech students, taking the total size of team to over 60. They are using existing facilities (OrthoCAD Lab in IITB, RP Lab in COEP, and CAD/CAM Lab in VNIT) to house the researchers and new equipment, even as additional space and infrastructure is being created to expand the activities in line with the approved project proposal. At present, 15 medical devices or technologies are in development, guided by clinicians. IITB team is working on two diagnostic devices (Diabetic Foot Stiffness Measurement; and Variable Length Biopsy Gun), three surgical instruments (Automatic Suturing; Multi DOF Laparoscope End-effector; and Endo-Retractor), two orthopedic implants (Suture Anchors and Modular TKA), and tablet-based 3D Osteotomy Planner using X-Rays. Indian patents have been filed or are in the process of filing for the above innovations. The team is working with selected companies to prototype the devices, and approaching others for pilot manufacture. Digital systems for streamlining the innovation process, documentation, communication, and project management have been implemented and are being continuously improved. The work and contributions are being recognized through awards and mention in media, motivating other institutions also to work in this important area.

Rational optimization of therapies for chronic viral infections
: Narendra M Dixit, Associate Professor, IISc Bangalore

Infections by viruses like HIV and hepatitis C become chronic, cause disease, and lead to significant morbidity and mortality globally. Current treatments are either unable to eradicate these infections, requiring lifelong therapy with escalating costs and side-effects, or fail in a subset of patients treated, resulting in rapid disease progression. In our work, we have devised strategies that enable rational optimization of available therapies leading to minimal drug exposure, personalized protocols, and improved treatment response. We accomplish this through novel insights into disease progression and treatment response that we acquire by the application of principles of engineering to biological phenomena central to viral infections. These insights also suggest new, more potent strategies of intervention.

Session 4: AUTOMOTIVE TECHNOLOGIES

Indian automotive industry is undergoing a major transformation – looking towards preparing needed human resources within India to support the technology needs for globally competitive automotive manufacturing. Hybrid vehicles are under trial internationally and nationally. But the critical mass of persons is yet to gather in the subject. In Defense applications, the development of efficient communication and weaponry integrated vehicles is an urgent need of the nation.

Session 4: AUTOMOTIVE TECHNOLOGIES		
1600	1610	Overview by Session Chairs : Himanshu Tyagi (IIT Ropar) *and* Philip Jose (Tata Motors, Pune)
1610	1650	*Latest Testing Methodologies In Defence Vehicle Testing* : A. Kannan (Scientist C, Vehicle Research & Development Establishment, Ahmednagar)
1650	1730	*Status and Way Forward for Hybrid Technologies in Indian Automotive Sector* : Avinash Kumar Agarwal (Professor, IIT Kanpur)
1730	1810	*Technologies to Improve the Driving Factors of the Automotive Industry* : P. Sivakumar (AGM, Engineering Research Centre, Tata Motors)
1810	1850	*Advancements in Modelling of Sheet Metal Forming Process for Effective Design of Automotive Panels* : K. Hariharan (Assistant Professor, IIT Delhi)
1850	1900	Concluding Remarks of Session Co-Chairs

Latest Testing Methodologies In Defence Vehicle Testing
: A. Kannan, Scientist 'C', Vehicle Research and Development Establishment, Ahmednagar

Today's modern world, Automobiles plays critical role in Defence sector. Starts from transportation of personnel or supplies to heavy weaponry systems are mainly rely on military vehicles. It has unique and specific requirements and attributes. It provides varying flexibility in terms of its mobility, protection, transportation and compactness to the armed forces. These vehicles should be designed robustly in order to accomplish the various levels of mission successfully under all circumstances. While designing the vehicle, the basic vehicle engineering should be retained and it must ensure the requirement and purpose what it is designed for. Numerous technologies in the field of automobile are evolving day by day. Hence various vehicle engineering attributes has been set appropriately to deliver a robust product. For any military vehicle reliability and performance are the key factor. These two things can only be measured through evaluation. Proportionately, the testing methodologies/facilities should be sufficient enough to ensure the same. The suitability of the designed product, verification of its production process and its quality can be ascertained only through testing. The Defence vehicle testing will be classified into outdoor & indoor testing. Outdoor testing further categorized into technical evaluation (track testing) and user trial evaluation (field testing). Both are carried out to ensure the particular design of the vehicle to meet the established requirements. In technical evaluation, various technical aspects such as performance, mobility, endurance, safety etc. will be tested by referring various standard test procedures and the results obtained needs to be consistent & repeatable. Setting-up these kinds of facilities requires more time & it's very expensive. User trial evaluation will be carried out under actual conditions. The extreme environmental conditions where the vehicle is going to deploy and its effects will be studied under field testing. Here, it will be very difficult to control the environment; hence it will be very difficult repeat the tests and the results may not be consistent.

The technical evaluation will be carried out at National Centre for Automotive Testing (NCAT) of Vehicles Research and Development Establishment (VRDE), Ahmednagar. The various vehicle testing facility at NCAT have been established to fulfill the specific requirements of the military vehicles. Different kind of test tracks used to trial evaluate the various vehicle design parameters such as maximum speed, acceleration, fuel economy and grade ability Also, they used to measure the safety and mobility parameters like brake efficiency, steering effort, fording, step climbing etc. In order to measure all those parameters specific, accurate and sophisticated instruments have been used. Other vehicle parameters in terms of component level such as engine and electronic & safety components have been tested with the help of unique test facilities. Depending on the role and application of the vehicle various design parameters have been measured. User trial evaluation will be carried out in various places such as high altitude areas, dessert etc. and with different climatic conditions like summer, monsoon and winter. Now-a-days, latest technologies such as Anti-lock Braking Systems (ABS), Electronic stability Programme (ESP) etc. introduced into the vehicles to enhance the safety of the vehicle. Setting-up test facilities and evaluation of those technologies will be the challenging task

for the test engineer. It involves huge risk and very expensive but, much needed to safe guard the passenger in unexpected circumstances. Defence sector is the only sector in the country has the advanced and leading edge technologies in all of their systems and it will be very challenging task for any engineer to design and develop those kind of systems and put them to testing to simulate real life conditions.

Status and Way Forward for Hybrid Technologies in Indian Automotive Sector
: Avinash Kumar Agarwal, Professor, Indian Institute of Technology Kanpur

Universal concern about degradation in ambient environment, stringent emission legislations, depletion of petroleum reserves, security of fuel supply and global warming have driven research for development of sustainable engines based on alternative combustion concepts and fuelled by environment friendly renewable fuels. Road transport sector is responsible for 17-18% global CO_2 emissions, primarily from fossil fuel combustion and in most countries, transport CO_2 emissions are growing at a faster rate than total CO_2 emissions. Significant fuel economy improvements in road transport sector are required to stabilize and eventually decrease GHG emissions.

Electric vehicles (EVs) have been around in various forms since early 1900's and have found niche markets in low power, low range applications such as golf buggies and small urban cars with low range. The key advantage of EV technology includes potential to significantly reduce usage of fossil fuels. This has benefits for energy security (by diversifying the energy sources used in the transport sector), and reducing tailpipe emissions. EV technologies can also lead to significant reductions in life-cycle (well-to-wheels) emission of CO_2. There are several barriers such as limited vehicle range, due to the current limitations of battery technology; high capital costs associated with batteries; limited availability of recharging infrastructure to the extensive uptake of EV technology which needs to be overcome before mass-market penetration can be planned and achieved.

Many other hybrid technologies for transport sector includes a range of powertrain options that can be applied to both petrol and diesel engines, including stop/start technology, micro-hybrid technology, mild-hybrid technology, and full-hybrid technology. In the last few decades, two new technologies have emerged on automotive horizon; development and implementation of Hybrid Electric Vehicles (HEVs) and more recently; the Plug-in Hybrid Electric Vehicles (PHEVs). These technologies may make it possible for the whole world to adapt these technologies on a larger scale and reduce harmful automotive emissions in addition to cutting down dependence on crude oil significantly. However, the future of these technologies will heavily depend on consumer's willingness to forgo the 'tried and true' combustion engines for the infantile technologies of the HEV and PHEV.

Apart from these hybrid vehicle technologies, automotive researchers have also focused on development of hybrid engines. These hybrid engines mainly combine two conventional combustion concepts such as spark ignition (SI) and compression ignition (CI). In this quest, a promising alternative as Homogeneous Charge Compression Ignition (HCCI) engine technology, which has been developed with twin benefits of ultra-low emissions and superior thermal efficiency. In an IC engine, HCCI combustion mode can the achieved by premixing the air-fuel mixture (either in the manifold or by early Direct Injection (DI) – like in a SI engine) and compressing it until the temperature is high enough for auto-ignition to occur (like in a CI engine). HCCI combustion is radically different from the conventional SI combustion and CI diffusion combustion. It incorporates best features of both SI and CI combustion. The charge is well mixed similar to a SI engine, which minimizes particulate formation, and the charge is ignited by compression therefore throttling losses are absent, which leads to higher efficiency similar to a diesel engine. Relative to a SI engines, HCCI engines are far more efficient and approach the efficiency of CI engines. Apart from this, HCCI combustion process has the potential to greatly reduce NO_x and particulate emissions simultaneously. However, HCCI engines have a limited operating range, where, at high loads and speeds, the rates of heat release and pressure rise increases leading to knocking and at low loads, misfire may also occur. Thus, a global research effort is underway to examine and control various factors, which can possibly control the HCCI combustion. Combustion characteristics of HCCI combustion including combustion chemistry, heat release rate, combustion duration, knock characteristics and high load limit, fuel conversion efficiencies and combustion instability have been investigated by researchers however, controlling ignition timing and combustion rate remains a primary challenge before HCCI combustion technology can be implemented commercially in automotive engines.

Technologies to improve the driving factors of the automotive industry
: P. Sivakumar , AGM, Engineering Research Center , Tata Motors

India imports about 80% of its crude oil from abroad. This is a severe depletion of revenue which results in major import-export imbalance. For a developing country like India a trade deficit like this is a growth dampener. On the other hand rapid urbanization, improving infrastructure and billion plus population is making the transportation sector grow manifold. The major driving factors such as Fuel economy and Emission, less maintenance, better comfort and improved safety provides an opportunity for automotive companies to introduce state of the art and frugal engineering solutions. However, this would not be possible without the collaboration between industry and institutes and it is the need of the hour. Hence, this presentation focuses on the different technologies to improve the driving factors of the automotive industry and the corresponding need of collaboration between the auto industry and academic and research institutes.

Advancements in modelling of sheet metal forming process for effective design of automotive panels
: K. Hariharan, Assistant Professor, Indian Institute of Technology Delhi

The advancements in the finite element method in the past have enabled modelling of sheet metal forming process for manufacturing automotive components. In the present paper, specific topics to effectively utilize the sheet metal forming simulation for better design of automotive components is discussed. The accuracy of forming simulation depends upon the choice and accuracy of material model used. The necessity of better experiments and improvement in the methodology of identifying the material constants of the material model is discussed. The applicability of material models for a particular sheet metal component is usually validated by comparing the prediction of surface strain with experiments. However, the strain based comparisons are path dependent. Two strain path independent evaluation methodologies, viz. residual stress and forming limit stress diagram and their potential application are discussed. The anisotropy in sheet metal due to texture also influences the subsequent manufacturing processes like welding and fatigue life. The improved prediction of resistance spot welding and fatigue behaviour of sheet metal components is demonstrated using phenomenological anisotropic yield criteria. The future research potential in leveraging the sheet metal forming analysis for functional design of sheet metal components in automotive design is explored.

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The Expected Outcomes

The National FoE will provide a forum to showcase the interdisciplinary nature of modern day engineering. It will, hopefully, encourage the best engineers in the country to interact and take some of the very challenging projects forward. Since the participation in the National FoE is *by invitation only*, it is expected, that over the years, an invitation to participate will be considered as a recognition and honor. Such a situation will increase competitiveness in engineering and promote excellence. The symposia are expected to promote interdisciplinary approaches across fields, and establishment of contacts among the next generation of engineering leaders.

There are other by outcomes of this event, including:

(a) Training

Young Engineers will be exposed to designing and delivering talks to diverse audiences. Also, this will help in preparing the speakers and choosing participants for bilateral events.

(b) Forum

Collaborative pilot research projects will be sought by INAE, and if found acceptable, will be funded. It is proposed to initiate a discussion board on the internet of all the 9NatFoE participants to continue the dialog and interaction even beyond the Symposium.

(c) Proceedings

All presenters will submit a full paper latest at the time of arrival of the Symposium. Participants should avoid embarrassments by sending them in advance to the Symposium Co-Chairs, or bring it with them and handing over the same to the Symposium Co-Chairs on arrival at the venue. These papers will be published in the form of proceedings of the Symposium, named **INDIA TECHNOLOGY MISSIONS**. Also, efforts will be made to work with reputed journal publishers to consider publishing select papers by invitation in their journal after due review process. Hence, the standard of the written papers should meet the associated state-of-the-art.

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SYMPOSIUM Co-Chairs

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Arun Kumar Singh

Arun Kumar Singh received the B. E. degree in Electronics and Communication engineering from Kumaun Engineering College, Dwarahat, India, in 2001, the M. Tech. degree in Communication and Radar engineering from Indian Institute of Technology Delhi, India, in 2002 and the Ph. D. degree in Electronics and Communications from the Telecom ParisTech (also known as École Nationale Supérieure des Télécommunications), France, in February of 2012. From April 2003 to January 2009, he worked as a scientist at Space Applications Centre, Indian Space Research Organization, India, where he was part of the system engineering team for communication and navigation satellite payloads. From May 2012 to April 2013 he was a postdoctoral researcher at the Mobile Communications Department, EURECOM, France. Since May 2013 he is an Assistant Professor in the Department of Electrical Engineering at Indian Institute of Technology Jodhpur.

He received the Best Student Paper Award at the 12th IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC 2011). He has been the recipient of the Institut Télécom fellowship for doctoral studies in France. His research interests are in wireless communications, communication theory, large deviation theory, spread spectrum systems, and satellite based navigation systems.

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Prafulla T Dahiwade received the B. E. degree in Mechanical Engineering from Government College of Engineering, Amravati, India, in 2002 and the M. Sc. degree in Military Vehicle Technology from Cranfield University, Shrivenham, UK, in 2013. He is associated with Vehicle Research and Development Establishment, Defence Research and Development Organization for 9 years and was involved in the design and development of the Armoured Engineer Reconnaissance Vehicle (AERV). The said vehicle has been inducted in Indian Army. Also involved in the design and development of Armoured Amphibious Doser (AAD). AAD is earthmoving equipment specially designed to meet the requirement of Indian armed forces. The vehicle has been accepted by user for the induction.

SESSION Co-Chairs

1. Arid Zone Technologies

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Rajasekar Elangovan

Rajasekar Elangovan received the B. Arch. degree in Architecture from Adhiyamaan College of Engineering, Hosur, India, in 2003, the M. S. degree and Ph. D. degree in Building Technology and Contruction Management from Indian Institute of Technology Madras, India, in 2006 and 2012 respectively. An Architect specialized in functional performance of built environments and building physics. He was with L&T Construction as a research and development engineer from 2010 to 2015 and handled environmental noise mapping, acoustical design consulting, thermal performance research in residential projects (2011 – 15), energy efficiency and daylight optimization (2010 – 13). His research interests are in methods and materials to achieve climate sensitive, environmentally responsive and high performance buildings.

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His research interests include the design, simulation, fabrication and characterization of MEMS structures; vacuum system design; and thin films and their characterization from the MEMS perspective. He has published over 16 papers in peer reviewed journals and conferences; he holds a patent; and has published a book-chapter.

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The Hosts

Indian National Academy of Engineering

The Indian National Academy of Engineering (INAE) founded in 1987 comprises India's most distinguished engineers, engineer-scientists and technologists covering the entire spectrum of engineering disciplines, and functions as an apex body to promote and advance the practice of engineering and technology and the related sciences and disciplines in India and their application to problems of national importance.

The aims and objects of the Academy include to:

(1) Encourage and promote the pursuit of excellence in the field of *Engineering*;
(2) Offer the Govt. of India, the local Governments and others, the views of engineers in co-operation with other professional bodies in regard to all matters pertaining to *Engineering*;
(3) Promote the National Policy on Education of the Government of India;
(4) Present at all academic forums, the research and development activities on engineering on mutual interactive and cooperative basis both in India and abroad;
(5) Encourage inventions, investigations and research and promote their applications for development of both organised and unorganised sectors of national economy;
(6) Institute and establish Professorships, Fellowships, Studentships, Scholarships, Awards and other benefactions; and
(7) Interact with Professional Bodies, Engineering and Scientific Academies, etc., in India and abroad.

The Academy is registered under the Societies Registration Act 1860 and is an autonomous institution supported partly through grant-in-aid by Department of Science & Technology, Government of India. As the only engineering Academy of the country, INAE represents India at the International Council of Academies of Engineering and Technological Sciences (CAETS).

Indian Institute of Technology Jodhpur

Indian Institute of Technology Jodhpur is one of the eight Indian Institutes of Technology (IITs) established by the Ministry of Human Resource Development, Government of India, under an *Amendment* of the *Institutes of Technology Act,* 1960. IIT Jodhpur is being planned and prepared to provide creative technological solutions to meet the technology grand challenges of the nation. Two pronged approach is taken at the Institute to achieve this goal, namely:

(1) Technology focus in all activities at the Institute; and
(2) Professionalization of the Institute for improved efficiency and efficacy in achieving the needed calm in the environment at the Institute, skills in personnel, and systems & processes to ensure technology focus.

IIT Jodhpur has launched its flagship *industry immersion-based* blended *technical education program* for B.Tech. students – a unique blend of classroom instructions at the Institute and shop floor experience in the Industry. It exploits interconnections between academia and industry, and by providing opportunities to understand the needs of the nation and thereby meaningfully engaging with the Indian society. Select Students and Faculty Members will immerse inside leading technology Industries during three successive summers. Other features of this Program include:

(1) Learning-by-doing,
(2) Experiential and cooperative learning,
(3) Working on live assignments under the tutelage of industry professionals, and
(4) Engaging in industry-supported projects.

The program is expected prepare Students and Faculty Members to meet eventually the grand challenges of Indian technology industry; the program helps build leadership skills in both of these stakeholders. To strengthen its industry interactions, IIT Jodhpur is constructing a *Technology Park* on its permanent campus for harvesting technologies of national importance. This *IITJ Technology Park* is poised to host the *Solar Energy Technology* development and *Defence Technologies*. Discussions are underway with Government and private industries to work on other select national technology missions, like water, healthcare and automotive.

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