MEEd
ASME Mechanical Engineering
Education Summit
INDIA

ASME
SETTING THE STANDARD

ENGINEERING EDUCATION SEMINAR WITH WORKSHOP

& ASME MAHARASHTRA SECTION ANNUAL MEET

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EXECUTIVE SUMMARY

The MEEd seminar on Computational Mechanics in Mechanical Engineering, held on **August 9, 2025, at IIT Bombay,** brought together **over 200 faculty, students,** and industry professionals to address a critical challenge: transitioning India from a service-driven to an innovation-led economy through advanced computational tools.

Event Overview

Hosted by the MEEd Steering Committee and the ASME Maharashtra Section, with invaluable support from IIT Bombay's Department of Mechanical Engineering, the event was a full day of deep dives and practical learning. Industry giants Altair, CADFEM, and Ansys were not just sponsors, they were active participants, providing their expertise and showcasing cutting-edge platforms.

Key Highlights

The inaugural session established context: IIT Bombay manages ₹187 crore across **275 sponsored** and consultancy projects, with **14,000 students including 7,000 postgraduates.** Prof. Atul Sharma emphasized that industry-academia collaboration is essential for India's innovation goals.

Academic sessions addressed teaching computational mechanics effectively. **Prof. Salil Kulkarni** advocated balancing theory with practice, while **Prof. Sandip Kumar Saha** detailed master's-level curricula covering finite difference, finite volume, and finite element methods with mandatory coding assignments.

Industry practitioners showcased transformative applications. Atomberg reduced prototyping time from months to days and achieved **65% energy** reduction using ANSYS simulation. **Dr. Rakesh Goyal** from John Deere demonstrated how multi-physics simulations, that is integrating structural, thermal, and fluid dynamics, accelerate off-highway vehicle development. **Mr. Gaurav Bhende** emphasized that domain expertise remains critical, citing an ISRO case where FEA accurately predicted bellow failure at 21.5 Bar.

Student presentations highlighted cutting-edge research: ROM-DNN hybrid methods accelerating CFD simulations and Physics-Informed Neural Networks integrating AI with traditional solvers.

ASME India also looked ahead, outlining its professional development programs. A major focus is a new course on green hydrogen, designed to help train the **600,000 engineers** India will need in that sector by 2030.

More than just a seminar, this event was a vibrant forum for collaboration. It successfully demonstrated how computational mechanics can be a powerful engine for India's industrial growth, closing the gap between academic theory and real-world industry needs through shared knowledge and hands-on skill-building.

INAUGURAL SESSION

The MEEd seminar on Computational Mechanics in Mechanical Engineering at IIT Bombay aimed to create an industry-academia platform to discuss the real-world applications of Computational Mechanics (CFD/FEA) in mechanical engineering, with involvement from leading technology providers through experience-sharing and technical demonstrations.

Prof. Milind Atrey, Deputy Director, ART (Academics, Research and Translation) at IIT Bombay highlighted the institute's significant research and academic achievements during the inaugural session. **Prof. Atul Sharma, Rahul Bajaj Chair Professor and Head, Department of Mechanical Engineering, IIT Bombay** emphasised that the goal for India is to transition from a service to an innovation economy through industry-academia collaboration.

IIT Bombay's Research and Academic Landscape

- The institute has **14,000 students, including 7,000 postgraduate students** and **500 postdoctoral students.**
- IIT Bombay is not just an engineering research hub but also conducts significant research in basic sciences with **200 high-end machines.**
- The institute has a Business Incubation Centre and a Translational Research Centre to bridge the gap between research and industry.

Industry-Academia Collaboration and Research Initiatives

- **Dr. Atrey discussed** the importance of industry collaboration, mentioning the Research Development and Innovation (RDI) Scheme by the DST Secretary to allocate Rs. One lakh crore for R&D in the industry.
- The institute has **35 companies working** with them, and they offer entrepreneurship programs with **270 students registered.**
- The institute aims to ensure that research does not remain confined to labs but reaches society and industry.
- The institute has provisions for NDAs, MOUs, and other collaborative measures to address industry pain points.

Interdisciplinary Research and Advanced Technologies

- **Dr. Atrey highlighted** the need for interdisciplinary research, mentioning ongoing projects in electric vehicles, hydrogen catalysis, and quantum sensing.
- Quantum sensing can detect early signs of diseases like cancer, and the institute is working on developing such technologies.

- The institute is also focusing on quantum computing and its applications in various fields.

Simulation and Experimental Techniques in Engineering

- **Dr. Atrey discussed** the use of simulations in engineering to predict the behavior of structures and systems without expensive experiments.
- Simulations are crucial in healthcare, for example, in simulating fluid flow in arteries to develop customized stents.
- The institute is working on developing medical devices using simulations and robotics.

Department of Mechanical Engineering Overview

- The department has **1,550 students, including 950 undergraduate students, 200 MTech students,** and **400 PhD students.**
- The department has **65 faculty members, 35 staff members, and 40 distinct research labs.**
- The department is transitioning from a teaching-focused institute to a research-focused institute, with a significant increase in postgraduate students.

Generational Shift in Teaching and Learning

- **Prof. Sharma discussed** the generational shift in teaching and learning, emphasizing the need for effective teaching methods.
- The institute is working on integrating AI and ML into teaching processes to enhance student engagement.
- Faculty and students provide feedback to improve teaching and learning processes.
- The institute aims to create a sustainable and effective learning environment.

Interdisciplinary Research Groups

- **Prof. Sharma highlighted** the interdisciplinary research groups in the department, including AI and ML, Biomechanical Engineering, and Robotics, Dynamics and Control.
- The interdisciplinary research groups aim to develop synergies between different fields.

Contributions and Achievements

- **Prof. Sharma discussed** the contributions of faculty members, including 862 journal publications, patents, and six startups.
- The research department has received funding worth **₹187 crore for over 150 sponsored projects** and **125 consultancy projects.**
- The department has **40 distinct research labs** and several central facilities.
- Faculty members contribute to national missions and objectives through collaborative research with industry.

Transition from Service to Innovation Economy

- **Prof. Sharma emphasised** the need for India to transition from a service to an innovation economy.
- The institute is working on collaborative projects with industry to develop innovative solutions.
- The institute is committed to achieving national and global sustainability goals through collaborative research and innovation.

CHIEF GUEST ADDRESS

Mr Ramakrishnan TN

Mr Ramakrishnan TN, Senior Director, Reactor Technology, Aether Fuels discussed the integration of computational mechanics and computational science in engineering, emphasizing its rapid evolution and essential role in industry growth. He stressed the importance of using advanced tools like FEA and CFD, and the necessity of validating and verifying results.

Challenges and Opportunities in the Industry

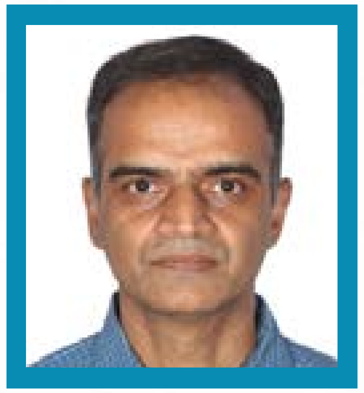
- **Mr Ramakrishnan** TN discussed the daily challenges faced in the industry, including the need for detailed analysis and the role of institutions like IIT in bridging the gap between academia and industry.
- The importance of supporting academia and institutions financially was highlighted, along with the need for specialized personnel in the industry.
- He described the passion and dedication of engineers who work on high-end analyses, emphasizing the need for this drive to drive innovation.

Importance of Validation and Verification

- **Mr Ramakrishnan** TN stressed the importance of validation and verification in computational mechanics, mentioning the role of societies like ASME in providing courses and resources.
- He emphasized the need for precision and accuracy in calculations, along with the challenges of working with international codes and standards.
- The role of state-of-the-art tools and technology in driving industry growth and innovation was discussed, along with the need for collaboration between academia and industry.

ACADEMIC INSIGHTS SESSION

Professor Salil S. Kulkarni



Professor Salil S. Kulkarni of the Department of Mechanical Engineering at IIT Bombay delivered a presentation titled “Teaching Finite Element Method (FEM) Today for the Challenges of Tomorrow.” He discussed the importance of FEM, the challenges in teaching it, and recommendations for an effective curriculum.

Professor Kulkarni began by defining the Finite Element Method as a numerical technique for solving complex engineering problems. He underscored its significance in mechanical engineering for simulating real-world phenomena, optimizing designs, and conducting failure analyses. He noted its wide-ranging applications in industries from automotive to biomedical engineering.

His talk addressed emerging trends in the field, including the integration of FEM with machine learning for surrogate modeling and the creation of digital twins. Professor Kulkarni also pointed out the industrial challenges associated with FEM, such as computational cost and the need for deep domain expertise.

A significant portion of the presentation was dedicated to the challenges of teaching FEM to undergraduate students. He identified several key issues: the inherent mathematical complexity, an imbalance where students use software without understanding the underlying theory, a general aversion to coding, and the difficulty students have in physically interpreting simulation results.

To address these challenges, Professor Kulkarni offered several recommendations. He stressed the need for a curriculum that blends theory with practice through hand calculations and coding with open-source tools. He advocated for a gradual introduction to commercial software, a strong emphasis on result verification and validation, and the use of project-based learning with real-world problems. He concluded that the goal of FEM education should be to develop strong core skills in mechanics, mathematics, coding, and analysis to prepare students for current and future demands.

Professor Sandip Kumar Saha

Professor Sandip Kumar Saha from the Department of Mechanical Engineering at IIT Bombay presented on the teaching of computational mechanics in thermal and fluid engineering.

Professor Saha outlined the structure of a master’s level course that begins with fundamental computational methods, including the solution of nonlinear equations, systems of linear algebraic equations, and ordinary differential equations.The curriculum then progresses to cover partial differential equations (PDEs) and their characteristics, focusing on transport equations for mass, momentum, and energy.

He detailed the course's coverage of various discretization techniques. Students learn the Finite Difference Method for solving problems in heat conduction and convection, as well as viscous incompressible flows. The course has been updated to include the Finite Volume Method, covering its application to advection-diffusion problems and flow fields using algorithms like SIMPLE and SIMPLER. An introduction to the Finite Element Method, unstructured grid formulation, and turbulence modeling is also part of the advanced curriculum.

A key aspect of his teaching methodology is the use of coding assignments. Students are required to write code for solving problems such as unsteady heat conduction and pipe flow, and then validate their results. Professor Saha also mentioned the resources used in his courses, including books by Professor Richard Hamming and Professor Atul Sharma, and stressed the importance of thorough documentation of the entire simulation process.

Professor Sushil Mishra

Professor Sushil Mishra of the Department of Mechanical Engineering at IIT Bombay presented an overview of his 'Sheet Metal Engineering' course. The course is designed for final-year undergraduate, postgraduate, and doctoral students.

Professor Mishra's session detailed a curriculum that combines theoretical principles with practical application. The course content covers the production of ferrous and non-ferrous sheet metals, fundamental forming processes such as shearing, bending, and deep drawing, and the assessment of mechanical and metallurgical properties. A significant component of the course involves the study of anisotropic yield criteria, formability analysis, and the use of both conventional and advanced forming machinery.

A key focus of his presentation was the course's hands-on project, which requires students to engage in the process modeling and analysis of typical sheet metal forming processes. This project emphasizes the scope of CAD/CAM and numerical analysis in the field.

He explained that students gain practical experience by manufacturing various parts, using software like AutoForm for simulation and MasterCam for cutting operations. This project-based learning allows students to apply theoretical knowledge to real-world applications. Examples of student projects include the fabrication of a tractor battery box, a stapler metal handler, a portable laptop stand, a smartphone back case, and a car door panel.

Professor Mishra also highlighted the methods students use to characterize material properties. This includes conducting biaxial tests and employing Digital Image Correlation (DIC) analysis to plot experimental yield locus curves, providing them with a deeper understanding of material behavior under different stress states.

ASME INDIA L&D

Mr. Balachandran Hari, Deputy Director of L&D Business Development & Operations at ASME India, delivered a session at IIT Bombay outlining the organization's current learning and development initiatives and future strategy. The presentation focused on new programs designed to equip mechanical engineers with skills for emerging industries while strengthening foundational knowledge through established codes and standards.

Overview of ASME's Role and Initiatives

- ASME, a Standards Development Organization (SDO) with a 140-year history, has established a Learning and Development (L&D) portfolio to make its extensive code book more accessible to engineers.
- The organization emphasizes the global importance and adoption of its standards and codes in critical functions.

Key Course Offerings and Programs

- ASME offers a range of technical short courses (8-16 hours) covering various sections of its code book, including:
  - **Section 1:** Boiler & Pressure Vessel Code (BPVC) Fundamentals
  - **Section 2:** Material Selection and Welding
  - **Section 5:** NDE Techniques and Digital Radiography
  - **Section 8:** Design & Analysis of Pressure Vessels
  - **Section 31.3:** Process Piping Design
  - **Section IX:** Welding Procedure Qualification
- A particularly crucial course highlighted was Y14.5, which covers Geometric Dimensioning and Tolerancing (GD&T).
- Learning formats are flexible, including in-company training, public seminars, self-study, and hybrid classes.

Emerging Trends and Future Focus

- ASME is developing new programs in high-growth areas, including Green Hydrogen, Sustainability, Industry 4.0 (Digital Twin, Smart Manufacturing), and Additive Manufacturing.
- There is a significant focus on green hydrogen, with India aiming to produce 5 million tonnes by 2030, creating a demand for approximately 6 lakh trained engineers.
- Future plans involve incorporating gamification, experiential learning, and collaborations with MOOC platforms like SWAYAM Plus to deliver globally benchmarked programs.

Professional Development and Certification

- Programs are designed for all career stages, from K-12 and university students to seasoned professionals.
- Offerings include Faculty Development Programs, a "Young Engineer Launchpad" for final-year students, and custom workshops for working professionals.
- Emphasis is placed on quality assurance through credentials aligned with the National Skills Qualification Framework (NSQF), with NCVET affiliation in process.
- New assessment methods will include hackathons and capstone projects.

Partnerships and Market Approach

- ASME is actively seeking partnerships with industry leaders (like IOCL, L&T), academic institutions (technical and Tier 1 universities), and government bodies (Skill India, MSDE).
- The market strategy targets sectors such as Energy (Green Hydrogen, Oil & Gas), Advanced Manufacturing, and Automotive/EVs.
- The organization is building a network of Authorized Training Partners (ATPs) to deliver training across different regions.

ASME MAHARASHTRA SECTION SUSTAINABILITY PLAN AND ANNUAL MEET

Mr. Anil Kumar Chahar

Mr. Anil Kumar Chahar, Chair of the ASME Maharashtra Section, and Mr. Anirudh Deodhar, Member-at-Large, hosted a session to outline the section's activities and future plans. The primary goal is to bridge the gap between academia and industry by creating engagement opportunities for both professional and student members within the state.

Objectives of the Maharashtra Section

- Provide engagement pathways for professional and graduating student members.
- Grow the ASME professional community in the region and facilitate the application of engineering knowledge.
- Promote multidisciplinary activities and encourage students to pursue mechanical engineering.

Review of Past Activities

Annual Meet 2024 (Pune): Attended by over 60 professionals and students, featuring discussions on changing technologies and encouraging women in engineering. The event included a talk by Mr. Vishal Dafal from Whirlpool and a panel of women engineers from companies like GE Healthcare, Reliance, and Cummins.

Webinar on Vehicle Crash Analysis: Presented by Nachiket Phadke, this session covered the fundamentals of crash dynamics, testing methods, and real-world case studies for over 50 attendees.

Webinar on Laser Shock Processing: Dr. Pratik Shukla discussed the science and industrial applications of this material strengthening technique for an audience of over 50 professionals and students.

Goals and Success Metrics for the Upcoming Year

- Conduct 10 leadership meetings and 4 major events.
- Engage at least 50 professionals and 200 students/early career engineers.
- Increase female participation to 20% in professional events and 40% in student events.
- Facilitate 4 industry visits for students and outreach to 4 institutes for new student section formation.

Activity Plan for July - December 2025

Webinars: Short sessions planned on "GD & PI Techniques" and "Industry Expectations from Newly Joined Engineers."

Virtual Event: A full-day event on "Emerging Trends in Mechanical Engineering" for professionals and early career engineers.

In-Person Workshop: A short workshop on "Product Design and Development" for students.

STEM K-12 Event: An outreach event to encourage high school students to pursue mechanical engineering.

Key Impact Areas for the Future

- Expand the section’s awareness and impact through regular events.
- Grow a strong community of professionals and create local networking groups.
- Provide volunteer leadership opportunities and empower student sections through industry exposure.

Ms. Avni Malhotra
Deputy Director, ASME Foundation India

1. **Plans for Events and Engagement with Early-Career Engineers**
   - Announced ‘E-Fest Careers’ event scheduled for November, which will be a virtual engagement focused on early-career engineers and students.
   - The event will feature HR professionals discussing how to use AI tools for resume creation, cover letters, trends in recruitment, and workplace expectations.
   - There will be practical guidance for students/new industry entrants on what to expect when joining the workforce.
2. **Philanthropic and Community Outreach Initiatives**
   - Shared information about ASME Foundation India’s ongoing STEM exposure project targeting 7th, 8th, and 9th grade students.
   - Explained that modules are being developed in Hindi, with plans to pilot them in a school near Kanpur.
   - The aim is to reach first-generation learners and broaden STEM access in local communities.
3. **Feedback and Communication Channels**
   - Encouraged members to share feedback on learning and development initiatives, which could inform further development in related programs and courses.
   - Invited members to join a dedicated and GDPR-compliant WhatsApp group.
   - This group serves as a communication channel for official updates on ASME professional events, virtual opportunities, and other section activities.

PRESENTATIONS BY INDUSTRY PRACTITIONERS

Dr. Santhanu Jana

Dr. Santhanu Jana, Senior Manager at Altair, discussed the industrial applications of simulation and AI-driven design in manufacturing. He emphasized the growing need for sustainable, innovative, cost-effective, and high-quality products. The session highlighted the challenges in product design, such as balancing strength, speed, power, weight reduction, and accuracy, and showcased how modern simulation technologies and Artificial Intelligence are providing solutions.

Industry Applications of Simulation and Design

- Product Innovation: There is a strong emphasis on creating products that are not only innovative and sustainable but also fast to market and cost-effective.
- Design Challenges: Key challenges in product design include achieving optimal strength, speed, power, and accuracy while reducing weight and considering climatic factors.
- Mega Casting: Dr. Jana introduced “mega casting” as a significant industry trend, illustrated with a BMW project that integrated multiple sheet metal parts into a single casting.

Challenges in Product Design and Manufacturing

- Balancing Performance and Manufacturing: A core challenge is balancing a part’s performance requirements with the constraints of manufacturing. **Dr. Jana** stressed using “design of freedom” to create optimized, manufacturable parts.
- Manufacturing Techniques: The discussion covered various manufacturing methods, including machining, casting, binder jet metal, and steel metal deposition.

Simulation and Design Workflow

Integrated Solutions: The workflow integrates generative design, performance analysis, and manufacturing process simulation. Altair Inspire is a tool that facilitates this by allowing for quick geometry creation, computational physics analysis, and design optimization.

Multidisciplinary Approach: Effective design exploration requires input from various disciplines, including structural, fluid, thermal, and electromagnetic analysis.

Manufacturing Processes: The simulation-driven design for manufacturing (SDFM) approach covers a wide array of processes like casting (Inspire Cast), metal forming, injection molding, extrusion, and additive manufacturing.

Case Studies and AI in Design

Real-World Examples: Dr. Jana presented case studies including a 16-meter welded part from Austria that was made lighter through topology optimization, a 35% lighter land machine part, a 3D-printed gearbox cover by Porsche, and an extruded battery case.

Topology Optimization: This is a key element of generative design, where algorithms optimize material layout within a given design space to meet performance goals.

AI in Design: The session introduced the use of AI and machine learning models to predict design parameters and enhance manufacturing efficiency.

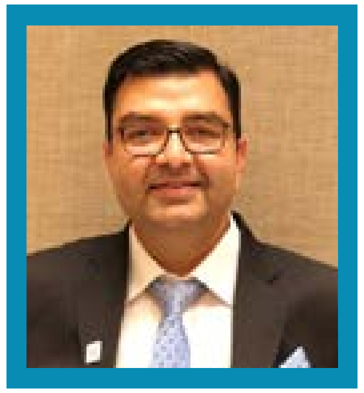
AI and Machine Learning in Design

Accelerated Simulations: A major benefit of using AI is the dramatic reduction in simulation time, from hours to mere seconds. For instance, in a comparison, an Inspire Mold simulation that took over 3 hours was predicted by an AI model (PAI) in approximately 10 seconds.

Predictive Power: Machine learning models can analyze hundreds of simulation variants to identify optimal outcomes, such as predicting homogenous filling behavior in high-pressure die casting simulations

Democratization of Design: **Dr. Jana** concluded by highlighting the potential of AI to make advanced design and manufacturing processes more accessible, leading to faster and better decision-making.

Dr. Rakesh Goyal



Dr. Rakesh Goyal of John Deere presented on the application of computational mechanics in the off-highway industry, tracing the evolution from traditional design to advanced simulation. He highlighted the critical role of Computer-**Aided Engineering (CAE) in accelerating development,** the necessity of multi-physics simulations, and the importance of cross-functional collaboration and practical education for engineers.

The Importance and Evolution of CAE

Accelerated Development: CAE is crucial for the industry as it reduces physical testing, accelerates the development cycle, improves design confidence, and enables cost-effective innovation.

From Physical to Virtual: The discussion highlighted the shift from historical methods, like the 1837 self-scouring plow, to modern designs that require complex multi-physics simulations involving structural mechanics, CFD, and Dynamical System Methods (DSM).

Product Design Workflow and Generative Design

Design Process: The typical product design workflow begins with concepts and proceeds through multiple simulation activities.

Generative Design: The use of generative design was highlighted as a tool for making optimal decisions early in the design stage.

Failure Modes: The simulation approach is often chosen based on potential failure modes such as fatigue, impact, corrosion, wear, and pitting.

AI and ML: AI and Machine Learning methods were mentioned as being particularly helpful for simulating complex scenarios that are otherwise difficult to model, like corrosion.

Common Simulation Methods and Multi-Physics Analysis

Simulation Types: **Dr. Goyal** listed several common simulation methods, including static and fatigue structural mechanics, thermal process analysis, fluid dynamics, and DSM.

Multi-Physics Integration: The need for multi-physics analysis to solve complex, interrelated problems was a key point.

Material Data: Accurate material property parameters, often generated using experimental equipment and proprietary data sets, are essential inputs for all simulation methods.

Design Guidelines and Verification Procedures

Documented Procedures: **Dr. Goyal** explained the importance of having well-documented internal design guidelines and verification procedures.

Standards and Regulations: External regulations and standards from bodies like SAE and ISO guide the design and verification process.

Compliance: Internal analysis procedures are essential for ensuring all designs comply with these standards.

Examples of Simulation Methods in Practice

Fatigue and Crack Growth: Practical examples included the use of simulation for fatigue analysis and peak crack growth analysis in welded components.

Dynamic Loads: Dynamic structural methods are used to understand the real-world loads acting on machines and systems.

Thermal Modeling: The complexity of transient thermal analysis was discussed in the context of process welding, where simulations help understand distortion and residual stress in large assemblies like vehicle cabs.

Heat Treatment and Additive Manufacturing

Process Simulation: The presentation covered the simulation of heat treatment processes to predict and control part distortion.

Additive Manufacturing: Simulation is also used in additive manufacturing to understand and optimize the mechanical properties of 3D-printed parts.

Advanced Modeling: The modeling of adhesively bonded joints using cohesive zone modeling was mentioned as another advanced application.

External Collaboration: **Dr. Goyal** noted that collaboration with academia and software partners is essential for developing and commercializing new simulation methods.

Recommendations for Students

Hands-On Experience: Dr. Goyal concluded with a call to academia, emphasizing the need for students to gain hands-on experience with CAE methods.

Project-Based Learning: He recommended project-based learning that takes students from the concept stage all the way through testing.

Curriculum Updates: It was suggested that curricula be updated to include topics like fatigue, multiphysics, and optimization to prepare modern engineers.

Industry Partnership: He encouraged partnerships between universities and industry for developing labs, arranging guest lectures, and creating relevant student projects.

Mr. Gaurav Bhende

Mr. Gaurav Bhende, Head of Advanced Engineering at Protton Synergy, discussed the real-world applications of Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD). His presentation covered the historical evolution of these simulation methods, their practical challenges and applications in the oil and gas industry, and the critical importance of fundamental engineering knowledge over mere reliance on software. Mr. Bhende emphasized that domain expertise is essential for interpreting simulation results and avoiding costly errors, while also highlighting the significant growth and career opportunities in the field.

Historical Context of FEA and CFD

Pioneering Work: The origins of these methods date back to the 1940s, with pioneers like Russian-Canadian engineer Alexander Hrennikoff and German-American mathematician Richard Courant.

Fundamental Principles: The Navier-Stokes equations were mentioned as the foundational principles for modern fluid dynamics (CFD).

Technological Advancement: The accessibility and efficiency of FEA and CFD today are largely due to massive advancements in computing power over the decades.

Challenges and Realities of Oil and Gas Engineering

Complex Environments: The oil and gas industry presents unique challenges, such as designing and managing cross-country pipelines to transport viscous fluids under high pressure.

Safety and Hazards: Engineers must account for potential hazards to pipelines, including earthquakes and sinkholes, making safety a paramount concern.

Domain Expertise is Key: Mr. Bhende stressed that solving real-world problems, like a cracked expansion joint, requires deep domain expertise that goes beyond theoretical knowledge.

Case Studies and Practical Applications of FEA

Validating Design with FEA: A case study for ISRO was presented where a bellow component designed for gas needed to be hydro-tested with a liquid. FEA was used to design a support structure, and its simulation accurately predicted failure at 21.5 Bar, which matched the experimental data from strain gauges, successfully validating the structure for the 21 Bar test pressure.

Choosing the Right Tool: In another case involving a 24-inch multiphase flow pipeline, an initial analysis with ASPEN HYSYS was inconclusive. A subsequent analysis using ANSYS Fluent successfully determined the specific flow type and checked for stagnancy, demonstrating the need for engineers to understand the limitations of different software tools.

The Importance of Basic Engineering Knowledge

Software is a Tool, Not a Replacement: : Mr. Bhende repeatedly emphasized that engineers must rely on their fundamental understanding of physics and not blindly trust software outputs.

Bridging the Academia-Industry Gap: While acknowledging the gap between academic syllabi and industry needs, he affirmed that basic engineering principles are more relevant and necessary than ever.

Conclusion and Future Prospects

Significant Market Growth: The presentation highlighted the strong financial future of FEA, with the global software market projected to grow from **$7.01 billion in 2024 to $12.56 billion by 2029.**

Future Enhancements: Future solver enhancements will include cloud-based platforms, AI and machine learning integration, and more user-friendly interfaces.

Career Opportunities: **Mr. Bhende** concluded by noting the exciting and significant career growth opportunities available for mechanical engineers in the oil and gas industry.

Mr. Piyush Vashist

Mr. Piyush Vashist, an Application Engineer at CADFEM Ansys, discussed the transformative role of computational mechanics in engineering. He emphasized how simulation replicates real-world scenarios virtually, thereby reducing product development workload, costs, and time. The presentation covered the key steps in Finite Element Analysis (FEA), from simplifying complex parts to executing advanced multi-physics simulations, and highlighted several industry success stories.

Motivation for Simulation

Reducing Development Time: Mr. Vashist highlighted a key motivation for simulation by explaining that physical prototyping and testing can take up to eight weeks for a component like a gearbox.

Cost and Risk Reduction: Simulation helps avoid the high costs of manufacturing tools for physical prototypes. It also mitigates the risk of prototype failure, which would otherwise restart the entire design and manufacturing cycle.

Simplifying Complex Mechanical Components

Strategic Simplification: The process begins by making logical simplifications, such as ignoring negligible time or temperature effects, using simplified material behaviors, or eliminating small geometric features that are not in a region of interest.

Careful Planning: Successful analysis requires careful planning, which includes outlining the goal, stating all assumptions, drawing free-body diagrams, and listing all required information like geometry, loads, and material properties.

Basic Steps in Structural Analysis

Pre-Processing: This stage involves defining materials, preparing the geometry, and creating a robust mesh. Key decisions are made here, such as choosing between a 2D or 3D analysis and determining if nonlinearities (geometric, material, contact) need to be considered.

Simulation and Post-Processing: This includes the simulation setup, execution of the analysis, and exploration of the results. This logical routine allows engineers to compare results and make design changes efficiently.

Advanced Simulation and the Ansys Ecosystem

Integrated Platform: Mr. Vashist highlighted the Ansys integrated ecosystem, which allows different physics (mechanical, thermal, fluid) to be easily coupled in a comprehensive multi-physics simulation.

Optimization and Customization: The platform provides in-built parametrization and optimization methods, along with customizable workflows that enhance design efficiency.

Industry Use Cases and Case Studies

Sanden Group: Used Ansys Sherlock for its electrical compressors, resulting in an 85% reduction in preparation time for PCB models.

Danfoss A/S: Leveraged Ansys Sherlock to evaluate new AC drive designs, reducing their time to market by 75%.

Continental: Utilized simulation to evaluate different adhesives for BGA packaging, which significantly reduced physical testing time.

Major Companies: A wide range of world-class companies, including AIRBUS, VOLVO, Samsung, Baker Hughes, and Pfizer, leverage the Ansys platform.

Ansys Innovation Courses and Learning Hub

Learning Resources: Mr. Vashist concluded by promoting Ansys's free innovation courses and its learning hub as valuable resources for both professors and students.

Hands-On Experience: He encouraged attendees to use the learning hub to gain hands-on experience with detailed problem statements and analyses.

L&D WORKSHOP (SKILL BUILDING)

Mr. Piyush Vashist

Mr. Piyush Vashist conducted a practical demonstration of ANSYS, using a flywheel model to illustrate a standard structural analysis workflow. He walked through the process from initial setup and meshing to applying loads and interpreting results. The session also touched upon advanced multi-physics and explicit analysis capabilities and was highlighted by a case study from the fan manufacturer, Atomberg, which achieved significant product improvements using ANSYS.

Interface and Initial Setup of ANSYS

Demonstration Environment: Mr. Vashist introduced the ANSYS Mechanical interface, explaining that it operates as a mathematical tool requiring initial engineering data.

Importing Model and Materials: He demonstrated the process by importing a flywheel geometry and showed how to assign materials, such as structural steel or carbon fiber, to the component.

Mesh Generation and Selectivity

Importance of Meshing: The session emphasized the critical role of mesh selectivity, where the model is discretized into a grid. Mr. Vashist noted that the mesh can be refined for greater accuracy in detailed areas.

Applying Loads and Conditions: He introduced the static structural analysis environment, showing how to apply boundary conditions like a fixed support or define operational loads, such as applying a specific rotational velocity to the flywheel.

Solving and Output Analysis

Generating the Solution: After defining all input conditions, Mr. Vashist initiated the “solve” command to generate the stiffness matrix and compute the solution.

Interpreting Results: The output visualized stress distribution across the model, with red areas indicating maximum stress. He demonstrated how to use probes to find precise maximum and minimum stress values at the various nodes of the mesh.

Multi-Physics and Explicit Analysis

Advanced Capabilities: Mr. Vashist briefly introduced the concept of multi-physics, which allows for coupling different types of analyses (e.g., thermal and structural) and sharing results between them.

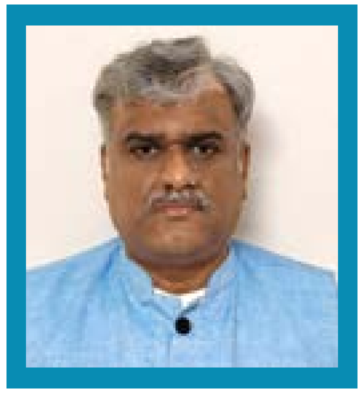
High-Impact Simulation: He also mentioned the software's explicit analysis capabilities through LS-Dyna, which is designed for simulating very short-duration, high-impact events like car crashes or helmet collisions.

Case Study: Atomberg and ANSYS

Industry Example: A case study of Atomberg, a fan manufacturer, was presented. The company faced challenges with prototyping and material selection in their innovation process.

Results of Simulation: By partnering with ANSYS, Atomberg was able to reduce its prototyping time from months to days. This collaboration led to a significant optimization of their products, achieving a 65% reduction in energy consumption.

Mr. Ramesha BS



Mr. Ramesha BS, Head of Academic Initiatives at Altair, presented on the power of optimization for developing sustainable and smart products. He highlighted the evolution of product design from purely mechanical to complex mechatronics systems, and major investment trends driving the industry. A key theme was the importance of using simulation-driven design early in the concept phase and Altair's commitment to empowering students with free access to its technology.

Siemens and Altair Overview

Global Leaders: The presentation highlighted the partnership between Siemens and Altair, who together deliver a comprehensive, AI-powered simulation portfolio. Altair serves over 16,000 customers globally, including major companies like Ford, Boeing, Airbus, Google, and Siemens.

Comprehensive Portfolio: The joint portfolio covers a wide range of needs, including Electronic Design Automation (EDA), Product Lifecycle Management (PLM) simulation (mechanical, CFD, electromagnetics), and manufacturing process simulation.

The Evolution of Product Design

From Mechanical to Mechatronics: Mr. Ramesh illustrated the dramatic shift in product design using the example of the Bajaj Chetak scooter. The original was a simple mechanical vehicle, while modern scooters are smart devices with Bluetooth, over-the-air updates, and geo-fencing.

System Integration: Modern vehicles are dominated by electrical and electronic subsystems, such as adaptive cruise control, automatic braking, and battery management systems. This requires engineers to have a deep understanding of system integration, data science, and electronics, not just mechanics.

Investment and Global Trends

Mega Trends: The presentation identified key "Mega Trends" indicating where investment is flowing, including Electrification (EVs), AI-Driven Simulation, Data-Driven Enterprises, and the Semiconductor industry.

Altair's Solutions: Altair provides a broad portfolio of solutions that address these trends, with specific applications for e-Mobility, Digital Twins, Additive Manufacturing, and Machine Learning. For EV development, Altair offers a full suite of virtual validation tools for structural analysis, motor design, battery design, and controller systems.

Student Engagement and Resources

Free Academic Licenses: Mr. Ramesh strongly encouraged students to use Altair's extensive suite of products, which are available for free through an academic student version. This includes tools for conceptual design (Inspire), advanced analysis (OptiStruct, Radioss), and data analytics.

Fostering Passion: He explained Altair's strategy of engaging with students through contests and free software access. The goal is to foster a genuine passion for the technology, identifying talented students who are motivated to innovate with their tools.

Empowering Design with Simulation and Optimization

Simulation Before CAD: A core message was the importance of using simulation technology before starting detailed CAD work. This approach allows engineers to explore optimal designs from the very beginning of the concept phase.

Nature as Inspiration: The presentation highlighted how nature is an excellent structural engineer, citing the efficiency of bamboo and honeycomb structures. Topology optimization allows engineers to apply these principles, defining requirements and constraints to let the software generate the most efficient and lightweight design concepts.

Mr. Mayank Maroliya

Mr. Mayank Maroliya of IIT Bombay, under the guidance of Prof. Sandip K. Saha, delivered a presentation on the "MATLAB Implementation of an Anisotropic Thermal Model for Honeycomb Heat Sinks." The research focused on developing a numerical model to investigate the performance of a Solid-Solid Phase Change Material (SSPCM) filled heatsink designed for cooling computing chips in avionics systems.

Problem and Simulation Approach

Objective: The primary goal was to create a robust numerical model capable of handling the heatsink's complex honeycomb geometry and the anisotropic (direction-dependent) thermal properties of the phase change material.

Tool Selection: MATLAB was chosen for its computational efficiency, its ability to provide precise simulation control, and its suitability for rapid design optimization.

Methodology: To simplify the complex problem, the analysis was reduced to estimating the transient temperature distribution within a single 3D honeycomb cavity filled with the Phase Change Material (PCM), a substance that stores and releases heat by changing its phase.

Conclusion on Computational Best Practices

Fundamentals First: The presentation concluded with a strong emphasis on mastering the fundamentals before tackling complex 3D transient scenarios.

Physics Before Programming: A key takeaway was the importance of thoroughly understanding the underlying physics, such as heat transfer mechanisms, before attempting to write the programming logic.

Incremental Development and Validation: Maroliya advised building MATLAB programming skills incrementally and stressed the need to systematically validate and debug code by verifying results against known analytical solutions.

Ms. Priya Tiwari and Mr. Peeyush Mahajan

Ms. Priya Tiwari and Mr. Peeyush Mahajan, under the supervision of Prof. Sushil Mishra, delivered a presentation on the "Effect of Strain Path on the mechanical and microstructural behaviour during the sheet metal forming." The talk covered the critical need for biaxial testing of advanced alloys and the application of micro incremental forming for modern technologies.

Biaxial Characterization of AA2219 Alloy

Motivation: The research focused on AA2219, an alloy used in cryogenic fuel tanks for space vehicles. Since these components operate under biaxial (multi-directional) stress, traditional uniaxial (single-direction) tests are insufficient for ensuring safe design.

Methodology: The team conducted planar biaxial tensile tests at various temperatures, validating their experimental results with FEA simulations and the Yld2000-2d material model.

Key Findings: At room temperature, the material's biaxial strength is less than its uniaxial strength. Increasing temperature significantly reduces strength, with a severe drop at 300°C. When comparing welding methods, Friction Stir Welding (FSW) performed better than TIG welding, though the weld was still weaker than the base material.

Micro Incremental Sheet Forming (μ-ISF)

Flexible Manufacturing: The presentation also introduced Micro Incremental Sheet Forming (μ-ISF), a highly flexible, die-less manufacturing process suitable for creating complex parts like cranial implants.

Application in EVs: A key application highlighted was the fabrication of microchannels. These are essential components in the cooling plates used for thermal management of battery packs in electric vehicles (EVs), including hybrid and pure-electric models.

Mr. Sachin SB

Mr. Sachin SB, from the Mechanical Engineering Department at IIT Bombay, presented a novel method for accelerating Computational Fluid Dynamics (CFD) simulations. Under the guidance of Prof. Atul Sharma, the presentation detailed a "Reduced Order Modelling and Deep Neural Network-based Computational Method" designed to make parametric CFD studies more efficient.

The Problem with Conventional CFD

Computationally Expensive: The core problem addressed is that CFD is extremely time-consuming for parametric studies. A single simulation can take hours or days to run.

Impractical for Large Studies: Exploring a large design space with many parameter combinations is often impractical, as it could require months of computation time.

The ROM-DNN Hybrid Solution

Reduced Order Modelling (ROM): The proposed solution first uses a technique called Proper Orthogonal Decomposition (POD) to reduce the dimensionality of complex CFD data. This captures the dominant flow dynamics in a compact set of "modes."

Deep Neural Network (DNN): A Deep Neural Network is then leveraged to accurately predict these modes for new parametric conditions. This predictive capability eliminates the need to re-run the costly CFD solver for each new parameter set.

Conclusion and Impact

- The in-house ROM-DNN method provides a powerful and highly accurate predictive tool for accelerating time-periodic CFD simulations.
- The final result is a tool that is several orders of magnitude faster than conventional CFD, making it well-suited for rapid parametric investigations, design optimization, and even real-time control applications in engineering systems.

Mr. Aman Vardhan Verma

Mr. Aman Vardhan Verma, from the Department of Mechanical Engineering at IIT Bombay, presented a "Hybrid PINN-CFD Methodology for Accelerating Rayleigh-Benard Convection Simulations." Under the guidance of Prof. Atul Sharma, the research detailed a novel approach that integrates Artificial Intelligence with traditional Computational Fluid Dynamics (CFD) to significantly improve simulation efficiency.

Integrating AI with CFD

- The methodology is based on Physics-Informed Neural Networks (PINNs), a deep learning framework used to solve partial differential equations.
- The goal of ML-CFD integration is a potential transformation in high-fidelity simulation, drastically reducing computation time and the need for extensive computational resources.
- Major benefits include the generation of a higher-order continuous solution (a function) instead of discrete data points, and a reduction in the resources needed for parametric studies.

The Novel Hybrid Solver

- The presentation concluded that the novel hybrid CFD & PINN methodology was successfully demonstrated to reduce the overall computational time compared to classical approaches.
- This hybrid method overcomes the problem of slow convergence often seen in pure PINN models.
- The model's superiority lies in its structure: it strategically replaces the computationally intensive Machine Learning training for vorticity and temperature with the more efficient CFD-FDM (Finite Difference Method). This combination creates a true hybrid solver that is both fast and efficient.

Ms. Jui Charudatt Karmalkar

Ms. Jui Charudatt Karmalkar of IIT Bombay's Mechanical

Engineering Department delivered a presentation on "Phase-field Method based Simulation of Fracture using MOOSE Framework." Under the supervision of Prof. Tanmay Bhandakkar and Prof. Salil Kulkarni, the work details a computational approach to analyzing crack propagation in composite materials subjected to dynamic loading.

The MOOSE Framework

Overview: MOOSE (Multiphysics Object-Oriented Simulation Environment) is an open-source, parallel, finite-element framework designed to solve complex physics problems. It is used by leading national laboratories in the United States.

Operation: The framework is lightweight and terminal-based, not requiring a graphical user interface (GUI). Users define their problem in an input file, which is then processed by a compiled executable.

Input File Structure

Key Elements: Any input file in MOOSE must contain seven essential elements, or "Systems."

Components: These systems include Mesh (defining geometry), Variables, Kernels (governing equations), BCs (constraints), Materials (properties), Executioner (solver options), and Outputs (for visualizing results).

Phase-Field Formulation for Fracture

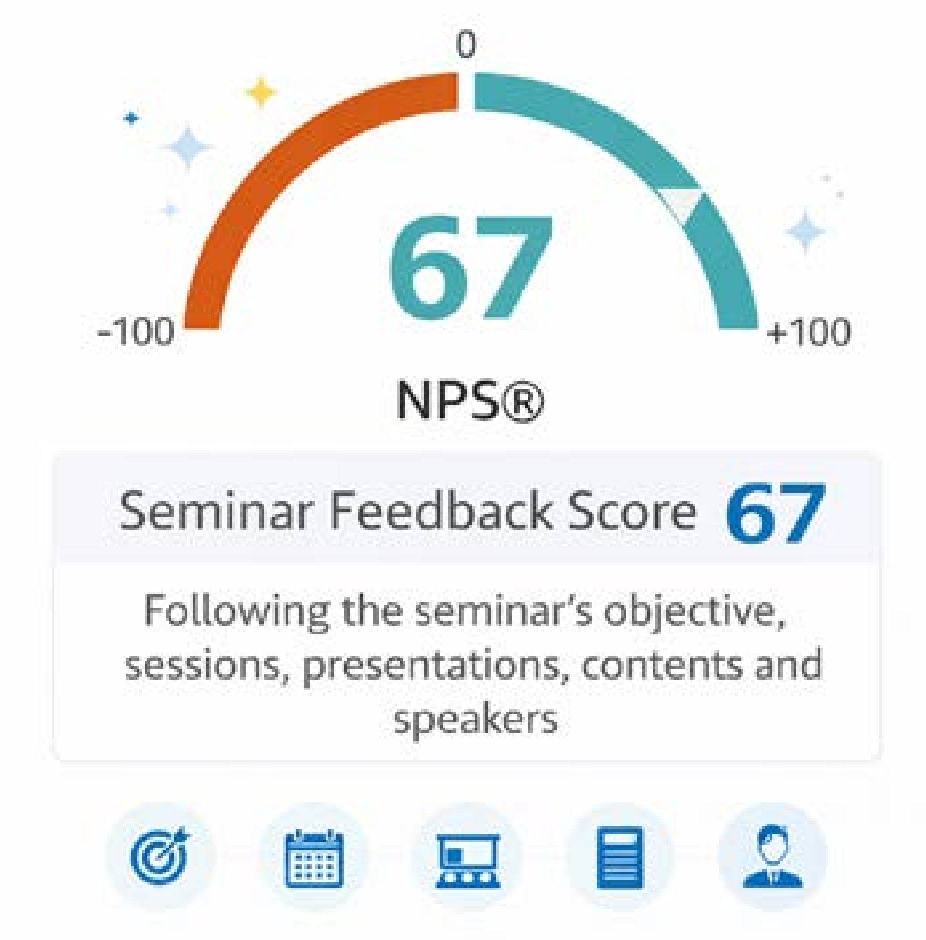
Research Focus: The study focuses on the computationally expensive problem of tracking crack propagation, which is an unknown, moving boundary.

Methodology: A "phase-field" parameter is used to model the sharp crack as a smooth, controllable interface, simplifying the tracking process.

Implementation: The MOOSE framework was chosen for this study due to its parallelism, which allows for efficient dynamic mesh refinement that follows the crack's movement, enabling various tests and increasing computational efficiency.

REGISTRATION & ATTENDANCE

NET PROMOTER SCORE (NPS) FOR MEED BOMBAY



EXPECTATIONS & SUGGESTIONS

Expectations

- How Educational Institute will connect with core industries
- How does the core Engineering Branches will perform in future
- Opportunity for the engineering professionals currently in market
- About the emerging technologies
- More on the employment for freshers' candidates of core engineering branches

Suggestions

- More interaction with audience would have made it even better
- ASME new approach to be discussed
- Some actual studies and trends should be discussed about recent developments in academic and industrial activities in that particular region. Need to reach more working professional
- In future, a short panel discussion or open Q&A with both academic and industry leaders together would add even more value.
- More particular problems should be discussed on employment.