REPORT

Emerging Trends in Additive Manufacturing for Real Life Applications

Date:15-12-2025 to 20-12-2025, Lakireddy Bali Reddy College of Engineering

AICTE TRAINING AND LEARNING ACADEMY

6-Days AICTE sponsored FDP was conducted from 15th to 20th December 2025 in which 47 participants from various institutions around Vijayawada.

The speakers for the 6-day FDP on “Emerging Trends in Additive Manufacturing for Real Life Applications” were:

	Name of the Expert: Dr. Y Ravi Kumar Designation: Professor & Head Organization: NIT Warangal Experience in Years: 20

	Name of the Expert: Dr. Adepu Kumar Designation: Professor Organization: NIT Warangal

	Name of the Expert: Dr. Gururaj Telasang Designation: Scientist E Organization: ARCI Hyderabad Experience in Years: 20

	Name of the Expert: Dr. M Ravi Shankar Designation: Professor & Head Organization: IIT Tirupathi, Tirupathi Experience in Years: 13

	Name of the Expert: Dr. TVK Gupta Designation: Associate Professor Organization: VNIT Nagpur Experience in Years: 15

	Name of the Expert: Mr. Yogendra Srivastava. Designation: Founder CEO Organization: VSD – 3D Hyderabad Experience in Years: 15

	Name of the Expert: Dr. K Siva Prasad Designation: Head R&D Organization: T-Works, Hyderabad Experience in Years: 20

	Name of the Expert: Mr. K Rakesh Designation: Technical and Industry officer Organization: National Centre for Additive Manufacturing. Experience in Years: 15

FDP Application Number: 1743739704
Title of the FDP: Emerging trends in Additive Manufacturing for Real Life Applications
FDP Start Date: 15/12/2025 **FDP End Date:** 20/12/2025

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
9:00 – 9:30 **Inauguration**					
9:30 – 12:00 **Session 1** **Name of the Expert:** *Dr. Y Ravi Kumar* **Designation:** Professor & Head **Organization:** *NIT Warangal* **Experience in Years:** 20 **Topic to be taught:** *Design for Additive Manufacturing (DfAM)*	**9:30 – 12:00** **Session 3** **Name of the Expert:** *Dr. Adepu Kumar* **Designation:** *Professor* **Organization:** *NIT Warangal* **Experience in Years:** 25 **Topic to be taught:** *Recent trends in additive manufacturing*	**9:30 – 12:00** **Session 5** **Name of the Expert:** *Dr. M Ravi Shankar* **Designation:** *Professor & Head* **Organization:** *IIT Tirupathi, Tirupathi* **Experience in Years:** *13* **Topic to be taught:** *Post Finishing of Additive Manufactured Complex Surface Features*	**9:30 – 12:00** **Session 7** **Name of the Expert:** Dr. *TVK Gupta* **Designation:** *Associate Professor* **Organization:** *VNIT Nagpur* **Experience in Years: 15** **Topic to be taught:** Issues in Metal Additive Manufacturing using Laser Cladding Process.	**9:00 – 1:00** **Industrial visit** **Name of the Organization:** *CITD Sub Centre, Vijayawada* **Complete address with Pin code:** *54-2-9 behind sunlight steel industries phase 3, Auto Nagar, Vijayawada, Andhra Pradesh 520007* **Industry Type:** *Engineering services* **Area of specification:** *Centre for rapid prototyping.*	**9:30 – 12:00** **Session 10** **Name of the Expert:** *Mr. K Rakesh* **Designation:** Technical and Industry officer **Organization:** *National Centre for Additive Manufacturing.* **Experience in Years:** 15 **Topic to be taught:** Frontier materials for Real life 3D printing applications
12:00 – 1:00 **Article Discussion** **Title of the Research Paper:** Design for Additive Manufacturing (DfAM): A Comprehensive Review with Case Study Insights **Name of the journal:** JOM **Year of Publication:** *2025*	**12:00 – 1:00** **Article Discussion** **Title of the Research Paper:** Investigating the performance of aluminium-steel bimetallic structure fabricated through Wire and Arc Additive Manufacturing with interlayer approach **Name of the journal:** Structures ***Publication:*** *2025*	**12:00 – 1:00** **Article Discussion** **Title of the Research Paper:** Sustainability aspects of composite filament fabrication for 3D printing applications **Name of the journal:** Advanced Industrial and Engineering Polymer Research **Year of Publication:** *2025*	**12:00 – 1:00** **Article Discussion** **Title of the Research Paper:** Influence of buffer layer on surface and tribomechanical properties of laser cladded Stellite 6. **Name of the journal:** Materials Science and Engineering: B **Year of Publication:** 2021		**12:00 – 1:00** **Article Summary**
1:00 – 2:00 **Lunch**	**1:00 – 2:00** **Lunch**	**1:00 – 2:00** **Lunch**	**1:00 – 2:00** **Lunch**	**1:00 – 2:00** **Lunch**	**1:00 – 2:00** **Lunch**
2:00 – 4:30 **Session 2** **Name of the Expert:** *Dr. Y Ravi Kumar* **Designation:** Professor & Head **Organization:** *NIT Warangal* **Experience in Years:** 20 **Topic to be taught:** *Design and fabrication of Patient-specific Implants using Metal additive Manufacturing.*	**2:00 – 4:30** **Session 4** **Name of the Expert:** *Dr. Gururaj Telasang* **Designation:** Scientist E **Organization:** *ARCI Hyderabad* **Experience in Years:** 20 **Topic to be taught:** *Laser Additive manufacturing of Metal components*	**2:00 – 4:30** **Session 6** **Name of the Expert:** *Dr. M Ravi Shankar* **Designation:** *Professor & Head* **Organization:** *IIT Tirupathi, Tirupathi* **Experience in Years:** *13* **Topic to be taught:** *Sustainable aspects of Additive Manufacturing Technology*	**2:00 – 4:30** **Session 8** **Name of the Expert:** *Mr. Yogendra Srivastava.* **Designation:** Founder CEO **Organization:** *VSD – 3D Hyderabad* **Experience in Years:** 15 **Topic to be taught:** Decision Making and Applications in Additive Manufacturing	**2:00 – 4:30** **Session 9** **Name of the Expert:** *Dr. K Siva Prasad* ***Designation:*** *Head R&D* **Organization:** *T-Works, Hyderabad* **Experience in Years:** *20* **Topic to be taught:** *Additive Manufacturing for Aerospace Engineering and various facilities available at T-Works.*	**2:00 – 4:00** **MCQ & Reflection Journal**
4:30 – 5:30 **Hands on training /Labs**	**4:30 – 5:30** **Hands on training /Labs**	**4:30 – 5:30** **Hands on training /Labs**	**4:30 – 5:30** **Hands on training /Labs**	**4:30 – 5:30** **Hands on training /Labs**	**4:00 – 5:00** **Valedictory Session**

The following participants were given approval for attending the One week FDP.

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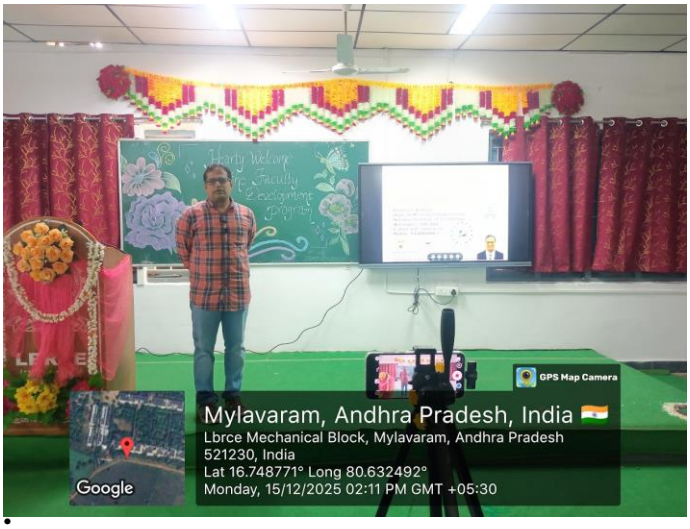
Day 1 **Date: 15-12-2025**

Session 1:

Dr. Y. Ravi Kumar who is Head of Department of Mechanical Engineering, NIT Warangal, Telangana State, gave a talk on *Design for Additive Manufacturing (DfAM)*. He was one of the most well-known presenters in the field of AM processes. He started talking about the Industrial Revolution 4.0 and 5.0. What is additive manufacturing (or 3D printing)? Later, He talked about how to classify AM processes, the design curve and steps in the AM process, the feedstock for AM, single-step processes in polymer and metal, DfAM design approaches, redesign for AM, a redesign-based approach in AM, topology optimization and bionic design, design guidelines for part consolidation, design guidelines for AM tooling design, design rules for polymer and metal AM, machine learning techniques in AM, and build simulation and challenges in AM.



Article Discussion:

Dr. Y. Ravi Kumar, Professor & Head, Department of Mechanical Engineering, NIT Warangal, Telangana State.

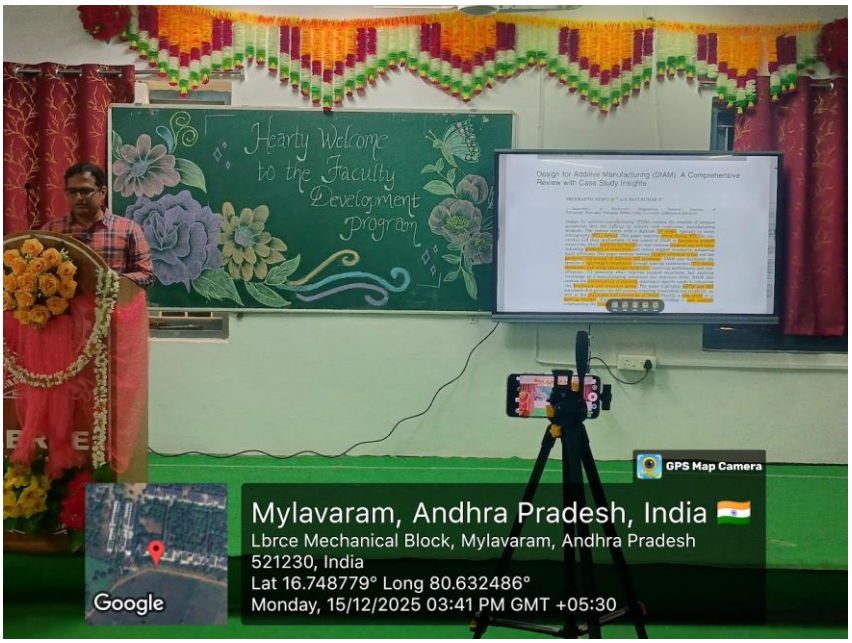
Paper Title: Design for Additive Manufacturing (DfAM): A Comprehensive Review with Case Study Insights,

Journal Name: JOM, The Minerals, Metals & Materials Society, Volume 77, pages 3931–3951,

DOI: https://doi.org/10.1007/s11837-025-07164-x

Publisher: Springer

He discussed the following: What are the main objectives of the paper? How to collect the literature relevant to the topic? he discussed on design for additive manufacturing (DfAM),



creation of complex geometries that are difficult to achieve with traditional manufacturing methods. One of the key aspects of DfAM is optimizing support structures, which stabilize the build but may increase material use and costs. Adjusting geometry or orientation can reduce support structures, enhance build efficiency. He explained the many forms of support structures as well as their geometric restrictions. DfAM was used to create lightweight components using topology optimization (TO), lattice structures, and lightweight materials, resulting in improved performance and cost effectiveness. DfAM also allows for product customization, which meets unique needs in industries such as healthcare and consumer goods.

Session 2:

Dr. Y. Ravi Kumar presented on Design and Fabrication of Patient-Specific Implants using Additive Manufacturing; It inspired many participants. In his presentation some contents are why physical models are required in the medical field. Fabrication of Physical Models, Medical Image Processing Software for AM, Steps in Medical AM, Bio-Metals and Alloys, AM Processes in Medical Applications, Medical Application Development, Medical Application Development from CT/MRI and RE Data, and Process Chain for the Production of Medical Models. Further he presented some case studies relevant to medical field. Case studies are

- Cranioplasty: Modelling and Analysis of Cranial Implant,
- Dental: Implant Placement

- Mandibular Distraction Osteogenesis
- Ameloblastic Fibroma of Mandible/Cancerous Bone Reconstruction
- Tempero Mandibular Joint Ankylosis
- Basal Osseointegrated Implant

Finally, he has given information on some funding opportunities in medical additive manufacturing (AM).

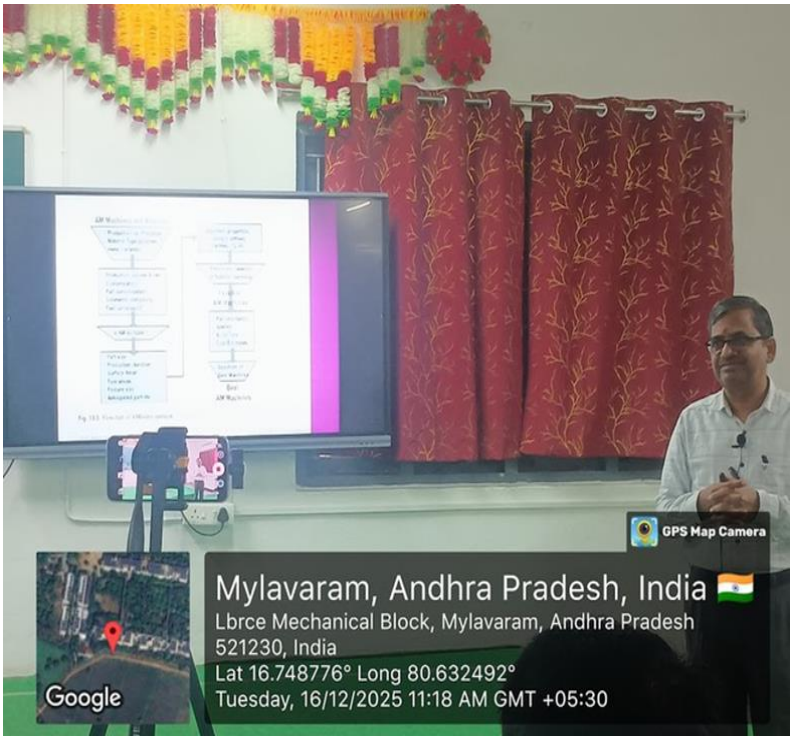
Hands-on Training

Hands-on experience with modelling software and the creation of small 3D geometric components. Modelling elements: sketches, drawings, etc.

Day 2 **16-12-2025**

Session 3:

A prominent resource person Prof. Adepu Kumar, Head of the CoE for Digital Manufacturing and Automation, Mechanical Engineering Department, NIT Warangal, delivered a talk on "Recent trends in additive manufacturing: automobile and aerospace applications." He discussed initially on the Introduction to Additive Manufacturing (AM) process; further, he has elaborated on various concepts like Non-Beam-Based Additive Manufacturing, Friction Stir Additive Manufacturing (FSAM), Additive Friction Stir Deposition, Wire Arc Additive Manufacturing (WAAM), Beam-Based Additive Manufacturing, Direct Energy Deposition Process, Powder Bed Fusion Process, and Hybrid Manufacturing Process.



Article Discussion:

Prof. Adepu Kumar, Head of the CoE for Digital Manufacturing and Automation, Mechanical Engineering Department, NIT Warangal.

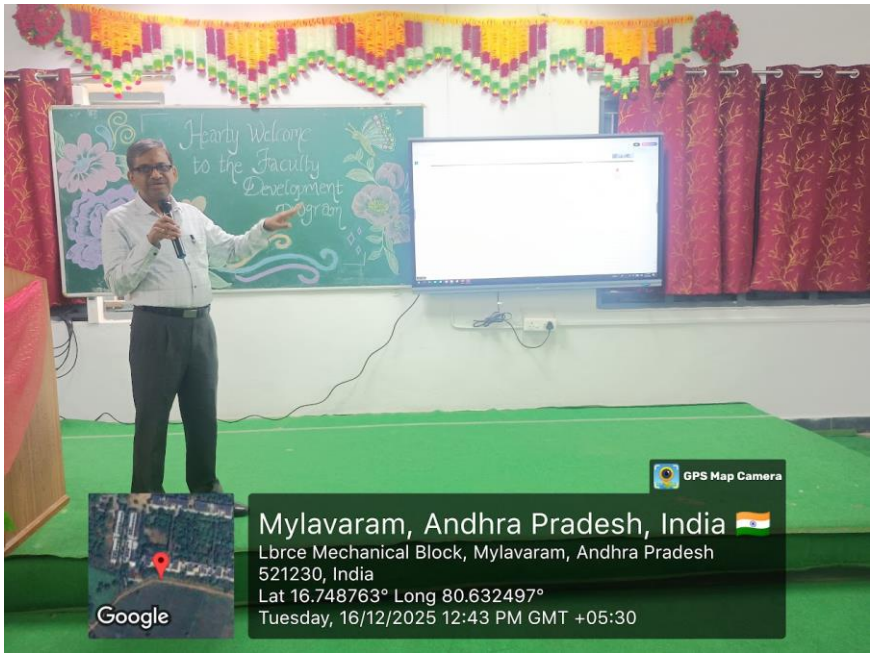
Paper title Investigating the performance of aluminum steel bimetallic structures fabricated through wire and arc additive manufacturing with an interlayer approach.

Journal Name: Structures, Volume 72, February 2025, 108304.

https://doi.org/10.1016/j.istruc.2025.108304

Publisher: Elsevier

He explained the article discussion entitled, “Investigating the performance of aluminum steel bimetallic structures fabricated through wire and arc additive manufacturing with an interlayer approach.” Detailed discussion on the literature survey on bimetallic aluminum-steel structures using WAAM technique. The paper addresses the aim of evaluating the performance of bimetallic structures in terms of tensile strength and hardness-related mechanical properties, which are crucial for the usability of these materials in various engineering applications. How to conduct experiments and then measured the performances characteristics elaborated. Some characterization techniques are advanced methods of analysis such as X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), and Energy Dispersive Spectroscopy (EDS). Derived results from such analyses will allow the explanation of microstructural features, phase compositions, and elemental distribution at the interfaces, which will be very important for an insight into bonding quality and overall performance of aluminum-steel bimetallic structures.

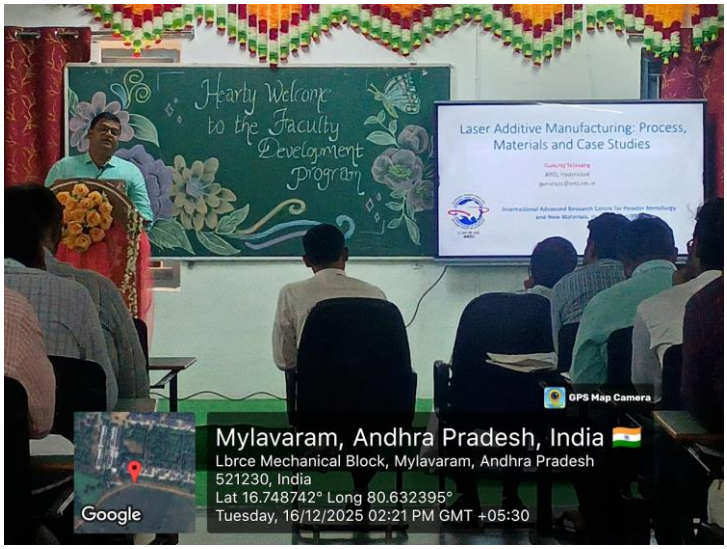


Session 4:

Dr. Gururaj Telasang, Scientist–E, International Advanced Research Centre for Powder Metallurgy and New Materials, Hyderabad. He delivered a talk on laser additive manufacturing: Process, Materials, and Case Studies. In the initial stage of the presentation, he explained the AM powder and advanced materials through the ARCI facilities. The facilities available in the ARCI are Powder Bed Fusion – Laser Beam – Melting (PBF-LB/M), Major Processing Facilities-Electron Beam Melting – AM, Selective Laser Melting, 10 & 6 kW Diode Laser, WAAM Setup, and Inert Gas

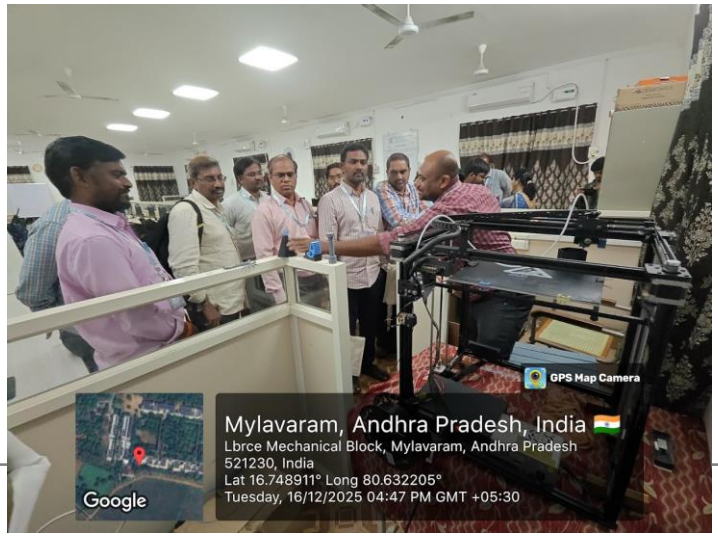
Atomization. Advanced powder characteristic facilities are also available and used to characterize morphology (size, shape, and surface roughness) and particle size and distribution (PSD). He also mentioned how to overcome the defects that occur when preparing materials. Finally, he presented case studies for AM process development in-house.

- Case Study I: Additively Manufactured High-Performance Conformably Cooled H13 Tool Steel Die Insert for Pressure Die Casting, Core-Pin with Conformal Cooling Channels: AISI H13 Tool Steel.
- Case Study II: Hybrid AM Demonstration-solutionizing temperature on the microstructural evolution of AM IN718 alloy, SS316L-IN718 superalloy bimetallic structure, and designed & developed components.



Hands-on Training

Hands-on practice with modelling software and 3D geometric file conversion formats, like STL, IGES, etc. The session covered conversion of file size, color options, single-component files, multiple-component files, and methods for error elimination.



Day 3 **Date: 17-12-2025**

Session 5:

The session 5 was conducted by Dr. Mamilla Ravi Sankar, Professor & HOD, Department of Mechanical Engineering, Indian Institute of Technology Tirupati, Andhra Pradesh. He is an eminent speaker in the field of additive manufacturing processes and a top 2% scientist in the world. His talk was on finishings of complex external and internal surface features on additively manufactured components. He discussed the importance of the AM process and post-processing techniques. His presentation covered various contents like conventional finishing: centrifugal iso-finishing, belt and drag finishing, vibratory finishing of 3-D printed implants, and the abrasive flow nano-finishing process.

Surface finishing characterization methods like XRD, EDS, SEM, AFM, and EBSD were discussed in detail. Some machining parameters on how to maximize and take advantage of the process were mentioned. Flow and deformation properties of the various mediums, effect of the percentage of the viscous component on the finishing, finishing of 3D metal features, Medium Capability—SLM Components, Laser Micromachining & Associated Thermal Layers, and Temperature Effect Based on Rheology of PRA Medium were discussed. He also discussed some case studies, such as Surface characterization before and after AFF, Nano Finishing of Fuel Injector and Turbulent Holes, and about the future scenarios like technology transfer and services.

Article Discussion:

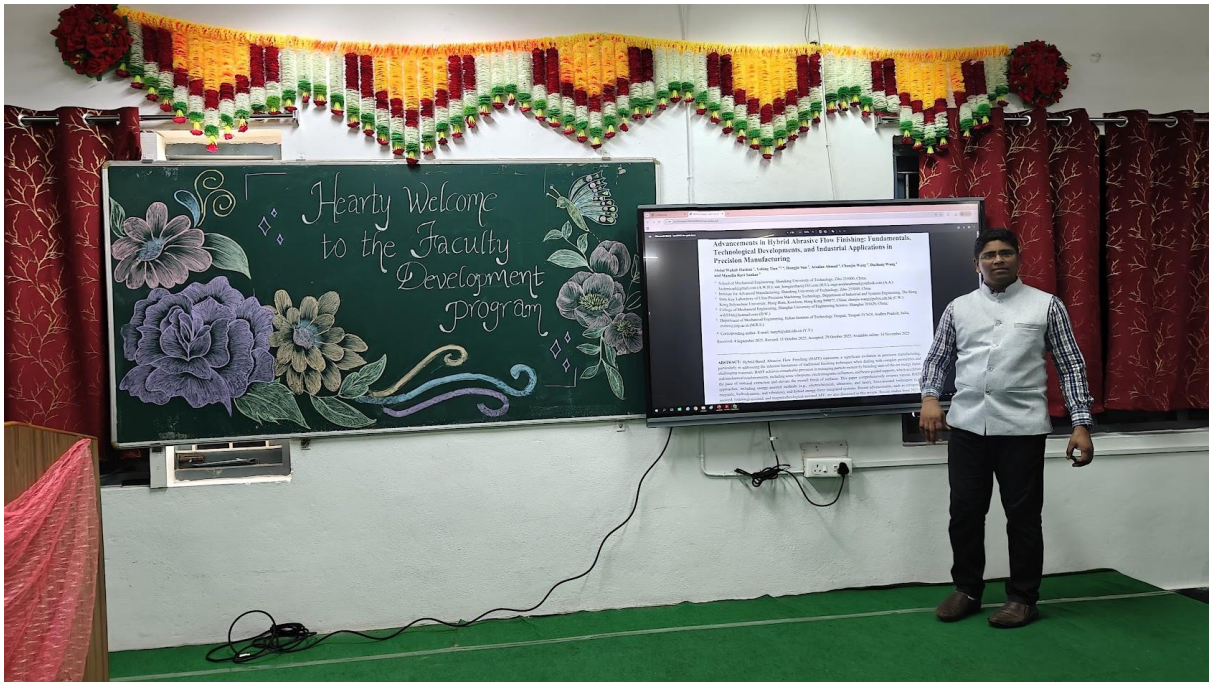
Paper Title: Advancements in Hybrid Abrasive Flow Finishing: Fundamentals, Technological Developments, and Industrial Applications in Precision Manufacturing

Journal Name: Intelligent and Sustainable Manufacturing 2025, 2(2), 10031; DOI: 10.70322/ism.2025.10031

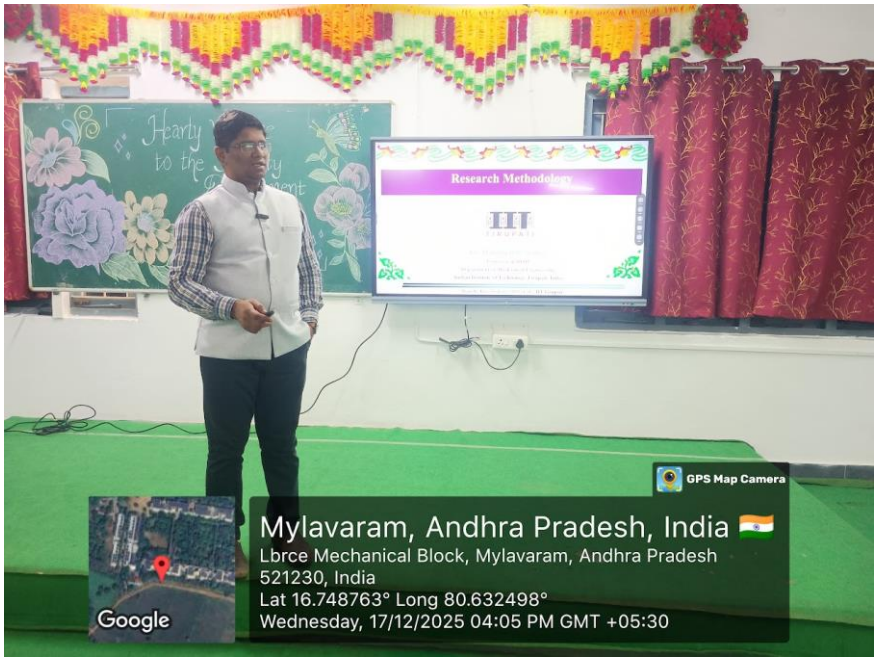
Publisher: Scientific E-Journals publishing

The paper comprehensively reviews various HAFF approaches, including energy-assisted methods (e.g., electrochemical, ultrasonic, and laser), force-assisted techniques (e.g., magnetic, hydrodynamic, and vibration), and hybrid energy-force integrated systems. It examines all existing HAFF technology solutions and evaluates product applications for aerospace, automotive, medical equipment, and micro-manufactured devices. The importance of the paper is that hybrid-based abrasive flow finishing (HAFF) represents a significant evolution in precision manufacturing,

particularly in addressing the inherent limitations of traditional finishing techniques when dealing with complex geometries and challenging materials.



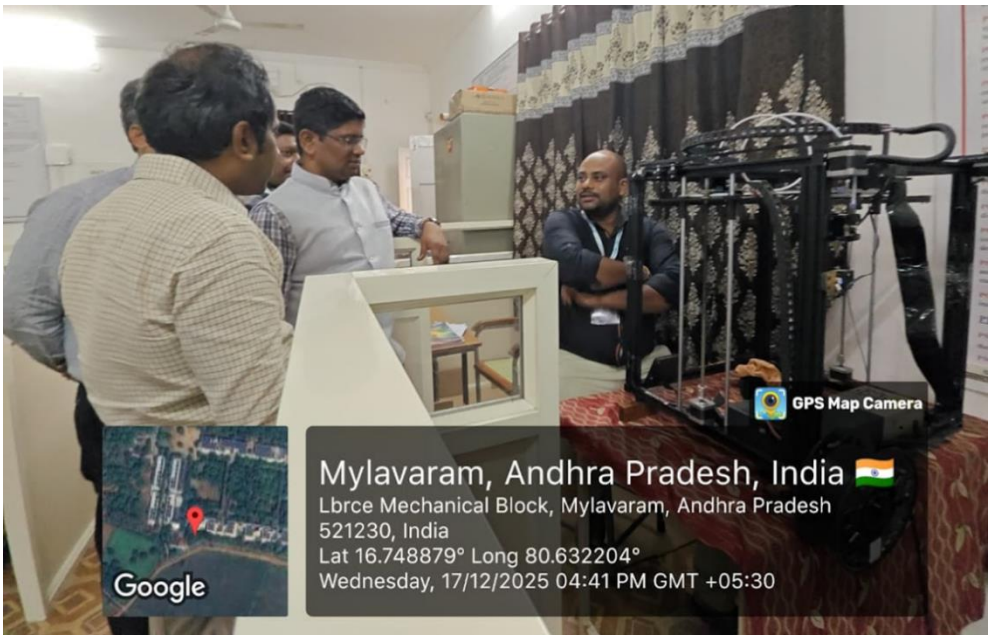
Session 6: Research Methodology



As a part of the session of Research methodology, Dr. M Ravi Shankar talked about the systematic approach that seamlessly integrates literature review, material selection, process parameter optimization, fabrication and characterization. He stressed on the importance of identifying the knowledge gaps that the researchers have to identify when starting on working with AM technology and he imparted the value of integrating the relevant industry partners into the research as it could benefit both the parties.

Hands-on Training

We imported modelling software files for hands-on practice into the machine. With STL files converted to suitable supported software (like slicer and 3D). Slicer software installation and utilization were discussed. The important input parameters for the 3D printer were explained. How to mention the input parameters to build components, estimation of time, layer height, thickness, shape, wire type, color, etc were practiced.



Day 4 **Date: 18-12-2025**

Session:7

Mr. Yogendra Srivastava, Founder and CEO of VSD Enterprises (VSD-3D), Hyderabad, Telangana as a resource person, delivered a talk on decision-making in Additive Manufacturing. He presented on, Introduction to Additive Manufacturing (AM), the journey of the AM process from 1984 to 2025. He explained the changes and innovations that have occurred in the field of rapid prototyping and additive manufacturing. He discussed the first invention and patent of a rapid prototyping machine. He covered the following topics: Technologies in AM, materials in AM, cost to material map, decision-making in plastic AM, decision-making in metal AM, and applications in AM. Later, he considered some live case studies, such as the English race car, the GE aircraft engine bracket, the Crown & Bridge for dental and Jewellery manufacturing, and finally display models in any industry.

Article Discussion:

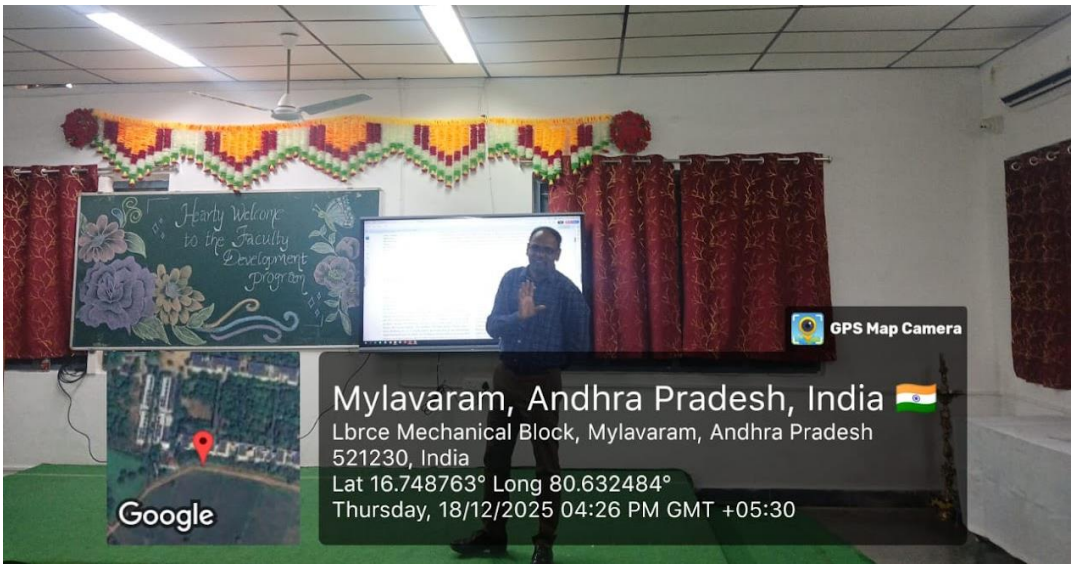
Dr. T V K Gupta, Associate Professor, Department of Mechanical Engineering Visvesvaraya National Institute of Technology, Nagpur.

Paper title: Influence of buffer layer on surface and tribomechanical properties of laser cladded Stellite 6.

Journal Name: Materials Science & Engineering B, 2021, 263, 1147799, https://doi.org/10.1016/j.mseb.2020.114799

Publisher: Elsevier

The main objective of the work was to study and compare the surface flaws, microstructure, micro-hardness, and wear resistance of Stellite 6 clads with a buffer layer with direct-deposited Stellite 6. The deposition of Stellite 6 with an Inconel 625 buffer layer on SS316 substrate materials. A Laserline LDF 4000–100 fiber-coupled diode having a maximum output power of
4 kW was used as the laser cladding system. The optimized process parameters, such as laser power from 2700 to 3200 W, scanning speed (V) of 20 mm/s, and powder feed rate of 45 g/min, were selected. Performance measures used different equipment, like wire EDM, disk polishing, optical microscope [G40x, Olympus], SEM [JEOL 6380A], and Vickers hardness tester [TUKON 2100, Wolpert, INSTRON]. Wear tests were performed on a Pin-on-Disc tribometer [Ducom, India]. When results were observed, it was found that dilution was reduced by 25% and 10%, whereas the microhardness showed an improvement of 12% and 5% with the addition of a buffer layer. Further, a fine-grain microstructure was found in buffer layer clads at the interface zone. The wear rate showed improvements of 14% and 3%, respectively, with a low coefficient of friction (COF) in buffer layer deposition because of high microhardness and fine grain microstructure. Thus, the laser cladding of Stellite 6 at the lower LHI with a buffer layer has shown excellent mechanical and microstructural properties.



Session 8:

Dr. T. V. K. Gupta, Associate Professor, Department of Mechanical Engineering, Visvesvaraya National Institute of Technology, Nagpur, acted as a resource person. He presented issues in metal additive manufacturing using the laser cladding process. The main objective of the presentation was to discuss distortion and the deflection history in metal additive manufacturing. Types of deflection

trends observed during the cladding process include the longitudinal bowing mode of distortion, which is also seen in other samples. He has explained some current work related to cladding of Stellite 6 and Inconel 718. Deposition of materials, parametric effect on the geometry, mechanical properties, microstructure evolution of single- and multi-layer cladding, Stellite 6 with buffer layer, temperature profile obtained during simulation of DED, SEM micrographs, EDS analysis, and elemental mapping: Nb distribution, clad geometry features, grain growth, dendrite matrix, and distortion residual stresses in DED components. Finally, he addressed the participants; ongoing projects and work-related presentations were given, one of which was Online Monitoring and Characterization of Distortion in the multi-Layer Laser Cladding Process. Another one is metal additive manufacturing using laser cladding for Inconel 718.

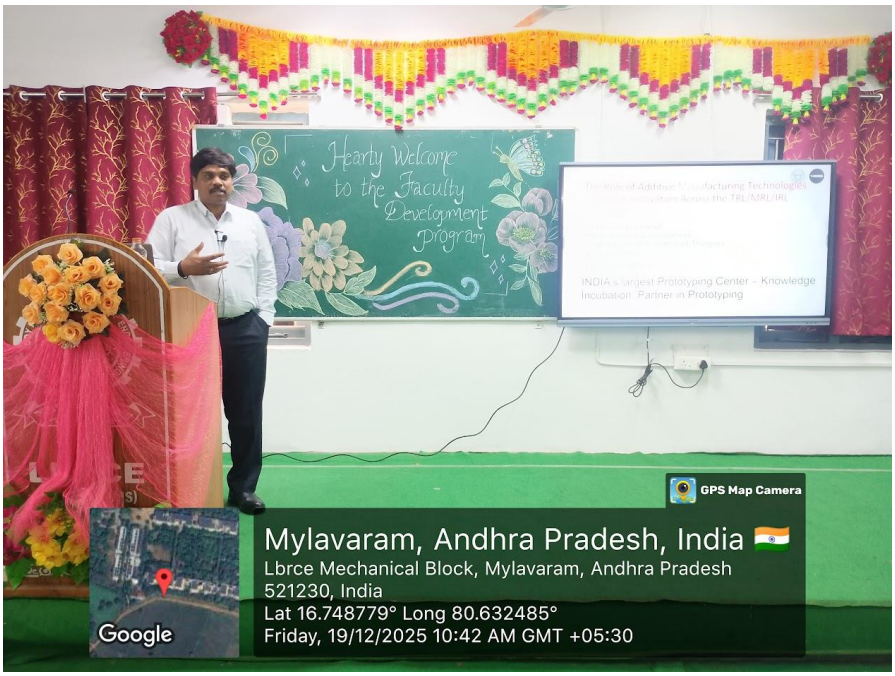
Hands-on Training:

Participants successfully build 3D components using an FDM machine based on their required modelling component.

Day 5 **Date: 19-12-2025**

Session 9:

Dr. Kowdodi Siva Prasad, Head of Research & Development, T-Works Foundation, Hyderabad, Telangana. The speaker delivered an insightful talk on the role of additive manufacturing technologies in driving innovation across the TRL/MRL/IRL spectrum, covering the importance of innovations and entrepreneurship in society, and also discussed some recent prototyping from TRL to TRL9. Some prototypes were developed through the innovative materials of the rover, spinal cord, test benches, virtual WEBOT-ROS, and complex problems. He also discussed various concepts, including understanding complex equipment, prototypes, problems, shapes, sizes, quantities, and quality; defining the boundaries of problems, failures, and successes; considering what to think and how to think; engaging in out-of-the-box thinking; and finally, managing our time.



Industrial Visit

An industrial visit to the Center Institute of Tool Design—MSME, Vijayawada was organized. The center was equipped with state-of-the-art infrastructural facilities in the field of materials fabrication

and machining. In this center, one of the prominent sections was designing dies and tools with advanced materials for Aerospace and Automobile applications. CITD was to meet the requirements of industry in the fields of tool design and manufacture and to train technical personnel in these fields. It also provides consultancy and advisory services, including assistance in the design and development of tools. CITD also recommends measures to standardize tools and tooling elements, including components of jigs, fixtures, and dies, and aims to provide skill development in cutting-edge technologies such as CAD/CAM, AI, electronics, and pneumatics. The FDP participants observed the various machines and machining processes. The SLA machine was used to fabricate polymer components with intricate geometries and functional components.

Day 6 Date: 20-12-2025

Session 10:

Mr.Rakesh Koppunur, Technical cum Industry Officer, National Center for Additive Manufacturing (NCAM), Hyderabad, Telangana. He explained the topic of materials in 3D printing ecosystems. An introduction to the 3D printing materials, the materials and their advances in FDM, the manufacturing of FDM materials, VAT polymerization, metal printer materials, ceramics, bio and wax materials, and research areas in AM were discussed.

Some of the key points are mentioned below.

- Elaborate on SLA process materials: resin-based materials, standard resin, tough resin, flexible resin, high-temperature resin, durable resin, castable resin, ceramic resin, and biocompatible resins.

- Composite materials like PEKK+Carbon Fiber, PEEK+Carbon Fiber, NYLON 6+Carbon Fiber, and NYLON 6+Fiberglass.
- Ceramic Materials like Zirconia 3Y ZrO_2, Zirconia 8Y ZrO_2, Silicon Nitride Si_3N_4, Alumina-toughened Zirconia (ATZ), Silica, Alumina (Al_2O_3), Hydroxyapatite (bone powder), and Cordierite
- Biomaterials such as CELL INK – BIO INK, CELL INK – SKIN, and CELL INK – BONE.

Later he mentioned some recent problems in AM techniques. These are

- Simulation is the process of predicting the properties of metal AM parts without any testing through a computer program.
- The surface treatment process in metal AM is performed to eliminate or reduce the defects in the metal AM part.
- A complex thermodynamic equation governs the process for metal AM, and it is challenging to simulate this equation accurately using conventional computer programs.
- Due to thermal, mechanical, and metallurgical changes, residual stresses are developed in the metal additive parts.
- Hybrid metal AM combines subtractive and additive manufacturing and metal AM in a single setup.

In the afternoon session we conducted **MCQ test** related to the six-day FDP-delivered contents, followed by **& Reflection Journa**l and **Valedictory Session** with feedback from participants.

Valedictory session Photo

Dr. P Lovaraju
Co-ordinator

Dr. K Appa Rao
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