I-4AM 2022

2nd International Conference on Industry 4.0 and Advanced Manufacturing

10-11 January 2022

Centre for Product Design and Manufacturing
Indian Institute of Science, Bangalore

BOOK OF ABSTRACTS

भारतीय विज्ञान संस्थान

CPDM · IISc

सत्यमेव जयते
Department of Heavy Industry, Government of India

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2nd International Conference on
Industry 4.0 and Advanced Manufacturing

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Centre for Product Design and Manufacturing (CPDM)
Indian Institute of Science Bangalore

Programme Schedule

Day 1, Monday 10 Jan 2022

About the conference

Inaugural Session
Time: 0900-0950 IST

Keynote Sessions 1 & 2

Time: 0950-1100 IST

Chaired by: **Prof. G K Ananthasuresh** 01

Keynote Session 1

Time: 0950-1035 IST

Speaker: **Mr. Giridhar M Prabhakar** 02

Keynote Session 2

Time: 1035-1100 IST

Speaker: **Smt. Nidhi Chhibber** 03

Coffee Break
Time: 1100-1130 IST

Panel Discussion 1: Industry Needs for I4.0 & Advanced Manufacturing

Time: 1130-1300 IST

Chaired by: **Dr. Purnendu Sinha** 05

Members:

Ms. Anandi Iyer 06
Mr. Anup Wadhwa 07
Dr. Anurag Srivastava 08
Mr. Jayakaran Christopher 09
Mr. Manikandan 10
Mr. Manoj Belgaonkar 11
Mr. Rajesh Nath 12
Mr. Sudhanshu Mittal 13
Dr. U Chandrasekhar 14

Lunch Break
Time: 1300-1400 IST

Day 2, Tuesday 11 Jan 2022

2nd International Conference on
Industry 4.0 and Advanced Manufacturing

About the Conference

International Conference on Industry 4.0
& Advanced Manufacturing

I-4AM'22

Industry 4.0 uses connected intelligence to improve productivity, quality, flexibility, safety & sustainability across manufacturing enterprises, in which advanced manufacturing such as additive manufacturing or robotics plays a critical role. I-4AM 2022 (pronounced I-forum 2022) provides a platform to bring together all stakeholders in manufacturing and Industry 4.0 in India and abroad to deliberate on the nature, needs, challenges, opportunities, problems, and solutions in this transformational area.

A specific focus of I-4AM 2022 is to provide a platform for evolving a vision of, and enablers for sustainable, affordable, and human-centric Industry 4.0, and showcase cutting edge practice, research and educational innovation in this area. I-4AM 2022 is organized by the Centre for Product Design and Manufacturing, Indian Institute of Science, under its CEFC on I4.0India@IISc (Smart Factory) within the SAMARTH Udyog Bharat 4.0 programme of the Department of Heavy Industries, Government of India.

Chair

Prof. Amaresh Chakrabarti

Centre for Product Design and Manufacturing (CPDM)
Indian Institute of Science, Bangalore, India

Bio:

Amaresh Chakrabarti is a Senior Professor and current Chairman for Centre for Product Design & Manufacturing, Indian Institute of Science (IISc), Bangalore. He has BE (Mech Engg, IIEST Shibpur), ME (Mech Design, IISc) and PhD (Engg Design, Univ of Cambridge UK). He led for 10 years the Design Synthesis group at EPSRC CoE Engg Design Centre at Univ of Cambridge. His interests are in synthesis, creativity, sustainability, and informatics. He published 14 books, over 290 peer-reviewed articles, and has 10 patents granted/pending. He co-authored DRM, a methodology used widely as framework for design research. He has been Associate Editor, AI EDAM & Design Science Journal (Cambridge University Press), Area Editor, Research in Engg Design, Regional Editor, J Re-manufacturing (Springer), and Advisory Editor for 7 Journals incl. Clean Tech & Env. Policy (Springer), and J of Engg D and Int J Design Creativity & Innovation (T&F). He was on Advisory Board and Board of Management, Design Society; member, CII Design Council India; Jury, India Design Mark; invitee, CII Smart Manufacturing Council India. He founded IDeaSLab – India's first Design Observatory.

He is Programme chair for International Conference Series on Research into Design (ICoRD), 22nd CIRP Design Conference 2012, 3rd Intl Conference on Design Creativity 2015 (3rd ICDC) and vice-Chair for AI in Design and Design Computing & Cognition Conferences. He is an Honorary Fellow of Institution of Engineering Designers, the peer society under the UK Royal Charter in engg design, and TUM Ambassador Awardee from TU Munich Germany. 16 of his papers won top paper awards in international conferences. He co-initiated India's first Smart Factory Lab. He also heads IISc-TCS Innovation Lab, IISc Press, and Springer International Book Series on Design Science & Innovation. He received Careers360 Faculty Research Award 2018 for being the 'Most Outstanding Researcher' in Decision Sciences. He is the current Editor-in-Chief for AI EDAM Journal (CUP).

Chair

Prof. Satyam Suwas

Indian Institute of Science, Bangalore, India

Bio:

Prof. Satyam Suwas is a professor and currently the Chair of Materials Engineering at the Indian Institute of Science, Bangalore, India. He obtained his Ph.D. in Materials and Metallurgical Engineering from IIT Kanpur, and worked at Defence Metallurgical Research Laboratory, Hyderabad; University of Lorraine, France and RWTH Aachen, Germany before joining the Indian Institute of Science. His specialization includes materials processing, microstructural engineering and mechanical behaviour of materials. He has authored more than 300 research papers. He is a Humboldt fellow and has been conferred with Friedrich Wilhelm Bessel Award by the Humboldt Foundation, Germany. In India, Prof. Suwas was awarded Metallurgist of the year 2012 by the Ministry of Steel and was conferred eminent engineering personality in the year 2014 by the Institution of Engineers. He is a fellow of the Indian National Academy of Engineering (INAE) as well as the National Academy of Sciences, India (NASI).

Vice-Chair

Dr. Manish Arora

Indian Institute of Science, Bangalore, India

Bio:

Dr. Manish Arora is an Assistant Professor in the Centre for Product Design and Manufacturing, Indian Institute of Science (IISc), Bengaluru. He obtained Ph.D. in applied Physics from the University of Twente, The Netherlands (2006) and B. Tech in Chemical Engineering from Indian Institute of Technology, Delhi (2002). He has got 70+ patent and research publications both in national and international level to his credit. He has employed with University of Oxford, UK between 2006-10, GE global Research 2010-12 and Nanyang Technological University, Singapore 2012-14. His areas of interest include biomedical devices, co-design, collaboration, open source in design and quality manufacturing of medical devices. He is the Principal Investigator in UTSAAH Lab, which aims at developing affordable and accessible medical technology solutions for promoting universal healthcare. He also teaches courses at IISc on Mechatronics and Design of Biomedical Devices and Systems.

2nd International Conference on
Industry 4.0 and Advanced Manufacturing

Keynote Session 1 & 2

Session Chair

Prof. G K Ananthasuresh

Indian Institute of Science, Bangalore, India

Bio:

G. K. Ananthasuresh earned his bachelor's degree from IIT-Madras, master's from the University of Toledo, and PhD from the University of Michigan, Ann Arbor—all in mechanical engineering. His principal research interests are compliant mechanisms and topology optimization with applications in microelectromechanical systems, biomechanics of cells, biomedical devices, and microrobots. In addition to the research output of more than 275 journal and conference publications and 16 patents, his research group has spun off four startups. He has served as the chairman of the Mechanical Engineering Department at Indian Institute of Science, and chairman of the Centre of Biosystems Sciences and Engineering at Indian Institute of Science. He currently serves as the Dean of the Division of Mechanical Engineering Sciences, Indian Institute of Science. He is a recipient of Shanti Swarup Bhatnagar Award in 2010 for Engineering Sciences, and a Fellow of the Indian National Academy of Engineering.

Keynote Session 1

Towards a Digital Twin-driven PLM: Trends and Challenges

Mr. Giridhar M Prabhakar

Senior Project Manager and Business Developer at Siemens Technology India

Bio:

Mr. Giri Prabhakar received a B. Tech. in Metallurgical Engineering from IIT, Bombay and an MS in Materials Science and Engineering from the University of Virginia, Charlottesville, with a focus on laser ultrasonic tomography. He has more than 23 years of experience serving in engineering, research, and management positions largely in high performance and scientific computing, with seven of these in Tokyo at companies such as NKK and RIST, and more than sixteen years in Bangalore at GE (JFWTC), IBM and Siemens. He is currently a senior project manager for Software Systems and Processes at Siemens Technology, where he has led global Digital Twin-related initiatives.

Abstract:

Product lifecycle management (PLM) is at the threshold of a leap in evolution. Technologies at the heart of the fourth industrial revolution are increasingly enabling the creation and interconnection of Digital Twins that are digital clones of all phases and functions of the product lifecycle, and could even control-related processes, with a potential to transform manufacturing and business ecosystems. Glimmerings of the North Star of an end-to-end Digital Twin-driven PLM are becoming apparent. We will examine trends leading to these developments, and some challenges along the journey.

Keynote Session 2

Smt. Nidhi Chhibber

Department of Heavy Industry, Ministry of Heavy Industries and Public Enterprises, Government of India

Bio:

Smt. Nidhi Chhibber is an IAS Officer of 1994 Batch, Chhattisgarh Cadre. In the state, she has worked in the departments of mining and geology, school education, technical education and manpower planning and as Chief Electoral Officer of the state. She joined Government of India in 2017, as Joint Secretary in Ministry ofDefence. Presently she is posted as Additional Secretary, Ministry of Heavy Industries and Public Enterprises, Government of India since April 2021.

2nd International Conference on
Industry 4.0 and Advanced Manufacturing

Panel Discussion 1: Industry Needs for I4.0 & Advanced Manufacturing

Session Chair

Dr. Purnendu Sinha

Group Technology & Innovation Office, Tata Sons, India

Bio:

Dr. Purnendu Sinha works with Group Innovation, Tata Sons, where he is engaged in fostering innovation in Tata Group Companies in the Infrastructure, Manufacturing and Aerospace & Defense sectors. He additionally leads Industry 4.0 & Data Analytics initiatives. Dr. Sinha is an adjunct faculty member in CPDM, IISc. He is also associated with the DHI CoE in Advanced Manufacturing Technology at IIT Kharagpur, driving research collaborations in areas of Digital Manufacturing and Additive Manufacturing. Dr. Sinha obtained his Ph.D. in Computer Engineering from Boston University, Boston, MA. An alumnus of IIM-A, he completed 3TP: Senior Leaders' Programme at IIM-Ahmedabad. He is a Fellow of Institution of Engineers (India) and also a Senior Member of IEEE. Dr. Sinha serves as the Chair of Program Review and Monitoring Committee (PRMC) of GoI DHI's SAMARTH Udyog initiatives at four centers, IISc, IIT-D, CMTI and C4i4. He is a core member of the CII Smart Manufacturing Council, where he leads the Working Group on Assessment. He is the Chair of Manufacturing Working Group of Future Tech Panel of the IET India.

Panel Discussion 1: Industry Needs for I4.0 & Advanced Manufacturing

Panel Member

Ms. Anandi Iyer

Fraunhofer Gesellschaft, India Office

Bio:

Ms. Anandi Iyer is the Director & Head of the Fraunhofer Gesellschaft, India Office. She was for several years also Special Advisor to the Federal Ministry of Education and Research Govt. of Germany (BMBF). She has repeatedly broken through several glass ceilings, working as she does in a male dominated, a multinational field of R&D and Innovation. She has been working in the field of collaborative Technology and Innovation in the Indo-European corridor for the last more than 20 years. Leading the establishment of Fraunhofer's presence in India, she has prepared the Strategy of Fraunhofer entry to India, acquired projects of nearly 18 million Euros in contract research in a little over 5 years, and established a strong network of research partners and industry clients who are of the top 50 of the Indian Industry, as well as Government. While most other research organizations struggle to establish a profitable relationship with Industry in R&D, Ms. Iyer led from the front to collaborate with Industry and Government alike; busting the myth that Indian Industry will not pay for research. In the last 3 years, significant and large-scale projects which have been innovative and path-breaking in the Indian landscape of Industry-academia cooperation have been curated by Fraunhofer in India, under the leadership of Ms. Iyer. These include the cooperation with the Department of Heavy Industries, Government of India to help Indian Industry upgrade its innovation capability, the establishment of Center of Excellence with Indian Institute of Technology Chennai on Advanced Automotive Technologies, and the initiation of a strategic partnership with the Council of Scientific and Industrial Research (CSIR). Additionally, through the India operations, collaborations with Indian companies based in other geographies such as Africa and USA have been initiated.

Panel Member

Mr. Anup Wadhwa

Automation Industry Association (AIA)

Bio:

Anup Wadhwa is an Alumnus of IIT Delhi from where he completed his bachelor's degree in Technology in Electrical and Electronics in 1975. His passion for Digital Electronics started in college and later took him to an exciting career in the field of Industrial Automation. Mr. Wadhwa has served in systems engineering and special projects, for BHEL, a premier public sector company, Rockwell Automation, a leading technology MNC and SAMTEL. As Director AIA, he conceptualized and steered the industry partnership with IIT Delhi and the Department of Heavy Industry to set up the IITD-AIA Foundation for Smart Manufacturing. Anup is an Evangelist of the Samarth Udyog Ecosystem that integrates the efforts of different agencies in Government and Academia. He has served on Government and UNIDO Expert Committees related to country relevant initiatives in Industry 4.0, with a special focus on inter-disciplinary cooperation.

Panel Discussion 1: Industry Needs for I4.0 & Advanced Manufacturing

Panel Member

Dr. Anurag Srivastava

Society for Innovation & Development (SID)

Bio:

Dr. Anurag Srivastava is currently the COO, SID, IISc and responsible to scale Industry and IISc research collaboration to address industry's innovation, applied research and breakthrough needs to help achieve global leadership in their markets. Prior to this, he was CTO, Wipro Technologies managing business innovation using futuristic technologies, technical steam and IP management, technology alliances in advanced areas with industry and academic forums. As an alumnus of IISc and IIT-BHU, he renders the right confluence of academic-research and technology-implementation.

Panel Discussion 1: Industry Needs for I4.0 & Advanced Manufacturing

Panel Member

Mr. Jayakaran Christopher

Tata Consultancy Services (TCS)

Bio:

J Christopher is the Head of Factory of Future CoE in TATA Consultancy Services Ltd. He is responsible for providing thought leadership to industries covering Auto, Aero, Hi-Tech, Life Sciences, Energy and Resources, etc., envisioning as well as developing technologies and integrated solutions that are essential for the Factory of the Future with more Autonomous operations. He has over 30 years of experience in areas like Product Engineering, Manufacturing Systems Engineering, Manufacturing, Consulting and Technologies like IIoT, AI, ML, Cognitive Robotics, Digital Twin that are essential elements in a Factory of the Future. Before TATA Consultancy Services, he worked with leading industry players like L&T-Komatsu, Larsen & Toubro, TAFE etc. and brings rich industry experience. New to the world initiatives & Solutions like Model Smart Factory, IoT enabled Virtual Test Bed as part of IIC (Industrial IoT Consortium) initiative, Real-Time System for Monitoring and Prediction with Digital Twin as a base, Decision Support Systems, Autonomous production systems with IIoT, Advanced Robotics, Autonomous Mobile Robots / AGVs, AI, ML, and RPA are piloted, demonstrated & being deployed under his leadership. He has published technical papers at international conferences and journals like ASME. Christopher has done his Post Graduate Program in AI for Leaders from the University of Texas in Austin, Advanced Management Program (AMP) from Indian Institute of Management (IIM), Bangalore, Post Graduate Program in Advanced Manufacturing Technologies from GTTC, Chennai and Mechanical Engineering Degree from Madurai Kamaraj University.

Panel Member

Mr. Manikandan

Bureau of Indian Standards (BIS)

Bio:

Mr. Manikandan has 15 years of experience in standards development & conformity assessment activities of the Bureau of Indian Standards (BIS), the national standards body of India. He is presently handling several important technical committees developing standards in the areas such as Quantum Computing, Industry 4.0/Smart Manufacturing, Smart Cities, Identification cards etc. He is also the convener of Working Group 1 Terminology of IEC SyC Smart Cities. He is an expert in developing standards in collaboration with stakeholders from the industry, government/regulators, academia. He has Represented India in several international forums and meetings in the standardization sector.

Panel Member

Mr. Manoj Belgaonkar

Federation of Indian Chambers of Commerce & Industry (FICCI)

Bio:

Manoj Belgaonkar has done his BE in E&TC, MBA in Systems, MBA in Finance & FIE, FIETE. He is currently Head of Regulations, Standards and Quality Management in Siemens Ltd. Mumbai. He is a leading expert in the areas of technical regulations, product conformity and market surveillance. He is working closely with ministries and industry associations on these topics in the context of industry 4.0, Cybersecurity, machinery safety, application of digital technologies such as blockchain for product conformity, etc. He is a Member of Indo-German Working Group on Quality infrastructure, Senior Assessor for CII-EXIM Bank BE Awards, FICCI Quality Excellence awards, member of BIS sectional committees working on topics of Quality Management, Electrical Safety, Automations and Robotics Recognized by World Coaching Congress as Business Excellence, Coach of the Year 2019, Fellow and Life Member of The Institute of Electronics and Telecommunications Engineers, New Delhi, Fellow and Chartered Engineer of The Institution of Engineers, Kolkata.

Panel Member

Mr. Rajesh Nath

German Engineering Federation (VDMA)

Bio:

Rajesh Nath joined the VDMA in 1999 and has been leading the Indian office of The German Engineering Federation as Managing Director, since 2008. Prior to holding various positions within the VDMA, Mr Nath has worked for Mitsui Babcock, KHD Humbold Wedag in the Environmental Technology Division, and with Rheinische Kalksteinwerke. Additionally, he is a Fellow Member of International Council of Consultants, a Member of the Institution of Engineers in India, and a Fellow member of MGMI and other well-known bodies in India.

Panel Discussion 1: Industry Needs for I4.0 & Advanced Manufacturing

Panel Member

Mr. Sudhanshu Mittal

National Association of Software and Service Companies (NASSCOM)

Bio:

Having spent 25+ years in technical roles in different companies like HCL, Agilent, Marvell, Freescale, Juniper among others, Sudhanshu has gained extensive experience in embedded domain in different verticals like networking, storage, printing and imaging, medical equipment, IoT, security etc. He also holds a patent in imaging area. Sudhanshu completed his graduation in Electrical Engineering from IIT-BHU and is also a certified Intellectual Property Rights professional from Indian Law Institute. As "Head – CoE Gurugram & Director – Technical Solutions" with NASSCOM Center of Excellence – IoT & AI, Sudhanshu leads the overall operations of Gurugram CoE and is also responsible for driving the solutioning of the problem statements brought by CoE partners. Vertical focus includes Automotive and Standard verticals for CoE-IoT. The key responsibilities include: a) Responsible for P&L for the Gurugram center; b) Driving the solutioning of the problem statements brought on by CoE partners in different areas, including the healthcare, manufacturing, mobility verticals; c) Driving standard body participation from CoE-IoT for Open Connectivity Foundation (OCF) and Industrial Internet Consortium (IIC); d) Driving academic research engagement activities.

Panel Discussion 1: Industry Needs for I4.0 & Advanced Manufacturing

Panel Member

Dr. U Chandrasekhar

Wipro 3D, Bangalore, India

Bio:

U Chandrasekhar has 35 plus years of experience in engineering analysis and structural integrity evaluation of aeronautical systems. He has Carried out many additive engineering projects for defense laboratories & Worked as the Additional Director in DRDO, and as the Director-General of the Institution of Engineers (and Visiting Faculty in the Mechanical Engineering Department of IIT Bombay. He led a senior group of scientists at the Central Institute of Aviation, Moscow for flying testbed trials of a development aero engine and established the first-ever Additive Manufacturing lab of DRDO, Ministry of Defense R&D during 1999. He Carried out the Indo Canada Project on the use of drones for structural integrity evaluation. He has Studied at NIT Surathkal and IIT Madras with a focus on mechanical design and Received Gold Medal from Dr. APJ Abdul Kalam for academic excellence at IIT Madras. He is Serving for the National Board of Accreditation as a Member of the Academic Sub Committee Developed MHRD NPTEL program along with IIT Madras on Future Manufacturing Technologies. He also Mentored a few startups in the domains of 3D printing and drone technologies.

2nd International Conference on
Industry 4.0 and Advanced Manufacturing

Keynote Session 3, 4 & 5

Session Chair

Prof. Satyam Suwas

Indian Institute of Science, Bangalore, India

Bio:

Prof. Satyam Suwas is a Professor and currently the Chair of Materials Engineering at the Indian Institute of Science, Bangalore, India. He obtained his Ph.D. in Materials and Metallurgical Engineering from IIT Kanpur, and worked at Defence Metallurgical Research Laboratory, Hyderabad; University of Lorraine, France and RWTH Aachen, Germany before joining the Indian Institute of Science. His specialization includes materials processing, microstructural engineering and mechanical behaviour of materials. He has authored more than 300 research papers. He is a Humboldt fellow and has been conferred with Friedrich Wilhelm Bessel Award by the Humboldt Foundation, Germany. In India, Prof. Suwas was awarded Metallurgist of the year 2012 by the Ministry of Steel and was conferred eminent engineering personality in the year 2014 by the Institution of Engineers. He is a fellow of the Indian National Academy of Engineering (INAE) as well as the National Academy of Sciences, India (NASI).

Keynote Session 3

Knowledge and Data in Manufacturing, Past and Future

Prof. Diane J Mynors

Brunel University London, UK

Bio:

Diane Mynors is the Head of the Department of Mechanical and Aerospace Engineering at Brunel University London. She has degrees in both physics and engineering disciplines and has led complex multidisciplinary projects and groups, enhanced by her background in physics and manufacturing engineering, both of which are multifaceted disciplines. Throughout her career she has focused on the collection and application of knowledge in the field of manufacturing.
She has received personal awards from:

- The Institution of Mechanical Engineers: The Thomas Stephen Prize.
- The Japan Society for Technology of Plasticity.
- The Scientific and Technical Research Council of Turkey.

Abstract:

Driving research is part hard work and part imagination. Without imagination things don't move forward, and without the hard work what has been imagined can't be realised.

This talk is a light-hearted look across several decades, decades across which the author has worked in developing ideas, decades where so much has changed in the acquisition, handling and application of knowledge and data. A world where the next generation of researchers have the opportunity to imagine and realise, in real and virtual space, manufacturing environments that result in products for a new era of customer expectations.

Keynote Session 4

Advances in Additive Manufacturing

Prof. Paulo Bartolo

Nanyang Technological University, Singapore

Bio:

Paulo Bartolo is a Professor on Advanced Manufacturing at the School of Mechanical and Aerospace Engineering (MAE), Nanyang Technological University (NTU), and Executive Director of Singapore Centre for 3D Printing (SC3DP), Singapore. At NTU, he is also Director of the National Additive Manufacturing Innovation Cluster (NAMIC) hub at NTU and a member of the Food@NTU programme. He is also a Professor at the University of Manchester (UK). He authored more than 600 publications in journal papers, book chapters and conference proceedings, co-edited 22 books and holds 16 patents. Paulo Bartolo was listed as a top 2% in the world by Stanford University and Microsoft Academic ranked him as the most salient author worldwide on the biomanufacturing field and among the top 25 most salient authors worldwide in the biofabrication field.

Abstract:

This keynote presentation will address new research trends in the field of additive manufacturing (AM) a key enabling technology of Industry 4.0. Key aspects related to AM digital twins, advanced materials and multi-modal AM systems will be discussed. Examples in the field of electronics, construction and medicine will be provided.

Keynote Session 5

Drones - Design Challenges

Dr. S N Omkar

Indian Institute of Science, Bangalore, India

Bio:

S.N. Omkar is the Chief Research Scientist (CRS) at the Indian Institute of Science, Bengaluru. He has a B.E in Mechanical Engineering from Bangalore University, M.Sc. and Ph.D. in Aerospace Engineering from the Indian Institute of Science, Bengaluru. His research interests include Satellite image processing, Biomechanics, Unmanned Aerials Vehicles (UAV) and bio-inspired design. S.N. Omkar has three labs under him: Computational Intelligence lab, the Unmanned Aerial vehicles lab and the Biomechanics lab. S.N. Omkar has more than 200 journal publications alone, has attended 83 conferences which includes both national and international conferences. He is also a member of 10 academic committees. He is also a celebrated practitioner and teacher of Yoga. S.N. Omkar has been conferred the Karnataka State Rajyothsava Award for his contributions in the field of Yoga.

Abstract:

The design challenges can be broadly classified as technical, financial, standards and regulation. The technical front includes a lack clear established drone sizing methodology, lack of interdisciplinary collaboration, custom battery, motor and propeller fabrication facility, noise reduction, UTM, cyber security rogue drone, lack of peer reviewed development of simulators for certification and understanding flying characteristics, lack of open-source software's for battery, motor and propeller sizing. Financial challenges include – (1) shortage of raw materials (Balsa, Birch, Depron, composites); (2) unforeseen delay in shipment due to international regulations; (3) shortage of skilled workforce. Regulations and standards are still exploratory in nature. Lack of lack of manufacturing expertise and volume on making specialized equipment is a major challenge.

Parallel Session 1: Materials Processing & Joining-I

Session Chair

Dr. Koushik Viswanathan

Indian Institute of Science, Bangalore, India

Bio:

Dr. Koushik Vishwanathan is an Assistant Professor in the Department of Mechanical Engineering, Indian Institute of Science, Bengaluru. His Research Interests Advanced manufacturing processes, In situ optical techniques in mechanics and manufacturing, Mechanochemical effects in cutting and surface finishing, Wave dynamics in soft adhesive interfaces, Processing of granular materials. He did his Ph.D. and Master's from Purdue University, USA.

Parallel Session 1: Materials Processing & Joining-I

ID11: Machining Characteristics Study of Ti-Al_2O_3 (20 vol. % of Ti Added as Alumina Fibre into Titanium Matrix) Composite Material while Undergoing WEDM Operation

Dwaipayan De[1*], Titas Nandi[1] and Asish Bandyopadhyay[1]

*dwaipayan88@gmail.com

[1]Jadavpur University

Abstract

With the advancement towards 21st century, engineering world started evolving to meet the demand of the modern society. As the world is approaching towards industry 4.0, new technologies are developed and thus to fulfill the desire of modern industries, new engineering materials are fabricated. These engineering materials like metal matrix composites, ceramic matrix composites etc. play an important role especially in the aerospace, automobile, and biomedical industries. But the problem lies machining these materials by conventional machining processes become very much difficult. Thus, non-conventional machining processes are developed to meet the demand of today's world. In this context, present research work initiated with the aim of developing new metal matrix composite material. Thus Ti-Al_2O_3 is fabricated in the present research work by adding 20 volume percentage of Titanium as Alumina fiber which reinforced into the Titanium matrix to form this type of new Titanium matrix composite material. The machining characteristics of Ti-Al_2O_3 composite material are studied by undergoing Wire Cut Electric Discharge Machining (WEDM) operation with the help of Box-Behnken Design of RSM optimization technique. The effect of the different process parameters on the output responses are analyzed in the present research work for the sintered Ti-Al_2O_3 material. The comparative study between the experimental results and theoretical data are carried out with the aim to validate the actual results, which found to be satisfactory in the present research work.

Keywords: Industry 4.0, Ti-Al_2O_3, Box-Behnken Design, RSM, Process parameters, Output responses.

Parallel Session 1: Materials Processing & Joining-I

ID12: Design and Development of Miniature Low-cost Vacuum Setup for Sand Casting

Subodh B Daronde[1*], Abhaykumar M Kuthe[1] and Bhupesh Sarode[1]

*subodhdaronde@gmail.com

[1]Department of Mechanical Engineering, Visvesvaraya National Institute of Technology, Nagpur, India

Abstract

The application of vacuum in casting technology is minimal. Vacuum technology is primarily used in investment casting or die casting processes, and this casting process is very costly compared with sand casting technology. In present study, the author developed a low-cost vacuum setup for the sand-casting process. A new vacuum casting setup is used to cast customized metal part that is oxidized in nature. The vacuum setup has a vacuum pump, induction furnace, vacuum chamber, and bottom pouring arrangement to pour melting metal. Vacuum melting prevents the reaction of molten metal to the environmental gases, crucible and materials in mould containers, and vacuum pouring confirms the molten metal flow into the mould cavity without any intrusion. This study made it possible to develop a new technique for the direct melting and pouring of metal alloys for customized casting. Experiments were carried out with aluminium alloys to verify the precision of the vacuum setup. The influence of vacuum sand casting on aluminium alloy's porosity and mechanical properties was studied and compared to the open sand-casting. This research demonstrated the usefulness of vacuum melting and pouring in sand casting technology.

Keywords: Low cost vacuum setup, Vacuum sand casting, Porosity, Mechanical Properties.

Parallel Session 1: Materials Processing & Joining-I

ID15: Technology Selection for Additive Manufacturing in Industry 4.0 Scenario Using Hybrid MCDM Approach

Anilkumar Malaga[1*] and S. Vinodh[1]

*aneelnitt@gmail.com

[1]Department of Production Engineering, National Institute of Technology, Tiruchirappalli, India

Abstract

Growth in customer requirements, markets, and organizations is increasing the need to develop customized products and processes in the manufacturing era. Industry 4.0 (I4.0) technologies could support organizations in their flexible and cost-effective approach to overcome these issues. Industries associated with Additive Manufacturing (AM) has been considered for this study. This study aims to implement Industry 4.0 technologies in the AM process to attain customized products and processes faster to the market. In order to implement Industry 4.0 technologies in AM process, technologies have to be identified. Identified technologies have been prioritized using a hybrid multi-criteria decision-making (MCDM) method. Integrated Fuzzy Analytical Hierarchy Process and Fuzzy VIKOR method have been used to prioritize the identified technologies.

Keywords: Additive Manufacturing, Smart Manufacturing, Industry 4.0 (I4.0), Multi-Criteria Decision Making (MCDM), Fuzzy Analytical Hierarchy Process, Fuzzy VIKOR.

Parallel Session 1: Materials Processing & Joining-I

ID22: Synthesis of ZnO Nanostructures on Woven Kevlar Fabric and Impact of Hydrothermal Conditions on Growth of Nanorods

Ravi Shankar Rai[1*] and Vivek Bajpai[1]

*rash.mait@gmail.com

[1]Department of Mechanical Engineering, Indian Institute of Technology (Indian School of Mines), Dhanbad, Jharkhand, India

Abstract

The investigation of fabrication of ZnO nanostructures and their morphological characterization on surface-functionalized woven Kevlar fiber (WKF) under different ZnO concentrations are described in this paper. The fabrication of ZnO nanostructures embedded in the surface of WKF was performed by a two-step seed-assisted hydrothermal route; that is seeding followed by growth treatments with controlled chemical predecessors. Various morphologies of ZnO nanostructures such as nanoparticles, nanograss, nanowires, and hexagonal nanorods were obtained by varying the ZnO molar concentrations and seeding under controlled set of temperature and time. Effect of seeding cycle on growth phenomenon was also investigated to check nanostructure growth. Analysis of various morphologies was examined by field emission scanning electron microscope (FESEM) and Energy Dispersive Spectroscopy (EDS) spectra. FESEM results illustrated the development of ZnO nanostructures on the strands of the Kevlar fibers and revealed that the amount of molar concentration and large number of seeding treatment majorly affects the growth of nanostructures. The crystallinity and structure of the grown ZnO crystals were examined by X-Ray diffraction. The crystalline peak height of the nanostructures increases with growth of nanostructures. The grown Zinc oxide nanostructures on the WKF surface were fabricated into composite panels using vacuum bagging technique which can further used for different applications.

Keywords: Hydrothermal synthesis, ZnO, Nanostructures, Nanocomposites, Woven Kevlar fiber.

Parallel Session 1: Materials Processing & Joining-I

ID23: Modeling and Optimization of RLT in Laser Trepanned ZTA Plate

Saini S. K.[1*], Dubey A. K.[2] and Upadhyay B. N.[3]

*surendra1feb@gmail.com

[1]Mechanical Engineering Department, Poornima College of Engineering, Jaipur, India
[2]Mechanical Engineering Department, MNNIT Allahabad, Prayagraj, India
[3]LDIAD Lab, RRCAT Indore India

Abstract

Zirconia Toughened Alumina has superior mechanical, physical and thermal properties. Therefore, it is used to manufacture different parts in military, aerospace, medical and cutting tool industries. Conventional drilling or cutting methods are not suitable for machining of difficult-to-cut ceramic composites like Zirconia Toughened Alumina. Recently, researchers are nurturing the processing capability of laser drilling for advanced ceramic composites. In laser trepanning, complete ejection of molten material from trepanned zone is very challenging. Adherence of this molten material after resolidification forms recast layer on trepanned hole surface. Present paper investigates the optimum input process parameters to achieve minimum recast layer thickness in laser trepanned hole surface using Genetic Algorithm. Optimum results reveal that recast layer thickness has been improved by 29%. Improvement has also been confirmed by SEM images obtained at predicted optimum parameter settings.

Keywords: ZTA, Laser Trepanning, RLT, Genetic Algorithm.

Parallel Session 1: Materials Processing & Joining-I

ID24: Assessing Suitability of Obsolete Parts for Additive Manufacturing

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Abstract

With increasing interest by companies to shift production of spare parts to additive manufacturing (AM), a guideline and framework for assisting companies to determine parts for additive manufacturing has become more relevant. However, there are currently only 2 main frameworks to do so, yet both do not examine relationships between company goals and classification factors. This research proposes a 2-stage framework to assist companies, especially those new to AM, in determining the suitability of obsolete parts for AM. The first stage identifies potential obsolete and feasible parts for AM, ranking mainly on potential inventory savings. The second stage utilizes a user dependent weighted matrix to align the companies' goals. A case study is presented to highlight its effectiveness. Results shown are as expected and highlights the effectiveness of using the criterion in accessing parts for AM. In the end, possible limitations are presented and discussed.

Keywords: Additive Manufacturing, 3D Printing, Spare Parts, Case Study Research.

Parallel Session 2: Industry 4.0

Session Chair

Dr. Manish Arora

Indian Institute of Science, Bangalore, India

Bio:

Dr. Manish Arora is an Assistant Professor in the Centre for Product Design and Manufacturing, Indian Institute of Science (IISc), Bengaluru. He obtained Ph.D. in applied physics from the University of Twente, The Netherlands (2006) and B. Tech in Chemical Engineering from the Indian Institute of Technology, Delhi (2002). He has got 70+ patents and research publications both at the national and international level to his credit. He has been employed with the University of Oxford, UK between 2006-10, GE global Research 2010-12, and Nanyang Technological University, Singapore 2012-14. His areas of interest include biomedical devices, co-design, collaboration, open-source design, and quality manufacturing of medical devices. He is the Principal Investigator in UTSAAH Lab, which aims at developing affordable and accessible medical technology solutions for promoting universal healthcare. He also teaches courses at IISc on Mechatronics and Design of Biomedical Devices and Systems.

Parallel Session 2: Industry 4.0

ID16: Application of Graph Theory Approach for Analyzing IoT Challenges in Maintenance Parameters Monitoring

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Abstract

The present scenario of manufacturing industries demands agile delivery and improved overall equipment effectiveness (OEE). For a long time, achieving zero downtime has been the utmost goal of industry practitioners and manufacturers. Due to the lack of automation and real-time monitoring, industrial manufacturers often find it difficult to remotely track machine health and manufacturing process, affecting production output. Although technology in I4.0, namely, the Internet of Things (IoT), helped in monitoring machine health with sensors, several challenges related to IoT in maintenance parameters monitoring restrict the proper utilization of technology. Thus, this paper attempted to study IoT challenges in maintenance parameters monitoring using a Graph Theory (GT) approach. 24 IoT challenges are identified and grouped into four dimensions: connectivity, data management, scalability and flexibility, and security. Diagraphs were constructed for the entire system and sub-system showing the interrelationship between several dimensions and challenges to explain the influence of IoT challenges in the maintenance of machines through an indicator calculated from permanent value.

Keywords: Industry 4.0, Internet of Things, maintenance, Graph theory, machine monitoring.

Parallel Session 2: Industry 4.0

ID20: Machine Learning Techniques for Smart Manufacturing: A Comprehensive Review

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Abstract

The smart manufacturing revolution is continuously enabling the manufacturers to achieve their prime goal of producing more and more products with higher quality at a minimum cost. The crucial technologies driving this new era of innovation are machine learning and artificial intelligence. Paving to the advancements in the digitalization of the production and manufacturing industry and with a lot of available data, various machine learning techniques are employed in manufacturing processes. The main aim of implementing the ML techniques being to save time, cost, resources and avoid possible waste generation. This paper presents a systematic review focusing on the application of various machine learning techniques to different manufacturing processes, mainly welding (arc welding, laser welding, gas welding, ultrasonic welding, and friction stir welding), molding (injection molding, liquid composite, and blow molding) machining (turning, milling, drilling, grinding, and finishing), and forming (rolling, extrusion, drawing, incremental forming, and powder forming). Moreover, the paper also reviews the aim, purpose, objectives, and results of various researchers who have applied AI/ML techniques to a wide range of manufacturing processes and applications.

Keywords: Machine learning, Artificial intelligence, Smart manufacturing, AI/ML techniques.

Parallel Session 2: Industry 4.0

ID36: Data Acquisition and Data Visualization Framework for Smart Manufacturing

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Abstract

The abilities of monitoring a manufacturing process in real-time and of generating insights from the acquired data are the fundamental pillars of Smart Manufacturing. This contribution proposes an architecture for data collection from field-level controllers, and for its subsequent visualization according to specific types of users. To achieve the former, KepserverEX has been used which acts as a bridge between the incoming data and further applications that operate on this data. Matlab and its in-built app designer act as a client running on the same physical system, and provides users with visualization and insights from the gathered field data. OPC-UA, with its client-server model, has been used for communication between these two applications. The resulting Matlab application is then deployed on Intranet, so as to enable access to authorized users. This general framework is applicable for different manufacturing environments, and one such example consisting of a Smart Lathe Machine has been described in this paper.

Keywords: Matlab, OPC-UA, Data Visualization, Real-time monitoring, KepserverEX, Industry 4.0, Smart Manufacturing.

Parallel Session 2: Industry 4.0

ID70: An Innovative Cryptosystem for Needham- Schroeder Authentication Protocols for Tertiary Industries

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Abstract

One of the main communication protocols designed for developing robustness across the entire insecure network has been proposed through an improved version of Needham-Schoreder (N-S) protocol. The propsed protocols and their conventions fulfill fundamental communication properties including confidentiality, common identification of the members, key authentication, and the construction of a common key. This paper outlines the improved version of N-S protocol based on a special case of binary quadratic Diophantine equation $x^2 - Dy^2 = N$ which has various industrial applications (where D is a nonzero positive square-free and N is a perfect square). In this paper, the critical applications of proposed N-S protocols in credit payment system and blockchain have been explained.

Keywords: Diophantine equation, Authentication, Symmetric key, Credit system, Block chain.

Parallel Session 2: Industry 4.0

ID74: Impact of Smart Incoming Inspection System on the Production, in a Medical Device Manufacturing MSME

Puneeth S Kannaraya[1*], Shreya G H[1], Manish Arora[1] and Amaresh Chakrabarti[1]

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Abstract

Quality of medical devices are important criteria when it comes to addressing health of a human being. Medical devices are manufactured with great effort to reduce risk. However, Micro, Small, Medium Enterprises (MSME)s in manufacturing are unable to afford high end technology and complex quality control methods. A Smart Incoming Inspection system was developed to address the quality challenges faced by a local micro-enterprise for medical device manufacturing. The system was deployed in the manufacturing location, and inspection of incoming raw materials were carried out. Comparison of the final inspection data with and without the use of the smart incoming inspection system exhibited significant improvement in quality control when the system was used. Using the Define- Measure- Analyse- Improve- Control (DMAIC) method of six sigma, the impact of introducing the system to the production line was analysed, indicating improved First Pass Yield (FPY) of 1.88% and over 3-fold reduction in rejection rate.

Keywords: Smart Incoming Quality Inspection, First pass Yield, Rejection Rate.

Parallel Session 2: Industry 4.0

ID75: What is Industry 4.0 for India?

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Abstract

This paper proposes a framework for analyzing the value and readiness of an industrial sector or organisation for adopting Industry 4.0 technologies. To do this, approaches have been proposed for supporting assessment of the degree of automation involved in a sector or organisation and its degree of implementation of Industry 4.0 technologies. Based on an analysis of the critical questions to be asked in determining the need and suitability of a sector or organisation in adopting Industry 4.0 technologies, six key factors have been identified to determine the value of Industry 4.0 for the organisation and its readiness to adopt these technologies. These factors can be used for driving empirical studies of organisations or sectors in order to understand the value and the main areas of support needed to empower them to adopt Industry 4.0.

Keywords: Industry 4.0, Smart Manufacturing, PLM, Connected Intelligence, Industrial Internet of Things, Industrial Automation

Parallel Session 3: Digital Manufacturing

Session Chair

Dr. Pradipta Biswas

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Bio:

Dr. Pradipta Biswas is an assistant professor at the Centre for Product Design and Manufacturing (CPDM) and associate faculty at the Robert Bosch Centre for Cyber Physical Systems (RBCCPS) of the Indian Institute of Science. His research focuses on user modelling and multimodal human-machine interaction for aviation and automotive environments and for assistive technology. He set up and leads the Interaction Design (I3D) Lab at CPDM, IISc, and principal investigator of projects funded by Microsoft, British Telecom, Faurecia, Harman, and Wipro. He was a Senior Research Associate at Engineering Department, Research Fellow at Wolfson College, and Research Associate at Trinity Hall of the University of Cambridge. He completed his Ph.D. in Computer Science at the Rainbow Group of University of Cambridge Computer Laboratory and Trinity College in 2010 and was awarded a Gates Cambridge Scholarship in 2006 and did his Ph.D. (University of Cambridge) 2010.

Parallel Session 3: Digital Manufacturing

ID17: Optimum Scheduling and Routing of Material Through Computational Techniques

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Abstract

Scheduling and Routing are two dominating factors in any production house which determine the throughput of the system. Proper scheduling ensures 'When' a particular activity is carried out, while the routing guarantees 'Where' is the activity executed. This paper emphasizes the collective use and elaboration of computational techniques for optimum scheduling and routing of material flow in an industrial environment achieved by amalgamating traditional techniques and methodologies with modern computational solutions. This computational piece of program deployed in and for the industry is programmed in python language along with further post computation enhancement done using Project Libre's .xml file support. The program computes minimum possible production time for given inputs subjected to constraints applicable and also the most optimum route for smooth material flow throughout the floor. A user-friendly U.I. has been developed along with further analysis aided by modifying the .xml file to provide the Gantt chart for floor level reference. A substantial increment in production activity was observed which also led in establishment of an autonomous system for scheduling and routing.

Keywords: Computational Scheduling and Routing, Multi-Dimensional Array Computing, Minimization, Linear Programming, Python Programming.

Parallel Session 3: Digital Manufacturing

ID19: Design of a Common Bulkhead Dome for Cryogenic Stage

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Abstract

Minimizing the mass and maximizing the utilization of the available space in launch vehicle have been key design objectives over the years. A cryogenic common bulkhead (CBH) tank is one of the best packaging solutions that utilize a single tank with a common bulkhead separating two independently pressurized compartments containing Liquid Hydrogen (LH2) at 20 K and Liquid Oxygen (LOX) at 77 K. A CBH tank can serve as a good replacement to the current cryogenic stage of Indian Space Research Organizations' (ISRO) launch vehicle consisting of a truss type intertank structure. A CBH tank eliminates all the major issues currently associated and encountered with a truss type intertank structure. A sandwich type CBH with a thermal insulation capacity and required mechanical performance is considered. A CBH core made of the foam-filled honeycomb (FFH) was found suitable in terms of the mass and space requirement compared to the previously existing concepts of a pure foam or a pure honeycomb core. An FFH core offered a maximum mass saving of 475 Kgs with respect to the current GSLV MKIII configuration. Manufacturing feasibility and NDI techniques are studied for the development of a CBH dome in a CBH tank. A decoupled test setup for testing the thermal and mechanical performance of the CBH material is planned, keeping in mind the complexities of handling cryogenics. The initial test results from our recent development for the thermal setup are presented and were found satisfactory for further testing with variable conditions and environments.

Keywords: Common bulkhead (CBH), Intertank, Foam-filled honeycomb (FFH), Sandwich common bulkhead, Truss type intertank.

Parallel Session 3: Digital Manufacturing

ID25: Implementation of Simulation Practices for Plant Optimization

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Abstract

Increasing in demand and product complexity, quick turnaround of new product launches with higher number of product variants have led to the shorter product design and planning milestones for launching the new products in the market. This has raised lot of difficulties and bottlenecks in the life cycle of new product introduction. Right strategy and planning have become the need of the hour to overcome the hurdles and this can be achieved with new technology innovations using efficient virtual simulation software. Hence, virtual simulation software has taken its place in efficient planning and implementing complex strategies in meeting their needs and requirements. The main objective of the paper is to showcase the virtual simulation importance and its advantages in increasing the throughput and launching of new products/variants. A case study has been performed on a digital model of the layout by virtually simulating the production and logistics possibilities, thereby validating the new engineering solutions to eliminate the bottlenecks in the process and increase the efficiency by eliminating the challenges in meeting the required volumes. The analysis and study in our discussion are done by using the software, Tecnomatix Plant Simulation by Siemens.

Keywords: Simulation, Tecnomatix, Bottlenecks, Digital Model.

Parallel Session 3: Digital Manufacturing

ID34: Industrial Application of Augmented Reality: Maintenance of Multi Process Robotic Cell

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Abstract

Augmented reality is a modern technique of data representation with the help of creating images or animation in the physical world. This technique can be effective in industry to optimize and understand the industrial process with ease. The paper work focused on the application of augmented reality considering specific domains as maintenance of the Multi Process Robotic cell (MPRC). MPRC is designed to perform the assembly, testing and packing of the direction control valves. There is need of maintenance for some common issues while working with automatic screw feeders. Maintenance of screw feeders using manuals is one of the hectic and time-consuming processes, so creating maintenance guidance of screw feeders and some replacement of parts with the help of augmented reality is one of the main objectives of the paper. With use of Creo illustrator 3D sequences are created to superimpose the same when viewed through the Vuforia view app. Generation of augmented reality experience is done on Vuforia studio. Use of augmented reality will increase the success rate for first time users (while doing maintenance) which increases efficiency of firm.

Keywords: Augmented Reality, Maintenance, Automatic Screw Feeder, Multi Process Robotic Cell, Creo, Vuforia studio.

Parallel Session 3: Digital Manufacturing

ID35: Augmented Reality Implementation for Fault Diagnosis on Robotic Welding Cell

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Abstract

Industry 4.0 driven by digitalization and smart manufacturing, involves the digital transformation of industries from automated to intelligent ones. Industrial robots and Augmented Reality which overlays digital information in the real world play a key role in achieving this. In this context, a Robotic welding cell (RWC) is considered which consists of two robots for material handling and welding process and also consists of various safety systems namely emergency buttons, safety interlocks, and light curtains. The end-users take quick action using safety systems to rectify errors involved in the process and they may not be able to identify the faults occurring in RWC safety systems which require fault diagnosis as the solution. The main objective is to identify the critical systems and faults of safety systems such as the breakdown of interlock and diagnose using AR implementation by monitoring real-time IOT data and training the user to correct the faults. The 3D model of RWC is designed through Creo parametric and then the animation sequences of the 3D model are created using Creo illustrate to train the user to identify safety systems errors. Thingworx is used to create an IoT-powered Augmented reality and connect real-time data as indicated in tower light and finally, AR experience is created and published through Vuforia studio, which can be experienced by a mobile app called Vuforia view, which overlays digital visualization. This method allows enhanced user experience, reduces downtime of the system, lowers production losses, and improves real-time capabilities and system monitoring.

Keywords: Augmented reality, Fault diagnosis, Robotic welding cell, Internet of things, Safety systems.

Parallel Session 3: Digital Manufacturing

ID77: Impact of Additive Manufacturing in SMEs

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Abstract

The role of small and medium-sized enterprises (SMEs) in the global economy is crucial with a high number of companies contributing significantly to the job market. With the emergence of the fourth industrial revolution (I4.0) and the rapid adoption of new technologies by large companies, the digital transformation of SMEs has become strategically important to increase profit and product quality while reducing waste. This paper summarizes the challenges faced by SMEs in the digitalization process and analyses the barriers that SMEs in adopting additive manufacturing which is one of the main pillars of I4.0 technology.

Keywords: Industry 4.0, SMEs, Additive Manufacturing.

Parallel Session 4: Controls, Autonomous Systems, Robotics

Session Chair

Dr. Abhra Roy Chowdhury

Indian Institute of Science, Bangalore, India

Bio:

Dr. Abhra Roy Chowdhury is serving as tenure-track Assistant Professor at the Centre for Product Design and Manufacturing, Indian Institute of Science, Bangalore. Previously, he was holding a Senior Research Fellow position with the Temasek Labs at the Singapore University of Technology and Design (SUTD) in collaboration with MIT during 2016 - 2019. He was also a senior member of the robotics research team at the Robotics Innovation Lab Singapore. He earned his Ph.D. degree in 'Robotics and Autonomous Systems' from the Department of Electrical and Computer Engineering, National University of Singapore in 2015. He has received his M. Tech degree from the Department of Electrical Engineering, Indian Institute of Technology (IIT) BHU Varanasi, India in 2010. He was associated with LG Electronics India as a Senior Design Engineer between 2010-2011. He holds various accolades and awards including Singapore Mark Design Award, IEEE Industry Applications Society (IAS) Best PhD Thesis Award, IEEE Oceanic Engineering Society (OES) Award, IEEE-SICE (Japan) Research Award, IEEE-ICROS (S. Korea) Best Student Research Award, the President of India IIT Gold.

Parallel Session 4: Controls, Autonomous Systems, Robotics

ID21: Articulated Robotic Arm for Feeding

Abhived Nair[1], Devan Rajendran[1], Joel Chacko Jacob[1], Nikhil Shobu Varghese[1*] and PS Suvin[1]

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Abstract

In today's fast paced world, disabled people are a large minority group, starved of services, mostly ignored by society, and live in isolation, segregation, pov- erty, charity and even pity. There are numerous forms of disabilities. The disability suffered by most persons includes mental disability, emotional, physical and cogni- tive. Perhaps the most overlooked effect of a disability that affects the motor functions of the limb is the reliance on other people for completion of even simple tasks that ordinary people perform on a daily basis, like taking a shower, dressing up, brushing teeth, or even having a meal. This chips away at the self-worth of a disabled person and gnaws away at their confidence. Through our project we aim to provide a solution to those with compromised motor functions. This project aims to develop a 4 DOF robotic manipulator that is able to map the facial structure of the user, and with a feeding device (spoon/fork) attached to its arm transfers adequate portion of food ac- curately into the user's mouth without spillage through smooth motion, by incorpo- rating Image Processing, Manipulator Kinematics and Machine Learning.

Keywords: Robotics · Kinematics · Image Processing · Motion Planning · Design · Autonomous · Manufacturing · Healthcare

Parallel Session 4: Controls, Autonomous Systems, Robotics

ID33: Autonomous Navigation for Mobile Robots with Sensor Fusion Technology

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Abstract

Autonomous navigation for a mobile robot is a method used to localize and navigate a robot in a random environment. The existing solution leverages a 2D lidar on top of the robot for mapping and obstacle avoidance but the Lidar at times is unable to detect objects due to their size and color properties. This paper aims to develop a robot that uses both lidar and a vision-based sensor as fused sensor technology and to navigate the robot in any direction without any constraints using four-wheel Mecanum drive. The method uses 2D lidar as the global sensor for mapping and obstacle avoidance and fusing it with a vision sensor for detecting objects which cannot be detected by lidar. The vision sensor uses a deep learning object detection method; YOLOv3. Whenever an object is detected by a neural network the program sends a false laser scan which is updated in the local cost map of the ROS navigation stack which makes the robot aware of an object ahead and takes an alternate path to reach the goal position. This robot was tested in a gazebo ROS environment and was able to avoid obstacles irrespective of the size or color of the object. This method was successful in a simulation environment and can be used in the industries which need 2D lidar as an affordable option and as a replacement for 3D lidar.

Keywords: Robot Operating System (ROS), SLAM, Vision, Convoluted Neural Networks, Sensor Fusion

Parallel Session 4: Controls, Autonomous Systems, Robotics

ID50: Design of Robotic Model Using White Line Sensor based Autonomous Carrier Robot in Industrial Applications – Task and Performances for Validation

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Abstract

The Robotic Prototype applies the Line following algorithm using a white line sensor to follow a predefined map. The theme of the performed robotic prototype is to be implemented in production and health care environments to perform repetitive and recurring tasks. In the present work, the robotic prototype follows a line to perform tasks and also to detect and decipher the possibility of any unpredictable non-static obstacles in its path. It is programmed to maneuver the obstacle by finding the shortest paths to reach the destination. Some of the tasks performed are picking and placing the materials from predefined and varied-elevation locations. Retrofitting and validation were done for the simulation in reality to solve tasks and challenges in applications for the chosen problem in the health care sector for mobilization. The application of the task associated with the workflow system is being retrofitted for line follower robots overcoming the issues and challenges with that of the real-field monitoring in the case of a General Hospital, involving all emergency operations necessitating a result-oriented performance.

Keywords: Autonomous carrier, Industrial application, Robotic prototype, Real model, Validation.

Parallel Session 4: Controls, Autonomous Systems, Robotics

ID66: Volume Decomposition of Faceted Models to Minimize Post Processing Issues for Multi-Robots Collaborative Material Extrusion Systems

Madhanagopal Manoharan[1] , Chitikena Hareesh[1] , Senthilkumaran Kumaraguru[1*]

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Abstract

The support structures used in Additive Manufacturing (AM) tech- niques cause poor surface quality in the contact areas of the support with the printed parts. Thereby this support structure usage is a critical issue, which needs to be controlled for minimizing the printing time and post-processing challenges associated with AM parts. To alleviate the errors due to the support structures, these faceted models can be deposited in multi-direction using multi-axis sys- tems. This paper presents an approach to decompose the design features and de- tect multiple build directions for certain cases of faceted models to print parts using Multi-Robots Collaborative Material Extrusion (MRCME) systems devel- oped by the authors. The use of support structures limits the surface finish of as- built 3-D printed parts. The objective of this work is to develop a volume decom- position algorithm, which can decompose the part into sub-volumes and identify the build direction of the decomposed sub-volumes. The build direction is found from the geometric reasoning of the concave and convex loop centroids. Initial decomposition is done with the concave-convex loop pair relationship and further regrouping is done with the bounding box of the identified pair of concave and convex loops in that particular build direction. The work presented in this paper would help process planning systems to automatically determine Multi-Direc- tional Sub-Volumes (MDSV) and carry out effective part deposition with mini- mum or no support structures.

Keywords: Multi-Robots technology, Multi-Axis Deposition, Cobotic Material Extrusion, Post processing.

2nd International Conference on
Industry 4.0 and Advanced Manufacturing

Keynote Session 6, 7 & 8

Session Chair

Prof. Satish Vasu Kailas

Indian Institute of Science, Bangalore, India

Bio:

Prof. Satish Vasu Kailas is a Professor in the Department of Mechanical Engineering, Indian Institute of Science, Bengaluru. His Research Interests are Friction studies during metal forming/cutting, Friction stir welding and Design and development of special purpose machines. He is the Editorial Board Member/ Associate Editor for ASME Journal of Tribology, STLE Tribology Transactions. He did his PhD and Master's from IISc, Bangalore.

Keynote Session 6

Self Sufficient and Resilient Supply Chains

Prof. Soundar Kumara

Pennsylvania State University, USA

Bio:

Soundar Kumara is the Allen, E., and Allen, M., Pearce Professor of Industrial and Manufacturing Engineering at Penn State and has an affiliate appointment with the school of Information Sciences and Technology. He is a Fellow of IISE, ASME, CIRP, and AAAS. He is the recipient of David Baker Distinguished Research Award from IISE, Excellence in Research Award from ASME Computers & Information Engineering (CIE) division and Listed among the 20 most influential academics in smart manufacturing by Society of Manufacturing Engineering.

Abstract:

Covid-19 has shown us the drawbacks of our supply chains and exposed our vulnerabilities. In this talk we will focus on the research aspects related to resilient supply chains keeping in mind the mantra, “self-sufficiency.” We will discuss our previous work using network science to build resilient and adaptive supply chains. Our research driven discussion will highlight how the “intelligent,” and “digital,” technologies can play an important role in driving the future.

Keynote Session 7

Additive Manufacturing with Robots: Improving Part Strength, Processing Speed, and Process Flexibility

Prof. Satyandra K Gupta

University of Southern California, USA

Bio:

Dr. Satyandra K. Gupta holds Smith International Professorship in the Department of Aerospace and Mechanical Engineering and Department of Computer Science in Viterbi School of Engineering at the University of Southern California. He serves as the Director of the Center for Advanced Manufacturing. He served as a program director for the National Robotics Initiative at the National Science Foundation from September 2012 to September 2014. Dr. Gupta's research interests are physics-informed artificial intelligence, computational foundations for decision making, and human-centered automation. He works on applications related to Computer-Aided Design, Manufacturing Automation, and Robotics. He has published more than four hundred technical articles. He is a fellow of the American Society of Mechanical Engineers (ASME), Institute of Electrical and Electronics Engineers (IEEE), Solid Modeling Association (SMA), and Society of Manufacturing Engineers (SME). He serves as the editor-in-chief of the ASME Journal of Computing and Information Science in Engineering. Dr. Gupta has received numerous honors and awards for his scholarly contributions. Representative examples include a Young Investigator Award from the Office of Naval Research in 2000, Robert W. Galvin Outstanding Young Manufacturing Engineer Award from the Society of Manufacturing Engineers in 2001, CAREER Award from the National Science Foundation in 2001, Presidential Early Career Award for Scientists and Engineers in 2001, Invention of the Year Award at the University of Maryland in 2007, Kos Ishii-Toshiba Award from ASME in 2011, Excellence in Research Award from ASME Computers and Information in Engineering Division in 2013, Distinguished Alumnus Award from Indian Institute of Technology, Roorkee in 2014, and ASME Design Automation Award in 2021. He was named "The 20 most influential professors in smart manufacturing" by Smart Manufacturing Magazine in June 2020. He was given Use-Inspired Research Award by Viterbi School

of Engineering in 2021 for creating solutions that are addressing US aerospace and defense industry's needs in the advanced manufacturing area. He has also received ten best paper awards at international conferences.

Abstract:

Additive Manufacturing (AM) is expected to revolutionize manufacturing. The current generation of AM technology has overcome many limitations of traditional manufacturing. However, the current AM technology still needs many improvements. This presentation will describe how robots can be used to realize the next generation of AM technologies. The first part of this presentation will describe how performing material deposition using articulated robot arms can significantly expand AM processes capabilities by enabling material deposition on non-planar layers. Many composite parts have thin three-dimensional shell structures. Achieving the right fiber orientation is critical to the functioning of these parts. Printing them using conventional planar-layer AM processes leads to fibers being oriented in the plane of the layer. The capability to deposit the material along non-planar conformal layers can produce parts with improved material properties. Robots can be used to perform multi-resolution printing that finds the best trade-off between build speed and surface finish. Robots can also be used to realize of supportless AM. In the near foreseeable future, AM is not expected to produce high-quality electronics (e.g., processor, sensors). The use of robots also enables the insertion of externally fabricated components such as sensors, actuators, and energy harvesting components during the AM process. The second part of this presentation will describe artificial intelligence techniques needed for generating and executing robot trajectories to build high quality parts using AM.

Keynote Session 8

Circular Economy: Role of Industry 4.0 and Advanced Manufacturing

Prof. Seeram Ramakrishna

National University of Singapore, Singapore

Bio:

Dr. Seeram Ramakrishna, FREng, Everest Chair is a Professor, a Highly Cited Researcher, and a Most Influential Scientist in the world at the National University of Singapore (https://www.linkedin.com/in/seeram-ramakrishna/). He has previously held various senior academic leadership roles at NUS, is a member of ISO/TC 323 on circular economy, and an elected Fellow of UK Royal Academy of Engineering, among other prestigious positions. He advises the Singapore Ministry of Sustainability and Environment as well as the World Bank; and is a member of UNESCO Global Independent Expert Group on the Universities and the 2030 Agenda (EGU2030).

Abstract:

COVID19 pandemic as well as changing geopolitics have accelerated the development and adoption of fourth industrial revolution technologies, 4IR so as to restore resilience of economies. The 4IR technologies coupled with advanced manufacturing are critical in attaining the UN Sustainable Development Goals 2030 via circular economy. Benefits include lower greenhouse gas emissions; reduction of solid waste going into the land, incinerators, and oceans; higher circularity of materials and products; low-carbon products and services; reduced social costs; and better and new jobs. This keynote presents a discussion of basics, trends, challenges, solutions, and opportunities.

Panel Discussion 2: Manufacturing Needs of the Strategic Sector

Session Chair

Dr. V Bhujanga Rao

National Institute of Advanced Studies (NIAS), Bangalore, India

Bio:

Dr. V Bhujanga Rao superannuated in October 2015 from DRDO as Distinguished Scientist & Director General for Naval Systems after serving DRDO for 43 years. Then he joined as ISRO Chair Professor at NIAS which he held up to September 2020. At present he is Hon Professor at NIAS and Chairman, Kims Foundation Research Centre (KFRC), Hyderabad. While at NIAS, he established an Inclusive Manufacturing Forum, a training program on Advanced Defence Manufacturing and a program on how to nurture frugal innovations to help the grassroot innovators. He is a specialist in naval engineering systems like underwater weapons, naval stealth, warship design, Submarine design among many other technologies. He is the Chief designer of indigenous Cochlear implant prosthesis for the hearing disabled which is currently undergoing human clinical trials. He received several national and international awards which include the National Award for the Empowerment of Persons with Disabilities by Ministry of Social Justice and Empowerment, National Award given by VASVIK (Vividhlaxi Audyogik Samshodhan Vikas Kendra) for Mechanical Sciences, National Design Award from National Design Research Foundation, Institution of Engineers India, DRDO Technology Leadership Award, DRDO Agni Award for Excellence in Self Reliance, Gold medal from Acoustical Society of America for research on bioacoustics of hearing disabled persons, etc. among many others.

Panel Discussion 2: Manufacturing Needs of the Strategic Sector

Panel Member

Mr. Dhiraj V Keskar

Walchandnagar Industries, Walchandnagar, India

Bio:

Mr. Dhiraj has done his Mechanical Engineering from AISSMS' College of Engineering, Pune & PG Diploma in Business Administration from Symbiosis,Pune. He has a profound experience in technical aspects of product and projects of Aerospace & Defence sectors. He has been associated with Walchandnagar Industries Ltd for 18+ years. With his strong business acumen and analytic ability with capability of identifying business trends and opportunities he has brought about transformation changes in the growth of business in A&M. He has been a co-partner in executing & delivering ambitious projects of supply of core/critical equipment and integration on board Defense Strategic Platform. Been an effective communicator he shares an excellent relationship across his customer base & with people at all business levels within WIL. He currently heads WIL's Aerospace & Missiles Business operations at Walchandnagar. With an aim to expand the offering portfolio of WIL to India's A&D sector , he has been gearing towards establishing a composite unit under his cluster.

Panel Discussion 2: Manufacturing Needs of the Strategic Sector

Panel Member

Mr. I V Sarma

Bharat Electronics Ltd (BEL)

Bio:

I.V. Sarma has over 40 years of experience in Electronics industry. Sarma is known for his significant contributions in the development of technologies, products, and systems as well as his innovations in Operations Management and Strategic planning. His experience covers several functions including R&D, Manufacturing, Domestic and International business development, Project Management, Offsets Management, Strategic Planning, Setting up of factories, and formation of JVs. He has worked in diverse fields of Defense Electronics. His domain experience includes Telecom, Application Software systems, and renewable energy. Sarma was Director (R&D) in Bharat Electronics Ltd (BEL), a Navratna PSU, in the business of Defence Electronics, for over four years. He also served as an Independent Director on Boards of Public sector and Private sector companies. He was an Adviser to IPC India and a member of the advisory committee of Project Management Institute. He was Chair/Co-Chair of IRSI and EWCI. Presently he mentors start-ups and is on Board of two private sector companies. He is an Electronics & Communications engineer with MBA from FMS, Delhi. He is a Fellow of IETE and a recipient of awards for Technology Development and innovation, and best contributor in PSUs. He is one of the 100 Managers in India selected for a book with the title “100 Managers in Action”.

Panel Discussion 2: Manufacturing Needs of the Strategic Sector

Panel Member

Mr. K Sundar

ABI Showatech, Chennai, India

Bio:

Mr. Sundar has done his B.Tech in Mechanical from IIT Madras, MPT from IIM Bangalore and AMP from Insead France. He has 42 years off Industrial experience across many functions in TVS group companies and he is Currently heading ABI Showatech India Ltd as its Executive Director.

Panel Member

Dr. M N Jha

Bhabha Atomic Research Centre (BARC), Mumbai, India

Bio:

Dr. Maha Nand Jha is a Scientific Officer (G) and Head, Electron Beam & Pulsed Power Machine Section Accelerator & Pulse Power Division at Bhabha Atomic Research Centre (BARC). He is Involved in the design, fabrication, testing and development of high-power electron beam welding and melting machines for advance manufacturing processes and material processing. His team has developed high power EB Welding machines (maximum power 12kW) for carrying out the EB wielding of similar metals (SS304/316, Copper, Aluminium etc.), dissimilar metals (such as Copper to SS304/316) and reactive metals (such as Nb, Ti, Zr alloys etc.). The machine is capable of welding 25mm thick Stainless-steel plates and up to 12mm thick Copper plates. His team has also developed high power EB Melting machines for metallurgical process such EB melting, refining, and scrap consolidation of metals and alloys. The 300kW EB Melting furnace developed and commissioned at NFC Hyderabad uses 150kW twin electron beam gun column for the melting of charges in the form of rods/bars/chunklets. The machine is capable of drawing metal ingots up to ϕ280mm (Diameter) and 1000mm (Long). Small tabletop version of EB Melting Machines up to a power level of 10kW is also developed for the studies and development of new alloys.

Panel Discussion 2: Manufacturing Needs of the Strategic Sector

Panel Member

Dr. Manoj Kumar Buragohain

Defence Research and Development Organisation (DRDO), Hyderabad, India

Bio:

Dr. Manoj Kumar Buragohain is a Scientist 'G', Group Director (Composites) and Technology Director at Composite Product Development Centre, Advanced Systems Laboratory DRDO, Hyderabad. He has done BSc (Engg.) in Civil Engineering from Regional Engineering College Rourkela (now, National Institute of Technology Rourkela), MTech & PhD in Aerospace Engineering from Indian Institute of Technology Madras & PGDFA (CFA) from Institute of Chartered Financial Analysts of India Hyderabad. He has nearly thirty years of hands-on experience in design and development of composite products – primarily in the fields of geodesic and non-geodesic filament winding, contact lay-up, tape winding, and rosette lay-up. Some of the major contributions have been in large size composite pressure vessels, gird-stiffened composite structures, tubular structures, ablative liners, and composite rotor blade. He has authored a book titled “Composite Structures: Design, Mechanics, Analysis, Manufacturing, and Testing”, published by CRC Press & over twenty-five journal and conference papers. He is a member of Indian Society for Advancement of Materials and Process Engineering (ISAMPE) & Aeronautical Society of India (AeSI). He has won several awards named as Laboratory Scientist of the Year Award, National Science Day Commendation Certificate & Silicon Medal, DRDO Award for Performance Excellence (as team member), Agni Award for Excellence in Self-reliance (as team leader), DRDO Scientist of the Year.

Panel Discussion 2: Manufacturing Needs of the Strategic Sector

Panel Member

Mr. P Marudachalam

Liquid Propulsion Systems Centre (LPSC), ISRO, Thiruvananthapuram, Kerala

Bio:

Mr. P Marudachalam is the General Manager of Semi Cryo Engine and Stage elements Fabrication (SESF), Liquid Propulsion Systems Centre (LPSC), Valiamala, Thiruvananthapuram, Kerala. He is currently working for the development of the semi Cryo subsystems. He did his B.E. in Mechanical Engg. & M.E. in Production Engg. from PSG College of Technology, Coimbatore, Tamilnadu. He joined ISRO in 1987. His area of work includes development and realisation of Cryogenic engine subsystems used in the Mark 2 Launch vehicle, Metal forming for thick/slender shells, five axis machining, Auto TIG/ EB welding and brazing of similar and dissimilar materials, acceptance testing of the hardware, etc.

Panel Discussion 2: Manufacturing Needs of the Strategic Sector

Panel Member

Dr. S V Ramana Murty

Gas Turbine Research Establishment (GTRE), Bangalore, India

Bio:

Dr S. V. Ramana Murty, Scientist 'G' working in Turbine Group of Gas Turbine Research Establishment. He is Technical Director of Turbine group. He has 25 years of experience in the Aero-thermal Design, Detailed configuration, manufacturing and testing of Axial flow / radial inflow turbines for aero, marine and land applications. He has done B. Tech (Mechanical) from JNTU, Kakinada, M.Tech (I.C. Engines and Gas Turbines) from REC, Warangal and PhD from VTU, Belgaum. He has also done Gas Turbine Technology Fellowship Course in Defence Institute of Advanced Technology, Pune. He has more than 35 publications in National/ International seminars and Symposiums and Journals. He is also a Recipient of DRDO Technology Day Award. His overseas professional expertise to engineering design and manufacturing are with Safran Aircraft Engines, Malichaud, France, Sukhoi Design Bureau, CIAM, and GFRI, NPO Saturn, Russia, Betshmesh Engines Limited, Israel, Centrax, AETC, Howmet, UK, Cranfield, UK and Formetal, Belgium. Is association with National / International Bodies includes Aeronautical Society of India, Institute of Engineers, Society of Aerospace Quality and Reliability and ASME.

Panel Discussion 2: Manufacturing Needs of the Strategic Sector

Panel Member

Mr. T Suvarna Raju

Former C&MD, Hindustan Aeronautics Limited

Bio:

T. Suvarna Raju is the former Chairman and Managing Director of Hindustan Aeronautics Limited which is an Indian Public Sector Undertaking under the Government of India. T. Suvarna Raju, took over as Chairman, HAL on 1 February 2015. He joined HAL in 1980 as Management Trainee and has worked in different capacities at HAL, before taking over as Director, Design & Development in 2012. He is also the first Member Secretary of Design Development Management Board established by Ministry of Defence (India). He was actively involved in the research and development programmes for the light combat aircraft the HAL Tejas, HAL HTT-40.

Panel Discussion 2: Manufacturing Needs of the Strategic Sector

Panel Member

Mr. Venkata Raju

VEM Technologies, Hyderabad, India

Bio:

Mr. Venkata Raju founded the VEM Technologies in 1988 with a passion to make VEM as "Lockheed Martin of India" covering Defence, Aeronautics and Space arenas. Thanks to the vision of Mr. Venkata Raju, VEM has grown multifold over the past three decades and is known for systems and systems integrations activities in the country. Mr. Venkata Raju did his Mechanical Engineering and Post-Graduation with Tool Engineering as a specialization. Understanding the growth potential in Defence and Aerospace sector, Mr. Venkata Raju build the organisation as self-sufficient not only with the necessary infrastructure to manufacture the systems but also created Design & Engineering Division and R&D divisions to handle over fourteen technologies that are essential for these vital domains. Though he hails from an agricultural background, he has dreamt of becoming an entrepreneur since childhood and today he reached a stage where VEM is one of the top three defence technology companies in India. Indigenisation of niche technologies has been the driving force for VEM, and Mr. Raju has steered the company to realise many of the niche technologies which otherwise have been only imported till date with lots of restrictions imposed by foreign countries. Few such examples are, RF & MW & Electro Optics. Mr. Raju's thrust upon indigenous development has resulted in specialized systems like Servos, RF Seekers, IIR Seekers etc which were being imported to meet the requirement of the services. He has built a state-of-the-art Seeker Manufacturing facility which is one of its kind in the country to build RF Seekers and IIR Seekers for Missiles.

Parallel Session 1: Materials Processing & Joining-II

Session Chair

Dr. N D Shivakumar

Indian Institute of Science, Bangalore, India

Bio:

Dr. N D Shivakumar holds B.Tech. Degree in Production Engineering from SIT, Tumkur and MTech. Degree in Manufacturing science and engineering from UVCE Bangalore and Ph.D. (Engineering) from Indian Institute of Science, Bangalore. Currently he is Principal Research Scientist, in CPDM, IISc. He was responsible for several Projects and the key person in the project team, making proposals, discussing for financial assistance, collaborations with Institute of Wood Science, BHEL, Indian Plywood Industries Research & Training Institute and more. His research interests focus on materials, biodegradable products, wood, and emission controls. Dr. N D Shivakumar is guiding few master's and Doctorate candidates. Dr. N D Shivakumar is a fellow/member of few professional Societies. His area of Interests is Polymer based composites, Bio-Composites, Foam based materials, Synthesis/Manufacturing of lightweight materials, testing of lightweight materials, Computer Aided Design and Analysis of lightweight materials, Optimization & DOE based studies, Design and Application of developed/Novel lightweight materials. Key Courses offered by him are Elements of Design Product, Visualization and Communication. He has published around 30 papers.

Parallel Session 1: Materials Processing & Joining-II

ID42: Numerical Analysis on Influence of Clamping Force on Distortions of S235 Tube-Plate Joints

Tapas Bajpai[1*], Arpana Parihar[2] and Dipesh Singh Parihar[3]

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[2]Microfluidics & MEMS Centre, CSIR-Advanced Materials and Processes Research Institute (AMPRI), Bhopal-462026
[3]Mechanical Engineering Department, Engineering College Tuwa, Godhra, Gujarat-388713

Abstract

Clamping devices are often used during welding for holding the workpieces firmly and to mitigate the distortions to manageable levels. However, an optimum degree of clamping must be applied so that residual stresses and distortions can be minimized at the same time. In the present paper, three dimensional finite element simulations are performed for tube to plate welding using MSC's Simufact™ welding software. Effect of clamping force and clamping time on distortions is investigated for tube-plate welded structure by considering different cases. It is shown that the clamping force and clamping time affects the amplitude of welding distortion.

Keywords: Residual stresses, Distortions, Finite element analysis, Tube-plate structure.

Parallel Session 1: Materials Processing & Joining-II

ID53: Development of an Ultra-high Speed Micro-milling Center: an FEM Approach

Arnab Das[1*] and Vivek Bajpai[1]

*das94arnab@gmail.com

[1]Department of Mechanical Engineering, Indian Institute of Technology (ISM), Dhanbad, Jharkhand 826004, India

Abstract

High speed micro-milling is a versatile micromachining technology to develop miniaturized components with highly finished surfaces. However, cutting vibration is a generalized problem for this technology due to high spindle speed. This paper describes two different configurations of ultra-high speed micro-milling machine tool. The micro-milling machine consists of an ultra-high speed spindle having maximum rotational speed is 140000 rpm and ultra-precision linear stages. The moving components have been accommodated in a developed rigid type machine structure. In configuration A, the spindle has been attached in the linear stage assembly. However, the spindle was attached in the upper block of the machine structure for configuration B. The purpose was to reduce the cutting vibration for the micro-milling machine. Both the configured models were undergone FE analysis to evaluate the static stiffness, natural frequencies and dynamic stability. Based on the performance, configuration A showed higher stiffness, rigidity and damping capability in contrast to configuration B under both static and dynamic conditions. Therefore, configuration A has been selected for ultra-high speed micro-milling operation.

Keywords: Ultra-high speed micro-milling, Cutting vibration, Modal analysis, Harmonic response analysis.

Parallel Session 1: Materials Processing & Joining-II

ID55: Effect of Print Speed and Build Orientation on Tensile Strength of FDM 3D Printed PLA Specimens

Sowmyashree P[1*], Satya Prema[1], Srinivasa Murthy MK[1] and Raghavendra S[2]

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[1]Department of Mechanical Engineering, J N N College of Engineering, Shivmogga
[2]Founder & CEO, Aakruthi3D Private Limited, Shivmogga

Abstract

Additive Manufacturing is a process of producing 3D objects by adding material in a layer by layer manner. It is gaining traction in recent times due to its advantages like zero/near zero wastage, tool less process and the design freedom. It has the ability to decentralize production and offers great speed and flexibility to accelerate the innovation process. It is also a major driving force for Industry 4.0.

The aim of the present study is to experimentally investigate the effect of build orientation and print speed on the tensile strength of the 3D printed PLA specimens. The build orientations considered are flat (XY), upright (XZ) and on-edge (YZ) positions. The print speeds are considered in the range of 20-60 mm/s. The 3D printed specimens are subjected to tensile test using a Universal Tensile Testing Machine (UTM) in which the material behavior is observed to find the peak load, necking and ultimate tensile strength.

Keywords: Print speed, Build orientation, Additive manufacturing.

Parallel Session 1: Materials Processing & Joining-II

ID57: Processing of Cementitious Materials for 3D Concrete Printing

Dhrutiman Dey[1], Dodda Srinivas[2*], Biranchi panda[1] and T.G. Sitharam[3]

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[2]Centre for intelligent Cyber Physical Systems (CICPS), Indian Institute of Technology, Guwahati, India
[3]Department of Civil Engineering, Indian Institute of Technology (IIT), Guwahati, India

Abstract

In the era of automation and artificial intelligence, the world is changing rapidly under the broad vision of Industry 4.0. In this framework, the building and construction industry is getting significant attention from both academia and industries with the advent of additive manufacturing technology. Additive manufacturing or 3D printing of concrete provides a complete digital solution to conventional construction practice and fosters sustainable, smart, and green building concepts. In this paper, some recent experimental research conducted at the Indian Institute of Technology Guwahati (IITG) on 3D concrete printing is presented. A custom-developed 3D printable cementitious mix was processed, and its rheological properties were measured using flow table and vane shear apparatus. The influence of process parameters such as print speed and extrusion speed on filament quality (shape retention surface finish) was studied using a lab-scale gantry 3D concrete printer. Finally, the letters of IITG were printed to demonstrate the proposed process parameters and mix design are suitable in practice.

Keywords: Additive manufacturing, Digital concrete, Rheology, Sustainability.

Parallel Session 1: Materials Processing & Joining-II

ID68: 3-D Printing for Fauna Research – Peeping into the 3rd Dimension with a Prototype Study

Guruprasad Kuppu Rao[1*], Sagar Parekh[1], Rashi Gupta[1], Rina Dev[2] and Prabir G Dastidar[3]

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[1]Imaginarium India Pvt Ltd, Mumbai, India
[2]Rina's Vet Clinic, Mumbai, India
[3]Ministry of Earth Sciences, New Delhi

Abstract

This exploratory prototyping project was undertaken as a follow up of an international workshop on Social Network of Animals in Extreme Environment of Antarctica with special reference to penguins, organized by the Zoological Survey of India (ZSI), Port Blair under the sponsorship of Ministry of Earth Sciences (MoES). Penguins despite small brain show a high degree of cooperative behavior is noticed in their lifestyle. It was decided to evaluate the brain though prototype study on a kite to assess the brain volume and in particular the front cortex. 3D printing has proved itself as a reliable method to produce prototype models. Its capability to fabricate complex geometries is acknowledged and used in medical research and teaching. The technology needs a virtual computer model to fabricate the physical models. Using CAD software, Scan data converted to a virtual model or a set of medical image data. In this study a method was developed to simulate and arrive at Bird's Brain volume. A test bird, Kite is subjected to a CT scan and data is captured as DICOM. Using the DICOM data set, a virtual model of the bird head is created. This model contains all types of structures such as the skull, eyes, brain, and other tissues. This model is further processed to alienate other parts and obtain our focus anatomy, Bird's Brain part. The segmented part of the desired anatomy can then be used to measure and analyze the structure, volume and other aspects of the organ that is not usually accessible or visible.

Keywords: 3-D Printing, CT scan, Segmentation, Kite, Bird, Brain volume, Penguin.

Parallel Session 1: Materials Processing & Joining-II

ID69: Comparison of Two Different Non-coupled Multi-step Simulation Techniques for Strength Prediction of an Electromagnetically Crimped Cu-SS Tube-to-tube Joint with Smooth Interface

Deepak Kumar[1*], Chinmay Morajkar[2], Sachin D. Kore[3] and Arup Nandy[1]

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[1]Department of mechanical engineering, IIT Guwahati, Assam-781039, India
[2]Entuple technologies private limited, Bangalore-560038, India
[3]School of mechanical sciences, IIT Goa, Ponda, Goa- 403401, India

Abstract

Simulation models have proven efficient in understanding and analysing the different characteristics of joining by the electromagnetic forming process. This work performs a comparative study between two different non-coupled multi-step simulation models to predict the pull-out strength of a smooth-surfaced Cu-SS tube-to tube joint joined by electromagnetic crimping. The first simulation model is performed in two steps using LS-Dyna TM, whereas; the second simulation is performed in two steps using Ansys Maxwell and Ansys explicit dynamics. The result indicates a 5% higher pull-out strength in the first simulation than the second simulation. Pull-out strength values and failure modes are further validated with experimental results.

Keywords: Electromagnetic Crimping, Cu-SS, Tube-to-tube, Multi-step simulation, Strength prediction.

Parallel Session 2: Policy & Entrepreneurship

Session Chair

Prof. Vishal Singh

Indian Institute of Science, Bangalore, India

Bio:

Dr. Vishal Singh is an Associate Professor in the Centre for Product Design & Manufacturing at the Indian Institute of Science Bengaluru. He is a former Assistant Professor at Aalto University, Finland. He is also a Co-founder & Chairman of the Board, Visualynk Oy, Finland, and was the Director of the Construction Innovation Hub, Helsinki Metropolia University of Applied Sciences, Finland. He has completed his B.Arch from Birla Institute of Technology, M.Des from Indian Institute of Science, and Ph.D. from the University of Sydney. His areas of research are Built Environment (BE), construction management, design management & innovation management.

Parallel Session 2: Policy & Entrepreneurship

ID41: Understanding Appropriate Teaching Pedagogy for Startup Entrepreneurship

Kumar Aashish1*, Krishna Dixit[2**] and Amit Kumar Dwivedi[2]

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[1]Institute of Public Enterprises
[2]Entrepreneurship Development Institue of India

Abstract

Industry 4.0 poses technological challenges and organizational implications, providing opportunities to enable innovation in a collaborative culture for the development and use of digital technology among various firms and startups. Startups and other forms of doing business are quite different from each other in origin, technique, and practice. Hence, this conceptual paper presents a comprehensive inquiry into startup education pedagogy with which the needs of participants from heterogeneous backgrounds who want to create an innovative, technology-driven, scalable solution to society's problems can be addressed. In this paper, we suggest that a course in a startup could emphasize an experiential learning approach with uniquely designed pedagogical strategies like administration of Ecosystem Understanding Module (EUM), preparation of Locality Startup Ecosystem Index (LSEI), and Startup Personality Map (SPM).

Keywords: Start-up Education, Curriculum, Pedagogy, Startup-Campus, Entrepreneurial ecosystem.

Parallel Session 2: Policy & Entrepreneurship

ID47: For the Greater Good in Sustainable Development: Linkage in Industry Initiatives, Stakeholders and Policy Implementation in the Residential Sector

Kratika Piparsania[1*] and Pratul Ch. Kalita[1]

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[1]Indian Institute of Technology Guwahati

Abstract

India experiences the fastest relative growth in per person residential energy use because of increased access to energy sources and increased use of appliances and other energy-using equipment. National codes, policies, and other reforms have emphasized building sustainability by integrating climate-responsive design elements that are low-cost and energy-efficient. This paper showcase processes that each segment has adopted and implemented in the development of high-performance construction and to reduce energy consumption. The study reviews all critical aspects of these guidelines and voluntary reforms and recognizes the collaboration amongst stakeholders to deliver the essentials in green buildings. This research suggests a few practical steps and recommendations increase awareness and participation in green building projects.

Keywords: Building Energy Policy, And Reforms, Stakeholders, Residential Sector, Sustainable Development.

Parallel Session 2: Policy & Entrepreneurship

ID56: Entrepreneurship for Differently-abled People: Getting Ahead with the Help of Assistive Technology and Policy Support

Simran Sodhi[1*] and Amit Kumar Dwivedi[1]

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[1]Entrepreneurship Development Institute of India, Gujarat, India

Abstract

As the globe moves towards building a sustainable economy with Sustainable Development Goals (SDGs) concerning social inclusion, this paper tries to throw some light on one of the disadvantaged sections in the society, i.e. differently-abled people. 'Disadvantaged section of society' is a broad term used for many sections combined in our community, and 'differently-abled people' is one such section still not getting the necessary support. Of late, there has been debate on the empowerment of differently-abled people through entrepreneurship and self-employment. Society has now started believing that entrepreneurship is the only option that would help develop confidence and strengthen the economic status of differently-abled people. This paper highlights that entrepreneurship is a choice for differently-abled people to be self-reliant rather than a compulsive choice. Technology plays a significant role by supporting differently-abled people and making them more abled in performing various activities. The diffusion of technology through Industry 4.0 has provided independence to these people through much-advanced technology. This accelerates the motivation and self-esteem of differently-abled people. Further, it contribute towards making an improved version of an entrepreneur in them. However, government interference is crucial to build a better ecosystem for all the differently-abled, especially those who want to be economically empowered. This paper discusses the entrepreneurial aspect for differently-abled people, further supported by assistive technology and government policies.

Keywords: Entrepreneurship, Differently-abled people, Differently-abled entrepreneur, Assistive technology & policy support.

Parallel Session 2: Policy & Entrepreneurship

ID72: Does University Entrepreneurial Ecosystem and Entrepreneurship Education Affect the Students' Entrepreneurial Intention / Startup Intention?

Raj Karan Gupta[1*]

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[1]School of Business Studies, Sharda University

Abstract

This paper is an attempt to investigate the impact of university entrepreneurial ecosystem and entrepreneurship education on students' entrepreneurial intention / startup intention. This study is empirical in nature and uses causal research design approach to explore the causal relationship among independent and dependent variables. Data have been collected by using a structured questionnaire and were analyzed with the help of SPSS version 21 software. A total of 186 responses were found usable and were analyzed. Correlation and regression analysis were performed to explore the nature of relationship among independent and dependent variables. It has been found that both the independent variables (university entrepreneurial ecosystem and entrepreneurship education) are positively and significantly affecting the dependent variable (Students' entrepreneurial / Startup intention). It is also important to mention here that entrepreneurship education has been found the most influencing factor than university entrepreneurial ecosystem. The study also presents few important suggestions which may be helpful towards startup policy formulation specially university level startup policy aiming to create a pool of potential entrepreneurs.

Keywords: University entrepreneurial Ecosystem, Entrepreneurship Education, Entrepreneurial Intention, Startups.

Parallel Session 2: Policy & Entrepreneurship

ID76: Types of Designers and How to Develop Them

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[1]Centre for Product Design and Manufacturing (CPDM), Indian Institute of Science, Bangalore

Abstract

Starting with a definition of design, and a space of possible types of designing as combinations of five aspects, the paper identifies six dominant, alternative types of the designer, and delineates the types of knowledge that are needed to train each of these designer types.

Keywords: Design, Innovation, Design Methodology, Design Education, Design Thinking, PLM

Parallel Session 3: Supply Chains

Session Chair

Dr. Abhijit Biswas

Indian Institute of Science, Bangalore, India

Bio:

Dr. Abhijit Biswas, Asst. Professor at Centre for Product Design and Manufacturing (CPDM), IISc has wide experience of R&D related to Electronics, Instrumentation, Power and Embedded systems, Biomedical Engineering, and Haptics to name a few. In his industrial career, he led R&D of Robhatah Robotic Solutions, Gears Energy Solutions, Merkel Haptic Systems, and is a founding member of Dynocardia and Abhipsita Technologies. He was a Postdoctoral Research Associate at MIT till 2018 leading research on the development of a novel BP estimation and continuous monitoring system funded by NIH to RLE and CSAIL, MIT and School of Medicine, Tufts University jointly. He obtained Ph.D. in applied mechanics with a specialization in haptics from the Indian Institute of Technology, Madras in 2015. He obtained his Masters (M.E.) in Biomedical Engineering from the School of Bio-Science & Engineering of Jadavpur University in 2008 and graduated (B. Tech.) in Electronics and Instrumentation from the Department of Engineering & Technological Studies (formerly USIC) of the University of Kalyani in 2006.

Parallel Session 3: Supply Chains

ID46: A Study on Impact of Industry 4.0 on Supply Chain Efficiency among Manufacturing Firms

R.Sujatha[1*], B.Uma Maheswari[1] and L.Ivan Kenny Raj[1]

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Abstract

Industry 4.0 involves implementation of new technologies in an organization which leads to process efficiency in the industry and in turn economic development of the country. Therefore there is a need to focus on supply chain strategy, supply chain orientation, inter-organizational collaboration, human centric issues and customer value creation. The supply chain being an integral part of the industry, it is essential to closely monitor the impact of these changes on the supply chain. The supply chain 4.0 has been strongly influenced by technology and this has impacted the supply chain. This study aims to understand the influence of Industry 4.0 on supply chain management. Review of the literature indicates that the technologies like IoT implementation, robotic working environment, data integrity through the cyber physical system has a prominent role in impacting the supply chain of the organization. Hence a frame work is proposed for this research work. An extensive literature was done and based on that a structured questionnaire was developed. This empirical study was conducted among manufacturing firms in Tamil Nadu state in India. The findings of the study indicate that IoT implementation, robotic work environment and data integrity positively influences the supply chain efficiency of an organization. Industry 4.0 is going to be the future of all Indian manufacturing firms. Supply chain efficiency can be improved only through the proper usage of the technologies in the way that will improve the performance and productivity. This research also gives future scope to the managers to do researches on impact on supply chain efficiency other technologies of industry 4.0.

Keywords: Industry 4.0, Supply chain management, Robotics, IoT, Cyber Physical System (CPS), Data Integrity.

Parallel Session 3: Supply Chains

ID64: A literature Review based Bibliometric Analysis of Supply Chain Analytics

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[1]New Delhi Institute of Management, New Delhi, India
[2]Indian Institute of Technology (BHU), Varanasi, India

Abstract

The management of the supply chain is an integral part of any organization and plays a critical role in efficient operational productivity and effectiveness. Supply chain performance excellence provides a competitive edge in the fast-changing marketplace. On the other hand, a wrong decision in SC activity can lead to the complications of improper supply-demand conditions, production in-efficiency, supplier selection difficulties, and many others. The role of Supply Chain Analytics is a systematic analysis of the assortment of data and statistics generated during the supply chain activities to come up with accurate information that can optimize the business processes. This paper defines the challenges associated with supply chain activities and the role of analytics in supply chain decision modeling and knowledge processing in business intelligence architecture. The role of supply chain analytics is also estimated over a supply chain SCOR model. The paper provides a systematic review of supply chain analytics implementation in the recent literature of the last 10 years (2010-2020). The paper concludes by defining the qualitative insights from the literature of supply chain analytics along with giving future directions.

Keywords: Supply chain management, Supply chain analytics, SCOR, Bibliographic study.

Parallel Session 3: Supply Chains

ID65: Shaping a New Shopping Experience for the Post COVID-Era

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[1]Department of Architecture and Regional Planning, Indian Institute of Technology Kharagpur, Kharagpur, West Bengal, India
[2]Department of Architecture and Planning, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand, India

Abstract

As cities worldwide are striving to cope with the ongoing crisis of the COVID-19 pandemic, switching to digital platforms has sparked interest in many stakeholders in response to pandemic recovery. The uncertainty of such future shocks questions our way of addressing urban issues at a micro and Macro-Level. The virus makes physical proximity vulnerable to risks. Hence urgency is required to shift operations to an online mode to ensure COVID-19 safety norms, maintain continuity in operation and productivity at a distance. It may indicate that worldwide, e-commerce giants have grown during the pandemic for their ability to operate through contact-less platforms. On the other hand, local stores and markets suffered due to such giants' growth and Covid restrictions. This research explores challenges in the local retail sector caused by the pandemic and proposes a Design-Based solution. Considering Industry 4.0, mobile apps hold the potential to ease workflow and are easily accessible to all. Our final proposition would be to design a mobile app prototype (which would also be co-designed with the users). Methodologically, we have followed a Bottom-Up model approach and performed exhaustive user research and a heuristic evaluation with a probable user group. Only through understanding and accommodating the 'larger' community can we all cope with the after effects of this crisis. This research presents an opportunity for consumers to show solidarity with the small Indian retailers and shop the old, local and sustainable way again.

Keywords: Pandemic, Supply chain, E-commerce, App prototype, Local, Grocery, Industry 4.0.

Parallel Session 3: Supply Chains

ID73: Simulation-based POLCA Integrated QRM Approach for Smart Manufacturing

Sandeep Kumar[1*], Sanyapong Petchrompo[2], Tanveer Ahmed[3] and Amit Kumar Jain[4]

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[3]Department of Computer Science and Engineering, Bennett University, Uttar Pradesh 201310, India
[4]School of Computing, Engineering and the Built Environment, Glasgow Caledonian University, UK

Abstract

Digitalization and Industry 4.0 have enabled real time interaction of customers and suppliers with manufacturing systems. However, this requires a high level of reactivity in the value chain to sustain in a competitive economy. As a result, Quick Response Manufacturing (QRM) in dynamic conditions such as wide product variety, change in demand, volatile market conditions, uncertainty in supply, machine failures, etc. is critical in capturing the benefits of digitalization in industries. To empower QRM, Paired-cell Overlapping Loops of Cards with Authorization (POLCA) is suitable for a manufacturing environment with a wide variety and highly dynamic conditions. The combination of QRM and POLCA provides a significant competitive advantage through their quick response to dynamic conditions. Such a combination is not reported in the literature. Accordingly, this paper proposes a simulation-based POLCA integrated with the QRM approach for smart manufacturing. The offered approach evaluates a dynamic sequence of jobs at each machine to meet the due date and at the same time control the material flow to improve system performance. The approach is illustrated with the help of a complex manufacturing scenario. A simulation-based technique is used to evaluate the system performance. Further, the performance of the approach under dynamic conditions is analyzed. Results show that improved system performance can be achieved by considering QRM and POLCA in dynamic conditions.

Keywords: Industry 4.0, Quick Response Manufacturing (QRM), POLCA, Modeling and Simulation.

Parallel Session 4: Sustainable Manufacturing

Session Chair

Dr. Thulasi Raman K H

Indian Institute of Science, Bangalore, India

Bio:

Dr. Thulasi Raman is currently leading the Centre of Excellence for Additive Manufacturing (AM-CoE) at Indian Institute of Science, Bangalore, India. He did his Ph.D. from Indian Institute of Science. He has been working on solid state batteries since 2008 in IISc and we are the first research group to start solid state micro batteries fabrication in India. Making of all solid-state batteries was funded by department of defence and MeITY with a value of 1.2 million USD.

Parallel Session 4: Sustainable Manufacturing

ID3: Study on Works Posture Assessment Using RODGERS Smart Form in Indian Firework Industries

R. Ramalakshmi[1*], V. Ajith[1], V. Arumugaprabu[1] and N. Indumathi[1]

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[1]Kalasalingam Academy of Research and Education, Krishnankoil- 626126, Tamil Nadu, India.

Abstract

This work mainly focused on the ergonomic assessment of manual handling operations which takes place in fireworks industries. The workload of workers increases during festival seasons as there is a huge demand for crackers. In fireworks industries, manual material handling is performed, which leads to many health issues. Due to this problem, industries face reduced manpower which in turn affects production. By considering those aspects, a study was carried out about the work posture assessment using one of the assessment tools like ROGERS smart form to point out the health-related issues and the body parts which get affected by the different stages of pyrotechnic manufacturing. The study also helps to identify the future health issues which may arise due to their present working posture. A simulation design and fabrication of equipment was also proposed to carry the bale, packages and raw materials from one place to another place with minimum input effort.

Keywords: Firework industry, Ergonomics, Manual handling, Assessment.

Parallel Session 4: Sustainable Manufacturing

ID14: Developing a Line of Sustainable Seashell Jewellery & Proposing a Manufacturing Loop to Improve upon Traditional Processes

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[2]School of Design, Indian Institute of Technology, Bombay, India

Abstract

Jewellery has been an indispensable commodity to mankind for over thousands of years. It has been part of the Indian culture and an invisible thread joins the fraternity of jewellers across the world. In the world of competitive manufacturing of jewellery, introducing seashell jewellery in a way that appeals to the customer and yet meets sustainability goals both pre and post production holds tremendous scope and potential for development.

Before the popularisation of metals and gems in the jewellery industry, diverse materials were used to create ornaments. Processes such as carving and engraving were applied to them to create unique embellishments. A lot of explorations happened in the form of costume jewellery in 1950's when composites such as Bakelite and rubber were introduced. The introduction of new materials in the Indian Jewellery Manufacturing Scenario in the form of neoteric jewellery with processes such as inlays and superfinishing give sustainable wearables and their production a new identity.

This paper investigates the scope of this line of seashell jewellery and proposes a model to introduce improved microprocesses within traditional manufacturing processes to build a sustainable production loop as compared to a wasteful cycle.

Keywords: Seashell Jewellery, Micro processes, Sustainable Jewellery.

Parallel Session 4: Sustainable Manufacturing

ID48: Sustainable Manufacturing Innovation for Woodturning Handicrafts

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[1]NIFT, Bengaluru, India

Abstract

India has a vast range of handicrafts succoured by the ecosystem of the region. Although sustainable by nature, some forms are gradually fading away due to the lack of new aesthetics to attract consumers. The research delves into understanding the shortcomings of the manufacturing techniques through a case study of turnwood lac-ware of Channapatna. It explores the possibility of new forms, while keeping the manufacturing methods constant and sustainable. It introduces an innovation in mechanism to allow the artisans to create asymmetric products, an unexplored technique in the two hundred years of the craft. The sustainability of the manufacturing method is assessed, and the acceptance of the innovation is determined through qualitative methods in the field.

Keywords: Handicraft of Karnataka, Turnwood lac-ware of Channapatna, Woodturning, Eccentric turning Chuck, Asymmetric form, Sustainable manufacturing.

Parallel Session 4: Sustainable Manufacturing

ID51: Implementing Industry 4.0 and Sustainable Manufacturing: Leading to Smart Factory

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[1]Department of Mechatronics Engineering at School of Automobile, Mechanical & Mechatronics Engineering, Manipal University Jaipur

Abstract

Industry 4.0, the fourth industrial revolution is rapidly increasing and is extremely relevant to practice due to multiple reasons, it is an important part of manufacturing engineering field and next wave of technology to drive efficacy across operations. Inability to implement Industry 4.0 would cause organizations to lag, as their functions will not be technologically advanced enough to compete with other organizations. Firstly, this paper will talk about the way how means of production get into a network and communicate, enabling new ways of manufacturing, value creation, and real-time optimization. The ambition of this upgradation would be to portrait live data into graphical form for a stronger and comprehensive data analysis. The target of this data would be to increase production and subsequently assist in proactive and preventive maintenance.

Energy efficiency and flexibility are two concepts that are becoming more important than automation. Due to the high prices of energy, Sustainability has become an important concern for companies. This paper also discusses a solution that is used to conserve energy by optimizing welding parameters, subsequently leading to Reduced cycle time and Energy Conservation for better manufacturing efficiency, resulting in a 5% increase in production and Energy being saved in one year be equivalent to 15 units of electricity for optimization of 1 part.

Keywords: Industry 4.0, Sustainable Manufacturing, Energy conservation.

Panel Discussion 3: Industry Needs for Training and Education in Manufacturing

Session Chair

Prof. B Gurumoorthy

Indian Institute of Science, Bangalore, India

Bio:

B Gurumoorthy is a Professor at the Indian Institute of Science in the Centre for Product Design and Manufacturing (CPDM) and the Department of Mechanical Engineering. He is presently the chair of CPDM. His research interests are in the areas of CAD, Product Information Modelling, Computational Metrology and Product design and prototyping. He did his B. Tech at IIT Madras in 1982 followed by M.E. and Ph. D. at Carnegie Mellon University, Pittsburgh, USA in 1984 and 1987 respectively (all in Mechanical Engineering). He serves on the editorial board of four journals. He is presently the Vice-Chair, Asia-Pacific, IFIP WG 5.1 on Global Product Development for the Whole Life Cycle. Two technologies (automatic feature recognition and visual interactive solids) developed in his laboratory have been licensed to industry and are in active use.

Panel Discussion 3: Industry Needs for Training and Education in Manufacturing

Panel Member

Mr. AN Chandramouli Natarajan

Aerospace and Aviation Sector Skill council, Bangalore, India

Bio:

A.N. Chandramouli, is a Graduate in Mechanical Engineering from NIT Trichy (RECT) @1979, and Postgraduate in Management from IIMC (Indian Institute of Management, Calcutta) @1984. In his over 4 decades of Industrial career, he has held many Leadership positions in diverse industries such as: Machine Tools (Starrag, Makino), Electrical Industry (Lapp,Cooper), Consumer Durables (Amtrex Hitachi Appliance), Consumer products (Unilever- Ponds division), Trucks (Tata Motors). Chandramouli superannuated as the MD of Starrag India, and now it's Board Member since June 2017 (Starrag is a global MNC headquartered in Switzerland in high technology machine tools of 15 decades heritage, widely present in diverse industries such as Aerospace, Power Generation, Transport, Industrial, Watches, Medical Implants, Oil & Gas). In this capacity, he set up a State of Art manufacturing facility and Technology center in Bangalore Aerospace Park and launched Horizontal Machining Centers with a significant local content under Make-In-India vision. He is highly passionate for Technology Collaboration, Strategic alliances, Project Management, Greenfield Ventures, Industrial product marketing, Product Innovation, Gemba Kaizen, Quality Management Best practices, World Class Manufacturing, Lean & JIT practices, Skilling initiatives, New age technologies such as Digital Manufacturing, Team Building with a clear focus on Customer orientation in the organizations he worked for. Since 2017, Chandramouli has established his own Independent Management Consultancy and he is coaching, advising, and mentoring Startup ventures in Industrial IoT, experiential tours and webinars in Industry 4.0, Training on Operational Excellence, conducting awareness and training seminars, Sales training for machine tool companies, and also contributing to Skill ventures and Industry-Academia interface.

Panel Discussion 3: Industry Needs for Training and Education in Manufacturing

Panel Member

Prof. B Ravi

Indian Institute of Technology Bombay (IITB), Mumbai, India

Bio:

B. Ravi is Institute Chair Professor of Mechanical Engineering at IIT Bombay, where he heads Desai Sethi School of Entrepreneurship as well as Biomedical Engineering & Technology Innovation Centre (BETIC). He is Fellow of Indian National Academy of Engineering and Abdul Kalam Technology Innovation National Fellow. Prof. Ravi led or mentored collaborative R&D projects in metal casting (AutoCAST, E-Foundry, SMART Foundry) and med-tech (BETIC, CollabDDS, OrthoCAD). These led to 60 patents and copyrights, most licensed to startups or industry; 8 products have reached the market. He shared this knowledge through 260 technical papers, 300 invited talks and 75 training programs. As a member of governing councils of CMTI Bangalore; KIHT Visakhapatnam; SCTIMST Trivandrum and other organizations, Prof. Ravi guides their vision and strategy. He is also a member of expert committees of many government agencies (AICTE, BIRAC, BIS, DBT, DST, ICMR, MoE, MeitY and NITI Aayog), contributing to project reviews and policy recommendations.

Panel Discussion 3: Industry Needs for Training and Education in Manufacturing

Panel Member

Prof. K P Karunakaran

Indian Institute of Technology Bombay (IITB), Mumbai, India

Bio:

Prof. K.P. Karunakaran is presently a Professor in Department of Mechanical Engineering at IIT-B. He has over 3 decades of professional experience. He, a 1984 graduate, worked as a CNC programmer in Hindustan Aeronautics Limited for about 9 years. He has been teaching and researching at IIT Bombay in the areas CNC, RM and Computer Graphics since 1994. He was a consultant to Mercedes-Benz Technology Centre in Stuttgart in 2000. He has been associated with Fraunhofer institutes in Stuttgart and Darmstadt since 1998 through summer visits. He is a Humboldt Fellow. He was a Visiting Professor in the University of Metz in 2005 and in Ecole Centrale de Nantes since 2006. He launched OptiLOM, a pre-processor for LOM-RP, in collaboration with Daimler Chrysler and Materialise during Euro Mold 2002. His two new RM processes, viz., HLM and SOM are at advanced stages of development. HLM which presently uses MIG deposition is being extended for TIG and laser depositions. RW-MAVs and Helicopters without tail rotors are his passions.

Panel Discussion 3: Industry Needs for Training and Education in Manufacturing

Panel Member

Dr. Mohit Law

Indian Institute of Technology Kanpur (IITK), Kanpur, India

Bio:

Mohit Law is an Assistant Professor in the Department of Mechanical Engineering at the IIT Kanpur. He studied at the University of Pune for his BE, at Michigan Tech for his Masters, and at the University of British Columbia for his PhD. He has worked as a machine tool design engineer at BFW and at the Tata Group, and as a researcher at the Fraunhofer Institute of Machine Tools in Germany. At the IIT Kanpur, he teaches and heads the Machine Tool Dynamics Laboratory. His lab works on use-inspired fundamental research related to modelling of machining processes, the dynamics of machining, and the measurement and control of machine tool vibrations.

Panel Discussion 3: Industry Needs for Training and Education in Manufacturing

Panel Member

Dr. Nagahanumaiah

Central Manufacturing Technology Institute (CMIT), Bangalore, India

Bio:

Dr. Nagahanumaiah has taken over charge as Director of Central Manufacturing Technology Institute (CMTI), Bengaluru, effective from 5th July 2018. He has served CSIR-Central Mechanical Engineering Research Institute, Durgapur as "Chief Scientist & Head, Micro-Nano Systems Technology Group" for more than two decades. He received PhD, from Indian Institute of Technology Bombay, Masters in Tool Engineering from Indo-Danish Tool Room, Bangalore and Bachelors in Mechanical Engineering from Bangalore University. He has 25 years of professional experience that includes 20 years in R&D, 3 years teaching and 2 years as a tool designer in industrial tool rooms. He was the Nodal Officer, successfully implemented three major multi institutional network projects in Micro Machines & Smart Manufacturing areas. He was also Principal Investigator in multi-institutional international projects likeIndo-EU-FP7 & Indo-US project in related areas of micro-nano manufacturing. He has published 88 research papers, filed 4 patents and successfully demonstrated working prototypes of 3 micro machines. He has guided 3 PhD and 18 M.Tech students, currently 6 PhD scholars are working with him. He is a recipient of 'BOYSCAST Fellowship' and 'Raman Research Fellowship'. He is one of recipients of 'We Think for India' award from Prime Minister of India for the Indian Manufacturing Policy draft prepared in 2003. In 2017, he was awarded as a Distinguished Scientist by Venue International Foundation. He is a member of International Association of Engineers, UK & Member of International Institution for Micro manufacturing (I2M2), USA.

Panel Discussion 3: Industry Needs for Training and Education in Manufacturing

Panel Member

Prof. P V M Rao

Indian Institute of Technology Delhi (IITD), New Delhi, India

Bio:

Prof. P. V. Madhusudhan Rao is a professor in departments of mechanical engineering and design at IIT Delhi. He also serves as head of the department of design. He is a co-founder of Assistech lab in Khosla school of information technology, which works towards development of assistive technologies for empowerment of visually challenged. As a coordinator of IIT Delhi Design Innovation Center (DIC), he is also responsible for initiating and driving multiple programs in design, innovation & entrepreneurship. He obtained his bachelor's in mechanical engineering from college of engineering, Osmania university, master's in mechanical engineering from IIT BHU and his Ph.D. from IIT Kanpur. He was a guest researcher to US government's National Institute of Standards & Technology (NIST), USA multiple times between 1996-2007. He was visiting scientist to Massachusetts Institute of Technology during summer 2005 and visiting faculty to Stanford University during 2012. His current teaching and research interests include product design & manufacturing, computer aided design & manufacturing, design for product life cycle, and design of medical & assistive devices. He has authored more than 120 research papers in journals and conferences. He has been conferred with of 2005 Vasvik Industrial Research Award and has received twice national award by Department of Science & Technology to scientists working on improving accessibility for the disabled. He has won many best paper awards for his papers in international conferences including ASME/IEEE conference.

Panel Discussion 3: Industry Needs for Training and Education in Manufacturing

Panel Member

Prof. Ramesh Babu N

Indian Institute of Technology Madras (IITM), Chennai, India

Bio:

Professor Ramesh Babu is professor at IIT Madras and also V Balaraman Institute Chair Professor & Head of the Department of Mechanical Engineering. Professor Ramesh Babu received his PhD from IIT Madras in the year 1990 (Investigations on laser dressing of grinding wheels). His research interest includes Manufacturing Technology, Grinding, Abrasive Water-jet Machining, Sheet metal fabrication, Laser Beam Machining, CNC, PLCs & Robotics, Precision Machine Tool development, Process modeling and Simulation of manufacturing systems. His publications include 61 International Journal Papers and 104 National/International Conference Papers.

Panel Discussion 3: Industry Needs for Training and Education in Manufacturing

Panel Member

Prof. Surjya K Pal

Indian Institute of Technology Kharagpur (IITKGP), Kharagpur, India

Bio:

Surjya K Pal is the Lord Kumar Bhattacharyya Chair Professor in Manufacturing in the Department of Mechanical Engineering at IIT Kharagpur. He is the Founder Chairperson of the Centre of Excellence in Advanced Manufacturing Technology; a Centre focused to solving the industrial problems. He has published 280 research articles, including, 164 International and National Journal Papers, 15 International Book Chapters, and 89 Conference papers. He has filed 11 patents. His innovation, *"Low-cost AI solution for metrological* inspection," is selected in the top 3 by INDIAai Lab2Market (The National AI Portal of India, a MeitY, NeGD, and NASSCOM initiative). He has two patents jointly with TATA Consultancy Services. He is the author of the textbook, *"Digital Twin – Fundamental Concepts to Applications in Advanced Manufacturing."* Under his esteemed supervision, 19 scholars have completed their doctorate degrees, and 17 are continuing. Prof. Pal has executed a huge number of projects worth over INR 85 Cr. He was also the Associate Dean of Alumni Affairs and Branding at IIT Kharagpur.

Panel Discussion 3: Industry needs for Training and Education in Manufacturing

Panel Member

Prof. Sunil Jha

Indian Institute of Technology Delhi (IITD), New Delhi, India

Bio:

Prof Sunil Jha did his Ph.D. in Manufacturing Science from IIT Kanpur and has been engaged in teaching and research on manufacturing processes, Computer Aided Manufacturing and Industrial Automation since last 12 years. He has developed new unconventional super finishing processes and filed 6 patents few of them have been successfully commercialized. Before joining IIT Delhi, he worked with TATA Motors, Jamshedpur in the area of CAD/CAM and was engaged closely in digitization of engine components and foundry tooling development. Currently in the capacity as Director IITD AIA Foundation for Smart Manufacturing, Dr Jha is closely supporting manufacturing industry in absorbing new technologies to make them ready for next industrial revolution.

Keynote Session 9 & 10

Session Chair

Prof. Dibakar Sen

Indian Institute of Science, Bangalore, India

Bio:

Prof. Dibakar Sen is a Professor in the Centre for Product Design and Manufacturing and Department of Mechanical Engineering in Indian Institute of Science Bangalore (IISc). He did his PhD from IISc Bangalore in 1997. Before joining IISc he briefly worked for Steel Authority of India Ltd, LPSC/ISRO and IIS XOX Asia Pacific Pvt Ltd His research interests include human factors in design, digital human modeling, mechanical assembly simulation, Virtual Reality and Haptics, simulation, and design of mechanisms etc. He has over 90 publications in journals and conferences; 3 of 8 of his Indian patent applications have been granted.

Keynote Session 9

Digitalisation of Skill-Intensive Manufacturing Processes

Prof. Ashutosh Tiwari

The University of Sheffield, UK

Bio:

Professor Ashutosh Tiwari (CEng FIMechE FIET) holds the prestigious RAEng/Airbus Research Chair in Digital Manufacturing at the University of Sheffield. Internationally renowned for research in digital manufacturing, he is Deputy Director of £20mn EPSRC Future Electrical Machines Manufacturing Hub, in the Executive Committee of £7mn Made Smarter Research Centre for Connected Factories and serves on the EPSRC Strategic Advisory Team (SAT) for Manufacturing. With over 20 years of experience, he has a track record of leading cross-TRL projects worth over £15mn, produced 343 publications (155 journal and 133 conference papers), graduated 36 PhDs, and was awarded an EPSRC HVM Catapult Fellowship.

Abstract:

This talk will focus on the development and application of novel digitalization techniques for smart industrial systems. The simultaneous tracking of human actions and the effect of those actions on the workpiece(s) during a manual task and the digitalisation of this real-time knowledge will be demonstrated in this talk using a gaming interface technology. The main steps in this research are the spatio-temporal segmentation of the captured continuous digital data into human and workpiece states and the subsequent human-workpiece state interaction modelling. These steps enable deeper investigation of manual tasks, paving the way for in-process monitoring and intelligent automation support for skill-intensive manual manufacturing tasks.

Keynote Session 10

Industry 4.0 Implementation along with Efforts to Pursue Inclusive Manufacturing

Prof. Manoj Kumar Tiwari

NITIE Mumbai

Bio:

Prof. Manoj Kumar Tiwari (FNAE, FNASc, FIIIE, FIISE, and FIETI) is serving as Director, National Institute of Industrial Engineering (NITIE) Mumbai since Nov 05, 2019. He was a Professor with Higher Academic Grade (HAG) in the Department of Industrial and Systems Engineering at the Indian Institute of Technology, Kharagpur, and currently on lien for five years. As a researcher, he is working in the domain of Manufacturing System and Supply Chain Management. His research and teaching interests are in modeling the Manufacturing Processes and Operations analysis in Supply Chain Networks. Optimization, Simulation and Computational Intelligence are the main techniques adopted by Prof. Tiwari to automate the decision support system for complex and large-scale problems in Manufacturing and Logistics System. His research interests have been supported by several industries, national and international research funding agencies. He has published more than 325 papers (H Index, Google Scholar – 71 and Scopus-57) in the International Journals of repute and he has been rated as Rank 1 among top 100 individual researchers across the world who had published research articles in International Journal of Production Research (Taylor & Francis) during the time period 1985-2010 (International Journal of Production Research, Volume 51, Issue 23-24, 2013). He is also mentioned as Top leading author in the domain of Supply Chain Analytical Techniques by Journal of Computer & Industrial Engineering (Volume 137, 2019). He is serving as Associate editors of IEEE System, Man and Cybernetics- System, (SMC-S), International Journal of Production Research (Taylor & Francis), Computers and Industrial Engineering (Elsevier), Journal of Intelligent Manufacturing (Springer), and Sadhana (Springer). Prof. Tiwari is also serving as Chairman, Sectional Committee of Global Initiative for Academic Networks (GIAN), Chairman of Board of UG Studies AICTE and Member, Board of Governor at NIFFT Ranchi. Prof. Tiwari is Fellow of Institute of Industrial

Engineers (IISE, USA), Fellow of Indian National academy of Engineering (INAE, India), and Fellow of National Academy of Sciences (FNASc, India).

Abstract:

Industry 4.0 implementation is on the board of corporates and academics. Wherein several emerging technologies are converging to provide digital solutions by utilizing the concepts of digitalization, advanced networking, and data analytics. Its implementation is not limited to manufacturing and production areas. Whereas Logistics and supply chain participants are increasingly interconnecting through advanced networking and computing technologies that enable design, production, and service capabilities far beyond anything previously possible. Manufacturing & service complexity is being realized to be resolved, covering a wider paradigm of social and environmental concerns. The idea coins a term “Inclusive Manufacturing”. It is a composition of various policies and standards for resolving societal issues, environmental degradation, and economic difficulties along with the integration of advanced manufacturing models and emerging technologies, like information and communication technologies, cyber-physical systems, Internet of Things and Semantic Web. In nut cell, the talk presents the adoption issues/patterns of Industry 4.0 technologies in a manufacturing firm along with the discussion on three industry cases, i.e., Airport baggage handling systems and fault detections, Competitive advantages of additive manufacturing over conventional manufacturing, Integrated forecasting, and order management.

Valedictory Session

Distinguished Paper Awards

Ms. Swati Meherishi

Springer Nature, India

Bio:

Swati Meherishi is currently the Editorial Director at Springer Nature. Since January 2019, she has been leading the Applied Sciences and Engineering books program at the Asia Pacific region. Swati is the recipient of a special contribution award from the Indian Institute of Metals for her work on their flagship journal Transactions of the Indian Institute of Metals. She is a member of the Materials Research Society (MRS), Institute of Electrical and Electronics Engineers (IEEE), and the American Institute of Chemical Engineers (AIChE). In her free time, she teaches technical communication courses to graduate students at the IITs. Swati is also involved in initiatives related to the Sustainable Development Goals, the state of engineering education, and women in engineering and STM.

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