Curriculum Vitae

Personal

Name	Dr Amit V Sata
Date of birth	17th July, 1979
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Sex	Male
Nationality	Indian
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Education

Degree	University / Education Board	Institute	Year	Performance
PhD	IIT – Bombay	IIT–Bombay	2010 – 2015	9.25/10 (CPI)
MTech	IIT - Bombay	IIT–Bombay	2008– 2010	8.8/10 (CPI)
B.E. (Mech.)	Saurashtra University	VVPEC –Rjt	1996 – 2000	71 %
H.S.C	G. S. E. B	SVP-Rjt	1996	70 %
Matriculation	G. S. E. B	SGV- Rjt	1994	69 %

PhD Title and Abstract

Prediction and Analysis of Defects and Mechanical Properties of Investment Casting *under the supervision of* ***Dr. B. Ravi*** *(Institute chair professor, IIT Bombay)*

Metal parts with intricate shapes and thin walls can be economically produced by investment casting process. It involves creating a ceramic shell around a wax pattern, melting out the wax, pouring liquid metal in the heated shell, and removing the solidified part after breaking the shell. These parts are used in automobile, aerospace, chemical, biomedical and other critical applications; they are required to be free of defects and possess the desired range of mechanical properties. In practice, this is a big challenge, since there are large number of parameters related to process and alloy composition; their values change for every casting, and their effect on quality is not very well understood. A large number of castings are therefore rejected, repaired or recycled, leading to wastage of production resources. There is a need for a systematic approach for prediction and analysis of defects as well as mechanical properties of investment castings, which can be easily implemented in industrial foundries.

A survey of 20 investment casting (IC) foundries located in Rajkot cluster in Western India was first carried out to understand their capabilities and quality issues. A hierarchical methodology for systematic categorization of major IC defects, such as ceramic inclusion, flash, misrun, shrinkage, and slag inclusion was developed. Several different models were evolved to predict these defects using Artificial Neural Network (ANN) and

Multivariate Regression (MVR). The models were trained using a large amount of data related to process parameters, alloy composition and occurrence of defects, collected from an industrial IC foundry. Principal component analysis was employed to reduce the redundancy in data, resulting in faster computations. The models were tested on a portion of the foundry data kept aside for the purpose, and their prediction accuracies were compared. A similar approach was evolved for prediction of mechanical properties (ultimate tensile strength, yield strength, and percentage elongation) of investment cast parts. The ANN (with LM training algorithm) gave better prediction of defects, while MVR gave better prediction of mechanical properties.

A probabilistic approach based on Bayesian inference was developed to analyze the defects and to find critical parameters (along with their avoidable range of values) to minimize their future occurrence. A similar approach was developed to analyze the values of mechanical properties, and determine the critical parameters (along with their preferred range of values) to obtain the desired properties. The methodology for prediction and analysis of defects as well as mechanical properties was further validated by applying the models (without any further training or customizing), to a different casting produced in the same foundry, but with slightly different values of process parameters and alloy composition. The entire methodology was found to be easy to implement and use by foundry engineers, unlike process simulation, which requires a high level of inputs (3D models, property data, etc.), domain knowledge and interpretation experience. This work has proved the feasibility and value of process data driven analysis, optimization and control, and is expected to pave the way for more work in this direction. That is also expected to benefit the industry.

Dissertation Title and Abstract

Shrinkage Porosity Prediction using Casting Simulation *under the supervision of* ***Dr. B. Ravi*** *(Institute chair professor, IIT Bombay)*

Shrinkage porosity is one of the most common defects in castings. Various existing techniques of shrinkage porosity prediction like modulus and equi-solidification time and criterion function have been reviewed. Various criteria functions including Niyama criterion, dimensionless Niyama criterion, Lee et al. criterion and Franco criterion for prediction of shrinkage porosity have been studied in this work.

From literature, L shape casting has been analyzed for predicting location of shrinkage porosity using solidification simulation. Simulation result is comparable with available experimental result. Threshold values of Lee et al., Davis, Franco and Bishop criterion for cast steel have been established by comparing results with Niyama criterion.

Benchmark casting, a combination of three T-Junction, has been cast and analyzed to understand dependency of shrinkage defect size on geometric parameters and thermal parameters. The experiments were carried out for Ductile iron (500/7), plain carbon steel (1005 steel) and stainless steel (SS 410). These experimental data are used to set limiting temperature gradient values in AutoCAST®. Further, simulation experiments were carried out by varying thickness ratio from 0.25 to 1.5. The result of experiments and simulations are used as input to regression analysis to evolve a set of empirical equations to predict shrinkage porosity defect size in T junction considering the effect of geometric parameter alongwith thermal parameters. Further, an empirical model of SS 410 is validated by casting of T junction which is having thickness ratio and length ratio of 1.75 and 5 respectively. The predicted size of shrinkage defect is approximately matching with observed size of defect.

Professional Experience

01/12/2016 – *Present*
Professor
Mechanical Engineering Department in MEFGI, Faculty of Engineering - Rajkot

01/01/2013 – 30/11/2016
Professor
Mechanical Engineering Department in BHGCET- Rajkot

04/08/2011 –31/12/2012
Assistant Professor
Mechanical Engineering Department in Om Shanti Engineering College- Rajkot

25/11/2002 –03/08/2011
Lecturer
Mechanical Engineering Department in VVP Engineering College- Rajkot

1/1/2002 – 31/08/2002
Assistant Customer Care Manager
Cargo Motors Guj. Pvt. Ltd. – Rajkot (An Authorized workshop for the Maruti vehicle)

1/12/2000 – 31/12/2001
Production Incharge
Dipak Metals – Rajkot (Manufacturer of wide range of Quality Kitchenware Products)

1/8/2000 – 30/11/2000
Quality Control Engineer
Rajan Techno Cast Pvt. Ltd. – Shapar (Manufacturer of High Precision Investment Casting)

Funded Projects & Grants

Year	Project
2016-2019	**SMART Foundry 2020** (Sustainable Metalcasting using Advanced Research and Technology) of 9.24 crore (Nearly $1.25 million) funded by Department of Science & Technology (India) under Technology Systems Development Programme (TSDP)
	The overall goal is to develop a Smart Foundry that can be used to rapidly create small intricate metal parts required in tiny order quantities
	Co Principal Investigator – Module E (Process Monitoring and Data Analytics)
	36.21 lacs

Year	Project
2017-2022	**RAPID Casting** funded The Centre for Entrepreneurship Development, Government of Gujarat under scheme 2 (Short-term bridge course by industries/institute).
	The overall goal is to set up skill enhancement center for imparting technical skills related to rapid product development in metal casting.
	Principal Investigator
	100 lacs (slightly above $0.14 million)
2020	**IoT Enabled Testing and Measurement Devices for Investment Casting** funded by New Generation Innovation and Entrepreneurship Development Centre (NewGen IEDC) - Gandhinagar
	The overall goal is to develop IoT enabled testing and measurement devices for investment casting industries.
	Mentor
	1.9 lacs

Research Interest

- Manufacturing engineering
- Metal Casting
- Internet of Things (IoT)
- Manufacturing Data Analytics
- Artificial Intelligence

Academic Contributions

- Developed course on Manufacturing Process focused on implementation of project based learning.
- Proposed minor course of one year on **SMART Systems** at under-graduate level. Also, proposed post-graduate course of two years on **SMART Systems**.
- Identified more than 75 technical skills focused on industrial needs, and necessary to be imparted in mechanical engineers to strengthen skill domain of engineers. Also, Initiated Centre for Skill Enhancement (CSE) focused on imparting technical skills to mechanical engineering students

Technical Contributions

- *Member of Editorial Board* - American Journal of Neural Networks and Applications; International Journal of Industrial and Manufacturing Systems Engineering

- *Topic Organizer*-International Mechanical Engineering Congress & Exposition (ASME-IMECE 2017), USA
- Part of executive committee for ASME IMECE Track on Safety Engineering Risk Analysis Division (SERAD)
- *Member of Scientific Committee*-International Conference on Applied Mechanics, Electronics, and Mechatronics Engineering (AMEME 2016), China
- *Chairperson (Technical Session)*-Indian Foundry Congress 2016, India
- *Peer Reviewer*-International Mechanical Engineering Congress & Exposition (ASME-IMECE 2017,2016,2015 & 2014), USA; CHARUSAT Journal (A scientific research publication from Charotar University of Science and Technology-Changa

International Exposure

- Nominated for **Teaching Mobility Program** under ERASMUS+ program during 7-11 May 2018 at University of Pitesti, Romania
- Presented research work on 9 November 2017 during ASME IMECE 2017 at Tampa, USA
- Presented research work on 24 May 2016 during World Foundry Congress at Nagoya, Japan

Award

Awarded with $1000 and five years membership by American Society of Mechanical Engineers (ASME) for mentoring the project ***Innovative Multi-Axis Wind Turbine*** that won **Best Overall Impact/Utility** under **Mixed Software Category** at **Innovative Design Software Challenge (IDSC) 2016** organized by ASME at Charlotte, US during 21-24 August 2016.

Intellectual Property Rights (IPR)

- Achieved IPR (SW-12195/2019) for software **Foundry Data Analytics System (FDAS)**. This tool takes input data (input parameters involved along with quality attributes) in the form of *spreadsheet*, and suggests critical parameters along with their specific range of values to achieve quality (defect free with desired mechanical properties) in metal casting.
- Achieved IPR (SW-10234/2019) for software **OptiTool**. This tool takes input data (input and output parameters) in the form of *spreadsheet*, and provides optimized range of values.
- Indian Patent (No: 202021018663) on A device to Measure Shell Permeability During Investment Casting Process. The proposed device is comprised of microcontroller further connected with sensors including flow sensors and pressure sensor. The device acquires the necessary input from sensors and computes the value of shell permeability as per standard guidelines published by Investment Casting Institute (ICI). This device minimizes human errors involved in data acquisition and computation in measurement of shell permeability.

Knowledge Transfer

- **Guided more than 30** undergraduate projects in different domains of mechanical engineering
- **Guided nearly 10** postgraduate projects in domain of manufacturing engineering
- **Supervising** PhD Students focused on extending application of IoT to manufacturing engineering
- **Mentoring** 4 startups including IoT Enabled Testing labs, Intelligent Inspection Devices for Metal Casting and Ceramic Industries, and IoT Enabled jewellery Casting.

Selected Publications

International Journal – Published

1. Divya Bhoraniya, Vishesh Dharaiya, Amit Sata **Application of *Niyama* Criterion to Predict Shrinkage Porosity in Vertical Centrifugal Casting (VCC) of ASTM A356 Alloy**, International Journal of Process Management and Bench Marking (in print), 2020
2. Dr Amit Sata, Dr B Ravi **Foundry Data Analytics to Identify Critical Parameters Affecting Quality of Investment Castings**, *ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems Part B: Mechanical Engineering,* Volume 5(1), pp. 011010-011010-7, 2018
3. Sata Amit, Ravi B, **Bayesian Inference Based Investment Casting Defects Analysis System for Industrial Application**, *International Journal of Advanced Manufacturing Technology,* Volume 90(9), pp. 3301-3315, 2017
4. Dr Amit Sata, **Investment Casting Defect Prediction Using Neural Network and Multivariate Regression along with Principal Component Analysis**, *International Journal of Manufacturing Research*, Volume 11(4), pp. 356-373, 2016
5. Dr Amit Sata, **Development of Cloud Based Casting Defects Categorization System (CDCS)**, *International Journal of Archives of Foundry Engineering,* Volume 17(1), pp. 216-222, 2016
6. Sata Amit, Sutaria M, **Scope of Investment Castings Supported by Survey of Foundries in Rajkot Cluster**. *Indian Foundry Journal*, Volume 60(6), pp. 42-46, 2014
7. Sata Amit, Ravi B, **Comparation of Some Neural Network And Multivariate Regression for Predicting Mechanical Properties of Investment Castings**. *International Journal of Materials Engineering and Performance*, Volume 23(8), pp. 2953-2964, 2014
8. Kedar Mehta, Robin Ranjan, Amit Sata, **Investigation of Various Airfoils for Maximization of Lift in Horizontal Axis Wind Turbine (HAWT) – A case study**, *International Journal of Interdisciplinary Environmental Review,* Volume 18(2), pp. 169-188, 2017

International Conference (Presented/Published)

9. Jaspal Singh Virdi, Wei Peng, Amit Sata, **Extending Application of Variable Selection Using Random Forest (VSURF) Technique in the Prediction of Mechanical Properties in Investment Casting**, *Proceedings of the 8th International Conference on Modeling and Simulation of Metallurgical Processes in Steelmaking (STEELSIM 2019),* Toronto, Ont., Canada, 13–15 August 2019

10. Jaspal Singh Virdi, Dr Wei Peng, Dr Amit Sata, **Feature Selection with LASSO and VSURF to Model Mechanical Properties for Investment Casting**, *Proceedings of 2nd International Conference on Computational Intelligence in Data Science (ICCIDS-2019)*, Chennai, 21-23 February, 2019
11. Dr Himanshu Khandelwal, Dr Amit Sata, Dr B Ravi, **Bayesian Inference Based Optimization of Process Parameters for Chemically Bonded Molding System**, *Proceedings of 73rd World Foundry Congress*, Krakow, Poland, 23-27 September, 2018
12. Dr Amit Sata, Dr B Ravi, **Foundry Data Analytics to Identify Critical Parameters Affecting Mechanical Properties of Investment Castings**, *Proceedings of ASME 2017 IMECE,* Florida, USA, 3-9 November, 2017
13. Sata Amit, Ravi B, **Novel Bayesian Inference Based Approach to Identify Critical Parameters Affecting Mechanical Properties of Investment Castings**, *Proceedings of 72nd World Foundry Congress*, Nagoya, Japan, 22 May – May 24, 2016
14. Dr Amit Sata, **Foundry Data Analytics to Prevent Defects in Investment Castings**, *Proceedings of 64th Indian Foundry Congress, Institute of Indian Foundrymen*, *Indian Foundry Congress*, Coimbatore, 29 January - 31 January, 2016
15. Sata Amit, Ravi B, **Mechanical Property Prediction of Investment Castings using Artificial Neural Network and Multivariate Regression Analysis**, *Proceedings of 63rd Indian Foundry Congress, Institute of Indian Foundrymen*, Greater Noida, 27 February-1 March, 2015
16. M S Parmar, S G Baraiya, A V Sata, **Development of Criterion Function to Predict Shrinkage Porosity in Aluminum Alloy Supported by Solidification Simulation**, *Proceedings of 63rd Indian Foundry Congress, Institute of Indian Foundrymen*, Greater Noida, 27 February-1 March, 2015
17. K P Adhvaryu, A V Sata, **Comparative Evaluation of ANN and MVR for Prediction of Different Output Parameters of CNC Turning**, *Proceedings of International Conference on Advances in Materials and Product Design (AMPD 2015),* SVNIT Surat, 10-11 January, 2015
18. Sata Amit, Mane V V, Pandit H, Dabade U, **A Novel Web-based System for Casting Defect Analysis**, *Proceedings of 60th Indian Foundry Congress, Institute of Indian Foundrymen, Bangalore*, 2-4 March, 2012
19. Mane V V, Sata Amit, Khire M Y, **New Approach to Casting Defects Classification and Analysis Supported by Simulation**, *Proceedings of 59th Indian Foundry Congress, Institute of Indian Foundrymen*, Chandigarh, pp. 87-104, 11-13 February, 2011

References

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