CURRICULUM VITAE

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Education

PhD (Doctor of Philosophy)	Purdue University School of Mechanical Engineering Advisor: Prof. Justin A. Weibel GPA: 4.0/4.0	2019-present
BTech (Bachelor of Technology)	Indian Institute of Technology, Madras Department of Mechanical Engineering Thesis: Towards Efficient Computation of Rarefied Flows using Field Inversion and Machine Learning Techniques Advisor: Prof. Balaji Srinivasan GPA: 9.43/10.0	2019

Profession Experience

Graduate Research Assistant, Purdue University, USA	Aug 2019-present
Intern, Research, Arm, USA	May 2022-Aug 2022
Physics Guest Lecturer, Mushtifund Aryaan HSS, India	May 2019-Jul 2019
Visiting Scholar, The Ohio State University, USA	May 2018-Jul2018
Research Intern, Purdue University, USA	May 2017-Jul 2017
Product Development Intern, Detect Technologies, India	Jun 2016-Jul 2016

Selected Honors and Awards

- Best Solution Award, Smoky Mountains Data Challenge, Smoky Mountains Computational Sciences and Engineering Conference 2021, organized by ORNL
- Outstanding Poster Award (Emerging Technologies & Fundamentals Track), ITherm 2021
- ASME K-16/IEEE EPS Student Heat Sink Design Challenge 2020 Winner
- Frederick N. Andrew's Fellowship at Purdue University, USA in 2019
- Vaidy Krishnan Memorial Prize 2019 for best overall performance in curricular activities in Mechanical Engineering, IIT Madras
- DAAD WISE scholarship for a research internship at RWTH Aachen, Germany in 2018
- RIYA scholarship for a research internship at The Ohio State University, USA in 2018
- PURE scholarship for a research internship at Purdue University, USA in 2017
- Summer Research Fellowship Program fellowship, 2017, by the Indian Academy of Sciences
- National Science Talent Search Exam (NSTSE) 2015, all India rank 17
- Kishore Vaigyanik Protsahan Yojana fellowship (KVPY) 2014, awarded by the Govt. of India
- National Talent Search Examination (NTSE) scholarship 2011, awarded by the Govt. of India
- All Rounder Student Award, by Shree Damodar Higher Secondary School of Science, 2013
- Science Talent Search Scholarship for 3 consecutive terms from 2010-2013 by Govt. of Goa
- National Standard Examination in Physics (NSEP) 2015 Statewise Top 1%
- National Standard Examination in Chemistry (NSEC) 2015 Statewise Top 1%

Research Highlights

Purdue University (2019-present)
Graduate Research Assistant

Advisor: Prof. Justin A. Weibel, School of Mechanical Engineering
Machine Learning Aided Design of High-Performance Thermal Management Components

This work leverages machine-learning methods to supplant traditional intuition-based design methods that require manual searching through a complex design space (boundary conditions and available surface morphologies), thereby enabling more optimal cold plate performance.

- Compiled an extensive database of fully developed Nusselt number and friction factor values of different constant cross section flow geometries (~800 distinct geometries).
- Developed machine learning based surrogate correlation for predicting the fully developed Nusselt number and friction factor of different constant cross section flow geometries.
- Used the surrogate correlations to find novel cross sections with desired properties.
- Developed a pipeline for automating the process of carrying out fluid flow and heat transfer simulations on thousands of geometries with one click, by coupling Python, Cubit, MATLAB and Ansys Fluent scripting.
- Compiled a massive database (~ 25,000 distinct configurations) of heat transfer and pressure drop characteristics of flow through pin-fin geometries of varying cross sections, angular orientations and pitch values, at varying Reynold's numbers, using the in-house developed automation pipeline
- Developed machine learning based surrogate correlations for Nusselt number and friction factor for pin-fin geometries of varying pin cross section, orientation, pitch values and Reynold's number using the above database as training data.
- Currently developing methods for coupling machine learning techniques with topology optimization (TO) for expediting TO based design processes for heat exchangers.

Indian Institute of Technology Madras (2018-2019)
Undergraduate Student

Advisor: Prof. Balaji Srinivasan, Department of Mechanical Engineering
Towards Efficient Computation of Rarefied Flows using Field Inversion and Machine Learning Techniques

This work used machine learning methods to bypass the need for expensive high-fidelity computations which are needed for accurate flow description of rarefied flows

- Successfully implemented the technique of 'Field Inversion and Machine Learning' on different cases of heat transfer and used it to model the structure of an acoustic shock wave.
- The Maximum Likelihood Estimation approach was used to develop an Artificial Neural Network model to predict the flow of rarefied gas around a spherical body.

The Ohio State University (Summer, 2018)
Visiting Scholar

Guides: Prof. Shaurya Prakash, Prof. Jonathan Song, Department of Mechanical and Aerospace Engineering
Device Fabrication and Electrical Characterization of Vessel Function Within Bifurcating Microfluidic Channels

This work focused on developing the trans endothelial electrical resistance measurement technique to study the endothelial barrier function in bifurcated vessels, the breakdown of which is linked to various diseases like multiple sclerosis, cancer, etc.

- Fabricated microfluidic devices using soft lithography and plasma oxidation and used them to make in vitro models of blood vessels using HUVECs. Also learnt the basics of cell culture.
- Used Electrochemical Impedance Spectroscopy (EIS) to study the vessel barrier function and suggested a new design for the microfluidic device to improve the quality of the EIS results.

Purdue University (Summer, 2017)
Research Intern

Guides: Prof. Justin A. Weibel, Prof. Suresh V. Garimella, School of Mechanical Engineering
Characterisation of 3D Printed Vapour Chamber Heat Spreaders

Metal 3D printing holds promise in thermal management applications by allowing integrated manufacturing of vapor chamber heat spreaders with the processor package. I worked on building the charging facility needed for studying the performance of these vapor chambers.

- Designed and fabricated a Fluid Charging Station for evacuating 3D printed vapor chambers and filling them with a precise volume of degassed fluid, and wrote down its User's Manual.
- Designed the vapor chamber heat spreader which was to be 3D printed.

Industry Projects

Arm (Summer, 2022)
Research Intern

Mentor: Javier DeLaCruz, System Integration, Arm
Numerical Simulations of Heat Transfer in High Power Smartphones

Thermal management of high-power, 5G enabled smartphones is crucial to prevent overheating of smartphones. I worked with the systems and packaging team and modelling heat flow in smartphones with two different kinds of PCB configurations, a first of its kind work at Arm. Such studies serve as a starting point for electrical-thermal co-design of electronic devices

- Developed CAD models of high-power smartphones using Autocad Fusion 360, and carried out steady-state and transient thermal simulations in Ansys Icepak to understanding the thermal systems of different design of smartphones better.

Detect Technologies (Summer 2016)
Intern, Product Development Team

Mentors: Harikrishnan A.S., Karthik R., CTOs, Detect Technologies
Real Time Non-Destructive Monitoring of Pipeline Integrity at High Temperatures

Detect is a leading intelligence platform for industries, with one of the most extensive and high-precision deep-learning model sets for managing risks to frontline workforce, assets and work practices.

- Worked on the initial mechanical design iterations of their flagship product GUMPS (Guided Ultrasonic Monitoring of Pipe Systems), which is the first of its kind fully automated and permanently installed guided wave LRUT sensor.
- Contributed in conceptualizing, designing and testing prototypes of some other products as well.

Publications

1. S. Ozguc, **S.S. Pai**, J.A. Weibel, L. Pan, "Experimental demonstration of an additively manufactured vapor chamber heat spreader", *The IEEE Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems (ITherm)*, Las Vegas, USA, May 2019.
2. **S.S. Pai**, D. Visaria, J.A. Weibel, "A machine-learning-based surrogate model for internal flow Nusselt number and friction factor in various channel cross sections" *The IEEE Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems (ITherm),* June 2021.
3. **S. S. Pai**, A. Banthiya, "Transfer-learning-based surrogate model for thermal conductivity of nanofluids" arXiv preprint arXiv:2201.00435, Jan 2022
4. A. Patel, **S. S. Pai**, H. R. Rajamohan, M. Bongarala, R. Samyak, "Finding novel links in COVID-19 graph using graph embedding techniques" *Smoky Mountains Computational Sciences and Engineering Conference*, pp. 430-441. Springer, Cham, 2021.
5. **S. S. Pai**, J. A. Weibel, "Machine-learning-aided design optimization of internal flow channel cross sections" *International Journal of Heat and Mass Transfer* 195 (2022): 123118

Conference Presentations/Posters

1. *Poster*: **S.S. Pai**, D. Visaria, J.A. Weibel, "A machine-learning-based surrogate model for internal flow Nusselt number and friction factor in various channel cross sections" *The IEEE Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems (ITherm)*, June 2021. (🏆 Outstanding Poster Award)
2. *Presentation, Poster*: A. Patel, **S. S. Pai**, H. R. Rajamohan, M. Bongarala, R. Samyak, "Finding novel links in COVID-19 graph using graph embedding techniques" Smoky Mountains Computational Science and Engineering Conference, Oct 2021. (🏆 Best Solution Award, 🏆 Runners up for Best Lighting Talk Award)

Invited Talks

- **IIT Madras**, Career Cheq, a webinar series on career guidance by the Alumni Relations Cell of IIT Madras, May 1 2021

Relevant Coursework

Thermo-fluids

- Thermodynamics
- Foundations of Fluid Mechanics
- Energy Conversion Systems
- Intermediate Heat Transfer
- Theory and Computation of Vortex Dominated Flows
- Computational Heat and Fluid Flow
- Inverse Methods in Heat Transfer
- Air Breathing Propulsion
- Heat Transfer in Electronic Systems
- Two Phase Flows
- Micro and Nano Energy Transport

Math and Math-Related

- Multivariable Calculus
- Differential Equations
- Linear Algebra
- Numerical Methods
- Numerical Analysis
- Introduction to Fourier and Laplace Transforms
- Introduction to Probability
- Process Optimization
- Multidisciplinary Design Optimization
- Machine Learning for Engineering and Science Applications
- Statistical Machine Learning

Software Skills

Design: SOLIDWORKS, Autodesk Inventor, Fusion 360, Creo Parametric
Simulation: Ansys Fluent, Ansys Icepak, Cubit
Programming Languages: C, Python, MATLAB, Julia
Documentation: MS Word, MS PowerPoint, MS Excel, LaTeX

Undergraduate Students Mentored

- Bruno Navarrese (Jan 2022 – present, BSAAE – Purdue University)
    - Working on generating flow and heat transfer data for several shapes of pin-fin geometries through numerical simulations, for training ML surrogate models
    - Carried out numerical thermal simulation on 3D pin-fin geometries in Ansys Fluent to understand the relationship between the numerical solutions and the simplified models used, as part of the SURF 2022 program
- Norawish Lohitnavy (Jan 2021 – May 2021, BSME – Purdue University)
    - Developed a code for representing some pin-fin geometries.
- Trevor Teague (Aug 2020 – May 2021, BSChE – Purdue University)
    - Studied the feasibility of different geometrical representation for representing 3 dimensionally varying heat transfer structures from a machine-learning training point of view.
    - Checked the feasibility of an approach for automating the process of carrying out numerical flow simulations.
- Dhvaneel Visaria, (2020 summer intern at Purdue University; BTech – IIT Bombay)
    - Assisted in compiling flow and heat transfer data, from the literature, on constant cross section ducts.

Outreach and Services

- Secretary of Purdue's ME Graduate Association (OMEGA) for the academic year 2022-2023
- Judge at the 2021 Virtual Lafayette Regional Science and Engineering Fair
- OMEGA Buddy Mentor at Purdue University (2020-2021) – helped new graduate students get accustomed to life and work at Purdue.
- Captain of IIT Madras Men's Table-Tennis team (2017-2018) - led the team to the finals at the Inter IIT Sports Meet 2017, held in IIT Madras.
- Saathi Mentor (2016-2017) – mentored new undergraduate students entering IIT Madras.
- Finance Coordinator at Shaastra 2017, IIT Madras' Technical Festival
- Part-time Mathematics Teacher (2016) at the Rosary High School, India

Other Relevant Projects

Effect of Type and Length of Bridging Material on Kapitza Resistance in Crystalline Solids as *Computational Methods in Nanoscale Energy Transport* course project
Guide: Prof. Xiulin Ruan, School of Mechanical Engineering, Purdue University

- Showed though molecular dynamic simulations, performed using the open-source code LAMMPS, that introducing a bridging material of in-between properties reduces the Kapitza resistance between two dissimilar crystalize solids. Further, that there is an optimal thickness of the bridging material beyond which the resistance starts increasing again.

Transfer-learning-based Surrogate Model for Thermal Conductivity of Nanofluids as *Micro & Nano Scale Energy Transfer* course project (2021, preprint available on arXiv)
Guide: Prof. Jong Hyun Choi, School of Mechanical Engineering, Purdue University

- Gathered and used data from experiments and empirical correlations to train transfer learning models for predicting the thermal conductivity of nanofluids. The ML model was

coarse tuned using the large quantity of low-accuracy data from empirical models and fine-tuned using higher-accuracy experimental data.

Finding Novel Links in COVID-19 Knowledge Graph as a competition entry for the *Smoky Mountains Computational Sciences Data Challenge 2021* (🏆 Best Solution Award)

- Used graph embedding techniques and machine learning algorithms to develop models for predicting as-yet-undiscovered links between biomedical concepts from PubMed, Semantic MEDLINE, and CORD-19, and determining their importance, to help researchers decide which research direction to pursue

The Tempest: An Air-Breathing Heat Sink as a competition entry for the *ASME K-16/IEEE EPS Student Heat Sink Design Challenge 2020* (🏆 Winner at the international level)
Guide: Prof. Justin A. Weibel, School of Mechanical Engineering, Purdue University

- Designed a novel forced convection heat sink by taking inspiration from Formula 1 cars and human lungs, by exploiting the capabilities of metal 3D printing techniques

Thermal Management for Next Generation Smartwatches as *Heat Transfer in Electronic Systems* course project (2020)
Guide: Prof. Justin A. Weibel, School of Mechanical Engineering, Purdue University

- Proposed, designed and analyzed a new cooling approach for smartwatches by using the straps to dissipate the heat

Particle Decay Classification Using Machine Learning as *Statistical Machine Learning* course project (2020)
Guide: Prof. Jean Honorio, Computer Science Department, Purdue University

- Open-source data from the ATLAS Experiment was used to classify events into 'tau-tau decay' and 'background noise' using three machine learning algorithms-kernel dual SVM, AdaBoost and Gaussian Mixture Models, and their classification capabilities were compared

Thermal Analysis of Clay Firing Process as *Intermediate Heat Transfer* course project (2019)
Guide: Prof. Amy Marconnet, School of Mechanical Engineering, Purdue University

- Obtained the transient temperature profile inside a kaolin-based ceramic plate during the firing process using analytical techniques, verified it using numerical method, and predicted the maximum permissible firing and cooling rates to prevent cracking due to thermal shocks

Media Coverage

- "Q&A: Purdue University's Panthers take inspiration from the natural world and human body to win additive heat sink design challenge", GE Additive Website, 2020
- Jared Pike, "3D printed Purdue heat sink wins competition", Purdue University Mechanical Engineering News, 2020

Extra Curriculars

Table Tennis

- Member of the IIT Madras Table Tennis team which won the Silver Medals at the 51st Inter IIT Meet, Kanpur in December 2016 and the 52nd Inter IIT Meet, Madras in December 2017
- Represented the state of Goa at the 70th Sub Junior National Table-Tennis Championship in 2008 (Vijayawada - Andhra Pradesh) and at the 56th National School Games Table-Tennis in 2011 (Nashik - Maharashtra)

Hobbies

- Reading, sketching and painting, playing the violin and bansuri (Indian Bamboo Flute), listening to music, playing various sports