Exponent®
Engineering & Scientific Consulting

Matthew Perrella, Ph.D., P.E.

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Professional Profile

Dr. Perrella uses his fluid dynamics expertise and broad knowledge of mechanical engineering to solve complex, multi-disciplinary problems for clients in a wide variety of industries. His experience encompasses industrial equipment and manufacturing systems (i.e. centrifugal compressors, natural gas liquefaction, hydroelectric power production, large-scale food processing, industrial ducting and HVAC), consumer products (i.e. espresso machines, milk frothers, and coffee cups), medical devices (i.e. peristaltic pumps, ventricular assist devices, and cryo-saunas), and defense (i.e. tactical cryocooler design, failure analysis, and reliability).

Dr. Perrella is a seasoned experimentalist who specializes in developing custom experimental setups. He is proficient in a variety of measurement techniques and is well-versed in measurement uncertainly and repeatability analysis. Dr. Perrella adapts novel, scientific techniques from the laboratory to industry by condensing complex concepts into practical, targeted solutions that address the diverse needs of his clients. Dr. Perrella applies fundamental engineering principles to nebulous real-world problems to efficiently identify the core issues underlying a challenge and quickly develop solutions. He also has expertise in the detailed modeling of complex thermal and fluid systems incorporating multi-mode heat transfer, buoyancy effects, pipe flow, and porous media hydrodynamics.

Dr. Perrella has applied his expertise in fluid dynamics and cryogenic refrigeration to solve problems involving the design, testing, and production of cryogenic cooling devices, linear electric motors, and thermal management systems. Before joining Exponent, Dr. Perrella worked as a cryocooler engineer who led the design and sustainment of multiple tactical cryocooler product lines and was intimately involved in all stages of the manufacturing process. His experience with the development and manufacture of defense articles for prime contractors spans conceptual design, detailed design, material procurement, production readiness assessment, and verification testing. Dr. Perrella is proficient at troubleshooting Stirling cryocoolers and similar devices and possesses hands-on experience with performance evaluation, reliability testing, root-cause analysis, and failure analysis due to material defects, vendor defects, and workmanship. He is conversant in geometric tolerancing, machining best practices, and evaluating components against various MIL-STD and ASME specifications. His doctoral research involved the development of hydrodynamic resistance parameters for oscillating fluid flow through the porous media of cryocooler regenerators at cryogenic temperatures and the theoretical modeling of novel pulse-tube cryocooler concepts for space applications.

Academic Credentials & Professional Honors

Ph.D., Mechanical Engineering, Georgia Institute of Technology, 2017

M.S., Mechanical Engineering, Georgia Institute of Technology, 2015

B.S., Mechanical Engineering, Auburn University, 2012

Licenses and Certifications

Professional Engineer, Georgia, #PE048670

Professional Engineer, North Carolina, #053885

Prior Experience

Cryocooler Engineer Specialist, L3Harris | Space & Sensors, 2017-2019

Graduate Research/ Teaching Assistant, Georgia Institute of Technology, 2012-2017

Mechanical Engineering Intern, Raytheon Space and Airborne Systems, 2016

Quality Control/ Design Engineer, Focus Engineering, 2012

Intern, Naval Surface Warfare Center, 2011

Co-op, VT Miltope, 2008-2010

Professional Affiliations

The American Society of Mechanical Engineers (ASME)

The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

Publications

Perrella, M., and Mostafa Ghiaasiaan, S., 2021, “Hydrodynamic Resistance Parameters of Regenerator Filler Materials at Cryogenic Temperatures,” Cryogenics (Guildf)., 117(May), p. 103320.

Presentations

Periodic Flow Hydrodynamic Resistance Parameters for ErPr Rare-Earth Regenerator Material at Cryogenic Temperatures, CEC, 2015

Periodic Flow Hydrodynamic Resistance Parameters for Multiple Regenerator Filler Materials at Cryogenic Temperatures, ICC 19, 2016

Development of a miniature Stirling cryocooler for LWIR small satellite applications, TTDR II, 2017

Project Experience

Managed a multifaceted cryocooler analysis project involving performance simulation, scoping analysis, material selection, and reliability analysis for several models of tactical cryocooler. Analysis included thermodynamic modeling, dynamic analysis, MTTF analysis, and component-level performance simulation.

Led a team of associates in the execution of an extensive suite of experiments for evaluating the performance and susceptibility to failure for exemplar medical devices. Designed and constructed

experimental apparatus and designed experiments for monitoring pressure, flow rate, and other key variables.

Quickly determined the root cause of an espresso machine malfunction. Rapidly prototyped a solution and demonstrated improved performance.

Evaluated the design of an industrial air duct system against nationally-recognized design standards (Sheet metal and Air Conditioning Contractors' National Association – SMACNA).

Determined the time-varying temperature and pressure distributions within an industrial food-processing oven using Computational Fluid Dynamics (CFD) to inform a root-cause fire investigation.