Luke Scime

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EDUCATION

Doctor of Philosophy in Mechanical Engineering (3.97/4.00)　　05/2018
Carnegie Mellon University (Pittsburgh, PA)

Masters of Science in Mechanical Engineering (3.96/4.00)　　05/2016
Carnegie Mellon University (Pittsburgh, PA)

Bachelor of Science in Mechanical Engineering (4.00/4.00)　　05/2014
Minor in Electrical Engineering
The University of Florida (Gainesville, FL)

CAREER INTERESTS

My research focus is on metal Additive Manufacturing (AM) with a special interest in developing in-situ monitoring technologies to increase system reliability, reduce operator workload, and ensure final part quality. Much of my work has utilized Computer Vision (CV) and Machine Learning (ML) techniques to accomplish this goal in Laser Powder Bed Fusion (L-PBF) and Metal Binder Jetting (MBJ) processes. I am highly focused on ensuring laboratory safety and I have a strong passion for engaging young students in STEM and teaching complex engineering concepts in a way that builds student confidence.

ADDITIVE MANUFACTURING EXPERIENCE

R&D Associate Staff Scientist, Oak Ridge National Laboratory (Oak Ridge, TN)　　05/2019 -
- As a member of the Imaging, Signals, and Machine Learning (ISML) group I support data analytics efforts at the Manufacturing Demonstration Facility (MDF). My current focus is on developing novel Machine Learning algorithms for real-time monitoring of all classes of metal powder bed Additive Manufacturing machines with a particular focus on quality control for the nuclear power generation industry.

Postdoctoral Research Associate, Oak Ridge National Laboratory (Oak Ridge, TN)　　06/2018 - 04/2019
- Development of a novel, machine-agnostic, ML algorithm for semantic segmentation of powder bed imaging data will allow for rapid deployment of layer-wise anomaly detection solutions across multiple metal AM technologies. Initial deployment of this real-time capability on the M-FLEX MBJ machine is provides significant insight into build failures.
- Development of CV/ML tools for analysis of melt pool imaging data will assist in effective utilization of Direct Energy Deposition (DED) processes.

PhD Research Assistant, Carnegie Mellon University (Pittsburgh, PA)　　08/2014 - 05/2018
- Thesis: *Methods for the Expansion of Additive Manufacturing Process Space and the Development of In-Situ Process Monitoring Methodologies*.
- Application of CV and ML techniques to (emitted-light) high speed camera images of L-PBF melt pools enabled the autonomous classification of in-situ melt pool morphologies and their correlation with processing defects.
- Autonomous detection and classification of millimeter-scale L-PBF powder bed anomalies was achieved using CV and ML techniques including novel Multi-scale Convolutional Neural Networks.

- Demonstrated the ability to improve fatigue life by a factor of two (in the 100k cycle regime) for as-built additively manufactured Inconel 718 test specimens by varying the L-PBF processing parameters and scan strategy.
- Demonstrated the ability to use non-standard (e.g. larger) metal powders in L-PBF machines to effectively build parts. As-built part quality was quantified via powder bed anomalies, bulk porosity, and edge roughness.
- Mapped the influence of L-PBF process parameters on melt pool geometry for the AlSi10Mg and Inconel 718 material systems. Defect generation and the relevant statistical behavior were studied for both systems.

Group Safety Coordinator, Carnegie Mellon University (Pittsburgh, PA)   01/2016 - 05/2018

- Managing lab equipment including four metal AM machines and coordinating with Environmental Health and Safety to ensure a safe working environment for the entire research group. Development of new safety protocols was required as AM is a nascent field and many of the processes present a variety of unique risks to their operators.
- Working and coordinating extensively with GBBN Architects, Inc. as part of the Carnegie Institute of Technology's MakerWing renovations to Hamerschlag Hall; with a focus on creating a new laboratory designed specifically for AM (online in March 2017 and complete in January 2018).
- Member of the Carnegie Mellon Graduate Student Safety Subcommittee.

Lead Operator of ExOne Innovent, Carnegie Mellon University (Pittsburgh, PA)   09/2016 - 05/2018

- The ExOne Innovent is a metal binder jetting AM process. Responsibilities included developing SOPs for the Innovent, machine maintenance, training other members of the research team on its operation, and building parts for both external and internal customers.

Operator of EOS M290, Carnegie Mellon University (Pittsburgh, PA)   08/2015 - 05/2018

- The EOS M290 is a metal L-PBF AM process. Responsibilities included machine maintenance, training other members of the research team on its operation, and building parts for both internal and external customers.

ENGINEERING WORK EXPERIENCE

Intern, DEKA Research and Development (Manchester, NH)   Summer 2013

- Mechanical design of a novel electro-mechanical medical device. Extensive prototyping was performed using a plastic SLS AM machine as well as creation of an associated DAQ system (mechanical, electrical, and software). Testing procedures were documented in accordance with US PTO/FDA requirements.

Intern, NASA IV&V Facility (Fairmont, WV)   Summer 2012

- Creation of a robotics test-bed for development of new verification and validation procedures and techniques. The work focused primarily on inverse kinematics algorithms for a five degree-of-freedom robotic arm, Ethernet communication protocols, and general software architecture.

Intern, NASA IV&V Facility (Fairmont, WV)   Summer 2011

- Development of a low-cost multi-robot system for cooperative, autonomous mapping of an indoor environment.

RELEVANT AND UNIQUE COURSEWORK

Computer Vision (CMU), Solidification Processing (CMU), Linear Systems (CMU), Geometry of Robots 1 (UF), Intelligent Machines Design Lab (UF), Digital Logic (UF), Microprocessor Applications (UF), Integrated Product and Process Design (UF), Modern Physics (UF), and Climate Change Mitigation (CMU).

TEACHING AND MENTORING EXPERIENCE

Future Faculty Program, Eberly Center for Teaching Excellence and Educational Innovation (Pittsburgh, PA)	11/2017 (completed)
▪ Attended seminars and workshops focused on course design, teaching philosophy, and creating positive and inclusive learning environments. Was evaluated by, and received feedback from, Eberly Center staff on my teaching effectiveness and style. Designed an undergraduate heat transfer course (created the syllabus) based on research-based teaching methods.	
Teaching Assistant, Carnegie Mellon University (Pittsburgh, PA)	Fall 2015/Fall 2016
▪ Fundamentals of Mechanical Engineering (24-101): Prepared and presented recitation lectures, held office hours, graded exams, and developed content introducing students to metal additive manufacturing.	
▪ Mechanical Systems Experimentation (24-452): Proctored weekly labs, performed administrative duties, held office hours, and graded lab reports.	
PhD Research Assistant, Carnegie Mellon University (Pittsburgh, PA)	08/2014 - 05/2018
▪ Presented guest lectures relating to Additive Manufacturing and applying computer science to Mechanical Engineering challenges at both the undergraduate and graduate levels. 24-302 (September 2017 and February 2018), 24-632 (October 2017), 39-603 (March 2018).	
▪ Mentored two PhD students in fundamental ML and CV techniques.	
▪ Mentored one PhD student to become the new Group Safety Coordinator.	
▪ Trained multiple PhD students and CMU staff on laboratory equipment including an ExOne Innovent, an EOS M290, and a Wire EDM machine.	
Intern, NASA IV&V Facility (Fairmont, WV)	Summer 2013
▪ Managed and guided the research projects of two high school interns.	
Intern, NASA IV&V Facility (Fairmont, WV)	
▪ Managed and guided the research projects of two high school interns.	Summer 2012

UNDERGRADUATE RESEARCH EXPERIENCE

Individual Senior Design, Intelligent Machines Design Lab (Gainesville, FL)	01/2014 - 05/2014
▪ Creation of an autonomous robot capable of basic navigation and locating artificial sea turtle nests using CV and a suite of sensors. Mechanical design/assembly, electrical design/assembly, and software development were performed.	
Group Senior Design, Integrated Product and Process Design (Gainesville, FL)	08/2013 - 05/2014
▪ As a member of a multi-disciplinary team and in conjunction with Mosaic Fertilizer, a device was developed to autonomously monitor aerosolized sulfuric acid concentrations in the processing tower during production. Mechanical design/fabrication, electrical assembly, and development of user interface software were performed.	

VOLUNTEER EXPERIENCE

FIRST Robotics Competition
▪ Lead controls system mentor with the Secret City Wildbots (FRC4265)	2018 -
▪ Lead Robot Inspector at the Greater Pittsburgh Regional	2018, 17
▪ Robot Inspector at the Greater Pittsburgh Regional	2016, 15, 12, 11
▪ Control Systems Advisor at the Palmetto Regional and WVRoX	2014
▪ Mentor with Mountaineer Area RoboticS (FRC2614)	2010 - 2012

FIRST Lego League
▪ Robot Design Judge at the Oak Ridge Qualifier	2018, 19
▪ Robot Design and Championship Judge at the Mountain State Invitational	2017
▪ Robot Design Judge at the Monongalia County Qualifier	2017, 16, 15, 14, 09, 08
▪ Field Referee at the West Virginia State Tournament	2012

HONORS AND AWARDS

▪ Dept. of Mech. Eng., Milton Shaw PhD Travel Award	2018
▪ Worcester Polytechnic Institute, STEM Faculty Launch program delegate	2017
▪ Dept. of Mech. Eng., Jeremiah Mpagazehe PhD Student Service Award	2017
▪ University of Florida Anderson Scholar of Highest Distinction	2012
▪ National Merit Finalist and University of Florida scholarship recipient	2010
▪ FIRST Robotics Competition Dean's List International Award Winner	2010
▪ National Youth Science Camp, West Virginia delegate	2010

PROFESSIONAL SERVICE, MEMBERSHIPS, AND CERTIFICATIONS

▪ Contributor to the Wohlers Report, *Process monitoring in metal powder bed fusion*.	2020
▪ Reviewer for the journals *Additive Manufacturing*, *Scripta Materialia*, and the *ASME Journal of Manufacturing Science and Engineering*.	2018 -
▪ As an active member of CMU's NextManufacturing Center I provided lab tours, presentations, and research overviews to representatives of over 50 different companies, government agencies, and universities.	2016 - 2018
▪ Pi Tau Sigma (Mechanical Engineering Honors Society)	2013
▪ PADI Open Water SCUBA certified	2011

RESEARCH COMMERCIALIZATION

Founder, Manufacturing Software Solutions LLC — 2018 -
- ▪ The CV/ML algorithm developed for offline powder bed anomaly detection and classification in the EOS M290 L-PBF process is currently available for sale as a stand-alone software package.
- ▪ At this time, software seats have been purchased by one (1) government research laboratory and three (3) private engineering companies.

PUBLICATIONS

- **L. Scime.**, D. Siddel, S. Baird, V. Paquit. *Layer-Wise Anomaly Detection and Classification for Powder Bed Additive Manufacturing Processes: A Machine-Agnostic Algorithm for Real-Time Pixel-Wise Semantic Segmentation.* Additive Manufacturing. Under Review.
- **L. Scime**, J. Beuth. *Melt Pool Geometry and Morphology Variability for the Inconel 718 Alloy in a Laser Powder Bed Fusion Additive Manufacturing Process.* Additive Manufacturing. October 2019.
- **L. Scime**, J. Beuth. *Using Machine Learning to identify In-Situ Melt Pool Signatures indicative of Flaw Formation in a Laser Powder Bed Fusion Additive Manufacturing Process.* Additive Manufacturing. vol. 25. January 2019. [cited: 26]
- **L. Scime**, J. Beuth. *A Multi-scale Convolutional Neural Network for Autonomous Anomaly Detection and Classification in a Laser Powder Bed Fusion Additive Manufacturing Process.* Additive Manufacturing. vol. 24. December 2018. [cited: 25]
- S. P. Narra, **L. Scime**, J. Beuth. *Integrated Control of Melt Pool Geometry and Microstructure in Laser Powder Bed Fusion of AlSi10Mg.* Metallurgical and Materials Transactions A. vol. 49. October 2018. [cited: 1]
- **L. Scime**, S. DeVincent Wolf, J. Beuth, S. Mrdjenovich, M. Kelley. *Safety and Workflow Considerations for Modern Metal Additive Manufacturing Facilities.* JOM. vol. 70. September 2018. [cited: 2]
- **L. Scime**, B. Fisher, J. Beuth. *Using Coordinate Transforms to Improve the Utility of a Fixed Field of View High Speed Camera for Additive Manufacturing Applications.* Society of Manufacturing Engineers Letters. vol. 15PB. April 2018. [cited: 3]
- **L. Scime**, J. Beuth. *Anomaly Detection and Classification in a Laser Powder Bed Fusion Process using a Trained Computer Vision Algorithm.* Additive Manufacturing. vol. 19. January 2018. [cited: 61]

MANUSCRIPTS IN PREPARATION

- S. P. Narra, J. Beuth, **L. Scime**. *Mitigating Near-Surface Porosity in a Laser Powder Bed Fusion Process.*

INVITED CONFERENCE PRESENTATIONS AND SEMINARS (RECENT AND UPCOMING)

- **L. Scime**, D. Siddel, S. Baird, V. Paquit. *Peregrine: A Machine-Agnostic Approach to Layer-Wise Process Monitoring and Control of Powder Bed Additive Manufacturing Technologies*. The Minerals Metals and Materials Society Conference. San Diego, CA. February 2020.
- **L. Scime**. *Applications of Data Analytics and Machine Learning for Additive Manufacturing*. West Virginia University. October 2019.

CONFERENCE PRESENTATIONS (RECENT AND UPCOMING)

- **L. Scime**, A. Singh, D. Robertson, B. Mathis, W. Halsey, J. Haley, S. Leach, K. Saleeby, A. Ziabari, M. Sprayberry, D. Rose, R. Dehoff, V. Paquit. *A Comprehensive Digital Platform for Additive Manufacturing*. Materials Science and Technology Conference. Pittsburgh, PA. October 2020.
- **L. Scime**, D. Siddel, V. Paquit. *Layer-wise Anomaly Detection and Process Control Using a Machine-agnostic Algorithm for Semantic Segmentation of Powder Bed Images*. Solid Freeform Fabrication Symposium. Austin, TX. August 2019.
- **L. Scime**, J. Beuth. *Using Machine Learning to identify In-Situ Melt Pool Flaw Formation Signatures*. Materials Science and Technology Conference. Columbus, OH. October 2018.
- **L. Scime**, J. Beuth. *Autonomous L-PBF Powder Bed Anomaly Classification using a Multi-scale Convolutional Neural Network*. Materials Science and Technology Conference. Columbus, OH. October 2018.
- **L. Scime**, J. Beuth. *Anomaly Detection and Classification in a Laser Powder Bed Additive Manufacturing Process using a Trained Computer Vision Algorithm*. Materials Science and Technology Conference. Pittsburgh, PA. October 2017.
- **L. Scime**, S. P. Narra, J. Beuth. *Exploration of AlSi10Mg in the EOS Laser Powder Bed Additive Manufacturing Process*. Solid Freeform Fabrication Symposium. Austin, TX. August 2016.

POSTER PRESENTATIONS (SELECTED)

- **L. Scime**, J. Beuth. *Machine Learning-Enabled Powder Bed and Melt Pool Monitoring in Laser Powder Bed Fusion*. Carnegie Mellon University NextManufacturing Consortium Membership Meeting. Pittsburgh, PA. January 2018.
- **L. Scime**, S. DeVincent Wolf, J. Beuth, S. Mrdjenovich, M. Kelley. *Designing a Research Laboratory for the Future of Metals Additive Manufacturing*. Carnegie Mellon University NextManufacturing Consortium Membership Meeting. Pittsburgh, PA. July 2017.
- **L. Scime**, J. Beuth. *Powder Bed Monitoring in a Laser Additive Manufacturing Process using a Trained Computer Vision Algorithm*. RAPID+TCT. Pittsburgh, PA. May 2017.
- B. Fisher, **L. Scime**, R. Cunningham, J. Beuth, A. Rollett, J. Mireles, R. Wicker. *In-Situ Process Monitoring of Metal Additive Manufacturing at Carnegie Mellon University*. Carnegie Institute of Technology President's Advisory Board. Pittsburgh, PA. May 2017.
- **L. Scime**, J. Beuth, H. Gu, G. Le Mon. *The Effect of Non-Standard Powders on Final Part Quality in a Laser Powder Bed Additive Manufacturing Process*. Carnegie Mellon University NextManufacturing Consortium Membership Meeting. Pittsburgh, PA. February 2017.

RESEARCH IN THE MEDIA

- S. Saunders. *Machine learning and metal 3D printing combine for real-time process monitoring algorithm*. 3DPrint.com. June 7, 2018.
  https://3dprint.com/215991/cmu-process-monitoring-algorithm/.
- D. Carroll. *The intersection of 3-D printing and machine learning*. Carnegie Mellon University, College of Engineering. June 7, 2018.
  https://engineering.cmu.edu/news-events/news/2018/06/01-intersection-scime.html.
- A. George. *Looking through the eyes of a 3-D printer: MechE Ph.D. student Luke Scime uses machine vision to optimize the metal 3-D printing process.* Carnegie Mellon University, College of Engineering. November 6, 2017.
  https://engineering.cmu.edu/news-events/news/2017/11/06-scime-3d-printer.html.

TECHNICAL SKILLS

- Additive Manufacturing Processes and Equipment: EOS M290 (metal L-PBF), ExOne Innovent (metal binder jetting), ConceptLaser M2 (metal L-PBF), various polymer FDM and SLA printers.
- Engineering Processes and Equipment: Buehler polishing and metallurgical sample preparation equipment, Alicona and Zeiss optical microscopes, high-temperature heat treatment furnaces, Wire EDM, manual mill, manual lathe, soldering, and various hand tools.
- Software Languages: Python , MATLAB, LabVIEW, TensorFlow, C/C++, and assembly code.
- Engineering Software: SolidWorks, Magics, Autodesk Inventor, and Linux OS (Ubuntu).
- Microcontrollers and Data Acquisition Devices: NI cDAQ, NI cRIO, NI RoboRIO, NI USB 6008/09, Arduino Due, ODROID-U3, Handyboard, and RoBoard.