Department of Mechanical Engineering, University of Wisconsin-Madison

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Mechanical Engineering Building, 1513 University Ave, Room 1163

Integrating Design Research into Hybrid Manufacturing Environments

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Although current hybrid manufacturing research has made significant developments, there is a lack of focus on how this new technology impacts both the designer and the operator of hybrid systems. Efforts to reduce this gap is addressed here through a holistic approach to understanding hybrid processes with aims to improve training, accelerate paths to expertise, and provide more effective decision-making. An exploratory case study targeted how heuristic decision-making is developed, employed, and modified by hybrid designers. Results found statistically significant correlations across perceived process attributes, specifically in regards to heuristic reliability, frequency of use, and frequency of modification. By bringing those attributes and influences to light, one can begin to clearly justify processes, how they are refined over time, and how they are passed onto others. Experimental research produced a new heuristic strategy for navigating hybrid systems capable of variable laser beam diameters. Using this strategy, parts were produced across five variable diameters with consistently minimal porosity, enabling the evaluation of trends across laser beam sizes. This method will ease process parameter development workloads, enable a more diverse DED hybrid design space, and drive research towards results that are less equipment specific. Lastly, an overview of research targeting operator intuition development, cognitive workloads, knowledge gaps, and error modes is provided, in order to move towards digital advancements that target specific operator needs. Overall, this work inserts hybrid manufacturing into the Operator 4.0 research space and supplements ongoing industry 4.0 accomplishments.

Dr. Kenton Blane Fillingim is a research associate for hybrid manufacturing within the Manufacturing Systems Design Group at Oak Ridge National Laboratory. His research at ORNL's Manufacturing Demonstration Facility primarily focuses on process development aimed towards expanding the hybrid manufacturing design space. This includes assessing powder-based directed energy deposition (DED) process parameters, computer-aided manufacturing (CAM) strategies for hybrid manufacturing, and human factors and human-machine interaction in hybrid system environments. Blane has a research background in design theory and methodology, with an emphasis on understanding the use of heuristics and biases in decision-making. Before working at ORNL, Blane received his B.S. in Mechanical Engineering from the University of South Alabama, and his M.S. and Ph.D. degrees in Mechanical Engineering from the Georgia Institute of Technology.

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