EHD Printing and Qin’s ‘Machine Shop’: From Trunk-of-Truck to In-Space Manufacturing, from In-Depth Methodologies to Broad Applications

Abstract: Long-duration exploration missions require a paradigm shift in the design and manufacturing of space architectures. The ability to perform in-space manufacturing (ISM) provides a solution towards sustainable, flexible missions (both in-transit and on-surface) through on-demand fabrication, repair, and recycling capabilities for critical systems, habitats, and mission logistics and maintenance. How can we 3D print things in outer space under no gravity? What are the challenges? Dr. Qin may have some answers!

As part of a NASA mission, Dr. Qin was selected to investigate how to integrate his electrohydrodynamic technique for NASA’s in-space 3D printer to manufacture on-body wearable sensors at the International Space Station (ISS). In this research seminar, Dr. Qin will first introduce his group’s recent NASA parabolic flight test results (Dec 7-9, 2021). For the first time in history, EHD printing was tested in a zero-gravity environment. Electrohydrodynamic inkjet printing (EHD printing) is one novel type of inkjet printing technique utilizing high electrical force for the ink to overcome surface tension at the tip of micro nozzles. Via the 3-day parabolic flight tests, Dr. Qin validated and confirmed that EHD printing is a unique gravity-free 3D printing technique. His recent efforts in modeling, in-situ monitoring, data analytics, quality assurance, and control schemes for EHD printing will be introduced. Dr. Qin built up his ‘machine shop’ trying to address challenges in advanced manufacturing, mainly focusing on 1) process development for in-space additive manufacturing and assembly, 2) new material characterization, 3) quality assurance and real-time inspection, 4) micro/nano scale prototyping. Some highlights are ‘in-situ NDE for AM and data fusion’, ‘digital twin for micro/nano manufacturing systems, and ‘origami design for manufacturing’. Dr. Qin will introduce some other ongoing projects and collaboration opportunities, including a) 3D concrete printing for civil infrastructures, b) 3D biomaterial printing for pharmaceutical and medical applications, c) 3D metal printing and in-process quality assurance, d) Virtual Reality engineering education laboratory (VReel), and e) in-space logistics and supply chain systems.

Biography: Dr. Hantang Qin is an Assistant Professor in the Department of Industrial and Manufacturing Systems Engineering and Center for Nondestructive Evaluation at Iowa State University, started in August 2017. He received his Ph.D. in Industrial Engineering at North Carolina State University in 2016. Dr. Qin’s expertise covers in-space manufacturing, electrohydrodynamics, micro/nano 3D printing, advanced manufacturing for flexible electronics, biomedical applications, system design, control, and optimization. He also works on engineering education via Virtual Reality (VR) pedagogy to train next-generation engineers. He has one U.S. patent, over 30 journal articles, and has been sponsored by NASA, NSF, Department of Energy – REMADE Institute, U.S. Army Research Laboratory – FlexTech Institute, ASNT, Iowa Economic Development, Iowa Department of Transportation, ISU College of Engineering, and industrial collaborators.

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Room 1153 ME