Additive Manufacturing: Virtual - Physical Processes

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Since its emergence in 1970s, 3D printing, or additive manufacturing, has slowly evolved as a way to produce prototypes of manufacturing products. Today, however, research and development of 3D printers have been progressing rapidly, and its role is expected to expand in myriad directions beyond a mere prototyping. President Barack Obama referred to the technology as “the potential to revolutionize the way we make almost everything” at State of the Union Address in 2013, and that statement is already proving to be true in a few areas of manufacturing. Earlier the same year, the German-American Frontiers of Engineering Symposium discussed the idea of the 4th industrial revolution based on cyber-physical systems, and included presentations that captured industrial applications and design.

Research focuses over the last four years have increased from a limited number of high value components using only a handful of materials to a wide range of materials developed for an exponentially growing range of applications. Additive manufacturing has high potential for many more applications and fields, but developments in both the physical world and the virtual world are needed in order to fully realize additives benefits or the “4th industrial revolution”. Most materials in additive were originally designed for conventional process. However, additive manufacturing enables development of new materials with highly tailored properties. In addition, new equipment is possible to deposit a widening array of materials; the new additive systems can be optimized to achieve mainstream manufacturing applications with faster deposition rates, new process methodologies, and new scales of printing. Additive manufacturing has demonstrated complex geometries, but only a few industries currently use these components due to the challenges and costs associated with certification and post-manufacturing inspection. Developments in computational applications including data analytics and process simulation provide opportunities in new methodologies for qualification and better understanding of these advanced manufacturing technologies.

This session introduces the cutting-edge research of the technology that is required to bring current 3D printing to integrated “advanced” manufacturing, focusing primarily on four critical components: hardware, materials, data, and infrastructure. We will also discuss possible ways the technology revolutionizes conventional manufacturing and its influence on our society. The first two talks will focus on the physical world, capturing how new materials and equipment can provide unique properties. Dr. Furukawa will discuss the 3d printing of designable gels in developing advanced functional materials, addressing limitations of currently available materials and the impact of the advanced materials to manufacturing and hospitals. Dr. Compton will then follow with a presentation that will focus on the use of additive manufacturing to fabricate hybrid materials and structures. The second two talks will delve into the virtual world, discussing how data and computational infrastructure can change the way we design and qualify additive components. Dr. Tanaka will discuss how “Deep Learning” neural networks can both develop new user interfaces interconnecting design, engineering, manufacturing, and testing, and be used to develop “Big Data” analytic tools. Dr. Schwalbach will introduce the stringent demands of materials in aerospace, the complications of additive manufactured components for aircraft, and the potential for a computational framework to understand additive processes by representing and analyzing data taken during and after deposition.