A Furniture Industry Concept for a Sustainable Generative Design Platform Employing Robot Based Additive Manufacturing

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Abstract : The furniture manufacturing industry has been slow in general to adopt the latest manufacturing technologies, historically relying heavily upon specialised conventional machinery. This approach not only requires high levels of specialist process knowledge, training, and capital investment but also suffers from significant subtractive manufacturing waste and high logistics costs due to the requirement for centralised manufacturing, with high levels of furniture product not re-cycled or re-used. This paper aims to address the problems by introducing suitable digital manufacturing technologies to create step changes in furniture manufacturing design, as the traditional design practices have been reported as building in 80% of environmental impact. In this paper, a 3D printing robot for furniture manufacturing is reported. The 3D printing robot mainly comprises a KUKA industrial robot, an Arduino microprocessor, and a self-assembled screw fed extruder. Compared to traditional 3D printer, the 3D printing robot has larger motion range and can be easily upgraded to enlarge the maximum size of the printed object. Generative design is also investigated in this paper, aiming to establish a combined design methodology that allows assessment of goals, constraints, materials, and manufacturing processes simultaneously. 'Matrixing' for part amalgamation and product performance optimisation is enabled. The generative design goals of integrated waste reduction increased manufacturing efficiency, optimised product performance, and reduced environmental impact institute a truly lean and innovative future design methodology. In addition, there is massive future potential to leverage Single Minute Exchange of Die (SMED) theory through generative design post-processing of geometry for robot manufacture, resulting in 'mass customised' furniture with virtually no setup requirements. These generatively designed products can be manufactured using the robot based additive manufacturing. Essentially, the 3D printing robot is already functional; some initial goals have been achieved and are also presented in this paper.

Keywords : additive manufacturing, generative design, robot, sustainability

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