

## Product Life Cycle Assessment of Generatively Designed Furniture for Interiors Using Robot Based Additive Manufacturing

**Authors :** Andrew Fox, Qingping Yang, Yuanhong Zhao, Tao Zhang

**Abstract :** Furniture is a very significant subdivision of architecture and its inherent interior design activities. The furniture industry has developed from an artisan-driven craft industry, whose forerunners saw themselves manifested in their crafts and treasured a sense of pride in the creativity of their designs, these days largely reduced to an anonymous collective mass-produced output. Although a very conservative industry, there is great potential for the implementation of collaborative digital technologies allowing a reconfigured artisan experience to be reawakened in a new and exciting form. The furniture manufacturing industry, in general, has been slow to adopt new methodologies for a design using artificial and rule-based generative design. This tardiness has meant the loss of potential to enhance its capabilities in producing sustainable, flexible, and mass customizable 'right first-time' designs. This paper aims to demonstrate the concept methodology for the creation of alternative and inspiring aesthetic structures for robot-based additive manufacturing (RBAM). These technologies can enable the economic creation of previously unachievable structures, which traditionally would not have been commercially economic to manufacture. The integration of these technologies with the computing power of generative design provides the tools for practitioners to create concepts which are well beyond the insight of even the most accomplished traditional design teams. This paper aims to address the problem by introducing generative design methodologies employing the Autodesk Fusion 360 platform. Examination of the alternative methods for its use has the potential to significantly reduce the estimated 80% contribution to environmental impact at the initial design phase. Though predominantly a design methodology, generative design combined with RBAM has the potential to leverage many lean manufacturing and quality assurance benefits, enhancing the efficiency and agility of modern furniture manufacturing. Through a case study examination of a furniture artifact, the results will be compared to a traditionally designed and manufactured product employing the Ecochain Mobius product life cycle analysis (LCA) platform. This will highlight the benefits of both generative design and robot-based additive manufacturing from an environmental impact and manufacturing efficiency standpoint. These step changes in design methodology and environmental assessment have the potential to revolutionise the design to manufacturing workflow, giving momentum to the concept of conceiving a pre-industrial model of manufacturing, with the global demand for a circular economy and bespoke sustainable design at its heart.

**Keywords :** robot, manufacturing, generative design, sustainability, circular economy, product life cycle assessment, furniture

**Conference Title :** ICADDM 2021 : International Conference on Architectural Design and Design Methodologies

**Conference Location :** Vancouver, Canada

**Conference Dates :** May 20-21, 2021