



AUTOMATION OPPORTUNITIES FOR FABRICATION OF MASS TIMBER BUILDING COMPONENTS

Rafael V. Coelho^{1*}; Martin O. Kemmsies²; Andre Dagostin³;
Eric Marshall⁴; and Iris D. Tommelein⁵

*Corresponding author: rvcoelho@berkeley.edu

¹ PhD Candidate, Department of Civil and Environmental Engineering, Researcher, Project Production Systems Laboratory (P2SL), University of California, Berkeley, CA, USA

² Consultant and Sales Director, Birka, Curitiba, PR, Brazil

³ Director, COMAC Robótica e Automação Industrial, Carlos Barbosa, RS, Brazil

⁴ Plant Manager, Timberlab, Piedmont, SC, USA

⁵ Distinguished Professor, Department of Civil and Environmental Engineering, Director, Project Production Systems Laboratory (P2SL), University of California, Berkeley, CA, USA

ABSTRACT

As demand for mass timber building structures rapidly increases, project production systems must increase their delivery efficiency in order to keep pace. This study, focused on the fabrication of glulam columns and beams, therefore proposes that production systems integrate automation into a number of fabrication steps, such as machining, sealing or coating, and metal hardware installation. Three production cells were conceived, each with specific automated solutions aimed at alleviating production bottlenecks, improving production consistency and product quality, reducing cycle times, and increasing production throughput. This paper emphasizes the importance of aligning automation investments with overall production system design to ensure system-wide efficiency and effectiveness. The findings of this study contribute to advancing automation in mass timber fabrication, supporting sustainability and improving production efficiency.

Keywords: mass timber; industrialized construction; off-site construction; project production system design; automation; robotics.

RESUMO

À medida que a demanda por estruturas de edifícios em *mass timber* aumenta rapidamente, sistemas de produção de projetos devem aumentar sua eficiência de entrega para acompanhar esse crescimento. Este estudo, focado na fabricação de colunas e vigas de *glulam*, propõe, portanto, que sistemas de produção integrem automação em várias etapas da fabricação, como usinagem, selagem ou revestimento e instalação de conexões metálicas. Três células de produção foram concebidas, cada uma com soluções automatizadas específicas, visando aliviar gargalos de produção, melhorar a consistência da produção e a qualidade do produto, reduzir os tempos de ciclo e aumentar a capacidade produtiva. Este artigo enfatiza a importância de alinhar os investimentos em automação com a configuração do sistema de produção para garantir eficiência e eficácia em todo o sistema. Os resultados deste estudo contribuem para o avanço da automação na fabricação de *mass timber*, apoiando a sustentabilidade e melhorando a eficiência da produção.

Palavras-chave: mass timber; construção industrializada; construção off-site; configuração de sistemas de produção de projetos; automação; robótica.



1. INTRODUCTION

Mass timber (MT) has gained prominence as a sustainable construction material used for structural systems in buildings. Its global adoption has been driven by advancements in materials science, building codes, growing awareness of its structural strength and environmental benefits, and innovations in manufacturing processes and digital tools. These developments have contributed to the expanding MT market (Connick et al., 2022).

As interest in the use of automated manufacturing and fabrication equipment continues to grow in the construction industry (ABB, 2021), this study explores the opportunities for automating the fabrication of MT components, such as glulam columns and beams. A company's decision to invest in hardware and software tools must be aligned with the design of a production system that supports its business goals. Production system design is the process of determining the characteristics of a system for making products (P2SL, n.d.), considering both production goals and constraints. Deciding whether automation is the right strategy and if so, selecting the appropriate automation equipment is an integral part of this production system design process. A holistic approach allows for informed decision-making regarding automation investments, ensuring that technological solutions are not just implemented in isolation but contribute to improvements in productivity, quality, and overall system efficiency.

For clarity, manufacturing must be distinguished from fabrication in the context of MT. Manufacturing refers to the production of engineered wood products by bonding multiple layers of lumber boards with structural adhesives. In contrast, fabrication involves transforming these engineered wood products into structural elements, such as columns, beams, and floor panels. This paper focuses exclusively on the latter. The research question this study aims to answer is the following: **What are the opportunities to automate the fabrication of MT components?**

We begin this paper by defining MT systems, providing an overview of Industrialized Construction (IC) and its relevance to the MT supply chain. Next, we examine the role of automation in construction. Finally, we describe the fabrication process for MT components and propose ideas for automating steps of this fabrication process, while emphasizing the significance of designing production systems that efficiently and effectively meet both production demands and customer needs.

2. MASS TIMBER (MT) SYSTEMS

An earlier paper by Coelho et al. (2023) provided a background on MT systems. To summarize, MT can refer to several engineered wood products, such as Cross-Laminated Timber (CLT), Glue-Laminated Timber (Glulam or GLT), Nail-Laminated Timber (NLT), Dowel-Laminated Timber (DLT), Mass Plywood Panels (MPP), and Mass Plywood Lams (MPL), or a complete structural building system. In North America—where the authors have studied the MT supply