Mapping Human Agency in the AR-Enabled Co-Production of an Urban Community Podium

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Keywords: AR-Enabled Production, Timber Dowel Structures, Human-Machine Agency , Urban Communities, Co-production.

The application of Augmented Reality (AR) in construction is transforming how non-expert users engage with complex assembly processes, with its potential to foster broader community involvement in urban space production remaining underexplored. This paper presents an integrated framework that incorporates AR-enabled phygital instructions with timber dowel structures, facilitating the active participation of non-experts in the design-to-production process of an urban community food podium. By leveraging AR and computational design, the system bridges the gap between expert and non-expert users, enabling wider participation in the construction process while maintaining precision through robotic fabrication and step-by-step digital guidance. Tested within a graduate-level course and showcased at a public event, the project aims to empower community members to engage in production and assembly, offering insights into participatory urban design and co-production. The results demonstrate the capacity of augmented fabrication to enhance human agency, making complex construction tasks accessible and collaborative, and paving the way for resource-driven, community-enabling urban developments.

INTRODUCTION

The integration of Augmented Reality (AR) and robotics into construction and design processes is reshaping how designers and builders engage with digital information on-site, creating new possibilities for interaction in the physical world. This paper maps the role of human agency in the co-production of an urban community food podium, emphasizing the use of AR technology to guide and empower non-expert participants throughout the building and assembly process. Additionally, the paper introduces site-specific factors alongside an integrated computational design system. The project develops an AR-enabled framework that combines computational design, robotic fabrication, and real-time human collaboration to construct a free-form timber dowel structure. The study aims to establish a replicable workflow that fosters active community involvement while maintaining precision and efficiency through digital tools.

As assembly processes become more complex in construction, several technologies are being developed to support the production of free-form and non-standard structures. Since its early development, augmented reality is applied to complex assemblies, providing real-time information by overlaying digital instructions onto the worker's field of vision, improving efficiency and reducing errors [1]. With the development of computational design tools and the introduction of numerically controlled machines such as CNC machines, laser cutters, 3D printers, and later industrial robots in assembly lines, the importance of interactive and user-friendly instructions continues to increase. Augmented reality, as a medium between the numerical world and the real world, delivers essential information to human operators at each step of the assembly process.

While AR has mostly been tested in professional settings where participants already have knowledge about the process and production, its potential to include non-expert designers and builders remains unexplored. Using holographic instructions, AR helps overcome the difficulties of interpreting traditional 2D drawings, making it easier for non-experts to participate. The system, with mapped human agency, is based on the hypothesis that AR makes specific parts of information accessible, allowing non-expert community members to understand and apply them effectively. This approach offers a solution for increasing community involvement in shaping their built environment, addressing a key barrier to broader participation in urban spaces.

This paper examines the role of human agency in the augmented co-production of an urban food podium, emphasizing the pivotal role AR technology plays in facilitating the preparation and assembly processes for non-expert users. A resource and performance-driven design-to-production and assembly framework is developed and prototyped within a graduate-level course at Texas Tech University, Huckabee College of Architecture (TTU HCoA) in collaboration with the South Plains Food Bank (SPFB). While the design is tailored to meet site-specific conditions, the production process is mapped to establish a replicable workflow that promotes active community involvement throughout the building process. The project employs a timber dowel structure as the material system, generated through an integrated design-to-production framework. This framework includes the