



Improving Building materials by Employing Advanced Manufacturing (IBeam)

The size of the building materials industry is estimated to be \$1.1 trillion in 2021, and is expected to increase significantly due to increased infrastructure spending by government and industry. The process for manufacturing various building materials is energy intensive, heavily reliant on fossil fuels, not centered around job creation, and has largely been overlooked as an area to implement advanced manufacturing practices. There is tremendous potential to streamline this industry, drive flexibility, agility, decarbonize the manufacturing processes, encourage waste upcycling, and create manufacturing jobs in rural and underserved areas.

Mass customization provides an opportunity to streamline manufacturing processes and drive quality improvement. Using additive manufacturing techniques to create custom building materials or upcycle extrusion from waste to fabricate materials creates the potential for building facilities to manufacture materials on-site. Building smaller-scale facilities would allow for job creation in regions without large-scale, centralized manufacturing facilities. For industries like the timber industry, the development of noninvasive diagnostics and field evaluation techniques would allow engineers to determine the best use for the timber based on its properties, therefore enhancing forest management and connecting the raw materials producers with engineers producing the end product to optimize the production process. Additionally, implementing process control techniques to engineer materials with enhanced properties (such as engineered lumber) can accelerate advancements in energy and material-usage efficiencies in this industry.

A scarcity of research regarding building material waste upcycling, processes for mass customization, manufacturing materials with superior properties, and implementing process control techniques to minimize energy consumption as well as insufficient techno-economic analyses create a need for identifying future research and challenges for implementation.

In this framework, the American Institute of Chemical Engineers (AIChE) is proposing the development of the IBeam (Improving Building materials by Employing Advanced Manufacturing) roadmap. The roadmap effort aims to convene a group of key stakeholders across industry, academia, trade organizations, NGOs, and national labs to identify and prioritize the gaps, that, if addressed with advanced manufacturing, could enable step changes in key metrics such as energy efficiency, environmental footprint, capital costs, as job creation, as well as economic improvement of rural, underserved areas of the U.S. The project will be led by Michelle Bryner, Director of Publications, Facilitation, and Business Development, and Izabela Balicka, Engineering Specialist, Facilitation and Business Development.

The roadmap will focus on advanced manufacturing challenges related to producing three types of building materials: (1) Wood, timber, engineering lumber, and sheeting materials (2) concrete and asphalt and (3) insulation materials. The roadmap will be developed using AIChE's proven method that was used to develop the six roadmaps for the RAPID Manufacturing Institute. The process involves carving out the landscape into focus areas, convening teams of experts within each area via virtual meetings to identify gaps, surveys to prioritize the gaps, and then finally a two-day workshop to bring the teams together to identify missing items and trends seen across the focus areas. The final roadmap will identify the high-priority gaps for each focus area that if addressed by advanced manufacturing technologies would lead to step changes in the metrics of success — (1) Decarbonizing the building materials industry; (2) Creating jobs in regions without a strong manufacturing workforce, including rural and underserved areas; (3) Implementing tools, technologies, and diagnostics to optimize the production process and to connect various parts of the supply chain. The roadmap will also include a time component to identify when, and in what order, the team believes the gaps could be solved. The roadmap will serve as a guide for identifying where research could have the largest impact for the building materials industries in the key metrics listed above, as well as promote American excellence in advanced manufacturing. Because these efforts have not been implemented on a large scale in the building materials industry, the challenges that will be discussed are high-risk/high-reward, and will increase US manufacturing competitiveness. In addition, they will require a collaborative effort that not just one company or institute can solve alone.