Improvements in SMR Modular Construction through Supply Chain Optimization and Lessons Learned

PI: Chelsea C. White III-
Georgia Institute of Technology

Program: NEET: Advanced Methods for Manufacturing

Collaborators: Bojan Petrovic- Georgia Institute of Technology

Jurie J. van Wyk and Mathew Kelley- Westinghouse Electric Company

ABSTRACT:

There is renewed interest in Small Modular Reactors (SMRs), with the nuclear industry investing significant resources in their design, licensing, and fabrication facilities. DOE is supporting these efforts through R&D funding and a major licensing cost-share program. While the technical characteristics of SMRs and their specific advantages are well understood, their competitiveness is yet to be proven in practice. Using the same type of design and construction methods as they are currently used for large reactors would likely challenge economic viability of SMRs due to economies of scale, which is generally valid when applied to similar designs and fabrication processes. Instead, the proposed research will aim to identify potential improvements in modular construction, in particular those that offer unique or preferential opportunities for SMRs, and may thus become one of the key enabling elements toward the competitiveness and ultimate deployment of SMRs.

The objective of this project is to advance methods for manufacturing Small Modular Reactors (SMRs), and in particular to improve modular construction techniques and develop best practices for designing and operating supply chains that take advantage of these techniques. The overarching goal is to accelerate the construction schedule and reduce its variability, reduce the cost of construction, reduce interest costs accrued during construction (IDC), and thus enhance the economic attractiveness of SMRs. To achieve these objectives, this project aims to identify, address, and resolve or ameliorate challenges and deficiencies in the current modular construction approach. The expected outcome is a range of novel approaches, combined with an optimized integration of known techniques. This effort will reflect the fact that the cost of a construction activity is often smallest when accomplished in the factory, greatest when accomplished at the construction site, and at an intermediate level when accomplished at an assembly area near the construction site. The transport from factory to construction site or to an assembly area near the construction site and from the assembly area to the construction site constrains the size and weight of the modules. If there are several possible transport strategies for moving material, modules, or other forms of work-in-progress, then the concomitant sets of constraints will also be subject to analysis. Further, irrespective of where the activity is to occur, but focused mainly on activities in the factory, we will investigate ways to reduce waste, improve quality, efficiency, and throughput. This effort will also reflect the fact that the more done early in the construction process, i.e., in the factory, the more upfront funding is required and hence the more IDC will be accrued.

The scope of the proposed project is to:

- Evaluate the differences in stick build and modular construction for SMRs;
- Examine transportation limitations as they relate to modular construction;
- Investigate one-tier and two-tier modular construction options for SMRs;
- Analyze the impact of front-loaded fabrication cost.

The analysis will lead to a better understanding of under what circumstances modular construction performed mainly in the factory will result in lower expected total cost, relative to more traditional, on-site construction procedures. Further, we anticipate that insights will be gained regarding how the role of standardization for modularization can be most effectively defined.

It is important to emphasize that while the optimization will be specific to SMRs, the methodology and the results will ultimately benefit all (small and large) new nuclear construction.