

## Executive Summary

Lights-Out Design is pleased to present the team's year-long senior capstone thesis project for AE482. Over the course of the year, the team has collaboratively assessed the current Penn State Ice Hockey Arena design and targeted areas where the team could explore design enhancements through integrated project deliver and building information modeling platforms. The Lights-Out Design team consists of a student from each discipline within Architectural Engineering at Penn State. Each discipline came into the IPD/BIM thesis with sufficient background in building information modeling programs. Together, Lights-Out Design has analyzed engineering systems of the Penn State Ice Hockey Arena using BIM software in an IPD environment. Specifically, the team made efforts to analyze and redesign the long span roof, the exterior facade, and to analyze and redesign the existing mechanical system to improve energy efficiency.

The existing arena roof consists of long span steel trusses that span 192 feet over the arena bowl with 30 foot steel joists above the north and south concourses. From an early design stage, Lights-Out Design wanted to investigate the possibility of spanning the arena roof the entire 252 feet from exterior wall to exterior wall. In order to accomplish this, a unique system would be necessary. A cable-stayed solution was selected after careful investigation into other cable structures. Throughout the semester, a cable-stayed roof was designed and compared to the existing design. The new roof proved to be very expensive and significant changes would be necessary to improve the feasibility of the cable-stayed roof.

After deciding to design a cable structure, it became necessary to redesign the existing facade. The existing facade consisted of mainly a brick veneer with slotted windows along the north and south concourse. With the teams new design goal, the facade was redesigned to be lighter through the use of glass and metal panels. A thermal analysis was conducted on the new facade to ensure that the arena would remain energy efficient. After conducting the analysis, it was discovered that the move to glass and metal panels would not impact the energy efficiency of the arena and would only cost \$85,701 over the life-cycle of the arena, a mere \$3,000 extra per year for 30 years. A new lighter facade is clearly feasible for the arena.

The final major redesign revolved around the community rink roof and the energy efficiency of the mechanical system. With the community rink being used extensively throughout the year, Lights-Out Design wanted to provide a greater aesthetic to the rink through an arched roof and infusing daylighting. In turn, after a preliminary analysis of the mechanical system, the team concluded that mechanical units had to be relocated. Through moving mechanical units to a mechanical loft, the team was able to save close to a million dollars in duct expenses and create flexibility in the design of the community rink roof. This redesign posed major coordination challenges to Lights-Out Design and provided a great opportunity to implement numerous BIM programs to ensure coordination between the engineering systems.

Through each phase of analysis and design, communications between team members and model sharing software needed continuous input. Lights-Out Design chose to continue use of Revit analytical models provided by the design team and share information across a spectrum of BIM software.