Executive Summary

The following report provides an overview of the proposed redesigns and analyses that BIM*ception*, composed of Stephen Pfund, Christopher Russell, Alexander Stough, and Thomas Villacampa, researched and produced in the spring of 2011 for the Millennium Science Complex. BIM*ception* is dedicated to improving design through innovation and coordination. The purpose of this report is to generate redesigns for the existing building that are more energy-efficient, cost-effective, and of higher value to the building. An integrated approach was taken to determine designs that were executed for this project. Integrated Project Delivery conceives design as a team product, allowing each member to incorporate their expertise early in the design phase adding value to the building project. Building Information Modeling will become the tool that allows BIM*ception* to quickly and effectively validate and communicate our design concepts.

Within this report, three main areas of focus have been evaluated. These interests were chosen as they provide opportunities for input from multiple disciplines, furthering the need for an integrated approach. These areas include the following:

1. Analysis of the building envelope with the intent to design a façade that is more efficient for the mechanical, lighting, and structural systems.
2. Investigation into the ceiling plenum space with the intent to examine the value of reducing structural depth through a redesign and reducing operational energy consumption
3. Redesign of the cantilever's structural framing and exterior plaza lighting system enhancing the architectural aesthetics with engineering solutions.

BIMception investigated the use of alternative system designs to modify the components of the Millennium Science Complex's building enclosure with the intent to engineer more efficient systems. Based on this, an analysis of the precast panel's composition, the window to wall ratio, and shading devices were conducted to improve optimal performance. While improving performance, the architectural aesthetics of the MSC remain unchanged, preserving Raphael Vinoly's vision. Each design alternative was selected based on criteria developed for energy performance, daylighting comfort, structural integrity, and life cycle cost.

The core investigation of the plenum space is a structural redesign entailing a change from the existing structural framing to a "three-building" design. This design is focused on redesigning the structural gravity system by maintaining the steel framing of the cantilever while using a concrete system for the wings. This design alternative investigated potential reductions of the structural depth within the plenum space. Based on the space gained through this redesign, the mechanical system investigated the opportunity to save fan energy by increasing duct size. The benefits of adjusting duct size are determined through energy consumption and life cycle cost. The coordination of the alternative structural and mechanical systems validates the opportunity to reduce system collisions and improve system integration. The concrete redesign of the wings also prompted a full redesign of the lateral resisting elements.

The cantilever of the Millennium Science Complex is the key architectural focal point of the building. An open-air plaza has been designed for below the cantilever, including an exterior lighting system. A redesign of the cantilever truss system produced a system that is efficient and reduces steel material costs. The structural truss modifications prompted an architectural change within the cantilever plaza. Subtle in nature, the new architecture of the plaza incorporates a progression of angles drawing the eye gradually from the ground to the tip of the cantilever revealing the massiveness and magnitude of this architectural statement. The redesigned cantilever plaza fully integrates structural efficiency, architectural masterpiece, and expressive lighting design.

Cost, schedule, and site logistic implications were assessed for all design decisions, adding additional measures to determine the benefits of alternative redesigns. Integration of all design decisions requires the input and selection criteria from each member of BIM*ception*. The final products of each analysis represent the coordination of each system's design implications on each other, producing the most beneficial improvements for the entire building solution.