Executive Summary

This report is the culmination of a yearlong study performed on the John Jay College Expansion Project located in Manhattan. This academic building includes a midrise tower with classrooms, laboratories, and office spaces that reaches a maximum height of approximately 240 feet above 11th avenue. A 14 story tower is connected to the existing building with a 5 story podium which encases a "grand cascade". Amtrak tracks pass beneath the South-West corner of the site, which led to a unique structural solution of the midrise tower.

Levels 1 through 5 are transferred over the Amtrak tracks using built-up steel girders. Limited in depth to 3'-0" between the 1st floor and Amtrak tunnel, these built-up steel girders only have enough capacity to support the first 5 levels. To transfer the remaining 9 levels, trusses at the mechanical penthouse cantilever out from a braced frame core. Perimeter plates hang from the trusses and support floor framing of the 6th through 13th levels.

While this innovative solution creates some attractive architectural features, such as thin perimeter plates instead of columns, it is complicated to construct. Since the major transfer system is located at the top of the building, temporary supports and bracing must be used until the penthouse trusses are completed. Therefore, the main goal of this study was to design a more constructible transfer solution.

In this study, 6 architecturally exposed transfer trusses were designed for the 5th level. These trusses use custom built-up steel sections to transfer 55% of the perimeter columns of the midrise tower. The remaining 45% of the perimeter columns are supported at the foundation using concrete caissons embedded into bedrock.

In the existing design, heavy W14 sections are used for columns at the top of the braced frame core due to transferring gravity loads from the penthouse trusses. After new transfer trusses were design for the 5th level, the lateral force-resisting system was optimized. Lateral loads were calculated using ASCE 7-05, rather than using the NYC Building Code. Wind loads were determined to control for both strength and serviceability design considerations. Once lateral drifts were determined to be adequate for the lateral drift recommendations of ASCE 7-05, a separate analysis was performed to ensure the new design would meet the criteria - set forth by the NYC Building Code - the existing structure was designed for. By transferring gravity loads to the braced frame at the 5th level rather than at the penthouse, a savings of approximately 71 tons of steel was achieved in the braced frame columns.

Major architectural changes were made to the 5th level of the John Jay College Expansion Project to implement the transfer trusses. Floor-to-floor heights of the 5th level were increased from 20 feet to 30 feet to incorporate the interior trusses. These interior trusses were elevated 10 feet to allow building occupants to circulate beneath them. By exposing the transfer trusses using custom built-up sections, a new aesthetic was achieved for the 5th level dining and serving areas.

To determine if the ultimate goal of a more constructible structural solution was achieved, a construction management breadth study was completed. First, to

determine if the new transfer system was a viable option, a cost analysis was performed. This resulted in a total estimated cost for the transfer system of $ 6.74 million and $ 6.15 million for the existing transfer solution. These values were calculated based on the weight of steel used, and do not consider the premiums charged for the complicated construction of the existing hanging structure. Therefore, it was assumed that the two transfer systems cost about the same.

However, differences in constructability of the two transfer systems were seen when comparing construction schedules. Assuming that 40 pieces of steel could be erected per day, steel erection for the new transfer system was determined to take 3 weeks less than the existing design. While this decrease in erection time is important, it is more important to understand how this was achieved: by using less transfer trusses with less web members, and eliminating the need for temporary supports.

The difference in total superstructure construction time was increased when examining the placement of concrete decking. Due to the built-up steel girders above the Amtrak tracks having to support 14 levels of construction loads, concrete work cannot begin until penthouse trusses are complete and the tower is hanging. If concrete work begins before gravity loads of the upper levels are transferred using the penthouse trusses, the built-up steel girders would be overstressed. By transferring gravity loads at the 5th level, conventional steel erection methods can be used and concrete work can be sequenced with the steel erection to approximately finish at the same time. Using the assumptions listed in this report to estimate the total superstructure construction time, the new transfer system was determined to take 6 weeks less than the existing design.

In conclusion, the new transfer system designed in this report is a viable solution. By exposing the transfer trusses at the 5th level of the John Jay College Expansion Project, a more constructible design was achieved. Although there are many other considerations that may need to be taken into account when comparing construction methods, this study used time to compare constructability between the two transfer methods. This reduction in time was found to be caused by using less pieces of steel in the transfer trusses, as well as eliminating the need for temporary columns and supports, resulting in a simplified transfer solution.