Construction workers are frequently exposed to considerable physical demands as construction tasks rely largely on manual handling tasks. Excessive physical demands beyond one’s capabilities may lead to productivity, safety, and health issues in construction. Assessing physical demands from construction tasks helps to not only identify the fundamental cause of the gap between physical demands and capabilities, but also to find an appropriate method of intervention to eliminate the gap. Although many researchers have worked on methods for evaluating physical demands, the use of these methods in occupational settings, especially in construction, is limited due to the difficulty in collecting reliable data on working postures and motions with the required level of detail according to evaluation methods. In addition, despite the increasing attention paid to the detrimental effects of excessive physical demands, discussion on how excessive physical demands affect workers’ time and cost performance in construction is sparse.

With this background, the overarching goal of this dissertation is twofold: 1) to enable practitioners to evaluate construction workers’ physical demands on sites in a timely manner without technical sophistication or skill, and 2) to enhance our understanding of the impact of excessive physical demands on construction operations. Specifically, computer vision-based approaches are proposed to non-invasively collect kinematic data (e.g., postures and motions) by recording and processing video sequences. The obtained kinematic data can be used to quantify and evaluate physical demands through postural ergonomic risk assessment and biomechanical analysis. Also, worker-oriented modeling and simulation of construction operations is proposed to capture the interactive effects between excessive physical demands and construction operations by combining a Discrete Event Simulation (DES) model with biomechanical and fatigue models. This approach enables us to evaluate workers’ fatigue due to excessive physical demands from operations in the early design stages, and then to quantify the impact of fatigue on workers’ time and cost performance. The proposed approaches have been tested through a series of laboratory tests and case studies, proving their feasibility and applicability under real conditions at construction sites. Ultimately, continuous evaluation and monitoring of physical demands during construction tasks using the proposed approaches will enhance the understanding of the gap between physical work demands and workers’ capability, and offer a firm foundation for the improvement of workers’ health (e.g., reducing WMSDs), as well as productivity in construction.