Design of a Modularized “Smart” Façade System

Objective: Comprehensively research façade-adapted systems and devices for maintaining building comfort and energy-efficiency, and design and build a prototype smart façade system that optimizes modularity.

Background: The facades of many contemporary buildings emphasize glazed curtain walls (i.e., exterior walls that are entirely or predominantly glass). The transparency of these facades offers the undeniable physical and psychological benefits of exposure to the outside world, remarkable views, and abundant sunlight. However, the low thermal resistance of these systems means they are a step backward when it comes to energy-efficient building envelopes. In recent years, glass technology has seen innovations such as multiple-layer glazing, inert gas fills, and low-emissivity coatings (microscopically thin layers of metallic oxide that block heat and ultra-violet rays). All of these methods, however, are defensive and therefore intentionally invisible. What is missing so far are overt architectural elements that explicitly communicate the intent to effectively regulate and manipulate environmental interactions. Light, heat, and ventilation need to be manipulated in the optimal way in the service of (i) the immediate comfort of the building occupants, and (ii) optimized energy efficiency within a “smart” building system. In addition, the smart façade design solution that accomplishes these purposes should ideally be one that envisions mass-producible modular units.

Suggested Approaches: In Phase 1, comprehensively research façade-adapted (decentralized) mechanical systems and devices capable of positively manipulating environmental impacts (solar radiation, light gain, heat gain, and ventilation). Also investigate possibilities for an easily-reproducible HVAC system that can accommodate the mechanical systems and devices, facilitate distribution of electrical and/or hydronic media, and be producible as a kit of interchangeable components to be combined in different configurations for different functional purposes. These two areas of Phase 1 research should balance architectural and engineering perspectives in moving toward a realistic and attractive solution for an active façade system. In Phase 2, investigate the optimal layering of components, evaluating optional configurations in terms of ease of assembly, aesthetics, ease of maintenance/repair, operability, costs, and mass-producible modularity. Select a customized set of criteria for this evaluation process. Use parametric modeling, incorporating reliable data, to predict the optimal configuration for the proposed façade system(s). Based on this prediction, design and build a prototype smart façade system that optimizes modularity. Prepare a report with bibliography, and a presentation.