El Louvers: Customizing Daylighting and Performance in Ceramic Louver Systems

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Ceramics research and specification have increased dramatically in recent years, spurred in part by environmental ratings systems that encourage use of the material because it's abundant, derived from the earth and durable. Additionally, materials engineers have made significant technological advances through molecular recomposition and polymer additives that increase the material's toughness and strength. Through advances in material composition, manufacturing and fabrication, ceramics composites and assemblies hold tremendous promise for both onsite and offsite construction.

Drawing from this research, this poster summarizes an investigation into the development of a climate responsive parametric model for the design of a heat mitigating and daylight-enhancing ceramic façade system. The project harnesses site-specific environmental data, which was tested through three climate zones (Los Angeles, Mexico City and Anchorage) and analyzed through Ecotect. The L-shaped louver profile can be modified according to the angle of incidence for different climate zones, and configuration densities can be manipulated to achieve the desired solar screening and daylight reflection for varying environmental and design parameters.

The louver profiles associated with different climate zones would be manufactured using a plasma cut die inserted into a vacuum clay extrusion machine in order to generate multiples. Each die would incorporate a serrated aperture to create a textured surface that enhances light diffusion (described in the accompanying diagrams). The use of the extruder highlights an environmental benefit of using ceramic: once molds are made, there can be minimal material waste. Additionally, the formwork for the high impact ram-pressed components can be selectively modified (through layering and inserts) to create aesthetic variation and environmental performance without generating the waste that would result from individualized forms.

Through advancements in tooling, which have reduced air pockets and enabled thinner profiles, manufacturers are currently fabricating hollow-core louver and rain screen elements 10' or longer that permit lightness for handling and transport. Polymer additives further strengthen the material and when it becomes more financially accessible, the composites will enable even longer spans with ever thinner profiles. This research holds tremendous promise for increased specification of ceramic not only as a fireproof coating and structural sheathing, but also as a stand-alone material suitable for structural modules.

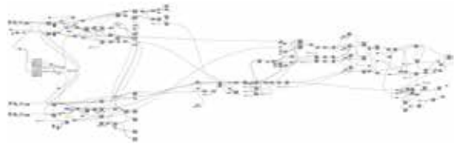
The louver system harnesses the capabilities of high-impact vacuum extruders and presses, pushing these technologies to an extreme through the use of polymer additives that facilitate lightness in both weight and appearance. Given the potentials of design customization and prefabrication as a unitized system, El Louvers hold tremendous promise for the growing prefabrication industry. Future development of the system will be a cross disciplinary collaboration amongst designers, digital fabricators and ceramics manufacturers - a formal outcome. In doing so it avoids using a mechanical solution to solve a previous industrial problem.

Research Questions

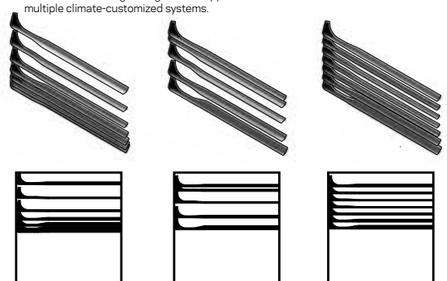
How can parametric modeling help to optimize louver profiles for specific climate zones while optimizing light transmittance and mitigating undesired heat gain?

Using a continuous feedback loop between Grasshopper and Ecotect, is it possible to develop a flexible system for multiple climates using a limited number of profiles?

Ceramic is an ancient material that is evolving through materials engineering research. How can polymer-infused ceramics and new extrusion technologies influence the design of thinner, longer profiles for unitized facade systems?



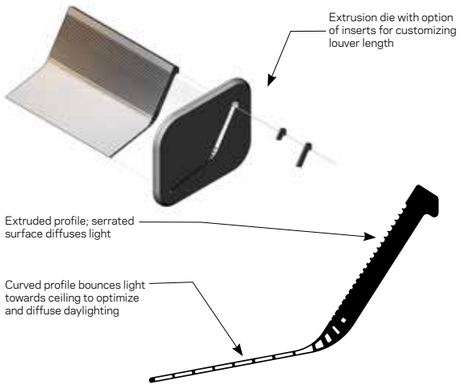
Parametric modeling through Grasshopper to test multiple climate-customized systems.

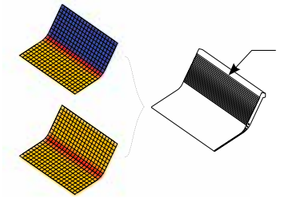


Project Summary

This design research focuses on the development of a climate-responsive parametric model for heat mitigating and daylight-enhancing ceramic façade systems. The project harnesses site specific environmental data, which was tested through three climate zones (Los Angeles, Mexico City and Anchorage) and analyzed through Ecotect. The latitude is inputted into the Grasshopper model, which adjusts louver length and configuration density.

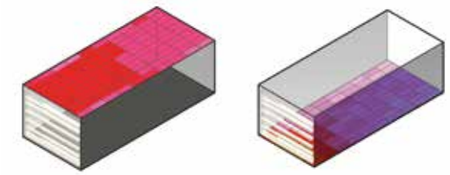
Ceramic extruder and ram press
www.tilemachinery.com/product/de-airing-extruder/,
www.hellotrade.com/ram-products/ram-press.html





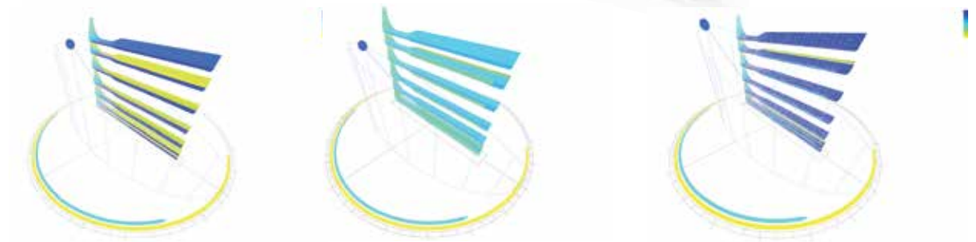
Daylighting Analysis Studies

The curved profile is intended to bounce light to the ceiling to maximize daylighting while also mitigating heat gain. The "L" shape deflects light at corner conditions and provides design options for variation in façade patterning.



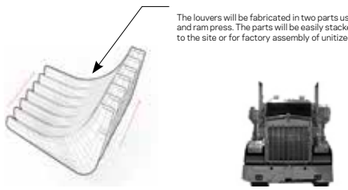
Seasonal Solar Mitigation Studies

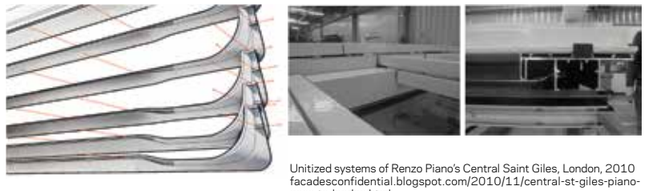
The ceramic louvers have a thicker section where the lower, winter sun will warm the elements for heat distribution. In colder climates, the louvers can be spaced apart or used only at the upper portions of glazing systems to take advantage of solar heat gain.



Future Directions: Prototypes and Unitization

This system holds tremendous potential for offsite construction. The ceramic material is durable and light enough to be easily handled and assembled. Hardware enables dry mounting, which speeds up the construction process and facilitates replacement or reuse of modules throughout and after the life of the project.





Unitized systems of Renzo Piano's Central Saint Giles, London, 2010
facadesconfidential.blogspot.com/2010/11/central-st-giles-piano-goes-to-london.html