The Role of Environmental Simulation in Achieving Contextual Fit: Evidence from a Longitudinal Undergraduate Study

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While contemporary architectural research continuously evolves to address climate crises through expanding 5R to comprehensive 10R and 15R strategies, first-cycle architectural education severely lags this theoretical progression. Instead, environmental performance is treated as an isolated theoretical package introduced into the design process as a late-stage add-on, rather than a core design driver. Consequently, students frequently rely on initial, intuitive starting concepts where massing is applied without considering site-specific climatic data.

This study addresses this gap by presenting the results of a comparative process analysis within a three-year longitudinal third-year building technology course on performance-based form-finding (2023–2026). Apart from theoretical lectures, the course is built upon a term-long design study of small-scale buildings located in diverse climate zones. The research observes the design iterations of 55 student groups. Through purposive sampling, this paper analyses the evolution of nine student group projects in response to empirical data provided by simulation tools, specifically Autodesk Revit Insight and Rhinoceros 3D/Honeybee.

The synthesis of these projects shows that simulation-driven workflows operationalize 'R' strategies to achieve contextual fit through two primary ways: (1) Morphological Refusal and Rethinking: Initial intuitions dismantled when performance failures necessitate relocation or fragmentation (e.g., Venturi effect) to optimize solar and thermodynamic efficiency; (2) Material Reduction and Substitution: Carbon benchmarks identify materials, compelling a shift from carbon-heavy systems to alternatives like Mass Timber. Ultimately, this process establishes a rational error-correction system, replacing intuitive habits with performance-validated decisions.

This study frames the design process as an iterative negotiated deal among the contextual data, comfort, form, and material. Hence, it suggests that environmental fitness requires a pedagogical shift toward being data-responsive in education, where design teams must be willing to mechanically dismantle any architectural decision that fails empirical performance benchmarks.