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Decoding Ivy Behavior for a Performative Flow Model

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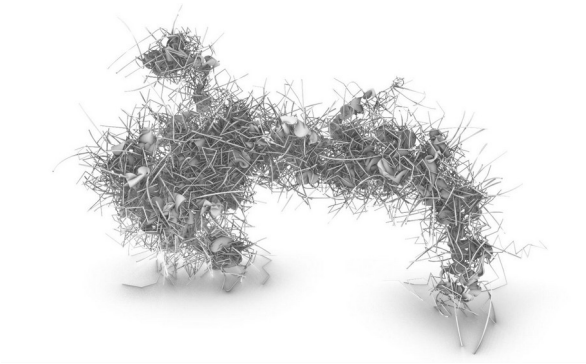


Figure 1. Flow Model (Image credits: Ataberk Kahraman).

Extended Abstract

Ivy plants exhibit a unique growth pattern that intertwines biological adaptation with structural interaction. Beginning their life cycle by taking root in the soil, they climb upwards upon finding a suitable surface. The climbing ability enables ivy to grow along vertical structures such as walls and trees, forming an intricate relationship with its environment. The study presents a computational model that deciphers ivy's growth behavior and water absorption dynamics, employing parametric design techniques for a more integrative simulation.

By leveraging ChatGPT 4.0's analytical capabilities, growth and flow parameters were systematically modeled using Python scripting in Rhino. Specifically, ChatGPT 4.0 was used for generating algorithmic rules that define ivy's exploratory growth patterns and simulating water absorption processes. The study employs digital experiments to simulate natural processes and their structural consequences.

The first experiment models the ivy's random yet biologically informed growth simulation, representing the plant's exploratory process, where curves and mass structures visualize organic expansion patterns. Beyond structural adherence, ivy plants interact with the material properties of built environments, particularly mortar—a porous substrate capable of retaining moisture. Ivy roots absorb this water, leading to a gradual depletion of moisture content in the mortar, resulting in drying and potential degradation. To represent this interaction, the second experiment introduces a dynamic flow simulation, tracking water distribution in relation to the plant's growth. This visualization highlights how moisture migrates through the wall and how ivy's absorption modifies its distribution over time. (See Figure 2: Flow Model Sequences)

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The computational model also considers the long-term effects of ivy on structural integrity. As the plant expands, its roots penetrate deeper into mortar joints, widening existing gaps. This process accelerates material deterioration, potentially causing separation of mortar, displacement of stones, and overall weakening of the structure. The interplay between biological growth and architectural decay is critical in understanding how natural elements interact with the built environment.

The study integrates computational approaches with performative design strategies. Inspired by the principles of complex adaptive systems, the model explores how biological self-organization influences architectural resilience. Complex adaptive systems entail processes of self-organization and emergence, where lower-level interactions generate coherent higher-level behaviors. In the context of this research, ivy's interaction with mortar is not static but evolves dynamically, modifying material properties over time.

Furthermore, the research on dynamic architecture proposes a shift from static material configurations to adaptive and performative structures (Hensel, M., Menges, A., & Weinstock, M. 2006). Instead of defining a fixed spatial condition, the study establishes a dynamically functioning space, responding to environmental forces and biological growth. This perspective aligns with contemporary discussions in responsive architecture, bio-integrated design, and ecological material strategies (Pfeifer, J. 2006).

By employing a computational framework that visualizes organic behavior and informs performative design strategies, this study provides insights into material resilience, bio-responsive design, and ecological interdependencies in the built environment. The findings contribute to the discourse on regenerative design, responsive architecture, and sustainable material applications. Future research will further refine the computational model by integrating high-resolution material analysis and experimental validation of simulated processes.

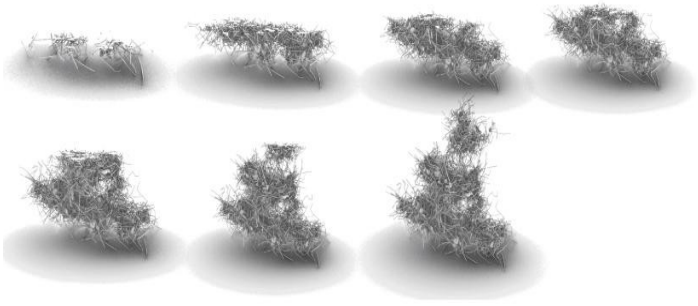


Figure 2. Flow Model Sequences (Image credits: Ataberk Kahraman).

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