Artificial Life inspired Architecture: a sustainable and adaptive treehouses ecosystem in the Chilean forest

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A project is presented in which ideas from Artificial Life are used to inform Architecture. The case study is the design of an ecotourism treehouses complex in the Chilean forest. The region of interest is located in the south-central Chile (Villarica, Araucania Region), characterized by natural landscapes (native forests, lakes, volcanoes). The forest represents the main entity to deal with in our design process, and an important source of inspiration: a living macro-organism hosting many individual ecosystems (most notably, trees). Accordingly, we view our treehouses complex as an organism of self-sufficient but networked cells: the housing units. The whole complex lives in a symbiotic interaction with the forest. Each unit is self-sufficient, but connected with others in order to share resources (water, energy) harvested from the environment, forming a macro-organism. Units are to be scattered in the area of interested, with an equilibrium between dispersion and aggregation. To devise their spatial distribution, the use of Cellular Automata (CA) is being investigated. CA are being evolved so that the final, emergent, planning accommodates different requirements. As biological cells, units are considered living and adaptive organisms. They depend on the forest for energy supply, shelter and structural support. The design process of the houses is performed within physical simulations, and is based on evolutionary and developmental processes. Each cell is born as a plastic entity, positioned at a predefined location. It then grows according to a developmental process guided by environmental stimuli, the parameters of which are devised by evolution. The living unit will try to reach out the open sky, finding its way amid the tree branches in order to maximize incoming sunlight and water, while establishing connections with nearby entities in order to exchange resources. A support structure will develop similarly to the cytoskeleton of living cells, exploiting trees as external structural support. Appendages withstanding mechanical load will be kept and strengthened, while others will be removed. Housing units will be made of sustainable materials: wood coming from the forest itself represents an optimal choice (no transport costs and pollution). The addition of other biodegradable materials is being considered as well, such as textiles (covering) and cellulose (insulation). Each unit is thus temporary and biodegradable. Digital fabrication methodologies will be put in place in order to build them on site (CNC machines, robotic arms). The living houses will maintain their adaptivity even once deployed in the actual environment, during their lifetime. Some parts of the houses will be able to move and adapt to stimuli in order to maximize efficiency and improve self-sustainability. They will orient towards sunlight, maximize the amount of collected water, adapt their shape to minimize wind resistance, and react to actions and habits of the visitors by adjusting both the interiors and the exteriors. The control required by these adaptive mechanisms will exploit the house itself as a computational resource (morphological computation). All this will bring integration and sustainability to unprecedented levels, with this living architectural complex representing an additional attraction for the visitors.