# AGENT-BASED MODEL FOR THE DEVELOPMENT OF INTEGRATIVE DESIGN TOOLS

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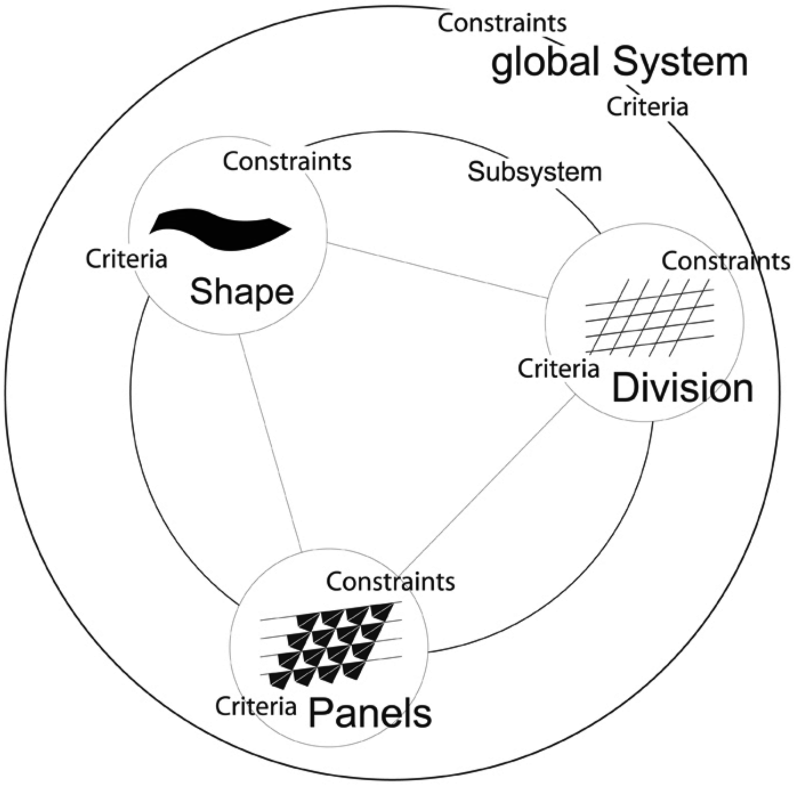



1 Integrative Design Process

Through the implication of a continuously growing number of participants in the building process, the need for an integrative design approach regarding input from all participating parties arises when confronted with an architectural design task. Through an integrative design approach, a growing capacity of adaptability may be reached, allowing the design process to constantly change and react to the information received.

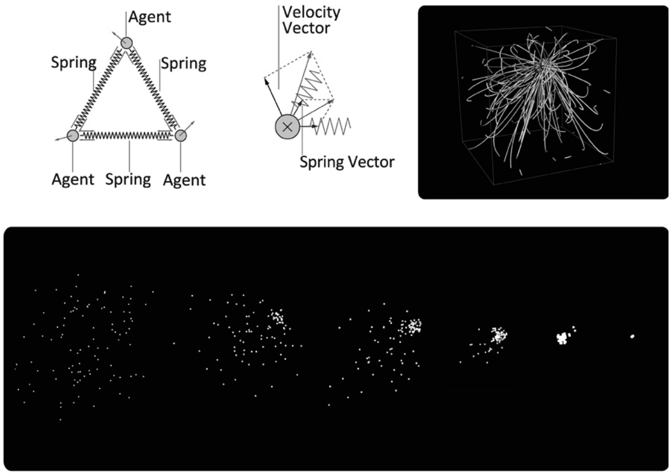
The presented research proposes a design method situated in between a top-down and a bottom-up process, described here as an integrative design method (Figure 1). A tool was developed to generate a roof-like, freeform grid shell structure that would constantly react and improve according to the defined requirements. Based on natural principles such as self-organization, an agent-based model was developed and fed with all input information thus being able to constantly adapt to required changes.

The chosen example represents a freeform structure composed of triangular elements, each composed of three agents. Through reciprocal attraction forces the agents auto-arrange and are joined to each other in order to create a smooth surface that connects to the support locations. Since the task is intended to be an example showing the interconnectivity of different systems and subsystems, the roof-like structure is dissolved into different hierarchically unequal subsystems: the global geometry, the panelling type and the covering panel. These three subsystems are constantly fed with information from the other subsystems or from independent systems and are reacting in order to achieve a smooth, efficient covering structure.

The triangular element composed of three point agents is the basis for the agent-based model and constitutes the entity receiving and processing the input information and translating it into behavioural rules. Two different sets of rules are defined through the process, one including the internal systems' requirements, and one consisting of external adaption criteria like lighting conditions or static optimization.

Based on the Boids swarm algorithm[1] all agents receive a moving direction and velocity defined by a vector that represents the change of state from one time frame to the next. In order to create triangular meta-agents, three agents are always connected to each other through spring-like elements (Figure 2).

The global swarm behaviour develops once the triangular meta-agents communicate and act according to their neighbouring agents. Two of the basic Boids algorithm behavioural rules,[1] attraction and repulsion, were transposed to the presented example and completed by a set of rules concerning connectivity between meta agents and boundary or support location behaviour. The second set of rules intends an optimization toward a number of criteria previously defined. In the presented example three adaption criteria were chosen, each based on one of the subsystems representing the global system. An adaption to lighting conditions applied for global shape, panelling and shading elements is achieved through the orientation of the agents. Other optimization methods include a geometric structural optimisation implemented through the increase of the surface's double curvature and a statical optimization achieved through the analysis of its structural behaviour.




2 Triangular Meta-Agent— agents are connected through springs in order to create a triangular meta-agent

## ENDNOTES

1. See Craig W. Reynolds, 1997, "Boids Algorithm Bevhaviour," in "Steering Behaviors For Autonomous Characters".

## WORKS CITED

Reynolds, Craig W. 1999. Steering Behaviors For Autonomous Characters in Proceedings of Game Developers Conference 1999 held in San Jose, California. Miller Freeman Game Group, San Francisco, California. Pages 763-782.

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