Open Columns: A Carbon Dioxide (CO2) Responsive Architecture

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Abstract
This paper describes the use of composite urethane elastomers for constructing responsive structures at an architectural scale. It explains the underlying material research and design criteria for constructing deployable columns that are responsive to carbon dioxide (CO2) emissions and are used to reconfigure and pattern the space of inhabitation.

Keywords
Responsive environments, interactive architecture.

ACM Classification Keywords
H5.m. Information interfaces and presentation: Miscellaneous.

General Terms
Design, Experimentation, Human Factors.

Introduction
The use of columns as not only structural but spatial devices is arguably as old as architecture itself. But perhaps it is most significantly in the work LeCorbusier [1] and Mies van der Rohe [2] that the column becomes preeminently a spatial organizer. Open Columns takes this one step further and makes the column exclusively a spatial device with no structural

figure 1. Two fabricated columns that can adapt relative to the change in carbon dioxide in the space.

responsibilities. In the installation, the columns reside collapsed within the ceiling of a space. They are made from composite urethane elastomers (figure 1) and can be deployed in a variety of patterns to reconfigure the space beneath them (figure 2). These patterns create gradations of enclosure, either in plan through the columns' full deployment, in section through their partial unfurling or through a combination of the two. These reconfigurations change the way the space is perceived and inhabited. At its most trivial, the columns can be preprogrammed to deploy themselves in prescribed configurations. This can be effective for re-proportioning a large space into smaller spaces or reorganizing the circulation of people through it.

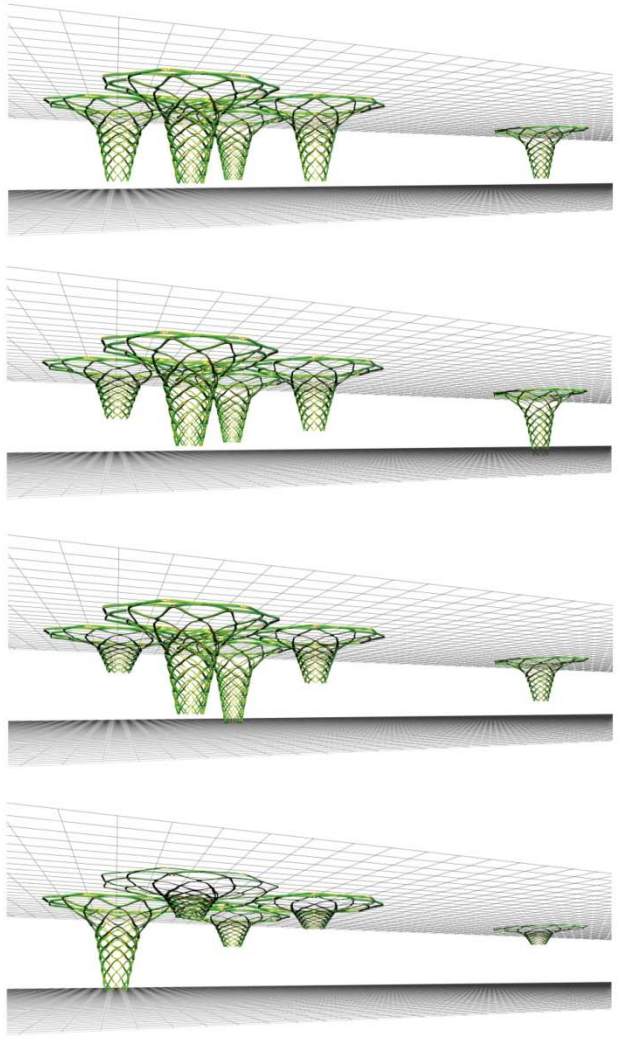

figure 2. Two fabricated columns that can adapt

A more complex program ties the columns to real time sensing such that they can respond to inhabitants' perturbations in space. A simple set of rules respond to data coming from a carbon dioxide (CO2) sensor. In a reasonably enclosed environment CO2 values can radically change with the inclusion of people. The columns are programmed to come down when CO2 levels are going up resulting in people dispersing into smaller groups. If the CO2 levels are going down the columns respond by going up and effectively inviting people into the space. If however the CO2 value stays static the columns cycle through a random set of configurations to elicit the CO2 either goes up or down. This action attempts is to create continual fluctuation in the space. If a particular configuration causes a change in CO2 (either going or coming down), it is put into the system's memory and reused the next time another static situation is encountered. However, if the next time round the stored configuration does not yield the necessary response then it is lowered in rank and purged if on subsequent uses it does not perform. In this way the columns learn about their space based on their own actions within it. This creates a teleonomic environment, one that acts on particular goals but has no determinate goal to which it is driven.

Fabrication

The columns, constructed with composite urethane elastomers, are assembled from smaller pieces that are fabricated from a single reconfigurable mold (RCM-J). The mold allows for a mixing of rubbers with different Shore hardness which can give varying elastic performances to the same sized object simply by altering its hard to soft rubber composition. The RCM-J positions and repositions 18 aluminum rods to consecutively produce different cavities for hard (80 Shore) followed by soft (40 Shore) rubber pours (figure 3). The two rubbers fuse to make a single component that when combined with other similar types produces the complex columnar structures of Open Columns.

figure 3. The reconfigurable mold J (RCM-J) that fabricates all the parts that make up Open Columns

Modeling

In order to test different programs for the columns a model was built that imagines an array of columns that can spatially change over different duration. It is scaled at 1"= 1'-0" and forcasts a pervasive distribution that would be the basis for an adaptable architecture. The project was conceptually inspired by Ashby's legendary cybernetic machine, The Homeostat [3], and Pask's interactive environment, the Colloquy of Mobiles[4]. Like the former, it is a demonstrative model of an idea, in this case a means to study an evolving

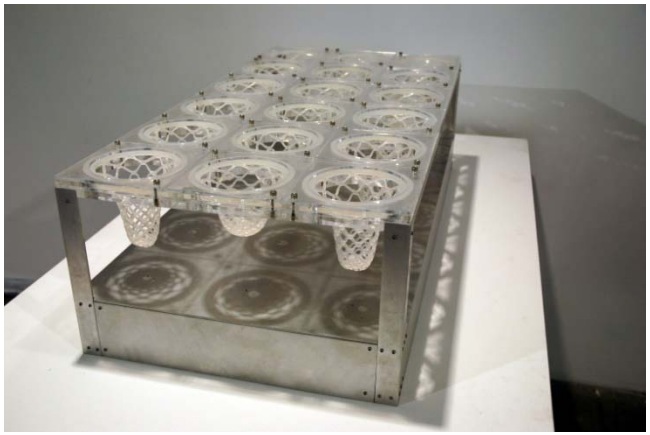

figure 4. The Open Columns Homeostat built to study programs for the columns to perform.

environment based on different heuristics. Like the latter, it imagines a space of interaction between people and their environment where the architecture has subjectivity and can adapt to changing condition.

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