Ephemeral Sandscapes: Using Robotics to Generate Temporal Landscapes

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ABSTRACT

Using commercially available parts, Ephemeral Sandscaper produces complex layered landscapes by semi-randomly selecting predefined elements and sculpting them onto a material field with compelling implications for Soft Architecture.

CCS CONCEPTS

• **General and reference** → **Design**; *Empirical studies*; *Experimentation*; • **Computing methodologies** → Simulation tools; • **Applied computing** → Computer-aided design;

KEYWORDS

Soft Architecture, Ephemeral, Robotic Art, Sand, Pattern Generation

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1 BACKGROUND: SOFT ARCHITECTURE

Neeraj Bhatia describes a 'Soft Architecture' - wherein the built environment creates a framework for users to define their own utilization of the space [Bhatia 2013]. Bhatia gives the example of a Piazza: the built portion consists only of a defined and accessible space, but inside occupants are free to rearrange and partition the space as they see fit, erecting stalls, cafes, protests, celebrations, and so on.

Bhatia further illustrates the meaning of soft architecture with the urban planning behind the Burning Man festival. At Burning Man, thousands of people gather to a Nevada desert to celebrate community, art, and cooperation. Initially, in the spirit of self-determination, attendees were free to arrange themselves on the field in any manner. This complete freedom invariably led to chaos and disagreements.

In future iterations of the festival, a simple radial pattern of markings was used to delineate the ground surface, indicating acceptable building locations and the paths that join them [Rawlinson 2017]. Within a building location, a user is entirely free to set up as they choose, but the framework allows for enough organization to avoid conflict and confusion: soft architecture at its most pure.

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Figure 1: An aerial view of the Burning Man festival

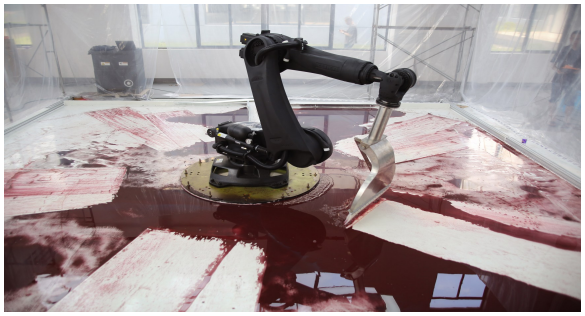

Figure 2: The Can't Help Myself Installation

On a smaller scale, architect Sergio Lopez-Pineiro shaped the fallen snow in a park in Buffalo, New York, to create dynamic public spaces [Lopex-Pineiro 2011]. Lopez-Pineiro intended to capitalize on what is traditionally a nuisance - snowfall - and use it to create a soft architecture. The spaces change both with user intervention (shaping the piled snow) and with time (melting) creating an ephemeral public space.

2 BACKGROUND: MACHINES AND THE EPHEMERAL

Thus far, the intersection of ephemerality and robotics has tended to be relegated to the realm of art. Autonomous robotics, using a set of responsive predetermined behaviors, combined with some form of flexible media, produce unpredictable results.

Can't Help Myself, an installation by Sun Yuan and Peng Yu, consists of an industrial robotic arm connected to a mechanical

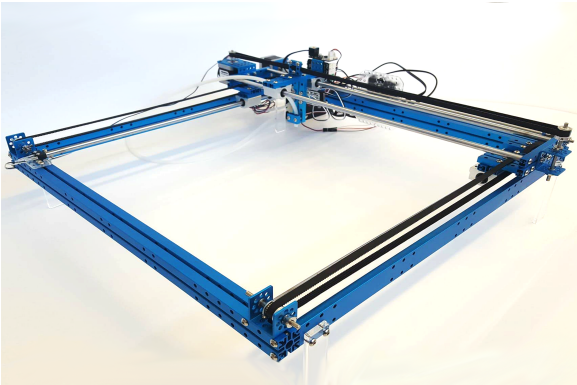

Figure 3: The Ephemeral Sandscaper

scraper [Yuan and Yu 2016]. In the center of the space is a puddle of red liquid which continuously flows outward. Using a suite of sensors, the robot frantically attempts to scrape the liquid back towards the center as it continues to escape outwards. This creates a Sisyphean symphony of machine effort - constantly fighting the inevitable and never making progress forward or backward.

Pablo Odysseus, a land art robot by a French engineer 'Ulysse,' uses GPS data to semi-randomly inscribe lines upon a beach [Ulysse 2014]. Described as 'Autonomous Land Art' the robot's pattern of markings creates ephemeral spaces and paths on the surface of the sand, which are slowly eroded away by wind and water.

3 THE EPHEMERAL SANDSCAPER

Ephemeral Sandscaper is built around an XY axis frame originally intended for plotting. In place of pen control, a small pump is used to drip water in patterns along the defined paths. The stepper motors used for the XY axis, the pump used for effective Z, and the switches used for position management are controlled by an Arduino.

To interface with the machine and input parameters for the pattern generation a Grasshopper script running through Rhino is used. The script takes in variables such as maximum depth, point density, and target surface size. The rough 'real depth' is a function of the point density, which is in turn interpreted by the machine by approximating duration of pumping and predicted depth.

The Arduino receives the G-code and parses the coordinates and movements into durations of motor and pump activations. The robot works its way across the surface of sand, spraying water and generating - based on the duration of pumping, as determined in the cyclical scripting process - small and large sculptural movements, creating complex organic patterns in the sand.

4 COMPLEX VOLUMETRIC PATTERNS

As the robot runs, the surface exhibits intricate spatial qualities. Sustained water impact sites create deep craters which ripple outward from the central point. In areas of long duration, the water stream hits the bottom of the container, spreading rapidly outwards and creating a wide, shallow depression. Shorter drip locations create smaller surface effects. The very light, rapid drips create a scale pattern over top the deeper impact craters.

Figure 4: An emergent sand pattern

Both cases, long and short stream durations, exhibit highly complex layering behavior. Due to the apparatus only dispensing a single steam of water at a time (reflecting a single point,) the robot must travel across the surface to mark each point separately - tying the result inherently to time. Each successive impact is altered by every impact that came before, and will be altered by each point that follows, creating a field of layers.

5 DECAY AND TEMPORALITY

Even after the robot is removed, the sculpted sand surface continues to evolve, now in response to environmental and mortal factors. Due in part to the moisture content of the sand - remaining from the water based sculpting methodology - the sculpted forms continue to hold complex volumes. Over time, as the humidity changes and the sand begins to dry out, the forms become increasingly frail.

At this point, disturbances start the process of sending the sand crumbling back into a simple planar form - the condition most at rest. Environmental factors, such wind or natural shaking, cause gentle but continuous decay in the volumes. Mortal factors, such as human or animal interaction, affect the sand in more dramatic ways, causing significant decay while creating new forms by way of the impressions they leave.

The simple acts of shaking the container of the sandscape, watching the water evaporate and the sand grow increasingly frail, the breeze wiping away the smallest details, or running your fingers across the sand forms and seeing the impressions left behind create a compelling, almost meditative interaction, heightening awareness of one's temporal position.

REFERENCES

Neeraj Bhatia. 2013. Resilient Infrastructures. *Bracket* 2 (2013), 216–224.

Sergio Lopex-Pineiro. 2011. OlmstedâĂŹs Blank Snow. Retrieved June, 2018 from http://www.holesofmatter.com/olmsted/

Duncan Rawlinson. 2017. Pablo Odysseus. Retrieved June, 2018 from https://www.eeweb.com/featured-projects/pablo-odysseus-autonomous-land-art-robot

Ulysse. 2014. Aerial View Burning Man 2014. Retrieved June, 2018 from https://www.flickr.com/photos/thelastminute/15106090680/

Sun Yuan and Peng Yu. 2016. Can't Help Myself. Retrieved June, 2018 from https://www.guggenheim.org/artwork/34812