POLITECNICO
DI TORINO

Honors thesis

MASTER'S DEGREE IN ARCHITECTURE FOR THE SUSTAINABILITY DESIGN

Abstract

MAKERS IN ARCHITECTURE
Fabrication experiments of a Responsive Surface

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KEYWORDS

MAKERS' REVOLUTION, DIGITAL ARCHITECTURE, INTERACTIVE ARCHITECTURE, OPEN SOURCE, COMPUTATIONAL DESIGN, RESPONSIVE ARCHITECTURE, PHYSICAL COMPUTING, ARDUINO, GRASSHOPPER, RESPONSIVE SURFACE, BIO_LOGIC SKIN.

Over the last decade architecture has seen **two guidelines** become the main protagonist of our time.

On the one hand, the **growing development of Information technologies** led every discipline: the growth of ICT (*Information and Communications Technology*) platforms and web radically transformed our way of living, working and communicating. For instance, thanks to the use of the web, sharing projects and ideas have become more common and easy. On the other hand, the increasing **awareness of planet conservation problems** and the sustainable philosophy led to a re-approach to nature and to a development of awareness-raising.

Architecture has exponentially moved its interest to the digital world incrementing research.

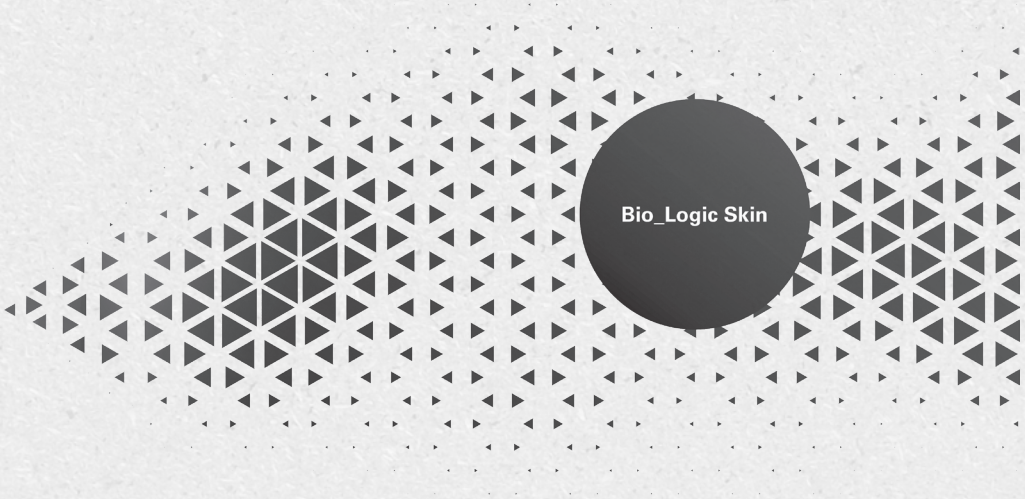
Joining these two features it's possible to define one of the main technological researches in ***smart architecture***: the ability to exploit external environment information in order to reach an architecture that reacts optimally to the conditions in which it's located, ensuring greater efficiency and comfort.

This paper explores a "*way of making architecture*" based on innovative tools provided by information technology and open source philosophy (such as *Digital Fabrication* and *Physical Computing*) in a world strongly linked to the Makers' ideology, whose implications seem to concern the whole social and economic model.

Cultural background shows along discussion flows into designing and prototyping an intelligent technology component, a ***Responsive Surface*** that, like a living organism, is able to react to surrounding environment pulses.

Project description: Bio_Logic Skin

Project was born as multidisciplinary experimentation between architecture, computer science and biomimetics. Through observation of nature and translation of its adaptation mechanisms in the design process and exploiting potentiality offered by computer science and digital media, the intention is to conceive and develop a concept of useful and efficient architectural design.



The *Responsive surface* designed is called **BioLogic Skin**, highlighting the (bio) logic of component, whose behavior is undoubtedly derived from natural world.
It's an interactive, adaptable element capable of constantly changing shape in *real-time* based on a system of feedback received and processed internally. In this context, adaptivity is understood as system intelligence.
Component is also adaptive to geometric shape of surface on which it's placed due to its parametric nature. By changing conformation of building, modular system is automatically reconfigured on the new targeted surface. Geometry control is indeed entrusted to *Grasshopper* (an open source visual scripting software), which is capable of developes generative architectures using algorithms.
Whole project is designed to be able to perform multiple functions in different scenarios of use, mainly due to **interchangeability of its sensors** (brightness, heat, humidity, rain, etc.)[1].
Nevertheless, study has provided for in-depth analysis of component use as **interactive solar shield**. This case study converged into a definition of a specific algorithm capable of managing components according to **solar cycle** in location set up and providing shading and daylight factor analysis.

PULSE ADAPTATION

Responsive surface is adaptable to stimuli received by sensors

SURFACE ADAPTATION

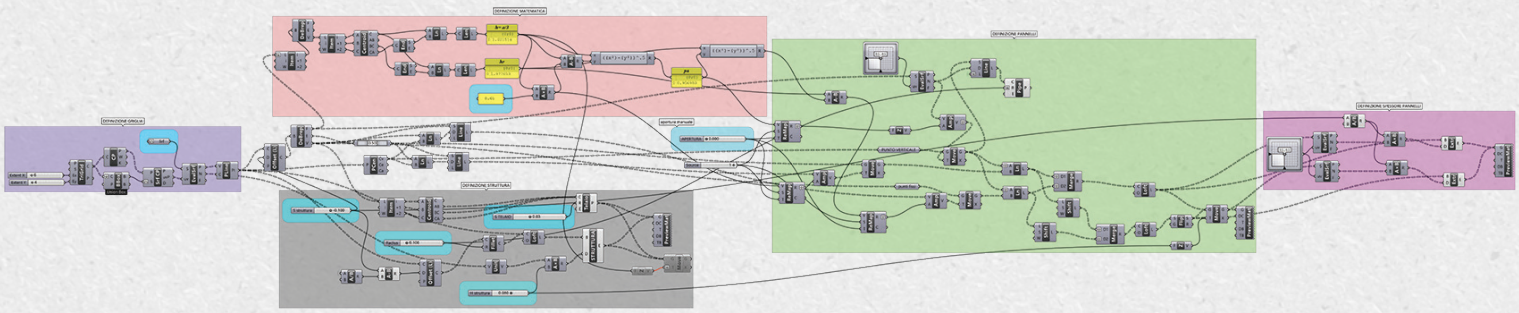
Responsive surface is adaptable to surface on which it's applied

USE ADAPTATION

Responsive surface is adaptable to several uses

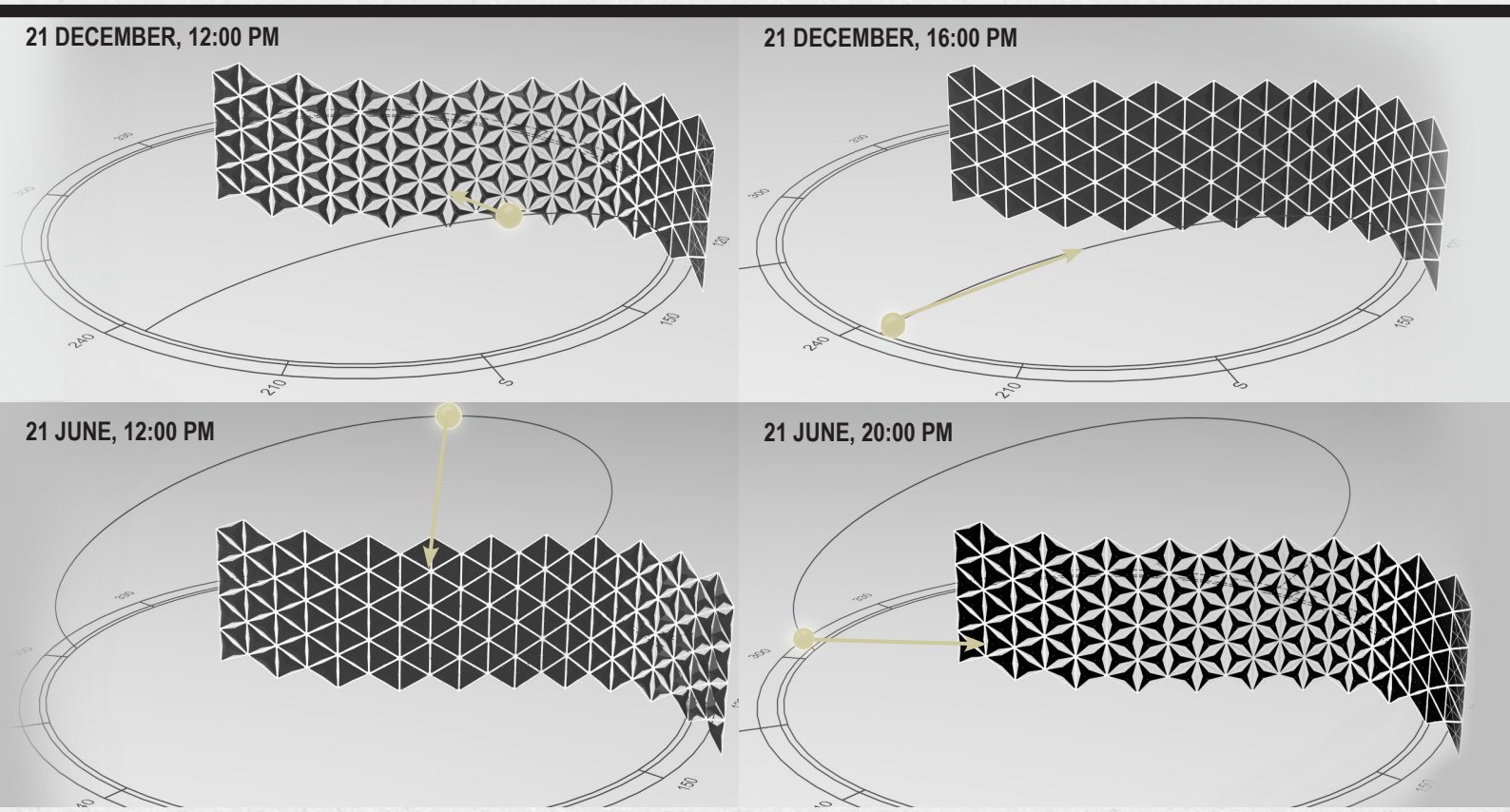
ENVIRONMENT ADAPTATION

In case of responsiveness to climatic conditions, responsive surface is easily programmable in each geographic location.



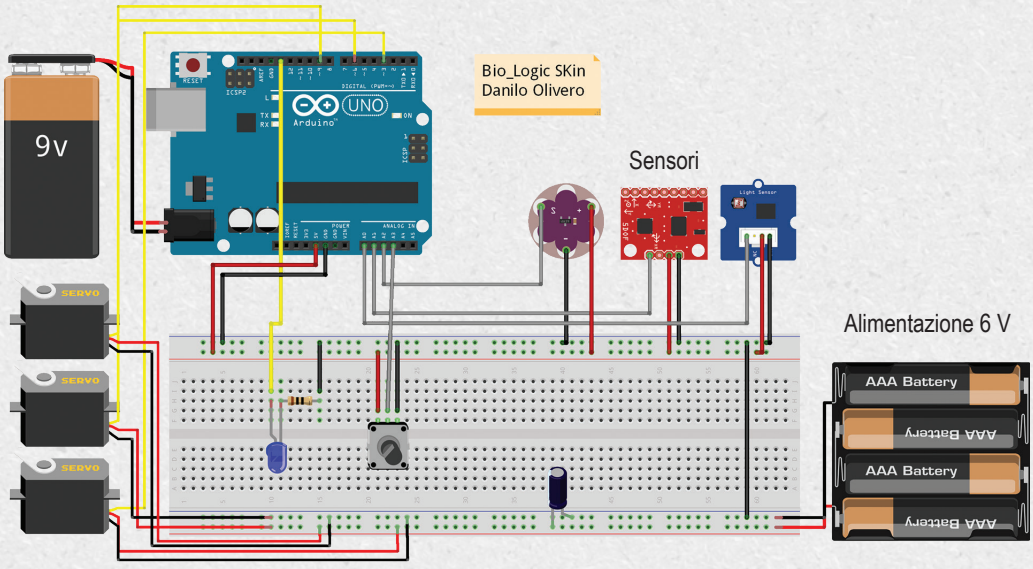
Generative Algorithm designing BLS geometries (Bio_Logic Skin). Software development: Grasshopper / Rhinoceros.

1 See page 4



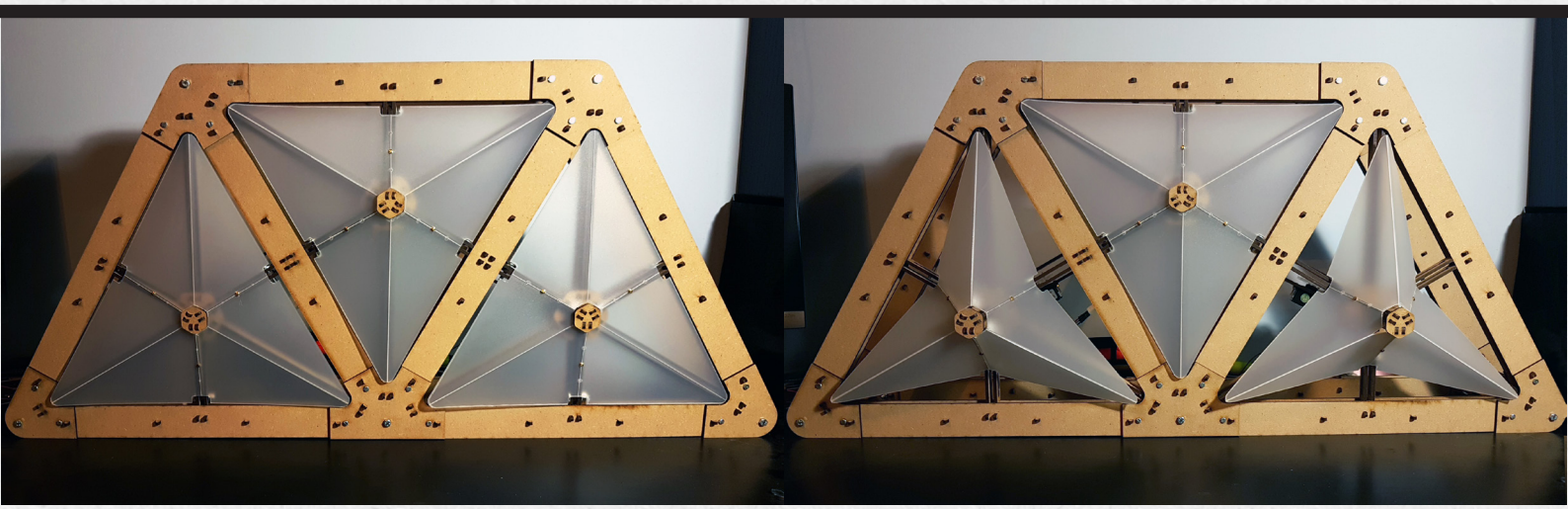
Shielding behavior in accordance with solar cycle in summer and winter conditions. Both system functional logic based on solar cycle and real-time behavior provide (for Turin area) shielding in summer and encouraging free solar inputs in winter.

Showing design functionality of developed system, the last phase of work involved the realization of a prototype through digital fabrication and physical computing tools: prototype has been equipped with an artificial "**nervous system**" able to make the component interactive in real time. By relying on *Arduino*, the open source programmable electronic board core of Makers' community, it is possible to read information from external environment and re-elaborate output reaction into the component.



Hardware circuit diagram designed to make interactive the prototype.

Some application of Bio_Logic Skin. From top to bottom: Solar shield, Water-responsive roof, Heat-responsive covering.



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