

Transparent Organ©: Designing Luminaire Art Deco with Kinetic Interaction

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Abstract. This paper purposed a novel concept for futuristic interactive product design, combined the emerging techniques of the digital design and fabrication, interactive kinetic structural system, and ambient display to form a hybrid luminaire art deco. This installation - Transparent Organ developing a specific characteristic of sensitive kinetic interaction in a computer augmented physical kinetic object producing ambient atmosphere in a space. It used digital fabrication with parametric design tools for construct transparent shape plays as a light conduction. The interactive system combined of capacitive touch sensor, dimming control, and motor controller for kinetic sculpture with adaptive algorithm. Furthermore, this precedent has demonstrated alternative aesthetics with functional applications in further interactive product design.

Keywords: Computer-aided design (CAD) · Kinetic sculpture · Interactive design · New media art

1 Introduction

Computer graphics and interactive techniques have changes the morphology of beauty in broad scales of design. CAD/CAM (Computer-Aided Design/Computer Aided Manufacturing) tools enable designer to break traditional limitation in making form freely [1], combining materials characteristics in fabricating processes making form complexity [2]. HCI (Human-Computer Interaction) techniques bring the possibilities for creating things with intelligent, communication, interaction, flexibility, and adaptability [3–5], not only augmented object with advanced features but also changes the definition of physical object in design. The futuristic interactive product emerges as the functional aesthetics object, embedded with smart application and displaying as a deco art in our living space.

Biological systems can be characterized as entities that “compute” material organization according to external performance criteria [6]. Biologically inspired computing consists with natural mechanism, generating organic form and making adaptive behavior on interaction, creating novel value in aesthetics representation. This paper presents our vision of futuristic product, which using natural mechanism to build novel morphology of beauty in design. The present work “Transparent Organ” is an interactive luminaire utilized by CAD/CAM and HCI techniques. According to the most

natural “forms” growth by the basic rules of symmetry and recursion. It used self-reorganized and synergy as main mechanisms for producing the “behaviours” with adaptation. This project demonstrates a novel approach to merge techniques for fabricating artificial nature, through the algorithm studies and simulating in “forms” and “behaviours” (Fig. 1).

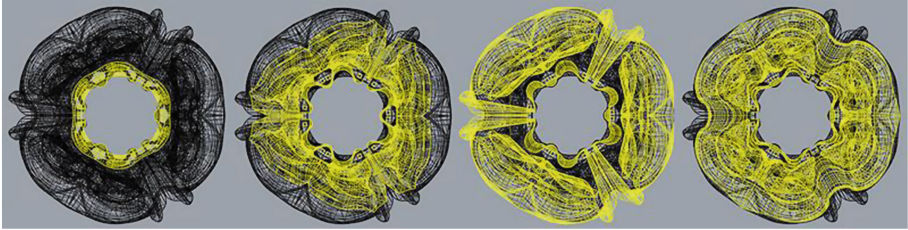


Fig. 1. Transparent Organ is inspired from the morphology of natural organism, and the visual representation from the Magnetic Resonance Imaging (MRI) sequences, shows the alternative aesthetics by diverse forms and functional organs.

2 Related Work

Emerging techniques bring novel design methods for create hybrid applications in design especially in architectural scale object. In terms of make forming, CAD/CAM tools provide designer to build alternative forms by inventing specific fabrication and design processes. Silk Pavilion [7] explores the relationship between digital and biological fibre-based fabrication on an architectural scale installation, discovering the silkworm’s spinning behaviour, material and structural characterisation, computational simulation and fabrication strategy devised for the full-scale construction. Aerial robotic construction [8] offers a new approach to architecture using flying machines, investigates the design potential and material relationship between architecture and construction.

In terms of making functional kinetic application with interactive techniques, Bubbles [9] demonstrated that interactive installation could be aware of a visitor coming and react with a spatially pneumatic form by deforming and performing dynamical behavior generated by real time calculations. The rolling bridge [10] presents a transformable structural design, which may opens smoothly, curling from a straight bridge into a circular sculpture, which uses a series of hydraulic cylinders integrated into its eight segments, causing its rolling character. The expanding video screen [11] demonstrates a giant screen that can change its size and shape, morph into a 7-story high cone-shaped structure, enveloping the band as it extends in the U2’s concert. The actuated tensegrity structure [12] demonstrated a vision of building adaptability, which could change the shape of building’s envelope in response to outside/inside sensors in the structure. These works bring a rich dynamic representation in both functional and aesthetics features.

Both kinetic function and dynamical forming merged together provide alternative applications in design. Hylozoic Soil [13] is an immersive, interactive environment made of tens of thousands of lightweight digitally-fabricated components fitted with meshed microprocessors and sensors. It contains infrared proximity sensors, micro-controllers, strands of titanium nickel memory wire, and custom circuit boards to perform mutual interactions between viewers and the kinetic object. The Muscle Tower [14] is an interactive & kinetic installation reacts to its environment, it consists of aluminium tubes, connected to each other and the FESTO-Muscles by iron joint. The FESTO-Muscles are controlled by a VirTools Script, which is connected to motion sensors. Outerspace [15] appears as a playful, curious creature exploring the surrounding space, looking for light, motion, and touch contact, and dynamical react with the posture changes in real-time adaptation. These works provide multiple approaches to utilize emerging techniques, discovering novel functional and aesthetics applications, to encourage recently boundary in design.

3 Digital Design and Fabrication

This work inspired from the morphology of natural organism, and the visual representation from the Magnetic Resonance Imaging (MRI) sequences, shows the alternative aesthetics by diverse forms and functional organs, emphasis novel design philosophy in functional aesthetics. In terms of design, we using generative algorithms Grasshopper, a graphical algorithm editor tightly integrated with Rhino's 3-D modeling tools to build form generators from the set of object relationship. The form is developing based on 3 rotational and reflection symmetry to generate, through the freely curve drawing and the setting with parametric adjusting and computing, the 3 rotational and reflection organic forms was build in virtual flexibility. In terms of manufacturing, in order to design the form as a light conduction for producing atmosphere in a space, this work used the layers of acrylic slice to fabricate the specific form with multiple sections in manufacturing apply. We used Grasshopper to setting up and generate the multiple sections drawing and then translating the files into laser cutting machine for manufacturing. Through the assembling of lots of numbered acrylic slices, the transparent form consists of layered light conduction patterns have been appearing (Figs. 2 and 3).

4 Interactive Kinetic Structural System

The interactive system designed on "Transparent Organ," used interactive techniques to developing kinetic sculpture with artificial behaviors as an embedded computing system. It used metaphor of "Phototropism" to build the algorithm for whisker-like object, using actuators to control the wire's tension and compression for effecting physically transform on flexible structure design (see as in Fig. 4). Viewers may used touch evoke the light sources, immediately guide the bending directions facing to the light in a soothing way. The Phototropism metaphor is meant to simulate the natural phototropism of plants and create the kinetic structural system of the interaction between the kinetic art form and humans. The build biologic mechanism is aimed to

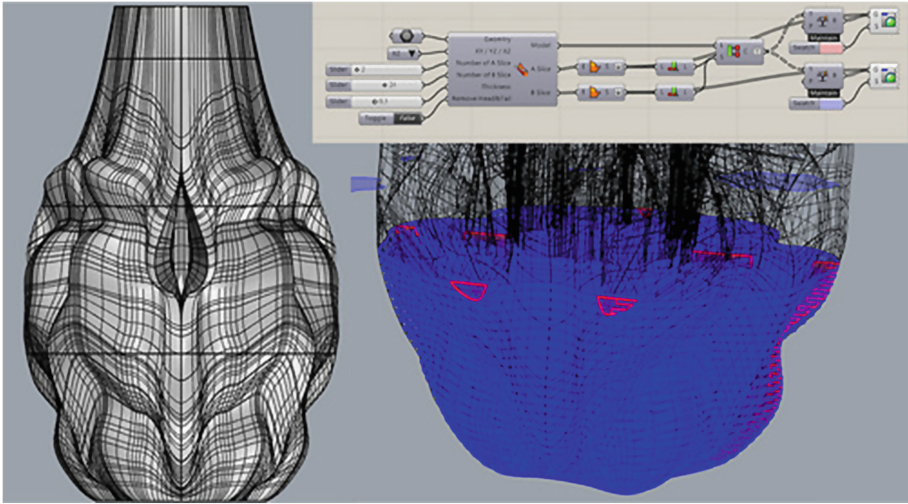


Fig. 2. This work using generative algorithms Grasshopper to build form generators from the set of object relationship, developing forms with three rotational and reflection symmetry.

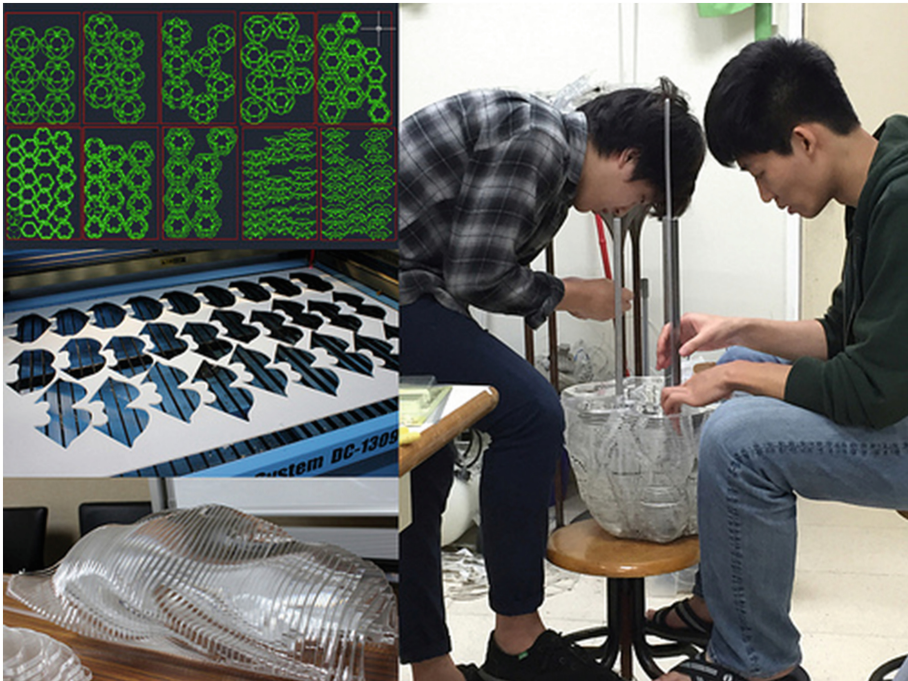


Fig. 3. The work used script to generate the sections drawing into laser cutting machine for manufacturing, and then assembling of lots of numbered acrylic slices in to an organic form.

evoke the reflection to lead a wise life in the trend filled with high technologies and find the sentimental temperature probably lost in the recent smart application in mundane world.

Users can immediately evoke the light sources of different directions on the work at any given moment to indirectly guide the bending directions of the whisker-like sculptural objects to interact with. The interactive kinetic structural system merges kinetic sculpture and lighting control mechanism for new kind of luminaire art deco, which provides a kinetic interaction mode according to variable-lights.

The detail of kinetic structure, is made by a frame of whisker form is fixed on a base, majority of disk are interval fixed on the frame along one axis direction of the frame, majority of driver are arranged in the base, at least one wire is driven by each one of the driver so as to restrict the frame flexible, majority of light sensor are arranged in the base, the each one of light sensor is electrical connected to the driver, those light sensors can sensing the ambient light intensity, so as to command the drives to pull or release the wire, then enable to drive the frame flexible.

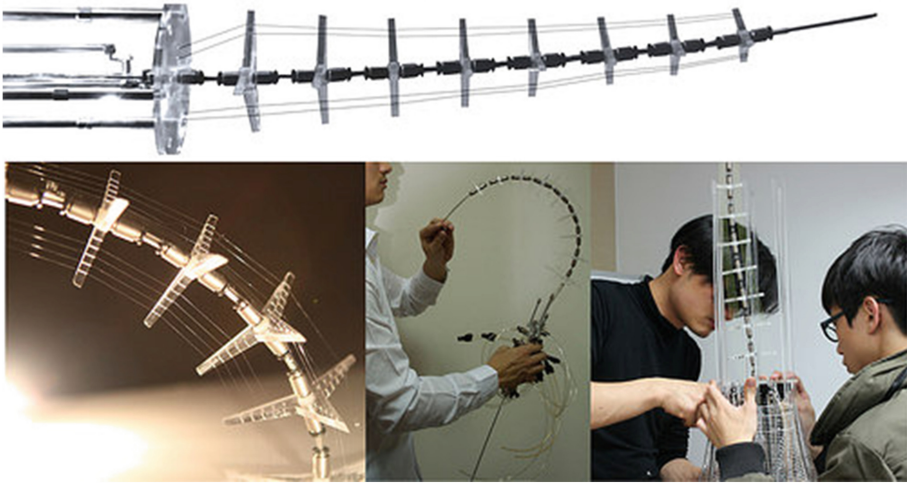


Fig. 4. The interactive kinetic structural system used metaphor of Phototropism building algorithm for whisker-like object interact by using actuators to control the wire's tension and compression for effecting physically transform on flexible structure design.

5 Display as an Interactive Art

This work extends the technological installation art into the space issue, exploring the various features of the ambient display and transforming the kinetic interaction constitute with atmosphere display into a space. The presentation of this work is thus liberated, inviting user to experience the aesthetics into ambient space. Transparent Organ also integrates the kinetic architectural structure into "kinetic sculpture" development, and the service situation with alternative illumination function, encouraging user to interact with the luminaire. It thus creates an interactive relationship between the luminaire and users in the experimental performance.

In this project, the application of digital technology does not appeal to much practical function. Instead, it starts from the perspective of interactive art to search of possibilities to be attached to the furnishing elements, through which the form has been represented. It means that the application of interactive art bases on the expression of visual art and it further explores the functional interaction with participators in the space. The use of digital technology in “Transparent Organ” visualizes the phototropism metaphor mechanism to interact with users. There are three micro-sensors set up under the installation to detect users touch contact real-time. The micro-sensors stimulate the microprocessor’s computing mechanism of the dynamic assemblies, calculated by the physical computing. The materiality of the digital information represents a biologic, which allows the real-time interaction with participators. In the work, the actuator element propels the material of the cable wire, changing the elasticity coefficient of the dynamic construction and stimulating the curves. In the end, it combines living beings’ adaptive behaviors with kinetic motion and atmosphere in space to form the reaction (Fig. 5).



Fig. 5. Transparent Organ plays as a luminaire art deco, producing ambient atmosphere in a space.

6 Conclusion

In the project “Transparent Organ,” digital technology plays an important role, which is not merely the tool to assist the artwork making process but an ambient display interface to create conversation and to connect the luminaire art deco and the users. Under the definition of computing mechanism, it starts a collaborated operation among the actuators, lighting, and sensors of the kinetic artifacts, revealing the effects of strategic

kinetic interaction and the expansion of atmosphere. As for its cross-disciplinary integration, digital design and fabrication processes merged the virtual computation and physical properties together to form a workable framework for the interactive kinetic structural system, which combines the “adaptive interaction system” in the field of artificial intelligence and the “kinetic structural system” in the field of architecture technique to represent its phototropism metaphor behaviors. The adaptive interaction system augmented the luminaire with behavioral features. Through the kinetic structural system design, it demonstrates soft visual vocabulary, creating an intimate conversation with users.

Recently, the kinetic design has become an emerging trend. It adopts the developments of kinetic structures, actuators’ components, robot technology, and kinetic transformative installation to create a luminaire art deco. Through the sensors, the installation can detect the behavioral changes of the participators in the environment in order to adjust its own behavior. These techniques allow the interactive installation to collective information from the environment, to changes its form as reaction, and to create a responsive space-situation art form. In the project “Transparent Organ,” the computing mechanism and the bionic kinetic simulation create the artificial life metaphor through the substantial installation. It adopts techniques from the fields of electronics, electric machinery, and information process as well as the computing mechanisms of sensor’s cyber system to produce a kinetic technological artwork with artificial perceptivity. The work is constituted by computing components, sensing components, and the components of the kinetic transformation mechanism within the systemic relationship of the interface. The bionic kinetic behaviors are created as the response to users’ contact.

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