TITLE: Mass Customization!
An approach through Generative Design *(Paper)*

Topic: Generative Design

Author:
Aamina Karim Malik (Visiting Lecturer at two universities)
Pakistan, Pakistan Institute of fashion and Design, Department of Jewellery Design and Gemmological Sciences.
www.pifd.edu.pk
Pakistan, Beaconhouse National University, Department of School of Visual Arts and Design.
www.bnu.edu.pk

Abstract

Historically, design has been associated with unique, handmade products and utilities; however, the advent of the Industrial Revolution introduced the system of mass-production, which generated a recurrent and ambivalent problem: the lack of customized products. Generative Design redresses this issue. This new design method is based on a system of rules, which produce a design that maintains individuality and character. Generative Design takes one away from natural elements and the distinct personalities of designs and products. Forming a design out of certain algorithms and sets of rules constricts it to artificiality and separates it from the natural. Hence, Generative Design has mostly developed without paying close attention to natural processes and human interaction. Based on the research, an attempt has been made to bridge the gap between the artificial and the natural, instituting a dialogue between the two. This study has brought together the two concepts of Generative Design and mass production to produce a series of designs which can be mass-produced yet remain unique because of their connection to the natural world.

Design enables the development of thoughts by creating a pattern to follow or work towards to generate a product or an idea. Before the Industrial Revolution, design had been associated with unique, handmade products and utilities. With the advent of the Industrial Revolution and interchangeable parts, manufacturing moved from the craft era to the mass production which resulted in one recurrent shortcoming: lack of customized products.
Today there is a new era emerging called Mass Customization. Mass Customization combines the best of the craft era, when customers had products built to their specifications that typically only the elite could afford, with the best of the mass production era, in which everybody could get the same product because it was affordable. This paper highlights the development of Mass Customization and how the manufacturing industry is positioned to capitalize on it. It further provides insight into the techniques that could be developed and used to achieve Mass Customization. In addition emerging fields to achieve Mass Customization, such as Generative Design, are discussed.

Email:
aamina.malik@gmail.com

Key words: Generative Design, Mass Customization, Analogue, Digital

Main References:
[1] Jack Buffington "Comparison of mass customization and generative customization in mass markets.", Industrial Management & Data Systems, Vol. 111 (2011): 41 – 62. accessed March 11, 2014.
[2] Celestino Soddu "New Naturality: A Generative Approach to Art and Design." , Leonardo 35, no. 3 (2002): 291-294.

Mass Customization!
An approach through Generative Design

Aamina Karim Malik, MFA. B.Des. /BS (Hons)
Jewellery Design & Gemmological Sciences, Pakistan Institute of Fashion and Design, Lahore, Pakistan
www.pifd.edu.pk
E-mail: aamina.malik@gmail.com

Introduction/Background:

Historically, design has been associated with unique, handmade products and utilities; however, the advent of the Industrial Revolution introduced the system of mass-production, which generated a recurrent and ambivalent problem: the lack of customized products. Generative Design redresses this issue. This new design method is based on a system of rules, which produce a design that maintains individuality and character. Generative Design takes one away from natural elements and the distinct personalities of designs and products. Forming a design out of certain algorithms and sets of rules constricts it to artificiality and separates it from the natural. Hence, Generative Design has mostly developed without paying close attention to natural processes and human interaction. Based on the research, an attempt has been made to bridge the gap between the artificial and the natural, instituting a dialogue between the two. This study has brought together the two concepts of Generative Design and mass production to produce a series of designs which can be mass-produced yet remain unique because of their connection to the natural world.

Design enables the development of thoughts by creating a pattern to follow or work towards generating a product or an idea. Before the Industrial Revolution, design had been associated with unique, handmade products and utilities. With the advent of the Industrial Revolution and interchangeable parts, manufacturing moved from the craft era to the mass production which resulted in one recurrent shortcoming: lack of customized products.

Currently making waves, the emerging industry called Mass Customization combines the best of the craft era, where products could be tailored to specific needs usually affordable by the elite alone, with the best of the mass production era, where products became affordable. This paper highlights the growth of Mass Customization and how the manufacturing industry is positioned to capitalize on it. It further provides insight into the techniques that could be developed and used to achieve Mass Customization. In addition emerging fields to achieve Mass Customization, such as Generative Design, are discussed.

Allowing consumer choices to interfere with production at an expansive scale is achievable through Generative Design. Hence, I seek to explore this opportunity through varied experiments finally reaching **Youniform**.

Due to the newness of Generative Design, criticisms have been levelled against it. First, the design process is not fully controlled and sensed by the designer. A design that is generated through pre-programmed software would not be fully felt during its process of development by the designer.

Moreover, Generative Design has the potential to not depict any social debate or capture within it an idea for a social change. This may be the case for most of the generative art and design that has developed over time; however, it is possible that a set of instructions be premised upon social and political ideas of the designer.

Given the criticisms of Generative Design, defending it would have been a daunting task. The foremost criticism of alienation of the designer from the process could be dealt with by allowing a code to be determined with certain individual traits capable of being added within the process to end in customized products. Such a process suits the domain of Mass Customization since bulk production makes the product accessible and affordable by many whilst customization adds the necessary individual character to it. Enzo Henze, for instance, uses a set of instructions to teach his computer to draw like a human (Red Ambush (figure 1)), which results in art forms, which are distinct every time they are made.

Figure 1. Red Ambush by Enzo Henze

Individual traits could also be added to the same process as has been exemplified by the Stamp Lamp design by Gaspar Battha (figure 2), which shows the development of a product with the anatomy of the creator. The digital code develops the lamp with customization being based on the variable fingerprint input.

Figure 2. Stamp Lamp-design with unique fingerprint by Gaspar Battha

Paul Atkinson in his article *Orchestral Maneuvers in Design* highlights the paradigm shift in the design process from analogical to digital processes. He further comments that the realization in the 1960s was that a single design solution would not be able to meet the needs of a wide heterogeneous market. A designer-dominated process could not serve the needs of a smart and aware consumer. Designers should develop systems that will be used by others rather than trying to remain the sole author of their work. Atkinson is mindful of the foremost challenge here of the integrity of the design and its identity, which he suggests could be ensured by making the user perceive the intention of the original design while retaining user freedom to adapt the work to their individual goal. For instance, Joon Hang Lee of Studio Homunculus designed a computer-aided process (Haptic Intelligentsia (figure 3)) whereby users could develop their own cylinders by holding the glue gun as a 3D human printer.

Figure 3. The machine Haptic Intelligentsia with some of its results.

Additionally developing a code would provide for a platform for designers to bring forth their ideas quite literally beyond their own imagination. Thus bridging the gap between the virtual and physical object.

One contention that remains is whether natural processes could be synced with Generative Design and Markus Kayser's 3D Solar Sinter Prints on Sand is an example of this (Figure 4). With the aid of photovoltaic panels to power the electromechanical apparatus, Kayser uses a lens to concentrate sunlight from a larger Fresnel lens onto a tray of sand thereby sintering it according to the temperature which may go over 1400°C. As a result glass or ceramic objects are created with their design being determined by exposure to sunlight.

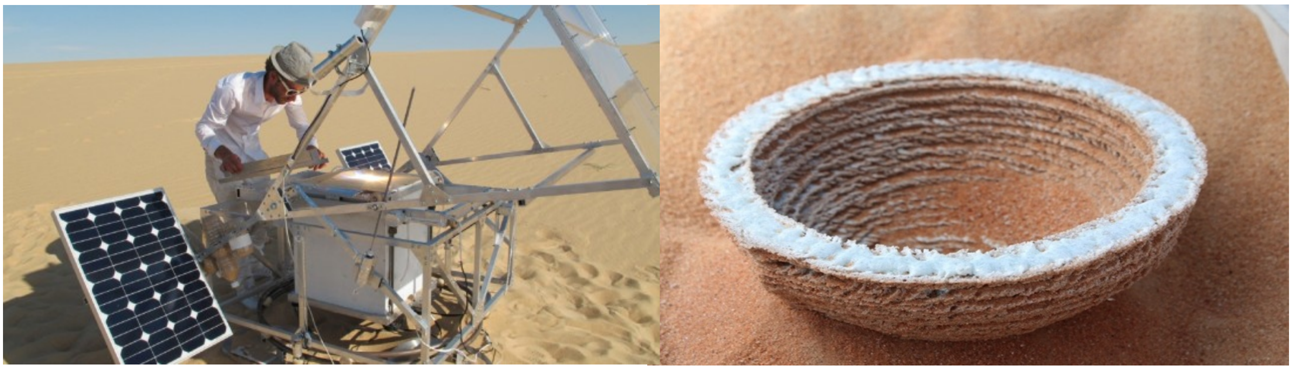

Figure 4. Markus Kayser's 3D Solar Sinter Prints on Sand.

The Investigation Process:

The investigation process to achieve my goal of Mass Customization through Generative Design involved study of uniqueness, natural processes and coding.

Uniqueness:

In order to achieve customization through Generative Design, uniqueness is to be ensured. However what is unique has to be determined along with those factors which influence uniqueness. The idea was explored with a group of five college students who were invited to participate with any metal object of their choice, which was unique and they only had to answer why was it unique. It transpired that the participants, for its emotional value, considered the most ordinary of metal objects unique. For instance to one of the subjects, a mass-produced and readily available pendant bearing verses of the Quran held great sentimental significance since it was a farewell gift from her sister wishing her good luck for her academic journey in Qatar.

The next phase involved developing further products with these unique objects. With the help of ordinary crockery, a mass-produced object, customization was achieved by placing the metal objects in unique permutations over the crockery and new objects were formed using a vacuum former. Figure 5 shows the making of a new product using a glass bowl and a Tiffany & Co.'s pendant, which are both mass-produced but the object finally made is customized.

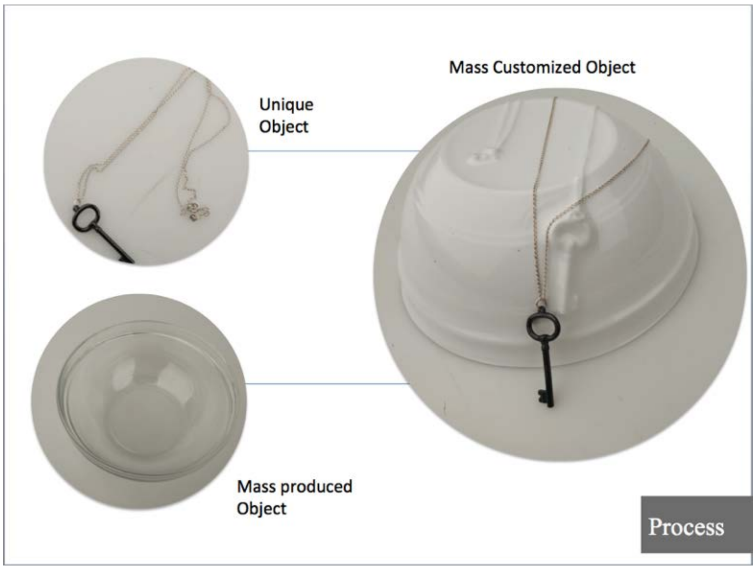

Figure 5. Diagram of the process used to create this object, and selection of the objects.

This project helped understand what unique means to people and that things are unique to people because of the value they hold for them. Also, by creating such a process for one individual, it was possible to understand that this process would mass-produce objects that are customized for each person and could be used as an example of Mass Customization as shown in Figure 6.

Figure 6. Diagram of the final outcome of this object along with the initial objects used to make the final product.

Natural Processes:

The second studio project focused on developing emergent systems from natural processes through experimentation. The objective was to understand that the mixing of two materials could generate unique designs thereby contributing to Mass Customization. Emergent systems describe the phenomena of complex behaviour from simple conditions; thus, this project seeks to answer questions about endless variations occurring in nature with one simple process: What is it that makes nature provide us with endless variations? What skills, materials and tools are required to bring endless variations through nature in this paper?

One of the natural elements used in the experiment was water because of its availability in abundance. The second element had to be such which could be used with water but it should solidify from a liquid state immediately upon coming into contact with water. Thus hot wax was poured into ice-cold water so it immediately solidified. The movement of wax was controlled by placing containers inside one another thus placing artificial process fetters on natural process of wax solidification. The end result was destined towards making of photo frames as exhibited in figure 7.

Figure 7. Diagram of the process used to create this object, and selection of the objects.

Although it was possible to control the direction of the wax, there was no control over the texture the wax ranging from a cloth-like texture to a crystalline structure. Hence, this experiment made it possible to understand the natural properties of water and what effects it can have on wax once they mix with each other under an artificial setting. This project was about the process of how chemical and physical properties of two different materials react when brought into contact. The focus is not on the final product but only the process.

Figure 8. The video making process and the final output.

Coding:

The third investigation process was that of digital coding in Generative Design to lead to Mass Customization. A digital code was hereunder designed to retrieve information from a social networking website, Twitter and make a visual display of it. This code was also used to read key phrases such as Mass Customization and mass production to determine the frequency of tweets using these words. Figure 9 depicts a visual image made by this code.

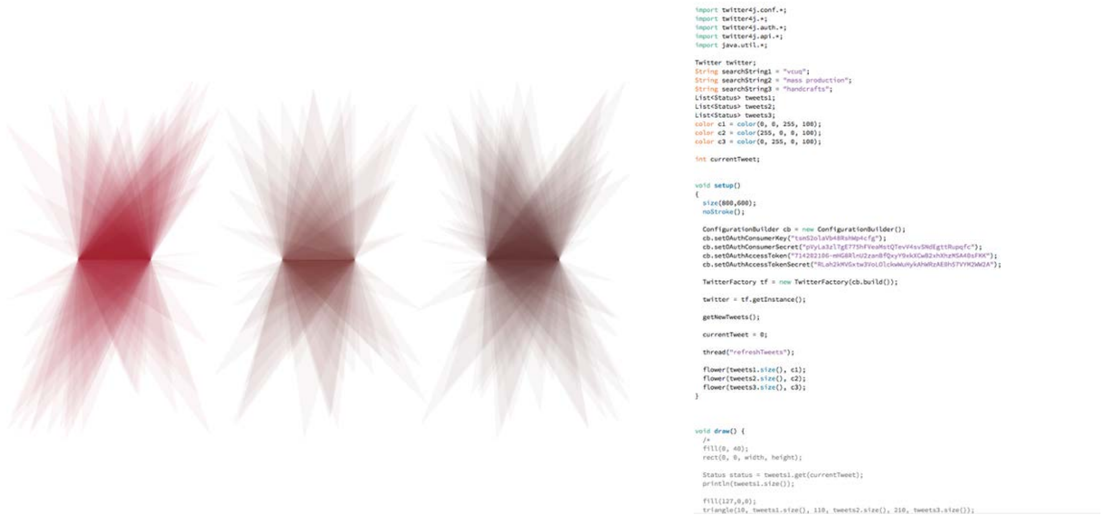

Figure 9. Code with the visual it generated.

YOUNIFORM!

As discussed earlier, people are connected to their objects emotionally; they find these objects unique. Thus a process was designed to create a product that would be unique for the user since it would bear sentimental value for them but it has to be a product of frequent use in order to create a popular and viable Mass Customized product. It could be seen that people are surrounded by a variety of products, which help them achieve different goals of their daily lives. Among other products, mobile phones have become a necessity for almost everyone to keep them connected. With an influx of smartphones, a great deal of business is carried out on a mobile phone such as managing email accounts and social networking sites. Thus mobile phones have become an archive of our digital world. From being a personal assistant to a confidante, a day planner to a gossip blog, a mobile phone does it all. Additionally it allows the user to control the privacy of his information as well. The process is designed to extract personal information and convert it into an interesting display projected over the mobile phone cover finished with a natural process of finger printing leading to a unique customized product involving a digital code and an analogue process both.

Mobile phones were chosen since they have taken the world by a storm and in a very short duration of time have witnessed an exponential growth in popularity and dynamism in design. So much so that mobile phones have the tendency to alienate the user from his surroundings as quite a distraction is created by the applications and games on the mobile. For instance in figure 10 the people standing at a train station in Bangkok are busy on their mobiles instead of talking to each other. A recent Facebook-sponsored study shows smartphone owners are often connected all day. People can be found glued to their smartphones even while crossing the street, disconnecting them with their immediate surroundings. Thus mobile phones seem to be an obvious choice for a Mass Customization experiment since the product is of most apparent value to its user.

Figure 10. People waiting for a train

This process used specific public information about the user in order to create unique designs for Mass Customized phone covers. These unique designs present users' individual personalities and elements of users' personal lives. While it may be perceived as privacy infringement, the user would have control over the display of such information as he chooses to illustrate on the phone cover.

Moreover, just the way people hold a phone tells one a lot about the user. Middle-aged people often use their mobiles in a different manner than the youth. Those who prefer texting are seen to be using mobiles differently from those who use them primary for calling. Figure 11 illustrates how a mobile phone company has used ergonomy of phones to advertise.

Figure 11. Nokia tells us that we can hold its phones any way we want.

The aim of this design solution is to make mass-produced objects highly customized to suit the personality of the users as well as trigger interesting social encounters between people. For instance, if the mobile phone covers present a travel destination or a popular song or celebrity, people around such a user might start a conversation with regard to this information. Adding interesting information to these covers can break the monotony of virgin covers. Such display of personal information on the object could allow others to see one's personality through the object.

System Overview:

Like mobile phones, mobile phone covers are mass-produced objects as well. As objects that are with us every second of every day, the covers are an ideal canvas for Mass Customization. This system contains a dialogue between analogue and digital design. Generative Design is used to produce an infinite variety of individual mobile covers based on input from the user. This design process resulted in the establishment of the brand,

Youniform (You-n-I-Form). Here one needs to focus on the brand name since it implies the relationship a consumer and a designer are going to have with the object,

YOUNIFORM = YOU-N-I-FORM = YOU (Consumer) + N (and) + I (Designer) + FORM (creating together).

It involves both the designer and the user working together to create a customized product, hence the name You-n-I-Form. The designer provides the system; the user interacts with that system to generate the final product. Thus, it is a brand under which the final formation of the object is only achieved when the user and the designer work together.

This process has the potential to be beneficial for both the consumer/user and the designer. The designer makes a system, a design solution capable of providing good quality and affordable products. The consumer saves time, as compared to the handcrafts era when one had to wait days for a customized product that would show their personal characteristics for a reasonable price. The consumer is saving time as compared to the craft era, but compared to mass production, the consumer is required to engage in the system, not as a passive consumer but as a collaborative entity. Although we want the speed of mass production, we also want the quality of the handcrafts. The ideal end result would be a cost effective mass production of customized products by means of Generative Design.

Individual Steps:

Youniform is comprised of a system, which is divided into six steps.

Step 1:

Step one involved designers' providing the user with virgin covers. Figure 12 is an image of the covers that are provided. These covers were for smart phones – in this case the iPhone 6s, Samsung Galaxy 5 and 4.The wide popularity of these smartphones would allow more users to interact with the design process. The provided covers were semi-transparent, giving the consumer enough freedom to add visual customizations. There have been insertions added in the holes of the covers so when the material (discussed in detail in step 2) is added, the holes are not inadvertently plugged (see Figure 13). Moreover the covers have a key imprinted on them (discussed in detail in step 3).

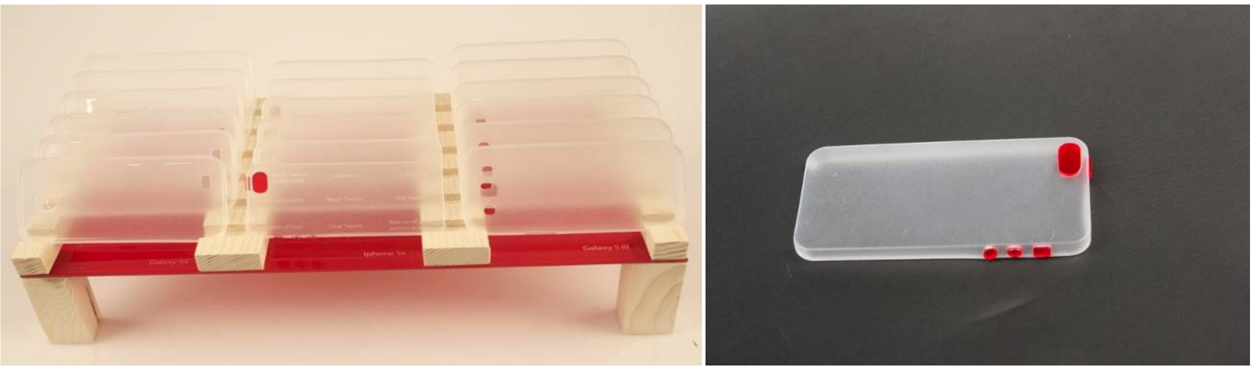

Figure 12. Virgin Mobile Covers.

Figure 13. Virgin covers with insertions.

Step 2:

All projects involve the use of materials whether they are electronic components or resistant materials or a combination of both. One of the important points in this research has been of experimentation with new and different materials to solve problems. Although experimentations were carried out with many different materials including mouldable plastic and modelling wax, it was determined that Sugru – a patented multi-purpose, non-slumping brand of silicone rubber that resembles modelling clay – is an ideal material for this purpose.

This step involved the user's extracting six packets of Sugru from the dispenser and applying it to the phone cover (see Figure 14). Since the material had to be applied by hand, the application would result differently for each user. This shows the ergonomy of phones discussed earlier. Although the user applies the Sugru, the designer is maintaining a marginal amount of control by providing a selected colour. Figure 15 illustrates the result.

Sugru turned out to be the best material for this system because of its pliability and the moderate time it takes to dry. Sugru, being flexible, allows the phone covers to bend so phones can easily be fitted to the covers. Also, it takes approximately ten hours for Sugru to dry. This gives the user and the designer enough time to interact with the material and personalize the outcome.

Figure 14. Sugru Dispenser.

Figure 15. Sugru Application.

Step 3:

The third step comprised of imprinting usage information from the mobile to the cover through a robot, built using Adruino board and nine servos/servomotors. Arduino is a single-board microcontroller, intended to make the application of interactive objects or environments more accessible and a servomotor is a rotary actuator that allows for precise control of angular position, velocity and acceleration. The robot connected to a user's Twitter account and extracted information that details the user's number of tweets made in the past week, the time tweets were made, the number of followers a user has, the number of people the user follows, and several other metrics. Figure 16 outlines the specific information being mapped onto the product. A key outlining the information recorded is etched inside the phone cover for instance if the pistons have punched for the tweets made at night, on the back of the phone cover it would etch insomnia (See Figure 17).

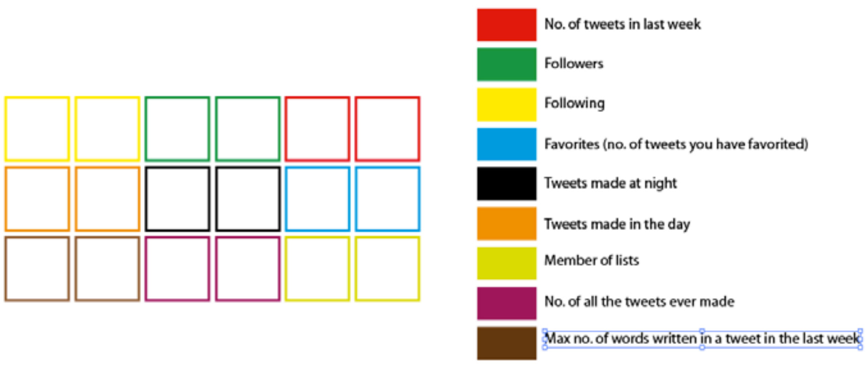

Figure 16. Information controlling each servo.

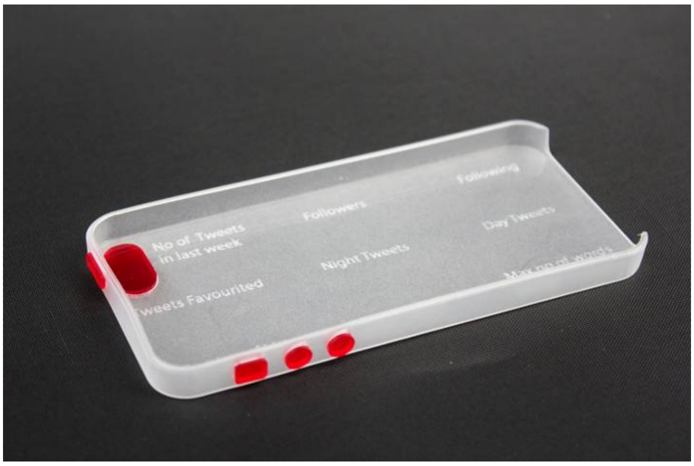

Figure 17. A key outlining the information recorded etched inside the phone.

The robot consisted of pistons, which moved vertically, based on the value of the data provided by Twitter. Two pistons were connected to one servo (see Figure 18 and 19), which was controlled by code running on both Arduino and Processing platforms. Processing was programming language and integrated development environment (IDE) built for the electronic arts, new media art, and visual design communities with the purpose of teaching the fundamentals of computer programming in a visual context, and to serve as the foundation for electronic sketchbooks.

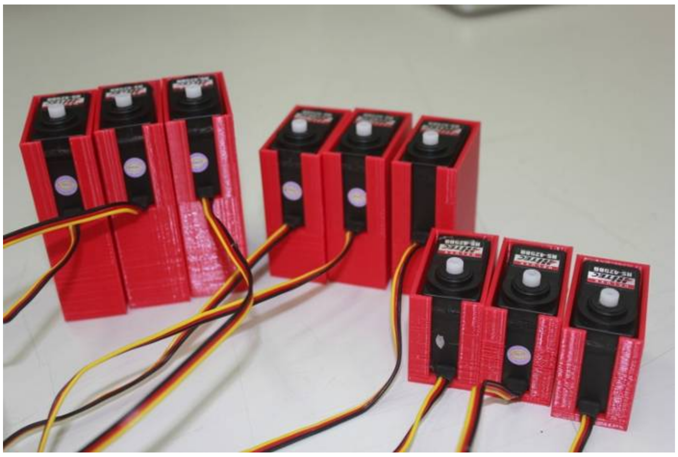
Figure 18. Nine servos used in the robot.


Figure 19. One servo motor controlling two pistons.

The tip of each piston resembled the tip of a human finger. This provided a discourse between the human touch and the digital touch by the robot. Printing the piston tops from the 3D printer gave it a pattern similar to a human fingerprint, highlighting the difference between human and digital touch. The print resulting from the digital fingers, which are identical, will contrast with the fingerprints left when the user interacts with the Sugru applied to the cover. See Figure 20 for reference.

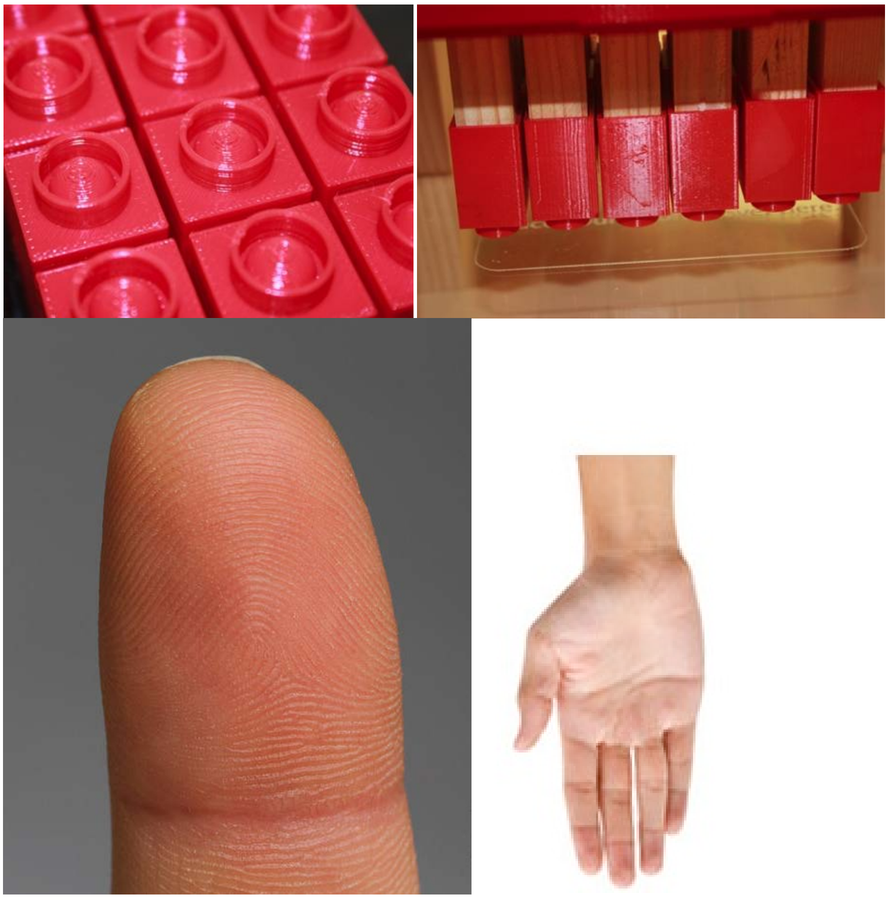

Figure 20. Comparison between human and digital prints.

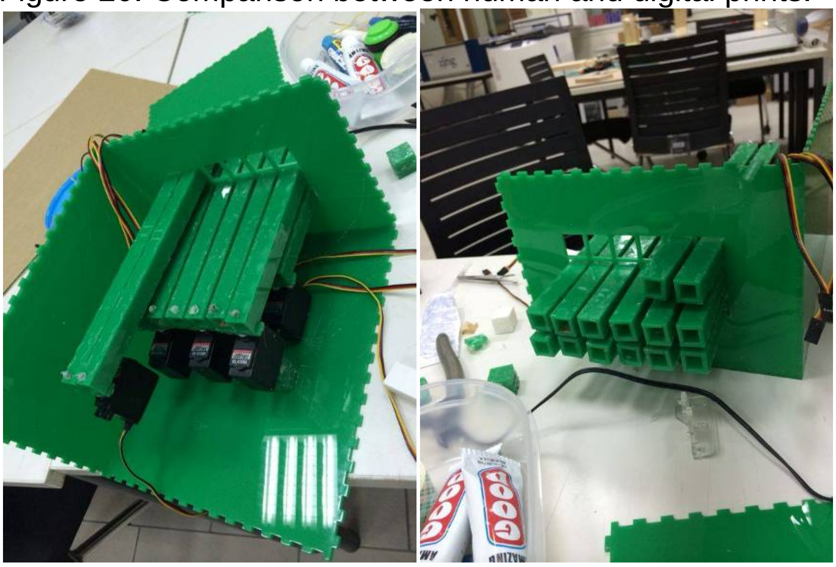

Figure 21. Robot in production.

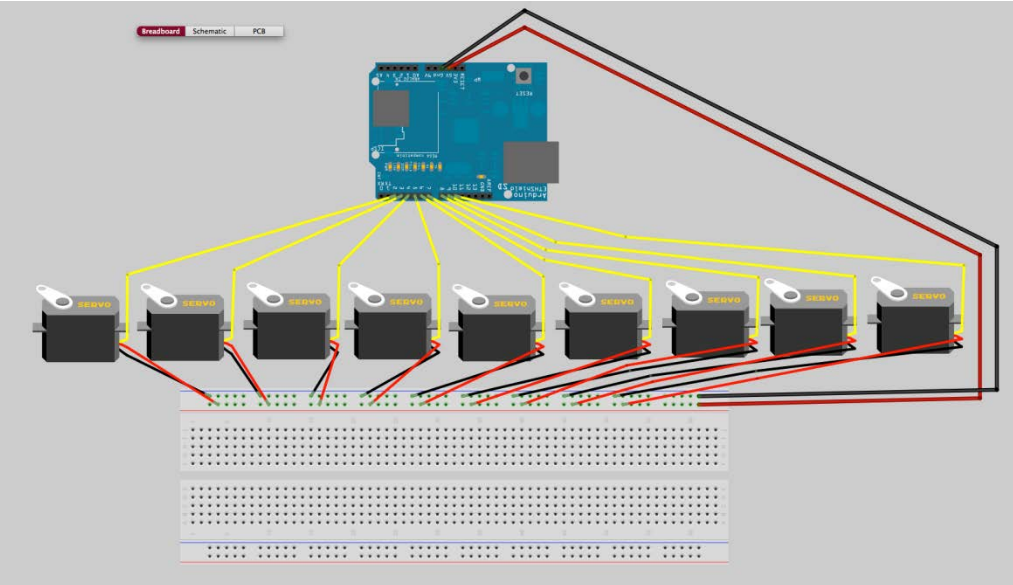

Figure 22. Schematics of the robot.

```
import java.util.concurrent.*;
import java.util.*;

import twitter4j.conf.*;
import twitter4j.*;
import twitter4j.auth.*;
import twitter4j.api.*;

// TODO go to http://dev.twitter.org and create your own consumer key and secret
String API_KEY = "TmORrg2WlN1MWn1zMUhmLw";
String API_SECRET = "DLCxpbqvd5dNPui7k6VV20Lyen8VRvrfHjllkk6AepY";
String ACCESS_TOKEN = "1391075048-fXHZ7KTjVyTiEJqkircVJDE0o3ucBFk4JnlZNet";
String ACCESS_TOKEN_SECRET = "RVohiAokO2o4vbYldfkaQfnRQg5XOidY1FYLvtDbmO15m";

PFont sans;

String cursor = "_";
String empty = "";
long blinkPeriod = 300; // Milli seconds
TextBox idBox;

color lust = #e62020;
color cream = #ffffcc;
color outer_space = #414A4C;
color midnight_blue = #191970;

FutureTask <List <Status>> currentTask;

int msgIndex = 0;
boolean isLoading = true;

String [] loadingMessages = new String [] {
  "loading",
    "loading.",
    "loading...",
    "loading..",
    "loading."
};

String [] item = new String [] {
  "Tweets in the past week",
    "Tweets favorited",
    "Number of followers",
    "Number of people you follow",
    "Tweets at night",
    "Tweets in the day",
    "Lists you belong to",
    "Total tweets made",
    "Maximum number of words used in the past week"
};

//{{{ Textbox representation
class TextBox {
  long lastTime;
  boolean showCursor;
  boolean hasFocus = true;
  String msg;
```

Figure 23. Code developed for the robot.

Step 4:

Step four involved the user's entering their Twitter account information into the interface (See Figure 24). As soon as the user typed in his/her user account, the processing program would extract information from Twitter and connect it to relative servos (See Figure 25). As discussed earlier in the text it is not a violation of someone's privacy since the user has the ability to choose to illustrate selected elements of his life to the people around him.

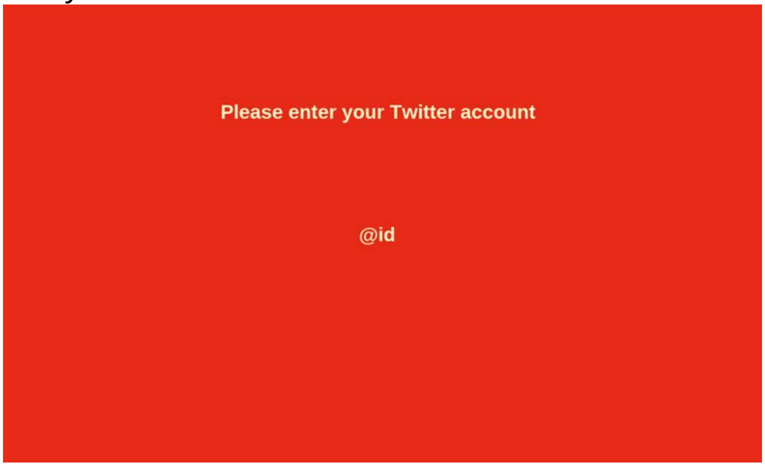

Figure 24. Interface.

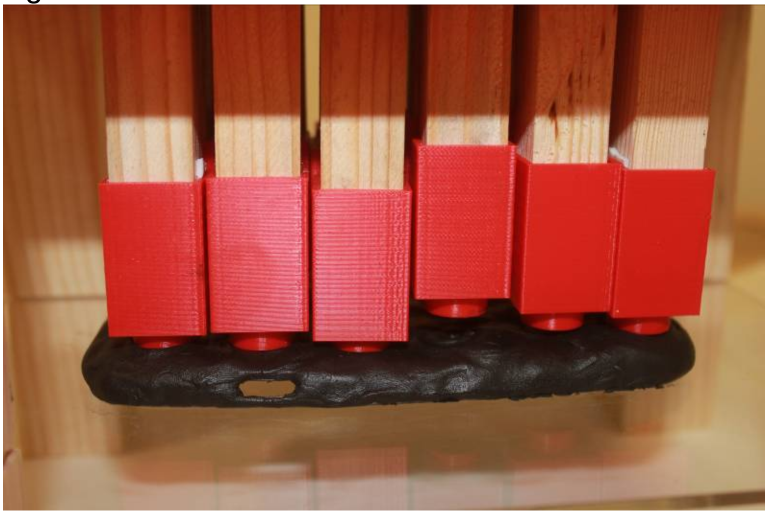

Figure 25. Robot Functioning after entering the Twitter account.

Figure 26. An outcome of the system.

Step 5:

Step five involved the user's taking the phone cover from the robot, inserting his/her mobile phone in it and placing it in a ventilation box to dry. See Figure 27 for reference. Although the ventilation boxes did not facilitate the drying process, they provided a safe environment for users to separate themselves from their phones. Their inclusion in the process forced people to disconnect from their phones and socialize with others participants. The shape of the box had been designed to invoke a sense that it is a safe and secure place to leave a valuable object.

Figure 27. Ventilation boxes.

Step 6:

The sixth and last step involved the user's waiting and socializing with other people while his/her phone cover dried. This step was inserted into the system as a critique to the concept of mobile phones' making people anti-social as discussed earlier in the text. Through the last step, people would be able to forget their phones for a couple of minutes and make a conscious effort to interact and talk to the person(s) sitting next to them while they all waited for their phones to dry.

Exhibition Display:

Youniform works as a stand-alone shop where the user goes in and interacts with the entire system to get a personalized mobile phone cover. The user experiences each step of the system according to the procedure created by the designer.

Figure 28. Youniform

Conclusion:

The concept of making uniquely designed products, which can be mass-produced, is relatively new and has great potential to come into the market and attract a large audience. This paper has produced a brand that can be released into the market and attract audiences.

This paper proposes a system that creates products, which are unique, affordable, and mass-produced. Each individual part of the system designed and manufactured has a narrative; it tells a story about nature, about Generative Design and makes the viewers aware of the concept. The pieces produced in this paper will convert viewers into buyers. These end-viewers will include retailers, buyers, and potential buyers, basically all those linked to the trade.

This paper contributes to the field of Generative Design. The Generative Design process produces differing results and designs in every instance. In this study, it is imperative that it develops customized designs where in of creating a dialogue between the natural and artificial emerges and penetrates the idea of bringing individuality into mass production.

The success of the research would be seen (1) if a debate is configured among people about design houses' lacking customization and designers losing emotional touch in their designs and (2) if it succeeds in bringing Generative Design into mass production. If the research is effective and affective, it will help bring back emotional impacts and the design uniqueness they contribute to mass production. This paper will be able to provoke productive arguments or debates among designers and customers about bringing customization into mass production.

List of Figures

All work and images by the author unless otherwise stated.

Figure 1: Red Ambush, 01/2008, Mural / Wallpaper. Commissioned piece for Maxalot Gallery.
Dimensions variable, max 3m x 6m.
http://enohenze.de/ambush/

Figure 2: StampLamp – design with unique fingerprint, Sommersemester 2012 by Gaspar Battha,
http://digital.udk-berlin.de/?/students/battha-gaspar/projects/ss12.BifurcationLamp/

Figure 3. Haptic-Intelligentsia, Joong Han Lee 2014.
http://studio-homunculus.com/portfolio/haptic-intelligentsia-human-prototyping-machine/

Figure 4. Markus Kayser's 3D Solar Sinter Prints on Sand, 2011, http://www.markuskayser.com/work/solarsinter/

Figure 10. Glued to the phones, April 14th 2014, Hindustan Times.
http://www.hindustantimes.com/photos-news/Photos-Technology/smartphones/Article4-1035520.aspx

Figure 11. Nokia cheekily tells us that we can hold its phones any way we want, June 6th 2010, Matthew Chung
http://www.ubergizmo.com/2010/06/nokia-cheekily-tells-us-that-we-can-hold-its-phones-any-way-we-want/

Works Cited:

Atkinson, Paul. "*Orchestral Maneuvers in Design*." In Open Design Now: Why Design Cannot Remain Exclusive, edited by Bas Van Abel, Lucas Evers, RoelKlaassen, and Peter Troxler, 24- 31. Amsterdam: BIS publishers, 2011.

Avital, Michael. "*The Generative Bedrock of Open Design*." In Open Design Now: Why Design Cannot Remain Exclusive, edited by Bas Van Abel, Lucas Evers, RoelKlaassen, and Peter Troxler, 58. Amsterdam: BIS publishers, 2011.

Bohnacker, Hartmut, Benedikt Gross, and Julia Laub. *Generative Design: visualize, program, and create with processing.* New York: Princeton Architectural Press, 2012.

Buffington, Jack. "Comparison of mass customization and generative customization in mass markets." Industrial Management & Data Systems, Vol. 111 (2011): 41 – 62.accessed March 11, 2014.

Friel, Martha, and Walter Santagata. "*Making Material Cultural Heritage Work*: From traditional handicrafts to soft industrial design." In *The Cultural Economy,* edited by Helmut Anheier and Yudhishthir Raj Isar, 274-282. Sage Publications, 2008.

Klanten, Robert, Ehmann Sven, HanschkeVerena. *In A Touch of Code, Interactive installations and experiences*. Berlin: Gestalten, 2011.

Ikea Hackers. “IKEA Hackers.” last modified March 28, 2014. http://www.ikeahackers.net/

Magrini, Boris. “*Should Generative Art be Political?”*2012. www.argenia.org/GA2012/boris.pdf (accessed March. 1, 2012).

MicherTraxler Studio. “mischer’traxler studio.” last modified February 19, 2014. http://www.mischertraxler.com/projects_the_idea_of_a_tree_recorder_one.html

Monro, Gordon. “*Emergence and Generative Art*.” *Leonardo* 42, no. 5 (2009): 476-477.

Soddu, Celestino. “*New Naturality: A Generative Approach to Art and Design*.” *Leonardo* 35, no. 3 (2002): 291-294.