Design Thinking LAB: Math Goes Fashion

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Abstract

This paper describes the strategy of approaching math through fashion using interdisciplinary methods such as "Design Thinking". A group of designers, artists, physicists and mathematicians from different universities mingle regularly at the Design Thinking Lab at the University of Applied Arts under the supervision of Ruth Mateus-Berr. Now they are approaching fashion through math. In Western Europe, the making of patterns in garments mainly comes from one tradition. As far as we know, no one has yet thought about an approach based on platonic solids or reformulated the traditional S,M,L,XL sizes with a new mathematical interpretation, Body-Index-Cloth. Rotational forms of conic sections enable us to find forms for a hyperbolic ball gown. The Lab covers a broad range of problem domains from pattern making to fashion for buildings with inflatable membranes. Recent experiments reveal new perspectives for fashion and, additionally, bring up educationally fruitful methods for working with mathematical topics using a creative base.

1. Design Thinking Lab at the University of Applied Arts

The Design Thinking Lab of Prof. James Skone at the Institute of Art Science and Communication focuses on Design, Architecture and the Environment for Art Education. "A parallel effort at Stanford University offers "Design Thinking Boot Camps" for teachers and other school officials. "We believe that there is room for innovation in every aspect of education, and that it can be taught," Stanford's website reads [1]. According to Kristensen, many design problems arise because there is little integration between the environment, people and technology. He recommends that physical space, virtual space and a visual working methodology need to be interconnected in order to enhance a collaborative participation and performance for dispersed teams [2]. The Design Thinking Lab is such a space.

2. Problem Domain: Pattern-making based on mathematical methods

Patternmaking is a challenging part of making fashion. It relates to several mathematical areas. Using measuring, angles and statistics, it demands mathematical skills and creativity at the same time. Western patterns are mainly based on one system of how a garment is constructed. It is a system of curves, lines and darts that shapes a flat fabric around the human body, giving it a form that follows the taste of the time; expanding (like shoulder-pads) or minimizing the body (like a corset). As most textiles are flat, the main challenge is: How can a three-dimensional form, like a garment, be made to lie flat, in order to be cut out? The fashion industry has already found its ways to dress the human body. Which ways can be found using mathematics? So far six approaches have been found:

Problem Domain 1: Triangulation

With the means of triangulation, we analyzed the human body itself by covering it with one geometrical shape, the triangle (see Fig. 1). Through this strict method, we became more sensitive about the complex topology of the human body. The next challenge was the cluster of several triangles, which cover the body as precisely as possible, in mathematical terms, develop it. We realized how many different ways of seams are possible apart from what we usually buy in shops and what further could be designed.

Problem Domain 2: The Hyperbolic Approach

We discovered what happens to plain shapes when they are put on hyperbolic forms, like a sphere, and what happens the other way round by drawing a square on someone's shoulder and divide it in half. The question arose how those two parts will look like in the plain. This experience is in general one of the main challenges in patternmaking. A patternmaker has to develop a feeling about the relation between plain and hyperbolic shapes. We learned that mathematical knowledge, such as, how curvature influences angels and shapes, which should be brought into the plain, or how plain shapes could be brought onto certain curvatures, is an important impact to teach patternmaking. The first two problem domains are related to each other, as triangles behave differently in the plain than on a sphere.

Problem Domain 3: Platonic Solids

While the first two problem domains were based on the human body, the further experiments started from the so-called platonic solids. These are built from regular polygons: equilateral triangles (icosahedra and tetrahedra), pentagons (dodecahedra) or squares (cubes). Dodecahedra and icosahedra are convex shapes, like all platonic solids, but these two in particular are quite close to the sphere. Consequently these two are interesting to use on the body: Body parts like the shoulders, head, derriere or breasts, and fashion pieces like puffed sleeves, crinolines, and hats resemble hemispheres, and therefore could be modeled using icosahedra or dodecahedra. (see Fig. 2)

The challenge embodies multiplying one single flat shape (like a pentagon or an equilateral triangle), putting them together in order to design a garment. The advantage is that each line fits with every other, so it is no longer necessary to measure. Additionally we gained form and seams we could hardly get by usual patternmaking, thus making this approach conceivably have the greatest creative impact.
Using icosahedra to start with, we quickly came close to what was described in problem domain one (triangulation). Starting to curve the sides of the triangles or pentagons, we gained the hyperbolic shapes of problem domain 2. So all three domains could be combined and used for a new way of patternmaking. This is an educational experience: it will certainly include surprising "Eureka!" moments and guarantees highly creative performances.

Problem Domain 4: Body-Index-Cloth

With *The Body-Index-Cloth* we aimed to emphasize on the relation of body and cloth. Our main attempt was to develop a patternmaking-technique, which acknowledges the individual body measurements, proportions and weight (the last aspect is neglected in common patternmaking). We used this data for developing parabolas, which became the main design elements of the Body-Index-Cloth.

On behalf of certain reference points: knees, hip, waist and shoulders, including the data of body height and weight the parabolas transform the individual body into a geometrical model. With the specific and varying combinations, separations and multiplications of these parabolas, they start to form and define - simultaneously relating to the same body - the shape and size of the piece of clothing. (see Fig. 3)

By exploring this mathematically, visually and logically understandable system, the relation between body and cloth was enforced. Firstly it is mathematics because of the use of a garment in an unmodified form of the calculated parabola-form. Secondly it turns visual when the cloth pieces adjust to reference points of the body. Thirdly the approach can easily be understood without any previous knowledge in fashion design, as the starting point is not an already predefined standard but reference data of an individual.

Problem Domain 5: Hyperbolic Fashion-Sketching

By analyzing the shape of the human body and several fashion silhouettes, historic as well as contemporary ones, we recognized how many mathematical function graphs can be discovered. Historic hooped skirts are just the most obvious examples. Math offers a fund of different curved shapes in the wide field between jump functions and asymptotic progressions. By modeling some silhouettes cocooning the human body by using rotational forms of the conic sections (sphere, ellipsoid, paraboloid and hyperboloid of revolution), we discovered that those rotational forms could be used in fashion sketches, especially if you combine them without any order. The main advantage of these sketching techniques are that you do not need to have a lot of drawing skills, but in fact are forced to imagine the model three-dimensional, which leads to inspiring abstract solutions.

Problem Domain 6: Inflatable Fashion

Through our workshops we discovered that by using technical membranes as fabrics, coated fabrics and foils one can develop a “fashion for buildings”. The goal is the radical implementation of the air-tight cover for so called passive houses. Their low mass relative to the surface area they cover is a tremendous advantage over their entire life cycle. Production, transport, assembly, maintenance and updating of inventory, as well as disassembly and re-use of the materials are all quite straightforward. Facades often are called “Third Skins”, so to say fashion in XXXXXXL. Inflatable habitats are the most reduced form. During the whole process of experimenting, we were often surprised by how shapes we blew up deformed. A challenging question was (and still is) to predict in which way shapes we construct will change, and what kind of seams would improve the “fitting” of the skin. The techniques from problem-domains 1 and 2 encouraged us further. Additionally we surprisingly found ourselves in the field of physics by how air expands. (see Fig. 4)

References

[1] http://dschool.stanford.edu/k12/images/img/Summer_Session_Flyer_08.pdf accessed on 14.1.2011.
[2] T. Kristensen, *The physical context of creativity. Creativity and Innovation Management*. Vol.14, Nr. 2, pp. 89-96, 2004;

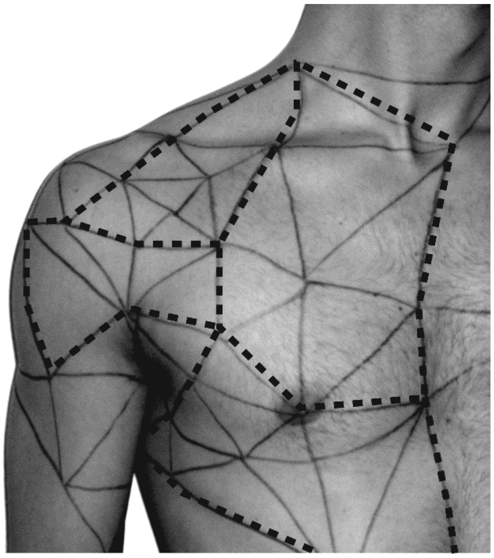

Figure 1: *Shoulder with triangulation and suggested seam.*
Fotocredits: Walter Lunzer.

Figure 2: *Bolero made out of three deconstructed dodekahedra by Walter Lunzer.*
Fotocredits: Walter Lunzer.

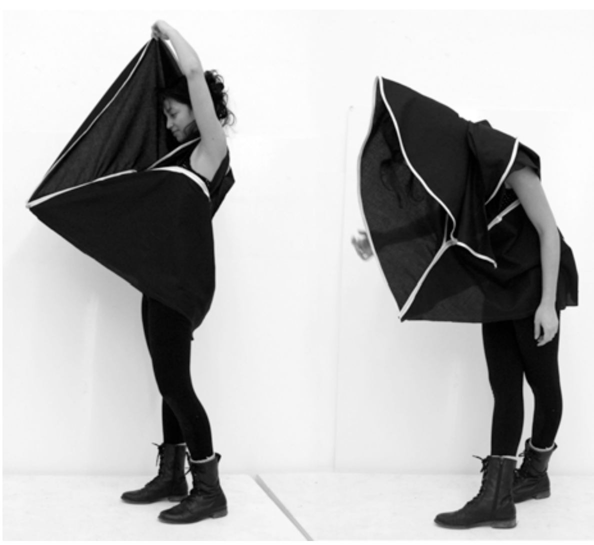

Figure 3: *Prototype for a Body-Index-Cloth by Jasmin Schaitl.*
Fotocredits: Jasmin Schaitl.

Figure 4: *Prototype for an inflatable fashion object by P. Michael Schultes.*
Fotocredits: Air-shaped cloud group ©dieAngewandte