The Box of Glorious Failures

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Abstract
This paper describes the advantage of failures and uselessness in the 3D printing of flexible, personalized shoes. The process of learning to make flexible printed shoes required a massive number of useless failures. Each failure produces understanding that creates a new discipline. Countless 3D printed cubes creates a material understanding. Years of failed printing tempered with perseverance depend that understanding. Crazy experiments with extreme support material inspired countless other shoes. In this paper I look at how the useless leftovers of a 3D printed shoe practice enriches the craft, inspires the art and innovates technology.

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Wearables, fashion, data, security, fitting

ACM Classification Keywords
H.1.2 [User/Machine Systems]: Human Factors

Discovering the Box
As a young child on a ranch in the middle of South Dakota I learned to sew a pocket. Using a box of fabric leftovers, I created well over 200 useless pockets. At the same time, I learned to sew. I replicated ever kind of seam and closure I could lay my eyes on. Years later I would learn their names

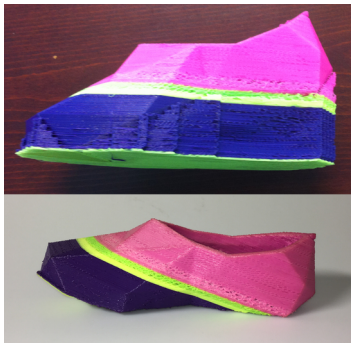

Figure 1: Printed shoe with support material and support material removed.

Figure 2: Useless support material being used as inspiration. Photo: Pauline van Dongen

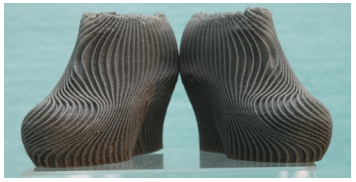

Figure 3: Shoes inspired by useless support

and uses. Enormous mistakes were made, but everyone was learned from.

Almost every 3D printing practitioner has experienced failure and useless prints in some sense. A successful print on a consumer grade machine often requires multiple attempts to achieve. Power failures, heating issues, ambient humidity/temperature, filament defects, and nozzle blockage all happen commonly. Many practitioners experience disappointments and stop practicing in these moments. Other practitioners take these moments to reflect upon the behavior of the material in the failed prints and engage their peers in discussion. An even smaller subset writes code to modify slicing software or generate their own G-code. Another interesting example of uselessness in 3D printing is found in the support material. FFF modeling requires the use of a removable support material to achieve certain geometries. While useful in the printing process it is removed and discarded immediately after printing is finished. In my practice of 3D printing shoes I have noticed that the failures and useless supports often inform future work. With my friends and colleagues at the Slem footwear institute in Waalwijk, NL.

The Cube

The printing of flexible materials is commonly considered to be an advanced practice cite. TPE is especially flexible and often gets crimped in the extrusion drive. Tension, nozzle flow and viscosity stopple operate within strict tolerances that can vary widely with ambient temperature, relative humidity and seemingly the phase of moon. Each printer also has an individual personality that requires personal attention. Printing of useless cubes in varying sizes and settings helps understand the printer and the material on any given day. On particularly difficult days as many as seven cubes were printed before I had the feeling the printer was running well. While some errors were obvious, other times a simple feeling about the machine would cause further adjustments. Prints oh a single shoe have taken as along as 105 hours. Printing perfect cubes created a trust that the printer could handle that kind of print.

The Support

FDM 3D printing often requires support material be printed then removed. This waste supports geometries that would otherwise collapse with gravity (see fig. 1). In experimenting with new ways to print shoes massive amounts of support material was created. In fig. we see a print where the support weighs more than the shoe itself. The shoe itself failed to behave in the ways expected, but the whole roll of filament used to make the support was embarrassingly useless. Being sustainable minded, the support was tossed into the recycling box. Months later when an important project to print high heels was started, that same scrap would become the inspiration for the shoe [2] (see fig. 2,3).

The Box

Fellow 3D printers and I found ourselves going back to the recycling box with increased frequency. We would look at our failures and those of others. Interesting pieces of failures and scrap were sorted from the true trash; the box of glorious failures was born. Cubes, support material and half prints became a source of inspiration. Clogged nozzles would reshape how the filament laid down. In these samples we found a way to create a very soft infill by causing a type of spaghetti to occur. In another sample we found a way to use the infill as surface effect that created a moire effect. In a final example we used a series of the original cubes as material behavior definitions as we started to write G-code.

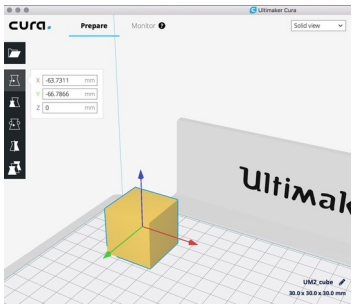

Figure 4: Slicing a cube into gCode

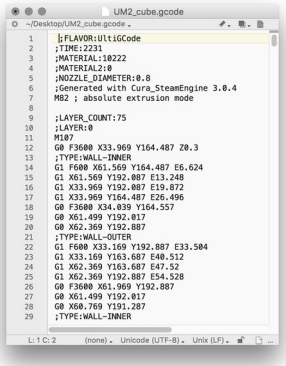

Figure 5: Modifying gCode by hand in an editor

What is means

Lessons learned from the making of pockets in my early years taught material exploration. Somewhere in looking through the failures and useless samples in the box of glorious failures new material, behavior, and form was found. This exploration laid the groundwork for the explorations that came next [1]. In the EVA Moccasin cite I started to explore how calculation can occur without electronics. There is something embedded the making of HCI that needs to be explored. Hybrid craft cite points to a new future and expression of HCI.

A Recipe for Glorious Failure

3D Printing machine gCode holds many opportunities for purposeful exploration of useless failure. This following recipe is meant as a provocation to help the reader on their way to gCode exploration.

1. 3D model a 30mm cube and generate gCode for the model using any slicer software of your choice. Cura is a common free software for this.
2. Open up the .gcode file in a text or code editor and realize how easy the code is to read. X and Y positions are commonly in millimeters and are constrained by the dimension of your 3D printer board.
3. Randomly change the values of X and Y throughout the code keeping in mind the dimensional constraints of your printer.
4. Save the file and print it. Enjoy and repeat.

In a short amount of time you will find it easy to manipulate gCode. You might even find yourself writing scripts, processing code or spreadsheets to make your own. (Just a hint, extrusion is cumulative.)

If you don't have a 3D printer handy, try modifying the knit of an unloved sweater. A pair of scissors, alligator clips, and a crochet hook are all you need.

1. Gently tug a yarn out of the knit with the crochet hook.
2. Attach the two alligator clips on the yarn, count down a random number of whales in the knit /(vertical); Repeat.
3. Cut the top yarn, gentle undo three stitches. Restitch the second stitch.
4. Undo the stitches in the courses until you arrive at the bottom clipped whales.
5. Clip and reattach the stitches. Massage the results back into the knit structure.

The result should be a slip in the knits that creates a unique hole. Feel free to repeat changing the number whales and courses skipped.

Biography

Troy Nachtigall is a Marie SkÅĆodowskaâĂŞCurie Research Fellow in the ArcInTexETN H2020 action. Troy investigates the programming of 4D material, form and behavior in flexible, wearable structures. Shoes are the most common expression of the exploration using research through design. Troy is part of the Wearable Senses Lab at Eindhoven University of Technology, Industrial Design. His background as a fashion designer in Italy has shaped his ideas of how a garment fits the user in many ways including physically and socially. Troy sees a future that goes beyond mass customization into data driven garments and accessories that some have called ultra personalization. His view

on ultra personalization in fashion is that it defines something beyond soft weft tailoring/shoemaking, yet has the capacity to be democratic in its application. TroyâĂŹs most recent project is Solemaker.io, a computational (generative, algorithmic, parametric) shoe platform that creates personalized shoe files (gCode, .stl and instructions) from a foot scan. This project is currently participating in the EU H2020 WearSustain project exploring the possibilities of sustainable wearable technologies.

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