

Math 315 Reflection Paper

(IN THE REFLECTION I HAVE ASSUMED THE ALGORITHMS I IMPLEMENTED WERE CORRECT. I KNOW THEY ARE NOT, SO PLEASE DO NOT COUNT OFF FOR THIS! I MOST LIKELY WILL NOT HAVE TIME TO EDIT THE REFLECTION IF I DO OBTAIN CORRECT VALUES. PLEASE SEE EMAIL ADDRESSING THIS.)

In designing my bottle, inevitably, I ran into some challenges along the road. How could I get the design I wanted while minimizing the amount of materials it took to print the bottle? The idea I had in mind was to build upon the original Coca-Cola bottle design, while adding to and innovating said design to give something with a more futuristic look and feel to it. I almost wanted it to be held as if it were a wine glass; grasping it from under the largest portion. Building on that idea, my first draft ultimately incorporated an hour-glass-like mid portion, while mimicking the features of a typical Coke bottle everywhere else. This first draft proved to be both pleasing to the eye and surprisingly comfortable, granted the printed version is considerably smaller than the typical glass bottle, which holds anywhere from 12 to 20 fl. oz.

The idea of designing a bottle that is comfortable to hold raises a few questions. Does it suffice to simply be able to look at the bottle in the form of a 3D model, or is it necessary to be able touch and hold the design? To me, there was a clear advantage to having a tangible version of the bottle. Being able to determine if the bottle is comfortable to hold, or what the most comfortable grips are, by experiencing it yourself, as the designer, is a key component of designing the best bottle. Of course, this component comes second to the practicality of producing the bottle on a large scale. This will be addressed later. In terms of using a tangible version of the bottle in the designing process, it would have been quite helpful to have scaled the bottle to sizes that are most commonly found today, to a capacity that would hold anywhere from 12 to 20 fluid ounces. In my original design, it seemed as though scaling the bottle to hold that capacity would have proven that it was not the most ergonomic design. However, the original glass Coca-Cola bottle was engineered with respect to the idea of producing the perfect “6.5 fl. oz. pouring experience”, so revolving the constraints of the entire project around one of the most iconic bottle designs in history seems to pay it’s respects to an important addition to the history of consumerism appropriately, not only in America, but for the entire world. That having been said, it was not sufficient enough to only have a digital version of what I was designing, so the benefits of using the 3D printer goes without question.

During the designing process of the first version of my bottle, the role of optimization, mathematics and scientific computing did play a role, clearly. Without the use of software such as Matlab, the precision to which I could manipulate the design, both to meet constraints and forming the shape of the bottle, would not have been possible to finally give a product I was happy with. In the first design, this included the essentials of being able to create the shape I wanted, and then scaling it such that it met the requirements. With regards to optimization, designing the first version did not require a full understanding of how to reduce the use of materials by optimizing the total surface area of the bottle. However, with the use of specific algorithms to determine said surface

area, while comparing it the required capacity of the bottle, I was able to apply concepts learned in class thoroughly, which furthered my understanding of the nature of mathematics and it's integral role in engineering. The real applications of my knowledge were more rigorously tested in redesigning the original bottle, to produce one with an optimized surface area, while still meeting the specifications of features that I wanted the bottle to incorporate.

Given the constraint of the capacity that was required, the minimal surface required was given in the form of a simply bowl-like structure. After having gained the knowledge from this course, while I may not have applied every concept, I believe that newfound knowledge did give me insight to the best methodology in redesign my own bottle, reducing the total surface area as much as possible. Insomuch that the concepts learned in the course gave me new insights into the idea of optimization, I believe these concepts shaped the way I went about the thought process of redesigning my bottle. At first, I thought the best method in the redesigning process was to simply adjust the points of my original bottle with no real guidance; a trial and error process that proved to be quite frustrating after hours of little to no success. The most I was able to reduce the surface area by, using this methodology, never exceeded more than about 10 cm^2 , and that was not enough for me. Then, after stepping back and trying to figure out how to attack the problem from a new angle, the idea dawned on me to actually use the points given by the minimal design to my advantage. I spent a good amount of time comparing the bowl to my own bottle. I noticed a very clear pattern, or philosophy, that each design incorporated. While my own design involved aesthetically pleasing curves, which mimicked that of a beautiful hour-glass figure, I realized that the curves themselves were the thing that was limiting my success in the redesign process. The bowl exhibited a very obvious pattern. As the height of the bowl increased, there was also a gradual increase in circumference. While I still may not fully understand the mathematical reasoning behind it, it dawned on me that my bottle's constant, marginal increasing and decreasing of circumference with respect to height was the very thing that was wasting so much material compared to the bowl. With that in mind, literally using the points given by the bowl design, I began to manipulate the vectors for the bowl in order to generate shape that minimized those changes. This process mostly consisted of changing the x coordinates, to produce the curves that I was looking for, while keeping the bowl-design's philosophy in mind. The final product (here I begin to assume that the volumes and surface areas given by my ParSpline and SurfaceArea algorithms were correct), enhanced the futuristic look I was going for, while keeping the hour-glass-like mid portion that the original bottle featured. Further, the original design featured a typical bottle-like top and a base that mimicked that of a typical bottle, which I was also able to retain. The constraints and philosophy that I discovered in analyzing the design of the bowl ultimately did not entirely impede the creativity and innovation that went into the original design. The redesigned product was better than I expected, giving a look that was alien and totally original. Further, while I have not had the chance to hold the redesigned bottle, with the subtle curves and accents to the base and top portion, it appears as though the redesigned bottle will be much more ergonomic. At a scale which is comparable to

bottles of a capacity that we typically see today, my new bottle will not force an awkward grip under the hour-glass feature. However, seeing as though we will not be exploring such scales, I will explore those comparisons between the two versions of my bottle myself. (Again, I am assuming my algorithms were correct-which they were not!) The original design yielded a surface area of 222.251 cm^2 (assumed to be correct) and the new bottle, while shorter in height, gave a surface area of 187.362 cm^2 , both of which were scaled to hold 192.2 mL, or “the perfect 6.5 fluid ounces.” In comparing the final reduction in surface area, I was able to reduce it by approximately 16%, which is a value that I believe can be accredited to the insights and knowledge of mathematics gained in this course.

I definitely enjoyed this project, not only because of the new insights that I can take away in problem solving and optimization, but also because I am very interested in the science of 3D printing and computer modeling, and this was my first real experience involving this, where science meets art.