Final Project Documentation

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By

Zackary Tileston

Professor Taubert

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1. Introduction

Before starting this course, I already had nearly ten years of experience with CAD, engineering drawings, and 3D printing – I'm overqualified. But I can still learn more and grow my skills. So when tasked with reverse engineering an existing assembly, I purposely chose something that will provide me a challenge and broaden my skillset. Specifically, I chose a model that has smooth curves with little distinct geometry. I chose to recreate a ½" garden hose bib.

This portfolio will be a showcase of the work I have done for making this project assembly. I will show that for each step of the process I adhered to the design of the original model with extreme detail.

2. Existing Object

As mentioned above, the main reason behind choosing to model a hose bib is because I want to give my experience a challenge. The main body of the bib consists of many smooth curves and fillets which are traditionally very difficult to model in programs like SOLIDWORKS. I do not have much experience with parts that have complex internal parts. The hose bib is mostly hollow but has internal walls to control the flow of water. This makes it the perfect item to test myself. Additionally, the other parts of the assembly must interact with the main body through this complex geometry and still provide a waterproof seal under pressure.



From the above picture you can see how this would be hard to make. There are different thread patterns throughout the part, the radiuses are difficult to measure accurately, and the inside has many parts. This hose bib successfully provided me a challenge and I can confidently say that this project has improved my CAD skills. I would not recommend other students chose the same object, at least not without prior experience.

3. Reverse Engineering

To measure each part the hose bib first had to be dismantled. Thankfully, this valve assembly was designed to be repacked, meaning the seals and internals can be replaced if they become worn or damaged. To take apart the valve I simply has to remove the screw in the handle, unscrew the nut on top of the body, and then unscrew the cylinder from the body. In total there is 8 parts: The main body, cylinder, handle, screw, nut, cylinder gasket, nut gasket, and a washer.



Next, I measured each part using my pair of digital calipers. Most of the parts were easy to measure, however the main body gave me difficulties with the curvature. I found the dimensions needed by measuring the diameter of the bib at multiple cross sections (and later creating sweeps between these profiles). Some details had to be placed using my best judgment, like the text on the bottom of the handle. However, I expect the dimensions to be accurate within 0.01 millimeters because that is the reported accuracy of my calipers.

4. Solidworks Part Models

I first created rough free-hand sketches of each part before modeling. These helped me visualize what steps I would take in the creation of the parts. From there, I started with the simple parts. Creating the files for the washer, gaskets, and screw was trivial. Modeling the nut was also easy but required a little more complexity to create the transition between the hex profile and rounded top.



The handle and cylinder were both much more complex. They were not especially difficult to model but required more attention to detail than the other parts. The most difficult part to model was the main body as expected. This part required the use of many SOLIDWORKS tools I did not have a lot of experience with: lofts, sweeps, revolves, etc. The biggest challenge was simply figuring out what the first step should be. I decided to revolve the center section of the body first and everything else naturally came in place afterwards.



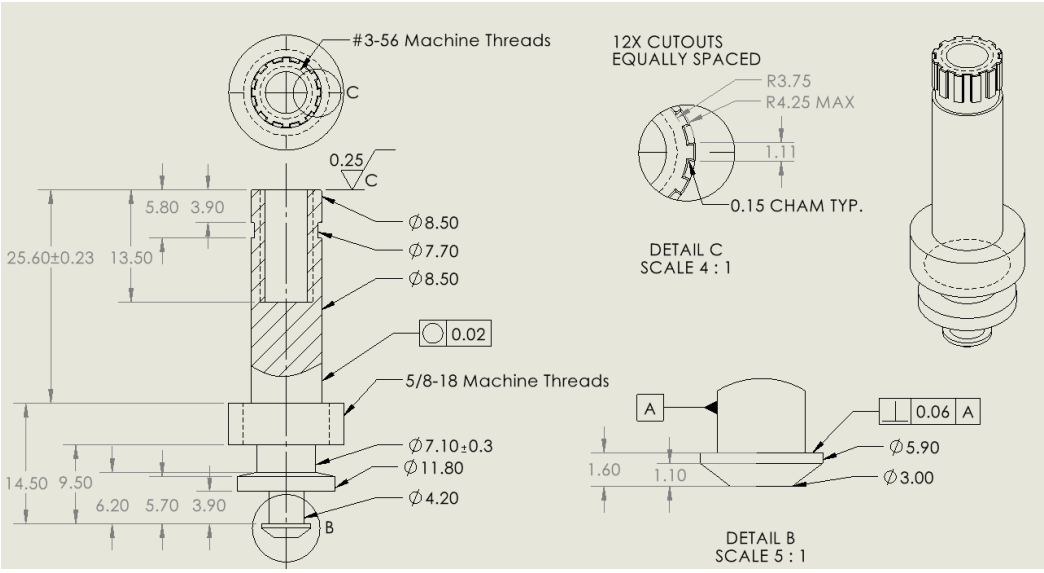
5. Assembly

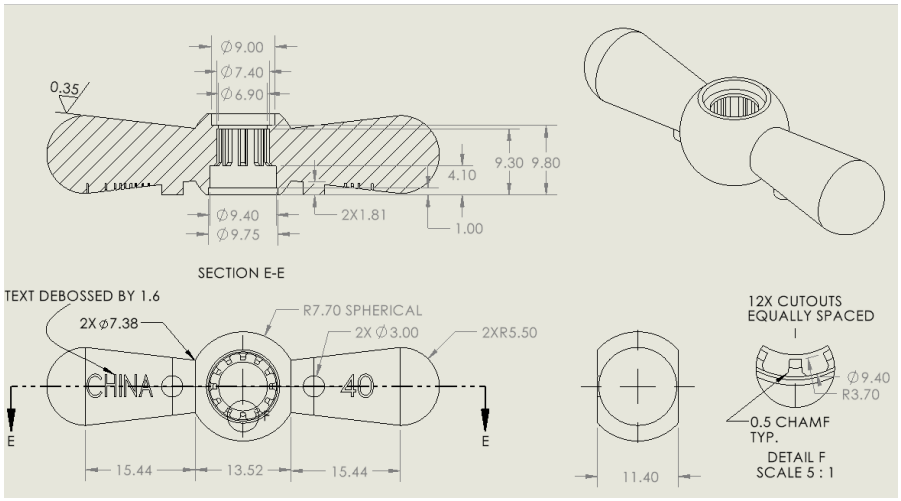
The assembly was straight forward. I placed all items into a SOLIDWORKS assembly file and constrained them to each other. For most of the parts, I simply had to place a concentric constraint between them and the cylinder. After that, each part was locked so they could not rotate freely. With all the constraints in place, I created an explosion view of the assembly and further used that to create a video animation of the hos bib assembling itself.



6. Shop Drawings

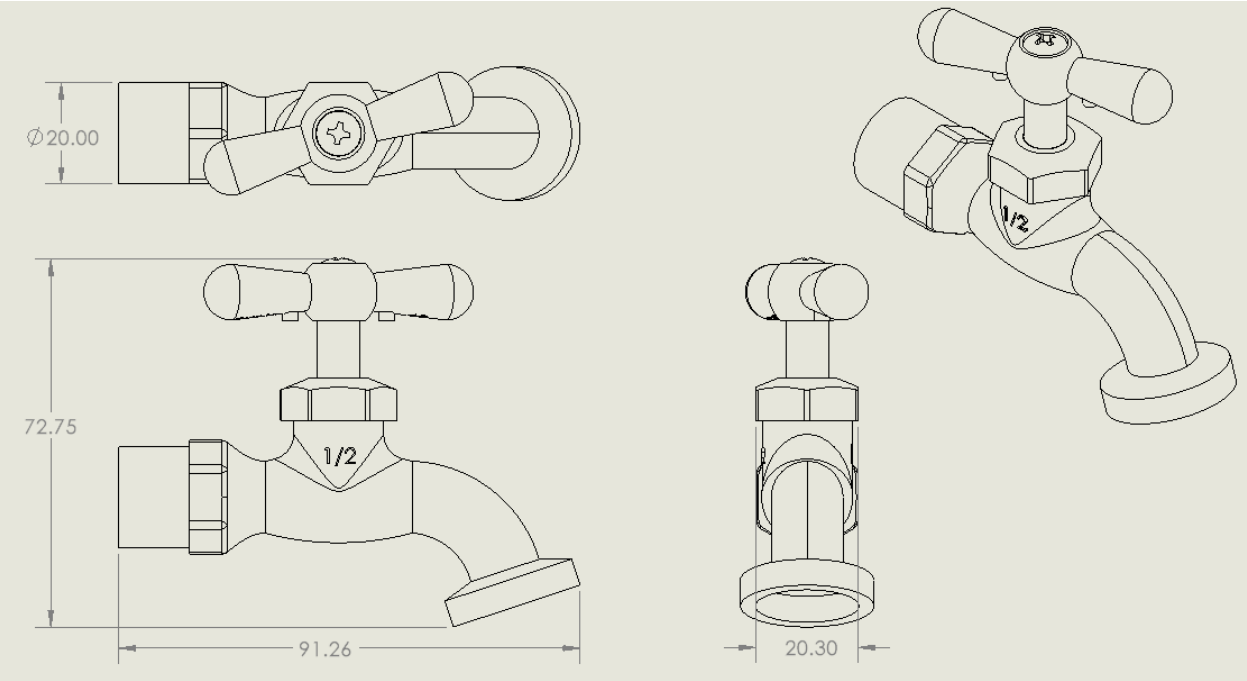
I next created shop drawings for each individual part. These drawings serve to provide a machine shop with all the dimensions to manufacture the parts. Additionally, I provided geometric tolerances and surface roughness notes as needed. The tolerances were chosen keeping in mind the parts need to physically fit together after manufacturing. Again, the drawings for the main body, cylinder, and handle were complex while the others were easy to create. For the main body in particular, it was difficult to include every detail needed within one drawing. The drawing process also improved my skillset when I was not necessarily expecting it.





7. Assembly Drawings

From the assembly I created two drawings, one for the normal view and another for the exploded view. Both drawings were simple to make as all the complex dimensions were already covered in the other shop drawings. The main assembly drawing also included a build of materials showing the details of each part.



FILE NAME	PART NAME	MATERIAL	MASS (g)	EST. COST	QTY.
FP_3 DWG_6	Cylinder	Bras	16	30¢	1
FP_3 DWG_7	Cylinder Gasket	Rubber	0.4	3¢	1
FP_3 DWG_2	Handle	Brass	22	30¢	1
FP_3 DWG_8	Main Body	Brass	80	$1.20	1
FP_3 DWG_3	Nut	Brass	6	10¢	1
FP_3 DWG_4	Nut Gasket	Rubber	0.5	3¢	1
FP_3 DWG_1	Screw	Brass	0.6	8¢	1
FP_3 DWG_5	Washer	Aluminum	0.1	1¢	1

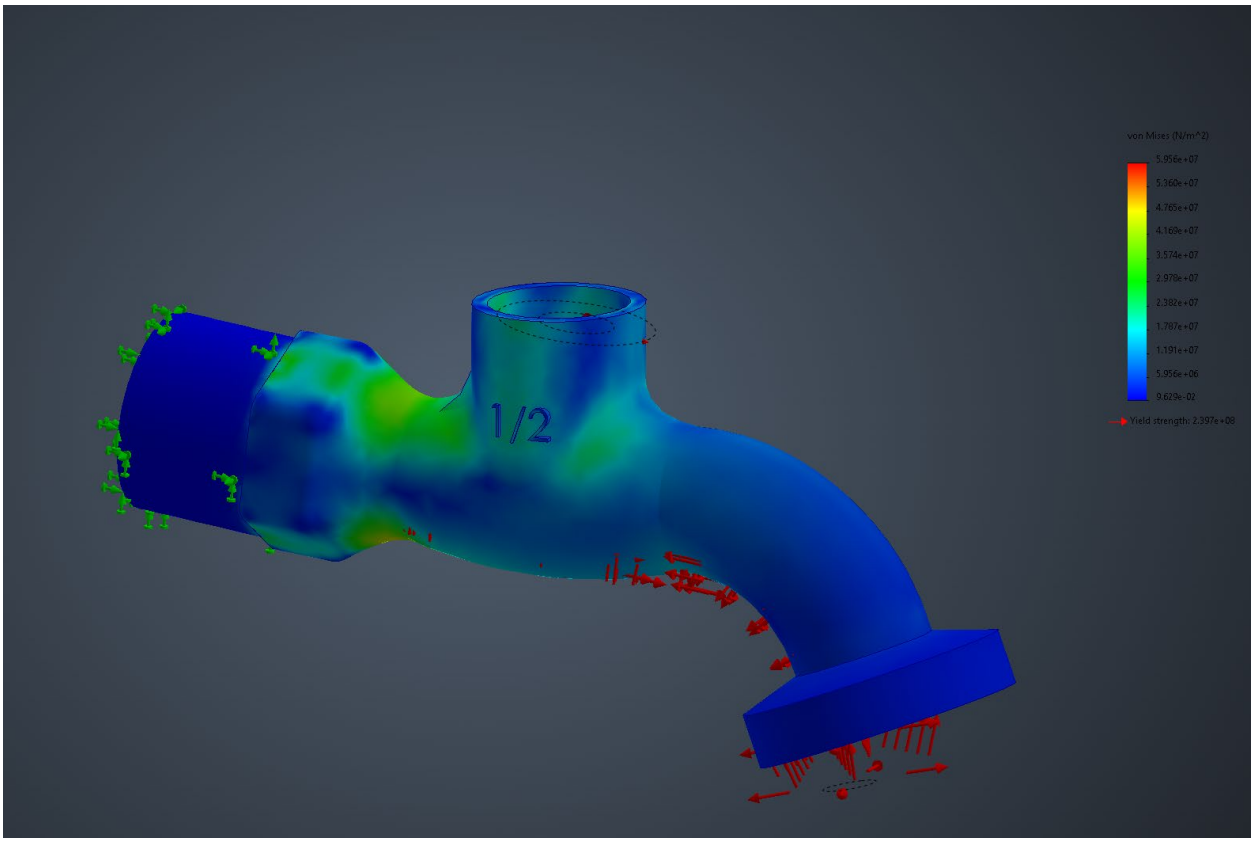
8. Assembly Video

Assembly drawings are a great way to show how parts are supposed to fit together, but do not always provide the full picture. I created a video animation within SOLIDWORKS to show how the pieces come together.



9. Finite Element Analysis

I performed a finite element analysis to see where stresses form under load for the hose bib. I chose to run the FEA on the main body to test the effects of water pressure through the hose. I set the long threads on the body to be fixed as they would be connected to a supply pipe in the real world. I set the load to be the upper limit of the typical American household, 80 PSI. The load was only applied to the internal faces of the body.



The results of the test show that the hose bib would not rupture or permanently deform under the supplied 80 PSI load. No part of the hose bib surpassed its yield strength of 2.4 $\frac{N}{m^2}$. This validates my model design as the original hose bib was designed to operate under these conditions.