

ENME 339 FINAL PROJECT: LEGO Minifigure

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April 10, 2021

Abstract

This design project presented students with the opportunity to demonstrate their Solidworks knowledge and model a household item of a minimum of 4 parts. For this project a LEGO Minifigure was chosen to be modeled and drawings of its components along with its assembly drawing rendered using Solidworks. A description for the major parts along with the process and experience with Solidworks is then combined with the drawings in this report.

Introduction

For this project I chose to model a LEGO Minifigure as my 4+ part household item. Each part of the minifigure was modeled in Solidworks, of which drawings were then made and attached in the appendix below. The parts were also used to make an assembly of the product which is also represented by a Solidworks drawing in the appendix below.

Description of the product

For this project I designed a replica of a LEGO Minifigure. A LEGO Minifigure is a buildable small human toy figurine made of ABS plastic, it was first introduced in 1978. It is part of the LEGO toy brand and so is compatible with other LEGO components. Its buildable nature allows for the interchanging of different colored parts or the replacement of one if a part breaks. The classic LEGO minifigure consists of 9 parts: a head, a torso, a waist, two arms, two legs and two hands. The legs, arms, hands and head are all able to rotate in 2 dimensions about the joint they are attached with. The main method for joining the parts together is tight holes and friction, as well custom clips on the arms.

Description of the major parts

There are 9 parts in this assembly, 8 of which are distinct. The list of distinct parts is: head (drawing 1 in the appendix), torso (drawing 2 in the appendix), waist (drawing 3 in the appendix), hand (drawing 4 in the appendix), right/left legs (drawing 6 in the appendix), right/left arms (drawing 7 in the appendix). Of the distinct parts the legs and arms are mirror images of each other. Both hand parts are identical. All of the parts are designed to fit together tightly to use friction to help hold it together. The Solidworks drawing of the assembly as attached in the appendix below as drawing 5.

The head is arguably the most important piece in the lego Minifigure, this is due to the wide variety of faces printed onto it, from the simple smiley face all the way to Darth Vader from Star Wars have been printed onto it. It is a rounded cylinder with a hole in the bottom to attach to the torso, and a hole and stud (name of the circles that stick out of the top of LEGO bricks) on top to allow other LEGO pieces to be attached to the head. For more details view drawing 1 in the appendix.

The Leg pieces are mostly hollow and have holes on the back and bottom to allow them to attach to other LEGO bricks, they attach to the waist. For more details check the undimensioned drawing 6 in the appendix below.

The waist piece connects the legs to the torso and allows the legs to rotate on an axle. The portion at the top of the waist is shaped to fit snugly into the torso and stop it from sliding out using friction. It is however easy to remove from the torso with light tensile force. Refer to drawing 3 in the appendix for more details.

The torso piece connects the waist to the arms and heads, It is the biggest component of the assembly. It is completely hollow with a large rectangular hole at the bottom for the waist to attach, two holes on the sides for the arms and an axle on top to attach the head to attach to and rotate on. Refer to drawing 2 in the appendix for more details.

The hand pieces slide into the arms using a shaft that is at an angle approximately 75 degrees from the back face of the hand. They are what the minifigure uses to hold other LEGO components. It resembles a claw hand of sorts with a stick coming out the end at an angle to attach it to the arm. For more information refer to drawing 4 in the appendix.

Lastly the arms, which attach the torso to the hands. They are free to rotate in two dimensions around where they attach to the torso. Due to the special clip that holds them inside the torso this piece is incredibly hard to remove from the torso without causing a small crack in the torso. This piece also is the most rounded piece of any of the pieces in this model. For more details view the undimensioned drawing 7 attached in the appendix below.

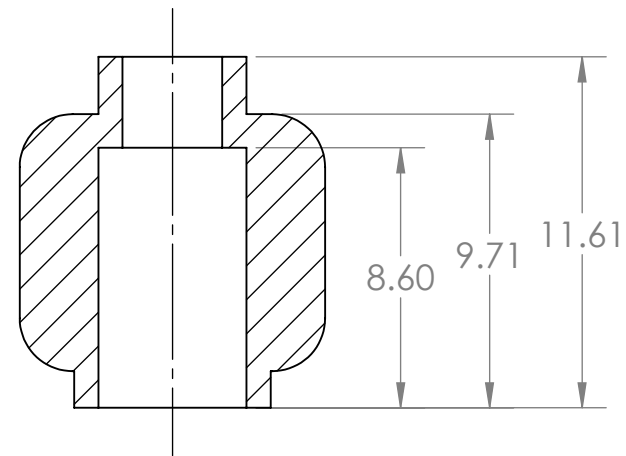
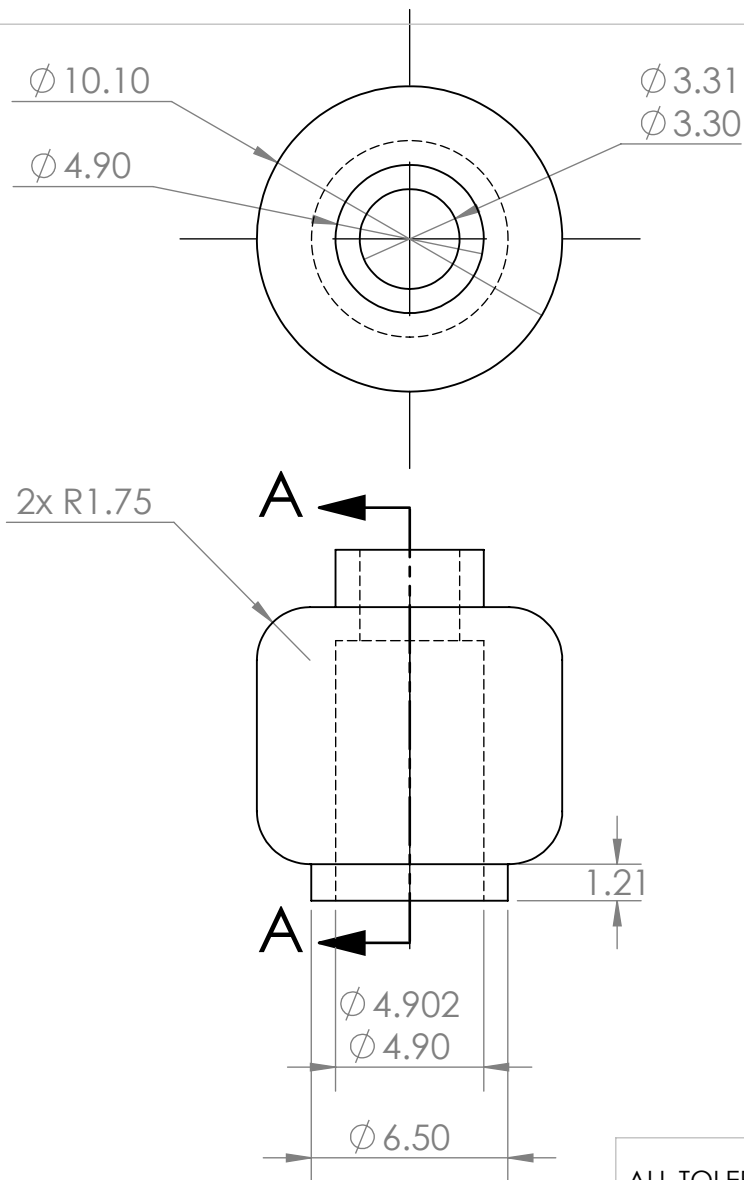
Discussions on experience of Solidworks modeling

Due to the highly geometric nature of this product the most important Solidworks tools to use were the extrude boss and extrude cut features. Some of the parts were also not at right angles (in the hand and arm) this required the creation of reference planes at the appropriate angle. In the hand part the extrude techniques to surface and offset were especially important in creating the cuff at the start of the hand. The fillet feature was incredibly important as well as many of the parts contained rounded portions such as the head or arms. The hardest part about creating the Solidworks drawings was by far deciding where to position the dimensions to ensure they looked clean and not overly cramped. The hand was by far the most challenging drawing to make due to its interesting shape and lots of dimensions, but this also made it the most interesting one to complete.

Appendix

The contents of the appendix in order are as follows:

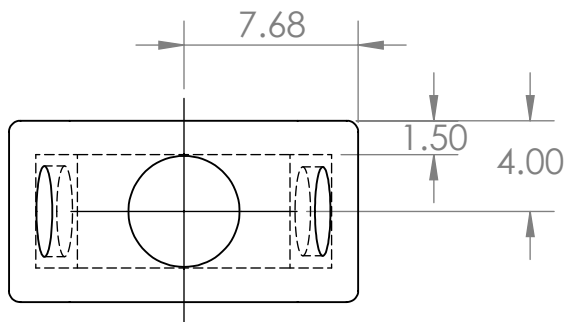
1. Solidworks drawing of the head
2. Solidworks drawing of the torso
3. Solidworks drawing of the waist
4. Solidworks drawing of the hand
5. Solidworks drawing of the assembly
6. Undimensioned Solidworks drawing of the legs
7. Undimensioned Solidworks drawing of the arms
8. Copy of the signed project proposal



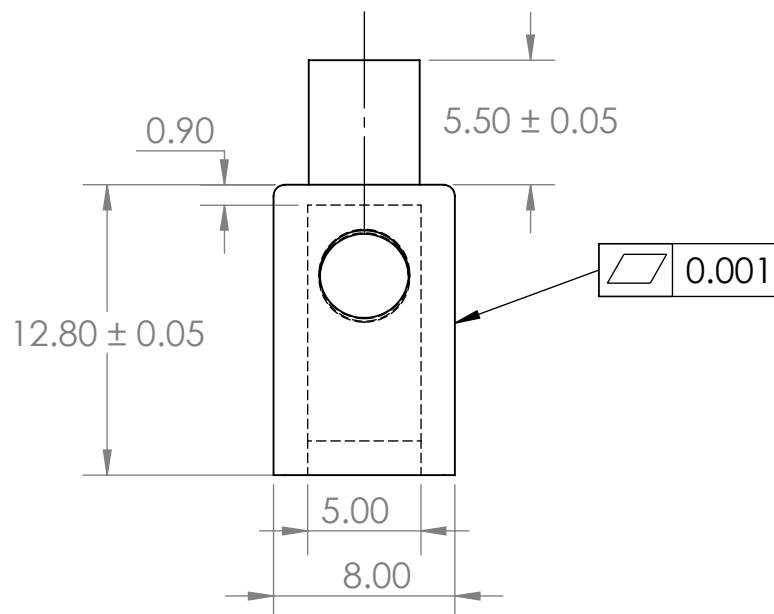
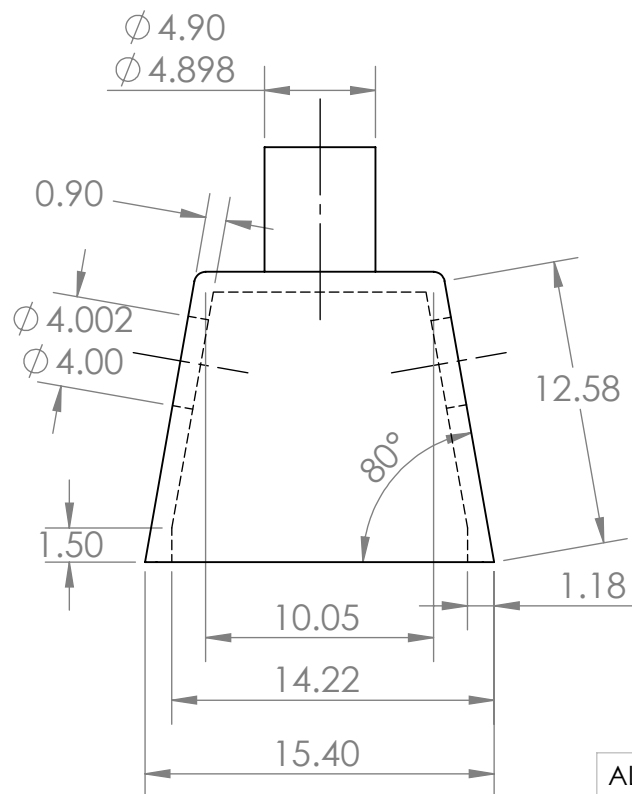
SECTION A-A

SCALE 4 : 1

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DO NOT SCALE DRAWING ALL DIMENSIONS IN mm		DRAWING TITLE Minifigure Head				
DRAFTED BY:	Maxwell Norris					April 10, 2021
ENGINEERED:	30094011					
ADDITIONAL APPROVAL						
ADDITIONAL APPROVAL		SIZE A	CAGE CODE	DWG. NO.	REV	
ADDITIONAL APPROVAL		SCALE: 4:1	WEIGHT:	SHEET 1 OF 1		



All R = 0.5mm \pm 0.0005 unless otherwise stated.



ALL TOLERANCES \pm 0.005mm
AND \pm 0.1 deg UNLESS
OTHERWISE NOTED

DO NOT SCALE DRAWING
ALL DIMENSIONS IN mm

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ENGINEERED: 30094011

ADDITIONAL APPROVAL

ADDITIONAL APPROVAL

NAME ENME339 Ltd.,
University Dr. 2500, Calgary, AB T2N 1N4

DRAWING TITLE

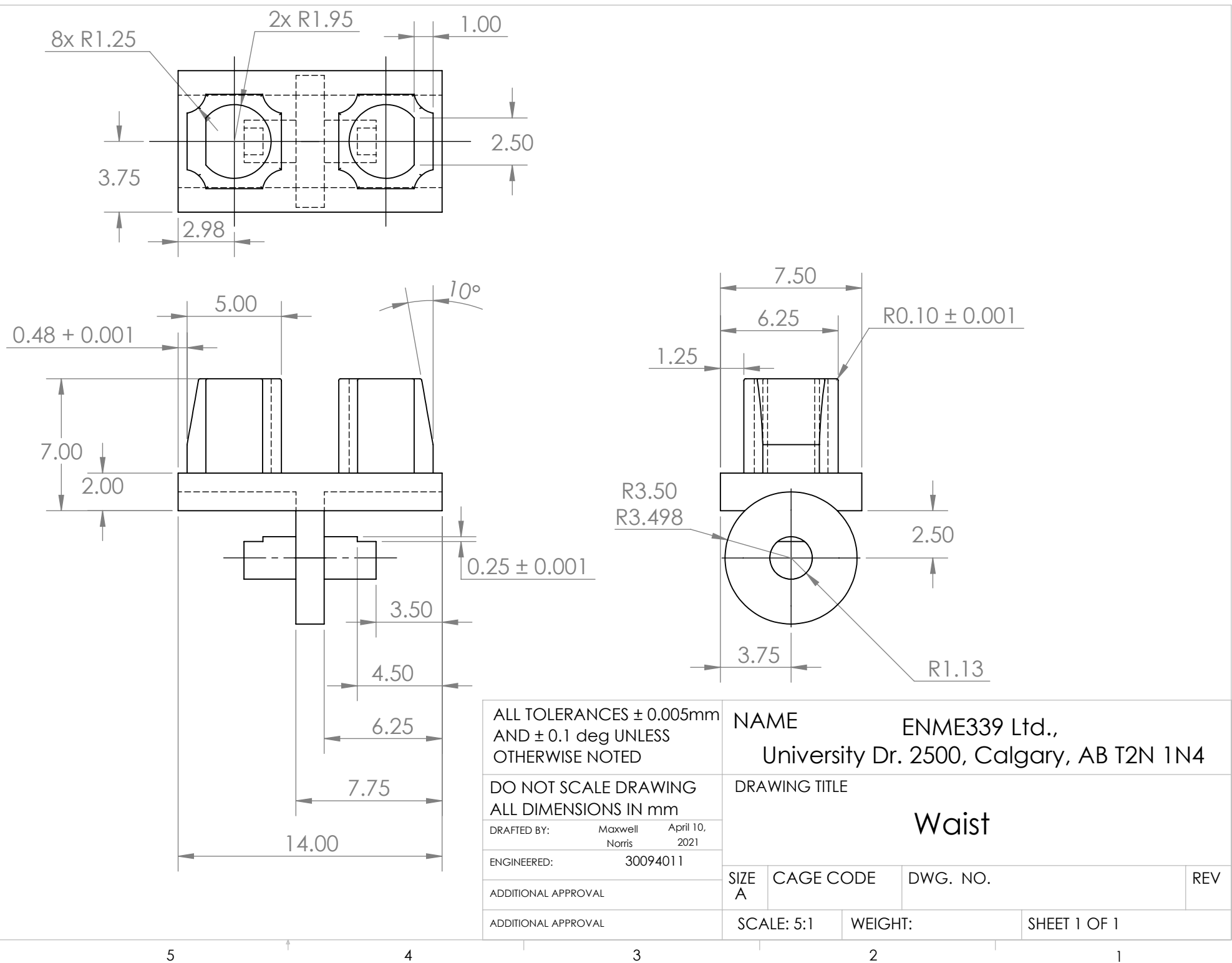
Minifigure Torso

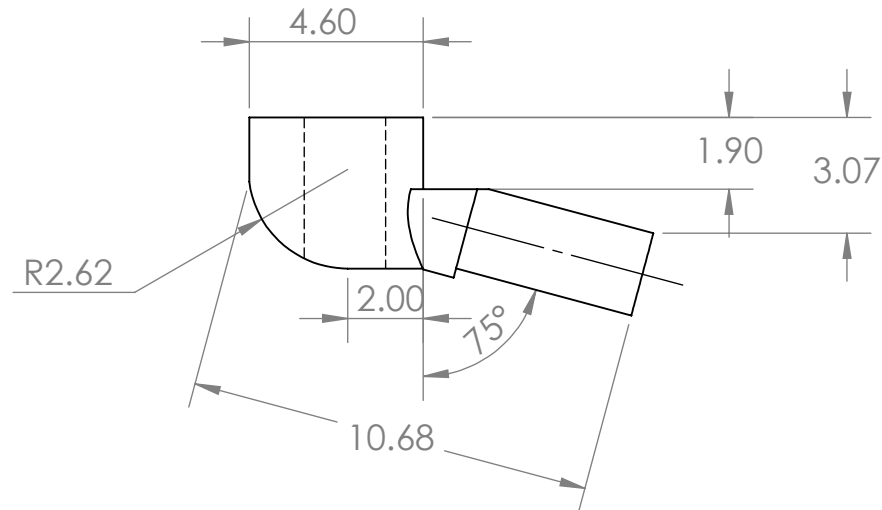
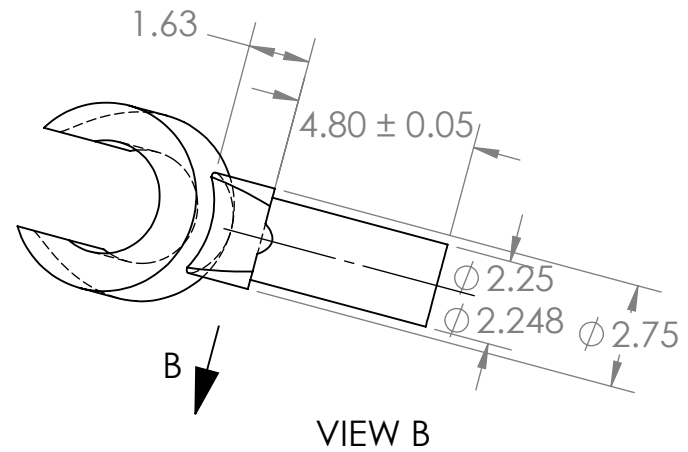
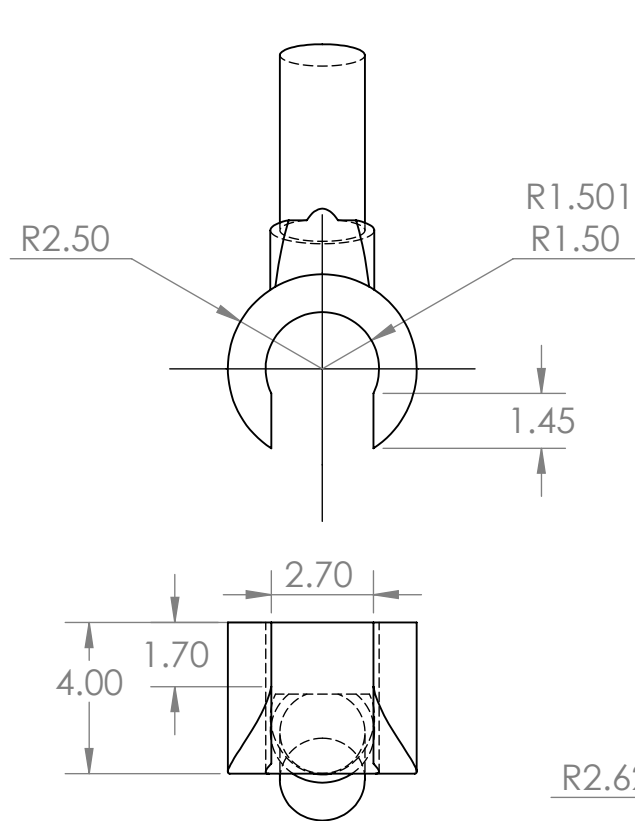
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SCALE: 2:1

WEIGHT:

SHEET 1 OF 1





ALL TOLERANCES $\pm 0.05\text{mm}$
AND ± 0.5 deg UNLESS
OTHERWISE NOTED

DO NOT SCALE DRAWING
ALL DIMENSIONS IN mm

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ADDITIONAL APPROVAL

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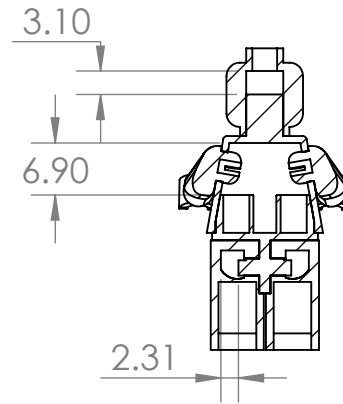
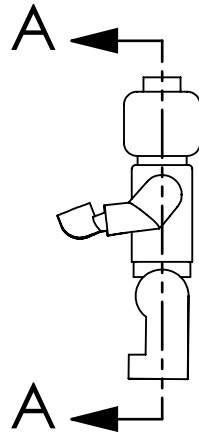
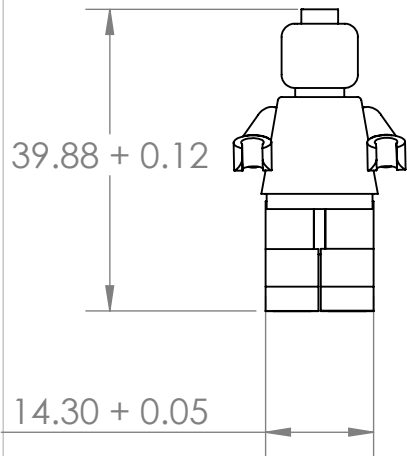
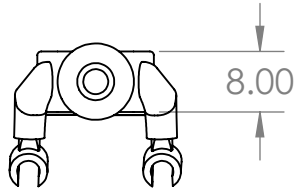
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University Dr. 2500, Calgary, AB T2N 1N4

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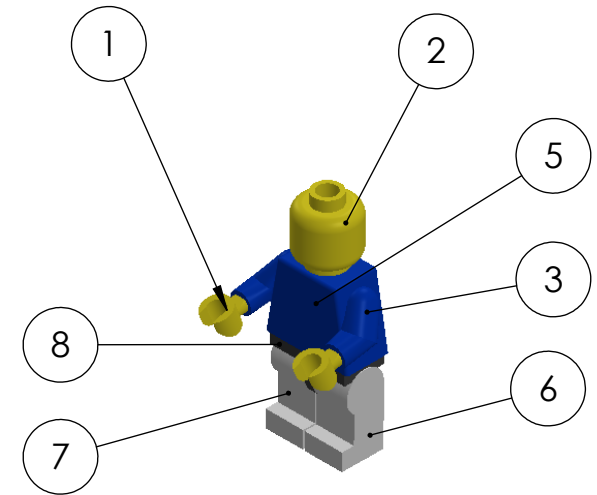
Minifigure Hand

SIZE A	CAGE CODE	DWG. NO.	REV
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SCALE: 5:1	WEIGHT:	SHEET 1 OF 1
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SECTION A-A

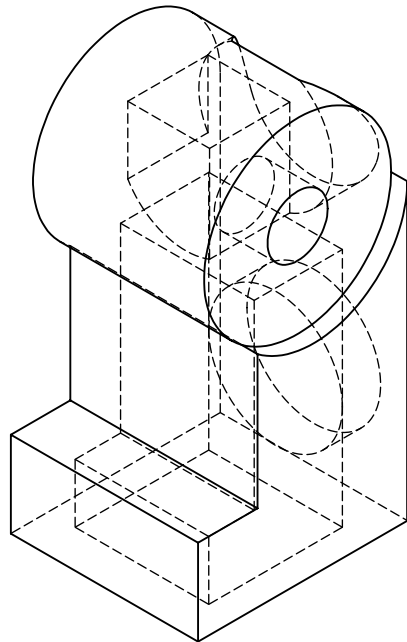


ITEM NO.	PART NUMBER	manual explode/QTY.
1	Hand	2
2	head	1
3	left_arm	1
4	right_arm	1
5	torso	1
6	left_leg	1
7	right_leg	1
8	Waist	1

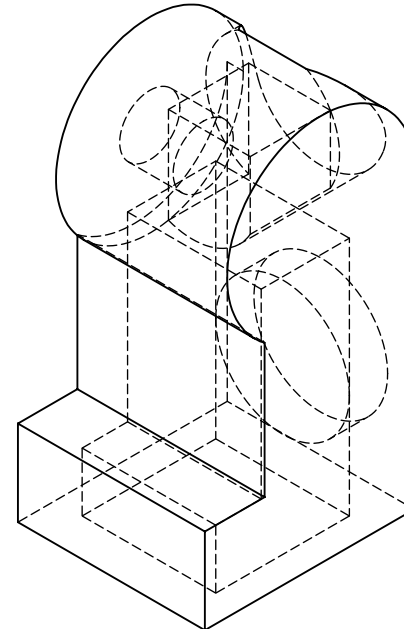
Note: While Left and right arms/legs are listed as differnet parts, they are mirrors of eachothere.

ALL TOLERANCES ± 0.005mm UNLESS OTHERWISE NOTED		NAME ENME339 Ltd., University Dr. 2500, Calgary, AB T2N 1N4				
DO NOT SCALE DRAWING ALL DIMENSIONS IN mm		DRAWING TITLE Minifigure				
DRAFTED BY:	Maxwell Norris					April 10, 2021
ENGINEERED:	30094011					
ADDITIONAL APPROVAL						
ADDITIONAL APPROVAL		SIZE A	CAGE CODE	DWG. NO.	REV	
ADDITIONAL APPROVAL		SCALE: 1:1	WEIGHT:		SHEET 1 OF 1	

Right Leg

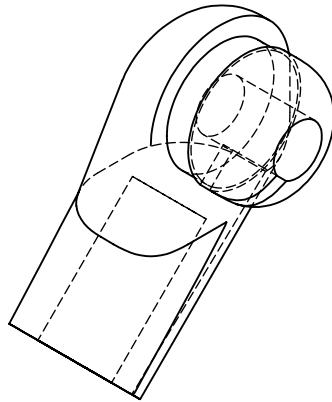


Left Leg

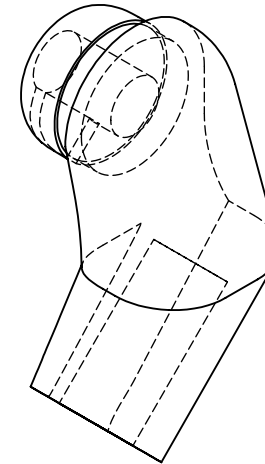


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DO NOT SCALE DRAWING ALL DIMENSIONS IN mm		DRAWING TITLE Minifigure legs				
DRAFTED BY: Maxwell April 10, Norris 2021						
ENGINEERED: 30094011						
ADDITIONAL APPROVAL						
ADDITIONAL APPROVAL		SIZE A	CAGE CODE	DWG. NO.		REV
ADDITIONAL APPROVAL		SCALE: 5:1		WEIGHT:		SHEET 1 OF 1

Right Arm



Left Arm



ALL TOLERANCES $\pm 0.005\text{mm}$ UNLESS OTHERWISE NOTED		NAME ENME339 Ltd., University Dr. 2500, Calgary, AB T2N 1N4						
DO NOT SCALE DRAWING ALL DIMENSIONS IN mm		DRAWING TITLE Minifigure arms						
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SCALE: 5:1	WEIGHT:				SHEET 1 OF 1			
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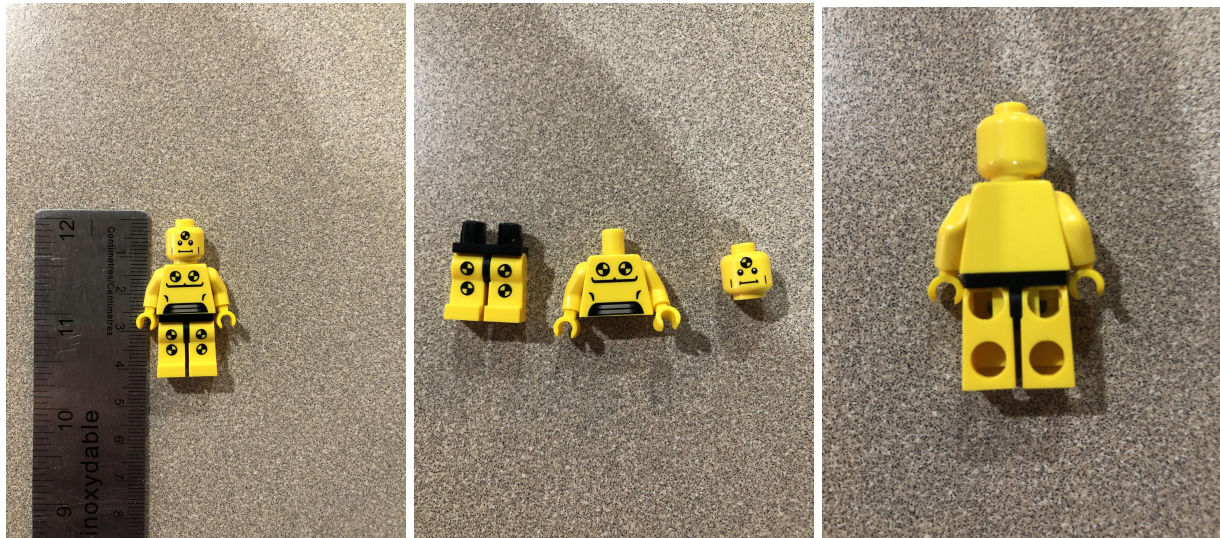
Project Proposal: Lego Minifigure

Project Title: Lego Minifigure

Name: Maxwell Norris

Student ID: 30094011

Photos:



Description:

The LEGO Minifigure is a buildable humanoid toy action figure made of abs plastic. It is one of the most common features included in any LEGO product, one of the most well known toy brands of all time. They come in a variety of colours, with a variety of objects they can hold in their hands, or hair and helmets that can attach to their head. However, the basic structure of all Minifigures is always the same and shown in the photo above.

The design consists of a head, a torso, two arms, two hands, two legs and a waist piece. The pieces can be assembled and reassembled with ease allowing for the mixing and matching of parts. The pieces are held together using mainly friction or custom clips. The minifigure is approximately 4cm tall, 2.5cm wide (at its widest) and 0.8cm thick.

Bill of materials:

Abs, the plastic that the minifigure is made out of, can cost around 1-4\$ per Kg on alibaba <https://www.alibaba.com/showroom/abs-price-per-kg.html>. It is sold in granules that can be melted down and poured into a mold to create the product. The minifigure weighs approximately 3g, so the resulting price for 1 minifigure would be around 0.003-0.012\$ if we consider only the cost of materials.

Total Part Count:

1x head
1x torso
1x waist
2x hands
1x left arm
1x right arm
1x left leg
1x right leg

Project Working Plan:

March 15 - 19

- Begin modelling of each part

March 22 - 26

- Finish modeling the parts
- Begin work on drawing

March 29 - April 2

- Finish drawings and begin report

April 5 - 9

- Finish report and review all work in preparation for project submission
- Submit prior to April 12 and 6:00 pm

P7