



Team 10B: Automatic Lego Sorting Machine

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Summary

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- ▶ Functional Model
- ▶ Black Box Model
- ▶ Design Description and BOM
- ▶ Analysis
 - ▶ Conveyor Belts
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- ▶ Budget
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Project Description

- ▶ To design an Automatic Lego Sorting Machine
- ▶ Sort Legos by type of brick, plate, rail, and specialized pieces
- ▶ Dump N' Go

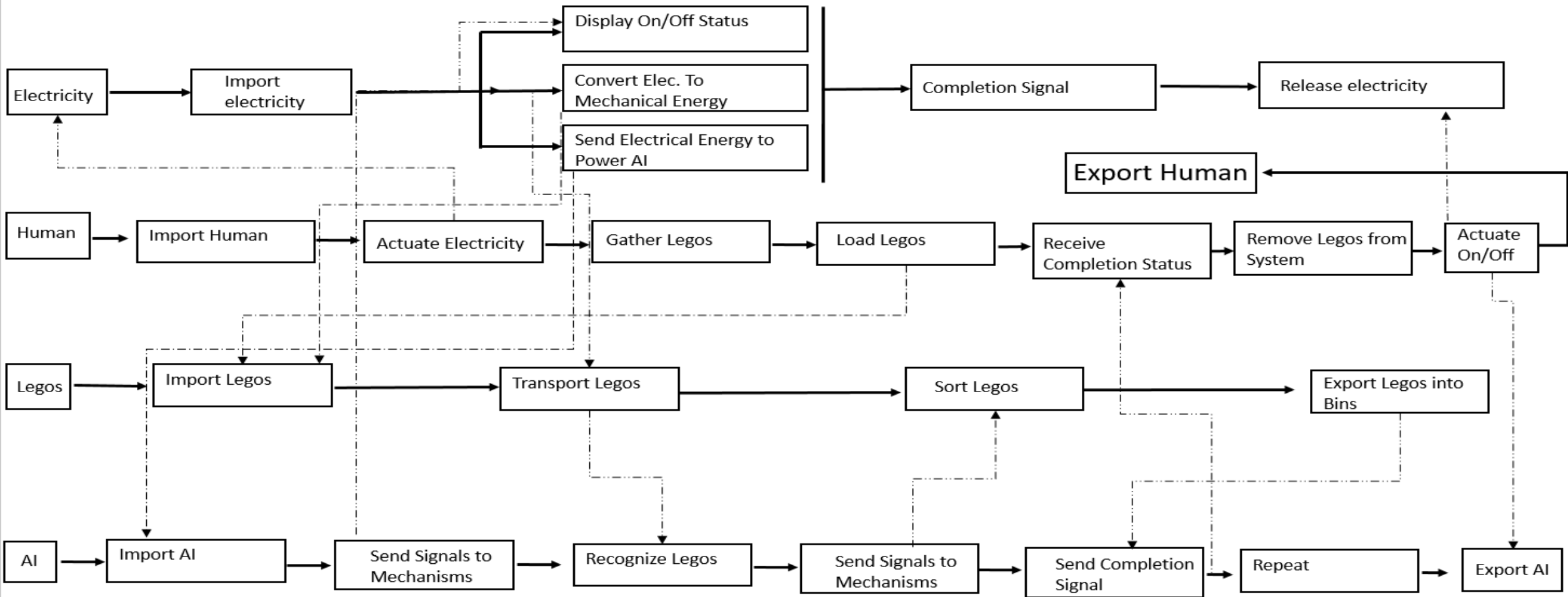
Client – David Willy



Black Box Model

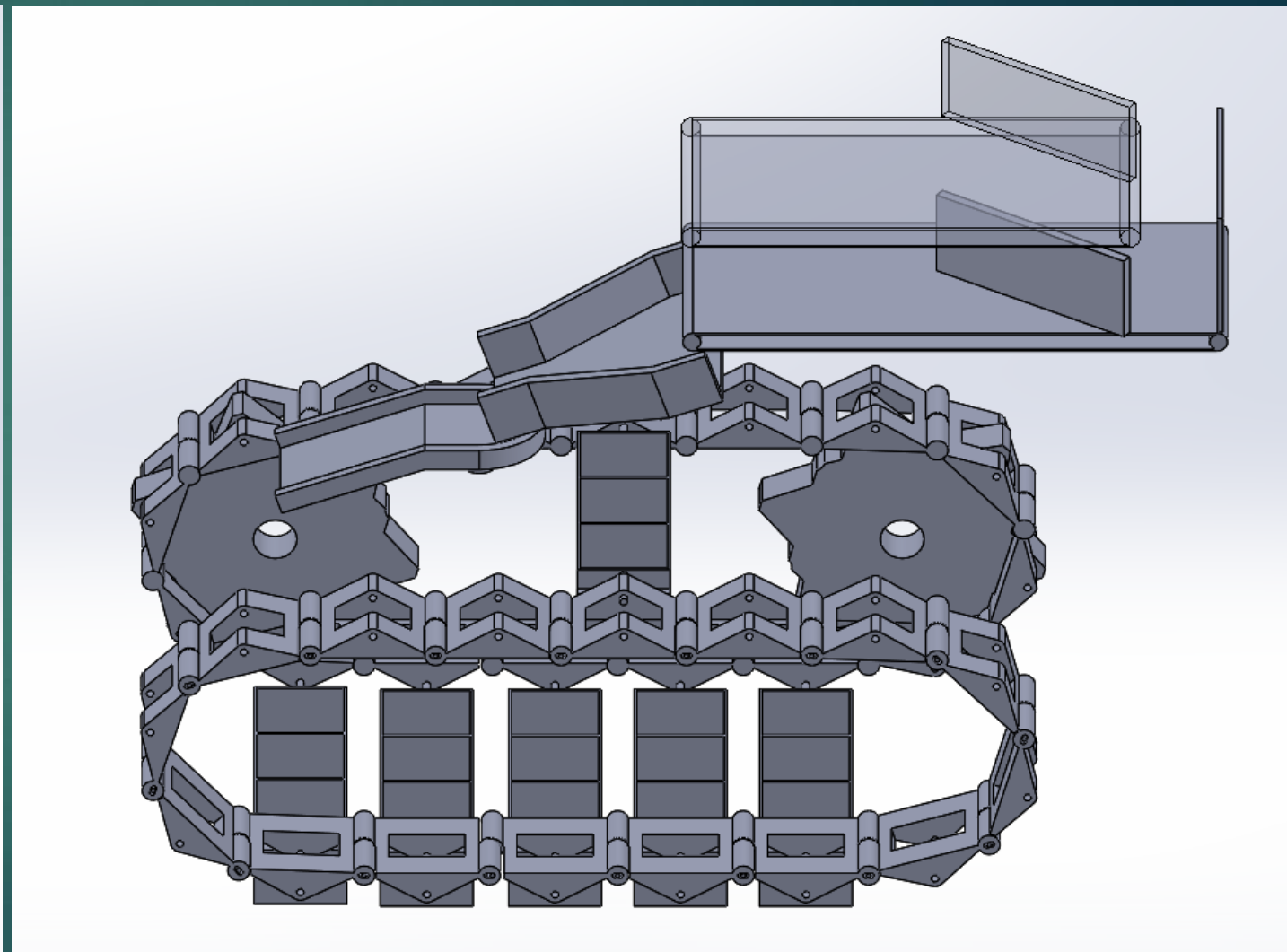
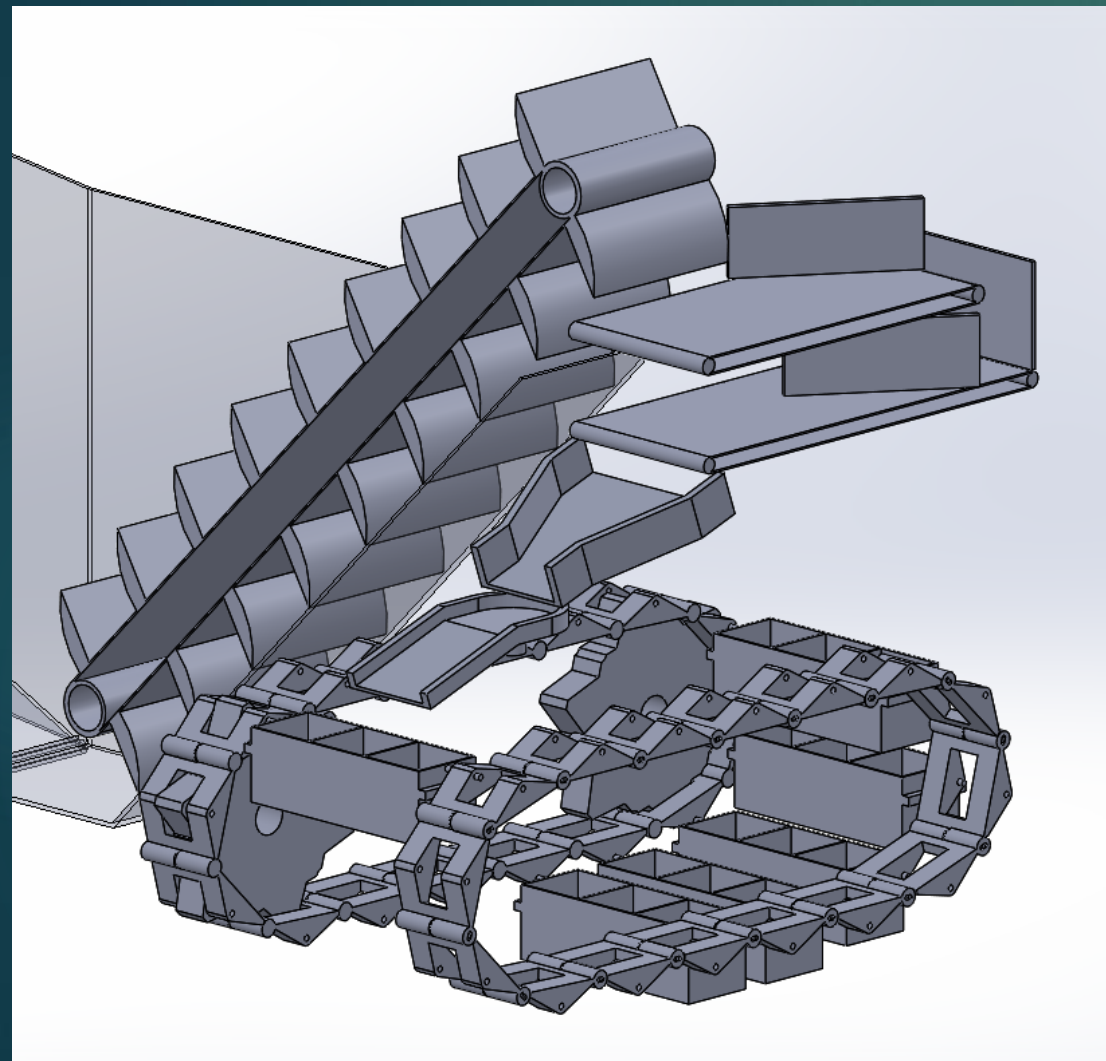


Functional Model



Design Description

► CAD Model



Bill of Materials

Item #	Description	Vendor	Part Number	Quantity	Price USD	Total Spent USD
1	CanaKit Raspberry Pi 3 complete Starter Kit - 32 GB Edition	Amazon	ASIN: B07BCC8PK7	1	79.99	166.59
2	Raspberry Pi Camera Module V2-8 Megapixel, 1080p	Amazon	N/A	1	29.95	
3	Aobbmok 12V 12RPM BLDC Electric Brushless Geared DC Motor CW/CCW Dia 37mm	Amazon	1212DE- BL3625	1	24.99	
4	Aobbmok 12V 66RPM Brushless Gear Motor DC	Amazon	1266DE- BL3625	1	29.99	
5	TOOGOO(R) 626Z 6mm x 19mm x 6mm Shielded Radial Miniature Deep Groove Ball Bearing 5 Pcs	Amazon	9246	1	1.67	

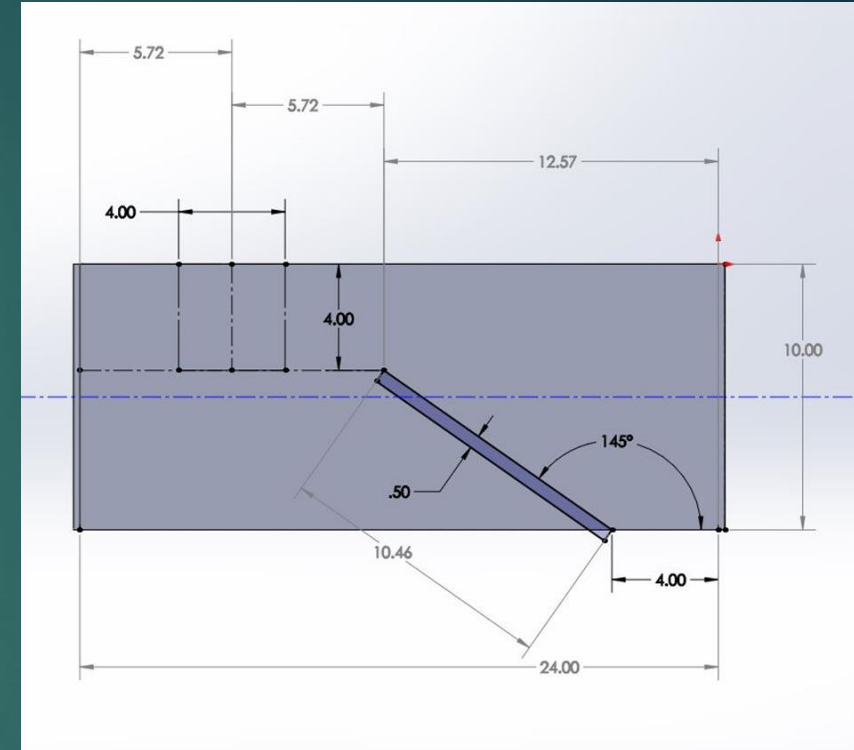
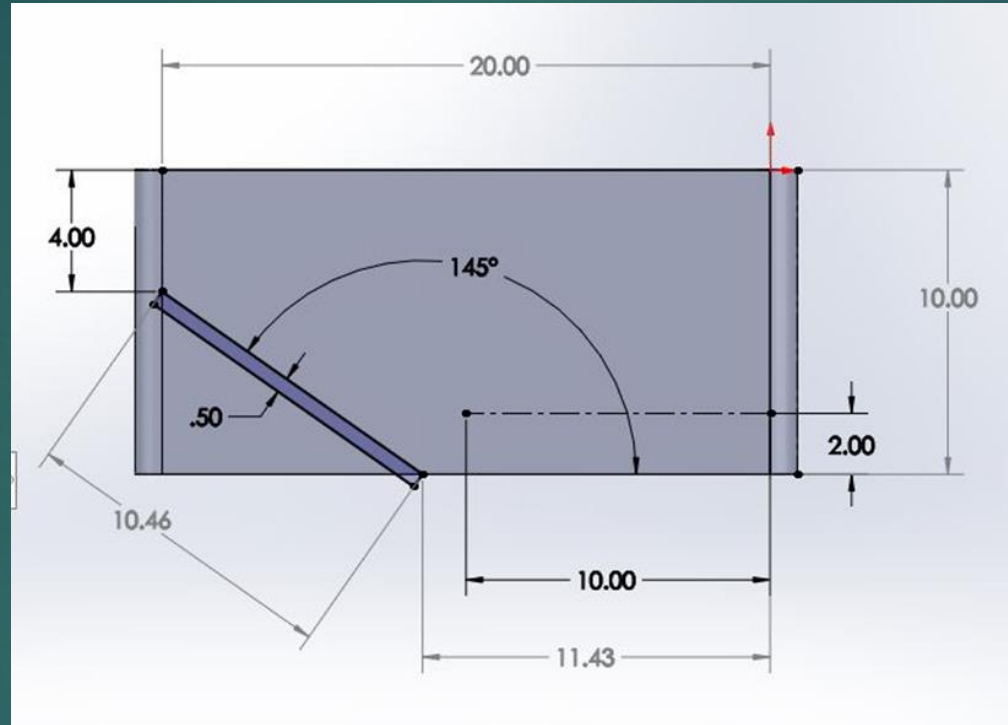
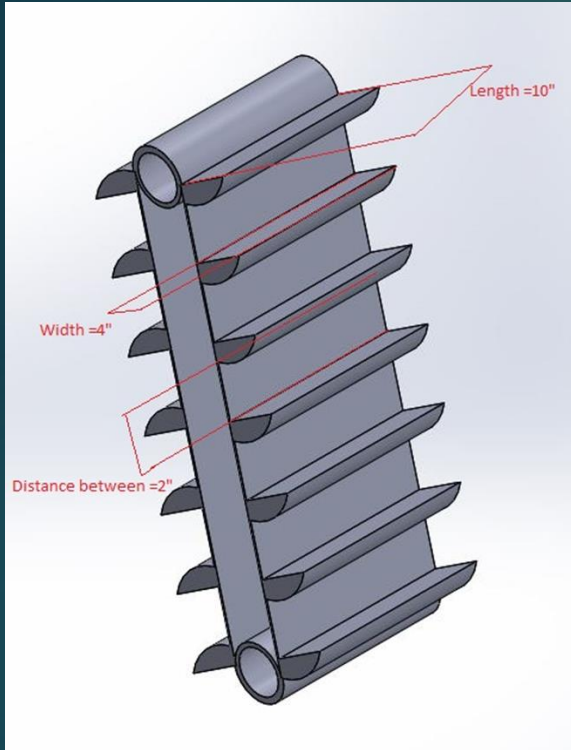
Motor Analysis

- ▶ Considerations:
 - ▶ Brushless motors preferred over brushed motors
 - ▶ Runs on 12 VDC and >4 Amp Power
 - ▶ Feedback signal desired
 - ▶ Integrated Gearbox
 - ▶ Output for one motor rotates 5X faster than the other
- ▶ Torque Equation

$$T = \frac{1}{2} \left(\frac{(V * 60)}{\pi * \omega(RPM)} \right) \mu W g$$



Conveyor Belt Analysis



- ▶ Lift Release Time

$$Rt_{Lift} = \frac{Length}{\left(\frac{Step\ size}{V_{Lift}}\right)}$$

- ▶ Belt Diameters

$$D = \frac{\left(\frac{Velocity}{RPM * \frac{1min}{60sec}}\right)}{\pi}$$

- ▶ Load on Belts

- ▶ Assume 2x2 Lego = 15.8mm_{long}

$$Load = mg * Long^2 * \left(\frac{Lego\ travel\ time_{max}}{interval\ time}\right)$$

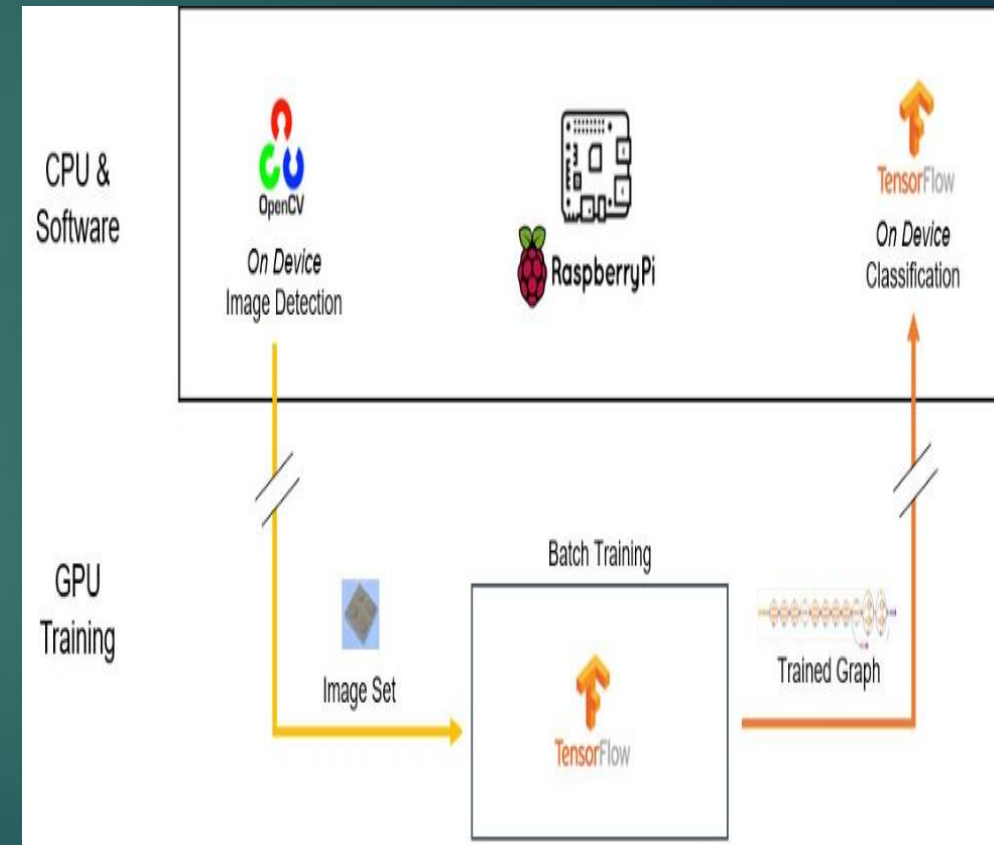
- ▶ Torque Load

$$T_L = \frac{F * D}{2 * \eta * i}$$

- ▶ Negligible TL

Image Recognition Analysis

- ▶ Hardware: Raspberry Pi 3 B+ with 1 GB RAM
- ▶ Software: OpenCV (image detection) coupled with TensorFlow (image classification)
- ▶ Results: Imaging processing uses around 50-65% of RAM and runs at 1-1.5 fps which is enough for real time object Lego sorting.
- ▶ It is important to note that extra cameras added to the system would likely use the rest of the systems RAM unless the neural network can be optimized to reduce RAM consumption (highly unlikely)



Design Requirements

- ▶ Easy Transportation
- ▶ Large Lego Capacity
- ▶ Intuitive Operative
- ▶ Minimum Human Interaction
- ▶ Must Not Be Made of Legos
- ▶ Robust and Safe
- ▶ Runs on Standard Wall Power
- ▶ Must Sort Large Variety of Legos

Budget

▶ Total Budget \$500

➤ Expected Spending

- Motors and Servos \$100
- Structure and Framework \$110
- Conveyor belts / Mechanical Elements \$85
- Raspberry Pi and Camera \$105
- Hardware \$60
- Miscellaneous electronics \$40

➤ Already Spent

- Motors and Servos \$52
- Raspberry Pi and Camera \$105
- Hardware \$2

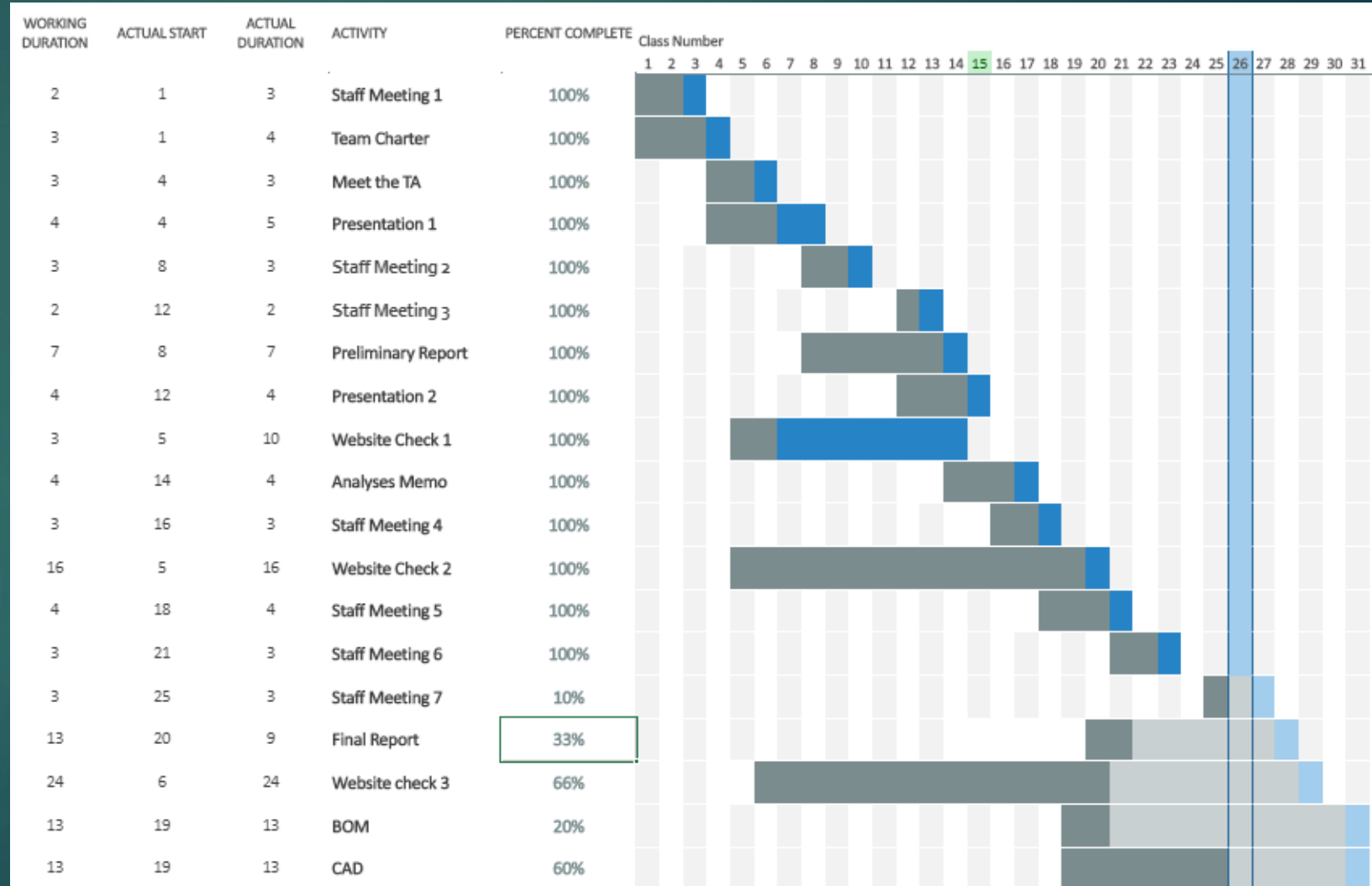
Schedule

On Schedule

- CAD
- Staff Meeting 7

Slightly Behind Schedule

- BOM
- Final Report
- Website Check 3





Questions?