SparkFun Autonomous Vehicle Competition 2018

Logistics Class – Rules v1.1

1. Overview

1.1. Task vs. Time: Each team will have 10 minutes to complete all tasks. Time will only be used to break a tie, in which case the shortest time wins. Performing compounded tasks fully autonomously will award the most points.

1.2. LIntent: In an effort to capture the nature of autonomous in-warehouse vehicles, the course will require robots to perform a number of tasks, including starting on a signal, picking up objects for delivery, dropping off objects in a designated zone, orienting objects and delivering the objects to a predetermined location. Robots can perform any or all of the tasks for points, but each task builds on the previous, so they should be done in order.

1.3. Autonomy: optional. Each task may be completed with or without human intervention (i.e., fully autonomously) Tasks completed autonomously will be scored with a multiplier applied to earned points. Robots may run the entire course teleoperated (remote control).

1.4. Piecemeal: The Logistics Class challenge was created to be extremely difficult. Teams can choose to tackle some tasks autonomously and others via remote control in the same heat.

1.5. One-at-a-Time: Only one robot will be allowed to compete at a time per heat.

1.6. Disclaimer: These rules are subject to change up until the day of the first race. On race day(s), referee rulings will be final. Latest rules can be found on avc.sparkfun.com and https://forum.sparkfun.com/viewtopic.php?f=56&t=48264.

2. Robot Requirements

2.1. Weight: The freight class autonomous/semi-autonomous vehicle must be less than 100 lbs. This is set to mitigate any dangers a heavy vehicle might pose to nearby spectators.

2.2. Size: Width $\leq$ 4 ft.; Length $\leq$ 4 ft.; Height $\leq$ 3 ft.; (before start of each heat). The robot size is limited to provide a challenge for lifting, moving, carrying, etc. objects (and to fit through a predefined starting area).

2.3. Remote Kill Switch to be demonstrated at check-in.

2.4. No part of the robot may leave the ground (e.g., no detachable flying drones). As cool as this would be, we have audience safety to consider.

2.5. Extra batteries are not required but strongly encouraged. Teams that miss a heat because the batteries are dead will not be allowed a makeup heat.

2.6. Only one person from the team is allowed to operate the robot during a heat. This person is known as the “Operator” for the remainder of this document.

2.7. If a person touches the robot during a heat, the heat will immediately end. Any points earned up to that point during the heat will be awarded.

3. Course

See appendix for diagram

3.1. The course layout drawing shows the basic course overview with the sections, labeled. The idea is to mimic the production of a SparkFun RedBoard. Start by retrieving components stored in the warehouse facility and delivering them to the pick and place machine in the production facility. The machine will produce a final product ready for pickup at the opposite end. Transport this product to the testing machine. Upon a successful test, the machine displays and transmits a number for the final delivery location. Deliver the product to the shipping box with that number in the warehouse facility.

3.2. Track Description

3.2.1. Starting Line

3.2.1.1. Shown by the black-and-white checkered bar in the warehouse.

3.2.1.2. Vehicles must start with their front behind the bar, facing into the warehouse.

3.2.1.3. A starting signal will be placed facing the robot in the corner of warehouse.

3.2.1.4. The starting signal will be a 2-foot circle with one side painted green 1 foot above the hay bales just to the left of the starting line.

3.2.1.5. At the start of the heat, the starting signal sign will flip to the green side.

3.2.2. Track

3.2.2.1. The track is a figure-eight layout with a major axis length of approximately 178 feet and a minor axis of approximately 78 feet.

3.2.2.2. Track width is 16 feet.

3.2.2.3. Track extents are defined by hay bales.

3.2.2.4. Vehicles may take any route between the facilities.

3.2.3. Facilities

3.2.3.1. Two mirrored facilities (Warehouse & Production) – They're not covered in mirrors; Warehouse is a mirror image of Production.

3.2.3.2. Each will have a 6-foot-wide entrance (shown by a break in the inner walls of the figure 8 track). The real entrances will be marked with a broad black line.

3.2.3.3. Warehouse

3.2.3.3.1. The warehouse has two shelves. Each measures 1 foot deep, 8 feet long, and 8 inches above the ground.

3.2.3.3.2. The raw material shelf contains 2 red boxes. They sit randomly dispersed along the center of the depth. The wide side of the box is parallel to the wide side of the shelf.

3.2.3.3.3. The finished product shelves have sections numbered 0 through 7. Sections measure 1 foot square.

3.2.3.4. Production

3.2.3.4.1. Producing a RedBoard in this scenario requires two machines: the pick-n-place machine and the test bed.

3.2.3.4.2. The pick-n-place input is closest to the entrance.

3.2.3.4.3. The test bed faces the pick-n-place.

3.3. Boxes

3.3.1. All boxes are our smallest SparkFun red boxes, measuring 7 ¼" wide by 4 ⅞" deep by 1 ¾" tall.

3.3.2. Each box has a stack of 2 magnets at the center of the top. The magnet's north pole faces up. The top side is the largest face that hinges to form a lid. The magnet is on our store https://www.sparkfun.com/products/8643.

3.3.3. Each box lid is glued shut to ensure they do not inadvertently open.

3.3.4. Each box weighs 6 oz (170 g). The weight is fixed inside the box so it will not shift.

3.3.5. The finished product box additionally has 2" copper tape covering the bottom side, bottom being the large face opposite the lid.

3.4. Manufacturing Machines
See appendix for diagram

3.4.1. Pick-n-place

3.4.1.1. This machine takes two boxes in the input zone and “produces” one box its output. It is meant to resemble the processes of solder pasting, component placement, reflowing and cleaning. It is grossly oversimplified.

3.4.1.2. The input and output zones are 12 inch by 18 inch rectangles, and 8 inches from the ground. These surfaces are parallel to the ground.

3.4.1.3. Between the input and output is a 24 inch covered section that houses many super advanced technologies that convert the raw materials into the finished product.

3.4.1.4. Finished products in the output zone

3.4.2. Test Bed

3.4.2.1. This machine verifies completion of a simple circuit and then displays a number for delivery in the warehouse. This machine represents testing, repair and packaging.

3.4.2.2. The test surface is a 12 inch square, 8 inches above and parallel to the ground.

3.4.2.3. Test leads of the top detect the copper taped surface of the finished product. The checker grid arrangement of test leads allows the bot to place the box on almost any two leads to complete the circuit.

3.4.2.4. Resulting Number

3.4.2.4.1. A successful test will produce a randomly selected number from a range of 1 to 7.The number also transmits by XBee for the sake of automated bots. (Transmission details coming soon)

3.4.2.4.2. The number displays on a vertical panel parallel to the back of the machine.

3.4.2.4.3. Numbers displayed and transmitted will remain available until the end of the heat.

4. Tasks

4.1. Teams may complete the following tasks only once to earn points.

4.2. *Start:* The robot should cross from the starting line completely.

4.2.1. A green signal will indicate the start of the heat.

4.2.2. A ZigBee (XBee) string “GO” will broadcast to indicate the start of the heat. (Transmission details coming soon)

4.3. *Pickup:* The robot must pick up two boxes from the raw material shelf.

4.3.1. Each box must be completely away from the shelf to earn points.

4.3.2. Teams may only complete this task once.

4.4. *Transport to Production:* The robot must move both boxes to the production facility.

4.4.1. A box must be completely inside its destination facility to count for points. Boxes can still be attached to the robot to count.

4.4.2. The robot may deliver a box to its destination in any way, so long as it does not violate the Robot rules (section 2).

4.5. *Deliver to Manufacture:* The robot must place boxes onto the pick-n-place input.

4.5.1. Each box must completely rest within the input surface perimeter.

4.6. *Pickup Finished Product*: The robot must pick up one finished product box from the pick-n-place output.

4.6.1. The box must be completely away from the output to earn points.

4.7. *Test*: The robot must place the finished product on the test bed in correct orientation.

4.7.1. The finished product box must complete the circuit of the test bed to earn points.

4.7.1.1. Other objects that complete the circuit will cause test points to be forfeit.

4.7.1.2. In event of false test, 0 (zero) is the destination shelf.

4.7.2. Correct orientation is copper side down.

4.7.3. Completing the circuit is accomplished by placing the copper covered side of the finished product on a sufficient number of leads.

4.7.4. Read number produced by the test bed. That's the destination for final delivery.

4.8. *Transport to Warehouse*: The robot will take the finished product to the warehouse.

4.8.1. A box must be completely inside its destination facility to count for points. Boxes can still be attached to the robot to count.

4.8.2. The robot may deliver a box to its destination in any way, so long as it does not violate the Robot rules (section 2).

4.9. *Deliver to Destination Shelf*: The robot must put the finished product on the finished product shelf.

4.9.1. The robot must release the finished product box completely within the bounds of the shelf section to earn points.

4.9.2. The number specified by the test bed is the target section for the finished product. The bot must place the finished product in the shelf section with the same number to earn full points.

4.9.3. The robot may deliver the finished product shelf section 0 for partial points.

4.9.4. Only one shelf section delivery may earns points.

4.10. *Get Back to Work*: The robot must cross the finish line.

4.10.1. The finish line is the same as the starting line.

4.10.2. The entire robot must cross the line in the direction of returning to the raw material shelf.

4.10.3. This event stops the timer.

5. Autonomy

5.1. Contestants may use remote control at any time during the heat to direct and control their vehicle.

5.2. The Operator must inform a judge that they intend to attempt a task autonomously before enabling autonomous mode on their robot.

5.3. To receive the autonomous bonus multiplier for the task, the Operator may not touch the vehicle's controls while the vehicle performs that task.

For example, you may pick up two boxes in the warehouse and then switch to autonomous mode before exiting the warehouse (after informing a judge that you are attempting the "Transport to Production" task autonomously). The robot navigates to the production facility on its own. Upon fully entering the production facility, you would be awarded points for transporting two boxes times the autonomous multiplier. Note that you would also receive points for picking up the two boxes, but no autonomous multiplier would be applied for that task.

5.4. If a robot does not complete a task autonomously (i.e., the Operator takes control of a robot midway through a task), then no multiplier is awarded (but base points for that task may still be awarded). All parts of a task must be completed autonomously in order to receive the multiplier bonus.

For example, moving one box out of their originating shelf autonomously but moving the second box with remote control will award base points for "pickup" for two boxes but no autonomous multiplier.

6. Scoring

6.1. Points will be awarded to individual tasks completed by the robot.

6.1.1. *Start:* 10 points for crossing the start line. 3x multiplier for autonomous (Max: 10 pts; Autonomous max: 30 pts).

6.1.2. *Pickup:* 10 points for each box (up to two boxes for section 4.3) moved entirely off of its originating shelf. 5x multiplier for autonomous (Max: 20 pts; Autonomous max: 100 pts).

6.1.2.1. All tasks beginning with the word “Pickup” are scored this way.

6.1.2.2. The “Pickup” tasks will start when a robot is within 10 feet of a shelf, or 2 feet of a machine.

6.1.3. *Transport:* 10 points for each box (up to 2 boxes for section 4.4) entirely within the opposite facility. 3x multiplier for autonomous (Max: 20 pts; Autonomous max: 60 pts).

6.1.3.1. All tasks beginning with the word “Transport” are scored this way.

6.1.3.2. The “Transport” task will start as soon as a box crosses onto the track.

6.1.4. *Deliver:* 10 points for each box (up to two boxes for section 4.5) placed within destination bounds. 5x multiplier for autonomous (Max: 20 pts; Autonomous max: 100 pts).

6.1.4.1. All tasks beginning with the word “Deliver” are scored this way.

6.1.4.2. The robot may not be touching a box at the end of the heat for it to count for points.

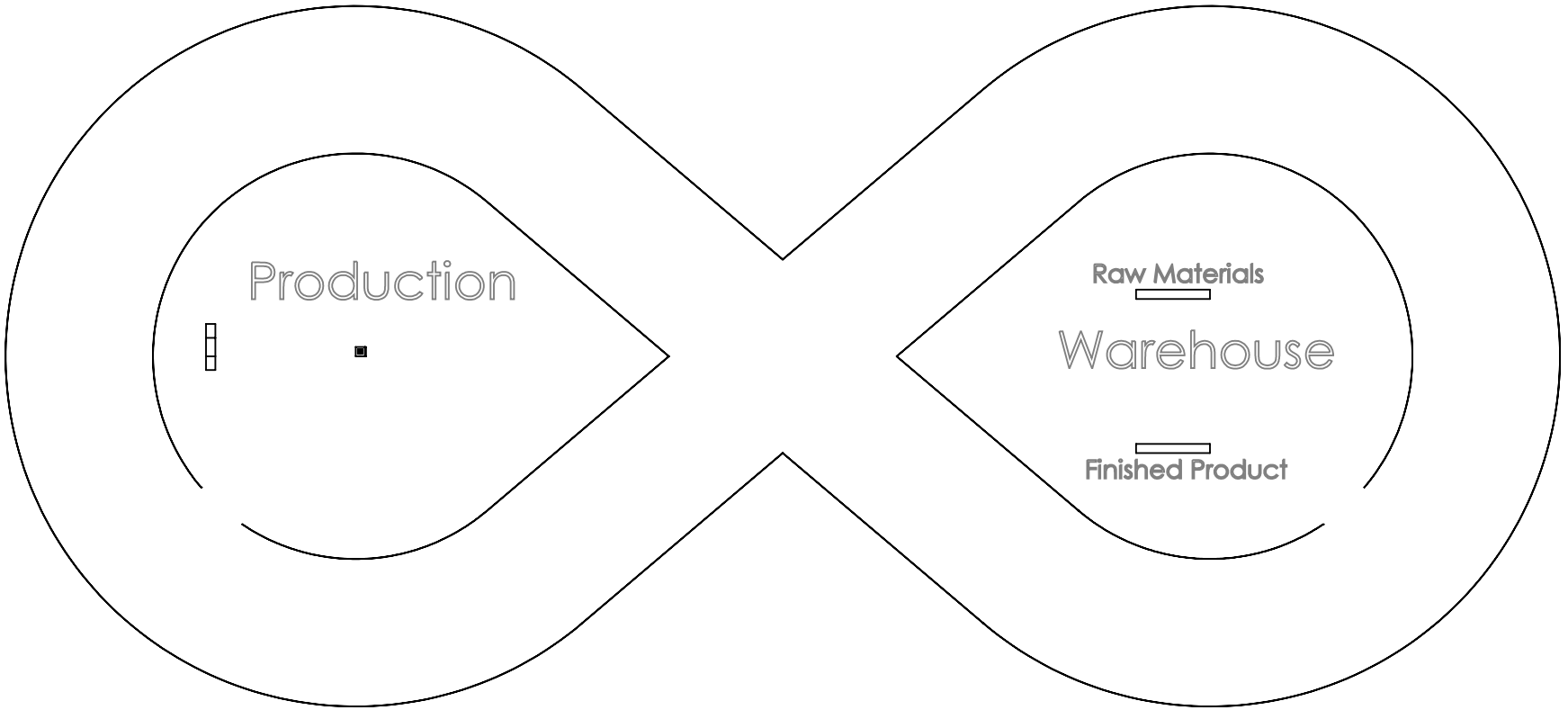
6.1.4.3. The “deliver” tasks will start when a robot is within 10 feet of a destination.

6.1.4.4. Delivering to shelf section 0 earns half points.

6.1.5. *Test*: 10 points for a successfully tested product.

Appendix

Drawings of the course and structures



TITLE:

AVC 2018 Logistics Class

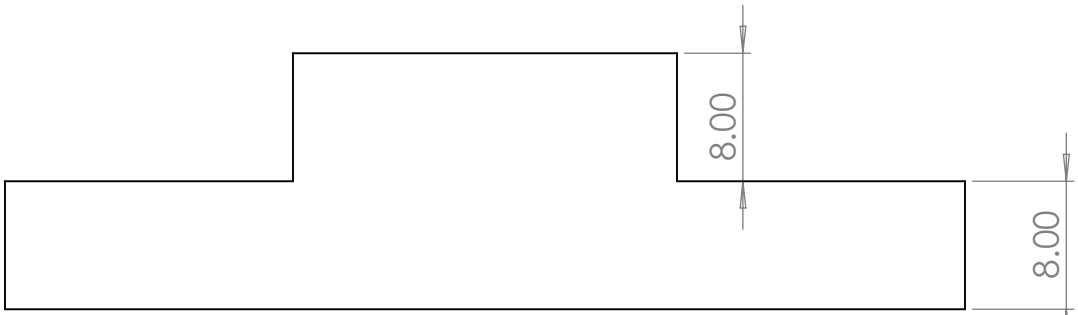
Drawing

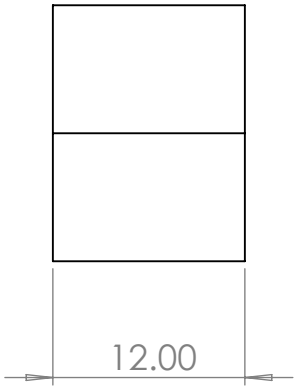
Course Layout

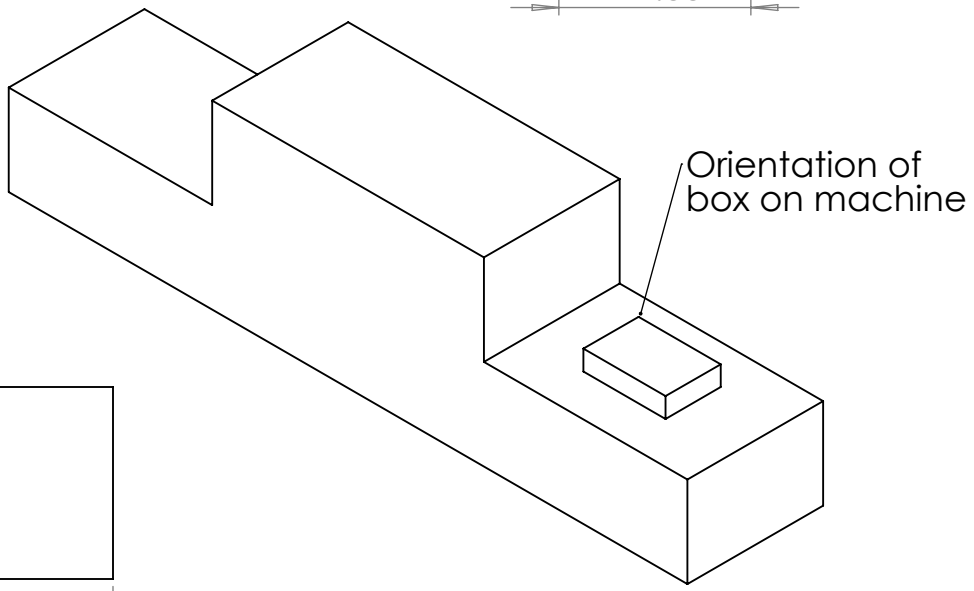
REV 2

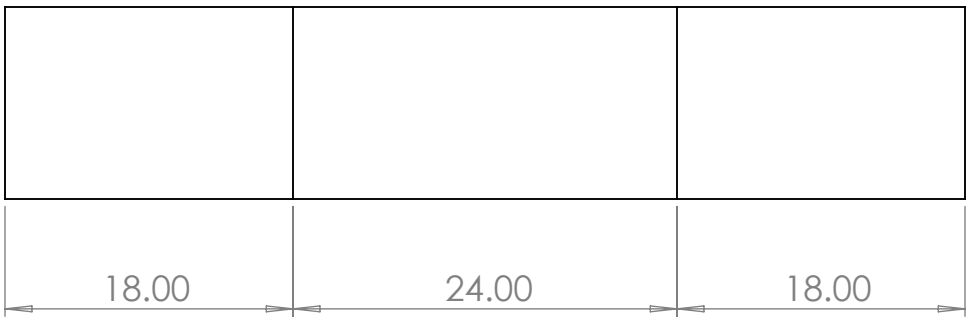
SparkFun Electronics

SHEET 1 OF 5









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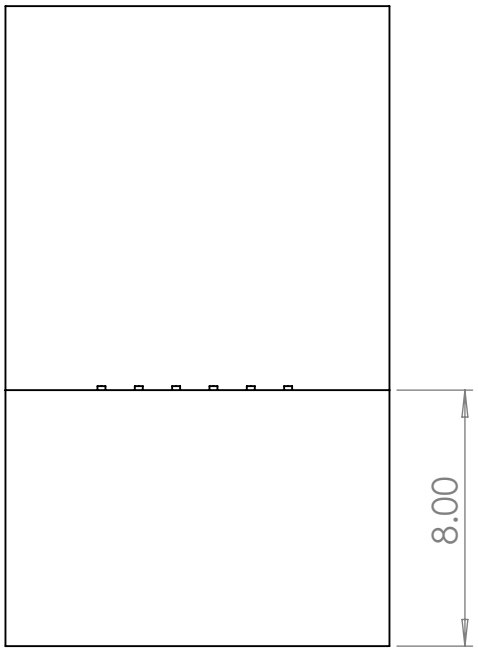
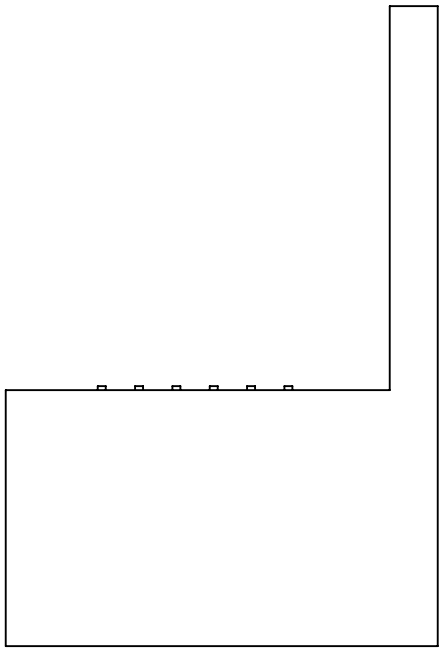
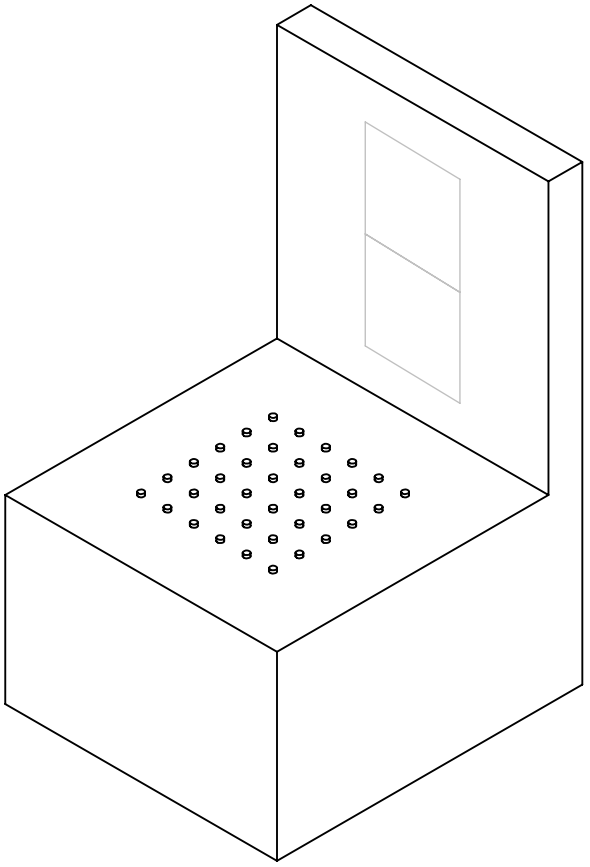
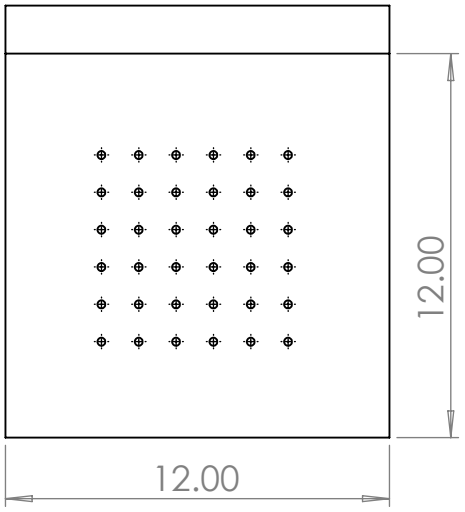
AVC 2018 Logistics Class

Drawing	REV
Pick-n-place	2
	SHEET 2 OF 5









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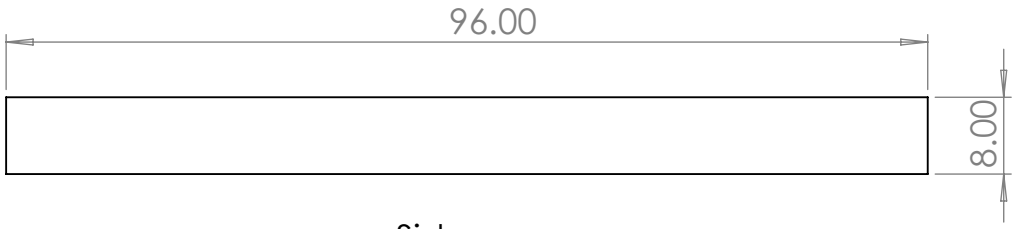
AVC 2018 Logistics Class

Drawing	REV
Test Bed	2

SHEET 3 OF 5



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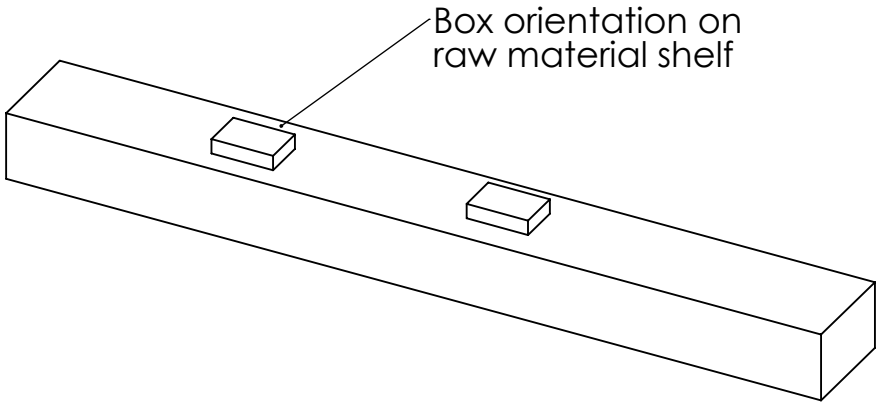
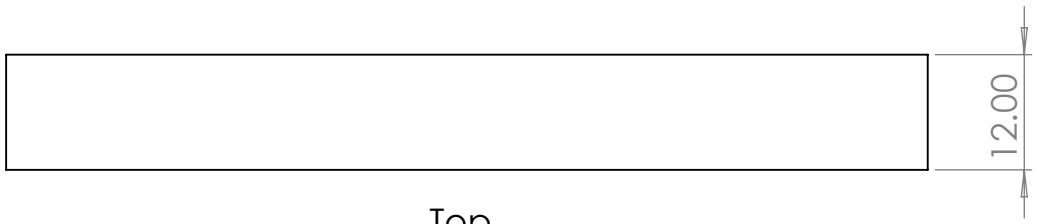


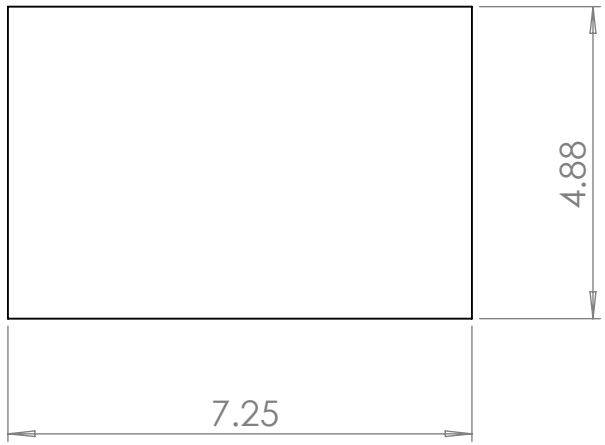


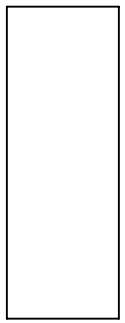
Top

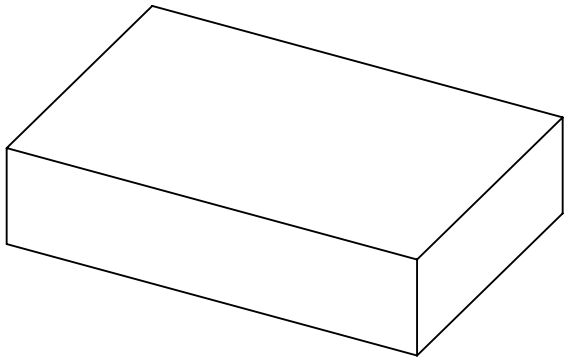
TITLE:

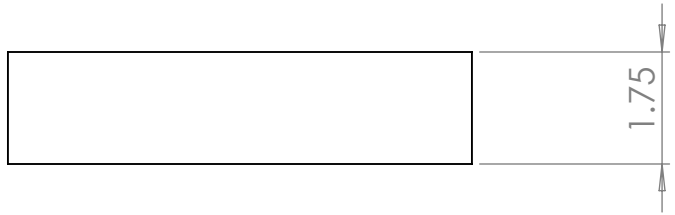
AVC 2018 Logistics Class

Drawing	REV
Shelf	2
	SHEET 4 OF 5









TITLE:

AVC 2018 Logistics Class

Drawing	REV
Box	2
	SHEET 5 OF 5