Spring Quarter Integration Project

BioComp, LL.C. has a need for a small robot to work in the company's cleanroom. The project is proprietary. Your team is competing for the contract to manufacture and maintain the robot. Your team must design and build an autonomous vehicle that can accomplish (capable of doing) all of the following three tasks

- Pickup-and-Place: Starting from a fixed location, the vehicle will approach a "pickup" platform. At the customer's discretion, a large or small, red or blue colored box will be placed on the pickup platform. The vehicle will pick up the box. Based on the color of the box, the vehicle will find and follow the colored path to the "placement" platforms. There are 4 placement platforms. Based on the size and color of the box, the vehicle will place the cube on the appropriate platform. The cube is fragile and cannot be damaged (e.g. crushed or dropped) throughout the pickup, transport, and place processes. The pickup and place platforms are shown in Figure 1. Note the difference in size of the pickup and place platforms. The initial layout of the pickup and place field is shown in Figure 2. The **revised** layout is shown in Figure 3.

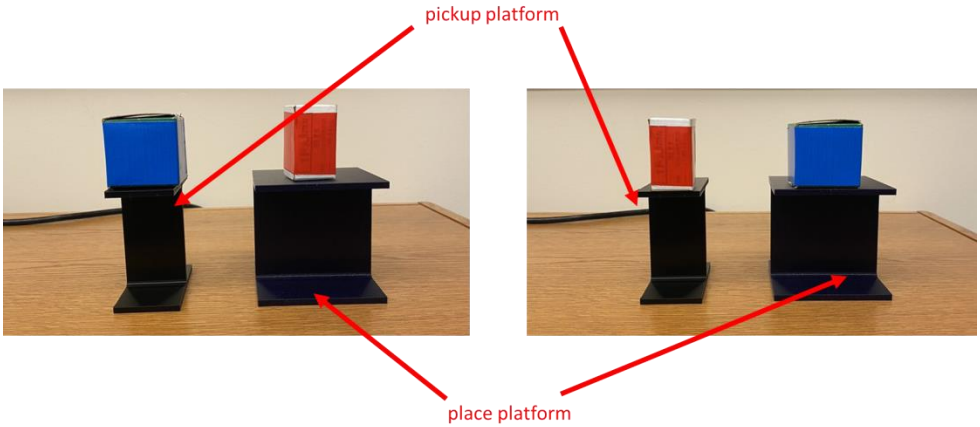

Figure 1. Pickup and place platforms with sample boxes.

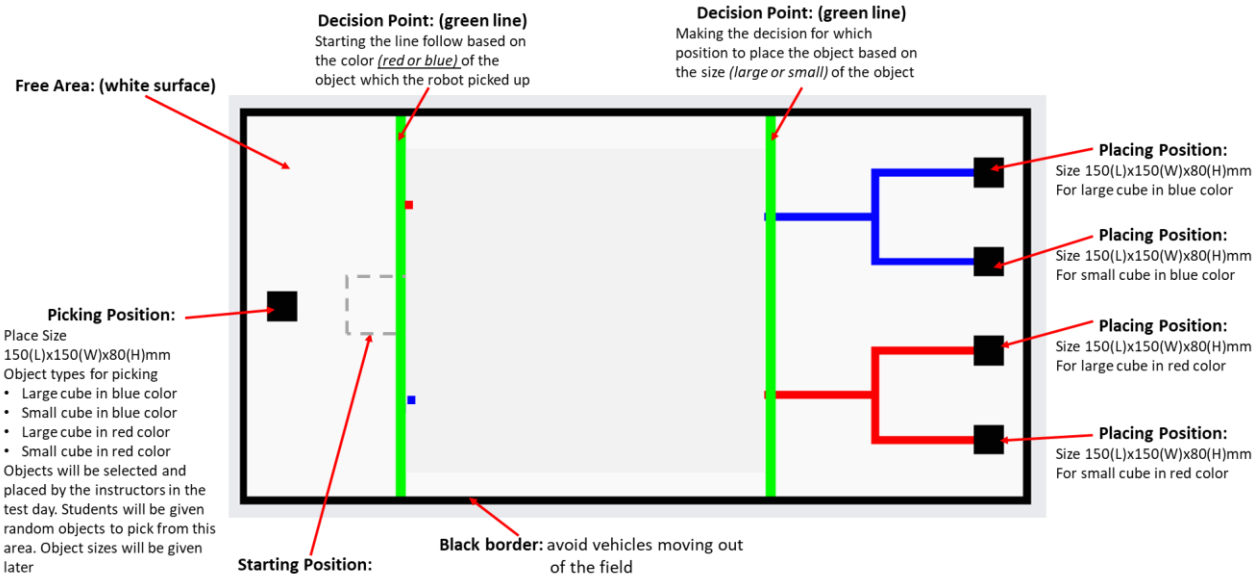

Figure 2. (Old, Initial) Pickup-and-Place layout.

The **revised** field layout, shown in Figure 3, features a black surface with a white colored boundary border.

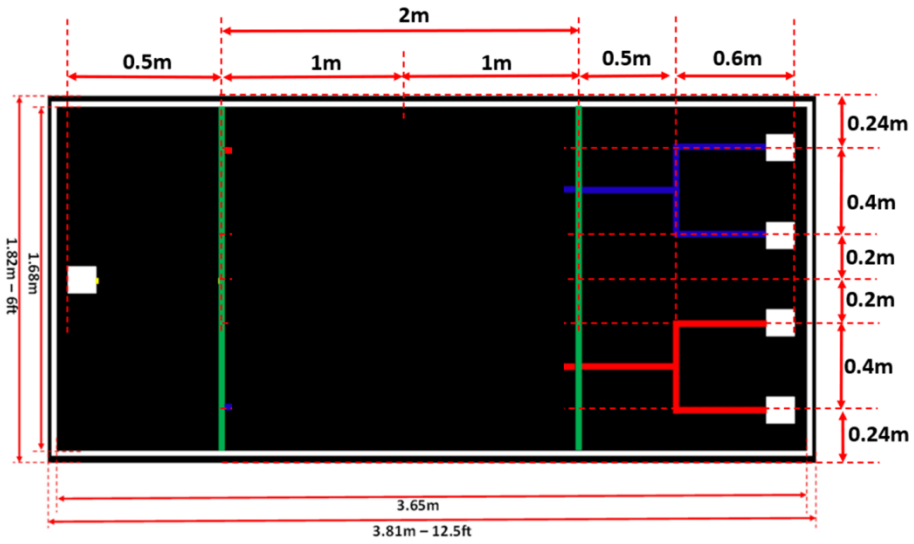

Figure 3. (**Revised**) Pickup-and-Place layout.

- Carry / Push / Pull: Starting at the bottom of an $18.5°$ ramp. The vehicle must $Carry + \{\, Push \oplus Pull \,\}$ an object to the top of the ramp. "Carry" is mandatory. The team can choose to either "Push" or "Pull" the object. The vehicle cannot lose or drop the object. The vehicle cannot tip over. Neither the vehicle nor the object can fall off the ramp. The length, height, and width of the ramp is $1500mm \times 500mm \times 600mm$ respectively. Evaluation of this task is based on how long it takes (time) for the vehicle to transport the object from the bottom to the top of the ramp; and how much weight the vehicle can transport. If the vehicle cannot transport the object the full length of the ramp, then the transport distance will be measured.
- Move with Obstacle Avoidance: Starting from one of three, fixed starting positions, the vehicle must navigate across a field with obstacles and cross the "finish line", at the end of the field, in the fastest possible time. The vehicle must stay within the bounds of the field and avoid the obstacles. The obstacles are walls. A gap in a wall or the gap between the end of the wall and the field boundary is $600mm$. (Recent change) The color of the field boundary is white. The color of the field and the color of a walls are **black**. The finish line is **green** colored. Wall placement is parallel to the finish line. The walls are arbitrarily placed in the field. There will be a gap for the vehicle to traverse in the middle and on the right and left sides of the field. Touching or knocking down a wall is a time penalty – time clock is paused, the vehicle is placed at the starting position, the wall is reset to its starting position, time and the vehicle are started again.

Vehicle Design Constraints

The maximum length and width of the vehicle are

- Length (max): $530mm$ or $21\ inches$
- Width (max): $280mm$ or $11\ inches$

Any part of the vehicle that exceeds the maximum length and width limitations is cause for course grade reduction or possibly failure of this assignment.

System Development Constraints

With the exception of wire, the development of the system is constrained to the components and devices in Tables 1 and 2. Each team is responsible for replacing damaged components. The links to where components can be purchased is provided.

Table 1. Allowed hardware components.

Hardware Components		
Component	**Qty**	**Link for more information**
Grid Plate 17 x 29 Hole	2	https://www.servocity.com/1116-series-grid-plate-17-x-29-hole-136-x-232mm/
U-Channel 1 Hole	6	https://www.servocity.com/1120-series-u-channel-1-hole-48mm-length/
2-Post Clamping Mount	4	https://www.servocity.com/1401-series-2-side-2-post-clamping-mount-43mm-width-22mm-bore/
Lightweight Set Screw Hub 4mm	4	https://www.servocity.com/1308-series-lightweight-set-screw-hub-4mm-bore/
Lightweight Set Screw Hub 6mm	2	https://www.servocity.com/1308-series-lightweight-set-screw-hub-6mm-bore/
Omni Wheel	4	https://www.servocity.com/3604-series-omni-wheel-14mm-bore-96mm-diameter/
Disc Wheel	4	https://www.servocity.com/3607-series-disc-wheel-14mm-bore-96mm-diameter-black-2-pack/
ServoBlock	2	https://www.servocity.com/servoblock-standard-size-25-tooth-spline-hub-shaft/
Round-End Pattern Plate 7 Hole	1	https://www.servocity.com/1105-series-round-end-pattern-plate-7-hole-176mm-length/
Round-End Pattern Plate 5 Hole	1	https://www.servocity.com/1105-series-round-end-pattern-plate-5-hole-128mm-length/
L-Channel 1 Hole	2	https://www.servocity.com/1113-series-l-channel-1-hole-48mm-length/
Parallel Gripper Kit A	1	https://www.servocity.com/parallel-gripper-kit-a/
Flanged Ball Bearing	4	https://www.servocity.com/1611-series-flanged-ball-bearing-6mm-id-x-14mm-od-5mm-thickness-2-pack/
Stainless Steel D-Shaft	1	https://www.servocity.com/2101-series-stainless-steel-d-shaft-6mm-diameter-300mm-length/
26 or 116 RPM DC brushed Motors	4	https://www.servocity.com/26-rpm-premium-planetary-gear-motor/ https://www.servocity.com/116-rpm-premium-planetary-gear-motor/
High-torque servo motors	2	https://www.servocity.com/2000-series-dual-mode-servo-25-2/
High-speed servo motors	2	https://www.servocity.com/2000-series-dual-mode-servo-25-3-speed/

Table 2. Allowed electronic components.

Electronic Components		
Component	**Qty**	**Link for more information**
Teesny 4.1	2	https://www.pjrc.com/store/teensy41.html
USB cable type A and type B male	2	https://www.amazon.com/MaGeek-Samsung-Motorola-Android-Smartphones/dp/B00WMARA04/ref
Ultrasonic Module HC-SR04 Sensor	2	https://www.amazon.com/Dorhea-Ultrasonic-Distance-Duemilanove-Rapsberry/dp/B07L68X65N/ref
IR Obstacle Avoidance Sensor	2	https://www.amazon.com/HiLetgo-Infrared-Avoidance-Reflective-Photoelectric/dp/B07W97H2WS/ref
RGB Color Recognition Sensor	3	https://www.amazon.com/DEVMO-TCS3200-Recognition-Detector-Compatible/dp/B07Y88WRNQ/ref
Thin Film Pressure Sensor	2	https://www.amazon.com/Pressure-Precise-Force-Sensitive-Resistor-Resistance-type/dp/B07T1CHY58/ref
Rotary Angle Sensor	2	https://www.amazon.com/ACEIRMC-CJMCU-103-SV01A103AEA01R00-Trimmer-Potentiometer/dp/B094XT5WMS/ref
L298 7A motor controllers	2	https://www.amazon.com/Controller-Regulator-Industrial-Optocoupler-Isolation/dp/B0B8RL7PXM/ref
Buck Converter 12v to 5-7v	2	https://www.amazon.com/AITRIP-Mini360-Converter-Airplane-Step-Down/dp/B09MVK48KY/ref
12V DC Power Connector	1m 1f	https://www.amazon.com/Power-Connector-Female-Adapter-Camera/dp/B07C61434H/ref
TalentCell Rechargeable 12V	1	https://www.amazon.com/TalentCell-Rechargeable-12000mAh-Multi-led-indicator/dp/B00ME3ZH7C/ref
Wire Stripper, 20-30 AWG	1	https://www.amazon.com/Eclipse-CP-301G-ProsKit-Precision-Stripper/dp/B005JVJDIA/ref
Breadboard	4	https://www.amazon.com/Breadboard-Solderless-Prototype-Male-Female-Female-Female/dp/B073X7GZ1P/ref
PCB Solder-able Breadboard	1	https://www.amazon.com/EPLZON-Solder-able-Breadboard-Electronics-Compatible/dp/B0B27XB69M/ref
Push button	2	
Thumb Joystick Module	2	https://www.amazon.com/Wishiot-Joystick-Controller-Breakout-Arduino/dp/B089VXPHDH/ref
Organizer box	2	https://www.amazon.com/DEVMO-TCS3200-Recognition-Detector-Compatible/dp/B07Y88WRNQ/ref