

# Robotics, Automation, and Integration

## PROJECT 1 GUIDELINES AND SPECIFICATIONS

The following sections provide the specifications for the Chocolate Box project as well as some tips that will help you overcome some of the more challenging items involved. Refer also to the rubric at the end of this document to see how you will be evaluated.

### Specifications and Guidelines

#### The Box

The SmartCart must be programmed to produce custom-designed boxes of chocolates. Each box must have four (4) chocolates. The chocolates are represented by different colored blocks.



An example box of “chocolates.” Pegs are used to secure the box cover.

All finished boxes must be covered, inspected by the QC camera, and presented to the customer. The box may be presented to the customer at the end of the conveyor or at the edge of the tabletop.

#### The Interface

The customer decides which chocolates are put into the box. The HMI must include screens in which the customer can select the chocolates and start the process (although the robot’s “main job” may already be played using the pendant).

HMI screens must conform to the design conformity guidelines that you learned about previously (see Activity 4-1). The interface should be simple and intuitive to use and to navigate through.

In addition to screens for customers, the HMI must also include at least one screen for system monitoring. The screen(s) must only be accessible to authorized personal and must include at least the following items:

- A *Reset System* button
- Sensor values
- A list of process stages with the current stage highlighted

For an additional challenge, also include:

- Quality control results and history
- Overall process time
- Remote monitoring of sensors (on a Moneo Dashboard)

## Quality Control

Before the box is presented to the customer, it must be inspected by the camera. At minimum, the box must be inspected for the presence of four chocolates (blocks) of any color. Any boxes that have failed quality control must be placed in the bin or an unused area of the SmartCart tabletop.

If you are looking for an advanced challenge, build a vision job that will assure that the exact box that was customized by the customer is indeed what the customer receives.

## Process Cycle

In terms of the process itself, the order and timing of the production of the box of chocolates is up to you. However, the process must be able to run continuously for at least several iterations (cycles).

This means that after completion and delivery of a box to a customer, the SmartCart must be reset, and any required parts (empty box and blocks) must be ready for preparation for the next customer.

After a box of chocolates has been delivered to the customer, the delivered box, lid, pegs, and blocks can be returned manually to the storage areas.

## Tips and Suggestions

### General Tips

Here are some general tips and suggestions to consider:

- Before you start integrating and programming in earnest, plan out a strategy for what you want to do and how you want to do it. Record your plan in writing and draw diagrams (such as a robot position map) that you can refer to later.
- If you are working in a team, you can split the load to save time. For example, one student integrator can program the robot, another the camera, and a third the PLC and HMI. Another way to save time is to perform most of the programming (both for the robot and PLC) offline and later download the programs to the relevant device. With regards to the robot, this is done by transferring JBI files via the pendant's USB port.
- Document all of your work (such as ladder routines and robot jobs) with legible comments.

## PLC Logic

One thing to think about when writing your PLC routines is how to integrate the new HMI interactions for the customers. If you are using a logic sequencer such as the one you built in the course, you can create and integrate PLC tags that correspond to various steps in the customer interface.

You will then need to bind those PLC tags to the elements of the HMI screens.

## SmartCart Storage

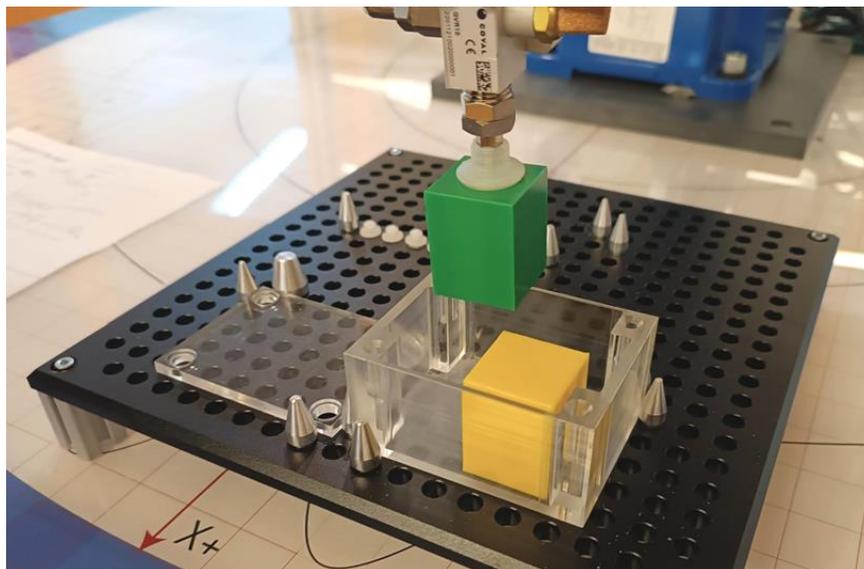
Use the rotary table to store the colored blocks. Make use of the pins, sensors, and/or RFID tags to keep your stored items secure and organized. The empty boxes, box tops, and pegs can be stored on the rotary table, the gravity feeder, or on another location in the SmartCart work envelope. If you choose to use the gravity feeder, the built-in microswitch and any mounted sensors can inform the system that a part is ready for use.

## Sensor Positioning

Sensors on the SmartCart can be swapped with each other. Consider where each sensor should be positioned before you start working on the project. In addition, think about whether a smart sensor is needed in a particular location or if a conventional sensor is enough.

## Material Handling and Assembly

Carefully consider how, where, and with which end-of-arm tool your robot will assemble the various components of the chocolate box. In order to successfully assemble the box of chocolates and to avoid damaging any of the equipment, the empty box should be secured to the palletizing rack using an appropriate pin set (try different combinations of pins and pin sizes to determine what that correct pin set is).



The box is secured on the rack by pins as the colored blocks are inserted.

Because the chocolates (colored) blocks will be on the conveyor at some point (where the position of the block to be picked may vary somewhat), you will need to think of a way to pick the block and place it in a precise location in the box (where the tolerance for error is extremely slim). This may require you to

program an intermediary position on the palletizing rack where the block can be placed before it is then picked again and transferred to the box.

## GRADING RUBRIC (REFERENCE)

The following rubric provides guidelines for evaluation of the various elements of the SmartCart project. This copy should be used by course participants and instructors as a reference. For grading purposes, instructors must complete the rubric in the Assignment Submission item on the course page.

The numbers in parenthesis indicate the number of points awarded for each criterion level.

Criterion	Level 1	Level 2	Level 3	Level 4
<b>Product and Process Efficiency</b>	The SmartCart is unable to complete any steps of the application process. (10)	The SmartCart completes some steps of the application process. (25)	The SmartCart completes the application process in its entirety. However, there may be some errors or faults, such as the final product not conforming to customer specifications. (35)	The SmartCart completes the application process in its entirety with no errors or faults. (40)
<b>Continuity and Repeatability</b>	The SmartCart is unable to repeat the process after completion the first time. (2)	The SmartCart is able to repeat the process. However, there are some problems with repeatability such as that the positions of blocks in storage are not presented to the robot properly. (8)	The SmartCart is able to repeat the process with no observable errors or issues. (10)	
<b>Customer Interface</b>	The customer’s HMI screen experience needs significant improvement. The interface is poorly designed and counterintuitive. (4)	The customer’s HMI screen experience is a decent one. The interface could use some changes here or there. (12)	The customer’s HMI screen experience is a good one. The interface is well designed and intuitive. (14)	The customer’s HMI screen experience is exceptionally well done. The interface is simple, intuitive, and graphically attractive. (15)
<b>Monitoring Interface</b>	There is no monitoring interface for the technician. (0)	The monitoring screen is poorly organized. Not all required elements (reset button, 4+ sensor values, and process stages) are present. (6)	The monitoring screen is somewhat clear, labelled, and organized. All required elements (reset button, 4+ sensor values, and process stages) are present. (8)	The monitoring screen is clear, labelled, and organized. All required elements (reset button, 4+ sensor values, and process stages) are present. (10)

Criterion	Level 1	Level 2	Level 3	Level 4
<b>Monitoring Interface Security</b>	The monitoring screen is accessible to all users. (0)	Authorized users must log in to gain access to the monitoring screen. (5)		
<b>Quality Control</b>	The camera is not triggered at any point. There is no quality assurance step. (0)	The product is inspected for defects. (10)		
<b>Program Clarity</b>	PLC routines and robot jobs are unintelligible. (3)	PLC routines and robot jobs are generally clear and documented but also contain several superfluous or indecipherable instructions or rungs. (8)	PLC routines and robot jobs are clear and documented. (10)	