# Robotics, Automation, and Integration

## *PROJECT 2 GUIDELINES AND SPECIFICATIONS*

The following sections provide the specifications for the *Smart Logistics* 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

### General Order of Operation

The main goal of this application is to track and sort parts. This is the general order of operation of the system:

1. Incoming parts are to be placed manually and at random on the gravity feeder.

2. A part falls to the mouth of the gravity feeder.

3. The system is initiated by the operator's screen on the HMI.

4. The ID of the part at the mouth of the gravity feeder is registered.

5. The part is moved to the quality control camera.

6. The part is processed based on the results of the quality control job:

   ▪ Cubic parts pass quality control and are sorted onto the rotary table. On the rotary table, the parts must be arranged by color. Parts of the same color can be placed next to each other, or they can be stacked.

   ▪ Rectangular parts fail quality control and are sorted into a bin.

### The Interface

Your HMI needs at least two screens – an operator's screen and a supervisory or monitoring screen, both of which require security clearance.

The monitoring screen must show the following:

- The RFID tag UIDs of the last two parts to be sorted.
- The color of the last part sorted.
- Process stages.
- The quantity of each type of part sorted, including the parts failing quality control.
- Sensor values regarding system health, such as air pressure.

The operator of the SmartCart system is responsible for the random placement of the parts on the gravity feeder and also for starting and stopping the system. The operator's screen therefore requires start ,stop, and reset buttons. The screen should also show whether or not the most recently accepted part passed or failed inspection.

### Quality Control

All parts must be inspected before they are sorted.

As you learned in the Machine Vision section of the course, the vision sensor can be used to differentiate between differently colored parts. If you are unable to automate sorting-by-color using machine vision, you can use the RFID tags to keep track of colors.

### Process Cycle

In terms of the process itself, the order and timing of system operation is up to you. However, the process must be able to run continuously and should only be stopped if the reset button is pressed or if there are no parts waiting on the gravity feeder.

## 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.

### Preparation of Parts

Before they are placed on the gravity feeder for sorting, all parts must be prepared. This includes sticking an RFID tag on one of their faces. At this time, you may record the tag's UID number and make a table of UIDs and corresponding colors or types.

A more advanced challenge for the project would be to only use sensors and machine vision for sorting, without relying on pre-recorded UIDs.

### Sensor Positioning

As in the previous project, you may relocate the sensors in the SmartCart work in order to suit the needs of the project application. Think about whether a smart sensor is needed in a particular location or if a conventional sensor is enough.

### Quality Control

One way to use the camera to sort by color is to load/run all pixel color count jobs in succession. The actual color of the part will correspond to the job that results in a pass.

# *PROJECT 2 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 rubrics in the Assignment Submission item in this section.

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

| Criterion | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|
| **Process Efficiency** | The SmartCart is unable to complete any steps of the application process. (0) | The SmartCart completes some steps of the application process. (20) | The SmartCart completes the application process in its entirety. However, there may be some errors or faults, such as items being sorted in the incorrect locations. (30) | The SmartCart completes the application process in its entirety with no errors or faults. (35) |
| **Continuity and Repeatability** | The SmartCart is unable to repeat the process. (0) | The SmartCart is able to repeat the process. However, there are some problems with repeatability. For example, the presentation of parts to the camera is not consistent. (13) | The SmartCart is able to repeat the process with no observable errors or issues. (15) | |
| **Quality Control** | The system does not demonstrate the process that occurs when an incoming part (rectangular block) fails inspection. (0) | The system imperfectly demonstrates the process that occurs when an incoming part (rectangular block) fails inspection. (13) | The system demonstrates the process that occurs when an incoming (rectangular block) part fails inspection. (15) | |
| **Monitoring Interface** | There is no monitoring interface for the technician. (0) | The monitoring screen is poorly organized. Not all required elements (UIDs, type, stages, quantities, and system health) are present and functioning. (12) | The monitoring screen is somewhat clear, labelled, and organized. All required elements (UIDs, type, stages, quantities, and system health) are present and functioning. (18) | The monitoring screen is clear, labelled, and organized. All required elements (UIDs, type, stages, quantities, and system health) are present and functioning. (20) |
| **Screen Security** | The screens are accessible to all. (0) | Authorized users must log in to gain access to the monitoring and operator screens. (5) | | |

| Criterion | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|
| **Program Clarity** | 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) | |