

**PRODUCT SPECIFICATION**

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# Robot Manufacturing Cell Product Requirements

## **Cyber Crew**

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## 1 Objective

The objective of the Robotic Manufacturing Cell is to integrate the two robots into a mini assembly line, constructing an object by sorting through varied pieces and using specified barcodes to determine the placement of each. One robot will place the objects, the other will push the pieces together.

## 2 Scope

The scope of this document is to define each requirement of the project. Each requirement shall be explicitly stated to ensure they are met.

## 3 References

### 3.1 Cited Documents

“Products.” Training Courses Available at DENSO Robotics, [denso-robotics.com/products/vs-g-series/download-materials](https://denso-robotics.com/products/vs-g-series/download-materials). (Manuals for the Denso Robotic Arms)

“Robotic Arm Manufacturing Cell.” Cutter Types (Mill) - Mindworks, [mindworks.shoutwiki.com/wiki/Robotic\\_Arm\\_Manufacturing\\_Cell](https://mindworks.shoutwiki.com/wiki/Robotic_Arm_Manufacturing_Cell). (Previous Robot Manufacturing Cell Group Project)

“Denso RC7M Manuals.” Manuals Library, [www.manualslib.com/products/Denso-Rc7m-8883395.html](http://www.manualslib.com/products/Denso-Rc7m-8883395.html). (Operating manuals for the Denso Robotic Arms)

WINCAPS III (Program used to write code and simulate the function of the robot)

Davison, Pat. Safety Standards and Collaborative Robots, [www.robotics.org/userAssets/riaUploads/file/6-Pat.pdf](http://www.robotics.org/userAssets/riaUploads/file/6-Pat.pdf). (Safety Standards for Robots)

Murashov, Vladimir, et al. “Working Safely with Robot Workers: Recommendations for the New Workplace.” *Advances in Pediatrics.*, U.S. National Library of Medicine, Mar. 2016, [www.ncbi.nlm.nih.gov/pmc/articles/PMC4779796/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4779796/). (Safety Recommendations for Industrial Robotics)

### 3.2 Acronyms

EPO     Engineering Purchase Order  
ER      Engineering Release  
POC     Proof of Concept  
PTP     Point to Point  
CP      Continuous Point  
I/O     Input/Output  
ISO     International Organization for Standardization

### 3.3 Variable Types

Type I: Integer  
Type F: Floating Point  
Type D: Double-precision

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Type S: String  
Type V: Vector  
Type P: Position  
Type J: Joint  
Type T: Homogeneous  
Type IO: I/O

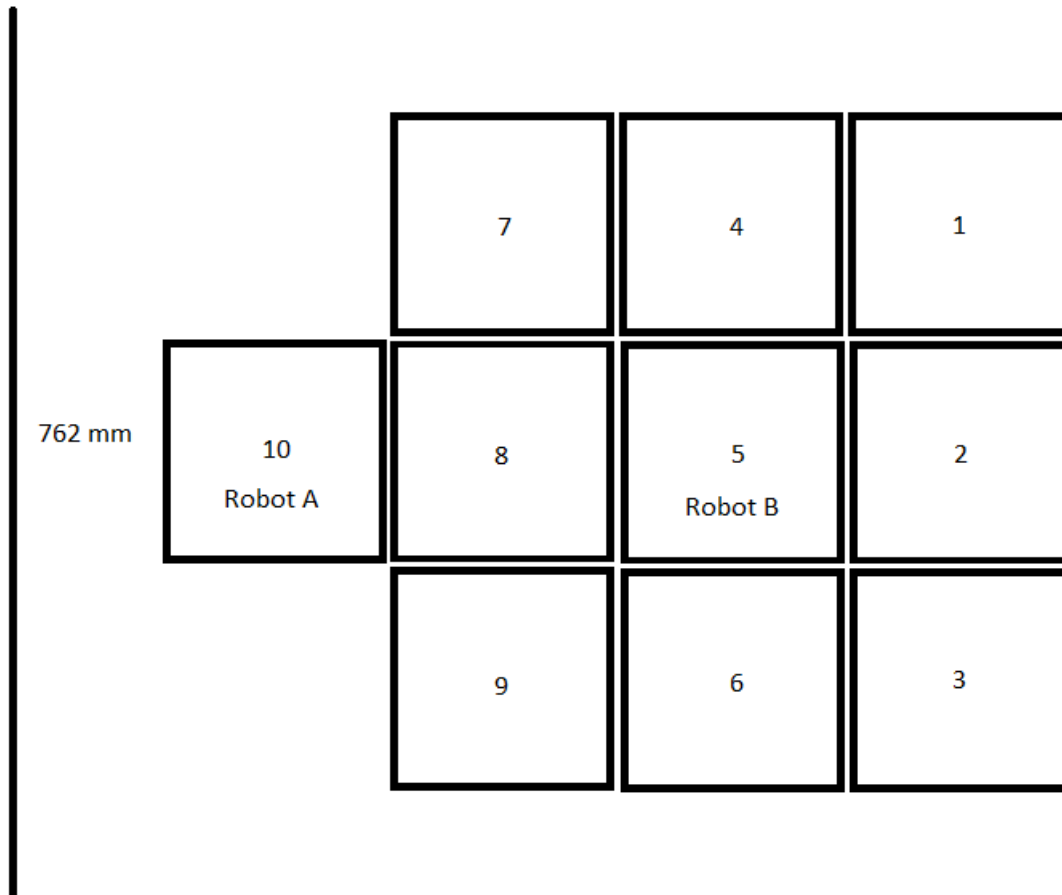
### 3.4 Commands

PROGRAM XXXX: Declares program name  
TAKEARM: Obtains arm control  
GIVEARM: Releases arm control  
SPEED ###: Sets the internal speed  
MOVE: Moves the arm from its current position to a targeted position  
END: Ends the robot motion and program  
APPROACH: Moves the tool end of the arm to the approach point specified  
DEPART: Moves the tool end of the arm to the depart point specified  
DRIVEA: Executes an absolute motion of each axis  
COM\_ENCOM: Opens the port and establishes connection with the external device for the data transmission  
COM\_DISCOM: Closes the port and disable connection with the external device  
FLUSH: Clears the input buffer  
INPUT: Gets data from an Ethernet port  
WRITE: Outputs data from an Ethernet port to an external device  
SET: Set an I/O port to ON  
RESET: Set an I/O port to OFF  
IF...THEN: Executes statement if condition is true  
ELSE: Executes statement if condition is false  
SELECT\_CASE: Executes statements block associated with the matching condition out of multiple conditions  
FOR...NEXT: Repeatedly executes a block of statements in a loop according to the specified condition

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### 3.5 Robot Cell Layout



## 4 Functional Requirements

### 4.1 User Interface Requirements

The assembly must be self-functioning, or automated. The only user involvement shall be to start the process, as well as end it. In case of malfunction, emergency stop switches are in place: one on each controller and one on the outside of the cell.

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### **4.2 What it should do**

The project must illustrate supervisory control between the two arms. The two robotic arms must be able to communicate with one another to complete a task – as an integrated assembly line system. One robot should utilize an electronic screwdriver, while the other will pick up and sort the pieces. A slide will distribute the parts to the robot, with a scanner recognizing which item is which. This data will be transmitted to one robot arm and a code will be in place for it to acknowledge what to do with that part. The other arm will then screw the bolts into the pieces. A final distribution of the parts will then occur.

## **5 Mechanical Requirements**

### **5.1 Strength Requirements**

The robotic arm has a limitation of 5-7 kg load.

Pressure limitations also take place. The operating air pressure is .1 - .39 MPa. The max air pressure is .49 MPa.

### **5.2 Spatial Requirements**

The assembly line shall fit within the space provided in the manufacturing cell. This area is a 2438.4 mm x 1835 mm rectangle (X vs Y). Due to limitations on the arm with University of Idaho serial number 196-549, the negative X-Axis must not exceed a length of 762 mm.

### **5.3 Weight/Mass Requirements**

Tools must have a maximum mass of 1 kg. Any pieces, or combination of pieces, shall remain at maximum 4 kg. In total, the maximum mass allowed by the robotic arm shall be 5 kg.



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### 5.4 Mounting / Interface Requirements



Any electrical or pneumatic connections will be attached into the back of the robotic arm, seen in the figure at the left. If connecting to the tool in the arm, the connections above the black screw ring will be used, seen at the right. Any tool must be able to screw into the figure at the right to be able to attach to the arm.

### 5.5 Appearance Requirements

The final process should be smooth cooperation between the two robotic arms.

### 5.6 Durability Requirements

The system shall be designed to continuously work, without any human interaction, until the process has ended.

### 5.7 Reliability Requirements

All components (bearings) shall have 90% reliability. The robots must be programmed to avoid collisions with each other, as well as the surroundings. Due to limitations on the arm with University of Idaho serial number 196-549, the negative X-Axis must not exceed a length of 762 mm in order to not collide with the wall. After each arm completes a task, they will return to a pre-specified origin point to avoid collision with each other. If necessary, multiple emergency stop switches are in place to shut down the program: One on each controller, and one on the outside of the manufacturing cell.

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## 6 Electrical Requirements

### **6.1 Operational Voltage**

The Denso robots will have an AC200-230V power limit.

### **6.2 Operational Power Capability**

Each axis has a different power limit.

Axis 1 – 750 W  
Axis 2 – 400 W  
Axis 3 – 200 W  
Axis 4 – 100 W  
Axis 5 – 80 W  
Axis 6 – 50 W

### **6.3 Energy Storage Capacity**

The storage capacity of the equipment shall be the sum of the power of the 6 axes working together. In total, this should be 1.58 kWh.

## 7 Software Requirements

### **7.1 Functionality**

We will be using WINCAPS III, Solidworks, MATLAB and LabView.

### **7.2 User Interface**

The robot will be controlled through WINCAPS III software via the controller. Using the specified controller for each robot, a unique code will program the robot after inputting through the unique IP Address of each robot.

## 8 Environmental Requirements

### **8.1 Temperature**

The robot is expected to be utilized from 0-40 C and to be maintained under 90% RH.

### **8.2 Environmental Sealing**

The manufacturing cell must be surrounded by a wall, to promote the safety of the workers. An emergency stop switch will be located outside of the walls, to kill the program if required.

## 9 Regulatory Requirements

### **9.1 UL Requirements**

ISO 10218-1:2006 - Standards for Robots, Robot system/cell and application  
ISO TS 15066 – Technical Specification Standards on Robots  
ANSI/RIA R15.06-2012 – American National Standard for Industrial Robots and Robot Systems

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ISO 10218-1:2011 – Standards for Robots, Robot system/cell and application  
ISO 10218-2:2011 – Standards for Robots, Robot system/cell and application

### **9.2 Shipping Requirements**

Standard shipping for parts will be used unless absolutely necessary.

## **10 Cost Requirements**

### **10.1 Prototype Cost**

Cost to build a POC prototype shall not exceed \$1000.

### **10.2 Production Requirements**

N/A

## **11 Schedule Requirements**

The following are the major Project Milestones:

- Approval of Requirements            June 25, 2018
- Concept Design Review            July 26, 2018
- EPO of long lead parts            Aug. 2, 2018
- Detailed Design Review            Aug. 2, 2018
- ER of drawing package            Oct. 2, 2018
- Complete Prototype build            Nov. 30, 2018
- Final Report / Drawings            Nov. 30, 2018