SkillsUSA
2010 Contest Projects

Robotics and Automation Technology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

ROBOTICS AND AUTOMATION TECHNOLOGY

2010

SKILLS CHAMPIONSHIP

444 Industrial Park Drive
Manchester New Hampshire 03109
603-625-8600

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COMPETITION BRIEFING

1. Welcome to the Robotics and Automation Technology competition. You should already have your system setup and tested, if not you will be given time to do so. I will try to apprise you of the contest during this briefing. Please wait until the end of the briefing to ask questions.

2. While in the work area observe all safety precautions. Unsafe acts could disqualify you from participating in the contest. Wear safety glasses.

3. If you have questions during the competition, contact a competition official. The official will evaluate your question and determine if it is a question that all teams should hear. If the official deems that all should hear, the response will be given for all to hear. If the answer is in the documentation provided, the question would not be answered. It will be suggested that you do more research. If it is obvious that you should know the answer to the question you are asking, there will be no answer.

4. Restroom breaks. Contact an official and you will be escorted to the restroom. Only one person from a team at a time. Please try to hold these to a minimum.

5. Breaks. A team may take a break in their work area when both team members agree.

6. Do not communicate with anyone other than the other person on your team or a contest official. Communication with anyone other than the above mentioned, may be grounds for disqualification from the contest

7. Start the competition when told to do so.

8. You will be apprised of time remaining as the contest nears finish time.

9. There will be a debriefing after the contest is over. You will be told when and where.

10. Good Luck.

Introduction

This document describes the Skills State Championship Robotics and Automation Technology Competition.

Acknowledgments

Since the inception of this contest it has had wide spread support. Interested companies and individuals provide equipment and materials for this event. Industrial experts, volunteers from companies, education professionals and private business, all donate their valuable services in designing and conducting the competition.

The success of this competition is the motivation of the contestants and their instructors, the determined efforts of the National and State Technical Committees, and the generosity of those donating equipment and material.

Intelitek is proud to sponsor the Skills State Championships, Robotics and Automation Technology competition:

Intelitek
Eshed Robotics / Light Machines
444 East Industrial Park Drive
Manchester, NH 03109-5317

ROBOTICS AND AUTOMATION TECHNOLOGY COMPETITION

OVERVIEW:

Robotics and Automation encompass a large field of manufacturing technologies. The integration of these processes is making the United States competitive in today's world market. It is essential that the labor force be on the leading edge of current and emerging technologies to maintain industry leadership in the manufacturing processes. With today's complex manufacturing problems, no individual can be an expert in all areas, so it is imperative for manufacturers to mold the necessary skills into a team using the combined resources to resolve problems. Workers in the field of Robotics and Automation have found the team approach to be successful, as it is our hope to emulate industry whenever possible. Therefore, we will use the Team approach in this competition. We suggest a two-person team comprised of a specialist from the following fields: Robot Programmer and Electronic and Mechanical Integration specialist.

Installing a new, up-to-date system, in a prompt manner is highly beneficial to remain competitive in the industrial market. The ability to change an existing system to a more efficient operation saves time in bringing a new product to market and reduces production time, thus lowering job costs.

Statement of the Problem

Robotics and Automation Inc. have just hired you. You have been teamed up with another new hire and assigned to a project, which involves designing a new production line. Supervision has provided you with a description of the required process and a list of equipment and material available for use in the system you are to design and implement. This task has also been assigned to other newly hired people who are paired into teams. As you may surmise, doing an outstanding job on this assignment could establish your future with Robotics and Automation Inc. Your assigned team number will be you team name.

Quality and production cost is essential in remaining competitive in the manufacturing industry. Therefore, you can be certain that, completeness of your project, elapsed time for you to come on line, cycle time, insight into good implementation techniques and documentation will all be considered in your job performance and evaluation.

DIRECTIONS

Your assignment is to:

Implementation

Using the description of the process and the provided equipment and material you are to layout your production system and develop a robot program to fulfill the requirement of the task. Complete documentation of the project is required. Minimum documentation is to include a sketch of the layout and equipment placement, a flow chart of the program and a copy of the robot program.

Line updating

Requirements of the project have changed. You are required to update your program and layout to meet the new requirements. Documentation for the updated system must reflect the changes. Cycle time has become an issue, and must be brought to a minimum.

Guidelines

The project manager has provided the base outline of the materials within this document to begin your planning implementation. Your success on this project is based upon the following criteria:

1. Providing complete documentation of the project.
    a. Sketch of layout
    b. Flow chart
    c. Robot program
    d. Input and Output Assignment
    e. Terminal Strip Assignment
    f. Block Diagram

2. Using the proper technology for the preparation of the documentation
3. Packaging the documentation in an orderly and professional manner
4. Effective use of teamwork in managing the project
5. Safety in the manufacturing process
6. Efficient use of time, material and resources

Team Guidelines

1. Your team is organized for primary responsibilities and duties.
2. Breaks are to be taken within assigned individual work areas.
3. Team members must notify a Technical Committee member or a judge before taking a bathroom break. Only one member of a team is permitted to leave at a time and must be accompanied by contest official.
4. In case of a software or hardware problem:
   You will communicate any problem(s) to a judge so that the running time clock may be stopped for that team. In the case of a stopped time clock, all work will stop for the entire team until the problem(s) is resolved.
5. The software for your robot should be loaded on your computer or controlling device. Teach pendants are optional
6. You must save your final programs to a usb drive. This is part of your project documentation.
7. No more than 3.5 hours will be allowed to complete the contest. Stopped clock as referenced in item 5 above will be considered.

OFFICIAL COMPETITION

Purpose

To evaluate each school's preparation of students for employment in the emerging arena of robotics and automation and the team approach to the problem-solving work environment. To recognize outstanding performance in the use of new work styles and technology by students and schools.

Clothing Requirements

Skills State Championships

Acceptable work clothes, safety glasses with side shields or goggles. (Prescription glasses can be used only if they are equipped with side shields. If not, they must be covered with goggles. Refer to the SkillsUSA – Championships below.)

Official khaki work shirt and pants, black or brown leather shoes, and safety glasses with side shields or goggles. (Prescription glasses can be used only if they are equipped with side shields. If not, they must be covered with goggles.) Refer to General Regulations Item 24, Page 11 and Robotics and Automation Technology, Page 265 of SkillsUSA Championships Technical Standards 2005 – 2007

Eligibility

Open to active SkillsUSA members enrolled in programs with robotics, automation and/or manufacturing as the occupational objective.

Scope of Contest

Teams of two will demonstrate their ability to perform, exhibit, and compile skills and knowledge necessary from the following list competencies determined by the Robotics and Automation Skills New Hampshire Technical Committee Members.

The team will be provided with a written description of the task requirement and a list of the available equipment and material. The team will develop a system layout and robot program then demonstrate their product. Upon completion of this task they will be provided a requirement to refine their system design and again demonstrate it's functionality.

A. Perform analysis of task

1. Evaluate written task
2. Evaluate provided equipment and material
3. Evaluate system revision

B. Design, Sketch and Plan

1. Determine sequence of operation
2. Select equipment and material to meet functional need
3. Create Flow Chart
4. Create layout
5. Create Input and Output Assignment
6. Draw block Diagram
7. Process system revision

C. Implement Design

1. Develop robot program
2. Install equipment
3. Integrate equipment with system controller
4. Modify system to meet revision requirements

D. System Performance

1. Perform functional test for total system operation
2. Present system for evaluation
3. Perform functional test to meet revision requirements
4. Present revised system for evaluation

Group Organization and Goals

This is a group competition and all members may interact at will. It is our hope that the competition will run much like industry.

The robot programmer will program the robot and peripheral equipment.

The Electro-mechanical integrator will install the peripheral equipment and integrate it into the system

We expect that when a team member has spare time they will help the other team member.

It is our hope that one person will not dominate a team. We do not want one person doing all the work while the other team member just assists. Each team member must take an active role in this competition. We have taken this course to promote creativity in organization of production responsibility.

All members are responsible for double-checking each other's work and quality control.

General Information

1. This competition will be accomplished using your robot system. (**SkillsUSA - Championships** will use the SCORBOT ER4U and other supplied peripherals)
2. Other equipment and material is from local supply sources.
3. Teams will consist of two members.

Goals

1. To have every team complete the contest.
2. To have each member demonstrate reading and writing skills.
3. To have each team member use their critical thinking and problem solving abilities.
4. To have each team member illustrate responsibility, teamwork, and self-management skills.

Notebooks

Each team will be issued a notebook and information packet. This will be a bound binder that will allow the team to complete the documentation of their assigned task.

Required Materials

The team will require the following equipment and material to complete the competition. The Technical Committee provides most of the required equipment and materials, but the team must also bring certain items.

Robotics and Automation Technical Committee Provides:

Robot and Controller	Bad parts bin
Gravity Parts feeder	Storage area templates
12 V Power Supply	Task assignment
Conveyor	Documentation
Metal and Plastic Blocks	
Stack Lights	
Sensor Station: Proximity Sensor and Micro Switch	

Team Provides:

Multi-meter with test leads	Wire strippers (electronic)
Long nose pliers (electronic)	Small screwdriver set (common and Phillips)
Diagonal pliers (side cutters)	Power strip, 6 outlets, circuit breaker protected
Extension cords, minimum 25’	100’ hookup wire (20-24 AWG)
Tape, masking & electrical	Jumper leads for troubleshooting
2-#2 pencils (sharpened)	12” ruler
Safety glasses	Any other tools specific to your equipment

Points will be deducted for items listed and not provided by the team. (5 points per item)
Points may be deducted for tools brought that are not list. (5 points per item)

Suggested Division of duties

Task analysis	Both team members
System layout	Both team members
Robot program	Robot programmer
Equipment placement	Electro-mechanical integration tech
Electrical integration	Electro-mechanical integration tech
System layout sketch	Electro-mechanical integration tech
Other documentation	Either team member
Program flow chart	Robot programmer
Hard copy of program	Robot programmer
Notebook	Both team members

SAFETY

The safety aspects are judged in this contest because in the real industrial environment safety is an economic business factor. The welfare of employees is in the best interest of any employer and employee to maintain the effectiveness and competitiveness of the company. Also, the safer a company is in their working environment the more cost effective they become which enables the company to obtain better insurance. In addition, workman compensation fees are reduced if the accident history of a company is good.

If during this contest a team or team member violates a safety rule or operates their system in an unsafe condition the following rule will be in effect.

1st Violation:

Team will be issued a written notice

2nd Violation

Team will have 50 points deducted

3rd Violation

Team will be disqualified

Some safety issues

1. Team members must keep their work area reasonably clean. Clean work places allow efficient and safe working conditions

2. Team members must keep other team members and teams aware of possible dangerous situations, such as: flying debris from wire cutting and stripping and/or noise

3. The Emergency Stop Switch must be depressed when working on an active system other than when an active system is required to accomplish a required part of the task, such as teaching the robot positions.

4. Team members must wear safety glasses when they are in proximity of an operational system or performing tasks that require safety glasses, such as cutting and stripping wire.

5. Overall safety is not limited to the above rules. Unsafe acts or practices will not be tolerated.

Proper safety practices are vital in all stages of this competition. Points will be deducted and/or contestants disqualified for unsafe practices in the work area. Judges decisions on safety are final.

State Competition

Directions

Your team is to assess the following task, then determine the layout and positioning of the provided components and develop a robot program to achieve the desired results.

Task

Refer to the Stack Light Specifications for stack light usage.

There are several Parts (metal and plastic blocks) provided that will be loaded in the gravity parts feeder. A judge will load the parts in any order with the holes facing down.

1. The Robot must take a block from the parts feeder if a block is in the feeder, otherwise loop until a part is placed in the feeder.
2. Robot must use the hardware in workcell to determine if a part is:
    - Metal block with hole
    - Metal block without hole
    - Plastic block with hole
    - Plastic block without hole.
3. All blocks must be placed on the conveyor for visual inspection and then placed in the appropriate template

    - Parts without holes are to be placed in the Bad Parts Bin with the hole facing up, in the appropriate area, and counted.

    - If there is more then one part, the part must be stacked on top of the existing block, inside the bin area. (Place the metal block part on the template –metal parts bin, and the plastic block part on the template –plastic parts bin.) If there is more then 1 part, the second block must be stacked on top of the existing block, inside the bin area.

    - The parts without holes are to be separated and placed on assigned templates, inside the associated bins. (Place the small block part on the template –Small Part Bin, and the large block parts on template, large part bin.) If there is more then 1 part, the second block must be stacked on top of the existing block, inside the bin area.

    - The stack light must display the appropriate colors.

Workcell Component Placement

The items are to be positioned on the table at your discretion. The choice is yours. Place them for the best implementation of the solution to the task. Use the double-sided tape to hold items securely in place.

Equipment/material supplied

1. Parts Feeder with parts present switch
2. Robot and Controller
3. Test box with inductive proximity sensor and micro switch.
4. Conveyor with sensor
5. Bad parts bin template (paper)
6. Storage area template (paper)
7. Blocks, cubes:
    - 2 metal blocks with hole
    - 2 metal blocks without hole
    - 2 plastic blocks with hole
    - 2 plastic blocks without hole.
8. Hand outs

Initial Block Placement

Load the supplied blocks into the Parts Feeder with the holes down in an arbitrary order. You may be requested to load the blocks in any order.

Special Criteria

1. Power cord for power supply will not be provided until a judge verifies the work cell wiring is connected to the controller appropriately.
2. Refer to the stack light specifications for usage.
3. With power applied to the system, and the program is not running, turn on a stack light to indicate the status of the robot.

Required Documentation

1. Flow Chart of program
2. Sketch of system layout
3. Block Diagram of Electrical Wiring
4. Terminal Strip Assignment
5. Inputs and Output Assignment
6. Saved program

Documentation Evaluation

A system that another person cannot use, troubleshoot or understand how it is designed to function is of little value. Therefore, it is necessary to fully document your system design.

The following will be given maximum attention in evaluating your system design.

1. Does the system function to achieve the assigned task?
2. Is the program “Remarked” to make it easy to follow?
3. Does the system layout match the system layout sketch?
4. Does the Flow chart match the hard copy of the program?
5. Is the documentation complete and accurate?

System Performance Evaluation

After your team has made your layout, developed and tested your program, call a judge to evaluate the performance of your program. For the judge to evaluate your process, you will start your program from the beginning and let it run a complete cycle. You may be asked to run your process in a continuous mode.

In the event your program does not meet the task requirements on the first and subsequent attempts the following scoring criteria will be used:

You will receive a multiplier of 1.0 on your overall score if you meet all the performance criteria on the first attempt.
A multiplier of 0.95 if you meet all of the performance criteria on the second attempt.
A multiplier of 0.90 if you meet all of the performance criteria on the third attempt
0.85 on the forth attempt.
0.80 on the fifth attempt.
Each additional attempt will reduce the multiplier 0.05
It pays to be sure your process is correct the first time you request evaluation.

Other Items for Evaluation

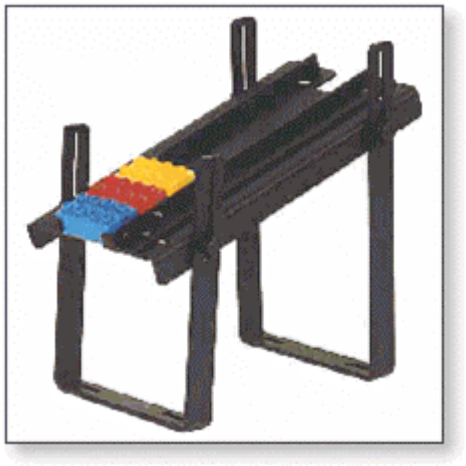
1. Were the parts accurately placed on the templates?
2. Was the system completed in a timely manner?
3. Is the program efficient?
4. Were safety rules adhered to?

Hardware connections

Hardware connections - Parts Feeder

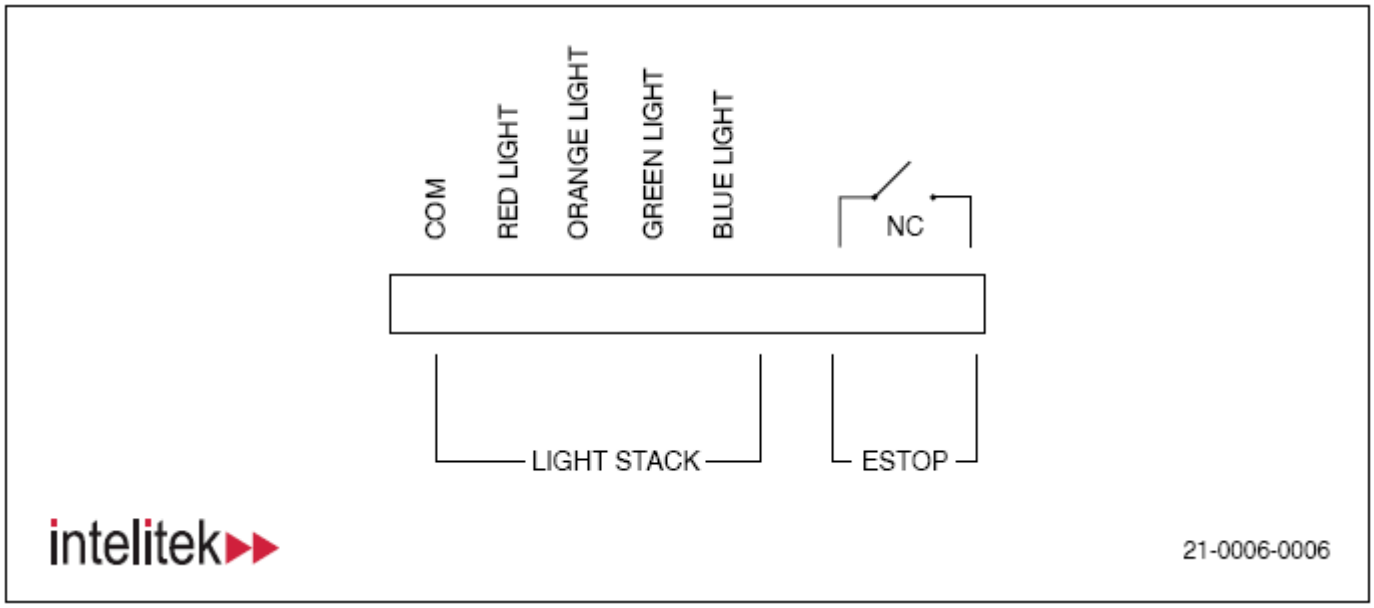
The parts feeder is a gravity feed assembly with a guide on each side and a parts present switch. A micro switch sensor detects the presence or absence of parts and communicates with the robot controller by means of I/O connections. One wire to input ground; one wire to the input terminal (1-8).

The feeder can be adjusted using a adjustable front leg support: (5.5"– 8.5") and an adjustable rear leg support: (8.5" – 12")



Hardware connections - Stack Light

DO NOT DISASSEMBLE THE STACK LIGHT UNIT



Stack Light requires 12 volts DC current.

Color	Usage
Red	ON when the robot motors have power and workspace is unsafe.
Yellow	ON when Testing parts, off at all other times
Green	ON (solid) when power for all motors is OFF and the work area is safe for technicians to work in. Program is not running.
Blue	ON when a "bad part" is identified and turned off after bad part is placed in Bad Template area.

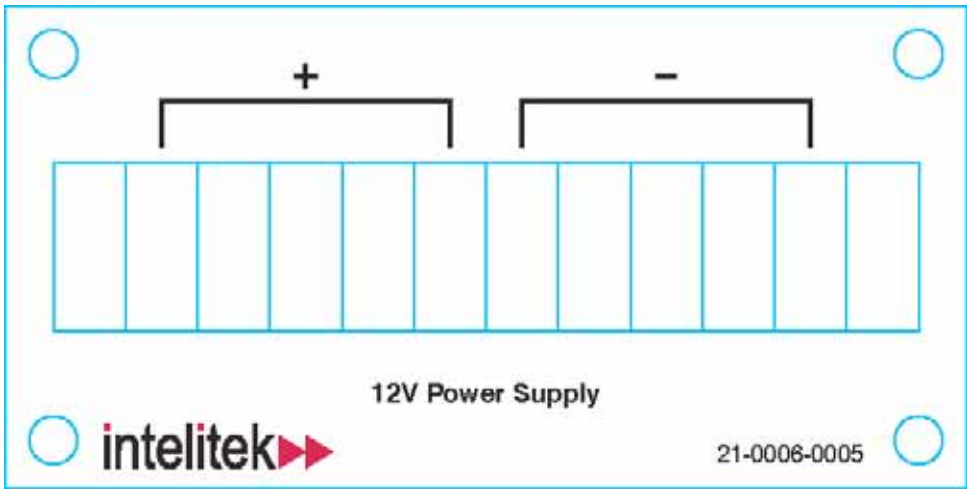
DO NOT DISASSEMBLE THE STACK LIGHT UNIT

If you have Questions, ASK a contest official.

Hardware connections - Power Supply (12 Volt DC)

+12 Volts DC current with common ground is used to power all devices in the work cell. The power supply is connected a terminal strip that can be located anywhere on the table.

DO NOT USE THE POWER SUPPLY ON THE CONTROLLER



Note: The above unit (12 V Power Supply) and the Controller each have their own power supplies.

Since there are multiple power supplies, one powering the device that produces a signal and the other apart of the device that accepts a signal they must have a common ground, a common reference between all power supplies.

Hardware connections - Sensor Box

Wiring

DO NOT OPEN SENSOR BOX

- The Sensor Box contains an Inductive Proximity Sensor and Micro-switch
- **All connections are made to the Terminal strip on the outside of the sensor box.**

Terminal Strip connections:

Inductive Proximity (Prox) Sensor:

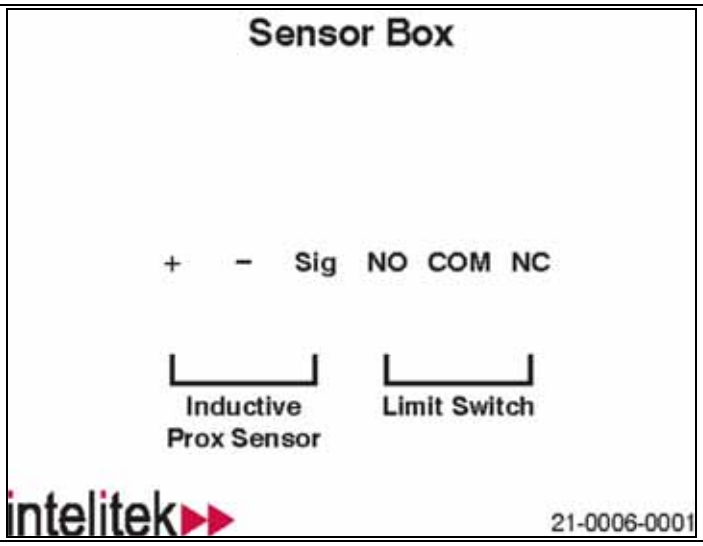
+	12 Volts DC (Power for the Inductive Proximity Sensor)
-	Ground (Common)
SIG	Output Signal (to controller input)

Limit Switch

NO	- Normally Open Contact
COM	- Common
NC	- Normally Closed Contact

DO NOT OPEN SENSOR BOX

If you have Questions, please ASK a contest official.



Hardware connections - Conveyor - Photo Sensor

13.1: Conveyor Sensor

Connect attached power supply to a 115 volt AC source.
Connect the remaining leads to an Input and Ground on the controller (Inputs).
The leads are polarity sensitive

Software - Conveyor Control - Sample SCORBASE Software program

In order for the conveyor to stop correctly, please use the following commands in your program.

```
Start Conveyor Axis 8 at Speed 5 in Plus Direction
Enable Input Interrupt 6
On Input Interrupt 6 On Call Subroutine STOP_CONVEYOR
Wait 100 (10ths of seconds)
.
.
Set Subroutine STOP_CONVEYOR
Stop Conveyor Axis 8
Return from Subroutine
```

Sample Program and Subroutines

In this example:

- **Positions 12 and 13 – Parts are above the conveyor.**
- **Positions 2 and 3 – Parts are on the conveyor.**
- **Photo Sensor is connected to input 6.**
- **Conveyor is connected to Axis 8.**

Program example:

```
Remark: **** Place part on Conveyor ****
Go to Position 12 Speed 5
Go to Position 2 Speed 5
Open Gripper
Go to Position 12 Speed 5
Start Conveyor Axis 8 at Speed 5 in Plus Direction
Enable Input Interrupt 6
On Input Interrupt 6 On Call Subroutine STOP_CONVEYOR
Wait 100 (10ths of seconds)
.
. The rest of the main program
.
.
Remark: ***Subroutine's start here***
Set Subroutine STOP_CONVEYOR
Stop Conveyor Axis 8
Go to Position 13 Speed 5 Position 13 – part is above the conveyor
Go Linear to Position 3 Speed 5 Position 3 – part is above the conveyor
Close Gripper
Go Linear to Position 13 Speed 5
Return from Subroutine
```

Notes: If using subroutines, they must be at the end of the program. Any remarks must be within the subroutines.

Required Documentation

ACCEPTABLE FLOW CHART SYMBOLS

Quite often, when employed by a Company or a Corporation, anything that you produce belongs to them. The corporation owns the patents and copyrights. Therefore, complete documentation is quite essential. You may think that keeping the knowledge to yourself is job security but at some time in your career you could be the recipient of an undocumented system. In this situation you will want all the documentation you can find. Document your work completely.

1. The Flow Chart symbols must be the symbols provided on the next page. Straight lines should be drawn with a straight edge. The program must start and stop with a Terminator symbol. Continuations without lines must use Connectors with identifying characters such as (A, b, 1 or 2 etc.). Use these symbols to develop your Flow Chart.

2. The symbols are representative of the required shapes. You may change the size to meet your needs.

3. Use a straight edge to draw the symbols.

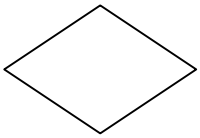
4. Be neat. If the judges can't read them they can't score them. Points lost.

5. Your Flow Chart and Robot Program must coincide. The Flow Chart/Robot Program scoring will be based on how well you designed your Flow Chart before you started developing your Robot Program.

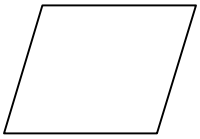
FLOW CHART SYMBOLS

Process

Alternate Process

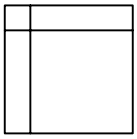


Decision



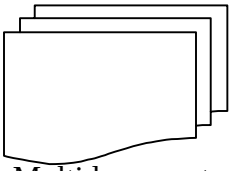
Data

Predefined Process



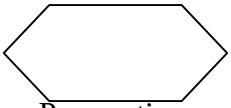
Internal Storage

Document

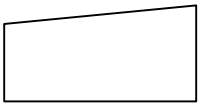


Multidocument

Terminator

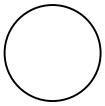


Preparation



Manual Input

Manual Operation



Connector Junction

Required Documentation - Safety Issues

Describe any safety issues that are of concern when running the robot program.

Required Documentation – PROGRAM FLOW CHART

Draw a flowchart of the Robot program. Use a straight edge. Be complete, neat and legible.

Total Points_____

See judges or instructor for additional copies.

Required Documentation – ROBOTIC WORKCELL LAYOUT

Draw a sketch of the hardware layout of your system. Use a straight edge. Be complete, neat and legible.

Total Points_____

Required Documentation – CONTROLLER INPUT ASSIGNMENTS

Document what is connected to each input on the controller interface. The judges must be able to read and understand what is connected to each input of the controller interface. ***(This must be completed before you receive a power cord for the DC power supply).***

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Notes:

Required Documentation – CONTROLLER OUTPUT ASSIGNMENTS

Document what is connected to each output on the robot controller. The judges must be able to read and understand what is connected to each output of the controller interface. They should also be able to look at the device and see the wire color etc. ***(This must be completed before you receive a power cord for the DC power supply).***

Output #1	NO	_____
	COM	_____
	NC	_____
Output #2	NO	_____
	COM	_____
	NC	_____
Output #3	NO	_____
	COM	_____
	NC	_____
Output #4	NO	_____
	COM	_____
	NC	_____
Output #5	NO	_____
	COM	_____
	NC	_____
Output #6	NO	_____
	COM	_____
	NC	_____
Output #7	NO	_____
	COM	_____
	NC	_____
Output #8	NO	_____
	COM	_____
	NC	_____

Required Documentation – WORKCELL DEVICE CONNECTIONS

Describe what is connected to each device. The judges must be able to read and understand what is connected to each device.

Stack Light

COM _____

Red _____

Yellow _____

Green _____

Blue _____

Sensor Box - Inductive Prox Sensor

\+ _____

\- _____

Sig _____

Limit Switch

NO _____

COM _____

NC _____

Attachment 1 – Metal Parts Storage
Attachment 2 – Plastic Parts Storage