PRIMARY DEVELOPERS:
Glenn Wisniewski – Corporate Trainer, Henry Ford College
Wes Bye – Mechatronics SME, Pontiac Coil

Mechapracticum Outline

Plant Floor Networking

Topic: Plant Floor Networking

Note: depending on equipment availability, the applications may vary by school.

Estimated completion time: 16 Hours

Purpose:

The purpose of this Mechapracticum is for the participant to demonstrate their ability to set-up and use the components of a shop floor network as prescribed in this document.

Pre-Requisites:

In order to gain the most value from this Mechapracticum, each student should have already completed the following labs:

- PLC to PLC – Produced and consumed tags and communication over Ethernet
- DeviceNet set-up and communications – Hardware and software; Interfacing with real world I/O
- Robot programming – Patterns on the floor of the cabinet or in the air
- PLC to Robot communications – Programming each; utilized Ethernet
- PLC tag creation for communications with Siemens HMI over Ethernet

Instructional Outcomes:

The participant will demonstrate:

- How set the parameters on the local communications adaptor to communicate with a selected PLC
- How to initiate circuit operation from a second PLC trainer (PLC #2) that contains the start, cycle start and e-stop inputs.
- How to use produced and consumed tags over Ethernet to communicate between the two processors.
- How to set the node on a DeviceNet I/O module and to communicate to the I/O wired on that module through a DeviceNet Scanner Module.
- How to write a simple program for a Fanuc robot material handling operation.
- How to establish communications with the module and demonstrate the ability to switch the module into and out of the “learn mode”.

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Instructions to Students:

Please program, wire, and debug the following circuits. When complete, ask your evaluator to verify the proper operation of the application. You may reference your notes and manufacturer's material.

Application 1:

Given a Computer with RSLogix 5000 and RSLinx software resident, the student will set the parameters on the local communications adaptor to communicate with a selected PLC. After the I/P address and the sub-net mask are set, the student will ping the processor to demonstrate the proper connectivity has been established. Once completed, the student will establish communications with the processor using the RSLogix software.

The evaluator must view the results of the ping operation.

The Evaluator must view the RSLogix 5000 communicating with the processor.

Application 2:

Given a simple clamp and drill requirement (simulated by the use of two pneumatic cylinders), the student will initiate circuit operation from a second PLC trainer (PLC #2) that contains the start, cycle start and e-stop inputs. The student will use produced and consumed tags over Ethernet to communicate between the two processors.

Circuit operation will be as follows:

- Start pushbutton must be depressed to enable the circuit. This will be sealed.
- Cycle start pushbutton must be depressed to initiate the circuit operation
- Cylinder one extends
- Circuit dwells for 2 seconds
- Cylinder two extends
- Once cylinder two is at full depth, it automatically returns
- Once cylinder two is returned, cylinder one returns
- Cycle is complete – awaiting a subsequent cycle start
- At any time, the e-stop bush button, if depressed, will return both cylinders and break the start pushbutton seal.

The evaluator must verify the proper operation of the circuit.

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Application 3:

The student will demonstrate the ability to set the node on a DeviceNet I/O module and to communicate to the I/O wired on that module through a DeviceNet Scanner Module. The I/O configuration will have to be modified to communicate with the module which now has a different node number. The student will demonstrate the ability to add the new node to the scanners list, map it to the proper address, read the inputs and activate the outputs connected to the DeviceNet Node.

The student will demonstrate to the evaluator the ability to operate an output and read an input that is connected to the node.

- PLC trainer with DeviceNet Scanner module
- DeviceNet I/O node with a minimum of 1 input and one output wired to the module
- Associated cabling

Application 4:

The student will demonstrate the ability to set the I/P address on an Ethernet I/O module and to communicate to the I/O wired to that module. The I/O configuration will have to be modified to communicate with the module which now has a different I/P address. The student will demonstrate the ability to read the inputs and activate the outputs connected to the Ethernet I/O module.

The student will demonstrate to the evaluator the ability to operate an output and read an input that is connected to the module.

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Application 5:

The student will have to write a simple program for a Fanuc robot material handling operation. A PLC processor will initiate the robot operation over Ethernet. The Pick and Place operation will be monitored by the PLC and output lamps on the PLC trainer will reflect the status of the robot progress. (e.g. robot in position, grippers open, robot lowers to the part, robot closes the grippers … cycle complete) The PLC trainer will supply the start, e-stop and cycle start pushbuttons. An e-stop will cause the robot to maintain its present position with the gripper also maintained. Once the e-stop has been cleared depressing the cycle start pushbutton will allow the robot to finish its sequence. A selector switch on the PLC panel will cause the robot to move to a maintenance position only from a home position and never mid-cycle. All robot to PLC communications must be Ethernet-based. This will require PLC configuration in the COW.

The evaluator will verify the operation of the system.

Application 6:

Given a managed Ethernet switch, the student will establish communications with the module and demonstrate the ability to switch the module into and out of the “learn mode”. The student will demonstrate the ability to reset a violated port.

The evaluator will verify that the student can activate and deactivate the “learn mode” and can reset a violated port.

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Safety:

The student will demonstrate safe work practices, safety attitude, and electrical safety practices.

Instructions to Evaluator:

From the list of applications presented, please select the applications that can be supported by your school. You may have to modify the above wording to match the PLCs that are available.

For **Application 1**, the instructor will have to clear the I/P address and the subnet mask. To increase the difficulty, issue a bad Ethernet cable to the student and see how long it takes for the student to eliminate the failed component. Also deleting the RSLinx driver would add to the challenge.
Time: 20 to 60 minutes to complete.

For **Application 2**, please ensure that all processors used have the same revision of software.
An interesting twist is to add a broken wire to the I/O wire available and see how long it takes for the student to eliminate the faulted wire. Also to improve the challenge, add a defective Ethernet cable.
Time: 2 to 4 hours to complete.

For **Application 3 and 4**, the application can be made more difficult by completely eliminating the I/O configuration for the DeviceNet Scanner Module and the I/O configuration in the RSLogix COW and forcing the student to enter these devices.
Time: 30 to 60 minutes each.

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For **Application 5**, it should be noted that most students that study robot material handling programming, do not study the robot signals to actually cause the robot to move and initiate a program. Therefore, before attempting this application it is critical that you are aware of the hardware background that the students have on the robot. If the actual signal necessary for robot movement, program selection and initiation have been well covered than this application may be attempted. Students may or may not be familiar with working with Ethernet data forms from both the robot and PLC's point of view. This exercise is only for advanced classes. To make this application simpler, give the students a spreadsheet listing the signals that are typically exchanged between the PLC and Robot that reflect the configuration of your training system.

Time: It could take day(s) even with an advanced class.

For **Application 6**, if the hardware has been well covered in the course, this application will take a few minutes to complete. What really challenges the student is not to cover the actual switch in the class lectures and force the students to interpret the manufacturer's information to complete the application. This could extend the time to several hours.

Time: A few minutes to several hours.

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Tools and Equipment:

- Computer with resident RSLogix software and Ethernet Port
- PLC processor with Ethernet Communications
- PLC – 1 trainer with Ethernet Communications
- 2 – N/O pushbuttons
- 1 – N/C pushbutton
- PLC – 2 trainer with Ethernet Communications
- 2 Pneumatic operated Cylinders
- 4 – Proximity or limit switches monitoring the extension and return of the Pneumatic cylinders
- Ethernet switch
- Cabling and I/O wires
- PLC trainer with DeviceNet Scanner module
- DeviceNet I/O node with a minimum of 1 input and 1 output wired to the module
- Associated cabling
- PLC trainer with an Ethernet adaptor module
- Ethernet I/O module with a minimum of 1 input and 1 output wired to the module
- Ethernet cabling
- Ethernet switch is optional
- PLC trainer with:
    - Ethernet adaptor module
    - 2 N/O pushbuttons
    - 1 N/C pushbutton
    - 5 Lamps minimum
- Ethernet switch – optional
- Fanuc robot with material handling configuration with Ethernet communications port
  Note: this could be grippers or vacuum-based
- Ethernet cabling and I/O wiring
- Computer
- Managed Ethernet switch
- Cabling

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Rubrics: Plant Floor Networking

	Application 1	**PTS**	***(A) Highly Proficient***	***(B) Competent***	***(C) Partially Competent/Developing***	***(D) Limited***	***(E) Major Improvement Required***
1	Pinging is successful	10	Pinging is successful		Needed some prompting to complete the Pinging		Unable to perform the action
2	RSLogix communicating with the PLC processor	10	Communications successful		Student needed minor assistance to establish communication		Unable to perform the action
	Application 2	**PTS**	***(A) Highly Proficient***	***(B) Competent***	***(C) Partially Competent/Developing***	***(D) Limited***	***(E) Major Improvement Required***
1	Application 2 operates as specified	40	Application 2 operates as specified. No evaluator assistance given		Application 2 operates as specified. Minimum evaluator assistance given		Application 2 did not function; Student required significant support
	Application 3	**PTS**	***(A) Highly Proficient***	***(B) Competent***	***(C) Partially Competent/Developing***	***(D) Limited***	***(E) Major Improvement Required***
1	Student will demonstrate the reading of an input and operation of an output on the DeviceNet I/O Module	20	Application 3 operates as specified. No evaluator assistance given		Application 3 operates as specified. Minimum evaluator assistance given		Application 3 did not function; Student required significant support

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	Application 4	**PTS**	***(A) Highly Proficient***	***(B) Competent***	***(C) Partially Competent/Developing***	***(D) Limited***	***(E) Major Improvement Required***
1	Student will demonstrate the reading of an input and operation of an output on the DeviceNet I/O Module	20	Application 4 operates as specified. No evaluator assistance given		Application 4 operates as specified. Minimum evaluator assistance given		Application 4 did not function; Student required significant support
	Application 5	**PTS**	***(A) Highly Proficient***	***(B) Competent***	***(C) Partially Competent/Developing***	***(D) Limited***	***(E) Major Improvement Required***
1	Application 5 operates as specified	50	Application 5 operates as specified. No evaluator assistance given		Application 5 operates as specified. Minimum evaluator assistance given		Application 5 did not function; Student required significant support
	Application 6	**PTS**	***(A) Highly Proficient***	***(B) Competent***	***(C) Partially Competent/Developing***	***(D) Limited***	***(E) Major Improvement Required***
1	Student demonstrates the ability to enable and disable the learn mode in the switch and can reset a violated port fault	10	Student demonstrated required skills. No evaluator assistance given.		Student needed minor assistance to activate the learn mode or reset a faulted por		Student required significant support to activate the learn mode or reset a faulted port

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	Safety	**PTS**	***(A) Highly Proficient***	***(B) Competent***	***(C) Partially Competent/Developing***	***(D) Limited***	***(E) Major Improvement Required***
1	Safe Work Practices	25	Used appropriate PPE; practiced common safety practices		Most safety practices used		Demonstrated unsafe working practices
2	Safety Attitude	25	Work practices demonstrated safety consciousness in all procedures; looked out for safety of others		Most of the time worked safely and showed some concern for safety of others		Dangerous worker; did not look out for safety of others
3	Electrical Safety Practices	25	Used appropriate control energy and safety procedures				Dangerous worker around electrical
	Tool Use	**PTS**	***(A) Highly Proficient***	***(B) Competent***	***(C) Partially Competent/Developing***	***(D) Limited***	***(E) Major Improvement Required***
1	Use of DVM and hand tools if required	25	Correctly and efficiently connected meter to device; handled tools carefully and respectfully		Somewhat efficient; mishandled one or more of the tools		Had to have assistance in connecting the meter to device; or showed disrespect for the tools

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	Work Habits	PTS	*(A) Highly Proficient*	*(B) Competent*	*(C) Partially Competent/Developing*	*(D) Limited*	*(E) Major Improvement Required*
1	Work Attitude	15	Alert to finding and correcting problem		Honestly attempted to find and correct problems		Showed frustration in finding and correctly problem
2	Work Procedure	25	Always followed standard procedures; demonstrated planning and organization skills in correcting the problem		Complied with standard procedures; Showed some plan and organization in working		Did not follow standard procedures; Disorganized and slipshod methods
3	Professionalism	20	Work showed pride in accomplishment		Tried hard and shows promise		Work lacks praise worthy factors
4	Self-confidence	15	Appeared comfortable and posed when performing tasks		Fairly self-confident; occasionally disconnected		Hesitant, timid, uncertainty
5	Knowledge of job	25	Has an exceptionally thorough knowledge of the job		Has good knowledge but needed coaching		Has inadequate knowledge of job

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