



Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
30 min.	<p>Start of Class:</p> <ul style="list-style-type: none"> • Introductions • Sign in Sheet • Housekeeping • Cell Phones • Breaks and facilities • Class Hours • Each day there may be downloads for the students' laptops that they will need to complete the exercises and labs. • Safety Glasses must be worn when working on the SMC • Watching Videos or other entertainment on the Laptops is only allowed during Lunch. • PPE must be worn when inside of the AMTEC trainer with unit plugged in • Etc. - NOTE: The first class was 9 Students. This explains the lab grouping later. This Class was scheduled for 80 to 120 Hrs. The class was competency based and the students were released when done. This also allows time for remediation if required. • Usually, at the start of each day, there is a short lecture that will aid in the completion of the upcoming labs. • The first day or two has significant lecture with exercises. This will change throughout the course. *Note: student log on to HFC is: • ID: XXXXX (Fill in for College) • PW: XXXXX (Fill in for College) 	<p>Lecture</p> <p>Note: Anything in red denotes material that was to be downloaded or made available on a flash drive for the students. Included in Download can also mean included on a flash drive.</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
30 min.	<p>Course Objectives Hand out course objectives or include in Download. (Attachment1) Review course objectives and discuss Grades will be assigned and credits will be granted. This course should pull together the skills learned in many of the previous courses. It may be helpful to review the course structure with the students to provide a sense of how the class will flow. (Attachment 2) The instructor will try to provide sufficient time for the student to individually solve the exercises and labs. Some activities can be performed as a team (such as becoming familiar with the operation of a trainer) Some activities will be individually completed and assessed. The students will be told which applies.</p> <p>Discuss Student tracking spreadsheet and Rubric. Note: the referenced tracking spread sheet in Attachment 3 was the initial form. A more complete tracking spreadsheet is included later.</p> <p>(Attachment 3 and 4) NOTE: It might be possible for some student to finish this work in 2 ½ weeks. If so, they will be released from class. Total time allowed is 80Hrs. to 120 Hrs.</p> <p>Review Student check-off form Master – Remember to emphasize the Safety and other competencies to be checked. Note the prompts on Attachment 3.</p> <p>INSTRUCTOR NOTE: Most schools do not have multiple AMTEC trainers and multiple SMC Trainers. Therefore numerous written exercises have been developed to provide beneficial work for the students when they cannot be on the trainers. The use of an open lab with flexible scheduling would also solve this problem.</p>	<p>Lecture</p> <p>Show sample of the tracking sheet and Rubric on overhead. Include in Download.</p> <p>On Overhead - go over the Student Check-off Form Master</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
	<p>INSTRUCTOR NOTE: This guide references student downloads. A copy of these downloads are included in the Attachments included with this document for the instructor's reference. These downloads will support overheads in lectures by the instructor. Copies of the exercises, prints, the logic of the trainers and course objectives and worksheets should be provided to the students on a flash drive. Links for the downloads are not provided. The students should be capable of referring to the Bill of Materials and locating the manufacturer's information on the web.</p>	
<p>1 Hour (1-1/2 hour)</p>	<p>Sequence Diagrams – Lecture and exercise</p> <p>Sequence Diagrams need to be covered in the class. A master (Blank) diagram (Template) is included. (Attachment 5) The instructor should go over the contents of the diagram:</p> <ul style="list-style-type: none"> • Step in terms of the machine action • Time duration of each step • The output being actuated in terms of the output Cylinder/Directional Control Valve Solenoid/ and the PLC address – (Which will reflect the I/O indicator on the module). • The triggers that cause the action – Proximity, limit, etc., Devices, and PLC I/O address (associated I/O light) • Remember the triggers that the student will identify from the machine operation are only guesses. The actual triggers can be identified through the PLC logic analysis. • Remember that the sequence chart starts with the cycle start Push Button. Any set-up logic prior to that point should be considered a permissive (set-up). • Discuss the importance of noting addresses on the sequence diagrams for future 	<p>Lecture using an overhead with the blank sequence diagram. Down Load Sequence Diagram Master</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
Continuation	<p>troubleshooting. (This identifies which I/O Module light to be analyzing) Note: On the AMTEC trainer, the load and unload junction boxes - addresses (tags) cannot be identified from the electrical prints. Please reference the handout named "AMTEC Junction Box Addressing". When this topic comes up in the Wiring Diagram exercise.</p> <p>The sequence diagram is the critical tool in troubleshooting the machine without access to the logic via terminal.</p> <p>NOTE: DO NOT HAVE THE STUDENTS DO THE CYCLE START SET-UP AT THIS TIME. IT GETS INTO THE PERMISSIVES. This implies the safety relays and safety controller on the AMTEC.</p> <p>Have 30 copies of Sequence Diagrams Available for class.</p> <p>Briefly discuss the contents of Troubleshooting Templates for Version 1 without the highlighting. (Not the troubleshooting methodology, just the information contained on the templates)</p> <p>Hand out hardcopy of Sequence Dia. Master. Handout a hardcopy of the Troubleshooting templates for the Version 1 troubleshooting. Have the student analyze the 2 pages and fill out the sequence diagram. (Attachment 6)</p> <ul style="list-style-type: none"> • Discuss the student generated sequence diagrams. • Note: Even though the circuits reflect A/B 1771 I/O, the exercises work very well in developing the sequence diagrams 	<p>Students developing Sequence Diagram Using the Version 1 Templates and the Sequence Diagram Master</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
	<p>Insure that the students have and maintain a copy of this sequence diagram. They will need to reference it several times later in this course.</p> <p>Discuss Dwells and how to reflect them on the sequence diagram.</p> <p>Discuss the use of dwells when there is not a feedback signal informing the logic that the action has been completed. (The SMC trainer used this logic in some situations)</p> <p>Discuss the mental order in which you view a machine (multiple passes – with each pass keep learning the sequence of the machine) and how that leads to the understanding of the machine sequence.</p> <ul style="list-style-type: none"> • Physical movement • Actuators • Feedback devices locations and indicators • HMI or Controls - look for manual controls • Remember the operator if applicable <p>Stress that observations to identify the triggers is only a guess. The logic analysis gives you the truth.</p> <p>Sequence Diagram Q & A</p> <p>INSTRUCTOR NOTE: AMTEC Prints and Logic should be made available – preferably – Hard Copy. Should also be available on the download. (Attachment 7) SMC Prints and Logic should be available as PDF's for a download to the students Laptops. Download Copies on Flash drive. (Attachment 8)</p> <p>Note: The SMC prints reflect IEC 617 symbology.</p>	





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
30 min	<p>Machine Overview</p> <p>The students will be given time to become familiar with the systems shortly.</p> <p>The instructor may want to stress the availability of information on the MSAMC – AMTEC Trainer operations Manual. This manual can be found on the MSAMC website under the resource tab, from the AIMS Simulator ITRS pull down. (Attachment 9)</p> <p>The internet address for the MSAMC Website is “msamc.org”.</p>	<p>Instructor Demonstration</p> <p>The instructor will demonstrate the following on the AMTEC and SMC trainers:</p> <ul style="list-style-type: none"> • Power up Sequence • Operation in Manual • Operation in automatic • Reset faults <p>AMTEC Only</p> <p>Review the contents on the HMI screens and Navigation.</p> <p>PPE should be reviewed. Remember: the plug & Lockouts should be reviewed.</p> <p>Stress manual operation of AMTEC</p>
	<p>Issue Print reading exercise and ask students to finish it and hand in. The AMTEC prints (Attachment 7) need to be available for each student.</p> <p>Print reading exercise should be handed out to each student. (Attachment 10)</p>	<p>Students working on the Print Reading Exercise</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
<p>20 min. to 2.5 hrs. Depending on the background of the students.</p>	<p>Discuss the exercise. Q&A on Print reading. Note: this same exercise can be replicated using the SCM prints, which reflects the IEC 617 symbology.</p> <p>Introduce the AMTEC remote (JB) I/O addressing if this has not been done previously. Provide Hard copy of the AMTEC Junction Box Addressing Reference. (Also on Flash Drive) (Attachment 11)</p> <p>Instructor Hint: The Remote I/O used in the junction box was selected to work with Allen Bradley or Siemens processors. Therefore, it is added to the I/O configuration as Generic I/O. Communications that requires 4 Bytes of data for the interface between the Ethernet Adaptor module and the PLC. This explains the 4 Sints in the Tag listing and the addressing scheme noted in the AMTEC Remote Junction Box Addressing handout.</p> <p>It should be noted on the AMTEC trainer (JB I/O) prints, Inputs 1 through 16 and outputs 1 through 16 are important. These are the identifiers that should appear on the sequence diagram and can be used to reference the I/O lights on the module. The exact PLC I/O address can be identified with the use of the handout identified as AMTEC Junction box addressing – included.</p> <p>Note: The download for the J-box addressing is not needed for the initial sequence diagram, but will be needed when analyzing the logic to verify the triggers.</p>	<p>Lecture</p> <p>Lecture</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
	<p>Remember: The instructor may have to review the following:</p> <ul style="list-style-type: none"> • Layout of print package • Terminal blocks • Splitters • Common abbreviations assumed to be understood. Examples are: FB, TB, MS, MCP, SR, SC, DS, CR, CBL, ES, SG, and other notation on the print package that is assumed to be understood. • Relay contact references under coils • Etc. 	
2 Hours (1.5 Hours) Per Station	<p>System Familiarity and Sequence Diagrams</p> <p>Assign the students to the AMTEC trainer or SMC stations Groups to start 2 – 2 – 2 - 3 students per group. The students will rotate through the stations in teams at this time. Use station 1, 2 and 4 of the SMC. Rotate all groups through these 3 stations. An SMC station may be done in 1 hour. AMTEC will take a little longer. (Attachment 12)</p> <p>Have the students fill out the Sequence Diagrams as teams and submit to the instructor for each station on which they work.</p> <p>The students must master the manual operation of the trainers and must become familiar with the HMI screens on the AMTEC trainer. Briefly review the students sequence diagrams for overall application of the concept. Do not correct any triggers at this time and let the student know that you are not checking the triggers. Their logic analysis will verify the triggers.</p>	<p>LAB</p> <p>The student will be given time to familiarize themselves with the operation of the trainers (Automatic and Manual modes) and then to start developing the sequence diagrams for the assigned stations.</p> <p>LAB</p> <p>Rotate and repeat Sequence Diagram Lab part 1 (without the logic analysis)</p>
	Introduction to Troubleshooting - Lecture	





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
1 Hr.	<p>Develop Troubleshooting Methodology on the white board. <i>Note this will be redeveloped and expanded on, several times.</i> Develop this methodology with the logic first and then later it will be done without the logic. This will give importance to the sequence charts.</p> <p>The instructor can use the AMTEC Troubleshooting Flow charts to help walk the students through the lecture available on MSAMC.org (Rough methodology found in Attachment 13)</p> <p>Note: This methodology is for a sequencing machine. This methodology does not apply to process control equipment or the troubleshooting of electronics.</p> <p>Remember that Sequence Diagrams used to be included in the working prints. Now, quite often, troubleshooters have to refer to the user’s manual on the equipment. Always emphasize the importance of working backward from the output that they are waiting for.</p> <p>Reference the troubleshooting flow chart, but develop on the white board. Do not issue the flow chart. Remember: Troubleshooting has different levels:</p> <ul style="list-style-type: none"> • A machine that was just working (The logic is good and the wiring and piping are correct). • A Machine that wouldn’t start in the morning (This condition causes examination of disconnects, estops, safety gates, interlocks, etc.) • A machine where the problem crosses shifts (Now there may be more than one fault and any replaced components may not have been installed correctly or configured correctly). 	Lecture





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
	<ul style="list-style-type: none"> Commissioning of a new machine (In this exercise, everything has to be considered. (Logic, wiring, piping/tubing, configuration of components, etc.) <p>(This course does not cover the last level.)</p> <p>Q&A</p> <p>Note: Prior to changing an input module or output module a meter check should be made on the module.</p>	
<p>30 min. to 1 Hr.</p>	<p>Assuming that a day has passed. Lecture: Redevelop troubleshooting methodology</p> <p>Expand to include PS lights – Proximity lights - how to check proximity and limit switches - etc.</p> <p>This is all white board work. The instructor should quiz the class for each step. These activities are normally done when verifying the operator’s complaint. (Step 2 in the troubleshooting methodology)</p> <p>If the sequence of a machine is known, a thorough examination can identify many faulty components.</p> <p>Example. Clamp one closed. Its closure is the trigger for the next step. The next step is clamp 2 should close.</p> <p>When examining the machine look for:</p> <ul style="list-style-type: none"> Insure that Clamp 1 did close completely Look to insure that the feedback device associated with clamp 1’s closure seems to be working (Proximity light is on or limit switch appears to be activated) Is the part seated correctly in the fixture Etc. <p>Knowing the sequence of a machine and the outputs that are associated with each step and the inputs triggering each step, is fundamental to troubleshooting.</p>	<p>Lecture</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
<p>1HR to 1 ½ hours.</p>	<p>Have the student reference the Sequence Diagram developed the previous day. (Version 1 from the templates)</p> <p>Referring to the sequence, Issue Troubleshooting exercise 2 with logic. Give the students the operator’s description of the fault. (This is noted on the bottom of the circuit page.) Have them apply the methodology discussed to isolate the fault. Answer sheet is attached.</p> <p>(Attachment 14)</p> <p>Have the students mark the answer on the bottom of the sheet and not share their answers. The instructor circulates through the room and confirms the answer</p> <p>Using the Overhead displaying troubleshooting exercise 2, discuss the proper application of the methodology that would have led to the answer. Q&A</p> <p>Issue exercises 3 through 8 one at a time and repeat above.</p> <p>(Attachment 15) Instructor Hint: Have hard copies available to support this activity</p>	<p>Students working on paper troubleshooting Version 1, exercise 2 – with logic.</p> <p>Students silently working on exercises 3 through 8 - one at a time</p>
	<p>Note: As the students complete Sequence Diagram Lab part 1, have them move on to Part 2. Review the Sequence diagrams for actions (steps) and outputs.</p> <p>Remember: the triggers are just guesses until the students have completed part 2.</p>	<p>LAB Rotate the students in lab, working on Sequence Diagrams Part 1.</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
<p>2 Hours Or more depending on how much was achieved in the first rotation.</p>	<p>SMC and AMTEC Logic should be made available to the students to support par 2. (Logic and the tag listings/cross reference)</p> <p>(Attachment 16)</p> <p>For this Capstone, the AMTEC logic/tag listings were also made available in hardcopy. If students are complete with their first pass on the Sequence Diagrams, have them start working on Sequence Lab part 2. This now includes the logic analysis to verify the triggers.</p> <p>Note: Rotation 1 get the students familiar with the trainers, power up, manual operation, and HMI screens. Rotation 2 has the students start to capture the Sequence Diagram Part1</p> <p>Note: The Sequence Diagram Lab part 2 has the students start to verify the triggers through the PLC logic analysis.</p> <p>Note: At this time we are working with Hardcopies of the AMTEC Prints and logic and PDFs of the SMC. Later we will be working with the terminals to analyze the logic. The students should be proficient in both approaches. The instructor may have to go over the organization of the logic: Main Routine (that contains jumps to all other routines), the Tag Listings, Mapping of I/O and etc.</p> <p>The students will find the logic analysis using the hard copies difficult at first. They are probably not proficient in analyzing the logic of machines. Also the SMC Logic is totally different than the AMTEC Logic. Please review prior to class. Let the students struggle for an hour or more.</p>	<p>Complete Sequence Diagram Part 2 When not on a trainer. Have the students verify the triggers through use of the prints and logic. (AMTEC hardcopies and SMC pdfs on Flash are available to support this activity)</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
	<p>NOTE: The time that it takes for the students to become comfortable using the Logic print-outs and Hard Copies and Tag Listings varies from a couple of hours to a day or longer. When the instructor is confident that the students can demonstrate proficiency, then proceed to the next step (using the Terminals with Studio 5000).</p>	
1 Hr.	<p>Issue PLC Logic Analysis Part 1 Allow the student to complete. (Attachment 17) Answers are provided in the attachment.</p> <p>Have the students download a copy of the Logix 5000 Controllers General Instructions Reference Manual from the Rockwell web site. This will aid them in the logic analysis here and later in the program. A copy is included in attachment 16 as an instructor reference.</p>	Student work on PLC Logic Analysis 1 exercise.
1 Hr.	<p>Lecture on analyzing logic on both the AMTEC and SMC trainers. This review the student performance on the PLC Logic Analysis 1. This is done without Studio 5000 support. The students need to understand how to navigate the logic using the Tag Listings as support (cross reference).</p> <p>Discuss</p> <p>Suggested order: AMTEC Extend Load Conveyor Stop</p> <ol style="list-style-type: none"> 1) Find Stop in electrical print 2) Determine PLC address using Drawings and Remote JB IO Handout 3) Refer to Tag Listings and find the OTE instruction. Determine where is it at in the program including subroutine and rung number 4) Go to logic output and look for qualifiers. Expect to find storage bits. Identify the address of 	Lecture





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
	<p>storage bit that you expect to lead the student to the triggers.</p> <ol style="list-style-type: none"> 5) Reference Tag listings and locate OTE instruction (what subroutine and rung) 6) Go to OTE instruction etc. etc. etc. <p>The Instructor will demonstrate the bouncing back and forth from the logic to the Tag Listing to the logic. It is helpful to keep track of your progress on paper, so that when you hit a dead end and want to back up, the student will not have to start over again.</p> <p>Q&A</p> <p>Issue Logic Analysis Part 2 for the students to work on when they are not on a trainer in Lab.</p> <p>(Attachment 18)</p> <p>Answers are available in the attachments.</p>	
2 - 4 Hrs.	<p>Have the students complete the analysis for the triggers reflected on their sequence diagram and submit to the instructor for review.</p> <p>See the Instructor's copy of the sequence Diagrams for answers. The students will complete this step individually. When finished, as a team they may correct their diagrams. As a team they will submit one copy of the sequence diagram to the instructor.</p> <p>Ensure that each student individually can navigate the hard copies. Once they demonstrate proficiency, have the students use Studio 5000 and a copy of the ACD. File.</p> <p>The PLC ACD files has been given to the students on the flash download. And can be found in Attachment 16.</p>	LAB/Written assignments





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
2 Hr.	<p>Develop Troubleshooting Methodology when the logic is not available Reference attachment 13. The instructor can Reference the MSAMC website to support this lecture or develop on the white board.</p> <p>Re-issue exercise 2 without the logic and have students reference the previously developed Sequence Diagram.</p> <p>(Attachment 19)</p> <p>Completed troubleshooting exercise 2 through 8 without logic. Again this should be completed one at a time with discussion each time of how they should have applied the methodology to solve problem. Remember to warn students to watch for fault lights.</p> <p>Associated with these exercises is a discussion about the use of the meter to troubleshoot the circuit. Remember to reference the backplane layout and identify where to attach the meter to a “common” on the terminal block.</p>	<p>Lecture</p> <p>Students working on Exercise Two troubleshooting without the logic</p> <p>Students working on Troubleshooting exercises 2 through 8 without the logic. One at a time with the instructor circulating to confirm correct answers.</p>
	<p>On the beginning of each day of the first five classes:</p> <p>Redevelop the Troubleshooting Methodology continuing to expand. This is done on white board with the students providing the info. Remember to expand the methodology to include a check for manual, how to get the machine back in sequence, use of Diagnostics, and use of the meter. This implies checking the meter connections, proper range and scale, and the proper deployment of the measurements.</p> <p>Instructor Hints:</p> <ul style="list-style-type: none"> • Can't troubleshoot a complicated system that is out of sequence • If a system is out of sequence - remove all parts - return all operators to set-up condition - reset 	<p>Lecture</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
30 Min.	<p>key signals (examples Cycle Complete, Clear to Transfer, etc.)</p> <ul style="list-style-type: none"> On the AMTEC trainer- remove all parts - robot to home - Cycle power on system (due to the students not understanding some of the key signals yet) OR on the AMTEC Simulator - run the part through in manual until the sequence is completed. Run the system in automatic and when it fails in sequence, start troubleshooting. It should be noted that when checking for the Diagnostics (Step 3) also look at the auto/manual selector switch. If not in auto, be suspicious that someone might have manually operated the system and have gotten it out of sequence. 	
5.5 Hr.	<p>The students are now ready for the start of troubleshooting.</p> <p>Level one faults assume that the machine has just been running and something has JUST failed.</p> <p>The instructor will have to bug the trainers and rotate the students through the faulted stations.</p> <p>Keep track of the faults and the students completing the troubleshooting.</p> <p>Instructor Hint: Reference the student checkoff sheet with notes for a fault listing and tracking mechanism.</p> <p>NOTE: it is critical that a good tracking sheet be developed. Students will be rotating through the faulted systems and the instructor will have to keep track of the students and the faults.</p>	<p>LAB – Level One Faults</p> <p>When not on the trainers, the students are working on the assigned written exercises. (for example, PLC Logic Analysis 2)</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
	<p>See Student Check Off form with notes. Several examples have been attached.</p> <p>See Attachment 29.</p> <p>Contact Henry Ford College for the Fault Lists associated with the AMTEC and SMC trainers.</p> <p>Ensure that the students have the Sequence Diagram with Permissive Lab and the safety information (Flash download).</p> <p>(Attachment 20)</p> <p>The students have corrected sequence diagrams - at least one – although they may not be complete with their Logic analysis to verify triggers. They should be familiar with the machines They should be able to operate the machines in manual and automatic.</p> <p>Remember that the set-up for the Cycle Start is extensive.</p> <p>Note the Safety information is necessary to finalize all the set-ups (permissives). This will lead the students into the Safety relays and Controller which will slow their progress.</p> <p>(See Attachment 20) Note the Safety Exercise is also included here.</p>	
	<p>Instructor Note:</p> <p>Home work. Have the students complete the Arc Flash training on the MSAMC web site. (msamc.org)</p> <p>This will take 1 to 2 Hrs.</p>	





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
	<p>Note: Please reference the AMTEC and SMC Fault Listings - These identify the faults and the Category (level) of the faults. The SMC faults are printed in this package. The AMTEC is too extensive to print. Please see the Electronic form. These are available from Henry Ford College – Corporate Training Department.</p> <p>Fault Listings are included in Attachment 21</p> <p>This is not to be issued to the students.</p>	
30 min. to 1 Hr.	Review Troubleshooting Methodology	Lecture
6 hrs.	Continuation of previous day's troubleshooting.	LAB Students are troubleshooting Level One Faults and working on Written Exercises.
2 to 3 Hours	<p>Lecture and instructor Demo.</p> <p>Attach terminal to overhead. View the PLC logic with Studio 5000 Review Controller Organization Review Tasks – programs – subroutines Review Tags Review Mapping Demonstrate the use of the cross reference function on terminal to work backwards Note from this point on the terminals can be used instead of the logic hard copies Remember to reference the J-box addresses Repeat this for the AMTEC and SMC</p>	Instructor Demo





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
	<p>Note: this could have been done earlier but the students have an increased attention level once they have struggled with the logic in the previous exercises.</p> <p>Flash- Download .ACD files for both AMTEC and SMC trainers. See attachment 16. The students will need this to utilize Studio 5000 when not on the stations.</p> <p>Reference Attachment 16 Also included are the programming manuals for Control Logix from Allen Bradley for an Instructor reference. The students should download this information from the Rockwell web site. The instructor may have to review the settings of the Lan Adaptor function on the computer; re-establishing the I/P address and subnet mask. I/P addresses are always reflected on the print packages.</p>	
5 Hrs.	Continue troubleshooting and written exercises	LAB - Troubleshooting
	<p>Note: Students will need to noodle through the safety information to solve all the permissives (set-ups) on the AMTEC trainer. After several periods of lab, the safety info (Not Arc Flash) will need to be lectured on.</p>	
15 to 30 min.	<p>Mini lecture on:</p> <ul style="list-style-type: none"> Inhibited or faulted modules in the Controller organization areas Ensuring - Run Mode vs Program mode on studio 5000 Forcing Electronically fused modules. <p>Have the students download light screen manufacturer's Info.</p> <p>See Attachment 22 for an instructor's reference.</p> <p>Have the students download Robot Interfacing lab and spreadsheet from Flash drive.</p>	Lecture





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
	<p>See Attachment 23 for the PLC to Robot interfacing lab and spreadsheet.</p>	
<p>30 Min. to 1 Hr.</p>	<p>Discuss the use of Manufacturer’s Literature. The Instructor may use the Light screen circuit for an example.</p> <p>Emphasize:</p> <ul style="list-style-type: none"> • General overviews • Wiring examples • Indicator explanations • Timing Diagrams. (if applicable) • <p>May want to give examples of how to use light screen information, PLC instructions, etc. Note: This mini lecture prepares the students to handle the Faults Crossing Shifts – troubleshooting Labs.</p> <p>Robot Interface Lab can be issued for filler as the students rotate. This information will be useful in the recovery from certain robot faults.</p> <p>Issue Remote I/O exercise. Flash - Download Have the student download the information on the remote Ethernet Adaptor module and Remote I/O modules.</p> <p>See Attachment 24 for Remote I/O Exercise and Instructor reference material. Have the students download the reference material from the manufacturer’s web site. Note: the instructor may want to direct the students to the Bill of materials to identify the proper model numbers and manufacturer’s names.</p> <p>Assign the Remote I/O exercise.</p>	<p>Lecture</p> <p>Students continue on Troubleshooting labs and working on written exercises when not on the trainers.</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
7 Hours	<p>The student now have been assigned: Sequence Diagram Labs Part 1 and 2 These Sequence diagrams are to be handed in on the AMTEC Trainer and 2 Instructor selected SMC stations. Print Reading Exercises Robot interfacing exercise Labs Level 1 of troubleshooting faults Remote I/O exercise - new New assignment of round two of written troubleshooting exercises and, sequence diagram with permissive listed. (Instructor's option)</p> <p>Instructor Note:</p> <p>Students can now start Level 2 troubleshooting which is a fault tied to permissives or a fault with a permissive add-on. Included is a second version of troubleshooting exercises. These can be used as homework or as supporting information for students that need remediation. (Instructor's option)</p> <p>See Attachment 25.</p> <p>See Level 2 fault list. Contact Henry Ford College-Corporate Training for the fault lists.</p> <p>Note that some of the Level 2 faults will force the student into the 480v panel and will require PPE.</p>	<p>LAB Student complete Troubleshooting Labs for Level 1 and level 2 faults.</p>
8 Hrs.	<p>Lab and exercise day</p>	<p>LAB and Written Exercise work</p>
	<p>Instructor Note:</p> <p>Have students download the specs on the pressure switch and optical pick-ups (Flash - Download)</p> <p>See Attachment 26 for instructor's reference.</p>	





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
	This information will be needed for the – Faults Crossing Shift Troubleshooting Labs. The students should download this information from the Manufacturer’s web site.	
15 to 30 min.	<p>Lecture on Crossing shift faults. Not only will the troubleshooter have to repair the original fault which may have not been corrected, but any additional faults or misconfigurations now introduced into the system.</p> <p>Remember: That some of the up-coming faults include the original problem and could include additional concerns due to:</p> <ul style="list-style-type: none"> • Misadjusted parameters on Pressure switch • Circuit Breakers in the Main Enclosure turned off • Flow controls misadjusted • Field Disconnects off • Air distribution valves off. • Miss set parameters on optical pick-ups on AMTEC • Physically misadjusted (Physically) Pick up on bearing station rejecting all parts (referencing the linear Potentiometer on the bearing station.) SMC only. 	Lecture
7 Hrs.	<p>Lab and exercise day</p> <p>Crossing Shift Faults.</p> <p>See Attachment 27.</p>	<p>LAB</p> <p>Students continue of troubleshooting labs, now including the faults crossing shifts.</p>





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
8 Hrs.	<p>Lab and exercise day. Issue the safety exercise to the students. Hard Copy Have the students download the manuals on the safety controller and safety relays. Reference Attachment 20.</p>	LAB
8 Hrs.	<p>Lab and exercise day. Issue System optimization labs for the students ready. INCLUDING:</p> <ul style="list-style-type: none"> • Cycle time improvements on AMTEC • Exit conveyor crash prevention on AMTEC • Disable fault on cycle start for optical PP, change to qualifier for cycle start. • Etc. <p>REFER to the System Optimization labs and verbally assign the tasks to the students.</p> <p>The students should have attempted to complete the Safety Exercise prior to discussing.</p> <p>See Attachment 28.</p>	LAB and Written exercise work
	<p>Instructor Notes:</p> <p>At the start of each Day the instructor should provide a mini lecture and then go to Lab. Samples of Mini-lectures include:</p> <ul style="list-style-type: none"> • Ensure that the concept of switching power to motion causing outputs is well established (when student have completed the safety exercise) • Fundamentals of the safety circuits need to be discussed. Including: Redundant switches (Safety Gates and Estops), checking the safety inputs for shorts to ground and pulse testing and etc. • After the students have had an opportunity to work on the Safety Exercise, the exercise needs to be checked and discussed on the board. 	





Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

Time	Instructor Topics	Activities
	<ul style="list-style-type: none"> • Discussed internal Block Dia. Of safety relay and safety controller from the manufacturer’s Literature. Note: the AMTEC drawing for the internal safety relay is incorrect on the prints but is correct on the Safety Exercise information. <ul style="list-style-type: none"> Evaluated the AMTEC print package. Examined the Control and safety relays circuits. Related the Safety Controller and Relays to the print package. • Additional print reading points include: <ul style="list-style-type: none"> - Hydraulic motor – Motor Starter - - Motor circuit protector (Mag trip - Adjustable) • Discussed wire numbers. Print references vs. I/O addresses. • Discussed Ethernet based machines vs. Remote I/O wiring. • Discussed Turck Blocks with integral Ethernet adaptors and I/O interfaces. • If the equipment is available, A/B Safety processors and Guard Logix can be demonstrated and discussed. <p>Note: Students are always weak on analog I/O and this has been used as an additional lab for some classes.</p> 	
	<p>For the remaining course: Remediation and completion of assignments and Labs.</p> <p>Instructor Note: Robot to PLC interfacing will have to be lectured somewhere, depending on the progress of the class.</p> <p>Sequence Diagram Answer Sheet – See Appendix 30.</p>	<p>Labs and Written Troubleshooting</p>





**Multi-State
Advanced Manufacturing
Consortium**

US DOL SPONSORED TAACCCT GRANT: TC23767

PRIMARY DEVELOPER: Glenn Wisniewski, Henry Ford College

RELEASE DATE 3/18/2015

VERSION v 001

PAGE 25 of 25

Instructor Guide

Integrated Manufacturing Systems Troubleshooting Capstone

SAFETY DISCLAIMER:

M-SAMC educational resources are in no way meant to be a substitute for occupational safety and health standards. No guarantee is made to resource thoroughness, statutory or regulatory compliance, and related media may depict situations that are not in compliance with OSHA and other safety requirements. It is the responsibility of educators/employers and their students/employees, or anybody using our resources, to comply fully with all pertinent OSHA, and any other, rules and regulations in any jurisdiction in which they learn/work. M-SAMC will not be liable for any damages or other claims and demands arising out of the use of these educational resources. By using these resources, the user releases the Multi-State Advanced Manufacturing Consortium and participating educational institutions and their respective Boards, individual trustees, employees, contractors, and sub-contractors from any liability for injuries resulting from the use of the educational resources.

DOL DISCLAIMER:

This product was funded by a grant awarded by the U.S. Department of Labor's Employment and Training Administration. The product was created by the grantee and does not necessarily reflect the official position of the U.S. Department of Labor. The Department of Labor makes no guarantees, warranties, or assurances of any kind, express or implied, with respect to such information, including any information on linked sites and including, but not limited to, accuracy of the information or its completeness, timeliness, usefulness, adequacy, continued availability, or ownership.

RELEVANCY REMINDER:

M-SAMC resources reflect a shared understanding of grant partners at the time of development. In keeping with our industry and college partner requirements, our products are continuously improved. Updated versions of our work can be found here: <http://www.msamc.org/resources.html>.

