

SkillsTrac

Industrial Maintenance Training for Advanced Manufacturing

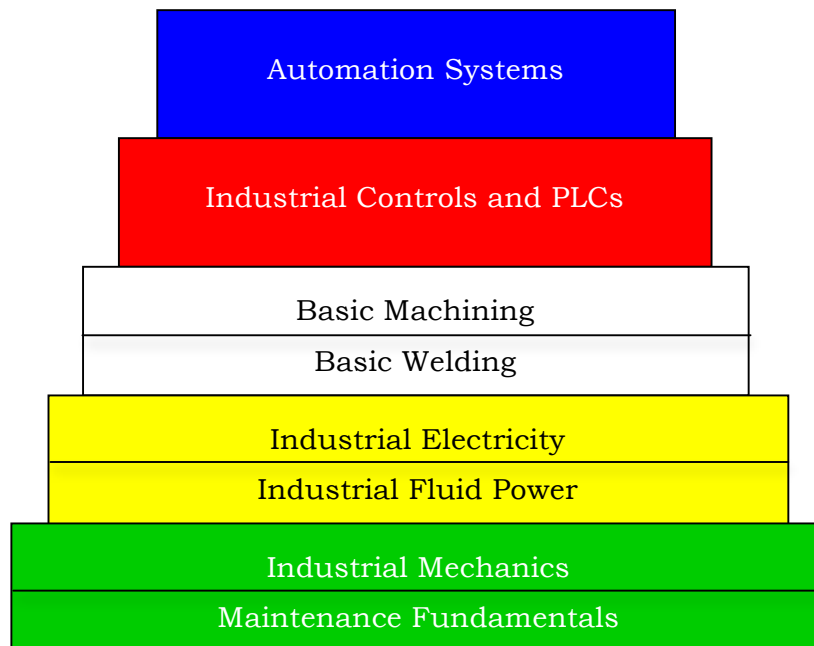
Introduction

SkillsTrac is a comprehensive industrial maintenance training program, specially designed for the advanced manufacturing industry. Advanced manufacturing operations employ modern automation systems, which include programmable logic controllers, human-machine interfaces, variable frequency control of AC motors, motion control of servomotors, and robotics. SkillsTrac prepares its students with the skills needed to maintain, troubleshoot and repair automation systems and components. While the program is geared primarily toward the industrial automation market, the principles taught can apply to maintenance in nearly any industry.

SkillsTrac Partners

The SkillsTrac program was developed by a consortium of four colleges and vocational schools, ten One-Stop and economic development organizations, and over thirty manufacturers and was funded by a U.S. Department of Labor Community Based Job Training Grant. The schools deliver the training to incumbent workers from the manufacturing community and to the dislocated worker base in western Ohio.

Program Structure



The program is made up of multiple levels, which grow in complexity with each successive level. The lower two levels provide the foundation on which modern industrial maintenance rests: Maintenance Basics and Industrial Mechanics, which form the bottom or Green Level, and Industrial Electricity and Industrial Fluid Power, which form the Yellow Level. Maintenance personnel can often run across the need to perform machining and welding operations to repair a piece of machinery. Thus the White Level, the third in the sequence, provides Basic Machining and Basic Welding training. The fourth level, Red, begins the advanced training in automation and consists of Industrial Controls and Programmable Logic Controllers. The top level,

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Blue, builds on all others and provides in-depth training in Automation Systems and Robotics and Motion Control.

The green, yellow and white levels have two topic certificates each. Upon successful completion of the courses in a certificate area, the student earns a certificate in that level and topic. For instance, completion of the Industrial Mechanics courses earns a Green Industrial Mechanics certificate. The red and blue levels have one topic each. The student must complete all of the courses in these levels in order to earn the appropriate red or blue certificate.

Course Content

Blue Level		Hours
<u>Automation Systems Certificate</u>		
Automation Systems		72
Robotics and Motion Control		62
Total Hours		134
Red Level		Hours
<u>Industrial Controls and PLCs Certificate</u>		
Control Systems		38
Programmable Logic Controllers		56
Total Hours		94
White Level		Hours
<u>Basic Machining Certificate</u>		
Basic Machining		66
<u>Basic Welding Certificate</u>		
Basic Welding		48
Total Hours		114
Yellow Level		Hours
<u>Industrial Electricity Certificate</u>		
Basic Electricity		30
Motors and Motor Controls		44
<u>Industrial Fluid Power Certificate</u>		
Pneumatics and Hydraulics		50
Total Hours		124
Green Level		Hours
<u>Maintenance Fundamentals Certificate</u>		
Professional Development		12
Math and Print Reading		20
Basic Safety		18
Maintenance Basics		34
<u>Industrial Mechanics Certificate</u>		
Materials and Measurement		16
Mechanical Systems		50
Total Hours		150

The Green Maintenance Fundamentals certificate consists of four courses: Professional Development, Math and Print Reading, Basic Safety, and Maintenance Basics. Maintenance Basics covers maintenance concepts, troubleshooting, mechanical and electrical safety and rigging.

The Green Industrial Mechanics certificate consists of two courses: Measurement and Materials and Mechanical Systems.

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The Yellow Industrial Electricity certificate consists of two courses: Basic Electricity and Motors and Motor Controls.

The Yellow Industrial Fluid Power certificate consists one course, Pneumatics and Hydraulics.

The White Basic Machining and Basic Welding certificates consist of one course each in the topic area.

The Red Industrial Controls and PLCs certificate consists of two courses: Control Systems and Programmable Logic Controllers.

The Blue Automation Systems certificate consists of two courses: Automation Systems and Robotics and Motion Control. The motion control topics include variable frequency drives and servo motion control.

The average number of hours required to complete certificates and levels are shown in the figure above. There are a total of 616 hours, on average, for the complete program. Total course and lab hours are essentially even: 312 hours for content and 304 hours for labs.

Training Delivery

SkillsTrac training consists of course content, taught mostly in an online format, and hands-on validation lab content, taught in an advanced training lab. There are also some instances in the program where an instructor leads the training in a traditional format. The online classes serve as the instructor and textbook for the basic course material. Students enroll at their local school, which assigns them seats in the online system. They can begin taking the online courses immediately.

Equivalent training labs are set up at the various schools. After students have completed a certain number of online courses, they request time in the lab at their local school to work on the validation lab content. Lab exercises typically take from four to eight hours to complete. Depending on the student's ability and the complexity of the lab exercise, they can take a little as two hours and as many as sixteen hours to complete.

Generally speaking, there is more course content at the lower levels of the program than lab content. The opposite is true at the upper levels, in particular the Red and Blue levels, where the hands-on validation in controls and automation is especially important for a skilled maintenance technician.

Curriculum Design

The basic structure and content of the program were designed by the consortium's curriculum committee, which was made up of educators and business representatives. This group determined the general thrust of the program and the topics to be covered. The criteria to which the group adhered in the development of the program required, among many things, that 1) the program should be self-paced, 2) it should minimize a trainee's time in class and away from the job, and 3) there should be a 50-50 mix of course content and hands-on validation lab content.

The first two criteria essentially eliminated traditional instructor-led training from consideration and caused the group to recognize that online content training was the best approach. The grant did not provide enough resources for the schools to develop

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their own online content, so the consortium partnered with Tooling University, which carries a full line of maintenance-related training courses and offers them asynchronously online. A trainee can take the online courses at anytime.

Members of the curriculum committee designed the hands-on validation labs under the grant. Most of the lab content was already being delivered at the schools in their regular academic programs, but it was not typically designed or delivered as self-paced lab modules. The curriculum group had to redesign the labs for self-paced delivery. The resulting set of 30 labs makes up one half of the training program. They are part of the SkillsTrac product. As with the online content, the validation labs are available for a trainee to take anytime the advanced training labs are open.

Program Details

The following pages show more of the curriculum details for each certificate and level in the program.

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Green Level
Maintenance Fundamentals Certificate

<i>Instructor-Led and Online Training and Hands-on Labs: 84 Hours</i>			
<i>Title</i>	<i>Content</i>	<i>Class Hours</i>	<i>Lab Hours</i>
<i>Professional Development</i>	■ Managing Conflict ■ Employer Expectations	12	0
<i>Math and Print Reading</i>	■ Math: Fundamentals ■ Math: Fractions and Decimals ■ Math: Units of Measurement ■ Shop Geometry Overview ■ Shop Algebra Overview ■ Shop Trig Overview ■ Basics of Tolerance ■ Blueprint Reading ■ Geometry: Lines and Angles ■ Geometry: Triangles ■ Geometry: Circles and Polygons ■ Trig: Pythagorean Theorem ■ Interpreting Blueprints	20	0
<i>Basic Safety</i>	■ Intro to OSHA ■ Fire Safety and Prevention ■ Bloodborne Pathogens ■ Personal Protective Equipment ■ Lockout/Tagout Procedures ■ Environmental Safety Hazards ■ Flammable/Combustible Liquids ■ MSDS and Hazard Communications ■ Noise Reduction and Hearing Conservation ■ Walking and Working Surfaces ■ Confined Spaces ■ Respiratory Safety	18	0
<i>Maintenance Basics</i>	■ Approaches to Maintenance ■ Total Productive Maintenance Overview ■ Troubleshooting: Identifying Problems ■ Troubleshooting: Understanding Causes and Effects ■ Troubleshooting: Taking Corrective Action ■ Safety for Mechanical Work ■ Safety for Electrical Work ■ Hand and Power Tool Safety ■ Safety for Lifting Devices ■ Intro to Machine Rigging ■ Rigging Equipment ■ Lifting and Moving Equipment ■ Rigging Inspection and Safety ■ Rigging Mechanics ➤ Hand and Power Tools Lab ➤ Rigging Lab	20	14
Total Hours		70	14

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Green Level
Industrial Mechanics Certificate

Online Training and Hands-on Labs: 66 Hours			
Title	Content	Class Hours	Lab Hours
Measurement and Materials	■ Basic Measurement ■ Linear Instrument Characteristics ■ Calibration Fundamentals ■ Intro to Materials ■ Structure of Metals ■ Overview of Plastic Materials ■ Mechanical Properties of Metal ■ Physical Properties of Metal ➤ Measurements Lab	12	4
Mechanical Systems	■ Intro to Mechanical Systems ■ Forces of Machines ■ Power Transmission Components ■ Mechanical Power Variables ■ Lubrication Fundamentals ■ Bearing Applications ■ Spring Applications ■ Belt Drive Applications ■ Gear Geometry ■ Gear Applications ■ Clutch and Brake Applications ➤ Lubrication Systems Lab ➤ Basic Mechanical Lab ➤ Advanced Mechanical Lab	16	34
	Total Hours	28	38

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Yellow Level
Industrial Electricity Certificate

<i>Online Training and Hands-on Labs: 74 Hours</i>			
<i>Title</i>	Content	Class Hours	Lab Hours
<i>Basic Electricity</i>	■ Electrical Units ■ Intro to Circuits ■ Intro to Magnetism ■ DC Circuit Components ■ Series Circuit Calculations ■ Parallel Circuit Calculations ■ AC Fundamentals ■ Electrical Instruments ■ Electrical Print Reading ■ DC Power Sources ■ AC Power Sources ■ Battery Selection ➤ Basic Electrical Lab	18	12
<i>Motors and Motor Controls</i>	■ Intro to Electric Motors ■ Symbols and Diagrams for Motors ■ Logic and Line Diagrams ■ DC Motor Applications ■ Solenoids ■ NEC Overview ■ Conductor Selection ■ AC Motor Applications ■ Contactors and Motor Starters ■ Control Devices ■ Reversing Motor Circuits ■ Distribution Systems ➤ Motors and Motor Controls Lab ➤ Wiring and Distribution Lab	18	26
	Total Hours	36	38

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Yellow Level

Industrial Fluid Power Certificate

<i>Online Training and Hands-on Labs: 50 Hours</i>			
<i>Title</i>	Content	Class Hours	Lab Hours
<i>Pneumatics and Hydraulics</i>	■ Intro to Fluid Systems ■ Safety for Hydraulics and Pneumatics ■ The Forces of Fluid Power ■ Intro to Hydraulic Components ■ Intro to Pneumatic Components ■ Intro to Fluid Conductors ■ Fittings for Fluid Systems ■ Preventive Maintenance for Fluid Systems ■ Hydraulic Power Variables ■ Pneumatic Power Variables ■ Hydraulic Power Sources ■ Pneumatic Power Sources ■ Fluid System Print Reading ■ Hydraulic Control Valves ■ Pneumatic Control Valves ■ Actuator Applications ■ Basic Hydraulic System Design ■ Basic Pneumatic Circuit Design ■ Hydraulic Fluid Selection ■ Contamination and Filter Selection ➤ Basic Fluid Power Lab ➤ Advanced Fluid Power Lab	30	20
	Total Hours	30	20

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White Level
Basic Machining Certificate

Online Training and Hands-on Labs: 66 Hours			
Title	Content	Class Hours	Lab Hours
Basic Machining	■ Metal Removal Processes ■ Safety for Metal Cutting ■ What is Cutting? ■ Machines for Metal Cutting ■ Cutting Processes ■ Metalworking Fluid Safety ■ Cutting Variables ■ Cutting Fluids ■ Cutting Tool Materials ■ Tool Geometry ■ Speed and Feed Selection ■ Basics of the Engine Lathe ■ Overview of Engine Lathe Setup ■ Toolholders for Turning ■ Engine Lathe Operation ■ Basics of the Manual Mill ■ Overview of Manual Mill Setup ■ Benchwork and Layout Operations ■ Milling Geometry ■ Manual Mill Operation ■ Intro to Abrasives ■ What is Grinding? ■ Grinding Processes ■ Grinding Variables ■ Grinding Wheel Materials ■ Grinding Wheel Geometry ■ Dressing and Truing ■ Surface Grinder Operation ➤ Engine Lathe Lab ➤ Manual Mill Lab ➤ Grinding Lab	42	24
	Total Hours	42	24

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White Level
Basic Welding Certificate

<i>Online Training and Hands-on Lab: 48 Hours</i>			
<i>Title</i>	Content	Class Hours	Lab Hours
<i>Basic Welding</i>	■ What is Oxyfuel Welding? ■ Oxyfuel Welding Safety ■ What is Arc Welding ■ Arc Welding Safety ■ Arc Welding Processes ■ Overview of Weld Types ■ Electrical Power for Arc Welding ■ Ferrous Metals for Welding ■ Nonferrous Metals for Welding ■ Oxyfuel Welding Applications ■ SMAW Applications ■ GMAW Applications ■ FCAW Applications ■ GTAW Applications ■ Arc Welding Symbols and Codes ■ Arc Welding Power Sources ■ Plasma Cutting ■ Electrode Selection ■ Visual Inspection of Welds ■ Arc Welding Aluminum Alloys ➤ SMAW Lab ➤ GMAW Lab ➤ GTAW Lab	30	18
	Total Hours	30	18

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Red Level
Industrial Controls and PLCs Certificate

<i>Online Training and Hands-on Labs: 94 Hours</i>			
<i>Title</i>	Content	Class Hours	Lab Hours
<i>Control Systems</i>	■ Timers and Counters ■ Electronic Semiconductor Devices ■ Photonic Semiconductor Devices ■ Limit Switches and Proximity Sensors ■ Photoelectric and Ultrasonic Devices ■ Reduced Voltage Starting ■ Solid State Relays and Starters ■ Deceleration Methods ■ Acceleration Methods ➤ Basic Relay Controls Lab ➤ Electronic Sensors Lab ➤ Manual Control and Safety Devices Lab	14	24
<i>Programmable Logic Controllers</i>	■ Intro to PLCs ■ Hardware for PLCs ■ Basics of Ladder Logic ■ Numbering Systems and Codes ■ PLC Inputs and Outputs ■ Basic Programming ■ PLC Timers and Counters ■ Hand-Held Programmers for PLCs ■ PLC Diagrams and Programs ■ Overview of PLC Registers ■ PLC Program Control Instructions ■ Math for PLCs ■ Sequencer Instructions for PLCs ■ PLC Installation Practices ■ Data Manipulation ■ Shift Registers ➤ Intro to PLCs Lab ➤ Intermediate PLCs Lab ➤ Advanced PLCs Lab	24	32
	Total Hours	38	56

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Blue Level
Automation Systems Certificate

<i>Online and Instructor-Led Training and Hands-on Labs: 134 Hours</i>			
<i>Title</i>	Content	Class Hours	Lab Hours
<i>Automation Systems</i>	■ Automation Systems Basics ■ Networking for PLCs ➤ Fundamental Machine Operations Lab ➤ Sequence, Sensors and Actuators Lab ➤ Process Improvement and SCADA Lab ➤ System Troubleshooting Lab ➤ Vision Systems Lab	8	64
<i>Robotics and Motion Control</i>	■ Intro to Robotics ■ Robot Safety ■ Robot Components ■ End Effectors ■ Applications for Robots ■ Robot Axes ■ Robot Sensors ■ Robot Troubleshooting ■ Robot Maintenance ■ Concepts of Robotic Programming ■ Robot Drives, Hardware and Components ■ Robot Installations ■ Robotic Control Systems ■ Vision Systems ■ PID for PLCs ■ Specs for Servomotors ➤ Variable Frequency Drive Lab ➤ Servo Motion Control Lab	30	32
	Total Hours	38	96

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Program Summary

Level	Certificate	Average Hours	
		Class	Lab
Green	Maintenance Fundamentals	70	14
Green	Industrial Mechanics	28	38
Yellow	Industrial Electricity	36	38
Yellow	Industrial Fluid Power	30	20
White	Basic Machining	42	24
White	Basic Welding	30	18
Red	Industrial Controls and PLCs	38	56
Blue	Automation Systems	38	96
Totals		312	304

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