Here is a standardized process using a systematic approach.

The head of a corporate reliability group for a worldwide consumer products company was having difficulty hiring maintenance personnel who possessed the skills the company required. He was adamant that troubleshooting skills cannot be taught. “Troubleshooting industrial equipment is an art more than a learned skill. You either have it or you don’t,” he said.

I totally disagree with this concept. There are many seminars, programs, and methods of teaching troubleshooting skills. However, most of these methods require considerable time and are not conducive to a factory floor setting.

Prerequisites to troubleshooting

The key to troubleshooting industrial equipment lies beyond the process itself. A prerequisite to troubleshooting is the knowledge and understanding of the equipment. Knowing how the equipment functions, what each component installed on the equipment is, what the component does, how the component does what it should, and how the components interact are essential in applying any troubleshooting methodology or process.

Information about the equipment can be taught to anyone. Employees with a maintenance background, whether mechanical or electrical, will learn much more easily than those who have no maintenance experience.

A company that expects to hire someone who possesses these so-called troubleshooting skills and expects to provide no equipment-specific training will undoubtedly be disappointed.

Is it feasible to train every maintenance technician on every piece of equipment in the plant? No, of course not. That would take more time and money than any company has in its budget. But is there a way to teach individuals to train themselves how to learn about specific equipment? Yes, I believe there is. A standardized process of learning is essential.

Apply a standardized process

How is this accomplished? Let’s take a look at the automotive service industry. A training program supports every major automotive manufacturer through one or more outside facilities

throughout the United States.

In most cases, before an individual can start a program specific to a manufacturer he must be a graduate of a nonspecific program. These programs involve a curriculum of generic classes such as fuel systems, computer systems, brake systems, etc.

Once the prerequisites are accomplished, an individual may enroll in a manufacturer's program. These programs include equipment-specific training. The individual, schooled in the specifics of component function, now learns how those components function together in an integrated system within a specific automobile. Once the systems are learned, diagnostics of the systems can be learned. In today's automobiles, troubleshooting has become a computer-aided science. Diagnostic outputs are built into many of the computer-driven systems.

This sequence from the automotive service training industry is directly applicable to manufacturing and almost every industry where equipment is involved.

An industrial curriculum including training on hydraulic systems, bearings, drive systems, etc., would be a prerequisite to equipment-specific maintenance training. Once the generic maintenance skills are learned, individuals may begin to train on equipment-specific functions.

Once the equipment is well understood, troubleshooting methods can be taught and then applied directly to the equipment on the factory floor.

Getting equipment-specific training

How does a company provide its employees with equipment-specific maintenance training without actually presenting a training class for every piece of equipment? The answer is simpler than it seems.

If an employee, for example, is knowledgeable on pneumatic systems then he can look at a piece of equipment containing a pneumatic system and identify the components that are involved in, for example, a functioning air cylinder. With a little creativity, and without a manual or blueprints, a maintenance technician would be able to identify the source of power (air) and

the various air lines, solenoid valves, flow control valves, regulators, etc., that are involved in the operation of that cylinder.

This methodology can be expanded to the other systems within the equipment.

The first step is to identify the sequence of operations within the machine. Every machine, no matter what the function, has a sequence of operations in which a specific input triggers a specific output and so on. Once the inputs and outputs of each operation are identified, the components involved in that operation can be identified. It is easier to use a chart for this purpose (See accompanying " Machine Information Chart ").

Once the components are listed, identify the element of power for the component. In other words, what makes this component work?

Next, identify the function of each individual component. For example, a solenoid valve switches a valve to supply air to a cylinder or, a flow control valve adjusts the airflow to the cylinder thus adjusting the speed of the cylinder.

After every operation of the machine is identified and all the components and their functions within the machine are listed, then apply a troubleshooting methodology or process.

Most troubleshooting methods teach a systematic approach or thought process. Using the newly acquired information about the machine, follow these steps:

- Identify or clarify the problem. What was the unwanted result?
- Identify the operation that this result (wanted or not) is controlled by.
- List the components involved in that operation, using the machine information chart.
- List the power needed for each component.
- Identify logically whether or not each component could have caused the unwanted result.
- Test the components that have not been eliminated thus far.

Using this methodology effectively eliminates every component not involved in the specific operation where there is a problem. This can be as many as 90 percent of the components of

the machine.

These skills and this process work very well for operations personnel as well as maintenance technicians. The more operators learn about how the machine functions and what specific components actually do, the better they can operate and maintain the equipment. **MT**

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MACHINE INFORMATION CHART

Machine Information Chart

Machine Name Balloon Maker *Machine Speed* 20 sec/pc *Elements of*
Machine Function Inflates Balloons

Sequence Of Operations
Operation Input Physical Press Start Button **Physical Result** Main Motor Turns Cam Bank
Operation # 1

Elements of Power	*Components*	*Component Function*
Mechanical	Start Button	Provides Power to the motor
Electricity 110v	Motor Starter & Overloads	Provides power to the motor
Electricity 110v	Gear-Motor	Drives the sprockets & chain
Mechanical	Drive (Chain & Sprockets)	Provides the means to turn th
Mechanical	Stop Button	Provides power to the start b
Mechanical	Cam Bank (Shaft & Bearings)	Supports the sprocket and ch

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