



Ron Beaufort Training, LLC

5900 Core Avenue, #102

Charleston, SC 29406

843-437-1883 www.ronbeaufort.com

Hands-On Technical Workshops

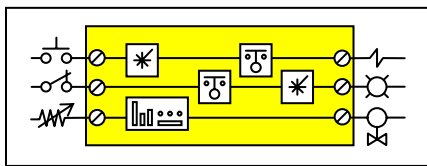
by Ron Beaufort

Problem/Solution Training Method

Removing the mystery from PLC-controlled systems by teaching practical information

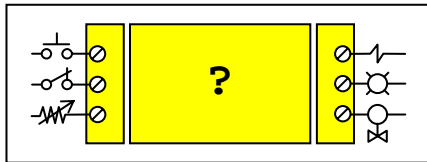
Based on our new **Problem/Solution** method of hands-on instruction, these workshops offer the following major advantages over the classic Lecture/Lab method of training:

- specifically designed for technicians who troubleshoot and maintain PLC-controlled equipment
- use a practical hands-on approach to help illustrate and explain the basic theory behind even the most difficult concepts
- build problem-solving skills and give students the self-confidence necessary to apply their new abilities on the job
- better training helps maintenance personnel reduce equipment downtime with less dependence on expensive outside contractors



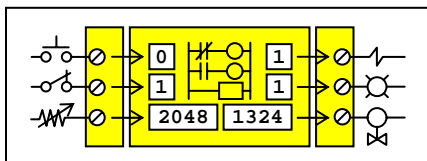
In the hardwired days before PLCs, any competent electrician could open the control cabinet and eventually understand and troubleshoot the equipment's control scheme. Of course a full set of electrical schematics made tracing the control logic easier, but even without a drawing, successful troubleshooting was ultimately just a matter of time. Once the control cabinet had been opened, any electrician could always just physically "follow the wire" all the way from the field input devices, on

through the electromechanical control devices, and finally on to the field output devices. Minor adjustments to timers, counters, and other operational settings were easy to make. Regardless of how complicated the control scheme became, even a poorly-trained mechanic could often simply swap out enough electromechanical parts to eventually get a faulty machine back up and running again.



In many ways, PLCs make the equipment's control scheme much more difficult to work with - at least for technicians with inadequate training. On the plus side, the troublesome relays, timers, counters, and other electromechanical devices inside the control cabinet have now been replaced by reliable solid-state logic circuits in the PLC. On the other hand, all of the familiar hardwired control circuits have been replaced by the PLC's ladder logic program. The electricians were once able to

monitor and troubleshoot most of the equipment's operation from the centrally-located control cabinet. Now suddenly they find themselves on unfamiliar ground. Without adequate training, they often regard the PLC as a mysterious and intimidating "black box" which is located at the precise center of every single control circuit. Fortunately most equipment problems ultimately turn out to be caused by the field devices or their associated wiring. Still, even simple problems often become needlessly complicated whenever the PLC cannot be quickly eliminated as a possible cause of a malfunction. And without PLC training, even minor adjustments to timers, counters, and other settings are now beyond the abilities of the personnel who are most familiar with the equipment.



The training provided by Ron Beaufort Training, LLC will give your maintenance technicians the skills and confidence they need to troubleshoot systems controlled by PLCs. The ability to systematically analyze and monitor the ladder logic program will make it possible to fully understand and troubleshoot the equipment. The all-important relationships between the system's inputs, and its controller, and its outputs will now become even more accessible than they were in the days of

hardwired control. Of course the obvious advantages of this will become most apparent during emergency troubleshooting situations. In today's highly competitive environment, eliminating the expense of just one hour of equipment downtime will usually fully recover the total investment in PLC training. Additional tangible savings will result whenever variations in raw materials, in operating conditions, or in machine alignment require minor modifications to the PLC program. Simply training your own technicians to safely adjust the operation of timers, counters, and similar settings can often eliminate the expense and delay of calling in an outside contractor. It takes very few cases like this to generate a significant return on your training investment.

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Teaching more material at a greater depth with better understanding and retention

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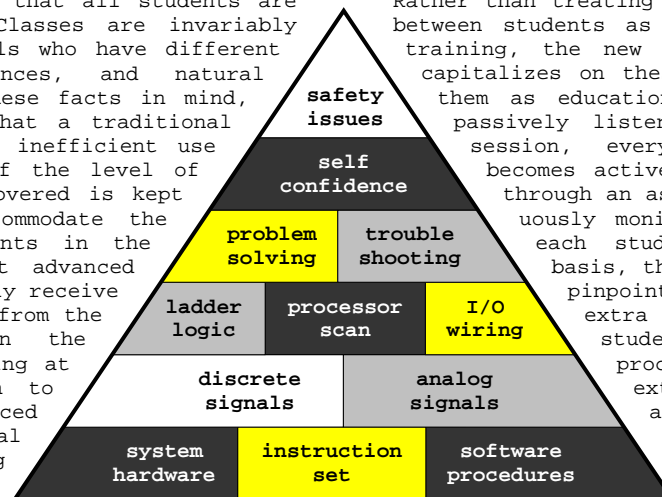
- significantly increase both the scope and the depth of the course material while improving understanding and long-term retention
- provide an effective "next step" in training for students who have attended traditional classes by other vendors with disappointing results
- promote understanding of concepts at a fundamental level which enables the students to continuously build upon their new knowledge once they have returned to the job
- safety issues are continuously emphasized and are incorporated into each step of the course

Disadvantages of the Lecture/Lab format.

It is a simple truth that all students are not created equal. Classes are invariably made up of individuals who have different backgrounds, experiences, and natural aptitudes. Keeping these facts in mind, it becomes obvious that a traditional lecture period is an inefficient use of classroom time. If the level of the material being covered is kept light enough to accommodate the least advanced students in the class, then the most advanced students will certainly receive little or no benefit from the lecture session. On the other hand, by teaching at a level high enough to challenge the advanced students, the material becomes too demanding for the students at the other end of the scale. In simple terms, a significant amount of inefficiency is inherent in every lecture session. This inefficiency not only limits both the depth and the scope of the material which can be covered in the lecture period, it also reduces the amount of time available for the hands-on lab session which follows. This is an extremely serious drawback since the majority of technicians pay little or no attention to the lecture sessions and tend to concentrate most of their learning effort on the hands-on lab periods instead. Most of these types of disadvantages are built into the Lecture/Lab method by the instructor's inevitable "outline" agenda. First topic "A" is presented and discussed in great detail. Then topic "B" is presented and discussed in great detail. Then topic "C" ... and so on. The very nature of an "outline" class agenda prevents the instructor from teaching how the various topics are interrelated to each other. The student comes away with a great deal of information - but no understanding.

Advantages of the Problem/Solution format.

Rather than treating the natural differences between students as obstacles to effective training, the new Problem/Solution format capitalizes on these differences and uses them as educational tools. Rather than passively listening to a dry lecture session, every student immediately becomes actively involved in working through an assigned task. By continuously monitoring the progress of each student on an individual basis, the instructor is able to pinpoint the areas in which extra coaching is needed. Any students who are able to proceed with little or no extra help may be assigned additional tasks to keep them constantly challenged and involved. This approach not only allows the instructor to focus on the unique needs of each student but it also increases both the scope and the depth of the material which can be covered. The instructor constantly insures that each student recognizes the specific problems presented by the task, and then makes certain that the student uses a systematic approach to finding solutions to those problems. This recurring association of problems and solutions forces the student to concentrate on the interrelationships between all of the various concepts being covered. This approach greatly improves the student's fundamental understanding of the course material and it also presents the material in a way that is easily remembered. This type of specific in-depth knowledge of the subject matter will form a permanent foundation for future advancement throughout the remainder of the student's career. An added benefit is the self-confidence which the student gains by truly understanding the material which has been covered.



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Involving each individual student to maximize the effective use of classroom time

Based on our new **Problem/Solution** method of hands-on instruction, these workshops offer the following major advantages over the classic Lecture/Lab method of training:

- continuous active involvement in the classroom proceedings greatly improves the students' attention span and maximizes their retention of the course material
- improving problem-solving skills and developing a systematic approach to troubleshooting are tightly integrated into the teaching format
- technicians invariably prefer to "learn by doing" and respond enthusiastically to this new task-oriented style of instruction
- tedious lectures, canned step-by-step lab exercises, transparency projectors, and PowerPoint slide shows are all eliminated

Disadvantages of the Lecture/Lab method.

Most technical training follows the classic Lecture/Lab format of instruction. To begin, the instructor uses a lengthy and detailed lecture to present a series of new concepts. This is followed by a short lab exercise intended to reinforce the same material covered in the lecture session. For students having an engineering mindset, this method of instruction often achieves satisfactory results. Students with a maintenance technician's mindset, however, invariably prefer to use a "learn by doing" approach for acquiring new skills. They often gain little or nothing from the lecture sessions, although they become eager participants in the lab exercises which follow. **Thus, as shown by the shaded area of the bar graph, most of the students become actively involved in the learning process during only a very small portion of the total available class time.** When we consider that most of the lab assignments consist of simple lead-through exercises, it quickly becomes obvious why the Lecture/Lab method often gives such disappointing results. Its primary disadvantage lies in its failure to actively involve the students in the educational process. Passively listening to a lengthy lecture of technical details, especially one in a darkened room with a monotonous PowerPoint slide show, becomes a serious challenge to the attention span of even the most motivated student.

| |
|---|
| instructor gives lecture |
| instructor assigns lab |
| students perform lab - students actively involved |

Advantages of the Problem/Solution method.

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|---|
| instructor assigns task |
| students accomplish task by finding solutions to problems - instructor coaches students to recognize problems and work out solutions - students actively involved |
| instructor leads follow-up group discussion - students actively involved |

Here the instructor skips the preliminary lecture and begins by assigning a task. This task has been carefully designed to present the same types of real-world problems which are often encountered while working in the field. As shown by the shaded areas of the graph, within a matter of minutes the students are all actively engaged in the learning process. The instructor circulates through the classroom and continuously monitors the progress of each student. Those who proceed rapidly are given additional assignments to keep the exercise challenging. Other students may need extra coaching to recognize the problems and to systematically work toward a solution. Rather than prompting the student with a simple "give away" answer, the instructor will make suggestions such as: "Remember how the system acted earlier today? How is this new problem different? How is it the same?" **The instructor coaches the student to systematically think through the indications, to recognize recurring patterns, and to come up with a workable solution to each problem.** This method has obvious benefits to the students' problem-solving skills and also to their self-confidence. During the follow-up discussion, the students are kept actively involved as they compare solutions with each other. The instructor insures that all aspects of the course material are discussed before assigning the next task.



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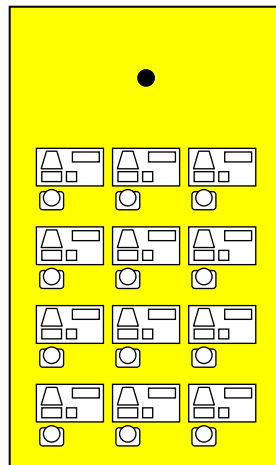
Insuring that each student obtains maximum benefit regardless of current skill level

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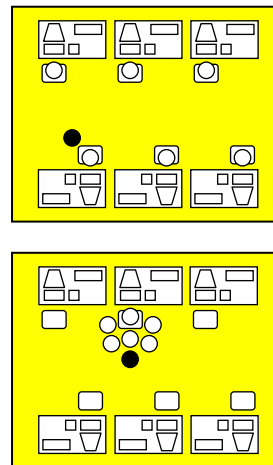
- small class size allows the instructor to focus adequate attention on the unique needs of each individual student
- strict limit of one student per workstation allows assignment of separate projects to accommodate students of various skill levels in the same class
- students are coached to recognize patterns and to master new material by relating its similarities and its differences to concepts which they already understand
- workshop-style seating arrangement provides more opportunities for the instructor to coach each student "over the shoulder" on an individual basis

Traditional Classroom Floor Plan. While the familiar "classroom" seating arrangement

shown here is usually a perfectly adequate floor plan for teaching in a simple lecture style format, one of its major disadvantages quickly becomes obvious during a hands-on lab session. The instructor finds it inconvenient to move through the classroom and monitor the progress of each of the students. Any student who requires additional coaching soon falls behind in the lab assignment and usually becomes discouraged. At the same time, other students might quickly complete the exercise and soon become bored and disinterested while waiting for their classmates to catch up. In spite of all of these disadvantages, the classroom style seating arrangement still remains popular for one simple reason: it maximizes the number of students that the available floor space will accommodate. **And so on one hand, the traditional classroom style seating arrangement increases the number of students - while on the other hand, it makes it more difficult for the instructor to interact with each student on an individual basis.** Teaching the concepts of problem-solving skills and developing a student's self-confidence naturally require a great deal of continuous personal interaction between the instructor and each student. The traditional "classroom" style seating arrangement is one of the major factors that makes this amount of interaction virtually impossible for the instructor to achieve.



New Workshop Floor Plan. In this new seating arrangement, the workstations are arranged



around the perimeter of the room so that the students are all facing outward. **The instructor is now free to circulate throughout the room and continuously monitor the progress of each student on an individual basis.**

As the students work through their hands-on lab assignments, the instructor is now able to closely monitor the progress of each of the students. Any student who needs extra help can receive the "over the shoulder" coaching he requires. The instructor

can also assign additional lab exercises to keep the more advanced students challenged and involved. Another classroom activity which definitely keeps the students alert and involved is the "group discussion" period which follows each lab assignment. Here all of the students gather around one workstation and discuss the problems which were encountered and the steps which were required to find a solution. By comparing the differences between the approaches used by other students, each member of the group gains a much better understanding of how to recognize the issues involved in a problem and also how to systematically work out a solution. By carefully monitoring these open discussions, the instructor gains a great deal of insight into how well each student actually comprehends the material that has just been covered. Knowing that their work will be examined in these open discussions keeps the students focused and motivated.

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