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Training for Troubleshooting

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A group charged with developing a training program for troubleshooting at Philip Morris learned some important lessons.

During the past year, the manufacturing training and development department at Philip Morris USA has worked to improve troubleshooting in the company's cigarette-manufacturing plants.

A comprehensive assessment of Philip Morris's technical training programs had pinpointed troubleshooting as a high-priority concern at every plant and for nearly every employee group, including hourly workers, first-line supervisors, and upper-level managers.

The systemwide nature of the troubleshooting problem demanded a systemwide response. The training department assembled a study group of workers, plant-based trainers, engineers, and department staff. The study group was charged with analyzing the problem, developing and implementing a pilot training program, and evaluating results.

The pilot program that emerged varied somewhat from plant to plant. But at all sites, troubleshooting training shared nine elements that the study group identified as keys to the pilot's success. The troubleshooting-training model:

- targeted work groups rather than specific occupations
- incorporated the three types of knowledge (procedural, declarative, and strategic) necessary for effective troubleshooting
- relied on cooperative-learning strategies to build collaborative working relationships
- encouraged plant managers to demonstrate support for the training
- relied on a troubleshooting procedure widely applicable to machines
- organized training by major machine components
- used varied instructional methods and media, discussions, instructor and trainee presentations, question-and-answer games, videos, mock-ups, and actual equipment
- used team teaching by three instructors representing three areas of expertise (operational, mechanical, and electrical)
- provided follow-up for trainees in their factories and optional advanced technical training for mechanics and electricians, where resources allowed.

Here's how the study group fulfilled its charge and what it learned about troubleshooting training.

Types of knowledge

Throughout the project, the group conducted extensive research. The study group analyzed surveys of basic and applied research related to troubleshooting, reviewed assessments of experimental U.S. Navy and Air Force programs, and examined other companies' troubleshooting-training strategies. Group members also talked at length with technical and subject matter experts both inside and outside the company.

The group decided that troubleshooting training had to

- address the varied needs of operators, mechanics, electricians, and supervisors
- address the needs of people with different levels of knowledge, skills, and troubleshooting ability
- be cost-effective and doable within the constraints of a unionized, high-speed production environment

- be adaptable to the varied and complex machines used in cigarette production.

The group resolved the last concern by opting to build prototype training around a single machine type, test it, and then adapt the training to other machines.

To devise training that filled the first three requirements, the group first had to determine: What knowledge and skills do workers need in order to troubleshoot?

Some members of the group thought the training mainly should bolster the generic skills used in troubleshooting, such as problem solving and critical thinking. Others resisted a completely generic approach. They argued that experts have more than well-developed skills; experts also have a larger body of subject-matter knowledge.

Research conducted by the human resources laboratory at Brooks Air Force Base in Texas helped resolve this debate. Air Force studies show that troubleshooters need to know

- how to do the steps in a task, such as taking measurements, swapping components, and running diagnostic tests (procedural knowledge)
- how a device or system works (declarative knowledge)
- what to do and when, such as setting goals, making plans, and making decisions (strategic knowledge).

The study group built the training on this multilevel framework for knowledge. This approach required the group to define specific procedures, clarify how different machines function and interact, and collect expert problem-solving strategies for frequent mechanical problems.

Delivering training

The research that led the group to rethink the types of knowledge necessary to troubleshoot successfully also led the group to rethink training delivery.

Traditionally, training at Philip Morris has been delivered to groups of people who do the same job. At first, the study group's plans called for mechanics and electricians to spend 10 days in training and for operators and supervisors to spend five days. Most of the time would be devoted to occupation-specific, in-depth technical training.

Later, the group recognized that one consequence of occupation-specific training is that people often do not understand the demands of their co-workers' jobs or how to help them. If people in different occupations are to troubleshoot as a group, they must understand each other's roles, work in teams, and communicate well.

The group revamped the training to re-create in the classroom the way people work together in the factory. Instructors would deliver the first two days of training to intact work groups (operators, mechanics, electricians, and supervisors); later, the instructors extended this span to five days. The study group also decided to design the training around cooperative-learning techniques.

TRAINERS HAD A CHANCE TO NETWORK AND ESTABLISH SUPPORT SYSTEMS

This structure, the study group concluded, would

- promote mutual understanding of job demands
- improve communication and encourage workers to share their knowledge and concerns
- increase group cohesiveness
- promote the transfer of learning from the classroom to the factory.

Both of these strategies—targeting training to work groups and using cooperative learning—were new to Philip Morris USA, and the company adapted them to fit its unique situation.

Cooperative learning provided instructors with a vehicle for technical training and reinforcement. It allowed them to model in the classroom the kind of behavior they wanted to occur in the factory. And it gave them the flexibility they needed to address employees' diverse training needs.

To prepare for the training, instructors from all four participating plants attended a first-ever, five-day, train-the-trainers workshop. The workshop introduced the instructors to the proposed teaching methods and materials and helped develop their skills as cooperative-learning facilitators. The workshop also gave instructors a chance to network and establish peer-support systems. Many of the instructors had never met their counterparts at other locations or knew them only as voices on the telephone.

In another departure from standard training models, instructors briefed plant managers before the training started and encouraged them to support the program. Managers were invited to participate in the kickoff and wrap up of each class. How extensively managers participated varied from plant to plant and class to class, but their participation was generally high, considering the lack of precedent.

Participation by plant managers raised the program's profile and helped motivate trainees. Some managers used the training as a chance to field questions and concerns about anticipated changes in the plants. Plant managers who participated reported that they were impressed with workers' depth of understanding of issues facing their plants. Plant managers also reported that they developed a better feel for workers' needs. Trainees reported a heightened sense of management's interest in their concerns.

Implementation

The pilot took place over three months. At each pilot site, trainers identified groups of workers who would serve as control groups and groups that would participate in the pilot training.

Altogether, 329 trainees from four different plants participated in the program. Most of these participants were machine operators (138), supervisors (73), mechanics (58), and electricians (40). The rest represented other job classifications, such as quality assurance.

Programs varied slightly at each of the four plants that participated in the pilot. Typically, on the first day of training, instructors introduced the program and the general troubleshooting procedure and explained how the training would take place. Each subsequent day focused on a major component of the machine.

At the start of the training, about a dozen work groups of operators, mechanics, electricians, and supervisors were merged into three teams. Team members worked cooperatively for the rest of the program.

For much of the training, instructors served primarily as facilitators. Teams had to conduct research, share information, and give presentations on different aspects of the machine. This technique helped trainees see problems from different perspectives, alter their communications to ensure mutual understanding, and develop a shared sense of accomplishment.

Classes wrapped up with a "game-show" competition among teams. Three plants used the television show "Jeopardy" as their model. The fourth plant ran a "Factory Feud," modeled after the television program "Family Feud." At all locations, teams—not individuals—gained or lost points. Winning teams earned special tributes or small prizes. The game-show format promoted teamwork and communication and reinforced new learning.

Throughout the training, instructors stressed intrinsic rewards, such as praise, positive feedback, and—perhaps most potent of all—peer recognition.

Evaluation

Four measures were used to gauge the effectiveness of the training:

Trainee reactions. The instructors assessed trainee reactions by administering a questionnaire immediately after each class. Trainee reactions to the troubleshooting program were overwhelmingly positive. More than 90 percent of the trainees at each location selected the most positive or second most positive response to each item on the questionnaire. Most participants strongly supported the strategy of having groups cooperatively address real-world troubleshooting problems.

Trainee behavior. Two to three months after the training, instructors administered questionnaires to assess changes in the behavior of hourly workers and supervisors.

Cooperative Learning

Cooperative learning, familiar in many school settings, is not widely used in manufacturing training.

Cooperative learning depends on individual and group involvement. Advantages of this approach include ensuring the active participation of all trainees in the learning process, building rapport among trainees, cutting training time, and promoting cooperative working relationships. Ideally, in cooperative learning:

- Goals are defined in a way that requires trainees to be concerned about each other's performance (referred to as "positive interdependence").
- Everyone is assessed and held individually accountable for his or her own performance.
- Everyone receives feedback on how everyone else in the group is performing.
- Group members receive rewards based on the performance of the group as a whole.
- Groups are organized for diversity.
- Learning activities develop skills that employees need to work well with others.

At one plant, 80 percent of respondents agreed or strongly agreed that the program had promoted more systematic troubleshooting, and 95 percent of respondents agreed or strongly agreed that the training had promoted a greater understanding of how the machine works. Most respondents from all plant locations also agreed or strongly agreed that the program improved teamwork and communication on their shifts and led to workers' greater willingness to help others or to seek help from others.

The anecdotal evidence supports these findings. The following comments are typical of those heard at all pilot sites:

- "When I came here seven or eight years ago, I'd go out on a trouble call, and there would be no one around to tell me what was wrong with a machine. Now, operators, mechanics, and electricians work together to solve the problem. I can see a difference between [groups that received the training] and [those] that haven't been through the program."

- "We have more respect, trust, and knowledge of one another's jobs. Everyone is more willing to put forth more effort to help, to work as a team."

Job performance. The training department assessed job performance by measuring machine production rates. Trainers collected data weekly at all pilot sites for both trainee groups and control groups for at least six weeks before the training, during the training, and for at least 10 weeks after the training.

At one plant, production rates increased at roughly comparable levels over the same time period for both trainee work groups and control groups. At another plant, production rates remained high and stable for trainee work groups and consistently lower for control work groups.

These findings suggest that troubleshooting training had a positive effect on machine production rates. But it was impossible to control for all the variables in the plants that could affect machine production rates, so the company cannot attribute improvements specifically to the troubleshooting-training program or any other factor.

Training system results. Department staff used personal observations and discussions with instructors to evaluate the pilot's implications for the way Philip Morris develops and delivers training.

The department identified lessons learned from the troubleshooting-training pilot about how to improve its training programs.

For example, involving trainers from different plants in developing the pilot helped eliminate duplication of effort. The participatory design process also laid the groundwork for more coordination among training centers in the future. The train-the-trainers workshop allowed instructors to meet their counterparts from other locations and to expand their support networks.

Also as a result of the pilot, Philip Morris will focus more attention on cross-occupational training and the use of cooperative-learning strategies. Finally, the pilot underscored the importance of recognizing people's value and contributions in order to motivate them to learn.

A critical element

All in all, the manufacturing training and development department at Philip Morris has gathered considerable evidence that the troubleshooting-training program devised by the study group was successful. The pilot program

- earned excellent ratings from trainees
- improved the behavior of workers in the plants
- improved the way training is designed and delivered company-wide
- sparked widespread interest among plants in expanding this model for training to other areas and for other types of machines.

The troubleshooting-training program was a highly visible initiative, influenced by the thoughts and efforts of many different people. The program was designed to improve technical troubleshooting. But it has also encouraged increased teamwork and communication among hourly and supervisory personnel in Philip Morris's factories.

Being a good troubleshooter takes more than a head full of technical knowledge and a grasp of the troubleshooting process. A good troubleshooter depends on his or her co-workers for help in solving problems. Helping people help each other might not be the first thing one would think of when developing a troubleshooting-training program, but it turns out to be a critical element. ■

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