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A New Training Strategy: Design the Work Environment for Continuous Learning

Peter Bullemer, Honeywell Technology Center
Ian Nimmo, Honeywell Industrial Automation Control
16404 North Black Canyon Hwy.
Phoenix, Arizona 85023-3090

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Operator Training Strategy: Design the Work Environment for Continuous Learning?

Peter Bullemer
Honeywell Technology Center
and
Ian Nimmo
Honeywell Industrial Automation Control
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Training has been around in one form or another since before the building of the pyramids. The training the industrial world has, however, not changed too much since the industrial revolution. The methods that the skilled craftsman uses to train the apprentice has not changed until just recently. The recognition that these old school techniques are out-dated and do not fit into the modern settings, which includes

fewer people, less time available, reduced budgets and the technical expertise required to be competent in a modern manufacturing unit.

A recent study by The National Institute of Occupational Safety and Health (NIOSH) recently presented a study that found that traditional modes of employee training involving seminars, posters and videos often fail because they miss the integral human factors that ultimately influence behavior at the worksite. Regardless of a person's knowledge and competency in a particular area, performance depends on motivational considerations like the anticipates cost and rewards, self-esteem, confidence and conformity pressure.

As we replace or enhance these old methods it does not mean we have to throw away structure and content, we need to understand the strengths and weaknesses of these techniques, we will review these in the section titled Assessment of Current Practices.

Few people begin a job fully trained. Furthermore, with changes in technology, promotion to higher management levels, job rotation and enrichment, nearly everyone needs to learn new skills, acquire new information and understand different processes. As a consequence, all organizations have to educate and train staff to raise their level of performance. This may be achieved by providing new and relevant knowledge and information, by teaching new skills, or by changing attitudes, values and motives.

The production operator is the employee who uses process safety information, safe work practices, and operating procedures to operate and maintain process plant equipment. Today's production operator must be competent in more than the technical aspects of operating and maintaining plant equipment, machinery and controls. (For a full list of the range of competencies see Industry Report 1996 - 1997)

The purpose of training is to enhance skill and knowledge. It is necessary when new systems, equipment or concepts are introduced in company. It differentiates the way in which people work but should provide a standardization of approach. Good training can and should:

be a focus for aligning the workforce with the company strategy.

ensure that workforce skill levels are up to national or industry standards

be a powerful individual motivator

be a good catalyst for change

be an arena for providing a link between the individual and the company values.

Some essential principles of operations training include participation and repetition.

Participation: For training to be effective, trainees must be actively involved, performing

the desired skills. People learn more quickly-and tend to retain their learned skills-when they actively participate in learning. This principle applies to cognitive skills as well as perceptual motor skills.

Repetition: Practice is more effective when spread out over time than when done all at the same time.

Assessment of Current Practices

Provide an abbreviated summary of previous papers describing current training practices and their limitations from an ASM perspective (Bullemer and Nimmo, 1996).

Heritage: As stated earlier the industrial manufacturing has a rich heritage and in the last 10 years training of productions operators has evolved due to changing environmental and regularity requirements which have been the main catalyst for change and have introduced a significant improvement in some areas of training such as process safety management and environmental. The training has resulted in more planned, structured, documented performance based solutions.

Citations: Some of today's training challenges are highlighted by OSHA and EPA citations. The citations highlight weakness in existing practices. Training violations comprise about 10 percent of total PSM citations, with initial training being the number one offense followed by refresher training and lack of employee participation about the frequency of refresher training and finally training records. Measuring the adequacy of training is a tough issue.

Successful practices: Surveys have been done by many different groups to identify the most successful operating training practices as identified by the end users, these surveys illustrate slight differences between different industrial groups with the chemical process industry, which highlights a need based on the process and the technology the process uses. The TTS Industrial Training Report identifies some common methods that are successful across all groups such as:-

On-the -job training using procedures and training manuals with introductory classes.

Written training manuals for each job with SOP's to enhance written information.

Peer to peer training and qualification

Computer Based Training (CBT) and other self-directed

courses.

The refineries group identified classroom training balanced with field training at about 50/50 ratio followed by more specific training at a 25% classroom and 75% field ratio; process simulation when it is specific is the best tool. TTS recommends that users of their report carefully review what others see as their most successful training practices in the listings and adopt those that offer the best fit for their operations. Each type of training has its place. Each plant has different conditions that determine the best type of training for their particular situation. Some factors that influence the selection of particular type of training include.

Number of operators to be trained in a given time frame

Funds available for training

Availability of training media and materials

Availability of trained trainers

Work schedule

Availability of overtime

Turnarounds and vacation schedules

Staffing

And many other significant factors

Most training organizations also take a more scientific view of designing training systems, they start from knowledge of how adults learn, Frank Bird and george Germain in their book on Practical loss Control Leadership identify five basic principles of learning, they state these are obvious when read. However, they are often ignored, especially in adult learning situations. Their application will make employee training less frustrating and more productive for everyone concerned:-

Principle of Readiness - we learn best when we are ready to learn. You cannot teach someone something for which he or she does not have the necessary background or knowledge, maturity or experience. When people are ready and have sound reasons for learning, they profit from teaching and make progress. Readiness also means that the learner is emotionally ready,

is motivated tp learn. You help to create this readiness by letting learners know how important the training is, why they should take it, and the benefits it should bring them (such as growth, recognition, easier work, variety, challenge, safer work and increased potential). Helping to create the desire to learn helps people learn. (*Canceling training because of budget cuts, bringing people in on overtime after three 12 hour night shifts, no involvement in the needs assessment is not the way to achieve this principle).*

Principle of Association - It is easier to learn something new if it is built upon something we already know. In training or teaching, it is best to proceed from the known to the new, to start with simple steps (based on what the learner already understands or can do) and gradually build up to the new and more difficult tasks or ideas. Make full use of comparison and contrast, of relationships and association of ideas.

Principle of Involvement - For significant learning to occur, learners must be actively involved in the learning process. The more senses involved (hearing, seeing, tasting, smelling, feeling), the more effective the learning. The more fully the learners participate in the learning process, the more effectively they learn. The good instructor gets the learners to do the repeating, the practicing, the "learning by doing." The good instructor uses learner involvement tools such as "hands on" training, question and answer, group discussion, audiovisual aids, case problems, role playing, simulations, quizzes and application exercises.

Principle of Repetition - repetition aids learning, retention and recall. Conversely, long disuse tends to cause learned responses to weaken and be forgotten. Application and practice are essential. Accuracy should be stressed before speed, to avoid learning a wrong habit that must later be "unlearned." The more often people use what they have learned, the better they can understand or perform it.

Principle of Reinforcement - The more a response leads to satisfaction, the more likely it is to be learned and repeated. For best resultes in a teaching/ learning situation, accentuate the positive (praise, reward, recognition, success). Also, breaking complex tasks down into simple steps allows the successful learning of one step to help motivate learning the next one. Whn learning us pleasant and beneficial, people more readily retain what they have learned, and are more likely to want to learn more. Successful learning stimulates more learning. The effective instructor facilitates learning climate. He or she uses feedback to satisfy learners' needs to know that they are doing things correctly and that they are making progress.

Curriculum - It is important that an organization have a structured curriculum that the new employee and the seasoned employee can measure their progress and achievements. Most companies are challenged to deliver this function as they no longer have dedicated trainers concentrating on this topic. Before the development of a curriculum a company needs to complete a needs assessment which will include competency evaluation. This task can be done with the aid of training consultants who themselves are competent in the best practices in this area, and who are familiar with industrial training initiatives such as the new recruiting phylosophy being adopted were a company will only employee operators who have completed an industrial foundation training diploma or two year associate degree offered by a local Community Training College. This means that the company will need to be in partnership with the Community Colleges to ensure that their needs are being addressed in this Foundation training.

Benchmarking - More than 58% of refineries, 57% of petrochemicals, and 36% of chemicals companies do some form of benchmarking their operator training practices against what is being done in the industry. Benchmarking is a comparative analysis of what others are doing in production operator training and a search for the best practices throughout the industry in an attempt to make their own training systems and methods the best.

Dimensions of Continuous Learning

An examination of the dimensions of continuos learning illustrates how specific aspects of the work environment influence day-to-day activities that can have either a positive or negative influence on operational performance. Specifically, we discuss aspects of the work environment in terms of culture, organization and work practices. Learning is defined as the acquisition of operative knowledge and skills needed to effectively operate the plant as a collaborative workforce. Continuoos refers to the fact that people are constantly learning about acquiring operational knowledge and skill while they perform their day-to-day activities. Understanding these dimensions is a critical first step in rethinking the operator training strategy.

Culture

Organizational culture consists of the set of values and beliefs that either explicitly or implicitly determine the acceptable behaviors of a group of people (McKenna, 1994). These values are frequently passed on to new members through war stories, rules and actions of veteran members of the group. Organizational cultures exist at many levels within an enterprise. For example, cultures exist at the level of a refinery with subcultures at level of shift teams within a specific process unit of a refinery. The shift team cultures are the most influential in teaching new employees the acceptable operational behaviors for a particular process unit. To the extent that a site management team treats all shift teams the same, there will be some common cultural themes across the shift teams within a site.

There are a number of ways to develop a culture. From the perspective of establishing a continuos learning organization, it is important to identify the important norms and desired behaviors. In this section, we discuss contrast types of behaviors that determine the kind of continuos learning culture that exists in the operations work environment. Once all levels of the organization have agreed on the desired behaviors, the organizational structures and processes need to be established to develop and reinforce the culture. Moreover, the kind of continuos learning culture that exists has a significant impact of the operational effectiveness of the group.

Finger Pointing or Fact Finding or Operations Improving

The response of the plant organization to incidents has impact on what the organization learns from the incident. We describe identified three kinds of reactions to incidents. Talk about how different cultures react to plant incidents. These specific kinds of reactions are manifestations of different cultures that teach individuals different things about how to operate the plant.

Finger pointing. The investigation of incidents identifies specific individuals as those accountable for the incident. Disciplinary actions are taken to teach people that this is unacceptable behavior. In extreme cases, individuals are fired for incompetence or negligence in their duties. There is a tendency for these organizations to report a small number of incidents. The incidents reported include significant observable events such as loss of life, major equipment damage, environmental release of contaminants, or significant loss of production.

In this type of environment, the shift team members cover for each other during the investigation when its possible. Individuals avoid reporting near-misses or incidents if there is no observable results that capture the attention of management or engineering. Often shift team members will establish the cause of the incident to be an equipment process failure. This practice protects individuals from blame and disciplinary actions. Individuals learn to tell others what are acceptable explanations for incidents. The organization outwardly believes people are doing the best they can and the people are infrequently the source of abnormal plant situations. Hence there is a tendency for ineffective practices to perpetuate and solutions to focus on solving the wrong problems.

Fact finding. The investigation of incidents identifies the specific root causes and contributing causes for incidents. There is less emphasis on identifying the specific individuals responsible. Disciplinary actions are rare but likely if there is a history of repeated occurrences. There is usually a greater amount of explanatory detail in the incident report. There is greater tendency in a fact finding organization to report near-miss as well as minor incident events.

In this type of environment, the shift team members feel free to provide explanatory information without fear of retaliatory actions. Individuals provide information if requested but usually do not initiate an investigation. It is expected that management will decide if an investigation is warranted. A major inhibitor to reporting or initiating a report is fear of appearing stupid or incompetent to peers. In this culture, there is a willing to admit that people are a frequent contributor to the cause of abnormal

situations. Consequently, practices can be effectively improved following a incident. However, there is a tendency to only share the understanding locally within the groups directly involved. Moreover, the information in the reports are not used to enhance the operative knowledge across the organization or in the training of employees entering the organization following the event.

Operations Improving.

The investigation of incidents goes beyond event description and emphasizes operations improvement. Individuals take initiative and pride in contributing to the improvement of the operations. Peers reinforce sharing of incident information and discuss details collaboratively to improve their understanding of the process and appropriate operational activities.

In this culture, the incident report database is perceived as containing important information regarding the process behavior and effectiveness of the operations practices. There are many events reported annually. The analysis is used to focus site project efforts and shift team activities on factors most impacting effective operations.

Reactive or Proactive Operating Posture

The operators of a process plant with a supervisory control responsibility must be prepared to identify, interpret and respond to process disturbances that impact the performance of the process equipment and automated control system. We use the term posture to characterize the specific attitude operators manifest in the performance of these duties. While individual operators assume different attitudes, the shift team culture tends to promote a dominate posture. Moreover, the dominate posture influences the general level of understanding and competency in preventing and responding to process disturbances.

Reactive Posture. In reactive operations, we observe operators waiting for nothing to happen. Operators engage in performing routine activities and wait for the alarm system to alert them to the existence of abnormal condition. When abnormal situations occur, these individuals go into the proverbial "fire fighting" mode. They must quickly come up to speed on what’s been happening in the process, identify the location of the disturbance and compensate to bring the process to a stable state. When the process is stabilized, they begin to investigate the root cause of the disturbance. After the operations are normalized, they resume their posture with their back to the monitors waiting for the next alerts. In this type of culture, individuals have difficulty in just maintaining their operative knowledge, much less extending it. Often this type of posture is compensated for by adding more and more pre-alarms or alerts to support the reactive operations. An abuse of the alarm system becomes an unfortunate side effect with excessive alarming under significant upset conditions.

Proactive Posture. In proactive operations, we observe operators continuously scanning the process critical indicators to find signs that the equipment or control system is behaving abnormally. In some situations, they may even mildly perturb the system to verify that everything is well. This is true of operators at the control console as well as those in the field. If anything appears slightly askew, it

triggers an investigation to better understand the systems behavior. Moreover, individuals will communicate with other team members or technical support personnel to help better understand. If there are early warning signs, individual team members are alerted to the possibility of future consequences.

"Do as I do not as They say" or "Do as we say, if its not right we'll fix it"

The level of compliance of work groups to published guidelines and policies indicates the level of uniformity of operations practices. Does everyone have their own way of doing things? Lack of compliance may be a sign that published guidelines and policies are out of date and ineffective The culture may be teaching individuals to figure out ways of operating that fit their needs.

Do as I do. We have observed work groups that accept behaviors that deviate from published guidelines and policies. We have characterized this type of culture as "Do as I do, not as it (policy) says." It is extremely difficult to eliminate this culture through management decrees. The experienced individuals of the work are mentoring others to do it the way they do it because it is a better way.

Do as we say. We have also observed work groups that do not accept behavior that deviates from plant guidelines and policies. There is usually strong leadership within the work groups to achieve compliance with stated policies and procedures. There is also a tendency for these groups to work hard at establishing acceptable, usable guidelines and policies. In this culture, there is more openness in evaluating the adequacy of the published practices. Consequently, if something is not working, the organization is better able to learn about the limitations and weaknesses of its practices.

Organization

The organization defines the relationships and roles of the collection of individuals in the plant work environment. (See Furnham, 1997 for detailed discussion on the individual in the organization.) In the plant work environment, organizational structure has tremendous impact on how effectively members of a shift team cooperate to achieve the goals of the company. Cooperation involves mutual coordination or assistance between members of a workgroup. In contrast competition can develop when an individual of a workgroup gains at the expense of another. Competition often arises between shift teams as well. Cooperative and cohesive work groups produce benefits in terms of motivation, coordination, help communications, and mentoring. It is imperative to effective, safe plant operations that people within and outside of the shift team work together to achieve common plant objectives. Moreover, when competition and clichés exist in workgroups information and knowledge is not shared because it provides individuals with an advantage over others.

Workgroup Structure

The design of a workgroup can influence levels of cohesiveness and collaboration that promote higher levels of information sharing and mentoring. In particular, group size, member proximity and group roles are important to consider in understanding the nature of continuos learning in the work

environment.

Group Size. Shift team workgroups vary in size from 3 to 20 depending on how the size of the process area the group is structured around. When management organizes people in groups larger than twelve members, they find mutual interactions difficult and tend to subdivide into smaller groups. The consequence of group size beyond 7-9 people include inhibition in participation level, slower communications, and less satisfaction with performance. Most importantly, when tasks require a high level of interdependence between activities of team members, performance decreases with increase in size beyond the optimal size of 7-9 members.

Proximity. Group cohesiveness and collaboration is also influenced by proximity or physical closeness of group members. The more contact shift team members have with each other the more cohesive the group can become. On the other hand, a cohesive group with significant past success can become complacent and show decrease in performance level. We have observed significant impacts of proximity on the sharing of information between groups and within workgroups. If the main means of communication is the telephone or e-mail, communications tend to be less informative and goal oriented. Moreover, if a group shares a physical workspace for 12 hours a day, they have a better shared understanding of each other needs.

We discuss the proximity issue again in the discussion on workspace design. The current trend towards centralized control rooms has a negative impact on the cohesiveness and collaboration of shift teams, and at the same time, strengthens the relationship between console operators sharing the control room space.

Group Roles. Group roles are the implicit or explicit behavioral expectations for each individual as a member of the workgroup. Typically, individuals discover their group role as they learn to perform their job. A significant aspect of the individual role in the workplace is defined in terms of their specific job duties. The group roles assigned to individuals in a workgroup influence levels of information sharing and mentoring.

Workgroup Interaction

Beyond workgroup structure, the processes established that govern how individuals interact in the workgroup delimit conditions that influence level of cooperation. We discuss the influence of decision making style, task interdependence and communication styles.

Decision-making style. The extent of individual’s participation in the decisions that affect the operations practices of a shift team affects the degree to which individual group members feel a sense of ownership in the results. One way to characterize decision making styles is in terms of how members of the group affected by the decisions actually participate in the decision making process (See Figure 1). Most importantly with respect to development of operative knowledge, participation in defining training needs and activities impacts individual motivation to learn. In organizations where at least a delegated

decision-making style is practiced, we have seen the most appropriate and effective training activities for members of shift teams.

Figure 1. Decision Making Styles differ in Level of Group Participation

Task Interdependence. Another important factor is task interdependence, if the members must work together to combine resources to achieve the workgroup goals, they will tend to be more cohesive. In addition, threat or competition can bring group members closer together. In normal operations, the shift team work in a process unit has a low level of task interdependence. Individuals have routine activities that they engage somewhat autonomously from those performed by other members of the group. However, under abnormal operation, the workgroup has a high level of task interdependence. Team members who have gone through a number of significant upsets together with positive experiences often become closeknit, cohesive workgroups. Organizations could enhance level of cohesiveness through involvement in activities with interdependence in normal operations.

Communication Styles. Communication styles characterize the way in which individuals express feelings and information to other members of the workgroup. The particular style of communication can encourage cooperation or inspire competition. Cooperation is fostered when descriptive rather than evaluative language is used. Moreover, when individuals take a problem orientation to assisting others, rather than a telling or controlling orientation, a spirit of cooperation is engendered. From the perspective of a recipient of a message, an attitude of willingness to learn or change invites others to offer assistance or instruction.

Workspace Design

Workspace design also impacts the nature of the continuos learning within day-to-day activities. However, the requirements for training are typically not considered as part of the initial design criteria of control rooms, workstation design or the placement of training systems. Training requirements are usually treated as an after thought, if considered at all in the workspace design. When training is considered in the up-front design, it can become an intrinsic and unobtrusive part of the day-to-day operation of the plant (Cox and Easter, 1989).

In this section, we characterize how decisions to configure control rooms within the plant environment impacts continuous learning. This is the issue of distributed versus centralized control rooms. It is related to the topic of workgroup structure, in that it can present a physical barrier to learning that impacts workgroup communications and cohesiveness. In addition, we discuss how content and placement of information displays in the control room environment can influence learning. Finally, we briefly outline some issues related to use of computer-based training environments to enhance learning. Computer-based training can facilitate the implementation of a training strategy that entails unique capability appropriate to user needs and availability for instructional experiences. If appropriate to operator needs and accessible. Include discussion of simulation based training here.

Control Center.

The current trend in the process control industry to move towards centralized control rooms significantly affects the group dynamics of the operations shift teams. The impact of this decision often means that the member of the shift team that serves the role of console operator is physically located remotely from the rest of the team in a central control room. The principal impact on the console operator remote is a loss of situational awareness. The console operator, who cannot hear or see the process unit directly, is no longer involved directly in team conversations and issues that arise in the local unit control room. The main mechanism for contact is telecommunications. In addition, the communications problem is exacerbated by the fact that there are typically separate log books in the field and in the control room, which are not seen by all of the operations team. Because the console operator is remote from the unit, the field operators (particularly those who are not yet trained on the console) do not get an opportunity to learn the kinds of things the console operator does, and how important it is to understand the kinds of things that are going on in the unit. Thus, if and when field operators are promoted to the control console role, they must "start from scratch" in terms of learning how to operate the unit from the distributed control system. There is virtually no opportunity for day-to-day incidental learning that currently occurs in environments with distributed control rooms located in close proximity to the process unit.

As a general rule, the need for communications between the console operator and the other members of the shift team were observed to be the more frequent than communications between different unit console operators. As universally found on all plants we visited, console operators must communicate with field operators over a radio or a phone, which is very difficult, particularly in a noisy environment. Console operators and field operators did not always communicate as appropriate, either due to a lack of understanding of each other’s roles, not knowing how and when to communicate, or not realizing that a

personal action would be relevant to the other person.

There is general recognition of need for improved understanding between operating groups where there is a direct supplier-consumer relation. This is one driver for creating centralized control rooms. In fact, we even observed some sites where there were plans to visit the control room of customer plants downstream of the site, as well as host similar customer visits to their own control room. The intent of the exercise is to improve understanding of the nature of the processes in units that interact, the kinds of problems that can arise that will cause impact on each other and the different tactics for dealing with problems upstream and downstream to minimize propagation of effects. Hence, regardless of the approach taken, the design of the control center will impact the day-to-day learning activities of the shift team.

Information Displays and Resources

This design of information displays and devices in the console workstation pertains to a computer monitors, annunciator panels, traditional instruments and sound signals. Information should be arranged in displays to support simultaneous viewing and interaction requirements anticipated for critical monitoring and control tasks. Appropriately designed displays illustrate to the operator directly how the plant behaves and is connected. This allows the operator to continually revise his knowledge during his normal day-to-day activities.

The advent of graphic representations of the process in operator displays has had a significant impact on console operator’s understanding of how the process equipment and control system behaves. At the same time, the loss of mimic boards has lead to a decrease in understanding of how a disturbance influences the system as a whole. People talk about the power of pattern recognition of information displays in helping operators understand the gestalt of the current situation. These patterns become implicit cues linked to appropriate responses in abnormal situations. These phenomena are manifestations of the impact of information displays on learning of operative knowledge.

A problem with the conventional selection and layout of information displays assumes that the book or declarative knowledge of plant processes that operators receive in training materials is well understood, completely assimilated by every operator, and the process data in the P&II&D based displays maps easily onto the book knowledge (Cox and Easter, 1989). A general strategy to enhance acquisition of operative knowledge through display design is to make sure the content and arrangement of information supports effective situation awareness of process status, functional models of the process and controls, and feedback of the results of control actions. For shift team situational awareness and learning, the use of large, dynamic, overview status displays to complement console operating displays in larger processes promotes visibility of process status to other console operators and/or operations team members. Topography and physical law should be observed in the arrangement of information elements. For example, process flow should consistently map onto information displays and devices arranged on screen or console from left to right flow patterns. The functional decomposition of the display schematics determines the navigation scheme and simultaneous viewing of key information when

operators are monitoring or controlling the process. This functional design of the information displays can enhance operator effectiveness when it provides to appropriate task- and behavior-related compositions.

Computer-Based Training Environments

Studies of human performance in the work place show that it is wrong to assume that, if a person is shown to possess a piece of knowledge in a circumstance, this knowledge should be available under all conditions in which it might be useful (Rizzo, Ferrante, & Bagnara, 1995). Possessing knowledge is not sufficient. Operative knowledge requires that relevant knowledge is available under the task conditions in which it is applicable. Computer-based training technology has a strength in allowing instructors to manipulate conditions in a safe environment and assist individuals in learning how to apply their book knowledge to a particular plant condition. Moreover, computer-based training environments provide the shift team members with flexibility in accessing instructional information at their convenience, either to solve a current problem or to improve preparedness for future activities.

The advantage is that realistic situations can be simulated so that individuals acquire an in depth knowledge of the behavior of the process in response to their interactions. To the extent that the behavior is functional equivalent to the process that they will interact with, individuals can gain more confidence and competency in dealing with conditions that may occur infrequently or require a fast, accurate response.

A limitation of most computer-based techniques that impacts the transfer of learning include factors like organizational setting, human-human interaction and resource management. Future systems could provide more benefit if more of these kinds of influences are incorporated into the training exercises. Another alternative is to supplement these experience with the kinds of work practice described in the next session to provide a more comprehensive learning experience.

The benefits that Computer Based Training (CBT) offers far outweighs the capital investment (when used effectively) , even the lower cost CBT training packages used for small modules can be very effective, a Texas Petrochemical company recently replaced their old training styles for CBT modules, this allowed them to shutdown their training office, they did not have to bring operators into work on scheduled days off for training and are saving millions of dollars a year by providing just in time, training at the job workspace and have seen a dramatic improvement in performance.

Work Practices

Effective training to handle abnormal situations requires more than high fidelity simulation based training (Rogalski, 1995):

> the target task, as well as its goals and the actors involved in performing it, is embedded in a socio-technical system. Ttrainees should have to deal with conflicts about evaluation

criteria, goals, negotiate resources and constraints, and handle the ways in which their own decision can propagate effects on lower and higher levels.

managing the temporal task dimensions: preserving the tempo of the dynamic environment is an unavoidable constraint.

Avoid oversimplifying interactions between tasks, communication constraints or complexity due to human limitations and possibilities for error.

In this section, we want to highlight some specific practices that will help a company improve their performance through continuos learning in day-to-day activities in an appropriate socio-technical context. Some of these represent best practices we observed.

A best practice company learns as day to day events unfold. During an event they review progress towards a solution to a problem and note new experience which later can be shared with other team members, first as a learning exercise but also as preperation for any re-occurrence of the event during the rest of the shift. Well documented events can be shared with other shift teams and if a simulator is available they can reproduce the events and share the learning experience that the shift who experienced the event. This is extremely important as some shifts experience often a lot more events than other shifts.

An event often involves several dependent units such as a refineries coker and hydrotreaters. When using a high fidelity simulators training should not only be done on basiic equipment failure faults but based on connectivity problems such as the feed disturbances from the coker unit. Allowing operators to learn impact analysis and learn collaboration skills. As operators work through role play synarios they should be a s real as possible and that includes collaboration between engineers and operators allowing each discipline to understand their unique skills and what benefit each discipline brings to problem resolution. Often the only time the engineer and operator get to work together is during high stress situations and often leads to unnecessary conflicts.

The best practice teams take daily opportunities to learn and prepare for future events, this can only be achieved if the work environment is a learning environment. This means on more practical terms that simulators and training tools remote from the work place is not the most ideal arrangement.

Training program

Training Policy - a written, approved and published production operator training policy is critical to the development of a viable, sustained, effective, production operator training and certification program. It lays down, in writing, the plant’s mission, philosophy, and principles for operator training and certification. Often policy statements either don’t exsist or are vague, sometimes written by operators rather than management, and sometimes difficulties are experienced in getting needed approvals. Bargaining unit contracts sometimes complicate the development and implementation of a formal training

policy.

TTS recommends that the training mission should clearly and precisely state the plant's and management's commitment to the training program and include statements similar to the following:- Management shall ensure that all production operators are trained and certified to perform their jobs with maximum regard to safety, health, the environment, and regulatory requirements. The plant's training philosophy should include the intent, and commitment to operator training with statements such as the following:- all production operators shall be trained and certified in the knowledge, attidudes, and skills required to perform their jobs to predetermined job standards.

Dedicated trainers (trained in training techniques and preferably drawn from operations) run the operator training program. Experience is the primary criteria for selection as a trainer, other criteria includes knowledge, ability to express thoughts and ideas, demonstrated skill, desire to participate in training others, unit knowledge, interpersonnel skills, oral and writtenn communication skills, rapport with peers and supervisors, skilled in training techniques, aptitude testing, targeted selection process, willingness to be a trainer, proven performance and availability.

Qualified operators have input into the training material. Shift "training panel" consisting of representation from each shift developing training scenarios.

Operators receive regular refresher training and evaluation, particularly against a set of abnormal operating scenarios.

A production operator is said to be qualified (declared competent to perform the job) when it has been verified that the employee can demonstrate the ability to perform a job to a predetermined level of competence in accordance with operating procedures. The predetermined level of competence may be determined by a job task analysis.

Certification is a procedure that documents technical training and job performance. Certification of production operators documents the employee has acquired the knowledge, skills, and attitudes required to perform the job. This is verified by testing. The employee can perform the job with minimal supervision, while maintaining the required level of safety, quality, productivity, and regulatory compliance. This is verified by job observation and performance evaluation.

Handling incidents

Give high level summary of an approach to incident reporting and distribution that could promote a continuous learning environment. Include discussion of performance reviews to improve operative knowledge and skill.

Mistakes were described as unusual incidents and were viewed as a learning experience (Hettenhaus, 1992). A form was developed that contained key information: description of the incident, probable causes and corrective action, along with responsibilities and a timetable for completion. The process involved, meeting with team members to perform analysis of incident, determining recommended corrective actions, and circulating a completed form.

> After each serious event (actual or potential) there is a formal review and training on the event to all of the operating teams to propagate the lessons learned.

Practicing responses

Give a summary of an approach to preparing teams to respond effectively to abnormal situations through walkthrus with situation analysis, role discussion, procedure review and response alternatives.

The concept of expertise should affect our conceptions of operators' daily activities. Expertise in automated work includes conceptual comprehension of the uncertainty inherent in the process (Norros, L. 1995). If work is conceived as mere routine, being prepared for problems and learning are hindered. As a result, overconfidence of control and regression of actual expertise may appear simultaneously. A consciousness of the need of change embedded in the routine, together with a comprehension of oneself as a subject of this change, adds to the routine the possibility of learning and development of expertise. Drives towards a reduction of the polarization between crisis and routine activity.

We have seen many striking examples of the value of shift team members having an implicit understanding of each other's activities. This is a critical component of operational knowledge, particularly, during abnormal situation intervention where there is a high level of task interdependence. The console operator needs to have enough understanding of the field operator's activities that he can predict how long certain activities will take and whether the individual will need assistance. Meanwhile, the field operator needs to know what the console operator is trying to accomplish, so she can be aware of the kind of information that may be useful to help solve current problems. When field and console operators are in closer proximity, they develop a better shared understanding of team member roles and needs. Because console operators are senior operators, they often fulfill a mentoring role in the shift team. Consequently, the proximity of collocation affords informal interactions that promote continuous learning situations.

This study looked at operator's ability to detect and correct errors and how operators utilize procedures (Woods, 1984).

These results illustrate the two kinds of operational problems that goal controlled requirements of emergency operations: (a) problems where rote rule following persist in the face of changing circumstances that demand adaptable responses and (b) problems where goal controlled performance is attempted without the knowledge or guidance to successfully manage resources to meet recovery goals.

The use of a multilevel view (and the specific results) point out that the criterion for skilled operator performance is the ability to adapt behavior to changing circumstances in the pursuit of a goal.

During relatively quiet times, the operating team reviews situations that could arise to retain familiarity with the necessary response steps. A knowledgeable operator facilitates the discussion.

Each member of the operating team has clearly documented roles and responsibilities during an abnormal situation. Operators know their responsibilities and accountabilities.

Rotating jobs

We have seen a number of groups with some form of job rotation. Emphasize value for continuous learning as well as acquisition of critical operative knowledge and skill.

Console operators are cross trained on other operating areas (to assist during abnormal situations).

Formal job descriptions and qualifications requirements exist for each job.

Operators are qualified for the jobs they are working.

Console operators have received "awareness" training on the operations immediately upstream and downstream of their area so that they understand the requirements of those operations.

Sharing experiences

Although we have not seen this particular practice. The idea here is to discuss possible ways for team members to highlight experiences regarding plant operations that can help existing team members as well as future team members. People often learn well from war stories, the idea here is to establish a plant practice to capture the war stories as company learning to pass on important knowledge to others. This can be outside of the near miss or incident reporting system.

There is a need for an effective communication process to convey an understanding of the need for change, the purpose of the change, where we want to be in the future and for the development of participation in the change process is vital (Hettenhaus, 1992).

What's New, plant weekly newsletter, focused on plant events both social and technical in nature, with care being taken not to disclose proprietary information. Individuals could call a hotline, remain anonymous, to report issues or concerns.

Extensive use of episodic memory and narrative accounts of incidents in system control. Episodic memory serves as a basis for analogical problem solving in the case of the occurrence of similar events, and as a medium for creating a foundation for shared knowledge among operators as well as general system knowledge (Samurçay, 1995).

Important incident response activities:

anticipate possible problem situations

analyze previous problem situations

analyze previously used knowledge and action rules to handle these situations and construct a posteriori possible knowledge and actions which could be used.

Many of the mechanisms involved in the development of competence in work situations remain to be discovered.

Training is worked into each on-shift meeting when conditions permit. Training often makes use of ‘what if’ scenarios.

Conclusion

In the conclusion section, we should have some kind of call for paradigm shift. Warn people that explicit or implicitly, there company has a operator training policy that determines the nature of the continuos learning that occurs within the work environment. It is time people took advantage of the tremendous opportunity to make it an effective strategy.

This article espouses a socio-technical approach. The approach address both technology and people as one system:

the technical process--finding extensions or alternative technologies to improve business performance

the interaction of people with the technical process-people learned many of the reasons why they were carrying out their assignments and, as result, improved their productivity by modifying their tasks to add more value. People were given the following time guidelines: 1/3 regular routine, 1/3 process batch cycle, and 1/3 breaks, exceptions and time to think. The critical factor is the guideline helps prevent the time for thinking, planning and exploration of better methods, from being crowded out with ‘urgent’ tasks.

interaction of people with each other-team size is a critical factor in effective interactions

among people. Teams of 10 to 12 have poorer inter-activity than smaller teams of 6-8.

management of boundaries across and within the system-pay incentive programs that pay for knowledge and skill. The team incorporates peer appraisal and work order performance evaluation by their customer, most often the production department.

Continuos Learning. Continuous training is essential for the transformation process to continue and to control better the core technologies (Hettenhaus, 1992). In many plants with rotating shifts, adequate time for training, meeting and communicating is not readily available. Employees may work 12-h shifts and are reluctant to stay over. Moreover, with schedules that include 3 days on, 4 days off, 4 days on, and 3 days off, it is difficult to arrange necessary time to be willingly present for training and other related activities.

A decision was made to go to 5 crews. They derived a schedule to provide for 10-15% on continuous training.

Training focused on attaining a more flexible set of job skills, i.e., operators increased their capability to work in multiple areas. They also gained an understanding ‘why’ they were performing particular activities. A just-in-time approach to training insures a better acceptance by the participants.

Another key training area was improving inter personal skills, the ability to effectively communicate, listen and interact with others.

Change Agents. Both internal and external change agents were employed to accelerate the transformation of the work environment. Internally a Manager of Change was named (Hettenhaus, 1992). The charter was to ensure that communications were occurring and that an understanding of the purpose for the change and the tasks and activities related to the change process were properly interpreted.

External change agents provide information on following topics:

stress management course

fundamentals of self-regulation

leadership and team training

fundamentals of interpersonal interaction

asking for help

rational problem solving

confidence and self esteem development

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