

Structured On-the-Job Training and Its Value to High Performance Manufacturing

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Introduction

In today’s agile manufacturing facilities, worker accuracy, consistency and flexibility is more important than ever. Companies are discovering that Structured On-the-Job Training (SOJT) provides many benefits for both the short-term and long-term success of their plants. Learning is less effective and transfer of knowledge is only temporary when trainees just learn by watching another worker or through informal instruction. With SOJT, the training that occurs at the work center becomes purposeful, intentional, and permanent. SOJT also links nicely to the use of standardized work practices in which the outcome of all work is highly specified. As we will discuss throughout this paper, standardized work is the best, safest and easiest method *that we currently know of* to ensure consistently high levels of job performance. We will also review the importance of SOJT and standardized work as it relates to Total Productive Maintenance, Lean Manufacturing and Six Sigma continuous improvement initiatives.

What is structured On-the-Job-Training?

Research has shown that casual, informal OJT does not provide consistent instruction for someone that is new to their job. In addition, bad habits are quite often passed down from one worker to the next in this type of arrangement. When trainees receive a different set of work instructions from each shift or team leader, performance of the learner suffers and worker morale is adversely affected. Unstructured or informal OJT can be incomplete, including only partial elements of the job, and is many times done in a hurry, often lacking the very important feedback regarding how well the job or task has been done. Without systematic feedback regarding job performance, the ability to create lasting, permanent knowledge can be limited. SOJT on the other hand uses a formalized system that breaks the training down into manageable units or chunks and provides consistency from shift to shift and day to day. A standardized work system that consists of well-written procedures, work instruction packages and job-aids provide a road map for consistent, sustained knowledge creation and learning. A system of SOJT also provides designated OJT specialists the tools to become successful trainers and leaders on the plant floor. When properly trained and supported, an OJT specialist can reduce training times in excess of 50%.

Organizational knowledge creation and OJT

A professor by the name of Ikujiro Nonaka has described information as a simple flow of messages, while formal knowledge is created and organized by the flow of information and is connected to the beliefs and commitment of the holder. Nonaka further breaks down knowledge creation into two categories, known as “explicit” and “tacit” knowledge. Explicit knowledge can be transferred through formal language or written documents, while tacit knowledge refers to knowledge that is harder to formalize and communicate. Tacit knowledge is usually connected to actions or involvement in a specific context or concept. Tacit knowledge is further broken down into two elements, “cognitive” and “technical”. The cognitive elements of tacit knowledge involve “mental models” that allow the employee to form an opinion or viewpoint that leads to perceptions about the task or job at hand. The technical elements of tacit knowledge involve concrete know-how such as skills, crafts, and procedures that apply to specific parts of their job or machine center.

The two elements of knowledge creation (explicit and tacit) can be directly linked to a learning system that involves both formal classroom training and SOJT. Much of the explicit knowledge can be transferred in the classroom and much tacit knowledge is picked up through formal instruction on the plant floor. When a worker receives training in the actual “doing” part of the job, tacit knowledge can be transferred through realistic work experiences. After engaging in shared observations and job experience on the plant floor with the OJT specialist, the trainee can loop back after repeated practice and make better decisions. Tacit knowledge can be acquired after repeated observation, imitation and practice. This allows the trainee to reach full operating potential faster with more accuracy than in informal OJT environments. In fact, research (Jacobs, 1996) has shown that full operating potential and productivity can be reached 85% faster with an SOJT system. A system that transfers tacit knowledge on the plant floor will allow operators to make more informed decisions, react to abnormal operating or “upset conditions” faster and have a much better understanding of how their machine center operates. As will be discussed later, this can have major implications for quality and reliability initiatives such as Six Sigma, Lean Manufacturing or Total Productive Maintenance (TPM).

Elements of successful OJT systems / creating organizational knowledge

The continued use of SOJT over time will lead to the creation of permanent organizational knowledge. This is accomplished when the full variety of tasks at the work location are included as part of the OJT system, including a clear understanding of the criteria for success in the processes. Procedures, troubleshooting, problem solving and quality inspections should all be part of the SOJT that is performed. Show/tell checklists, pre-shift inspections, actual operation of equipment and upset condition scenarios should also be part of the SOJT system. Using a wide-variety of training methods promotes what Nonaka calls the internalization of knowledge. Internalization is the ability to take explicit knowledge and convert it to tacit knowledge. This improves the productivity of workers in manufacturing systems while at the same time enhancing creation of organizational knowledge.

When all training topics or elements are linked systematically with feedback loops to evaluate the conditions for success, the learner will have an easier time internalizing the knowledge. Continued updates to training material or job-aids and frequent coaching and mentoring sessions for workers on the plant floor will also enhance the permanence of learning. SOJT systems that promote organizational learning will have many of the following elements:

- An initial evaluation and selection process for SOJT specialists
- Accountability for SOJT implementation is clearly defined
- Coaching and mentoring for SOJT specialists for skills upgrades
- Linked directly to written performance/work standards
- Data gathering for effective performance measurement

In order to implement a successful SOJT system, standards of performance must be developed that clearly link back to the employee job location. The standards of performance must be validated with job analysis processes including the use of a detailed functional position description. Effective standards of performance and related materials for use by the SOJT specialist should include the following:

- Step by step procedures associated with each job
- Job proficiency code system
- Qualifications cards
- Includes testing for task performance and task knowledge
- Job aids and administrative tools
- OJT product and process checklists

Team member collaboration on updates for OJT materials

SOJT can also benefit from collaboration among instructors and operators in the work or machine center. Collaboration among team members regarding changes to the SOJT system such as frequent update of qualification cards, job-aids and procedures in the work center enhance knowledge creation elements. Operators also need detailed instruction on the upstream and downstream ramifications of performing their jobs well. This can include interdepartmental issues and final product quality issues when the product is shipped to the end-use customer.

Case Study - Board Mill

In a northern board mill, the workers who are on the forming line need to understand fully how wood flakes come into their part of the production system. They should have a working knowledge of the drying and blending process that immediately precedes their work area. Forming-line operators require a complete understanding of the production process downstream from them as flakes are formed into a mat and ready to pass to the press. It is also necessary for them to understand quality defects from the standpoint of the press operator and his/her job. They should fully grasp the implications for the *final board product and the customer* if they do not perform their critical tasks correctly. When new techniques are discovered they need to be communicated to all team members and the team needs to make the changes to the SOJT materials and job-aids. In the board mill example, control room operators were also applying different meanings to low flake content at the in-feed bins. This, in turn, led to different actions when the levels became low. Providing training and job-aids allowed the operators on all three shifts to make the same adjustments when the flake in-feed system became out of balance. Previously, different responses to upset conditions led to inconsistent production levels and corresponding product losses. Once these changes were identified, the team updated all training materials. This type of collaboration promotes faster knowledge transfer to the rest of the team. This leads to internalization of tacit knowledge components that have been captured as part the SOJT system changes or updates.

Case Study - Truck Plant

A research case study was conducted at a Midwest truck plant in the early 1990's to verify the effectiveness of SOJT. The union plant had an open bid process that allowed workers to move among departments. This created a situation in which workers were continually seeking new positions within the plant. Current OJT instruction was informal, given by an experienced worker on the same shift as the trainee. Supervisors loosely monitored OJT and record keeping was spotty. Because of this, quality defects were on the rise as trainees with little practical experience often made errors. In management's opinion, little progress was being made to build a multi-skilled workforce, which was one of the objectives of the open bid process.

Multiple operating departments were selected as part of the study to provide a good cross section of hiring and influx of new operators for more than one machine center. Financial benefits of SOJT were measured by a system developed by Dr. Richard Swanson at the University of Minnesota. This model was developed specifically by Dr. Swanson to determine the financial ROI of organizational development programs. Detailed training programs were developed and training was provided to SOJT specialists. The SOJT specialists were then ready to train inexperienced operators as they entered their respective departments. Three major tasks were selected to be part of the study and time was measured for each trainee to reach a predetermined mastery level. Mastery was defined as the operator being able to complete the tasks without any outside help from the SOJT specialist or supervisor.

Mastery time analysis showed that the SOJT system was five times more efficient than the old system. That is, mastery was attained in 1/5th the time required with the informal OJT system. To put it into an operational context, workers achieved full production capabilities and achieved all operational objectives five times faster with the SOJT system. Direct correlation was also shown between areas of the plant in which many inexperienced workers were being trained and financial benefits for that area. Areas with more trainees showed the greatest financial benefits under Swanson's Organizational Development ROI model.

A second study focusing on reduction in quality defects, under identical research settings, showed a major reduction in defects during manufacturing. The use of SOJT reduced defects in the test areas from an average of three per week to one per week. This resulted in considerable financial benefit to the firm outside of the faster and more effective training in the initial study. Further study showed defect rates falling even further and the costs of re-work (for continued 1 defect per week) were also lowered.

Implementation of SOJT and the "Knowing-Doing Gap"

Pfeffer and Sutton described a "Knowing-Doing gap" in today's firms that also exists on the plant floor. SOJT implementation is enhanced and the "knowing-doing gap" is narrowed when people who develop performance improvement curriculum are also involved in its implementation. The SOJT specialist or master trainer provides that direct link by design with the updating of qualification cards, procedures and training manuals. When the SOJT specialist is included in performance improvement program development, the implementation focuses on what really needs to be learned. This provides for a more complete transfer of knowledge in the long run.

Defining not only **what** we are doing but **why** we are doing it also reduces the "knowing-doing" gap. This is achieved by explaining to a work team why they need to learn a new task. This is the heart of some of the major innovations made by Lean thinking or the Toyota Production System (TPS). Learning the philosophy and importance of a task prior to receiving formalized instruction greatly enhances the level of knowledge acquisition. The SOJT specialist supported with the right tools and techniques can explain to operators why we do it, and then, how the task is to be done. Equally important is the ability to describe why there is a correct sequence of tasks, which ultimately leads to completion of the overall group tasks or responsibilities.

In this way, tacit knowledge can be created within the performance of the work team. When working with other team members, workers learn through doing, checking and collaborating. Learning a new machine troubleshooting skill for abnormal operating or "upset conditions" is a good example of tacit knowledge creation.

Making quick, accurate judgments and learning subtle tasks based upon readily available job-aids at the work station can drive the creation of tacit knowledge. Trial and errors, less experienced workers watching team leaders, and team leaders providing consistent coaching and mentoring on the plant floor can lead to the creation and sustainability of organizational knowledge.

Lastly, all managers and team leaders in the organization must support the SOJT process. Leaders must not only be proponents of knowledge creation and implementation, they must also support the culture change and commitment to resources at the shop floor that are required to be successful. An “attitude of action” must be emphasized along with the ability to take chances, make mistakes and continually update organizational knowledge components.

Implications for Six Sigma, Lean Manufacturing and TPM

It is important that all High Performance Manufacturing (HPM) and Continuous Improvement (CI) initiatives be supported by the capability to upgrade operator skills. In this environment, it is internalized knowledge that is transferred to every day production that supports these types of plant-wide innovations. This can be very difficult to do if a learning structure is not in place on the plant floor. A valuable tool to support this knowledge transfer is the classic Shewhart Plan-Do-Check-Act cycle (Figure 1), which also reinforces the importance of the feedback loops in this system.

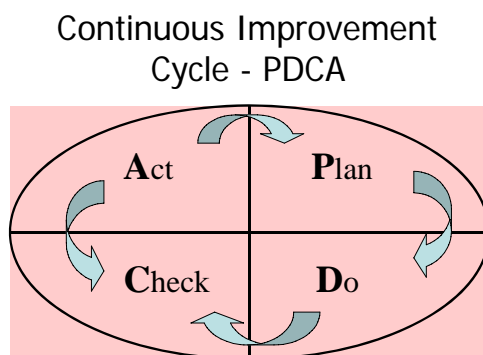


Figure 1 – Shewhart Plan-Do-Check-Act Cycle

When feedback is pervasive and systematic while being part of a comprehensive performance management system, ongoing organizational learning (Note – this is one of the underlying core values of the Baldrige criteria) becomes strategic and can help improve the company’s bottom line and long-term planning. Organizational learning coupled with effective continuous improvement tools utilized in SOJT techniques such as Six Sigma methods allows the company to use the results or lessons learned to plug back into the organization for next weeks/months/year plans.

SOJT will provide that system and structure to support HPM and CI initiatives. Recent research has shown that plants that have focused initial CI efforts on quality, human resources, and supply chain are highly successful. This is partly due to their ability to provide a structure to create organizational knowledge at all levels of operations, especially on the plant floor. By focusing on these areas of the business first, these plants have positioned themselves well to advance with technology and process innovations later in their drive for HPM.

Applications for SOJT are considered below for each type of Continuous Improvement initiative:

Total Productive Maintenance and SOJT

TPM is an equipment focused improvement effort. A cornerstone of any TPM program is equipment readiness and flexibility. By preparing a workforce to respond to these demands while simultaneously reducing knowledge gaps in equipment maintenance or operations, the plant can create the ideal equipment state. The use of SOJT specialists allows implementation of TPM to be focused, timely and consistent across machine centers and departments.

Additional performance improvement applications for SOJT include:

- Operators learning regularly scheduled PM work
- Operators learning troubleshooting for mechanical breakdowns / job-aid use
- Team based training issues for joint production/maintenance job planning
- Operators being trained more fully in housekeeping to reduce machine downtime
- Operators included in performance management system for maintenance operations
- Reduced line stoppages through effective technician troubleshooting skills
- Continued use of root cause analysis and problem solving skills for technicians and operators

Lean Manufacturing and SOJT

The use of SOJT specialists in each work area or cell allows for the continued analysis and update of work practices or procedures. The ongoing analysis of procedures, troubleshooting guides, and job-aids will allow operators to identify waste and improvement opportunities.

These opportunities are at the heart of lean manufacturing principles. Additional performance improvement applications for SOJT include:

- New manufacturing processes, systems and techniques through problem solving
- Reduced lead times through training of manufacturing and supply chain personnel
- Ensuring proper use of process equipment and machinery
- Reduced manufacturing variation through standardized work procedures
- SMED system training and job-aid development to reduce changeovers
- Predictive and preventative maintenance training, improved record keeping
- Team-building and use of CI hard and soft data from plant floor
- Training in use of Pull (Kanban) systems for work in process
- Internal plant customer training and value stream operations

Six Sigma and SOJT

Studies and literature regarding the training for DMAIC and Six Sigma implementation often focus on Black Belts and Green Belts. However, in order to implement new policies or procedures a consistent message must be delivered to operators or customer service personnel. In addition, data collection, system monitoring, schedule changes, and other production adjustments are accomplished through the actions of operators and technicians. Control charts are also sometimes used to make adjustments to current processes and production runs. Clearly, the Implementation and Control phases of a DMAIC project can benefit from the use of SOJT specialists.

Additional performance improvement applications for SOJT include:

- SPC related training at different levels of organization or plant
- Sustainability of Six Sigma projects through skills upgrade of all operators and technicians in particular work area
- Use of DMAIC tools during the production process

- Team based training issues such as story board development
- Job-aid use for new procedures, work standards, and defect correction
- “Customer-focused” operator training in material handling and packaging systems to reduce finished product damage

Implications for Service and other non-manufacturing sectors

The concepts of SOJT translate very well and offer opportunities for value-added continuous improvement when applied to the service, healthcare, education, government and not-for-profit sectors of our economy. These same opportunities apply to the customer service components of the manufacturing sector itself. The PDCA cycle, referenced to earlier, remains at the heart of any successful continuous improvement/change management initiative and is vitally important when considering the training and knowledge transfer needs for process improvement. It matters not whether the process involves processing airline reservations, fulfilling prescriptions, teaching a math skill, deploying drivers’ license examinations or processing community grants. All of these processes involve linked steps executed by workers in these processes. So, the same needs discussed here related to the Northern board mill or the Midwest truck plant also exists in these other sectors’ processes. True, it may be easier to see the effect of training and process change for manufacturing processes. Nonetheless, process improvement for service and other sector processes will not “sustain the gain” (i.e., ensure permanence of the process change), unless a systematic approach to applying the principles of learning and knowledge transfer are applied. Firms that share knowledge and experiences in a structured manner as described can expect to gain competitive advantage in the new economy.

Conclusion

SOJT can be deployed as the foundation upon which formal work standards are based. Systematically developed work standards (i.e., procedures, job-aids, troubleshooting guides) are a requirement for the success of any Continuous Improvement initiative. These all-important work standards drive organizational knowledge creation and permanent change because they:

- Provide a clear illustration of a desired condition
- Highlight process irregularities, or “upset conditions,” so that corrective action can be taken
- Are designed to be straightforward, clear and visual
- Are easily modified and updated to reflect system or machinery changes

The SOJT specialist can also help enhance team problem solving skills by having operators re-design their own work. Testing new hypothesis, learning-by-doing, and taking risks improves collaboration and the permanence of learning. Development of an SOJT system with careful attention to the feedback loop in supporting knowledge transfer to sustain the organizational learning will greatly assist in realizing these goals for HPM, and in a broader sense High Performance Process Execution. The ability to apply knowledge creation tools and drive innovation at the plant floor level will make implementation of CI initiatives successful and less painful. Without a formalized structure to effectively provide training and performance support and to close the PDCA cycle at job locations, these initiatives risk “flavor of the month” status. This can lead to frustrations and eventual abandonment by operators and management alike. It is also important for any plant to adopt CI initiatives within the existing context for manufacturing and organizational performance.

Organizations that have a systematic approach and structure to involving workers and OJT specialists together as a team to improve product (a service) quality and reliability are less likely to fail with innovations of this type.

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