Lean, Six Sigma, Quality Transformation Toolkit (LSSQTT)*
LSSQTT Tool #17 Courseware Content
"Standard Operating Procedures (SOP) For Lean And Six Sigma: Infrastructure For Understanding Process"

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Standard Operating Procedure (SOP) and Broader Relationships

Regardless of quality definition, part of the overall need for the future relates to becoming more efficient at identifying problems requiring solutions in production. This requires a thorough and detailed analysis of processes which go into products. Gaining this understanding has traditionally been difficult, disjointed and often not a top priority. But it is becoming increasingly clear that we cannot improve upon that which we do not understand. Generally under the purview of various engineering functions/personnel, these tools are used, administered and understood by various persons--absolutely to include front line workers in production.

Teams and individuals will need information, in accurate and complete forms, in the future to solve problems for on-going improvement. This relates to another very important point about problem solving and improvement. Much, if not all of it, is information based--and thus, a major part of discipline is related to building and maintaining systems accurately, methodically, and in a timely manner. This means gathering and documenting information and data which for use at later times for analyzing and solving problems related to quality.

As is discussed elsewhere, by contrast, the ongoing process control plan (OPCP) is a broad based and foundational document representing fairly comprehensive production knowledge about a given product or process. Generally driven by customers, the OPCP is designed to demonstrate that we either have a process under control, or that steps are being taken to bring it under control. Composed of detailed information and documentation from engineering, quality, customer requests, and other sources, the OPCP generally is a document made up of other pieces and sources of information. We will have, or be working on, at least one OPCP for each product or component, or for each major process.

Part of what should compose the OPCP is a strong SOP for each of the major operations. Obviously, a process is composed of numerous operations, both internal and external, and each represents opportunities for improvement--all carefully documented with SOP's. The basic relationship then, of the SOP to the OPCP, is simply that the OPCP requires careful detailed information about all operations which compose the process--this is one of the basic functions of the SOP. More specifically, the OPCP is designed to:

- Document key methods, techniques and other general information used in processing. This includes process name, tools, process parameters, perhaps product characteristics, and possibly other general process oriented information.
- Show step by step procedure for completion of tasks, including all phases of material or component process, from hand off by suppliers to your hand off to at a next customer.
- Identify key external customer information and expectations in the form of specifications, evaluation method, sample and inspection, analysis and reaction methods, and other.
- Provide additional important internal engineering and quality information about the specific operation, including drawings or sketches of parts, product, set-up, and so on.

Most basic information is the responsibility of first line personnel while other information may come from customer sources, supplier sources, standards, and so on. Particularly important are product characteristics, specifications, evaluation, inspection and analysis approaches and systems, since:

- Their determination relate to internal data collection and analysis systems by various employees--all part of the SOP.
- These are key areas for ongoing improvement, particularly documentation and data related.
- Cost savings can result by re-establishing levels and methods based on documented changes--improving product and process.
- If, due to un-disciplined approaches in processing or systems in general, we do not make improvements--or can not demonstrate our improvements in procedural quality--we can/may be losing dollars.

It is important that all involved recognize that if we are actually making progress--improvements are being made--the SOP should change. The SOP must be a dynamic not a static document. Systems used to maintain information must be built to respond in a timely way for enhancements to the system, including all involved both internal and external.

A key reason for the SOP, and all documentation, clearly relating to standards, is the need to evaluate ourselves over time. Whether we evaluate ourselves or not, customers and others will. This is why we must have our own internal review systems, based firmly on standards like are being flushed out through new and improved SOP's. Similar evaluation occurs with internal and external suppliers, and the basis is the ongoing development of detailed SOP's at work stations and elsewhere.

Continuous Improvement. Continuous Improvement (CI) is the process of finding improvements in our current standards through systematic analysis, development and implementation of creative solutions. CI is a fundamental approach for competitively fostering a learning organization at every level, to be integrated by management into the culture, and requiring active involvement and support of all employees. Certain preconditions have to be met, including time allocated to workers for participation, empowerment, training, and support. The goal of CI is to recognize and reduce non value-added activity, reduce process lead-time, eliminate waste and enhance the working environment. Waste is anything more than the absolute minimum amount of equipment, materials, space, time, processing, and staffing needed to add value in work. CI is a more intelligent, not a more strenuous, way of working—heavily oriented to waste reduction.

Waste elimination. Waste elimination says we constantly strive to improve in various areas, certainly to include safety and ergonomics, quality and reliability, delivery and overall customer satisfaction, cost reductions, and worker attitude and morale and increase profit by continuously eliminating waste and reducing lead times in work. The main points in support of waste reduction are extensive employee involvement in all stages of the process, standardized as has been illustrated and discussed in some detail earlier in the tool. Kaizen workshop event concepts are key parts of the overall systems for CI, driven and installed first by experts and ultimately done by workers. All types of waste are treated the same, to be quickly eliminated at all levels of the organization. Several systems are used to address continuous improvement, all directly related to the standardization principles previously presented.

- Plan, Do, Check, Act (PDCA); 7 Wastes; 5 Why`s.
- Process Map.
- Benchmarking best practices.

PDCA, 7 Wastes, 5 Why's. Also known as the continuous improvement cycle: Plan, Do, Check, Act (PDCA) cycle is a standard problem-solving procedure where we first plan: what needs to be done; second do: implement the plan; third check: verify the results over a defined period; and fourth act: agree and document the standard, correct any problems that arise and repeat the PDCA cycle over time to continuously improve. The PDCA cycle should be combined with other problem-solving techniques, such as the 7 wastes and 5 Why's. Problems are solved systematically with the PDCA focused generally on continuous improvements. Deviations from established standards are avoided by consistent corrective and/or preventive measures. Waste is defined as anything more than the minimum required to add value to the product. The 7 wastes are: over production; inventory; transportation; waiting; over processing; motion; defects/repair rework.

When procedures are redesigned, they should be consistently examined according to the 7 wastes. 5 Why's ask the question "Why is it so?" 5 times to precisely analyze and understand the cause of a problem. This is a way of analyzing causes as an integral component of the problem solving process. Subsequent problem-solving processes must sustain the corrective action. Knowledge and experience of all on the team regarding hidden waste has a part to play based on the KCI workshop steps outlined below. PDCA, 7 wastes and 5 why's help to systematically identify the cause of problems in easy to understand ways.

Process Map. Process maps are graphical representations of the current state of the process in question showing the main process flows. The map depicts the flow of manpower, materials and

information to establish the parameters for measuring the current and future state of the process. The process map forms a key part of the planning process for continuous improvement. By establishing system boundaries and key process areas of activity, general problem areas will tend to be identified, to be pursued for further analysis. Benefits of process mapping include development of visual aids for problem-solving. Process maps promote understanding of interrelations and systemic behaviors which can be used to plan for an improved state. The process map provides a mechanism for communications which allows consensus decision making.

Kaizen Workshops (KW). KW's are structured, action-oriented problem solving events, where improvements are identified, implemented. Any type of problem (waste, achievement of targets, customer complaints, changed surroundings, new start-ups, model updates, workstation design, ergonomics, etc.) can be covered. KW goals are formulated jointly by all participants with input by management. All must be involved in planning and preparing for KW with ample time for preparation.

Workshops are first done by experts, facilitators who have expertise in the area under study. Later this leadership role may be taken over by supervisors, team leaders or others. KW participants are selected operators and engineers who can benefit the organization based on the solutions brought about in the workshop. The direct supervisor manages, and is responsible for, the continuous improvement process, which includes workshop participation.

KW's generally last for 3 to 5 days, and all must be prepared to focus 100% on the KW. All on the team are informed about KW goals the week before. KW results are reported back by means of a presentation to all those concerned, where before and after conditions are demonstrated. Simple equipment is used wherever possible, which can also be made by team members themselves. The KW is followed by a phase where all outstanding solutions are implemented and changes to standards are agreed with work group. Basic structure of a KW includes:

- Analysis of the current situation. This includes data collection and various forms of documentation completed based on the work area to be improved. Use forms for data collection to quantify stock levels, measure and draw all transport routes taken, measuring and describing all activities and motions. Creation of a flow chart showing the process in detail is also recommended.
- Display the analysis of the current situation. Create and display an overview of the data and documentation obtained.
- Defining possible issues, solutions. Use the flow chart and other documentation to analyze the process at each workstation, marking value-added and non value-added activities, differentiating between cyclic and non-cyclic activities, grouping value-added and non value-added activities in each case. Reassemble the revised process and test it out. Draw the new layout and describe the sequence of activities, including a revised and updated flow chart. Check to see if the plan is realistic, workable.
- Display the agreed solutions. Create an overall view for all to see and further analyze, making any final changes for improvement.
- Implementing the agreed solutions. Try to implement all agreed solutions during the KCI workshop. Any outstanding measures are scheduled into the list of measures and tracked.
- Presenting the results: Prepare and carry out a final presentation to all team members and management, as well as all relevant departments.

We must involve as many of the team in the KW as possible to foster acceptance of solutions to be implemented. Do not start identifying solutions too soon, but rather concentrate primarily on waste identification—leading naturally to solutions. Produce a takt time/cycle time bar chart based on time and process data gathered and documented. Carry out as many simulations and trials as possible, consulting all concerned, allowing a day for the KW.

Specific benefits in KW's are that they can improve productivity, quality and working conditions, producing tangible cost reductions and improvements quickly. Employee involvement and cooperation is enhanced, producing creative and cost-effective solutions. KW's promote the concept of continuous improvement in the company culture, producing rapid and effective problem solving at the point of origin. A sustainable solution to a problem should be sought, since this ensures that the problem only occurs once.

Benchmarking best practices. The results of benchmarking best practices (BBP's) can be seen in the development of the system and in enhanced design standards over time. Exchange of experiences to avoid wasting time and resources can lead to effective solutions being identified and implemented globally, organized within, across teams, facilities. Cross team/facility best practice benchmarking can take place for exchanging information and documenting standards and solutions. Examples of best practice can be shared effectively, contributing to organizational CI processes. Benchmarking of best practices helps to overcome preconceptions and prejudices. Leading to broader standardization. Development and planning processes can be done in

a more synchronized manner by communicating around BBP's—as they are flushed out. Suggestions and ideas from workers, subsequent users of the machines and systems are adopted more readily. BBP's embrace all disciplines and information is exchanged between parties, available to all.

SOP procedural applications: Pivotal kaizen tool for lean. Briefly setting the stage for more to come in later tools, the SOP is important for several procedural reasons. Some of these are:

- *Best practices.* The SOP must represent general information related to the "best" and "correct" way to do our processing for this particular operation and product.
- *Establishes baselines.* How can we improve process if we do not know the procedure? The SOP sets a baseline in the immediate process--baselines that can help us reduce "moving targets"--and help us know we have improved, and why. Given baselines, after improvement, we can identify change in measurable ways.
- *Support documentation.* The SOP should be based on (or related to) other more detailed information and documentation such as engineering drawings, customer feedback, test results, statistical process control information, gage analysis results, among others. This represents much detailed procedural work which can be reduced or redirected over time, as we improve--or increased if needed.
- *Procedural summary.* Depending on maturity of product, amount of resources for a given program, and others, it is assumed the SOP will become a procedural and processing summary supported by various persons, teams, departments, and others internal and external. The SOP can be part of our "total documentation" or report about processing and procedural issues for a particular product--our best defense for broad customer negotiations and ongoing relationships--doing business in the future.

But all of the above assumes that we can continue building around the SOP system to document our procedures for improvement. It also assumes strong "team" and "cooperative" attitudes throughout the organization, a willingness to continue teaching and learning from one another, and a willingness to change toward improvement.

Standard operating procedures provide one of the kingpins for continuous improvement. Balancing and leveling in production, leading to synchronous production and lean, is facilitated by the SOP. The basis of being able to plan and conduct production in any rational manner assumes we all perform work similarly. SOP's, with their identification and detailing of standard procedures, or methods, provide much of this need for continuity. Standards we identify, through teams and other leadership methods, are not the end in and of themselves. Rather, standards must be ever evolving, changing for continuous improvement in our work.

SOP's provide the best methods, the correct approaches, and certainly what the customer demands--and documented for all to follow and improve. While they are not fixed or permanent, the SOP must not be changed in a frivolous or light-hearted manner. There should be an SOP in the organization for how we change our SOP's. Control systems must be used for several reasons to:

- Prevent unwarranted changes which have not been made through appropriate team methods.
- Assure methods and procedures to reflect operator view, vital to the success of SOP's.
- Assure individuals and departments, customers and suppliers are involved in change.
- Facilitate upgrades through broader improvement systems, to assure that we are using them.

The concept of standard methods has its basis in the need to separate the person's work from the machine. In the earlier form used to determine operation capacity, from a previous tool, this was identified as manual work and processing work. The SOP serves to provide the counter part to the machine's repetitive and consistent motion, providing the maximum capacity available, if used properly. Through the use of the SOP, operators can become standardized sufficiently to provide necessary discipline required to synchronize overall process and production system.

SOP's are dynamic as opposed to static, bringing an element of very real opportunity for change to the workplace. The operator and team dynamic, where knowledge and experience combine with innovative thinking and a desire to improve, are facilitated in a necessary way with the SOP. Also, the machine, with autonomation, or automatic controls and various types of mechanization, provides a consistent dynamic which operators and others can base their other operations on, bringing the dynamic better under control for competitiveness and profitability. Even where automation is prevalent, SOP's will be required, particularly given cost and complexity involved.

Capacity determination, SOP's, kaizen. Once individual capacities are determined, we can better

balance our total organizational capacity through improvements at individual operations and ultimately collectively through improved process. Determination of capacity assumes we understand the distinction between operation and process. Process is commonly thought of as being more broadly-based and composed of multiple operations, or that the process subsumes the operations. Process involves activities involved in production sequence, including those which appear necessary but may be wasteful, and thus, should be eliminated through Kaizen. Our function, or goal, and certainly task, in Kaizen, is to reduce these process inputs and maximize on the operations side of work, where value is added. After the capacity determination has been accomplished, we can rely on this to build or improve SOP's.

Part of the distinction between process and operation lies in the question of where value is being added, or if value is being added at all. Kaizen is about waste reduction, and it is assumed that by determining where process and operation are distinguished, we can then zone in on the non-value added areas. If we wish to reduce or eliminate waste, as we must do if we wish to be successful in Kaizen, we must identify the capacity of the operation for adding value, and use the operation to its optimum performance capacity. A work sheet was provided earlier to assist in this determination, targeted to further analyze the specific operation as part of the previously determined and analyzed process.

Use of the previous capacity determination form as related to SOP's assumes that an individual or preferably team will perform various steps to build the SOP. While many of these relate to the capacity determination analysis provided in the previous tool, there are clear distinctions. Building the SOP involves use of capacity determination and process presented earlier, and builds around this, as follows:

- *Identify coordinator.* The SOP, at the heart of Kaizen, can not be left to chance for completion or improvement. While all on the team and at the operation level must use the SOP, and interact with them, it is vitally important that we know who will actually keep the "ball rolling". This can be a person from quality, engineering, operations, or elsewhere, but should be clearly identified.
- *Process vs. operation.* As was indicated earlier, it is assumed that we can make the distinction between operation and the broader process. It should be stated that the broader process, or any procedural function can be detailed out in SOP form. The more we know about the broader process, in documented SOP form, the better are specific operations level SOP's. Identify and describe the distinction in writing and with flow charts and layout diagrams--show how the process and operation relate--where does the operation fit into the broader scope of things? Much of this should have already been detailed in the OPCP--or it should be if not already done.
- *Operations steps.* Identify the steps in our operations--likely based all or in part on the capacity determination information, or start from scratch. This can be initiated by various persons or teams, to involve operators, quality
- personnel, engineering, maintenance, etc.
- *Key support documentation.* Provide pertinent support and/or additional documentation as appropriate. This involves capacity planning documentation, layouts, process flows, man-machine sketches/drawings, at minimum. Whether related directly to the operation under study, or whether only indirectly related, various information should be available and used to help understand and explain the SOP for a given phase of production. At each operation or machine, there should be specific minimum information all are familiar with and which they rely on--stated and used as SOP.
- *Identify detailed operations.* Analyze and detail the specific operation processes and functions in terms of manual work, processing work, locations, and other time and/or distance related information. This is a take off from the previous capacity information, and steps from above, but now reworked in the newly provided SOP functions analysis form. This form is distinguished from the basic SOP form provided later since it is believed team and others may wish to perform various levels and types of analysis for improvement in the work.
- *Build standard, procedures.* Working with operators or others on the team, and based on observations and the capacity analysis activity, as well as the SOP functions analysis form, fine tune the SOP to provide an actual working procedure, provided as the basic SOP form which may be actual working level information, depending on complexities in production, improvements needed, and so on.
- *Continuously upgrade SOP*. Repeat steps above to continually upgrade the SOP, based on various operators and others knowledgeable, and certainly to include key suppliers and customers, both internal and external. The reworking function, over time, should be repeated with regularity, perhaps every one or two months, to assure that we

have current and up to date SOP's. Part of the importance is that the SOP is dynamic rather than static. It is a standard work procedure that must be getting better--not worse.

- *Update/revise SOP.* Based on the above steps, update the SOP revision form, located in the front of the SOP manual or elsewhere. If the SOP is a simple set of steps at the workstation, then the SOP revision and update form may be kept in a different location such as quality or engineering, or perhaps in a resource and learning center, depending on how much documentation is included. The SOP revision and update form will likely be at least in duplicate, and whomever is responsible for the SOP function organization-wide will keep the original. This is true since these will also relate to documentation for ISO, QS or perhaps other forms of certification.

It should be obvious from the above that this process analysis technique, while still macro from the previous tool, is now also facilitating a micro technique. The specific application being discussed as a micro analysis technique for Kaizen and documentation purposes is being provided as a tool for building the SOP. It should be remembered that the operation capacity study is based on the assumption that we can detail out our operation processes and functions, all which will be studied further for improvement later as we build the SOP's and use all in the broader Kaizen process. It should also be apparent that the capacity determination and SOP building processes, while quite useful as independent techniques for improvement in any isolated circumstance, are necessities for improvement through synchronous and JIT techniques in the broader Kaizen and improvement sense. Two additional SOP analysis tools will be added to the three just presented, providing a five tier system for Kaizen.

SOP's expanded and summarized: Kaizen five tier process as a system. The purpose of the current section is to provide helpful hints regarding how to use the various SOP formats, and to assist users in understanding how they relate to the broader Kaizen functions and systems. The current section summarizes SOP, ties in line balancing, capacity determination and other industrial engineering fundamentals and cost information, and expands the concepts of Kaizen around same for lean and six sigma. These SOP formats, as techniques and approaches in the broader system, can not be regarded as end all or essential in and of themselves. Rather, they should be considered as possibly useful in building and maintaining the broader system. They may or may not have immediate or long term applicability in all organizations, and are considered a starting point.

The SOP formats, capacity determination, functions and takt analysis, basic form, line balancing for cost efficiency, and SOP comparison for takt analysis should probably be thought of as a multi-tier system for determining and maintaining SOP's. More importantly, perhaps in the broader sense, is the reality that the SOP systems are simply tools and techniques for supporting teams and workplace improvement. Users and developers of systems for improvement will need to develop systems, analyze how they can be optimized, and determine ways to improve.

SOP operation capacity determination for lean. The capacity determination, as a start-up device at the first tier level, should be considered the primary source to be used where information is lacking. Once in motion, based on capacity determination, it may not be required for some time thereafter, depending on how the other parts of the system are designed and used. As a tier one approach, it may be more useful with customers and suppliers to assist in "growing" the system for everyone's benefit. Depending on amount and nature of change, particularly oriented to expansion and growth, capacity determination may be quite useful. It should also be remembered, in the non-growth, simply use what we have to the fullest, in many cases we really do not know what we are capable of due to waste in the system. The capacity determination approach can be pivotal as a start-up assessment tool, providing a base for further analysis.

SOP functions and takt analysis. The SOP functions and takt analysis is designed to be used by teams and others at the workplace level. Used iteratively, this form can assist in further assessing and defining our process and/or operation, particularly focused on showing relationships between manual functions, processing functions, cycle and capacity time, and other sequential issues and concerns. As the operation is in motion, other activities should be going on--in motion. For example, in die changeover, if all we do is change the die without showing what was done in preparation, or what operations or machines were running during preparation, then we lost an opportunity for improvement. When a machine is running autonomously, we should recognize that this is a chance to be doing something else, hopefully, adding value, as in multi-machine handling. This should begin to be picked up, preferably by operators or

other team members, by using function analysis formats.

SOP basic format. The most functional or immediately useful assessment approach, particularly to the operator, is likely a basic SOP. This should contain the basic necessary information, in terms written and conceived by operators, for running equipment and interacting with equipment in other ways, to get product out the door. This, in effect, becomes the most important standard procedure, since it is the actual point of contact for operators and others, in gemba or the workplace. The basic work area SOP is important since it facilitates:

- Manpower redeployment, occurring since through the SOP we can begin to see a leveling effect in all persons. This leads to idle time by some, and their opportunity for redeployment.
- WIP reduction occurring naturally since procedural leveling standardizes production, and inefficiencies are difficult to hide.
- Quality, since it is more readily built in and identified in the SOP, and since work is done with greater consistency, person to person.
- Maximizing on capacity, since we can more readily predict all aspects of production and leveling for synchronization.
- Layout improvement due to disciplined work method emerging through the SOP. As we conduct standard work over time we are increasingly likely to observe and act on this.
- Visual management techniques more readily facilitated, based on workers' repetition. This includes work sampling, kanban, or others.

Waste, or muda, in general becomes increasingly apparent as we use SOP's. This occurs since we continually improve methods and procedures, and reflect these in the SOP. As we document, and take ownership, we will naturally analyze and assess for improvement based on enhanced process knowledge.

SOP, takt and line balancing. Part of what was presented in the previous tool related to cost and economic analysis was concerned with line balancing. This also tied together numerous sections and tools, by bringing process analysis, time study, MRP issues and WIP together. This was all driven by our need to address line balancing as a function of a well balanced and synchronized production process. The basic assumption is that costs can be minimized as a function of waste reduction and optimum efficiency at the point of production. The line balancing analysis approach also provides a complimentary form of documentation, consistent with other systems presented throughout the toolkit.

The form provides the mechanism for further analysis and assessment of variables associated with balancing the production function. This includes distance, time, people, cycle times, WIP levels, units actually produced at each location, among others. All categories are intended to provide opportunities for cost reductions and productivity improvements based on a smoother production function. This assumes a fourth tier, intended to be used after thorough analysis with other SOP and documentation systems has occurred.

SOP comparison for takt analysis. SOP comparison for takt analysis provides an increasingly less complex system for teams at the workplace level. Improvements in line balancing and waste reductions for productivity enhancements will be derived through the multi-tier SOP system for assessment, culminating in the comparison for takt analysis. This is intended to provide an easy to use, read and analyze approach which can be quickly interpreted for improvement.

Standards Development. Development of standards, SOP's, is a philosophy, way of life which never ends. This is part of the key to continuous improvement. Control still may be labor-by reducing muda you decrease cost and it cost you nothing to eliminate waste. The most fundamental concept inherent in SOP's is to "do it the same way every time". Every operation takes same amount of time to produce one part per customer requirements. Goal of SOP's is to capture and use the best method, and train from this. Defining and building quality, safety, WIP limits, and productivity into steps to do work, procedurally is part of key.

Change easily and with flexibility, to pursue continuous improvement, can happen best when standards for work are in place. By having clearly defined procedures, in the form of SOP's, flow and balance in production can be more readily planned for and managed systematically. Waste can be identified and reduced or eliminated based on the SOP's put in place. Existing work sequence, layout and material flow, work and cycle times, can be more readily identified and analyzed based on SOP's put in place. Standard work sequence should be used to conduct an improvement project. Done properly, this can be used to create and/or modify standards in the process of doing a project:

- Document current layout, current operator work sequence
- Analyze for improvements, possible changes
- Rework layout and sequence

- Mapping processes, reorganizing the workplace (5S)
- Draft SOP's
- Train workers per new SOP's
- Make physical changes in standard operations, creating new layout and work, standardized work
- Establish visual controls and management
- Document standardized work systems based on improvements, finalizing SOP's
- Establish standardized work discipline
- Run the revised work process, continuing to do analysis, make improvements
- QS9000 should be used as a means of standardization sustainability
- Make standardized processes a habit, a way of life in the culture
- Frequently audit systems, and benchmark against others to find ways to improve

Standardizing a method requires that we choose out of many methods, assessing the best one, refining and using it. It means nothing if not standardizing upward—meaning we must continually improve on the standard. Thus, a new standard is the sum of all good ways we have discovered to present. There should be no resistance to standardize upward, improving continuously. Today's standards must be the standard upon which tomorrows' improvement is assessed and based.

Particularly a well thought out process is simple, and with simplicity generally comes greater safety. High production efforts have been obtained by preventing the re-occurrence of defective products, operational mistakes and accidents and by the incorporation of employee ideas. We eliminate wastes by assessing available resources, rearranging equipment, improving processes and tools, analyzing methods and transportation, and optimizing materials. Resources include manpower, materials, information, equipment.

All work is creative work if done by the thinking mind. No work is if it's repeated by the routine learned by others. SOP's help us develop and use a common language which can form the base of communication internal and external. The creative person needs to communicate their creation to other people, perhaps best done through standards, procedures and other documentation described here.

Standardization Around SOP's

Standardization is a fundamental practice to determine how a process is performed. Each work standard represents the best and safest way, and at a specific time and in a sequence, to perform a task. The goal of standardization is to guarantee work and process reliability to optimize quality. Where work is mature, standardization provides stability in existing processes to prevent them from slipping back to a previous inefficient condition.

The only change that is permissible for a standard is one of improvement. Done correctly, any deviation from a standard should be visually apparent and it should not restrict the necessary flexibility of production. Employees participate in developing and changing standards by working with technical efficiency experts to standardize and optimize their processes. Work and processes are standardized to ensure safety, reduce process variability, ensure optimum quality and form the basis for continuous improvement.

While all work should be documented as SOP's, manual/cyclical activities are key areas requiring highly detailed SOP's, particularly those which are complex actions carried out repeatedly by different people and at different times/locations. This could include setup procedures, tests/inspections, rework, among others. SOP's provide an overview of the sequence of work activities and include detailed descriptions of how to carry out key activities, providing information relating to quality, safety, responsibilities, roles. The goal is to provide single, separable, small steps with the aim of standardizing different activities carried out between stations or work areas. SOP's must be posted clearly at each station and kept up-to-date. All employees must be familiar with their format to document all data required to properly complete one takt or cycle and/or a repetitive activity.

SOP's are developed in a fairly methodical manner as follows. Under the direction of a team leader or supervisor, members of engineering and related teams provide any necessary data and documentation which may not normally be readily available to work groups, or considered essential in new areas under development. Based on information provided, a draft is initiated. Involve all team members affected, and managers, as early as possible in the process. Use plain English, written in a manner which will communicate broadly and in straight forward ways. Assuming changes are made to SOP's as the work progresses, it is key to inform all affected routinely and document changes appropriately.

Work with the best and most seasoned workers to draft out the basic written procedures. Once drafted, this is discussed and agreed to by team members and supervisors and released for use by the team and others. The entire process is run by supervisors and/or team leaders, who provide both theoretical and practical support for the members of the team. Generally, SOP's are developed in three stages:

- Based on best practices having been identified previously, proceed to write these, procedurally as the basis for all else.
- Describe in writing, specifying direct activities for each work station or area, with the aim of optimizing and equalizing workloads and with the agreement and involvement of the workgroup involved.
- Describe in writing, specifying indirect tasks required to do the work, combining tasks for functions and work stations, and taking into account overall aggregate workload and quality criteria.
- Create documentation/visualization of activities for each station/work area in the form of a standard work instruction/work station description.
- Combine all information into an appropriate media format which can be optimized by those using, to guide and positively help them improve.
- Test and improve until all key individuals have been involved and have helped develop a workable model to be shared with others.

The SOP, once developed, is signed by a team representative and the supervisor/team leader. The author of the SOP records the revision status in appropriate locations as may be needed. All team members concerned are notified of any changes to the standard.

SOP's provide a generally valid standard for work done, helping ensure uniform product quality even though different employees may work at the same station/function. This helps form the basis of product quality overall, since this basic documentation provides the "correct" or "best" way to do a task. SOP's help ensure process stability and reliability in work, and thus safe working practices and inherent quality in the workplace. Workers are encouraged to participate in the creation of SOP's, enhancing employee participation and ownership of setup of the work area. SOP's record the best standard for current work and are therefore the starting point for continuous improvement.

Along with the SOP's, several support documents and materials should be available and visible to operators at every work areas to assist in enhancing communications:

- data collection forms and procedures
- visual quality documentation, emphasizing both good and bad work accomplished
- maintenance procedures, TPM diagrams and information
- assembly diagrams, including quality alert information as may be needed
- parts listings, WIP
- total cycle and production times, value adding and non-value adding steps and actions
- safety and ergonomic documentation
- desired outputs, production standards
- audit procedures to be followed when auditing of work area occurs
- any necessary tools required to do the job
- scoreboards used to assist in knowing when work has been achieved at necessary takt levels
- standard shift change procedure to help assure smooth continuity among work periods
- inspection, quality gates used to assist in knowing when work has been properly completed, or not

Standards must be checked regularly to see that SOP's are maintained and controlled in a systemic manner. If the content of the SOP is substantial, it should be grouped logically and in a manner which is least likely to overwhelm users, leading to confusion and a likelihood of non-use. Operational sequences should be tested and verified against the standard periodically—to make sure all other related forms and materials are relevant and updated as well.

Implications of SOP's. The purpose of standardized work is to produce high quality products economically, quickly, safely. Reliability in the workplace is brought about by standardization. It is only by understanding the process and documenting the steps that we can hope to improve. The standard, set by all involved, helps lead to lower cost, higher quality, and shorter lead times to deliver the work. We can only hold our people, team to higher standards, if we actually take the time to identify and determine the standards, through a collaborative effort with all involved. Based on the standards it is then the task of management, working with teams, to enforce and use the standards in all that we do.

Standards either cause normalities or abnormalities to surface. By determining and setting standards, and then holding all to the standards, people will either conform to the standards or they will become increasingly conspicuous as being outside the standard. Two possible situations occur in production: we are either in control or we are out of control. Whether in or out of control begins with having standards upon which to measure the work conditions against. Environmental and cultural systems within which we do the work will then become major determinants regarding what does or does not happen to cause enforcement and empowerment of the use of the standard.

It is impossible to pursue improvement of any sort without first having the baseline of standards. Standards are the basis upon which improvement is done. If we do not first have the baseline of some sort of written standard, it is

impossible to move forward with improvement, let alone to do continuous improvement. Other built in plusses based on written standards, in the form of SOP's, include:

- SOP's help to simplify and streamline performance evaluation for all involved.
- Discipline is more readily brought about and reinforced.
- Providing a written sequence of productive steps.
- Ability to assign work to a single team, work area, or worker.
- Quicker turn around time, and higher levels of accuracy on preparing quotes for new work, competing for new contracts.
- Training and talent matrix development which shows individuals and work areas, teams having abilities to perform specific types of work.
- Being better able to match up customer demands with internal supplier talents, all based on agreed SOP's defining what we are to do.
- Key part of the system for systematically designing work to meet the needs of customers.
- Derives short and long term objectives, indicates training goals.
- Represent the best, easiest, safest way to do the job, reflect wisdom, empowerment and accountability.
- Provides a systematic way to preserve know-how and expertise, retains history.
- Show relationship between cause and effect, baseline for variation analysis.
- Provides an objective basis for consistency and improvement (maintenance vs. improvement).
- Base for auditing/diagnosing to assess daily/weekly/monthly/quarterly progress as a frame of reference in system or standard.

Thus, the SOP becomes an extension of work requirements agreed to, all based on a written document which identifies the correct way to do the work. The SOP is agreed to as the best way to perform the work, our best practice.

Written standards in the form of standard operating procedures (SOP's) are key to the determination of best practices. The basis for reducing the variation within tasks in a process, and ensuring that workers are consistently performing the same tasks and procedures, can only come about based on the written documentation, in the form of SOP's at the lowest level. Critical to the development and identification of SOP's, as standards, is to identify tasks and work that are value adding versus those that are not.

Standardized work, in the form of written SOP's, defines the culture we work in, leading to possibilities for complacency based on the standard needing to be changed, challenged. It is key that we learn, and reinforce appropriately, that improvement must take precedence over maintaining paradigms. It is the pursuit of new paradigms that will lead to challenges to the current SOP's, and therefore potential improvements. Thus, an appropriate balance must be struck between a natural desire to "lock in" to the SOP forever, administratively, and the need to continuously identify better ways to do the tasks.

This involves, in part, the identification and understanding that there will be unique and different types of SOP's in various work areas and tasks. Some standards will be operational, due to the need to safely operate equipment for example. Other standards will be administrative rules or policy guidelines due to regulatory or certification standards. Still other work is standardized around the need to simply agree on one common approach which best serves the needs of all involved as customers and suppliers.

The system for standard work, and standardizing work must build in, and upon, the principle of continuous improvement. It is imperative that we not identify the standard, the SOP, and then become defensive about it, never being willing to change. Thus, how we identify what is best, and how we go about making changes in the SOP, as well as maintaining it, is critical as part of the broader system.

Standard Work-in-Process Potentials

The "standard work-in-process" is the stock of semi-finished products and/or materials, which goes up and down between a fixed minimum and maximum depending on where we are in the production scenario at any given point in time. This can apply between two production processes or within one process and general takes into account that stocks of materials should be visibly limited (areas, stack heights, etc.) to allow for easy control and visual checking. Similarly, specific rules and guidelines are defined regarding stocks of brought-in materials at the place of use. Particularly where launches or other new plans are concerned, we must provide for the minimum possible stock levels to assure that we do not run out (overages can be adjusted later). Stock control can utilize digital systems (red and green lights) or color coding in storage areas, as kanbans.

If lengthy set-up times are the reason for large inventory stocks, introduce set-up optimization projects as a means to reduce set-up times and reduce inventories. Set-ups should be systematized and documented in SOP's just like all other processes, as they are optimized. Use of SOP's in this manner can assist in avoiding extra stock and overproduction (sometimes called the 7 Wastes). SOP's also supports

takt time build and single part flow production and other JIT principles. Similarly, SOP's applied in this way can quickly reveal overproduction, bottlenecks and unstable processes.

Buffer stock will be required for use in the system until the SOP's have been sufficiently developed to balance the work. Automatic operations require standard work-in-process stock to enable the worker to be separated from the automatic machine cycle. The amount of standard work-in-process stock may be determined by standard tote quantities, if one piece flow does not exist.

Several important components in the standardization arena are noteworthy, and require additional explanation. These include scorecards, visual communications, Each of these are further detailed in the next section.

Scoreboards. The basic system for scoreboards is standardized for all departments, work groups and teams in an organization focused on improving communications. Scores are displayed on the group work board based on the following types of measures: housekeeping; safe work practices; quality improvement; customer focus and delivery; productivity and costs; innovation and creativity; suggestions recently implemented; projects recently done; visual improvement examples, and others.

Various types of color schemes and shapes may be used to help communicate to all in the organization. It may also be appropriate to use flip charts and other communication devices to assist in telling the story of various teams, and overall, what is going on in the organization. As with other empowerment techniques, it is important to involve employees as much as possible in showing achievement of targets, evaluating data and documenting actions. Obviously, it is important to display the boards in an easily accessible, central location.

Scoreboards are part of a team building and general management tool which serve to communicate goals and outcomes. They also serve as a way to help train and educate people throughout the organization. The presence of the boards drives achievement of targets, goal setting, strategic thinking and so on. Scoreboards can help create employee awareness of targets and strengthen commitment to achieving targets.

Work area measurement, analysis. Actual data being collected and documented in various ways is one of the key standard procedures at the work area. The extent to which workers actually understand and use a data and documentation system, at the work area level, is a pretty good indication of the actual maturity and depth of where an organization is with the broader change and transformation system, culturally. Examples of local work area data and documentation could include:

- The completion of a quality control chart
- Work area inspection and test plan integrated in the work area system
- Execution of an internal audit by members of the work area team
- Determination of capacity utilization using various documentation and analysis tools
- Time and motion measurements, analysis
- Analysis for possible improvement on any of SOP related information

This type analytical activity can only be carried out in a fairly mature and well supported work area and organization. But this type SOP measurement and analysis illustrates the power in SOP's to a great extent. Individuals that are truly empowered and motivated to pick up the ball and run with it will do so in an environment like we are discussing. The empowerment offered via SOP type documentation is key to facilitating this. Also, it is worth considering the power of computerizing the work area to enable online activity in work area documentation.

Benefits of work area measurement may be obvious but could also require some brief illumination. As suggested in the previous paragraph, this enables team members to take ownership of the process at a fairly high level. This also increases team members' awareness of quality issues by involving them in the quality control process via analysis and data gathering, documentation. The process is being monitored and analyzed right at the level and function where action needs to be taken. Finally, this type SOP driven work area facilitates initiating problem-solving processes, and consequently the structured analysis of the causes of those problems in disciplined ways are more likely to be addressed.

Standard shift change procedure. One of the key areas between shifts and times, as well as locations in work area changes is what may be called standard shift change procedure (SSCP). The SSCP provides standard communication rules between related shifts and other changeover in personnel. Binding agreements can be established in regard to the form and content of the SSCP to enable smooth transition at necessary times and places. The SSCP type agreement takes operational interests into account and will typically be drawn up with the involvement of employees and management. SSCP agreements will typically cover the following type elements:

- Duration of the shift change procedure
- Rules governing which job holders are involved

- Content of individual shift change discussions/records
- Significant changes or other issues needing to be communicated

The timing and specific rule in SSCP's are defined locally according to specific work and cultural issues and regulations. Important procedural information which can be passed along in the SSCP documentation could includes can include equipment and process faults as well as changes to equipment, parts, processes, etc. Deadlines upcoming, and any related data (program, quality, audit, etc.) on specific projects. TPM data and documentation would also be a likely SSCP area of ongoing dialogue to be carried over periodically and routinely.

SSCP standardization benefits can be pretty far reaching, to include minimizing disruption due to absence of or insufficient communication with various persons. Promotion of cooperation, while an indirect and less tangible item, can be significant. Clarification of responsibilities and holding all in the system accountable as a "larger team" may also be an indirect benefit of SSCP. The SSCP can support smooth production sequences to help ensure continuity of tasks and documentation between shifts and workers in different times and places. At a broader level, buildings and equipment must be standardized over time, and the SSCP can help facilitate this.

Standardized Equipment, TPM. Heavily oriented to TPM, standardization of equipment may not be readily apparent as a typical area to be standardized. This comprises selection of areas for standardization and evaluation to be addressed (standardized) in terms of potential value added through:

- General technical issues
- How to operate, run equipment
- Economic issues, cost relationships
- Ergonomic ("friendliness") advantages
- Layout issues
- Maintenance scheduling
- Broader TPM relationships

When evaluating and standardizing operational resources, priority is given to "lean production" and arranging equipment in "U" formations to enable ease of movement and activities in the work area.

Equipment and work area standards are evaluated and agreed by the team leaders and managers, designers and technical staff, operators, purchasers and all other employees affected. The basic aim is to standardize all operational resources for operators to facilitate efficient operations. System components/modules and spare parts are standardized separately for maintenance tasks in routine ways, all documented as SOP's.

During a project, standards are developed through close cooperation and communication between the standardization manager, project manager and others engaged in the work and work area. The standards are documented in the design documentation and in the specifications, and in other ways related to how the new equipment will be integrated into existing process flow. The project specifications are adapted to the appropriate standard and the system is tendered based on the work underway. As the systems are actually brought on line, with newly implemented equipment, checks are made to see if the standards have been implemented correctly and appropriately.

Quality gates/project standardization. Quality gates/project standards are described with reference to any applicable process where improvement may be necessary. The quality gate/project may be identified by an internal or external customer or supplier, or in other ways, intended to assist all in improving quality and productivity. The quality gate/project standard process may revolve around four cycles or phases:

- Definition phase and initial assessment
- Project control or preview phase
- Preparation for final quality gate assessment
- Evaluation phase

Upon completion of the definition phase responsibilities and deadlines in the quality gate/project cycle will be clearly established. Measurables and preconditions are fully understood, and all are in agreement regarding how to treat all factors. Customer-supplier linkages have been agreed upon and defined sufficiently to enable progress to be facilitated among the broader project culture. The criteria by which the project will be measured at the forthcoming quality gate are made appropriately clear. The project is coordinated by a quality gate team representing all factors in the work.

Project control or preview phase provides periodic progress checks in relation to the forthcoming quality gate. The chosen measurables and preconditions are evaluated and assessed at appropriate times and in ways which are satisfactory to facilitate progress. Where may be necessary to achieve satisfaction, evaluations must be backed up with corrective actions as part of the way to proceed. Previews are used as a key part of the progress checks in new product launch and selected development projects involving large capital outlays or other known risks. Depending on project level of maturity, the overall work may be more closely monitored as part of a measure for project control.

After a preview, the status of the project should be clear to everyone involved, and potential conflicts between customer and supplier objectives are uncovered and a solution found where necessary. The degree to which measurables, at time of preview, for the forthcoming quality gate, have been met, is established. An overall project evaluation is prepared, summarizing the preview status, documented and communicated to all engaged. Preview documentation becomes pivotal information to be used in the preparation for final quality gate/project closure.

Preparation for final quality gate assessment involves measuring and evaluating the maturity of the product and process in the project. Various types and levels of evaluations may be performed as checks that all function groups and participants are at the same stage of maturity toward completion of the project. It may be necessary to identify critical deviations and introduce corrective actions as means to help assure that all engaged will be brought together in a timely manner for closure on the work. It will be critical that we make and document binding decisions regarding the future course of the project—necessary steps to achieve closure, including any necessary changes in allocation of resources.

Evaluation phase is a procedure for tracking critical actions, introduced as the mechanism to get closure. Transparency and necessary flexibility is created for any existing deviations or issues identified during implementation. Although a project only goes through a quality gate once, it should be noted that corrective actions and previews allow teams to have essential flexibility without failures.

It should also be noted that increasingly this type work, both as the project itself, in teams, and the review and quality gates, will be done online and in various ways revolving around the web. Most organizations will have there own secure intranet which will facilitate access to the quality system and other communications systems, both as customers and suppliers, internal and external.

Quality gates/project standards provide a systematic way to structure, conduct and manage major projects. Standards defined and developed in the quality gates assist in providing structure and discipline in the act of improvement. This will be particularly important where multiple disciplines and teams are grouped together to address issues of benefit to the organization. Additional benefits of the quality gate/project standards include:

- Shorter lead times in development, planning and start-up since communications are enhanced and speeded up.
- System is designed so that management intervenes as soon as is necessary, although we must be cautious not to "micro manage", yet be supportive and understand thoroughly what is going on.
- Project and organizational management can intervene in good time, particularly since the majority of the information, and much of the work will be done using internet and digital capability.
- Incomplete and delayed actions are not tolerated, and accountability becomes increasingly obvious, and transparent, as work is moving electronically.

Visual Techniques, 5 S's. The processes and work functions are organized so that everyone can tell at a glance if production and work activities are proceeding normally. Any abnormalities are readily apparent based on easy to see and visually pleasing work areas. The areas are well kept and orderly, giving rise to any suspicious and out of place items. This is congruent with TPM, and having workers maintain their own work areas in down time and ways which help to use idle time in productive and value adding activities focused back into the work area. These visual techniques are **s**upported by a 5 S (Sift, Sort, Sanitize, Sweep, Sustain) system and process. The 5 S's are further defined as:

- Sift
- Sort
- Sanitize
- Sweep
- Sustain

This method must become the basic daily task of team members to ensure that the workplace is labeled, cleaned and tidy. There should be a cleaning schedule for the department, and all cleaning materials should be stored in specified, visible locations. Workplace audits must be performed on a regular basis according to an established checklist during daily 5-minute maintenance and clean-up before start of shift. These audits are performed jointly by the supervisor and team members. It will generally be helpful to display "Before/after" photographs in the workplace to show the improvements in process. Involving the group in drawing up and implementing standards in workshops, and where possible give team members responsibility for performing the audits.

The 5 S's offer many benefits including increasing transparency and safety in the workplace by presenting a simple and straightforward standard system for keeping the work area clean and organized. Everything has its own place, which makes it easier for other employees (different shift or rotation) to find their way around. This simplifies the transfer of employees from one workplace to another, increasing flexibility, enhancing cross functionality. The robust and intensive employee involvement

brought about by 5 S promotes responsibility for well-organized and efficient work systems, a key foundation for process reliability. Searching for necessary work materials and parts, resulting in wasted time is avoided or at least minimized and discouraged by use of 5 S's. Safety in the workplace is easier to enforce and facilitate since discipline built around cleanliness and orderliness is a natural and parallel function for safety, as well as quality and productivity. Standards in 5 S's help avoid friction between employees and leads to enhanced cooperation since the work place is enhanced overall.

Labeling, marking, visual management. Various types of labeling and marking are used as standardization methods in the work place. For example, floor marking, color coding and labeling may be used in defined work areas such as storage areas for in-process goods, rejected parts/rework, materials and tools, empty pallets. **M**oving objects and other safety issues are commonly marked or identified in ways which are intended to assist in keeping a safe work environment.

Labels frequently will contain specific descriptions and be color coded where potential for error exist. Labels and foot prints define fixed maximum inventory levels and other WIP type information used in visual management. Standardized color coding for labeling and marking is used throughout the organization to communicate effectively regarding important management issues.

Labeling, marking and foot printing can be clear and useful for all employees if all are aware of them. It will be important to keep relevant departments informed of new measures, changed locations, etc. Introduce the method as part of a scoreboard or other visual management technique to gain greater employee acceptance. Used carefully, labeling, marking and foot printing standardization can help create orderly, visually transparent work areas and enhance safety. Walk times and dead heads can be minimized and abnormal conditions can become increasingly obvious. Footprints help employees not to overlook particular work steps, particularly as related to preventive maintenance. Floor markings can improve orderliness and safety.

We are more likely to modify our own behavior when we participate in problem analysis and solution. This can help us improve, learn, and take action from our own efforts. The bottom line is that we are less resistant to change. When employees participate in creation and upgrade of standards, they develop ownership and self-discipline to follow them. By contrast, when management creates standards it creates us vs. them approach. Workers should take charge of their own standardization effort Roles/Activities create accountability. Can not seek greater efficiency, increased productivity by simply telling workers to work harder or faster. Inducing greater stress is not leadership, nor will it lead to improvement Standards

Process mapping: Plant layout and flow diagramming. Related to time and motion studies, and work methods, other tools useful for addressing productivity are plant layout, process flow charting and inventory related approaches. Process flow charting uses symbols placed in a condensed format. The typical flow symbols, shown in the flow chart example provided, are usually placed in a progressive line format, connected, and numbers are placed in or near the symbol to correspond to a chart with all procedures for producing the product. The advantage of process flow charting is that the entire enterprise system (or a sub-component) can be analyzed from a graphical schematic. Times and costs can be placed alongside each process on the chart, permitting further comparison and analysis. After those processes or tasks where the greatest time and/or cost is incurred we will troubleshoot these tasks/processes for greater efficiency and productivity.

Similarly, by placing the plant layout in schematic diagram form, analysts can readily identify obvious trouble spots. For example, if in studying the layout diagram it is observed that some space is not being fully used, the prudent manager would attempt to better maximize on the space. As a general rule 75-80% of all space should be in use for optimum capacity planning to be prevalent. If this is not the case the industry may be losing money due to increased energy and maintenance cost, mortgage and interest cost, and perhaps other non-productive costs.

Based on actual and simulated production problems, relationships in layout and flow diagrams can prove useful in resource allocation, both on a day-to-day basis as well as for future plant/capital expansion.

When this is documented, it is pivotal that various inventories in storage, and WIP, are completed. Since much cost is associated with inventory, it makes sense to try to reduce and control these elements. Often labeled materials requirements planning (MRP), the idea is to know in very detailed ways where all materials, components, and assemblies are in the operation. This also relates to detailing times for set-up, changeover times of various products and components, throughput times and total time to complete a product. This relates to total time and costs to produce the product, much of what is driving profitability and competitiveness. Relationships of people, machinery, and materials movement should be carefully analyzed to determine lengthy (costly) movements and potential bottlenecks

or other down-time possibilities. Properly used time studies, flow charts, and plant layout diagrams can lead to removal of potential safety hazards, avoiding down-time, retraining of personnel, insurance payment increases, and so on.

Man-machine analysis--common sense approach. Man-machine analysis is presented as a systematic and informal method for improving quality and productivity of work areas by better understanding our personal situations. Designed to use data and information already discussed in time study and work method analysis, man-machine analysis is a common sense approach to "looking at how we work"? This can be done by hand drawn, self generated, sketches and other information, with the other forms and approaches, used by teams and individuals. It can also use simple CAD generated drawings, depending on equipment available.

Sketch or draw the work area, or the task/area. If no machine (in the traditional sense) is involved, then put the items which are involved in your work in the sketch. Use the following as guidelines:

- Keep the entire sketch on one 8 X 12 sheet of paper. This is done to show the entire work area or task in one glance, graphically, and to view it as an operation in the broader process.
- Lay out the sketch so that it is roughly proportional to the actual area being represented. If the total area is shown on the 8 X 12 sheet, and a machine is in the center of the actual work area, then it should also be in the center of the 8 X 12 sheet. If the actual machine, in reality, takes up half of your work area being analyzed, it should also take up approximately half of the sheet of paper.
- Measure distances in the work area, and show them as actual measurements and distances on your sketch. These can/should be shown and that symbols for transport and storage should be used as part of the analysis.
- Show each major device or machine, bin or cart, desk or stool, and so on as a square or circle rather than trying to detail the art work. Try to get a graphical diagram for analysis--not a perfect drawing. Be sure to label each item so others will know what they represent--make notes to yourself for clarification.
- Related to number 4, try to show time, space and distance relationships in such a way that sufficient details are known to assist you and others in understanding for improvements. If your proposal is "moved forward" for improving your work area, it will need to be packaged with other information in a neat and legible way to be communicated with others.
- After current methods, times, and other details are shown on the sketch, and related to other information and forms, analyze what you have drawn or assembled for improvements.
- Talk to others knowledgeable in your work area and try to determine if other approaches might be possible and helpful. This could include supervisors, quality and engineering persons, operators, and others to factor in other information which may help improve the situation. Quality charts, inventory and cost information, and so on should be used since this will likely show relationships and benchmarks for improvements.
- Using your knowledge of task/work area, reflect on circumstances which cause fatigue, pain, or other problems, and determine ways to improve.
- Based on analysis, and inputs, redraw the sketch, and simulate all steps, distances, times, space relationships, and so on, to try to make this work.
- Compare your new proposed approach to the existing method, looking for possible gains and improvements. Share this with others and get their views, to improve your idea--done through a team.
- Try to implement your approach, and assess its effectiveness against various measures or benchmarks for evaluation. This could be time, defects, cost information, units produced, or others.

This is a simple approach to improvement, a "common sense" method. But it also relies upon some rather well established approaches developed through years of work by many persons in the industrial engineering field. Regardless of how simple or complex, if used in conjunction with others on your team, and from other teams and work areas, you can make improvements.

8-D Problem Solving, Corrective Action

One key to success of the overall improvement approach is disciplined corrective action. The common approach is "8-D", which uses several questions, or categories of response/reaction information to inform all involved of necessary actions being taken. The process is introduced here, and is also part of the discussion on OPCP:

- Team members/function.
- Source, general description of complaint.
- Immediate interim action, date, containment.
- Identify problem defect, detailed description.

- Root causes/definition/corrective action.
- Permanent action, effective date, verification.
- Control for prevention.
- Congratulate and reward the team.

As with the OPCP, and any other corrective action situation, the 8-D may be a rather short report and documentation, simply filling in the blanks on the form. Or it may be important, depending on the complexity and significance of the complaint or issue under investigation for improvement, to provide a more detailed and lengthy report.

8-D, or eight disciplines, is a problem solving tool for corrective action which, by design, emphasizes our disciplined team effort in the broadest sense. Virtually all facets of our quality system can be called upon to help solve, document, and/or control a process or product situation requiring attention. Even where the root cause of the problem may be known, it may be useful to place the issue in the 8-D reporting format and process, if for no other reason to help manage and systematically follow.

The 8-D is a systematic tool for communicating progress on resolving quality issues or problems of a technical nature. It is a fact based tool used for standard reporting and disciplined approach, followed in all functions and applications, and driven by teams. Credence for placing the 8-D process in this portion of the toolkit, focusing on documentation and Kaizen tools, is that the fact-driven 8-D relies upon SPC data as a prime element within the documentation for corrective action, the 8-D is a living document which is action and problem solving. Like many other documentation forms, this is intended to be updated and tracked over time. The 8-D also provides a paper trail which demonstrates and explains our pursuit of quality and improvement, to be used in new product development, other related products and projects and future problems as identified. 8-D's, often driven by customers, both internal and external, are further improved by involving other suppliers and customers.

Team members/function. It is important to use the team approach as the first 8-D component. This is likely a newly formed team, particularly brought together for resolving the issue, as opposed to an ongoing or standing team. It is important that the knowledge be provided in the team, appointed with other concerns in mind for proper representation of the organization and all other parties represented. As with any other team function, the team should be large enough to accomplish the task but not so large that it becomes cumbersome and unmanageable. A team leader should be identified and listed on the form, as well as all persons, their function and phone numbers and other critical information, to assist in logistical and managerial issues and circumstances.

An immediate answer on the composition of the team, as well as many other issues, may be less important than our ability to reach out and take care of those concerns which will likely arise in any situation. This point becomes increasingly important when we consider the increasing reliance on teams composed of operators and individuals who traditionally may not have the authority required for such matters. Success or failure in many circumstances will be directly related to the way we structure the team--and it is vitally important that we have some successes with any venture or approach.

Source and general description of complaint or concern. While identified as a source and general description of complaint, this disciplined step is vitally important since it is essentially the start of identifying and defining the problem in broad conceptual terms. As was discussed in earlier tools, if we do not sufficiently understand the problem how can we adequately address it? Time spent in this step or phase is not only important, it is essential. If not adequately addressed the likelihood is increased that we will address the incorrect problem or source, possibly a symptom of the problem, or an effect of the problem--rather than the actual problem, or root cause. Typical questions to ask in an attempt to assure that we begin to get to the root of the complaint or concern may be the traditional who, what, where, when, why and how, type variety.

The source and general area of concern would only begin to identify the broad parameters--effects noted at some point--of the problem, rather than to actually identify the problem. In production it would be noted that the concern was at a specific line or process, and further detailed analysis would begin to occur, based on attributes noted, in subsequent phases. Or in maintenance troubleshooting this may be the early phase where a system is identified for further pursuit. Chronologically this is also understandable since we are only in the early stages of problem identification, primarily based on effects noted. As we continue to pursue the problem over time the problem effects and hopefully, causes, will become better focused, identified and understood.

Immediate interim action, effective date and containment. Based on the early knowledge of the concern, source of the problem, and other details, an immediate interim action will be taken. This interim action is not intended as the "end-all" solution, but is intended to determine effects of the problem which

are undesirable to the customer, and improve these, without necessarily providing a final solution. Obviously, if we know there is a problem, but don't know the cause, yet we are clearly seeing effects of the problem, we must take immediate action. The bottom line is that without taking action immediately we run the risk of shipping bad product, and damaging our relationship with the customer. We must tell the customer what the action is for purposes of containing the effects of the problem, and reduce sources of bad product being shipped to them.

Specific steps commonly taken in the immediate action and containment stage of the 8-D is identified in the following listing. It should also be noted that, once again, this all relies upon a disciplined approach for follow through and "bringing the problem home". These include implementing immediate actions, identifying specific containment actions, and verification actions. It should be noted that dates and specific actions become very important as part of this step in the 8-D process. We must have the team in place, staff on line, and other resources to accomplish what we say we will do since the customer be counting on us, and holding us accountable. If the broader 8-D process is working properly with all concerned, this actually addresses effects of the problem early on, contributing back to better understanding of causes of the problem, and the ultimate solution.

Identified problem or defect, detailed description. After the general area of concern is identified and flushed out, it is necessary to further detail the problem and focus on root cause issues. This is a continuation of the previous step and is built on and around what was learned and documented at that time. The questioning process would continue, with enhanced degrees of specificity. As we strive to define the problem it will be important to give details in operational terms which are relevant to our culture and will be readily understood by all involved. It is anticipated that brainstorming and continued cause and effects charting would be prevalent as part of the documentation at this phase.

Root causes/definition/corrective action. As the 8-D process moves forward over time, the necessity is to get to the root of the problem. This may happen naturally, assuming continued energy is focused, but we must remember that the problem exists in part because we have not focused sufficient energy and resources in this area prior to this point. Several continued efforts and disciplined activities, all requiring additional time and other resources, will need to be done, all as a sub-set of the broader 8-D. These may be parallel functions simultaneous to and with other previous and subsequent steps.

As the problem becomes better understood over time, possibly months and almost assuredly months, it is significant to note that all involved are going to be learning much valuable information and knowledge. This should not only be anticipated, but it must be understood for the tremendous opportunity that it is. Not only should this information and knowledge be carefully documented, but it should be used for training others, growing the entire knowledge base of the organization--one of the key applications for the entire 8-D process. Not only should the team directly involved be growing, but others must also be brought along. This also speaks again to care in the early stages of forming the team.

Permanent action, effective date and verification. As the 8-D process moves forward, part of the design of the overall discipline is to implement permanent actions which will assure that the problem is corrected. This step is one of implementing the necessary long term actions and assuring that we evaluate ourselves and our actions over time. The device which may be most obvious as a long term mechanism in this regard is the ongoing process control plan (OPCP) as discussed elsewhere in the toolkit. As a long term action plan is put in place, either as an OPCP or some other vehicle, obviously, careful detail must be paid to who, or which group (s), is responsible, dates for deliverables, and other details of the broad plan--as outlined in the OPCP. And it would seem to go without saying that we must carefully communicate with customers involved to assure that all are in the loop--and providing positive and proactive inputs and information which moves us all forward in the improvement process.

Control for prevention. Control for prevention within the broader 8-D system requires that all persons and groups within the affected circumstances become fully apprised of the corrective actions. Moreover, it is vitally important that all understand why their production environment allowed the out of control situation leading to the problem in the first place. At this point we are interested in working to prevent recurrence of the conditions which bore the problem. Several approaches are common to combat recurrence, including education and training, and documentation such as FMEA'S, OPCP's, SOP's.

As the new approach becomes recognized and standardized within the broader system, it will be necessary to provide regular and routine reviews which provide documentation that indicates control and improvement over time. At some point in the future, as we gain additional confidence and

reliability in the system, we can likely divert some of the resources once required to address the current problem into other more pressing issues and circumstances. This will only be done with full support and knowledge of the customer and others concerned--based on solid data and documentation.

Congratulate and reward the team. The final step in the 8-D process is the congratulation and reward phase. It is important that the team leader pursue appropriate "marks of excellence" for all concerned. Creative recognition should be offered in addition to remunerative types, wherever possible. It may be helpful to videotape or report the results in other ways such as a standard technical report format for wide distribution, company-wide. If company-wide competition is offered for "best practices" the problem solution and full report should be submitted.

Role of the worker and team. But what is the role of the operator in the SOP? Consider that a team of operators and others knowledgeable with the operation probably are the best suited to help others learn--and to critique existing SOP's. Regardless of who starts or continues the SOP process, the operator should be a driving force in constructing and using them. This should also be done with strong input from the supervisor, maintenance, quality, and engineering personnel.

Once documentation is begun in SOP format for a given operation or process, to keep it accurate, of course, is not always an easy task. Who should initiate a change and what should the process be for changing the SOP? And certainly, shouldn't the SOP remain a living document--but how? Much of the burden for assuring accurate and lively SOP's will likely fall to quality and engineering persons--but with strong involvement and input from those closest to the operation--the operators and supervisors. This also relates to maintenance and safety.

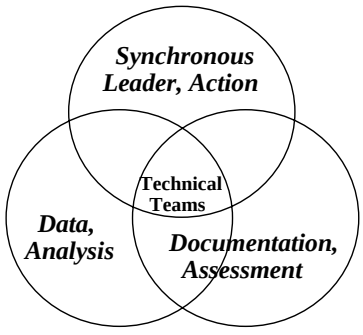
The reality of ongoing improvement is part of what the SOP is about. Perhaps on a regular basis, once a month or so, teams should review SOP's for each process or operation under their responsibility. Where data and statistical process control information suggests something is "out of control" or not right in any way, we must evaluate SOP's as one of the first lines of attack. By reworking the SOP periodically, targeted with data driven customer issues, we can expect to contribute both directly and indirectly to improvements in our processes and product.

Team Based Problem Solving, Documentation, Training Functions, Variation Reduction

Focusing specifically on problem solving, this section provides a context within the broader infrastructure. This section is designed to give general guidance to a technical problem solving system which is designed particularly around the various toolkits. The broad basis for the system being discussed is the tool kit technological change model, using data and documentation with teams and leadership within the proper culture as depicted in the model earlier.

A graphic nearby depicts relationships between and among tool kit elements for team building, problem solving and improvement. Appreciating that the team requires data and documentation seems less difficult to understand on the surface, relative to how to conduct the broader problem solving act. It is the synergy inherent in the relationships built around and between the data, documentation and leadership, all synchronized toward the collective team effort which can and must provide the technical solutions' infrastructure as well as mechanism. This only happens if proper design consideration is given to infrastructure and organizational aspects technologically and regarding human resource issues.

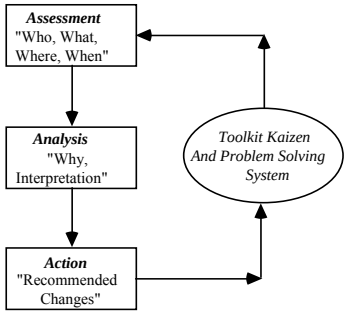
The overall problem solution will be a function of three fundamental phases, each wrapped within the broader context of data, documentation and synchronized leadership as depicted throughout the tool kit. The phases are assessment, analysis and action, each to be further explored and defined within the remainder of this section. This would seem to be at the core of the concept of ongoing improvement.



Toolkit Relationships For Technical Team Building, Problem Solving And Improvement.

The graphic nearby provides the three tiered linear relationship between assessment, analysis and action,

all related and ongoing based on feedback within the context of problem solving. While depicted as a straight line linear function, obviously the functions will not always be this discreet, straight forward and simplistic. Relationships embodied provide a useful strategy for the context of bringing forward technical solutions and improvements.



Toolkit Kaizen And Problem Solving System.

Assessment. During the assessment phase of problem solving, the team must document the current circumstances surrounding the problem or opportunity for improvement. This may involve demographic data such as persons and equipment involved, process flow charts of the macro process as well as the micro process. Regardless, much documentation will be involved to flush out the "who, what, where and when" type issues surrounding the way we currently do what we do. This could be a total line or production job site at the macro level and a micro work area within the broader system further analyzed. Both would likely require layouts, time and cost data, standard operating procedures, and flow charts on the current process and system.

Product design and specifications documentation would also be well advised as part of the assessment. Various tools for data analysis and documentation would begin to be formulated as a function of the nature of the product and process. It should also be clear that the data and documentation tools selected and used in the assessment phase will have a direct relationship to outcomes overall for the study in general, and subsequent phases in particular. Based on a thorough survey of all persons engaged in the work areas, it is quite likely that specific areas for further analysis will become apparent.

Analysis. While the major focus for assessment was to determine the current methods for processing product, the analysis phase builds on and around the assessment. Data and documentation begun in the assessment phase are fine tuned and multiple iterations may be required based on further analysis. Various experiments or trials may be run to determine optimum conditions or to further analyze what was flushed out from the original assessment. Pivotal in the analysis phase is the establishment of baseline data and documentation as performance baselines upon which to base measures of improvement. As baselines are established, sources of variation are determined, focused on and causes flushed out for optimization. Stabilization in process must be achieved in reasonable ways, facilitating a clearer understanding of broader relationships in production process. As this occurs, factors and levels appropriate for further study will begin to surface. But this all assumes that under control conditions can facilitate a sufficiently "noise free" circumstance for focused improvements. This analytical environment can demonstrate optimum conditions in process.

Conflicting views or information may be found in the assessment, requiring various analytic tools and/or further clarification. Tools being required at this phase may consist of basic data such as attribute and variable charts, gage R & R, CPC, and so on, all organized within the ongoing process control plan (OPCP) and failure mode and effects analysis (FMEA) documentation tools. When these tools are used in the team mode, the overall complexity of the problem solving situation has shifted. Perhaps only one or two tools will be used, rather than all at the same time. But the array of tools available for analysis should not be under stated. The number of iterations with any one tool, to continue to interpret and understand the overall problem circumstance for improvement, will vary. Quality of problem solution will determine whether further iterations may occur.

Action. The final phase in the pursuit of a problem solution will be recommendations for action. Actions consist of new procedures to be followed uniformly in the process, new equipment based on conclusions that processes analyzed were not capable, or others. All of this drives establishment of new standards, training and additional studies. Assuming new equipment is evaluated as being appropriate for implementation as part of the solution and improvement, new studies and iterations will be required. It would be quite common to determine that additional training were required, or better gaging needed, or shifts from one characteristic to another to be studied identified. Costs of such actions will need to be detailed and presented with justifications for changes, and hopefully, improvements noted.

PDSA as an improvement system. Use of the SOP, in any of the forms presented, must be

identified and explained, from a problem solving and improvement perspective. Based generally around the PDSA presented earlier in a separate tool, the SOP can be paralleled in its use. PDSA stands for plan, do, study, act. This logic system, and graphic is put in motion with the SOP as shown nearby.

The major components in use of SOP to solve problems and improve gemba follows:

- *Plan.* Identify problems, raising, clarifying and asking five W's, based on SOP's in gemba.
- *Do.* Pursue root causes via analysis, observation, collection of data for documentation, further study.
- *Study.* Kaizen at this point, predicting and comparing documentation and data for feedback.
- *Act.* Changes in the SOP, providing improvements at gemba, reductions in muda. Ideas are sought to plan for the future and further Kaizen through SOP.

This is an ongoing and dynamic approach to improvement. Relationships to documentation and training, and teams and leadership, are also apparent in the graphic.

PDSA As Applied To SOP Problem Solving.

It is important to recognize the importance of the SOP as a documentation and communication device. Many persons, depending on function, may not have had a great deal of involvement in building and/or using the SOP. As teamwork and cooperation become increasingly prevalent for all persons, particularly for supervisors and operators, it is believed this device will become more useful and necessary. The SOP is a basic communication and documentation device representing and summarizing many other inputs and sources of information:

- When customers wish to determine how we are processing their product, the SOP provides a foundational part of the basis.
- When, internally we wish to determine how something is being done, processing a product, the SOP provides one key part of the basis.
- When suppliers wish to better understand what is happening to raw material or component in our procedures, SOP's are a key starting point.
- When detailed analysis is done on any application, SOP's have critical information.
- When being considered for new customer programs or projects, SOP's demonstrate capability.
- SOP's document a "paper trail" for certification and verification of process if questions arise.
- SOP is a system for evaluating ourselves over time, based on strong and accurate documentation of process at various points in evolution of product.
- SOP's are a straight forward method for understanding our involvement and role--and our responsibility becomes increasingly apparent.

Each SOP can be a substantial document, one that forms the basis for much that is important to the future. The SOP relies upon accurate and timely information--gathered and compiled by many persons and organizations. Obviously, the SOP can only be as good as the information upon which it is based--and the people which are providing the data. The role of the operator, supervisors, teams and others who support them, ought not be underestimated in the SOP--either in building or using them.

One key function of SOP's is training. Whether used with new or ongoing employees, if the SOP is correctly and carefully put together, it can form the basis of essential steps for the operator to follow. When "coached" by knowledgeable operators and others, such as a supervisor, based on the SOP documentation, the new operator can be efficiently brought up to speed--and proficient in the correct methods and procedures--based on the SOP.

An additional connection remains related to variation reduction based on documentation, and used both as routine communication as well as for non-traditional training and education purposes. The issue is one of having the ability to get all persons on the same sheet of music, applying the documentation in creative ways to assure that all are running equipment in similar ways. When this occurs it represents a substantial step toward variation reduction since we can more readily attain consistency in production. This becomes even more essential as we connect the data with the documentation to perform increasingly robust analyses and studies for improvement.