TOTAL QUALITY CONTROL
AND THE
PROBLEM SOLVING STORYBOARD

In 1951 Armand V. Feigenbaum coined the term Total Quality Control (TQC). He said "Total Quality Control is an effective system for integrating the quality-development, quality-maintenance, and quality-improvement efforts of the various groups in an organization so as to enable marketing, engineering, production, and service at the most economical levels that allow for full customer satisfaction." --Source: A. Feigenbaum in Total Quality Control

Kaoru Ishikawa's definition neatly blends the major element of Deming, Juran, and Feigenbaum. He says "The fundamental message is this: Commit to continuous improvement throughout the entire organization. Fix the problem, not the blame. Strip down the work process -- whether it is the manufacture of a product or the performance of a service -- to find and eliminate problems that prevent quality. Identify the customer, internal or external, and satisfy that customer's requirements in the work process or the final product. Eliminate all waste. Instill pride in performance, encourage teamwork, and create an atmosphere of innovation for continuous and permanent quality improvement. Source: Bowles and Hammond in Beyond Quality

Other definitions for quality include.

<table>
<thead>
<tr>
<th>Source</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Deming</td>
<td>Meeting or exceeding customer expectations.</td>
</tr>
<tr>
<td>Dr. Juran</td>
<td>Fitness for use. Conformance to specifications.</td>
</tr>
<tr>
<td>Philip Crosby</td>
<td>Conformance to requirements.</td>
</tr>
<tr>
<td>Dr. Taguchi</td>
<td>Reduction in variation around target values. The loss a product causes to society after being shipped.</td>
</tr>
</tbody>
</table>

The first three definitions say about the same thing. The last is notably different.

In soccer if you kick the ball into the net, you score. It doesn't even matter if the ball hit a post going in. It counts the same. Suppose we are to make a part 1 millimeter long. Specifications will allow us to accept the part if it is 1 mm, plus or minus .0001 mm. Therefore, as long as the part falls between the limits it is fantastic. But, if it falls out by even .000101 it is lousy. This is known as the Goal Post Model of Quality.

Dr. Taguchi says there is more to quality than simply getting the part or service between the goal posts, or acceptable limits. In quality, the further the part is from the target center, the more loss there is. The more variation we have, the more we have to inspect, reject, and rework. Variation causes one part, or service, to not be as good as another. The more variation we have, the less we will satisfy our customers. Variation drives costs up.

Another way to understand TQC is thorough the 5 P's, or its philosophy, purpose, principles, process, and practice.
The Philosophy of TQC
The philosophy of TQC is to make "continuous process improvements to increase customer satisfaction." Note that the focus is on our customer, not ourselves. That customer can be an internal customer at the next process step, or an external customer that purchases or uses our product or service.

The Purpose of TQC
The purpose of TQC is to help us reduce two of the biggest drivers of cost in our processes -- variation and complexity. The more complex our processes are, the more chance we have of performing them incorrectly. Variation in our processes causes deviation from the target. The further away we are from the target, the more loss we have.

The Principles of TQC
One way to understand TQC is through its five principles. They are:
1. Establish a commitment to continuous improvement
2. Eliminate root cause of problems
3. Assign clear responsibility for action
4. Build customer/supplier relationships
5. Provide feedback
Let's look at each in more detail.

Establish a Commitment to Continuous Improvement
According to John Young, former Hewlett-Packard CEO, "Quality is not something you delegate; you must do it yourself." A change in thinking occurs as each person becomes responsible for continuously improving his or her own quality. No longer is the expectation that someone else will check for our mistakes. No longer is the expectation that we simply need to point out problems and someone else has the job to fix them. If we see a problem with TQC, we are more than likely going to be part of the team that fixes it. This applies to not only workers and operators, but also executives, managers, and professionals. It applies to all people, whether we wear a blue or white collar, and whether we are hourly or salaried. Everyone has a stake in improving his or her own processes.

The commitment to continuous improvement takes the form of minimizing complexity, reducing variation, and eliminating waste. (We will discuss the Seven Forms of Waste later in this document.) It is not enough to just say it -- we must do it. Or, as Dr. Deming said, "It is not enough to work hard, we must know what to." Except for the simplest of problems, we must understand and use proven problem solving processes and tools. Finally, we must understand there is no point of diminishing returns. The need to improve always exists. We must understand what the problem is, what its causes are, what the solutions can be, when and how to make the necessary changes, and whether or not the changes were effective.

Eliminate root cause of problems
We quickly find that without the facts, without quantifiable data, we cannot get to the root cause of the problem. For most problems, the root cause lies deep under the surface. Emotion and casual analysis are not sufficient for most problems. We must use data to point the way.

The root cause appears as a single bar at the bottom of a multi-level Pareto Chart. When we see it, there is no choice or debate about what we need to correct.

Assign clear responsibility for action
Very few problems of any consequence involve just one person. The difficult problems involve multiple organizations and multiple skill sets. Nevertheless, someone has to be responsible. Someone has to know that he or she is going to be the one to head up the effort to find a solution on a given opportunity. Someone must follow through. Otherwise, although everyone knows of the
problem, we may find no one did anything about it. It simply fell into the cracks between organizations.

“There was an important job to be done, and Everybody was certain Somebody would do it. Anybody could have done it. Nobody did it. Somebody got angry about that because it was Everybody's job. Everybody thought Anybody could do it, but Nobody realized that Everybody wouldn't do it. It ended up that Everybody blamed Somebody when Nobody did what Anybody could have done.” -- by an Unknown body.

Build Customer/Supplier Relationships
TQC views our processes as a series of customer and supplier links. No one, and no process, is an island. All are related. Some customers are internal to our company; some are external. Requirements emanate from the customer. The supplier’s job is to satisfy or conform to them, or better yet, exceed them. This cannot be done without close customer/supplier communications. These communications need to occur peer to peer, not up and down some laborious chain of command.

Provide Feedback
Each person is responsible to improve his or her own quality. We must realize, however, that we do not work in a vacuum. Each person must feed data back to his customers and suppliers.

When we see a problem, we are often quick to say, “That's not my problem.” However, with TQC, if we see a problem or opportunity, it is our responsibility to do something about it, whether the root cause lies in our area or not. We may be the only one who sees it, and if we do not feed the data back, it may never be resolved. Again, we may not be the only one involved in the solution, but we will likely be part of the team, because our data is necessary in establishing a clear understanding of the cause.

The Process of TQC
The Plan/Do/Check/Action is at the heart of a proven problem solving process. Figure 1 shows the PDCA circle and flowchart. The circle is sometimes called the Deming Circle, but Dr. Deming said he didn't develop it, Shewhart did. Whatever! Adopt the Nike slogan and "Just do it!"

Plan
The TQC process begins with the plan section. Here, we must concisely describe the problem or opportunity. We also need to identify someone to head a team that is clearly responsible for following this opportunity through to a satisfactory conclusion. We must explain the nature of this problem (without jumping to conclusions or solutions). We might also want to explain how the opportunity relates to a key objective, or project, if appropriate. We then have to determine the priority of the problem; we have many opportunities, so we need to know if this problem commands attention over others currently competing for our time. We then need to quantify the magnitude of the problem in terms of key performance measures and state the intermediate and long-term goals. When the intermediate goal is reached, we will assess the need for any further concentrated effort on this problem. This too will be gauged in light of the priority of other opportunities.

Do
In the Do section, we need to describe the causes of the problem (not the problem itself again, and without jumping to an explanation of solutions). We must ask why the problem occurred in order to expose the first level causes of the problem. Once we have identified those first-level elements, we must again ask why each of them happened and how they contributed to the development of the problem's second-level elements. For most difficult problems, we must ask why at least four or five times, or levels. Once we have uncovered the root cause of a problem, we can creatively develop a countermeasure. Then we must implement that proposed solution to the problem.
TQC Process

Desire to improve customer satisfaction

Select issue

Identify Performance Measures

Data collection strategy

Data collection & analysis

Major cause identified?

YES

Assess need for immediate counteraction

Proposal for process improvement

Implement proposed actions

Collect & analyze data

Compare with previous status

Improvement objectives met?

YES

Monitor Document & Standardize

Repeat process for next opportunity

NO

Action

Plan

Standardized change

Where else might change apply?

Are all needs satisfied?

Have any other problems surfaced?

Check effects.

Compare to goal.

Is cause/effect understood?

If results achieved, go to ACTION.

If results not achieved, go back to DO.

Check

Do

Quantify the current situation.

Ask 5 levels of why this problem occurred.

Change way of thinking.

Develop countermeasures.

Implement countermeasures.

"One less"

Process flowchart

Cause / effect

Control charts

Run charts

Flip chart

Ideas to eliminate waste

Check sheets

Pareto charts

Histograms

Scattergrams

Cause & Effect

Force field analysis

Bar charts

Pie charts

4-whys

Kepner-Tregoe

Mistake proof

...The problem solving storyboard provides a structure through all TQC steps
Check
Once we have implemented our proposal, we must check to see if we were effective. If we have correctly identified the cause to the problem and satisfactorily implemented the correct solution, we should see the performance measures converge on the goal. If the performance does not change, either we have not identified the cause and effect of the problem, or we have proposed ineffective countermeasures. If we converge on the goal but do not reach it, we must go back to the Do section. Here, we will trace down another level, expose more aspects of the problem and correct them also. Once we have reached the goal we can proceed.
(Note: some people prefer to call this section Study, and define the circle as PDSA. Whatever! Again as Nike says, "Just do it.)

Act
In the Act or Action area, we standardize the change by asking in what other areas a similar constraint might arise. It is often difficult and time-consuming to trace to the root cause of a complex problem chain. Therefore, we should leverage our efforts by implementing the countermeasures in other areas that are likely to experience the same problem.

PDCA Rotation
When using the PDCA circle, we tend to move in and out of quadrants instead of following them sequentially around the circle. Later, we will learn how to use the Problem Solving Storyboard to guide us through each PDCA step.

The Plan/Do/Check/Action process requires us to analyze the problem carefully and then track the results of our countermeasures to see that our actions were correct. It also requires us to try to apply what we have learned to other areas by standardizing the change.

If we don't follow this step-by-step PDCA process once a problem is exposed, we increase our chance of jumping straight to an incorrect conclusion. Often, there is nothing wrong with applying our best judgment to solve a problem when it first appears. If the problem is not corrected, however, or if the solutions of today wind up being the problems of tomorrow, we will need to institute a more rigorous problem-solving procedure, like the PDCA process.

During a discussion of the PDCA process, someone once objected, "We don't have time to go through that time-consuming process. When we have a problem, we solve it right away!" If his "jump to a solution" process were effective, it would follow that he would have no old problems. But, of course, every organization has difficult problems that don't seem to go away. Shooting from the hip does not prove to be a very effective way of dealing with difficult constraints.

The Practice of TQC
The most difficult thing about the Seven TQC core tools, especially the first six, is simply comprehending just how powerful simple tools can be. We are conditioned that if tools are not more sophisticated and computerized, they are not as effective as they should be. Learning TQC is similar to learning to ride a bicycle. A little difficult at first, but easily mastered. Learning TQC is 20% education, and 80% practice. Unfortunately, companies spend mounds of money on TQC education only to find a handful of the people using it. Often it is not the instruction, but the approach to the instruction, that is the problem.

One of the most widespread approaches to education for TQC (and other technologies) is to select appropriate courseware, provide training for everyone, and then wait for the results. A more effective approach is to acknowledge that necessity is the mother of invention. Making change happen works much better if first you identify a specific problem, second form a team to address the issue, and then third provide education that specifically addresses the needs of the team. During class let them practice what they have learned on their own, real, problems. Regularly scheduled follow-up support for a while is also essential.
In the past, Total Quality Control has taken on a heavy statistical flavor. Fortunately today, the non-statistical tools are beginning to be recognized for their power also. One of the biggest barriers to acceptance of these non-statistical tools is that they are too simple. However, those that cannot make these more simple tools a habit, will not likely master the more complex ones.

In Dr. Ishikawa’s estimation, 95% of all problems can be solved using the seven basic or core TQC tools. Those tools are:
1. Flowcharts (also known as Process Maps or Flow Diagrams),
2. Cause and Effect Diagrams (also known as Ishikawa or Fishbone Diagrams),
3. Check Sheets (also known as Tally Sheets),
4. Stratification Charts (e.g., Pareto Charts, Histograms, Pie Charts)
5. Scatter Diagrams (e.g., Concentration Diagrams),
6. Run Charts, and
7. Control Charts.
(Note: different lists include and exclude various techniques in the TQC core repertoire.)

Most problems can be solved with this set of tools. Probably two thirds of the problems can be solved with the first six tools. Each of these tools is useful individually, but enhanced power comes when one tool feeds another (see Figure 2).

“Normal” people are capable of proficiency in the use of these core TQC tools. Cause and effect diagrams require the ability to read and write. Check sheets require the ability to make tic-marks. Concentration diagrams require the ability to point. Pareto charts require basic math skills. Control charts require a little understanding of statistics. However, we do not need to know how to build a car to drive one. Likewise, we don’t

Figure 2

Linking the techniques

<table>
<thead>
<tr>
<th>Type</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workmanship</td>
<td>16</td>
</tr>
<tr>
<td>Part</td>
<td>9</td>
</tr>
<tr>
<td>Adjustment</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>29</td>
</tr>
</tbody>
</table>
need to be a statistician to use control charts, but it is helpful if a statistician helps us get started. All of the tools require the ability to think and follow process steps.

Finally, as the late Dr. Deming was fond of saying, “It is not enough to work hard. We must also know what to do.” The Core TQC problem solving tools help us know what to do. And the Ideas to Eliminate Waste® and Problem Solving Storyboard® aids help us to do it according to the PDCA process. These two aids are discussed in the balance of this document. Use the Ideas to Eliminate Waste® form for problems are simple enough that surface or intuitive analysis is sufficient. For more complex, but quantifiable problems, use the Problem Solving Storyboard.

The focus of this document is on the original TQC tools (TQC1). These tools make use of quantifiable data. The original TQC1 techniques are useful for many applications. However, they are not particularly effective for unquantifiable problems.

Therefore in the 1970's and 80's, The Japanese Federation of Science and Technology, and later the Tokyo Industrial University, gathered and refined a set of tools designed to deal with this previously unaddressed category of problems. They are The New Management and Planning TQC tools (TQC2 for short). These tools use thoughts as data. They are useful for the wide variety of complex, fuzzy, and unquantifiable problems faced by today's managers and professionals.

One of many uses of TQC2 is to translate a strategy, or a vision, into prioritized actionable items. In essence, these TQC2 tools provide an effective methodology to reengineer the strategic planning process.

The purpose of this document is to discuss the powerful TQC1 tools. However, if you have a complex, fuzzy, and unquantifiable issue to resolve, Bill Sandras can provide you with more information about these TQC2 tools.
HOW TO USE THE IDEAS TO ELIMINATE WASTE® FORM

The purpose of this form is to help you document waste, suggest solutions, and monitor implementation progress. It is to help us eliminate forms of waste. Its purpose is not for complaints and grievances.

Use the Ideas to Eliminate Waste® form for problems that are simple enough that surface or intuitive analysis is sufficient. For more complex problems, use the Problem Solving Storyboard.

Dates
Each time you update the form, enter the Current Date. The Current Date reflects the latest revision date of this form.

The Start Date shows when you initially wrote and submitted this form. It does not change once entered.

The Completion Date shows the date the problem was resolved. Enter the Completion Date only when you satisfactorily resolve the problem by meeting the agreed upon goal, or mutually agree to suspend effort.

Name, Location, Telephone
Provide the necessary information for someone to contact you regarding the intent, and progress, of this initiative to eliminate waste.

Observation
The question for this section is "What waste are you observing?" Write your observation of waste in this section of the form. For example, if you observe "large batches of work accumulating at step 3," that is what you write. Or, you may observe wasteful motion, repeated trips to retrieve supplies, or a frequent need for rework. It is not necessary to say why yet. Just describe what waste you see, and where and when it exists.

If you see the waste in other areas, it is OK to document them. However, you should spend most of your time examining ways to improve your own processes, not pointing fingers at other areas. First, you are more familiar with your own processes, and second in a better position to improve them. Look inside more than outside.

Cause
Now it is time to answer the question "What is causing the waste?" If you know, say it. If you suspect a cause, identify what you say as a theory, not a fact. Perhaps all you know is that waste exists, but not why. Then simply say that.

Proposed Solution(s)
Here, outline possible ways to eliminate the cause of, or need for, the waste. Try to come up with more than one solution to choose from. There are expensive solutions, home remedies, workarounds, simple changes, major overhauls, etc. Almost always there is more than one solution to a problem.

Solution Progress
This section is for the person(s) that will actually resolve the problem. Hopefully, in most instances, the person that observes the waste will also be the one that leads the effort to correct it. You need to avoid the situation of one person or group pointing out problems for someone else to fix. We all need to be problem solvers. However, in some instances the problem requires skills we do not have, or an organization we are not part of. Then the responsibility for solution may fall to someone else.
Here itemize the steps you plan to take to prove the cause, change the process, and eliminate the waste. Later, as you see other steps that you need to take, add them to the list. The last entry should result in the completion of this Ideas to Eliminate Waste initiative.

Realize that resolution of your idea may take several forms. Hopefully, you will implement most ideas immediately. However, others may be incorporated into the next piece of equipment you purchase. Still others, while worthwhile, may be tabled due to lack of funds or resources. In the latter case, at least a thorough and satisfactory explanation of a larger problem should be explained to complete this improvement initiative. No one that comes up with an idea should be left hanging without a timely answer to his or her observation.

The next page that follows shows the Ideas to Eliminate Waste form as a single sheet. Following that is an example for a flip-chart stand and with a pad of paper. Some prefer the more visible flip-chart version in their work areas.
<table>
<thead>
<tr>
<th>Observation</th>
<th>Proposed Solution(s)</th>
<th>Solution &amp; Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe the problem, not the solution(s), here. What problem do you observe? Describe the waste you see. Explain the problem in terms of who, what, where, and/or when. If the problem is simple enough and you clearly know why or how it is happening, explain that also. Quantify the cost of the waste you see, if you can.</td>
<td>Explain recommended solutions to correct the problem or eliminate the waste. More difficult problems may result in the initiation of a Problem Solving Storyboard team effort.</td>
<td>List the corrective actions taken and planned.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Who's Resp?</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### IDEAS to ELIMINATE WASTE

**Waste:** waiting, motion, stocks, transportation, defects, process, overproduction.

*(Note: this is not a complaint form. It is to be used to record our observations about waste primarily within our own area so we can focus on process improvements to eliminate the waste.)*

<table>
<thead>
<tr>
<th>DATE</th>
<th>IDEA BY/SHIFT</th>
<th>IDEA / OBSERVATION</th>
<th>POSSIBLE SOLUTIONS / PROGRESS</th>
<th>RESP OF SHIFT</th>
<th>DUE/DONE</th>
<th>RANK OR WT.</th>
</tr>
</thead>
</table>
| mm/dd/yy | Name of person writing the idea | As you observe waste, **print** your observation here, completely explaining the situation. Avoid two or three word explanations. Print in **1” HIGH BLACK LETTERS.** | If you have a possible solution in mind, write it here in **green** letters. Try to come up with more than one possible solution.  
**Leave room to write progress information before writing second observation below.** | Name of person responsible for completing the idea | mm/dd/yy | |
| | Write second observation here. | Write solutions for second observation here. | | | | |

**Procedures for review:**
1. Quickly review the due and new ideas with team 3-5 times/wk.
2. Communicate new observation so everyone understands.
3. The person assigned to be responsible should report the status of their items on the agreed dates.

**Procedures for data analysis:**
1. Keep each pg. attached to the pad, do not destroy completed pgs.
2. Larger organizations find it useful to enter the chart’s data into a data base **each day.**
3. Using the weighting criteria, the vital few items can be separated from trivial many.
4. **Do not** debate the solutions during the meeting. Simply assign someone to be responsible for completing and reporting back.
5. Cross off finished items
6. Celebrate finished pads

4. Those assigned to complete the action item can then sort the list to select the action items assigned to them.
THE PROBLEM SOLVING STORYBOARD

Storyboards have been in use in the film industry for decades. Writers use them to develop the script and directors use them to guide the course of events during the shoot. Storyboards are also useful for developing audiovisual presentations. The resulting storyboard is then available for the presenters as a guide.

This paper describes how to use the storyboard technique for problem solving. In this application, Problem Solving Storyboards guide us through the Plan/Do/Check/Action problem solving process. The written part of the documentation chronologically lists corrective actions taken. The numerical part of the documentation graphically displays the results of the corrective actions. Interested parties can quickly review the status of the problem solving efforts any time during the process. At the end, the Storyboard contains the full story leading to resolution of the problem.

Use the Problem Solving Storyboard technique for more difficult problems. (Use the Ideas to Eliminate Waste form for problems that are simple enough that surface analysis is sufficient.) The Problem Solving Storyboard technique can help us avoid errors in the problem solving process because it acts as a guide. It can also help us avoid wrong conclusions or actions by providing feedback on the results of our countermeasures. In addition, Problem Solving Storyboards simplify progress reviews -- both for the team and the reviewers. Its flexible, yet standardized format, allows the reviewers to quickly understand the causes of the problem and the effectiveness of the countermeasures being taken to resolve the situation.

Because the Problem Solving Storyboard contains a running story of the countermeasures and results, the team’s preparation for periodic reviews is minimal. The team can spend time solving the problem rather than preparing presentations. And, since each Storyboard is a working document, each reviewer only needs to look at the latest entries on the Storyboard. When the problem is resolved, the last entries into the Storyboard should complete the documentation.

People from all areas and organizations, addressing a variety of problems, can benefit from using the Problem Solving Storyboard technique. Although people and problems vary, the basic scientific approach can be consistent. This consistency makes it easier to learn how to correctly approach problem solving and therefore enables more people to become effective problem solvers.
HOW TO USE THE PROBLEM SOLVING STORYBOARD

Title
In the box with the double lines on the cover page, write the name of the company, and the name of the team or problem being addressed.

Dates
Each time we update the Storyboard, enter the Current Date. The Current Date is the latest revision date of this Storyboard.

The Start Date shows when the team was formed to address this problem; it does not change once entered.

The Completion Date shows the date the problem was resolved, the Storyboard finished, and the team disbanded or moved on to another problem. Enter the Completion Date only when we satisfactorily resolve the problem by meeting the agreed upon goal.

Team
Identify the team leader and the individuals that are responsible for resolving this problem. Make certain that the team has people with knowledge of the problem and with the right skills to solve it.

Just because you are selected for the team, does not mean the problem is your fault. Problems do not have faults, just causes. You are on the team because your knowledge and skills can make positive a difference.

Try to keep the team size manageable. Include only people that have a current role to contribute. Avoid having people attend meetings until they can be productive. If you find that you need additional skills several months later, add those people at that time.

Problem Statement
Carefully define the problem. What is the nature of the problem? Do we have too many part shortages? Are we experiencing too many engineering changes? Are customers changing their orders too frequently and at inconvenient times? What problem will the team address?

Focus on who, what, when, and where. Be alert not to let why or how the problem is happening slip into the problem definition. That will come later. Take it one step at a time.

The problem statement should define the scope of the investigation. Will it include other departments, customers, or suppliers? What are the boundaries? Describe the box around areas you plan to investigate, and clearly exclude those you don't.

You need to be able to express the characteristics of the problem in a graph so we can monitor the improvements. Think about the desired condition. Think about where we are today. Then think about what indicator(s) will change if we move from the current to the desired state. If the cause(s) of this problem is corrected, what measurable indicator(s) will improve?

As we begin our investigation into this problem, we may decide that we need to modify the problem statement, or the scope of the investigation. We might expand our efforts, or even narrow them into phases. Feel free to modify the problem statement to clarify the problem and the approach. However, avoid modifying the statement just to look successful. Improve the process, don't fake it by distorting the system or changing the measure.

Problem definitions are not necessarily wordy -- just complete. Some are quick to define; others take more explanation. Write it using full sentences, not cryptic phrases. Also, in the statement,
and throughout this Storyboard, avoid too many acronyms. Spell it out. Remember that we will not be the only ones looking at and learning from your efforts.

**Priority**
How important is this problem, compared with others? Is this a key problem causing us to lose customers? If it is, the priority section should say that fact. No one ever believes they have enough time to solve problems methodically. However, if this problem is a key factor in causing us to lose customers, we can't afford to procrastinate in our efforts to find and implement solutions. If the priority is moderate, we may choose to begin to collect data for the history section only. We may choose not to spend the time to trace to the root cause at this time. We will just prepare for the day when we will aggressively attack this problem. If the problem has a low priority compared with others, we may decide to postpone any action at this time. A low priority does not mean this is not a valid problem. It simply means we have bigger issues to tackle with our limited resources at this time.

**History...Goal...Check**
This section of the Storyboard will contain graphs of the key performance measures, or characteristics, of the problem. Here we will graph the indicators or effects of the problem. As the countermeasures take effect, the performance measures should improve. If not, we do not yet understand the cause(s) of the problem, are not completing the correct countermeasures, or are measuring the wrong indicators.

Charts used here should show the changes over time. Graph more than one characteristic of the problem if possible. For example, we might characterize a part shortage problem by the number of shortages seen week to week. We can provide additional insight to the problem by graphing the average duration of the shortages in each week. Both charts correctly show the effect, not the cause, of the problem from different perspectives. Neither attempt to explain the cause, which will occur at the next step.

Also, on each history graph show the goal? As we carry out solutions or countermeasures, we will check the performance measure graph(s) for the desired results. We will also check to see if we have reached the goal. When we reach the goal (i.e., checkpoint), we will reassess our efforts and perhaps move on to bigger problems. Or, we may tighten up the goal and continue to focus on this problem.

It is not unusual, particularly for new problems, that little or no data about the problem is available. When we have no data to quantify the size of the problem, it is not unusual that we are unable to intelligently specify a goal. It is difficult to say where we should be if we do not even know where we are. In these instances, we must first collect data and graph it. When we know enough about the problem, then we can establish intermediate and long term goals. Don't procrastinate determining the goal. Get a checkpoint or target established as quickly as you logically can.

**Cause**
Now, we can begin thinking about what might be causing this problem. This section includes, or refers to, documents such as:
- Process flowcharts,
- Cause and effect diagrams, and
- Multi-level Pareto charts.

Cause and effect diagrams outline probable causes of the problem. From them come check sheets that will provide the data for Pareto charts. Data tracking forms change to become more focused for each level down in the Pareto tree. The Pareto charts should go down deep enough to clearly show the root cause of the problem. The root cause appears as a single bar on the lowest Pareto chart.
Considerable data can accrue in this section. It is common that this space refers to other supporting documents. However, most problems can be condensed into a thin stack. If it takes several notebooks of material to describe the problem, we probably don't really understand it. The team responsible for the solution may have considerable backup data, but the Storyboard should be concise.

**Solutions**

In the solution section, we list the action items we plan to initiate to understand and eventually resolve the problem. Continue to add entries here throughout the life of the Storyboard. A Storyboard often begins with the following entries in the solution section:

- Form a team
- Define the problem
- Flowchart the process
- Determine the causes of the problem
- Develop performance measures, and goals,
- Develop a data collection strategy.

Here list each significant step leading to the root cause, and each significant solution or countermeasure. Also list the person responsible for each task and the date it is to be completed. Again each person may act alone, or head a sub-team.

**Check**

As we are progressing toward final resolution of the problem, we need to Check our progress against the graphs and Goal in the History section. If our analysis and countermeasures are proving to be effective, then the data in the graphs should converge on the goal line.

When we meet the goal, it is then time to decide if we will conclude this problem solving effort. Or, we might decide to tighten the goal and go further into resolving other root cause chains associated with this problem. If we continue with the team, make a note in the solution section or on the History graph saying that the original goal has been met, that a new goal has been established, and that work will continue.

Once the early problem stages are complete, we will repeatedly cycle through the History/Goal/Check and Solution sections, occasionally going back to the Cause section to identify lower level causes of the problem.

**Potential Problems**

Here list likely potential obstacles to success. The potential problems might be constraints that prevent us from carrying out countermeasures, such as time, money, or organization. Potential problems may also be secondary consequences of our countermeasures on someone else.

List each significant potential problem. Next to each, assign a person, or head of a team, to make certain the potential problem does not inhibit our progress. If a due date is appropriate, list it. When we are confident that the potential problem is no longer a concern, put the date in the due date column.

**Standardize**

When we reach the goal, then examine how to standardize what we have learned. How can we apply what we have learned to other areas that might have the same problem or similar problems? We have worked hard to define the problem, isolate the root causes, and implement effective solutions. Spare others the need to repeat our efforts. Help them learn and copy from us. This is where we can significantly leverage our efforts and results into other areas.

**Residual**

When we have met the goal, or the revised goal, there is no longer any need for the team to continue to pursue this problem. Apply your skills with another problem solving team addressing
bigger issues. However, before we disband, document any remaining causes of this problem, and any other related problems that we did not resolve.

While we have removed this problem from the top of the Pareto Chart, that does not mean that it will never be important to work on it again. Hopefully, the problem will not become a high priority in the future because it got worse (and it won't if we correct the root causes and keep them corrected). However, it might become a high priority in the future because other higher level problems were also corrected. By continuing to solve problems, eventually what was once a low item on the Pareto Chart, will move up to become one of the largest remaining problems. Thorough wrap-up documentation will allow the new team to begin where we left off more easily.

**Getting Started**

Problem Solving Storyboards are useful for many problems. It is best to learn the power of this technique by starting with well-defined problems that are easily quantified. This does not mean the early problems need to be trivial problems, just more concrete and less “fuzzy.” Good examples are inventory record accuracy, accounts receivable days, product or paperwork defects, and survey results. As you become more proficient in the use of Problem Solving Storyboards, you might decide to put departmental objectives in this format. It will help you to monitor progress throughout the year.
PROBLEM SOLVING STORYBOARD

for

(COMPANY NAME, TEAM, OR PROBLEM)

(This cover sheet identifies the Storyboard subject)
Problem Statement (Explain the problem in terms of who, what, where, and/or when, but not the why, how or cause. Explain the gap between current and desired situation. State the scope and limits of the investigation. Make certain you can measure the characteristics of the problem you describe.)

The problem statement should:
1. be understandable by those unfamiliar with the problem,
2. focus on who, what, where, and when, but not why this is happening,
3. make a statement about the gap between the current and desired situation (avoid focusing on the cause, that will come later; avoid being negative or posing questions, simply state the situation using white hat thinking),
4. state the scope, limits, or boundaries of the investigation, and
5. Be measurable (make certain you can measure and graph the changes that will occur).

Team (Who is responsible for solving this problem)
Team leader:
Team members:

Priority (Why should resources be allocated to this problem?)

Problem Solving Storyboards© are usually used on more difficult problems. Difficult problems take time. Why should you spend time on this problem rather than others?
History ... Goal ... Check (Graph historical data for the key performance measures. Indicate intermediate and long term goals on the graph. Graph progress towards the goals) Note: if the Problem Solving Storyboard is on Microsoft Word, graphs can be copied from Excel and pasted here.

Here you will show the progress you are making from the current state to the desired state (the goal). Your problem should be measurable and quantifiable. Therefore, you should be able to graph your progress over time. Make a graph(s) that characterize your problem. Is there more than one way to characterize the problem (e.g., number, duration, and deviation)? Hand drawn graphs are just as good as computer created ones. The main considerations are that they be reasonably accurate and legible.

This example shows only two graphs, but more can be included here as long as they measure the problem from different perspectives, and at the problem statement level. Usually it is best to include lower level graphs of the causes of the problem in the next section, not here.
### Cause
(Isolate the root cause(s) of each contributor to the problem. Ask why four or more times. Numerous techniques apply: process flowchart, cause and effect, check sheets, Pareto chart, etc.)

- Process Flowchart can be found in Appendix ______
- Cause & Effect Diagram can be found in Appendix ______
- Check sheets and Multi-level Pareto Charts can be found in Appendix ______

Here show results of your analysis seeking the root cause (or refer to the page number on which the analysis is shown):
- process flowcharts,
- cause and effect diagrams,
- multi-level Pareto charts, etc.

### Solutions
(This is a working document. List the corrective actions taken and planned.)

**Corrective Action Items**

<table>
<thead>
<tr>
<th>Corrective Action Items</th>
<th>Who's Resp?</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form a team to address the identified problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ensure adequate levels of TQC1 education on team</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete Problem Statement, History/Goal/Check/ Priority</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete Process Flowchart, Cause &amp; Effect Diagram</td>
<td></td>
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</tr>
<tr>
<td>Develop data collection strategy and procedures</td>
<td></td>
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Here keep a chronological log of all significant activities that have occurred and are planned to occur. Show who is responsible for each item and when the action item is due or was completed.

**Check results of solutions in History/Goal/Check section.**

**Check (see History/Goal/Check)** (Check the effectiveness of the solutions. Update the graphs in the History/Goal/Check section. Have the goals been met? If not, circle through the Cause and Solution sections again.)
### Potential Problems

**Identify major likely obstacles to success, i.e., show-stoppers**

<table>
<thead>
<tr>
<th>Potential Problems</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Here show significant potential problems to success of this problem solving effort. Assign someone to each potential problem to ensure that it does not become a reality.</td>
<td></td>
<td></td>
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</tbody>
</table>

### Standardize

*Where else might this problem exist? Where else might this solution apply?*

When you have corrected a root cause, ask where else might this problem exist? See if your solution applies there also.

### Residual

*When you finish with this problem, and the team disbands, itemize any known problems that you did not resolve so that they are not lost.*

Here itemize related problems, and causes related to this problem, did you not resolve prior to stopping work on this Storyboard. Even though you may have reduced the relative importance of this problem, that does not mean you will not have to readdress the remaining causes in the future. Adequate documentation in this section will allow you to start again quickly.
Problem Statement (Explain the problem in terms of who, what, where, and/or when, but not the why, how or cause. Explain the gap between current and desired situation. State the scope and limits of the investigation. Make certain you can measure the characteristics of the problem you describe.)

Team (Who is responsible for solving this problem)
Team leader:
Team members:

Priority (Why should resources be allocated to this problem Why should you make time for this problem?)
History ... Goal ... Check  
(Graph historical data for the key performance measures.  Indicate intermediate and long term goals on the graph.  Graph progress towards the goals.  Note: If you are using the Problem Solving Storyboard is on software, copy and paste the appropriate graphs here.)
Cause (Isolate the root cause(s) of each contributor to the problem. Ask why four or more times. Numerous techniques apply: process flowchart, cause and effect, check sheets, Pareto chart, etc.)
Process Flowchart can be found in Appendix ______
Cause & Effect Diagram can be found in Appendix ______
Check sheets and Multi-level Pareto Charts can be found in Appendix ______
## Solutions
(This is a working document. List the corrective actions taken and planned.)

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<td></td>
<td></td>
</tr>
<tr>
<td>Complete Problem Statement, Team, Priority, History/Goal/Check, and Potential Problem sections</td>
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<td></td>
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<td>Develop data collection strategy and procedures</td>
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### Check (see History/Goal/Check section)
(Delete the effectiveness of the solutions. Update the graphs in the History/Goal/Check section. Have the goals been met? If not, circle through the Cause and Solution sections again.)
### Potential Problems

*Identify major likely obstacles to success*

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### Standardize

*Where else might this problem exist? Where else might this solution apply?*

### Residual

*When you finish with this problem, and the team disbands, itemize any known problems that you did resolve so that they are not lost.*
The mission of Productivity Centers International (PCI) is to help organizations (1) reengineer their manufacturing, service, and support processes, (2) incorporate processes for continuous improvement and problem solving, and (3) develop their people to become self-sufficient in PCI's methodologies.

PCI achieves its mission by providing education, facilitation, implementation, and project management support to:

- Implement the full concepts of Just-in-Time using broad projects to link multiple operations and focused Kaizen events to improve specific areas (also known as Lean),
- Reduce defects and variation using the quantitative Total Quality Control tools (TQC1) and Problem Solving Storyboards (also known as TQM or Six Sigma),
- Discover solutions to non-quantifiable management problems using the new thought-based Management and Planning tools (TQC2), and
- Develop project plans to manage complex changes.

Bill Sandras founded PCI in 1985, and has provided his expertise and services to manufacturing, engineering, distribution, health care and other service companies throughout the world.

William A. Sandras, Jr.

Bill began his career with Continental Oil Co. as a computer systems/programmer analyst. He then worked for Hewlett-Packard (HP) for 16 years in various management positions. While at HP, Bill worked at two mature divisions and helped to start three new divisions. These divisions manufactured high-volume/low-variety products, and complex low-volume/high variety products.

As a manager, Bill led HP's first successful Manufacturing Resource Planning (MRPII) and JIT/TQC implementations. Later he championed three more MRPII and two more JIT/TQC implementations. He and his team were the first to link JIT and MRPII together, and pioneered Team-Based Organizations and efforts leading to Activity Based Costing. He also led product design, and then product marketing and support efforts for an MRPII software package.

At HP, Bill managed production, manufacturing engineering, purchasing, planning, order entry, warehousing, shipping, transportation, software development, product marketing, product support, and information systems. Bill also introduced and managed the JIT/TQC worldwide education and consulting services for the Oliver Wight Consulting Companies for four years.

Bill holds a Bachelor of Science degree with dual majors in production management and statistics, and a Master of Business Administration degree in management science from the University of Colorado. He passed the American Production and Inventory Control Society's certification exams at the highest level and was on their JIT certification test committee.

He wrote the popular "how-to" text book titled Just-in-Time: Making it Happen, booklets titled About Face to JIT (100 Changes), Competition Killers (Competitive Technologies for 2000), and TQC2: The New Management and Planning Tools, plus many articles including "High Velocity Manufacturing" selected for the Best of Chief Executive Magazine. He is on the Association for Manufacturing Excellence editorial board for their Target magazine.

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