



*Instructor Guide*

# Problem Solving

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# Unit Description

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## Overview

This module is divided into two major sections: Problem Solving Process and Problem Solving Tools. The first section introduces a six-step problem solving process and the second section provides tools that can be used during the problem solving process.

### Problem Solving Process

Problem solving refers to the ability to use critical thinking to assess situations and to act decisively to resolve problems when they arise. This section presents a six-step problem solving process which includes identifying problems, applying a systematic approach to solving the problem, and following up to ensure that the problem was resolved.

### Problem Solving Tools

This section focuses on the tools that can be used within the problem solving process to contribute to the success and continued excellence of an organization.

While these skills are not required for day to day activities, they are needed to solve specific problems when participating in ad hoc functional and cross functional teams.



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## Objectives

The information, activities, and practice provided during this module will enable participants to:

1. Justify a structured approach to solving problems.
2. Use a systematic six-step process for solving problems.
3. Assess the circumstances of a problem.
4. Analyze alternative solutions to a problem.
5. Plan how the solution will be implemented or executed.
6. Evaluate the effectiveness of an implemented solution.
7. Reassess a decision and take corrective action as necessary.
8. Handle difficult situations more efficiently and effectively.
9. Use basic tools to aid in the problem-solving process.

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## Materials

1. Participant Guides
2. Name tents and markers
3. Projection system for slides
4. Flip chart stand, flip chart paper, markers and tape
5. Pencils and pens
6. Several packs of Post-it Notes
7. One copy of the Problem Solving Assessment per student



## **PowerPoint Slides**

1. Problem Solving
2. Objectives
3. Definition of a Problem
4. Six Steps to Problem Solving
5. Step One: Define
6. Step Two: Investigate
7. Step Three: Produce Solutions
8. Step Four: Select the Best
9. Step Five: Try It
10. Step Six: Evaluate
11. Principles of Excellence
12. Eight Problem Solving Tools
13. Goals for Brainstorming
14. Rules for Brainstorming
15. Flow Chart Symbols
16. Sample Flow Chart
17. Flow Chart Symbols
18. Sample Product Chart
19. Custom Milling Tally Sheet
20. Optical Framus Milling Tally Sheet
21. Optical Framus Milling Pareto Chart
22. Steps to Preparing a Pareto Chart



- 23. Daily Rejects Run Chart
- 24. Steps in Preparing a Run Chart
- 25. Custom Milling Cause and Effect Diagram
- 26. Steps in Preparing a Cause and Effect Diagram
- 27. Steps in Preparing a Force Field Analysis
- 28. Custom Milling Force Field Analysis

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## **Agenda**

Introduction.....	10 minutes
Six Steps to Problem Solving .....	110 minutes
Problem Solving Tools .....	300 minutes
Summary .....	20 minutes
Assessment .....	40 minutes
<b>Total .....</b>	<b>8 hours</b>



# Introduction



**DISPLAY** the slide titled “Problem Solving.”



**DIRECT** participants to the “Introduction” in their Participant Guide.

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## Overview

### Six Steps to Problem Solving

**EXPLAIN** that in this section, you will learn how to follow a structured six-step process using the “Problem Solving Model” that will enable you to identify and solve problems.

**STATE** the problem solving steps are:

- Step One: Define
- Step Two: Investigate
- Step Three: Produce Solutions
- Step Four: Select the Best
- Step Five: Try It
- Step Six: Evaluate

### Problem Solving Tools

**STATE** that this section introduces tools used within this process to contribute to the success and continued excellence of an organization.

**EXPLAIN** that the participants will work in large and small groups to use each tool. Each group will then discuss their experiences and identify appropriate times for using the tools in the manufacturing environment.





**STATE** that while these skills are not used during day-to-day activities, they are needed to solve specific problems when participating in ad hoc functional and cross-functional teams.

Examples:

TQM – Total Quality Management Teams

CIT – Continuous Improvement Teams

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## Objectives



**DISPLAY** the slide titled “Objectives” and review the objectives.

The information, activities, and practice provided during this module will enable participants to:

1. Justify a structured approach to solving problems.
2. Use a systematic six-step process for solving problems.
3. Assess the circumstances of a problem.
4. Analyze alternative solutions to a problem.
5. Plan how the solution will be implemented or executed.
6. Evaluate the effectiveness of an implemented solution.
7. Reassess a decision and take corrective action as necessary.
8. Handle difficult situations more efficiently and effectively.
9. Use basic tools to aid in the problem-solving process.



# Six Steps to Problem Solving



**DIRECT** participants to the “Six Steps to Problem Solving Process” in their Participant Guide.



**DISPLAY** the slide titled “Definition of a Problem.”

**READ** the definition.

*“A problem exists when a product does not meet specifications or when production does not meet demand.”*

**STATE** that problem solving refers to the ability to use critical thinking to assess situations and to act decisively to resolve problems when they arise.

**EXPLAIN** that World Class Manufacturing requires workers to have the freedom to stop and correct a process when it is producing a bad product. In this system, management provides employees with the authority and the tools required to solve problems or to improve the system of production. This is known as employee involvement.

**STATE** that all institutions exist to provide a product or service. Products or services are designed to perform specific functions. When products are produced in accordance with design specifications, the product will perform as required. A quality product is one that is within specifications. When products do not measure up to specifications, a problem exists that must be rectified. A company’s success, in fact its very survival, depends on ensuring that problems are solved so that quality products are produced.

**EXPLAIN** that human beings are natural problem solvers. Over the decades, some of the greatest inventions were created as a result of finding a solution to a problem. During the problem solving process, we analyze, we ask questions, we gather facts, and we follow up to see what worked and what did not.



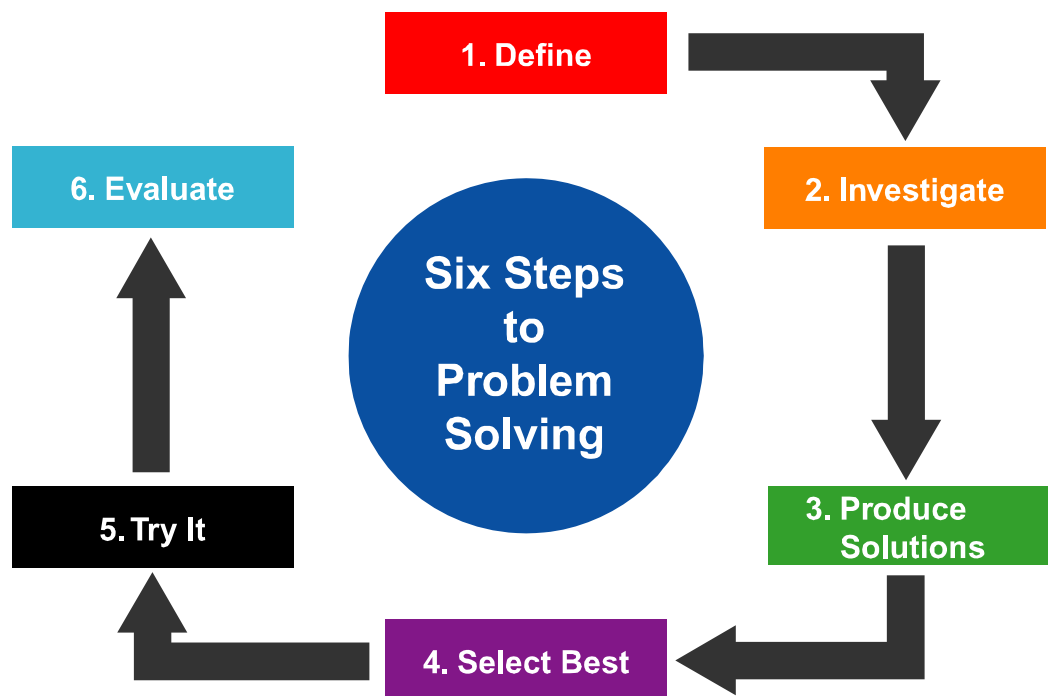
**STATE** that this section presents a six-step problem solving process that includes identifying problems, applying a systematic approach to solving the problem, and following up to ensure that the problem was resolved.

**EXPLAIN** that in this section, they will learn how to follow a structured six-step process using the “Problem Solving Model” that will enable them to identify and solve problems.

### Problem Solving Model



**DISPLAY** the slide titled “Problem Solving Model.”



*Problem Solving Model*

**REVIEW** the steps of the “Problem Solving Model” with the participants.



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## Step One: Define



**DISPLAY** the slide titled “Step One: Define.”

**EXPLAIN** that defining the problem is not always as easy as it sounds. A common tendency is to race off toward possible solutions without taking time to give careful consideration of the problem itself.

- List Possible Problem Areas
- Collect Data
- Select an Area to Work On
- Focus on the Facts
- Simplify the Problem

### List Possible Problem Areas

**STATE** that it is often helpful to use a variety of tools and techniques to identify possible problem areas. Some of these tools and techniques will also be helpful when collecting data. These tools include brainstorming, check sheets, flow charts, and interviewing.

### Collect Data

**EXPLAIN** that collecting data will help to identify key problem areas as well as possible root causes. Asking questions is often a good way to better understand a problem. Detail and background information are important to achieving a solution. Always verify information by checking several sources.



**ASK:** “If you attempt to solve a problem while still gathering information, what can happen?”

***Anticipated response:***

*Attempting to solve a problem while still gathering information may lead to faulty conclusions.*

### **Select an Area to Work On**

**EXPLAIN** that problems should be prioritized and solved based on their relative importance to the business. They should also be selected based on their probability of success.

### **Focus on the Facts**

**STATE** that once you decide which information is relevant and which is irrelevant, you may then define the problem.

### **Simplify the Problem**

**EXPLAIN** that once you have gathered all the information and looked at it from all points of view, you should now simplify the problem and represent it clearly and concretely. For example, sketch a drawing of the problem, describe the problem in words, create a diagram to show the chain of events. Describe the desired state in measurable terms.



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## Step Two: Investigate



**DISPLAY** the slide titled “Step Two: Investigate.”

**STATE** that once you understand the problem and all the factors involved, the real work begins.

- Break Down the Problem
- Find the Root Cause

### Break Down the Problem

**EXPLAIN** that many problems are actually a collection of smaller problems. It can be helpful to break down a problem into several smaller problems and deal with them separately. For example, it might be necessary to find out exactly what steps are involved in a particular process to isolate the problem. Look for any smaller problems that may be contributing to the overall problem.

### Find the Root Cause

**STATE** that the “root cause” is the single and original cause of the problem. You may have to dig deep to find the underlying or “root” cause of the problem. One of the easiest traps to fall into is assuming that you know what is causing the problem without taking time to investigate further. If only the “symptom” of the problem is fixed, the same problem will recur.



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## Step Three: Produce Solutions



**DISPLAY** the slide titled “Step Three: Produce Solutions.”

**STATE** that in most situations, there are several different approaches to solving a problem.

- Generate Possible Solutions
- Clarify Solutions
- Develop Options

### Generate Possible Solutions

**EXPLAIN** that it is important to identify as many ways as possible to solve a problem. Be willing to accept novel or unusual options and ideas.

### Clarify Solutions

**EXPLAIN** that it is always important to clearly understand the potential solutions and their implications.

### Develop Options

**EXPLAIN** that it is important to consider options beyond the obvious to resolve a problem. Be well prepared and willing to look at an ordinary situation from a new perspective.



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## Step Four: Select the Best



**DISPLAY** the slide titled “Step Four: Select the Best.”

**STATE** that it is important to identify the best possible solutions.

- Identify Possible Alternatives
- Select a Solution
- Plan Solution Implementation

### Identify Possible Alternatives

**EXPLAIN** that criteria may be developed for evaluating possible solutions. Forces that can either help or hinder implementation must be identified. After reviewing all the possible alternatives and identifying the pros and cons of each, you must make a decision based on what you know.

### Select a Solution

**STATE** that after having uncovered the root cause of the problem and generating some possible solutions, you are now ready to act.

### Plan Solution Implementation

**EXPLAIN** that the solutions should be divided into sequential, easy to manage steps. A control system and contingency plan should be defined. When other individuals are involved, each must know what he or she must do and be committed to carry out his or her share. Planning tools such as Gantt Charts, Pert Charts, or Flow Charts may be used.





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## Step Five: Try It

### Execute the Plan



**DISPLAY** the slide titled “Step Five: Try It.”

**STATE** that it is now time to put the plan into action. Monitor the implementation of a solution and utilize contingency plans as required.

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## Step Six: Evaluate



**DISPLAY** the slide titled “Step Six: Evaluate.”

- Collect Data
- If the Problem is not Resolved, Return to Step 1
- Review What Happened

### Collect Data

**EXPLAIN** that data collection is important in order to learn how effectively the solution solved the identified problem. Data may be compared with data collected to analyze the problem in Step 1. In this way, the solution may be compared with the desired state, defined in Step 1. If new problems arise as the solution is implemented, they will need to be addressed.

### If the Problem is not Resolved, Return to Step 1

**STATE** that if the problem has not been resolved, you must start the process over again. Find out if the solution is working or if an alternative solution should be tried. It might be necessary to refer the problem to a manager or a different department.



## **Review What Happened**

**EXPLAIN** that it is important to take some time to reflect on what the problem can potentially teach you and how the entire organization can benefit. Determine what worked well and what could be improved. Other departments or people may need to be notified of the problem.

**STATE** that future problems can be prevented by using the experience and the information attained to make necessary changes to improve products, services, or procedures. Once the problem is resolved, close the loop on the problem solving process.



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## Activity: Ranking the Steps



**DIRECT** participants to “Activity: Ranking the Steps” in their Participant Guide.

**EXPLAIN** that they will now apply the “Six Steps to Problem Solving” using a manufacturing example. Allow participants to work in groups of two or three. Give them enough time to complete the exercise then discuss the answers with the class.

**EMPHASIZE** to the participants both before and after completing the activity that getting a “good” score is not the most important part of this exercise. Remind them that the purpose of this unit is to introduce a problem solving process that can be used in a variety of situations. They should be ready to discuss their rationale for choosing a particular sequence.

### The Situation

You are the manager of a unit of a small paint production facility that supplies paint for light industrial use. You have been contacted by a local distributor of the product concerning a color separation problem. During the last six months, there has been sporadic incidence of color separation after the paint has been applied to metal surfaces.

This paint product has consistently met production specification standards before leaving the plant. In the field, the problem has been corrected by using additive prior to reapplication. Although this solution has been successful, the continued incidence of the problem has resulted in increased costs and loss of confidence in the product itself.



## **The Assignment**

Review the following list of activities that can lead to the successful resolution of this problem. The activities are listed in random order.

Your task is to sequence these activities in the order that you would follow in identifying the problem, resolving the problem, and learning from the experience.

## **Activities**

**Steps 1 and 2** of the Problem Solving Model include defining and investigating the problem:

### ***Step 1: Define***

1. List Possible Problem Areas
2. Collect Data
3. Select an Area to work On
4. Focus on the Facts
5. Simplify the Problem

### ***Step 2: Investigate***

6. Break Down the Problem
7. Find the Root Cause



Number the following activities in the order in which they would occur.

3. A. Test results at the plant showed that the product meets specifications, therefore the investigation will concentrate on post-production.
4. B. The problem is that sporadic color separation occurs during post-production handling.
7. C. Since the problem occurs with new as well as older (though not outdated) product, and since contamination has not been found in post-application testing, it appears that storage is affecting the incidence of color separation.
1. D. Possible problem areas may include product formula, contamination, age of product, or storage.
5. E. A flow chart which shows the movement of product through post-production was created. The goal will be to completely eliminate the incidence of color separation.
2. F. Interviews were held with distributors and end-users who have experienced the problem, and product tests were conducted during and after production in order to gather information about the problem.
6. G. Each of the elements of post-production was broken down into the following areas: storage, contamination, and age of product.



**Steps 3 and 4** of the Problem Solving Model developing and refining possible solutions:

***Step 3: Produce Solutions***

8. Generate Possible Solutions
9. Clarify Solutions.
10. Develop Options

***Step 4: Select The Best***

11. Identify Possible Solutions
12. Select a Solution
13. Plan Solution Implementation

Number the following activities in the order in which they would occur.

10. H. Additional options may need to be developed based on the needs of individual distributors or end-users.
8. I. Possible solutions include using a different storage container or storing the product in a climate controlled location.
12. J. Climate controlled storage will be implemented.
9. K. Although potential storage locations may already exist, a container change may cause unknown product interactions.
11. L. After considering a list of pros and cons of the two best possible solutions, a decision will be made to address the long term solution of the problem.
13. M. Possible storage areas will be identified. Input from distributors, end-users, and plant personnel will be solicited. Once approved areas are identified, the product will be moved to those locations.



Steps 5 and 6 of the Problem Solving Model include implementing and evaluating the solution:

***Step 5: Try It***

14. Execute the Plan

***Step 6: Evaluate***

15. Collect Data
16. If the Problem is not Resolved, Return to Step 1
17. Review What Happened

Number the following activities in the order in which they would occur.

17. N. Future product development will include storage recommendations.
14. O. Controlled storage areas will be utilized.
16. P. It is expected that no further problems will be recorded.
15. Q. Once controlled storage is implemented, incidence of the color separation problem will be recorded and compared to the number of previous incidences.



# Problem Solving Tools



**DIRECT** participants to the section titled “Problem Solving Tools” in their Participant Guide.

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## Principles of Excellence

**EXPLAIN** that the success of companies that are industry leaders or labeled “excellent” is usually attributed to hard work, high quality products, and a firm focus on several sound management philosophies and principles.



**DISPLAY** the slide titled “Principles of Excellence” and discuss the following:

- Focus on customer needs and expectations.
- Recognize shared responsibility for quality and the success of the company.
- Prevent errors.
- Emphasize shared involvement to continuously improve the quality of services.
- Efficiency of processes.

**EXPLAIN** that these tools help us collect, organize and interpret data or facts.



**DISPLAY** the slide titled “Eight Problem Solving Tools.”

**STATE** that there are eight problem-solving tools that include:

1. **Brainstorming** to generate a list of ideas.
2. **Flow Charting** to illustrate a process.
3. **Tally Sheets** to capture data.
4. **Pareto Charts** to show the number of items fitting into any one category.
5. **Run Charts** to graph data plotted over time.





6. **Cause and Effect Diagrams** to organize potential causes of a problem.
7. **Force Field Analyses** to analyze the driving and restraining forces that surround a proposed change.
8. **Action Plans** to identify what needs to be done, who is responsible for what and when.

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## Brainstorming



**DIRECT** participants to the section titled “Brainstorming” in their Participant Guide.

**ASK** if anyone has been involved in a brainstorming session before. If so, facilitate a brief discussion on their experiences.

### Goals for Brainstorming



**DISPLAY** the slide titled “Goals for Brainstorming” and review the following:

- Generate a wide variety and extensive number of ideas.
- Ensure everyone becomes involved.
- Ensure nothing is overlooked.
- Create an atmosphere of creativity and openness.

**EXPLAIN** that brainstorming is used to generate a list of ideas.

### Brainstorming Methods

**STATE** that there are two methods of brainstorming:

- Round Robin Style
- Free-Wheeling



### ***Round Robin Style***

Everyone takes a turn offering an idea.

Record each idea on a flip chart.

Anyone can “pass” on a turn.

Continue until there are no more ideas.

### ***Free-Wheeling***

Share ideas all at once.

List all ideas as they are “shouted-out.”

## **Rules for Brainstorming**



**DISPLAY** the slide titled “Rules for Brainstorming” and review the following:

1. No criticism

Criticizing, or even commenting on ideas, is not allowed. There should be no evaluation or criticism of ideas during the process. Criticism will only inhibit team members from sharing their ideas. There will be a time later to review the ideas for feasibility.

2. Equal opportunity

Each person has equal opportunity to express ideas. It is important that no one dominates the offering of ideas. This can be accomplished using a structured process where everyone is given a “turn” to offer ideas in an orderly manner.

3. Emphasize quantity

The quantity of ideas is more important than quality of ideas. The goal at this time is to generate as many ideas as possible.

4. Piggybacking encouraged

Ideas breed other ideas. There is no ownership of ideas in a brainstorming session. Once an idea has been offered, it “belongs” to the team.



## **Steps in Running a Brainstorming Session**

**REFER** participants to the “Steps in Running a Brainstorming Session” in their Participant Guide.

**REVIEW** the following steps:

1. Select someone to act as group facilitator.
2. Establish a time limit.
3. Identify recorders.
4. Determine method of brainstorming.
5. Write the problem statement at the top of a flip chart page.
6. Generate ideas.
7. Record all ideas.
8. Pause to review list.
9. Add to list.
10. Stop brainstorming when everyone has had a chance to participate and no more ideas are being offered.

**EXPLAIN** that at the end of a brainstorming session, you should:

- Clarify ideas from the brainstorming session.
- Combine like ideas (with permission of the group)
- Eliminate exact duplicates.
- Label ideas.
- Prioritize ideas.
- Develop an action plan for top-priority items.



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## Activity: Brainstorming

### Large Group



**DIRECT** participants to “Activity: Brainstorming” in their Participant Guide.

**INSTRUCT** participants to work together as a group to brainstorm ideas for causes of a high reject rate from the milling operation. (*An example of possible outcome is provided at the end of these instructions.*)



**ASK** for a volunteer facilitator to write the ideas on a flip chart.

**EXPLAIN** that throughout the unit you will be asking for participants help facilitate each exercise because the ability to stand in front of a group and present information is a critical skill in the workplace, especially in environments that encourage teamwork and team problem-solving.

**INFORM** participants that the Round Robin Style of brainstorming will be used in this activity.

**FACILITATE** the brainstorming exercise using the following directions:



1. **Write** the problem statement at the top of a flip chart page.
2. **Circulate** the room, asking participants to take turns offering ideas on the topic. Participants may “pass” on a turn but everyone is encouraged to participate.
3. **Ask** the facilitator to write each comment on the flip chart.
4. **Remind** participants that all ideas are valid and that no one is allowed to be critical.
5. **Use** a “popcorn popping” analogy to end the brainstorming session - eventually the ideas die down and the brainstorming is considered complete.
6. **Review** the list aloud.
7. **Combine** similar ideas (with group permission)
8. **Eliminate** exact duplicates
9. **Hang** the flip chart on the wall. It will be used as input to other tools



The flip chart should contain the following:

**Problem statement:  
Reject rate on machined parts  
is excessive.**

*Anticipated responses:*

<i>Machines are old</i>	<i>Poor morale</i>
<i>Machines are out of adjustment</i>	<i>Quota is too high</i>
<i>Too few operators</i>	<i>Mistakes are going to happen</i>
<i>Too many operators</i>	<i>Untrained operators</i>
<i>Defective materials</i>	<i>Slow operator in middle of line requires others to have to work faster</i>
<i>Parts are mis-cut</i>	<i>Too much talking during work</i>
<i>Pattern is wrong</i>	<i>Too many hours without a break</i>
<i>Operators don't care</i>	<i>Sweatshop conditions</i>
<i>Have to work too fast to make quota</i>	<i>Too noisy, can't concentrate on work</i>
<i>Long breaks cause "catch up"</i>	

**EXPLAIN** that the next step is to refine the ideas on the list that the entire team feels are worthwhile.

**SUGGEST** multi-voting as a method for refining this list. Explain that multi-voting is a process whereby everyone votes on the ideas they like best, either through secret ballot or by show of hands. The goal is to get the list down to a manageable size. Once the list of ideas is manageable, a process improvement team is assigned a topic.



**REMIND** participants that at the end of a brainstorming session, they should:

- Clarify ideas from the brainstorming session.
- Combine like ideas.
- Eliminate exact duplicates.
- Label ideas.
- Prioritize ideas.
- Develop an action plan for top-priority items.



## Small Group



**INSTRUCT** the participants to work together in small groups (3-4 per group) and brainstorm the reason for poorly baked bread.

### **Situation:**

Customers of the Daily Bread Company have noticed a change in the taste and quality of bread purchased from that company. Lately, the bread has not been as soft and seems to lack some of its normal good flavor.



**ASK** each group to select a recorder and spokesperson.

**INSTRUCT** them to brainstorm the reasons why the bread is not of the normal quality. Have each group print their findings on a flip chart.

**ASK** a spokesperson to report findings for each group and discuss.

## Flow Charting



**DIRECT** participants to the section titled “Flow Charting” in their Participant Guide.

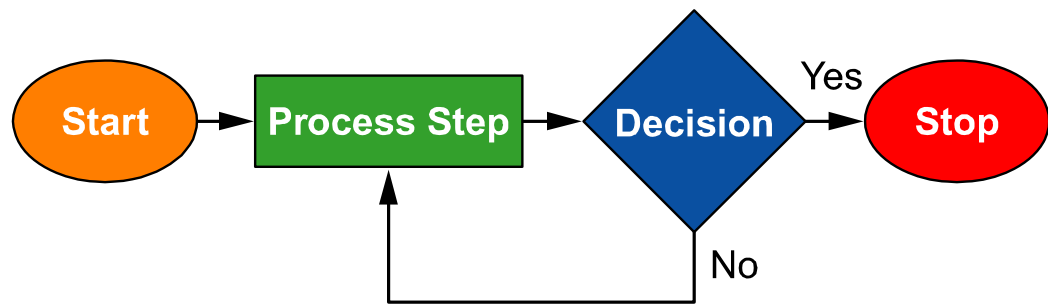
**ASK** if anyone has used a flow chart. Facilitate a discussion of those who have.

**EXPLAIN** that flow charts are pictorial representations of the major steps and decisions in a process.

**EXPLAIN** that because pictures are powerful communication tools, flow charts can be useful in describing and documenting relationships among various steps in a process.



**DISPLAY** the slide titled “Flow Chart Symbols.”



*Flow Chart Symbols*

**REVIEW** the flow chart symbols and stress the following points:

- Ovals show Starts and Stops.
- Rectangles are Process Steps.
- Diamonds are Decision Points which always require Yes/No answers.



## Steps in Preparing a Flow Chart



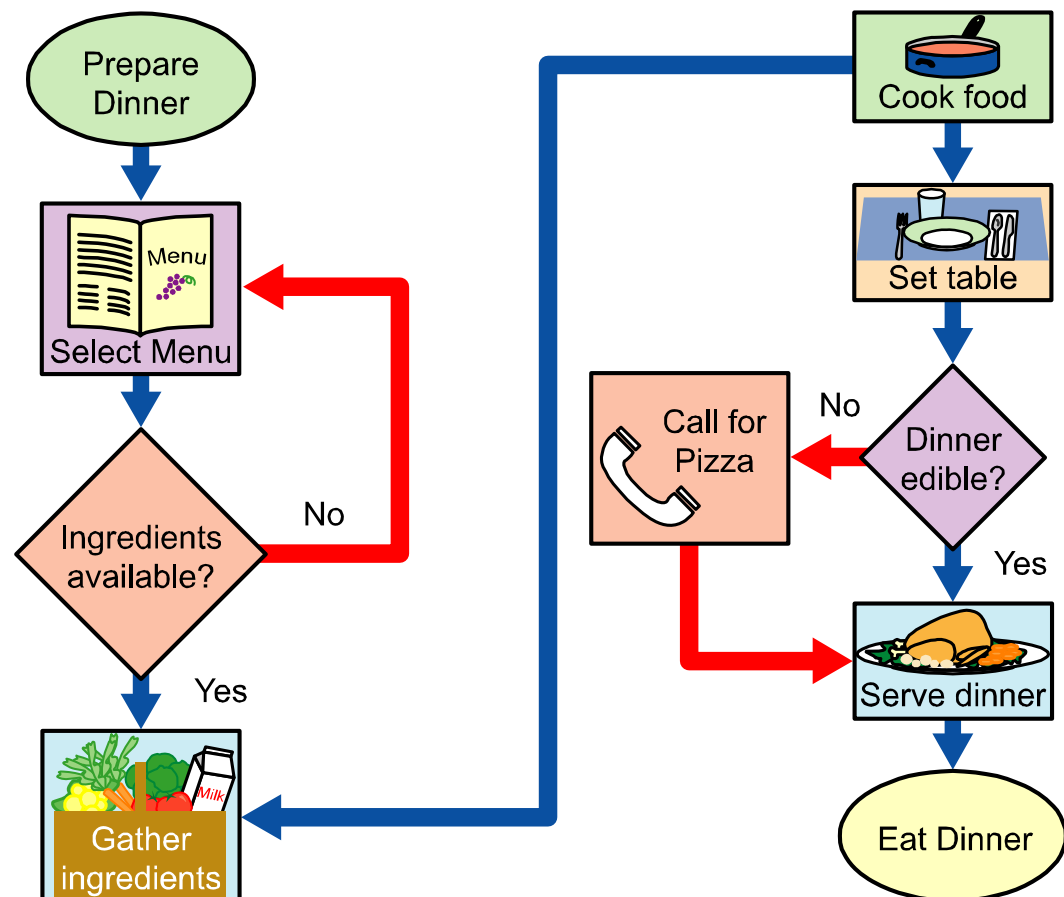
**DIRECT** participants to the section titled “Steps in Preparing a Flow Chart” in their Participant Guide.

**REVIEW** the following steps:

1. Define the process boundaries to be charted, e.g. what will and will not be discussed.
2. List major steps in the process.
3. Arrange the steps in sequence.
4. Draw the flow chart.
5. Study the flow chart.



**DISPLAY** slide titled “Sample Flow Chart” and review the process.



Sample Flow Chart

## Activity: Flow Charting

**Note to Instructor:** Depending on available time, the instructor may select either or both flow charting activities available.

### Large Group Flow Chart



**DIRECT** participants to “Activity: Flow Charting” in their Participant Guide.

**INSTRUCT** participants to work together as a group to create a flow chart that starts with receiving raw materials and ends with a manufactured product ready for shipping to the customer.

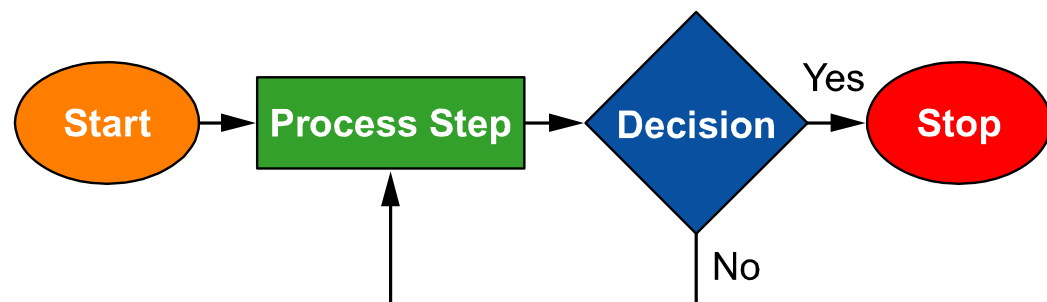
**NOTE:** Suggest keeping this flow chart at a high level.

**ASK** for a volunteer facilitator to draw the flow chart on the flip chart.

**IMPLEMENT** the activity by following these directions:



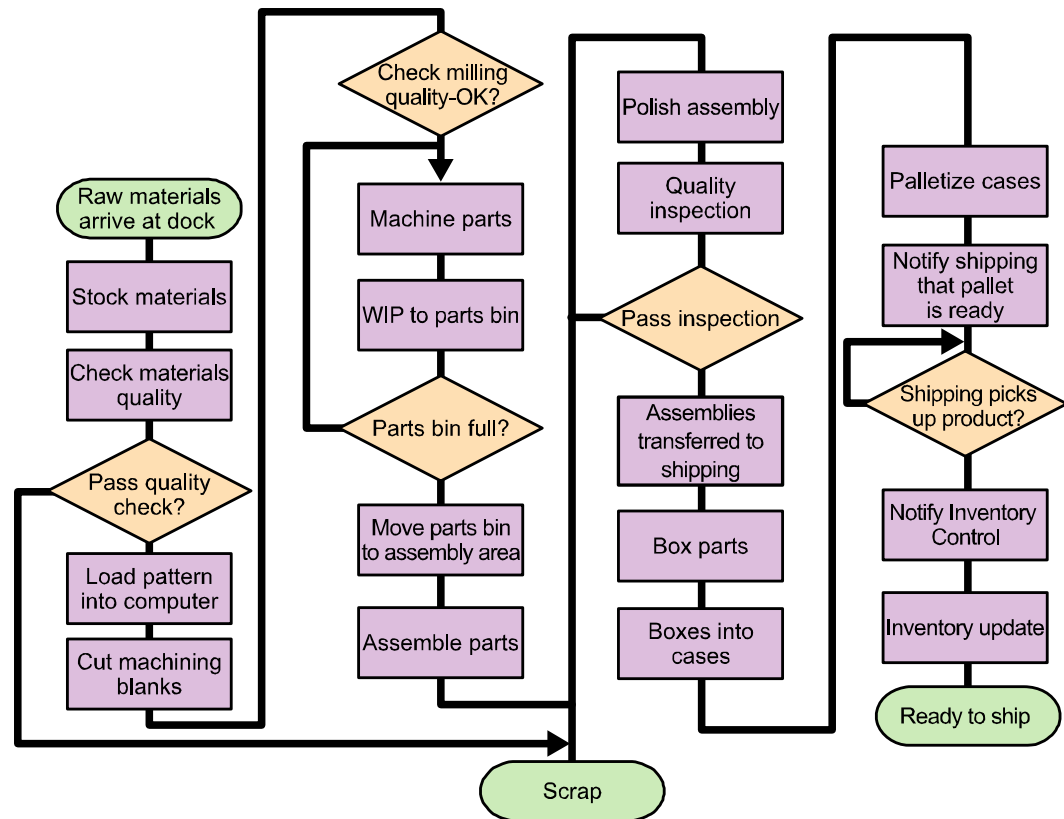
1. **Display** the slide “Flow Chart Symbols” and leave the slide displayed.



2. **Ask** participants to suggest steps in the process.
3. **Ask** participants to identify the symbol in which the step should be enclosed.
4. **Instruct** the volunteer facilitator to draw each step of the flow chart on the flip chart.
5. **Answer** all questions and provide guidance so that all the symbols are used and the process is complete.
6. **Review** each of the flow chart symbols when chart is completed.

Upon completion of the activity,

**DISPLAY** the slide titled “Sample Product Chart,” and discuss.





## Small Group Flow Charts



**DIVIDE** the class into small groups.

**IMPLEMENT** the exercise using the following directions:

1. **Ask** each small group to assign a new facilitator and draw a flow chart depicting the steps involved in changing a tire.
2. **Instruct** groups to hang their charts on the wall when completed.
3. **Ask** new spokesperson to read and explain their process charts.
4. **Note** the similarities and differences among the charts.
5. **Answer** all questions about flow charts.



## Tally Sheets



**DIRECT** participants to the section titled “Tally Sheets” in their Guide.

**EXPLAIN** that a Tally Sheet is a form constructed and used for recording how often an event occurs. Tally Sheets are used to gather data based on simple observation in order to begin to detect patterns.

**DESCRIBE** the following uses of Tally Sheets:

- to identify a logical starting point in the problem-solving cycle.
- to physically track the number of occurrences over a specified time.
- to understand the significance of the number of times an event occurs.
- to collect information.



**DISPLAY** the slide titled “Custom Milling Tally Sheet.”

Custom Milling Mill Defects		
Date	<u>6-3</u>	Time <u>10:00am - 9:00pm</u>
Number of Complaints	<u>20</u>	
Analyst Name	<u>Jill Mamy</u>	
Defect	Tally	Total
Out of Spec. Width	/	1
Out of Spec. Length	###	5
Rough Spots	### ##/	11
Can't Adjust	/	1
Lens Broken	//	2
Remarks _____		
_____		

*Custom Milling Tally Sheet*



## Steps in Preparing a Tally Sheet



**DIRECT** participants to the section titled “Steps in Preparing a Tally Sheet” in their guide.

**REVIEW** the following steps:

1. Identify what is being observed and counted. Everyone should be looking for the same thing.
2. Decide on a time period for collecting data.
3. Design a form (tally sheet) that is clear and easy to use.
4. Collect the data consistently.
5. Count the occurrence of the event being observed over a specific period.
6. Total the tally marks and observe trends.

**REVIEW** the information on the Tally Sheet.

**EXPLAIN** that the results provide data to track defects in items or processes and detect patterns that signal underlying problems.



---

## Activity: Tally Sheet



**DIRECT** participants to the “Activity: Tally Sheet” in their Participant Guide.

**DIVIDE** the class into small groups.

**EXPLAIN** that a manufacturer of portable classrooms and accessories wishes to improve their products. They decided to collect information regarding the abuse of structural items such as walls, floors and ceilings. They wish to gather this information at different intervals between classroom sessions.

**INSTRUCT** participants to work together in small groups to create a Tally Sheet to record the type and number of defects or damage found in the classroom.

**SOLICIT** a volunteer to serve as facilitator for each group.

**IMPLEMENT** the activity using the following directions:

1. **Direct** the facilitators to draw a box of the Tally Sheet and to clearly label the time, date, and title.
2. **Ask** participants for sample types of inquiries. Explain that this is purely conjecture.

***Anticipated responses:***

*Marks on the walls, chips or nicks on table tops, chairs that wobble or are broken, carpet stains or scuff marks on floor, damaged ceiling tiles, etc.*

3. **Instruct** the groups to create their Tally Sheets and allow 15 minutes to complete the activity.
4. **Instruct** the facilitator to tally or add the number of inquiries in each category.
5. **Solicit** spokespersons to read and explain their Tally Sheets when completed.
6. **Instruct** the groups to hang their tally sheets on the wall when completed.
7. **Answer** all questions about creating Tally Sheets.



**STRESS** the following:

- Tally Sheets are a quick form of data collection.
- Tally Sheets show obvious pattern recognition.
- Tally Sheets provide specifics.
- Tally Sheets provide data that may need further investigation to make a decision.



**DISPLAY** the slide titled “Optical Framus Milling Tally Sheet” and review the information.

Date	Time:	MISC. DEFECTS	Analyst Name
3/11/02	0001-2359		B.B. Hanes
Mill	Shift		Total
A	1,2,3	25	25
B	1,2,3	10	10
C	1,2,3	4	4
D	1,2,3	5	5

*Optical Framus Milling Tally Sheet*

**EXPLAIN** that this Tally Sheet was created to gather information about all the defects created during a 24 hour operation.

**STATE** that this data will be used to build the next tool, a Pareto Chart.

**TRANSITION** to the next section, “Pareto Charts.”





## Pareto Charts



**DIRECT** participants to the section titled “Pareto Charts” in their Guide.

**EXPLAIN** that once the data is gathered, it needs to be explained in some logical format.

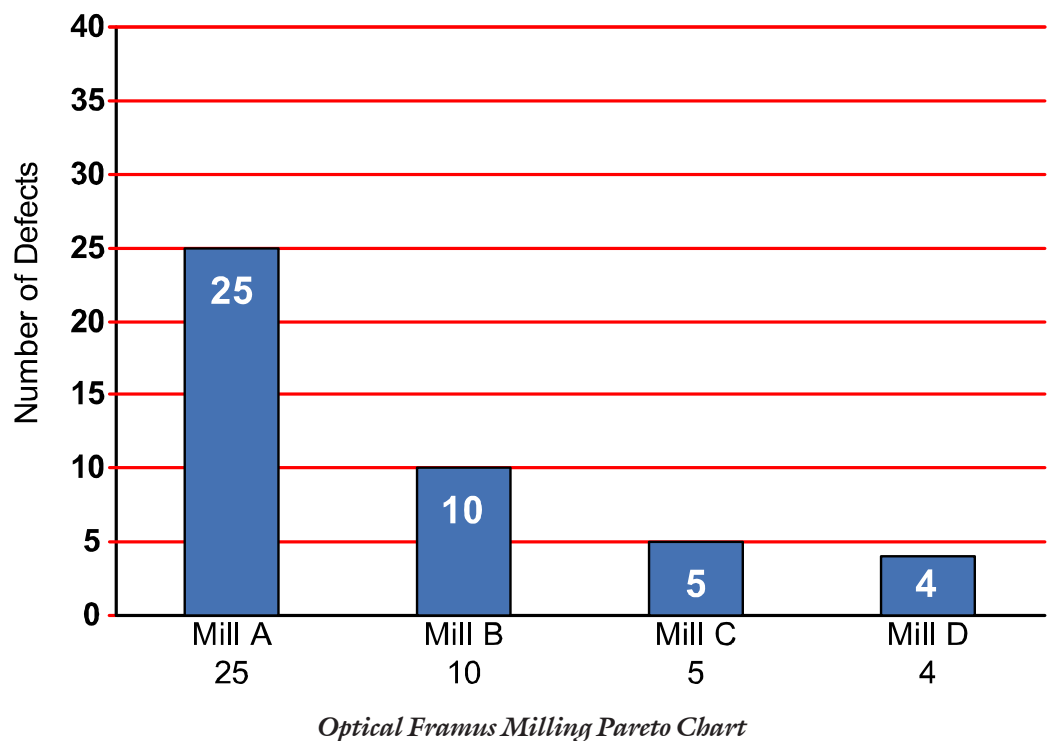
**ASK** if participants have ever seen a Pareto Chart. If yes, ask them to explain how they had used it.

**ADD** that a Pareto Chart is a special type of bar graph that you can use as a tool to display the relative importance of all problems or conditions in order to choose the starting point for problem solving.

**STATE** that the chart derives its name from Alfredo Pareto, the man who created the chart. The Pareto Principle states that 80 percent of problems are caused by 20 percent of the processes/people/machines.



**DISPLAY** the slide titled “Optical Framus Milling Pareto Chart.”





**REVIEW** the Pareto Chart.

**POINT OUT** how the Pareto Chart illustrates the data collected on the Tally Sheet in the previous section.

**ASK:** “Which mill is contributing the most problems?”

*Anticipated response:*

*Mill A*

**STATE** that further calculations based on this Pareto chart would show that Mill A and B, together, contribute 80% of the problems. Therefore, maintenance, repair or replacement of both these mills would solve 80% of the defects.

**ASK:** “If one mill could be replaced, which should it be?”

*Anticipated response:*

*Mill A*



## Steps in Preparing a Pareto Chart



**DIRECT** participants to the section titled “Steps in Preparing a Pareto Chart” in their Participant Guide.



**DISPLAY** the slide titled “Steps in Preparing a Pareto Chart.”

**REVIEW** the following:

1. Select the categories and the units of comparison such as frequency, time or cost.
2. Order the categories from largest to smallest.
3. Compare the frequency or cost of each category relative to all other categories.
4. Draw and label the left vertical axis with the unit of comparison. Scale this axis from 0 to the grand total of all categories.
5. Draw and label the horizontal axis with the categories, largest to smallest, left to right.
6. Draw bars for each category. Each bar's height should be the category sum as measured on the left vertical axis.
7. Title the Pareto Chart.
8. Study the results.



---

## Activity: Pareto Chart



**DIRECT** participants to the “Activity: Pareto Chart” in their Participant Guide.

**DIVIDE** the class into the same small groups that compiled the Tally Sheet data for classroom defects.

**IMPLEMENT** the exercise using the following directions and allow 15 minutes to complete the activity:

1. **Instruct** participants to use the Steps to Preparing a Pareto Chart to create a Pareto Chart illustrating the information gathered on the Tally Sheets used to record the type and number of defects or damage found in the classroom.
2. **Reiterate** that Pareto Charts depict information from the highest to the lowest.
3. **Advise** groups to select different facilitators (eventually each team member will have acted as facilitator).
4. **Instruct** the groups to hang their charts on the walls when completed.
5. **Solicit** a spokesperson from each group to read and explain their Pareto Chart.
6. **Answer** all questions about creating Pareto Charts.

**TRANSITION** to the next section, Run Charts.

## Run Charts



**DIRECT** participants to the section titled “Run Charts” in their Participant Guide.

**Note to Instructor:** Run Charts are fully covered in the “Statistical Process Control” module. The intent here is to introduce their use as a problem-solving tool and to indicate that they will be explored in the following module.

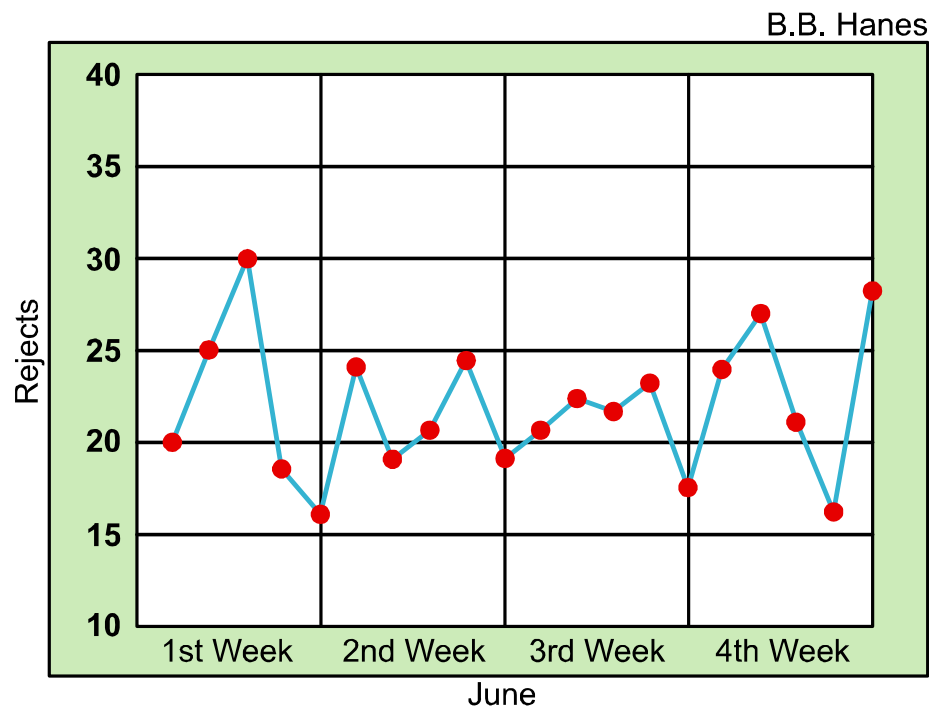
**EXPLAIN** that Run Charts are:

- Line graph data plotted over time.
- Used to monitor the long run average changes.
- Used to note trends.

**STATE** that a more sophisticated version of a Run Chart is a Control Chart that includes calculated limits that are rarely exceeded unless there is a fundamental change in the process.



**DISPLAY** the slide titled “Daily Reject Run Chart.”



*Daily Reject Run Chart*



**REVIEW** the Run Chart by stressing the following:

- the information includes, the subject name, the date, time, and recorder.
- the chart depicts rejects over time.
- the vertical axis shows the number of occurrences.
- the horizontal axis shows the time or date for each observation.
- the average number of rejects can be derived (about 22 per day).

### **Steps in Preparing a Run Chart**



**DISPLAY** the slide titled “Steps in Preparing a Run Chart.”

**REVIEW** the following:

1. Complete the header information.
2. Record the information.
3. Determine the scales for the chart.
4. Plot the values on the chart and connect the plot points with a line.
5. Interpret the chart.



---

## Activity: Run Chart



**DIRECT** participants to the “Activity: Run Chart” in their Participant Guide.



**INSTRUCT** participants to work together as a group to design a Run Chart to track production on Mill A on Shift 2 for 20 days.

**SOLICIT** a volunteer to serve as facilitator.

**IMPLEMENT** the activity using the following directions:

1. **Explain** that you will be designing a Run Chart to track the defects from Mill A, Shift 2 for 20 days. The data is found in the Participant Guide.
2. **Ask** the volunteer facilitator to outline the box.
3. **Instruct** the facilitator to title the chart and provide a date, time, and the name of the recorder.
4. **Facilitate** discussion on the vertical and horizontal axis labels. Suggested labels include:  
  
Vertical Axis: Number of Rejects  
  
Horizontal Axis: Weeks in June
5. **Label** the vertical (0 – 40 Rejects) and horizontal axis accordingly (1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> week of June).
6. **Use** the table titled “Rejects for Month of June – Mill A – Shift 2” located in the Participant Guide.



Rejects for Month of June - Mill A - Shift 2

1st Week	Rejects	2nd Week	Rejects	3rd Week	Rejects	4th Week	Rejects
Day 1	23	Day 6	19	Day 11	27	Day 16	17
Day 2	21	Day 7	20	Day 12	16	Day 17	23
Day 3	23	Day 8	18	Day 13	21	Day 18	21
Day 4	25	Day 9	25	Day 14	27	Day 19	22
Day 5	23	Day 10	30	Day 15	24	Day 20	20

7. **Review** the Run Chart when complete.

8. **Answer** all questions that arise.

**TRANSITION** to the next section, Cause and Effect Diagrams.





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## Cause and Effect Diagrams



**DIRECT** participants to the section titled “Cause and Effect Diagrams” in their Participant Guide.

**ASK:** “We have a problem, we have collected data, what do we do next?”

*Anticipated response:*

*Solve the problem.*

**STATE:** “All we have at this point is data that indicates that we have a problem. We can’t solve the problem until we know the cause.”

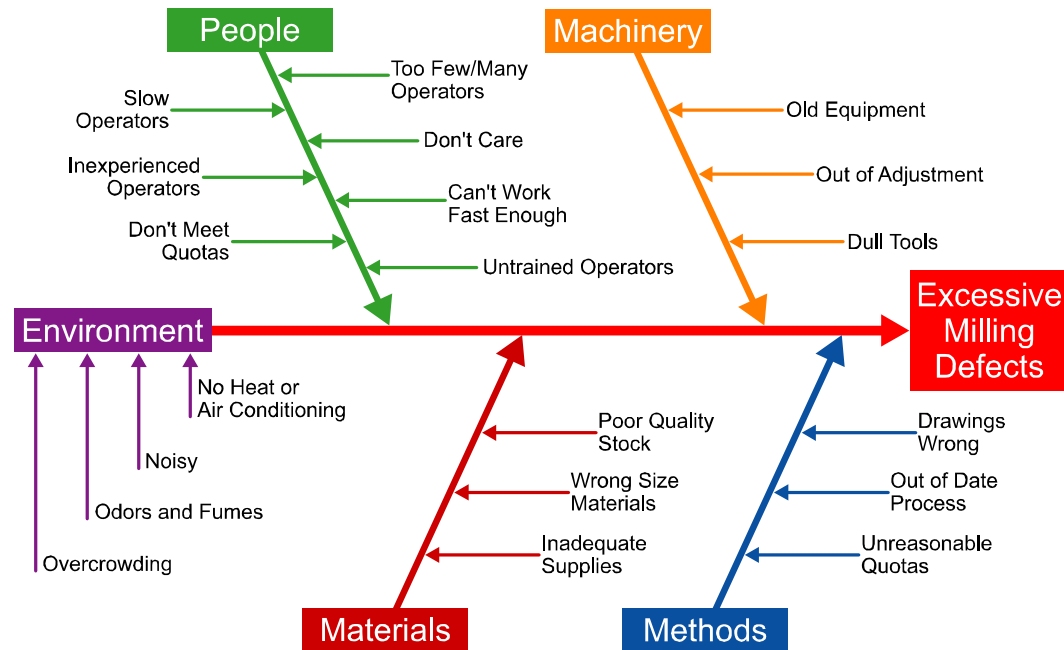
**EXPLAIN** that the data did not say what was causing the problem, only that a problem exists.

**STATE** that Cause and Effect Diagrams are tools used to identify, explore, and display the possible causes of a specific problem or condition. These diagrams are also called fish bone diagrams or Ishikawa Diagrams for the man who invented them.

**EXPLAIN** that a Cause and Effect Diagram is a great way to get to the root cause. When attempting to get to the root cause, a rule of thumb includes asking, “Why?” five times.



**DISPLAY** the slide titled “Custom Milling Cause and Effect Diagram.”



*Custom Milling Cause and Effect Diagram*



**DIRECT** participants to the Cause and Effect diagram in their guide.

**REVIEW** the diagram by discussing the following:

- The “Effect” is the problem being investigated.
- The “Causes” are possible reasons for the problem that have been divided into categories.

**ASK:** “What is the Effect in this example?”

*Anticipated response:*

*Excessive milling defects*

**ASK:** “What are the categories identified in this example?”

*Anticipated responses:*

*People, Machinery, Environment, Material, Methods*



**STRESS** that asking “Why?” five times helps to find the root cause of a problem by relating this following story:

A big pharmaceutical company developed a new brand of detergent. They did market research and developed this special brand of detergent for clothes. After a big advertising campaign, the detergent sold like crazy. But shortly thereafter sales subsided drastically. The company went out and did additional market research, reformulated the product, etc. but sales never did pick up again. Finally after much time and money, the company went to their customers. They asked why five times. It ended up that the measuring cup for the detergent sank to the bottom of the box; customers were not going to dump out all the soap just to get to the scoop so they stopped buying the product. Notice that now most detergents, especially those sold in liquid form, have the scoop as a cap to the detergent bottle.

Example of asking “Why?” five times:

I stopped using this new brand of detergent.

1. Why?

It was giving me inconsistent results.

2. Why?

The number of loads washed per container were inconsistent.

3. Why?

I never seemed to have a measuring cup handy.

4. Why?

The one they provided was not available.

5. Why?

It was in the bottom of the container.



## Steps in Preparing a Cause and Effect Diagram



**DIRECT** participants to the section titled “Steps in Preparing a Cause and Effect Diagram” in their Participant Guide.



**DISPLAY** the slide titled “Steps in Preparing a Cause and Effect Diagram.”

**REVIEW** the following:

1. Identify the problem or effect.
2. Record the problem or effect statement.
3. Draw and label the main “bones” of the diagram skeleton.
4. Brainstorm all possible causes.
5. Identify the most likely causes.



---

## Activity: Cause and Effect Diagram

### Large Group Cause and Effect Diagram



**DIRECT** participants to “Activity: Cause and Effect Diagram” in their Participant Guide.



**INSTRUCT** participants to work together as group to draw a Cause and Effect diagram illustrating the reasons for production fluctuation. The class begins as a large group and then divides into smaller groups.

**SOLICIT** a volunteer to serve as facilitator.

**IMPLEMENT** the activity using the following directions:

1. **Explain** that you will be designing a Cause and Effect diagram for the production fluctuation shown in the Run Chart created in the previous activity.
2. **Advise** facilitator to draw a horizontal line across the piece of paper and document the problem at the far right of the line. Then instruct facilitator to draw a box around the problem statement. Next, advise facilitator to draw and label the main bones of the skeleton and draw a box around each.
3. **Explain** that the main bones represent primary input categories or casual factors. Traditional labels include:
  - Materials
  - Methods
  - Machines
  - People
  - Environment

**NOTE:** Use other labels if appropriate.

4. **Direct** the class to brainstorm all possible causes.



## Small Group Cause and Effect Diagram



**DIVIDE** the class into small groups to complete the diagram after the class has built the major structure and added 2 or 3 causes.

**ANSWER** all questions on Cause and Effect Diagrams.

**EXPLAIN** that when problems are specified and their causes are identified, you are ready to research possible solutions.

**TRANSITION** to the next section “Force Field Analysis.”



---

## Force Field Analysis



**DIRECT** participants to the section titled “Force Field Analysis” in their Participant Guide.

**STATE** that a Force Field Analysis is a tool used to analyze the reasons a change may be necessary (driving forces) and the reasons which make the change difficult to accomplish (restraining forces).

**EXPLAIN** that Force Field Analysis is used when a change is expected to be difficult. Driving Forces move a situation toward change and Restraining Forces hinder change. If the Restraining Forces are more powerful, change will not occur. Change can only occur when these opposing forces have been modified.

### Steps in Preparing a Force Field Analysis



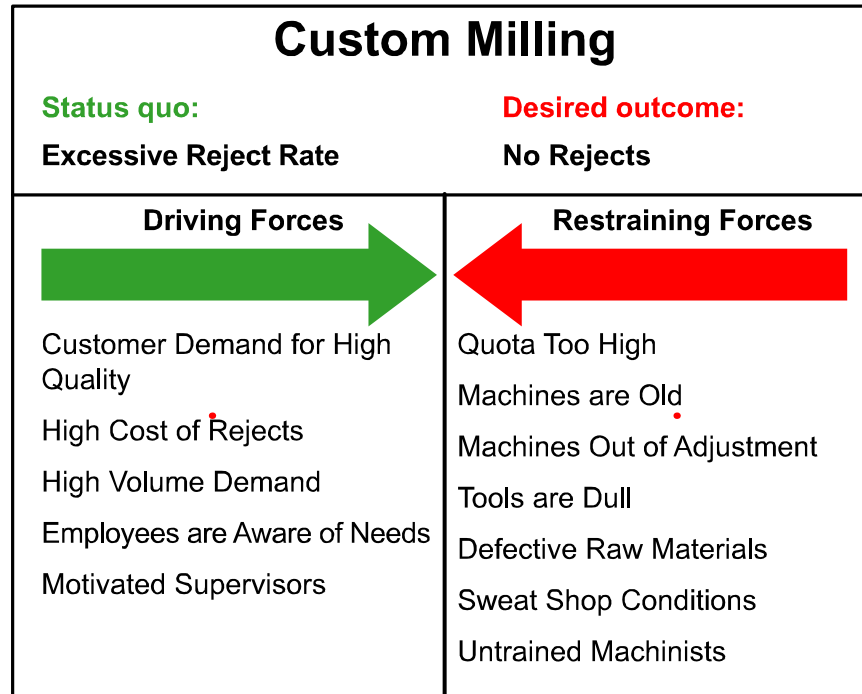
**DISPLAY** the slide titled “Steps in Preparing a Force Field Analysis.”

**REVIEW** the following:

1. Define the desired change or action.
2. Draw a force field chart (a large “T”) and write the current situation at the top of the chart (above the “T”).
3. Brainstorm the “driving forces” (pushing you toward what you want) and list them on the left side of the chart.
4. Brainstorm the “restraining forces” (preventing you from getting what you want) and list them on the right side of the chart.
5. Discuss the chart and determine which items could be altered to increase the chances for success.
6. Develop an action plan to alter the forces.



DIRECT participants to the sample analysis in their Participant Guide.



*Sample Analysis*

REVIEW the analysis.





## Activity: Force Field Analysis

### Large Group Force Field Analysis



**DIRECT** participants to “Activity: Force Field Analysis” in their Participant Guide.



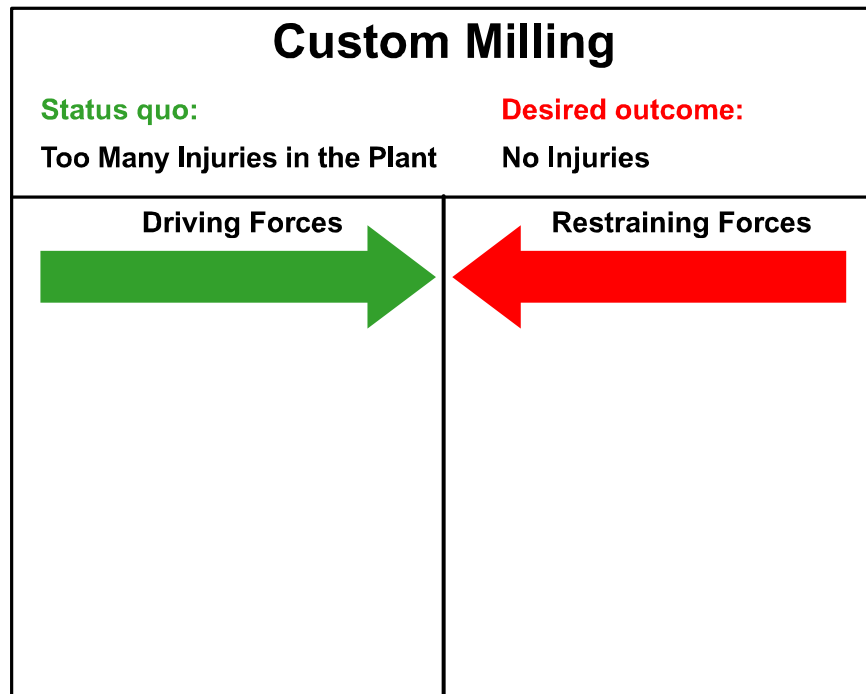
**INSTRUCT** participants to work together as a group to develop a Force Field Analysis investigating the large number of injuries at the plant.

**SOLICIT** a volunteer to serve as facilitator.

**IMPLEMENT** the activity using the following directions:



**DISPLAY** the slide titled “Custom Milling Injuries” field force diagram.



*Custom Milling Injuries*



1. **Explain** that you will be designing a Force Field Analysis to investigate the elimination of injuries (driving forces) and what would make that difficult to accomplish (restraining forces).
2. **Instruct** facilitator to draw the “T” chart and to label the change or problem statement, as well as label the columns titled “Driving Forces” and “Restraining Forces.”
3. **Instruct** the participants to use brainstorming as a tool to seek ideas for the “driving forces” as the facilitator lists those ideas on the left side of the chart.
4. **Instruct** the participants to use brainstorming as a tool to seek ideas for the “restraining forces” as the facilitator lists those ideas on the right of the chart.
5. **Review** the final chart.
6. **Answer** all questions about Force Field Analysis.

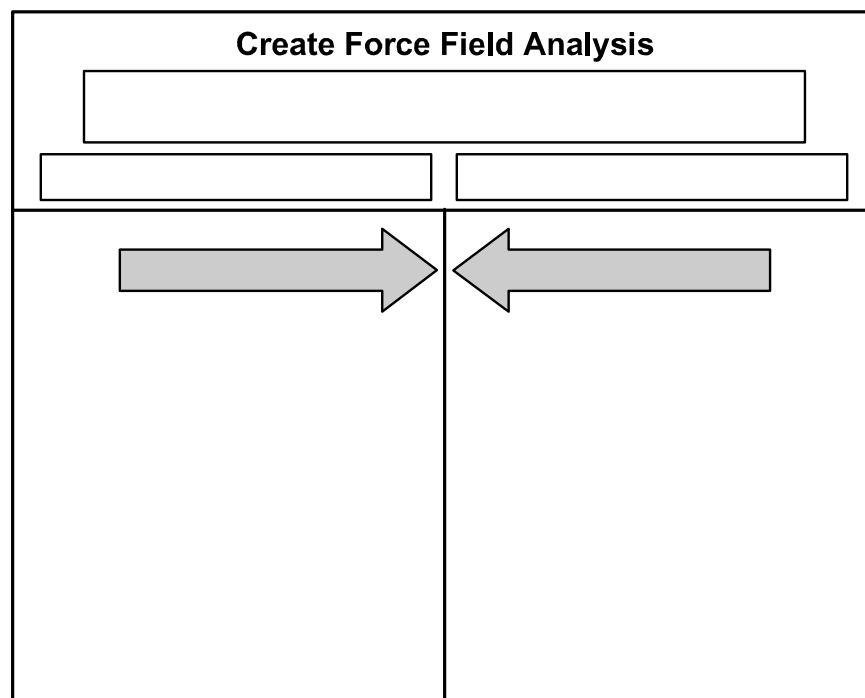
## Small Group Force Field Analysis



**DIVIDE** the participants into small groups.

**IMPLEMENT** the exercise using the following directions:

1. **Ask** each small group to develop a Force Field Diagram showing driving forces to reduce rejects and what restrains the rejects problem from being resolved.



2. **Advise** each group to pick a new facilitator and new spokesperson.
3. **Instruct** each group to draw a Force Field Analysis chart.
4. **Instruct** each group to hang their charts on the walls when completed.
5. **Ask** spokespersons to read and explain their chart.
6. **Point** out the similarities and differences among the charts.
7. **Answer** all questions about Force Field Analysis.



**REMIND** participants that we have been discussing tools used to solve problems. These tools help to:

- specify the problem
- identify the causes
- analyze the reasons a solution is necessary



## Action Plans



**DIRECT** participants to the section titled “Action Plans” in their Participant Guide.

**EXPLAIN** that Action Plans identify:

- What needs to be done.
- Who is responsible for each task.
- When each task must be completed.

**STATE** that Action Plans keep track of the “to do’s” decided upon during the problem solving sessions.

Action Plan			
Improvement Project			
Objective:			

*Sample Action Plan*

**REFER** to the sample Action Plan in the Participant Guide and discuss the following:

- categories
- objective
- tasks
- persons responsible
- completion date
- details and follow-up



# Summary



**DIRECT** participants to the “Summary” in their Participant Guide.

Problem solving is a skill that requires critical thinking. The “Problem Solving Model” provides a systematic approach that allows difficult situations to be handled more efficiently and effectively.

Step 1 of the “Six Steps to Problem Solving” is to define the problem. This step includes listing possible problem areas, collecting data, selecting an area to work on, focusing on the facts, then simplifying the problem.

In Step 2, Investigate, the problem is broken down in order to find the root cause. The root cause is the single and original cause of the problem. If only the symptoms of the problem are addressed, the problem will continue to recur.

Solutions are produced in the third step of the problem solving process. Generating and clarifying possible solutions are important elements of Step 3. It is here that options beyond the obvious are considered.

Once several possible solutions have been generated, it is time to select the best. Evaluation criteria may be developed to identify possible solutions. All the possible alternatives as well as the pros and cons of each will need to be identified before an implementation plan can be developed.

Once the plan is put into action, implementation should be monitored and contingency plans developed as needed. Finally, the solution should be evaluated. This is done by collecting data and comparing it with the desired state that was identified in Step 1. If the problem still has not been resolved, the problem solving process must begin again. If the problem has been resolved, it is important to take time to reflect on what can be learned from it and how the entire organization can benefit. Future problems can be prevented using the experience and information attained from the problem as well as from the process of solving the problem.



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## Review

**EXPLAIN** that during the review that participants may use their Participant Guide and/or the information on the flip charts posted around the room.

### Brainstorming

**ASK:**

“What is used to set the framework for brainstorming?”

*The problem statement.*

“What is the purpose of brainstorming?”

*To generate a large number of ideas related to the perceived problem.*

“What are the rules for brainstorming?”

1. *No criticism*
2. *Equal opportunity*
3. *Emphasize quantity*
4. *Piggybacking encouraged*

### Flowcharting

**ASK:**

“What is the value in drawing a flowchart for a process?”

*It defines how the process is currently done so it can be examined to make modifications that will improve the process and quality.*

“What symbols are used in flowcharting and what do they mean?”

*Oval Start or terminate a process*

*Rectangle Process Step*

*Diamond Decision*



## Tally Sheet

### ASK:

“What is the purpose of a Tally Sheet?”

*To count occurrences of observable actions, behaviors or outputs.*

”What needs to be done before observing and tallying data?”

*Reason for collecting data (the problem)*

*Design an easy to use data collection or tally sheet*

*Decide what data to collect*

*Decide the time period for data collection*

“What value or information can be deduced from a Tally Sheet?”

*Trends*

*Input to Pareto chart*

*Indication of problem source*

## Pareto Chart

### ASK:

“What is the value of a properly constructed Pareto Chart?”

*It turns the data collected on the tally sheet into information about the problem or process being studied.*

“What are the steps in creating a Pareto Chart?”

*Collect data (tally sheet)*

*Plot the data on a vertical bar chart, sorted by occurrence (highest to lowest)*

*Draw a horizontal line at 80% of the total occurrences*





## Run Chart

### ASK:

“What is a Run Chart?”

*A line graph of data collected over time*

“How is it used?”

*To monitor long run changes*

*Indicate trends*

## Cause and Effect Diagram

### ASK:

“What is the purpose of the Cause and Effect Diagram?”

*To identify issues that effect the system of the problem*

“What are the 5 major ‘bones’ on the Fishbone diagram?”

*People*

*Machines*

*Materials*

*Methods*

*Environment*

“What is at the head of the diagram?”

*The problem or issue being studied*

“How many time should you ask ‘Why?’ to get at the root cause?”

*Until you get to the root cause. Usually 5 times.*



## Field Force Diagram

### ASK:

“What does the Field Force Diagram show?”

*Driving forces or forces pushing towards resolving the problem*

Restraining forces or forces blocking the resolution of the problem

*“How can the diagram be used to solve a problem?”*

*If you increase the driving force or decrease the restraining force the system will settle at equilibrium. The paradigm will shift towards resolving the problem.*

“What do you do next?”

*Develop an Action Plan!*

## Problem Solving Tools

**ASK:** “Which tools can be used to accomplish the first step of the Six Step Process discussed in the first section: Define the problem?”

*Brainstorming*

*Flow Charts*

*Tally Sheets*

*Pareto Charts*

*Run Charts*

**LIST** the responses beneath the first step on the flip chart.



**ASK:** “Which tools can be used to accomplish the second step: Investigate the facts?”

*Brainstorming*

*Cause and Effect Diagrams*

*Flow Charts*

*Tally Sheets*

*Pareto Charts*

*Run Charts*

**LIST** the responses beneath the second step on the flip chart.

**ASK:** “Which tools can be used to accomplish the third step: Produce solutions?”

*Brainstorming*

*Cause and Effect Diagrams*

**LIST** the responses beneath the third step on the flip chart.

**ASK:** “Which tools can be used to accomplish the fourth step: Select the best?”

*Tally Sheets*

*Brainstorming*

*Pareto Charts*

**LIST** the responses beneath the fourth step on the flip chart.

**ASK:** “Which tools can be used to accomplish the fifth step: Try it?”

*Brainstorming*

*Force Field Analysis*

*Pareto Diagrams*

*Run Charts*



**LIST** the responses beneath the fifth step on the flip chart.

**ASK:** “Which tools can be used to accomplish the sixth and final step: Evaluate results?”

*Pareto Charts*

*Run Charts*

**REVIEW** the items listed on the flip chart and ask if there are any more suggestions to be added.

**HAND OUT** copies of the Problem Solving Assessment. Allow enough time for them to complete the test. Collect the assessments when they finish and go over the answers with the class.