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# ***Process Improvement in the Mining Industry***

Processes, Tools, Techniques and Results  
September 20, 2005

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Prepared by **Norbridge** 

30 Monument Square

Suite 300

Concord, MA 01742

(978) 369-2944

[www.norbridgeinc.com](http://www.norbridgeinc.com)

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- Introduction
- What Processes and Issues are Typically Addressed?
- What is a Typical Project Like?
- What Tools and Techniques are Used?
- What Results Can be Achieved?
- Information about Norbridge

**Focus on process improvement has grown significantly in the mining industry in recent years.**

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**Typical Process Improvement Objectives: Improve Performance and Results!**

- Improve safety
- Reduce cost
- Increase production
- Enhance productivity
- Other

**Examples of Mining Companies with Process Improvement Programs**

***Metals***

- Barrick Gold
- Cleveland Cliffs
- Comalco
- Falconbridge
- Inco
- Kennecott Utah Copper
- Newmont Mining
- Noranda
- Phelps Dodge
- Placer Dome

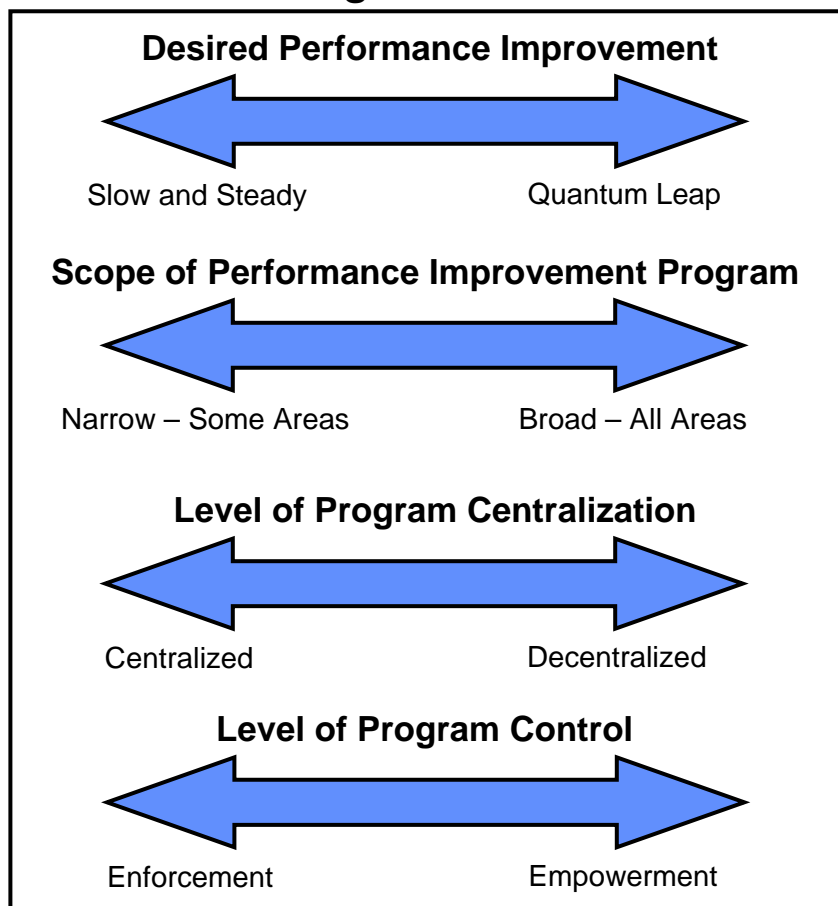
***Coal and Non-Metallic Minerals***

- Arch Coal
- Foundation Coal
- Florida Rock
- IMC Global
- Kennecott Energy
- Massey Energy
- Peabody Energy

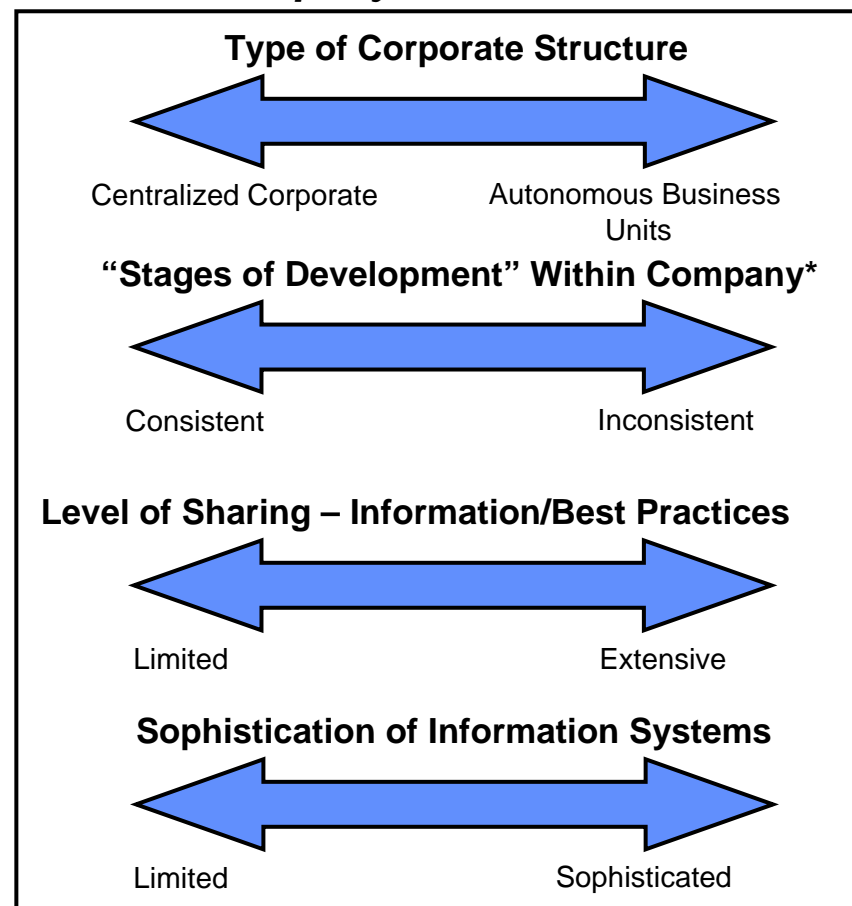
There are a wide range of mining process improvement programs since each company has its own unique goals and characteristics.

### *Illustrative Range of Performance Improvement Program Drivers*

#### **Program Goals**



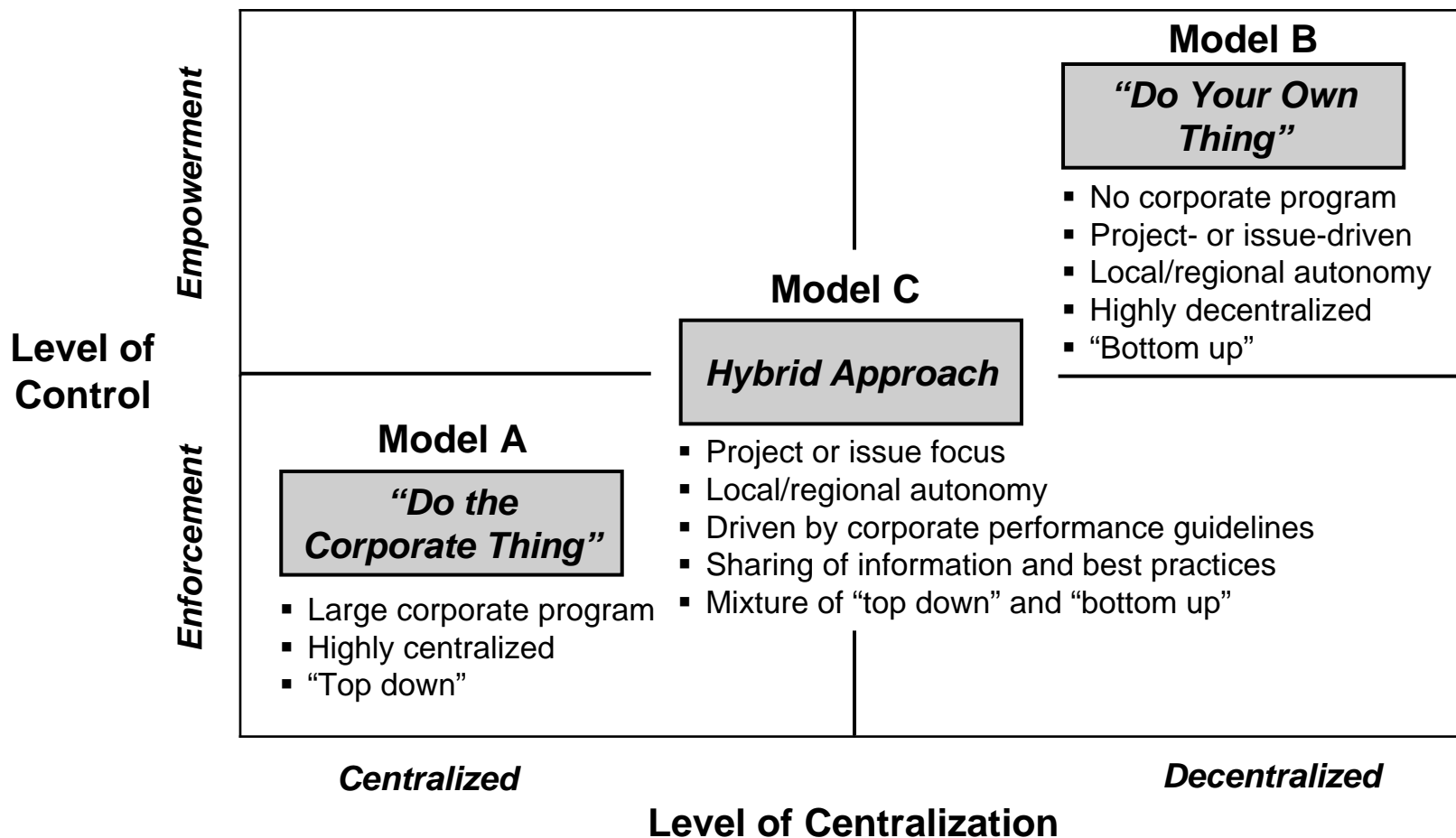
#### **Company Characteristics**



\* Related to process and performance improvement

As a result, companies follow different performance improvement models based on their needs, cultures and styles.

### Example of Spectrum for Performance Improvement Programs



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**While performance improvement programs differ across mining companies, the types of processes they address are similar.**

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- This seminar focuses on operational processes in the mining industry.

***Examples of Processes Addressed in Mining Process Improvement Programs***

***Operational***

**Mining**

**Processing**

**Transportation**

**Safety**

***Administrative***

**Planning**

**Budgeting**

**Purchasing**

**Other**

**Within each process, there are a wide range of issues that can be addressed.**

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***Examples of Operational Issues by Process***

<b><i>General Issues</i></b>	<b><i>Underground Mining</i></b>	<b><i>Surface Mining</i></b>
<ul style="list-style-type: none"> <li>■ Performance consistency</li> <li>■ Cost reduction</li> <li>■ Facility-based planning</li> <li>■ Communication and teamwork</li> <li>■ Standard operating procedures</li> <li>■ Organization and staffing issues</li> <li>■ Roles and responsibilities</li> <li>■ Performance measurement and monitoring</li> <li>■ Work schedules</li> <li>■ Maintenance planning</li> <li>■ Parts and supplies</li> </ul>	<ul style="list-style-type: none"> <li>■ Production shortfalls</li> <li>■ Loading time lost</li> <li>■ Equipment issues</li> <li>■ Timing of production and development</li> <li>■ Usage of scheduled downtime</li> <li>■ Belts</li> <li>■ Belt and power moves</li> <li>■ Construction planning and management</li> <li>■ Drainage management</li> </ul>	<ul style="list-style-type: none"> <li>■ Dragline performance</li> <li>■ Truck shovel performance</li> <li>■ Haulage – coal and overburden</li> <li>■ Drilling and blasting</li> <li>■ Pit planning</li> <li>■ Reclamation</li> <li>■ De-watering</li> <li>■ Equipment maintenance</li> <li>■ Fuel and lube</li> <li>■ Heavy haulage</li> </ul>

**Within each process, there are a wide range of issues that can be addressed.**

***Examples of Operational Issues by Process (Continued)***

<b><i>Processing</i></b>	<b><i>Transportation</i></b>	<b><i>Safety</i></b>
<ul style="list-style-type: none"> <li>■ Plant availability shortfalls</li> <li>■ Feed rates</li> <li>■ Linkage to mine operating plans</li> <li>■ Sampling</li> <li>■ Refuse disposal</li> <li>■ Mobile equipment productivity and management</li> <li>■ Magnetite usage</li> <li>■ Coal losses</li> <li>■ Coal quality compliance</li> </ul>	<ul style="list-style-type: none"> <li>■ Priority/Effectiveness of loadout operations</li> <li>■ Integration of mining, processing and loading</li> <li>■ Delay tracking</li> <li>■ Loadout maintenance</li> <li>■ Utilization and maximization of track/loadout capacity</li> <li>■ Manual processes</li> <li>■ Railroad issues, for example:                             <ul style="list-style-type: none"> <li>■ Bad cars</li> <li>■ Crew availability/timing</li> <li>■ Dispatching</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>■ Training</li> <li>■ Awareness</li> <li>■ Communication, coordination and teamwork</li> <li>■ Safe operating procedures</li> <li>■ Supervision</li> <li>■ Monitoring and enforcement</li> <li>■ Accident investigation</li> <li>■ Repeat incidents</li> <li>■ Root cause analysis</li> <li>■ Analysis e.g. injury types and categories</li> </ul>

## Contents

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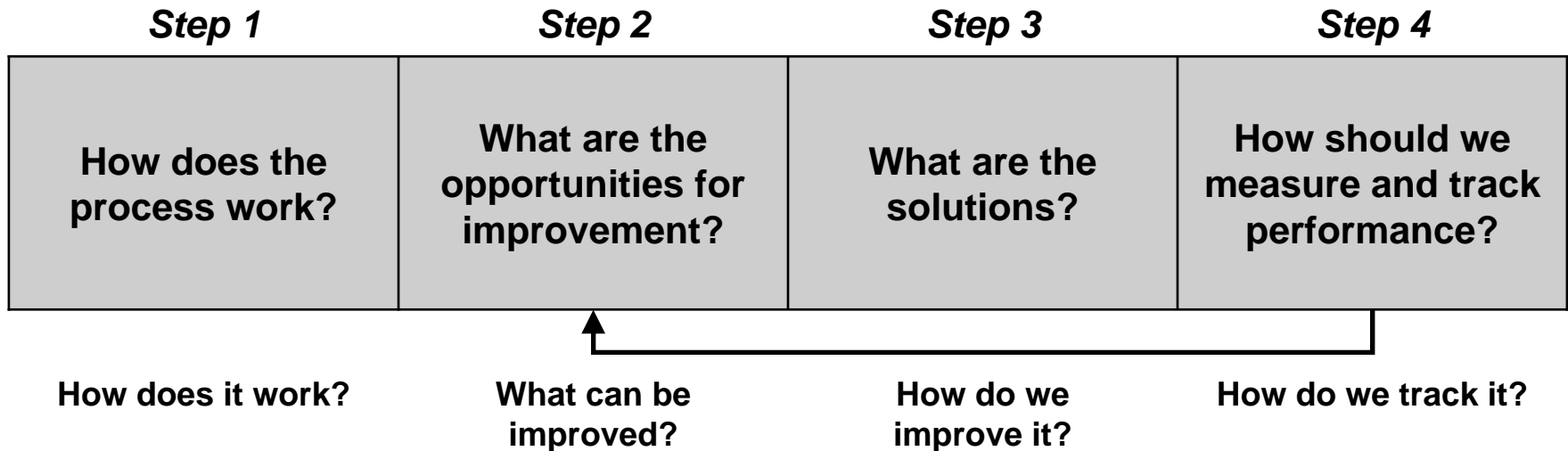
- Introduction
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**A process improvement project typically includes four steps.**

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- Each project is driven by a cross-functional team with clear objectives.
- It is focused on significant performance improvement.

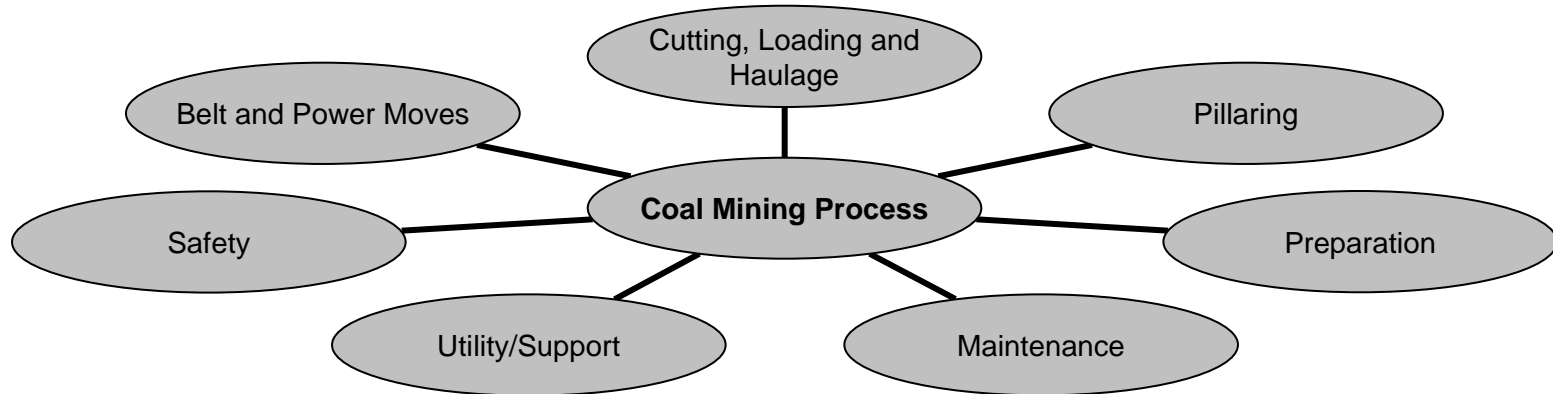
***Typical Project Steps***



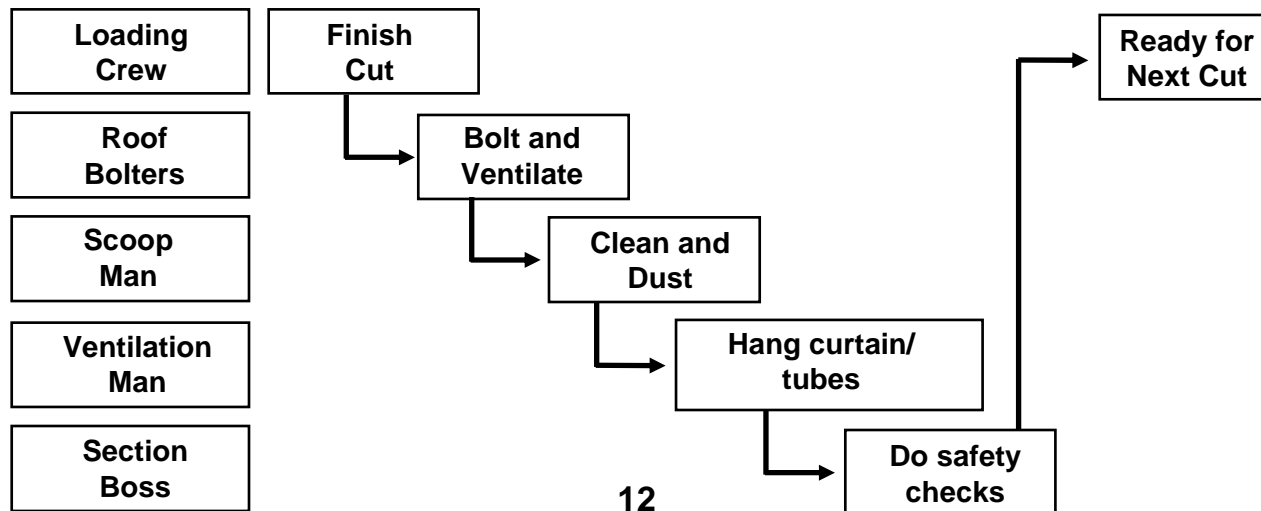
**A facilitator can act as a neutral third party, bring together the key players, and provide an independent perspective on issues, problems and solutions.**

## Step 1: How does the process work?

### *Illustrative Example of Underground Coal Mining Process*



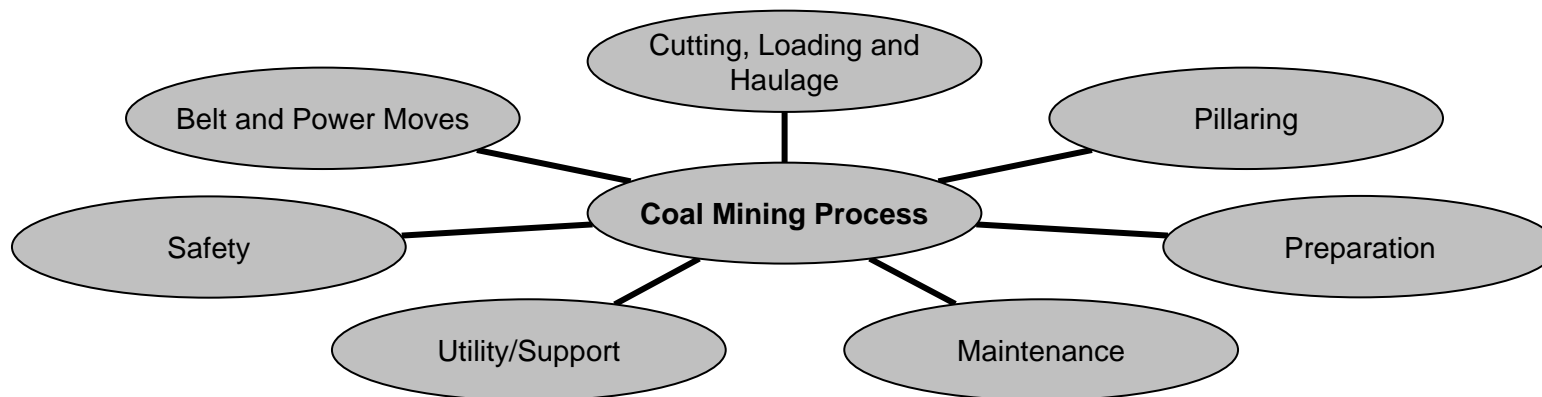
### *Illustrative Example of Preparation Sub-Process*



## Step 2: What are the opportunities for improvement?

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### *Underground Coal Mining Process*



### *Typical Process Problems Can Include:*

- Lack of procedures and standards
- Inconsistent section set-up
- Inconsistent/nonexistent cut cycle
- Poor teamwork within crews and across shifts
- Large amount of loading time lost
- Cable damage
- Frequent emergency breakdowns
- Poor preparation for following shift
- Violations and accidents
- Belt and power moves disrupt loading time

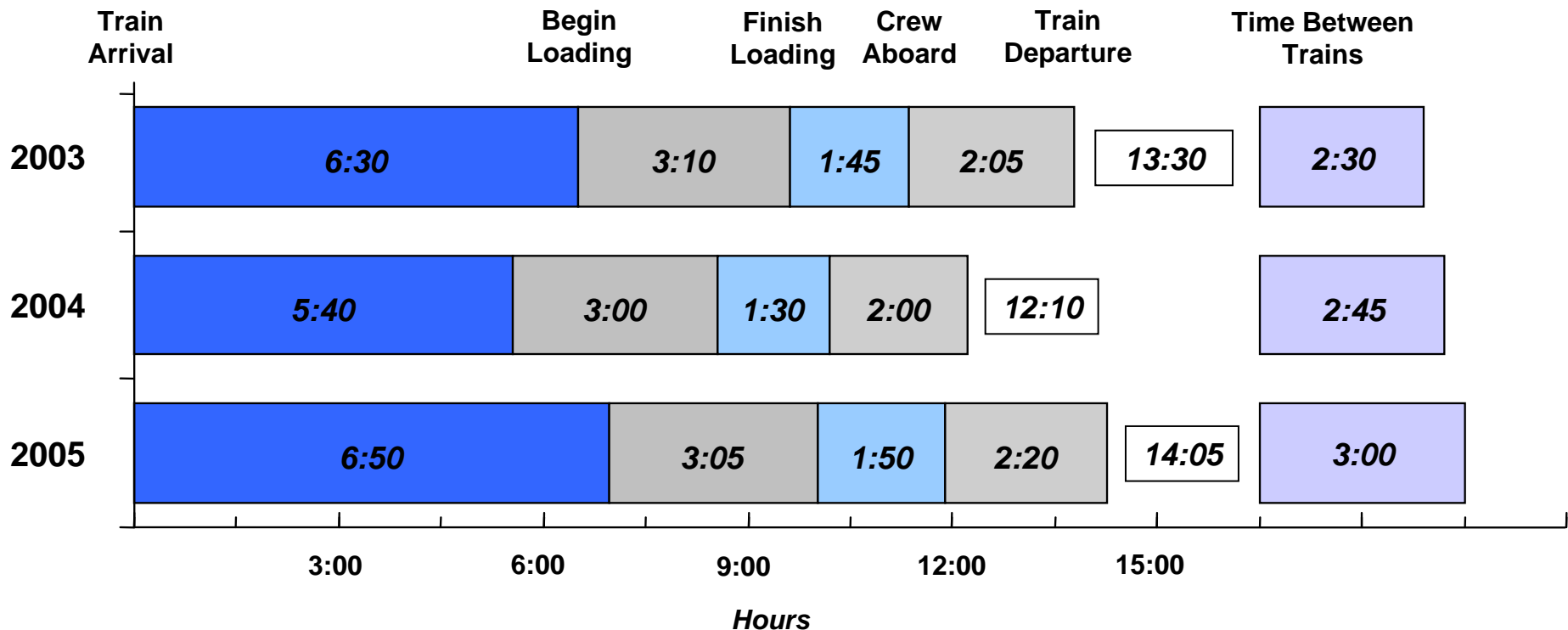
## Step 2: What are the opportunities for improvement? (Continued)

### *Performance Example at Underground Coal Mining Complex*

<i>Performance Measure</i>	<i>Performance Level</i>
<b>Production</b>	
<ul style="list-style-type: none"> <li>▪ Tonnage per shift</li> </ul>	<ul style="list-style-type: none"> <li>▪ 30% below goal</li> </ul>
<b>Cutting, Loading and Haulage</b>	
<ul style="list-style-type: none"> <li>▪ % of time on cut cycle at end of shift</li> <li>▪ % of time on cut cycle during shift</li> <li>▪ Time to load first shuttle car</li> </ul>	<ul style="list-style-type: none"> <li>▪ 30%</li> <li>▪ 30%</li> <li>▪ 40 minutes</li> </ul>
<b>Preparation</b>	
<ul style="list-style-type: none"> <li>▪ % of time ready for next shift</li> <li>▪ % of time brattices up to standard</li> <li>▪ % of time scoop battery power sufficient</li> </ul>	<ul style="list-style-type: none"> <li>▪ 78%</li> <li>▪ 35%</li> <li>▪ 80%</li> </ul>
<b>Maintenance</b>	
<ul style="list-style-type: none"> <li>▪ % equipment availability</li> <li>▪ % scheduled maintenance done</li> <li>▪ % washing done</li> <li>▪ Time lost due to cable splices</li> <li>▪ Lost time loading due to unscheduled maintenance</li> <li>▪ Equipment violations</li> </ul>	<ul style="list-style-type: none"> <li>▪ 91%</li> <li>▪ 82%</li> <li>▪ 45%</li> <li>▪ 24 minutes</li> <li>▪ 57 minutes</li> <li>▪ 11/month</li> </ul>
<b>Other</b>	
<ul style="list-style-type: none"> <li>▪ Lost time loading</li> <li>▪ Accidents</li> <li>▪ Violations (total)</li> </ul>	<ul style="list-style-type: none"> <li>▪ 188 minutes</li> <li>▪ 38/month</li> <li>▪ 25/month</li> </ul>

## Step 2: What are the opportunities for improvement? (Continued)

### Rail Loadout Process Times



## Step 3: What are the solutions?

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- There are frequently many options to address the problem areas that have been identified.
- Options need to be identified, evaluated and narrowed down before the best solutions can be selected.

### ***Examples of Key Options in Underground Coal Mining Process\****

#### ***Cutting, Loading and Haulage***

- What is the best section layout/set-up?
- What is the best cut cycle?
- Do we run two continuous miners at the same time or not?
- How many entries do we have?
- What cut depth should we have?
- What do we do when we get off the cut cycle?

#### ***Other***

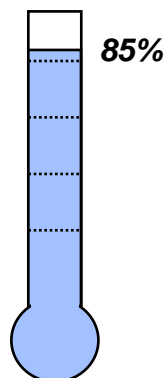
- How do we leave the section for the next shift?
- What preventive maintenance/servicing system is best for the cut cycle?
- Do we have on-shift or off-shift maintenance?
- How many men should there be on each section?
- What equipment should each section have?

\* Based on continuous miners

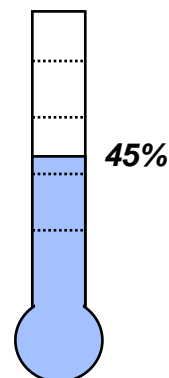
## Step 4: How should we measure and track performance?

- Measuring and tracking performance are key steps to help identify potential changes and sustain improvements.
- Performance measures for the underground coal mining process can include current performance levels and an early warning system.

### Shift Performance



*Current Performance*



*Early Warning System*

#### Potential Current Performance Measures

- Tons mined
- Operating cost per ton
- Cost versus budget
- Productivity
- Accidents and violations
- Other

#### Potential Early Warning System Measures

- Ability to remain on cut cycle
- Time to start loading at beginning of shift
- Section ready for next shift
- Loading time lost
- Completion of planned maintenance work
- Belt and power moves completed effectively

## Step 4: How should we measure and track performance? (Continued)

### *Performance Measurement System at Underground Coal Mining Complex*

<i>Performance Measure</i>	<i>Performance Level</i>	<i>Short-Term Goal</i>	<i>Long-Term Goal</i>
<b>Production</b>			
• Tonnage per shift	• 2,200	• 3,100	• 4,500
<b>Cutting, Loading and Haulage</b>			
• % of time on cut cycle at end of shift	• 30%	• 95%	• 98%
• % of time on cut cycle during shift	• 30%	• 95%	• 98%
• Time to load first shuttle car	• 40 minutes	• 15 minutes	• 15 minutes
<b>Preparation</b>			
• % of time ready for next shift	• 78%	• 100%	• 100%
• % of time brattices up to standard	• 35%	• 95%	• 98%
• % of time scoop battery power sufficient	• 80%	• 100%	• 100%
<b>Maintenance</b>			
• % equipment availability	• 91%	• 95%	• 98%
• % scheduled maintenance done	• 82%	• 90%	• 95%
• % washing done	• 45%	• 90%	• 95%
• Time lost due to cable splices	• 24 minutes	• 15 minutes	• 7 minutes
• Lost time loading due to unsch. maint.	• 57 minutes	• 30 minutes	• 26 minutes
• Equipment violations	• 11/month	• 5/month	• 0/month
<b>Other</b>			
• Lost time loading	• 188 minutes	• 90 minutes	• 75 minutes
• Accidents	• 38/month	• 0/month	• 0/month
• Violations (total)	• 25/month	• 12/month	• 0/month

## Surveyed companies highlighted keys to success for BPI programs.

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### *Examples of Keys to Success*

#### ***BPI Projects***

- Focus on the issues that count
- Scope the projects appropriately – not too big; not too small
- Get the key people involved
- Reward results
- Give credit to the people involved
- Hold people accountable
- Build management systems to support sustainability of results
  - Measurement
  - Monitoring
  - Information
  - Communication
- Follow up! Follow up! Follow up!

## While the programs are diverse, the problems are similar – most are people issues.

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### *Examples of BPI Problems*

- Senior/middle management resistance
  - People are set in their ways and don't want to change
  - People may perceive BPI as a threat e.g. cost-cutting
  - Turf issues
  - Getting people to recognize the value
- Project/initiative overload
  - Lean staffing at many companies
  - Lots of initiatives – BPI and other
  - Concern about workload “in addition to” their regular jobs
- BPI staffing and training
  - Hard to find enough qualified people
  - Hard to “replace” their operating expertise
  - Hard to replace people if/when they go from BPI role back into operations – lots of BPI training required
- Unwillingness to share and utilize best practices
  - “Not invented here”
  - Jealousy of ownership
- Difficulty in quantifying value creation for specific projects
  - Costs for many inputs are rising
  - Difficult to split out project value
  - How much resource/time to apply to it?
- Sustainability
  - Sustaining BPI programs and platforms over the long-term
    - Many of the programs/platforms are new
    - Many companies had previous programs that were discontinued or changed
  - Sustaining results after projects are completed

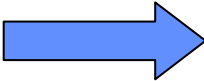
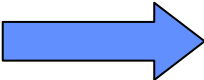
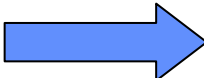
## Surveyed companies gave examples of problems and how they attempt to overcome them.

### *Examples of BPI Problems and Suggested Solutions*

<b><i>BPI Problem</i></b>	<b><i>Suggested Solution</i></b>
<ul style="list-style-type: none"> <li>■ Senior/middle management resistance</li> </ul>	<ul style="list-style-type: none"> <li>■ Lots of awareness training on BPI and its value</li> <li>■ Presentations from managers who have “seen the light” e.g. before and after; “how it changed me”</li> <li>■ Highlight the “wins” to show the value</li> <li>■ Allocate benefits to the field to incent desired behavior at facilities</li> </ul>
<ul style="list-style-type: none"> <li>■ Project/initiative overload</li> </ul>	<ul style="list-style-type: none"> <li>■ Combine projects, if possible</li> <li>■ Highlight that BPI projects are not “in addition to” people’s jobs, they are “part of” their jobs</li> <li>■ Focus projects on the issues that people care about most – the project will help solve their problems</li> </ul>
<ul style="list-style-type: none"> <li>■ BPI staffing and training</li> </ul>	<ul style="list-style-type: none"> <li>■ Focus on the best and the brightest</li> <li>■ Give them the tools/training to succeed</li> <li>■ Replace them in their previous positions as effectively as possible – most people aren’t irreplaceable</li> <li>■ Be flexible – if they need to move back, move them back</li> </ul>

## Surveyed companies gave examples of problems and how they attempt to overcome them. (Continued)

### *Examples of BPI Problems and Suggested Solutions*

<b><i>BPI Problem</i></b>	<b><i>Suggested Solution</i></b>
<ul style="list-style-type: none"> <li>■ Unwillingness to share and utilize best practices</li> </ul>	 <ul style="list-style-type: none"> <li>■ Use cross-site training/projects e.g. cross-fertilize</li> <li>■ Leverage corporate personnel to spread best ideas from one facility to others</li> <li>■ Utilize and encourage e-mail/internet forum to ask questions and share ideas e.g. “Chat room”; “Has anyone done this before?”</li> <li>■ Set aggressive targets</li> <li>■ Leverage senior management to ask tough questions – “why aren’t we doing this everywhere?”</li> </ul>
<ul style="list-style-type: none"> <li>■ Difficulty in quantifying value creation for specific projects</li> </ul>	 <ul style="list-style-type: none"> <li>■ Set clear criteria and clear measures during project for how project value is to be measured</li> <li>■ Get Finance Department involved if needed</li> <li>■ Determine, in advance, how much rigor is needed e.g. Are benefits to be made public? How much rigor is required to ensure that results are credible? Is a range of results sufficient?</li> </ul>
<ul style="list-style-type: none"> <li>■ Sustainability</li> </ul>	 <ul style="list-style-type: none"> <li>■ See keys to success (already discussed)</li> </ul>

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## Process Improvement Tools and Techniques

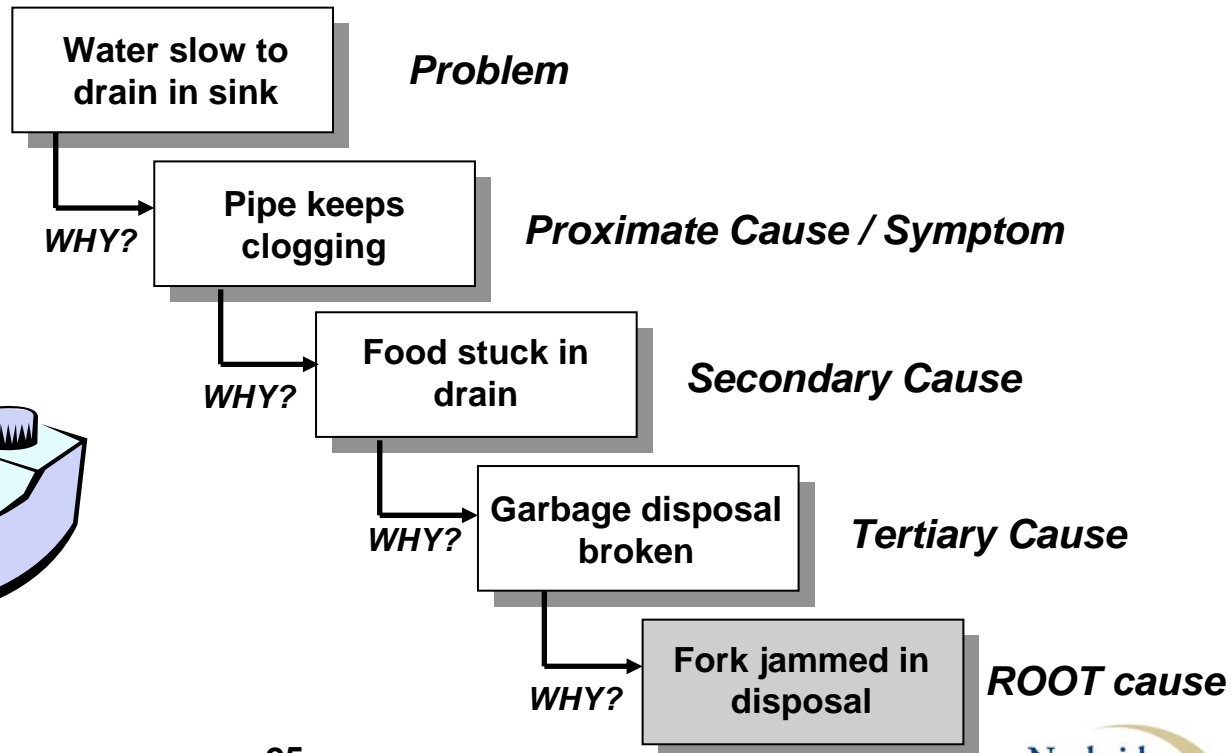
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- Root cause analysis
- Process mapping
- Importance/Performance matrix
- Histogram
- Pareto chart
- Run chart/control chart
- Flow chart
- Scatter diagram
- Force field chart

**Root cause analysis is used to “drill down” from the symptoms of a problem to the actual root cause.**

**Definition:** *Root Cause Analysis is a step by step method that leads to the discovery of a fault’s first or root cause. A RCA investigation traces the cause and effect trail from the end failure to the root cause (beyond just symptoms), similar to a detective solving a crime. The detective follows up on each clue to narrow down the possibilities.*

**Example Problem: A Slow Draining Sink**



## **A great tool for performing root cause analysis is the fishbone diagram.**

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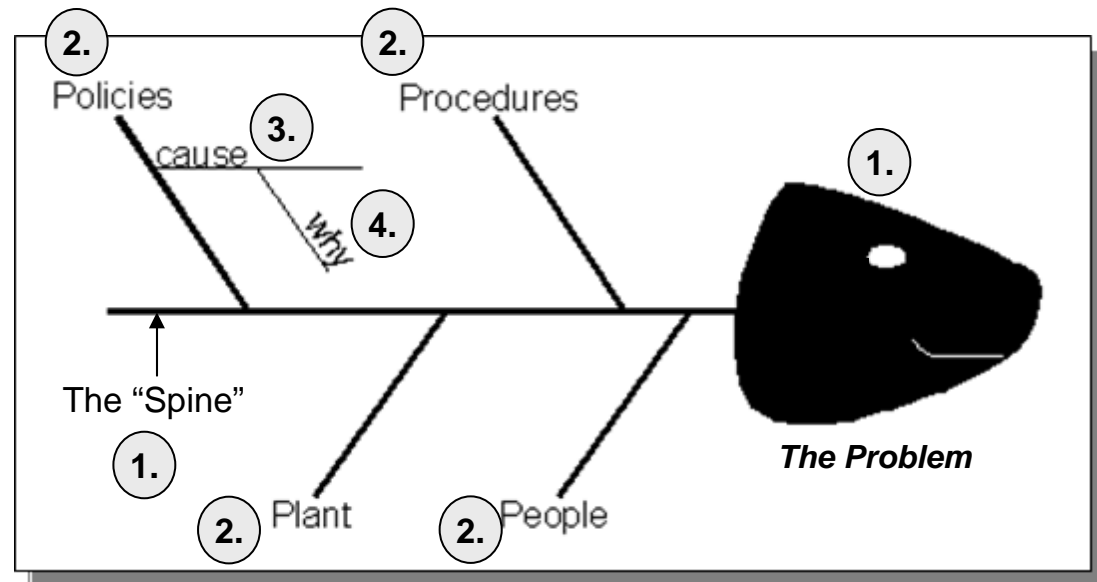
A fishbone diagram shows the relationship between a problem and its root causes. Because it is structured in a way to look at many different causes, it can be used to analyze any type of problem. Fishbone diagrams are typically used to:

- Help search for root causes
- Identify and categorize all potential causes of a problem
- Understand the relationships between various causes of a problem
- Provide structure and focus for a brainstorming session
- Evaluate processes e.g. why are they having difficulties, problems or breakdowns? Why are they not producing desired results?

## How is a fishbone diagram constructed?

1. Draw the “spine” and identify the problem (the “head” of the fish)
2. Draw and label the factors that may be causing the problem (the main bones)
3. Brainstorm the potential causes of the problem
4. Identify sub-causes (root causes, or “why does this happen?”)
5. Identify the most likely causes

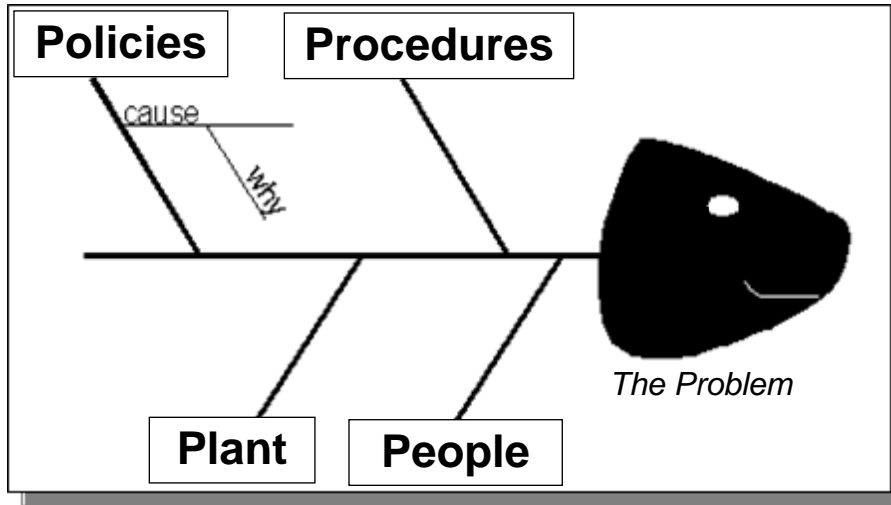
### Creating a Fishbone Diagram



**Continue to ask  
“why” until it cannot  
be asked anymore!**

## How do you create the “main bones” of the diagram?

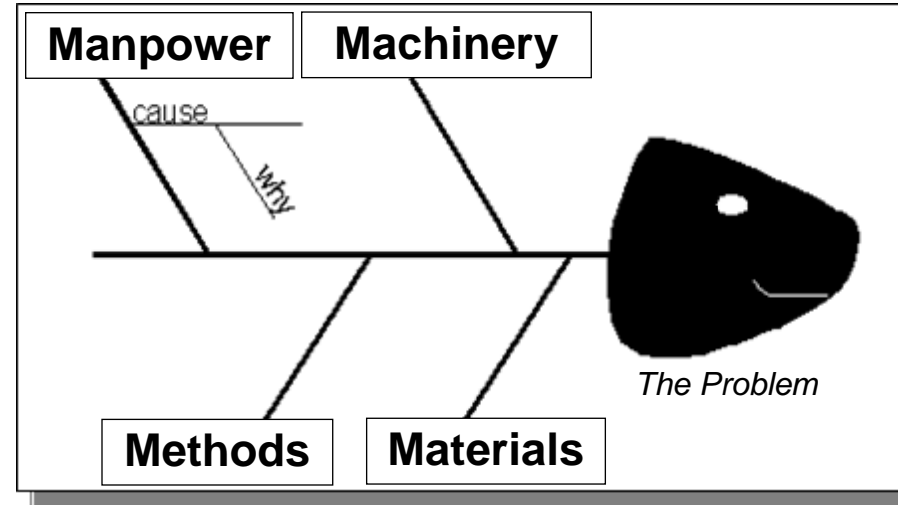
### *Administrative and Service Areas*



#### ■ The four P's:

- ✓ Policies
- ✓ Procedures
- ✓ Plant
- ✓ People

### *Operations and Manufacturing Areas*



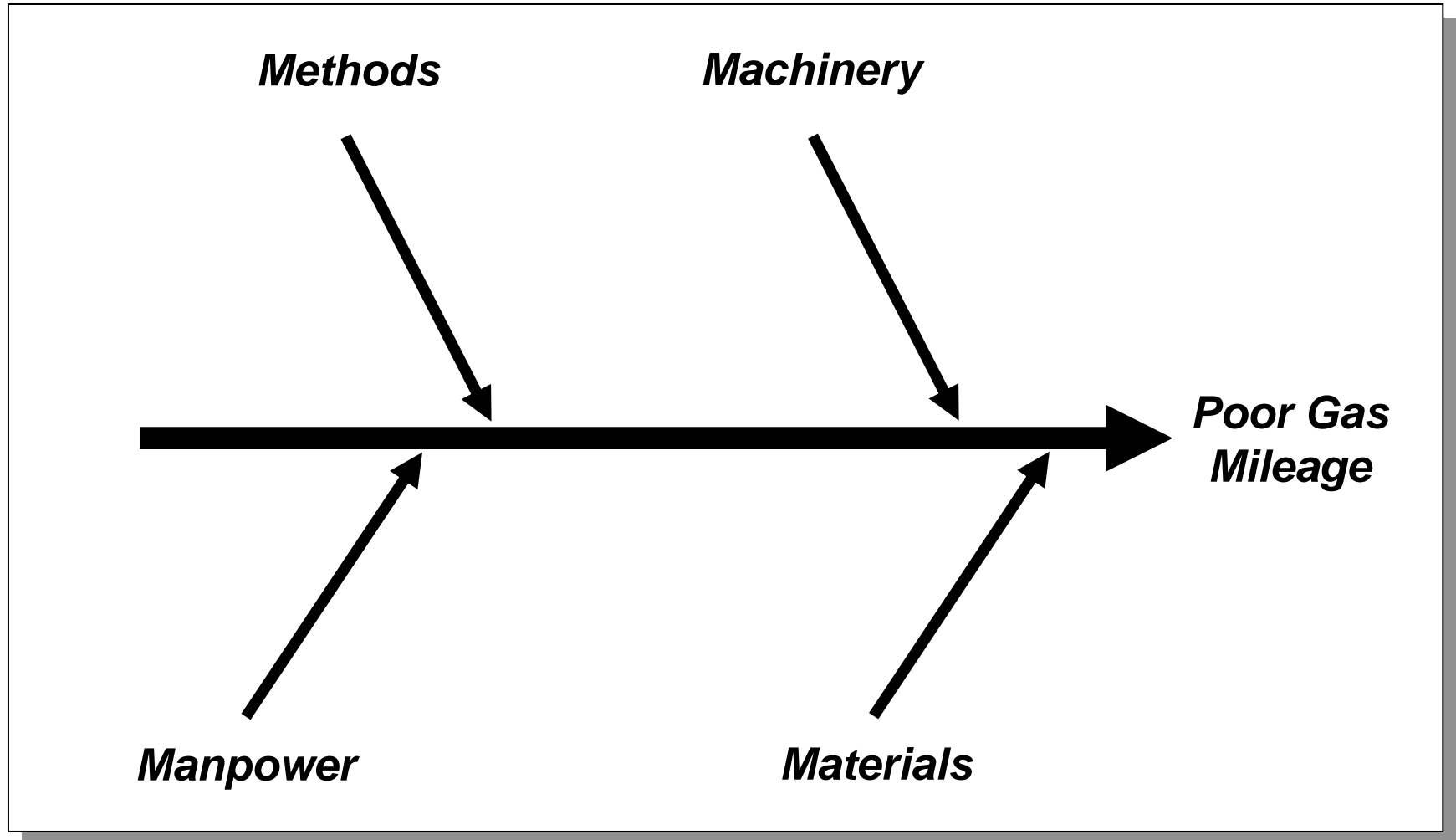
#### ■ The four M's:

- ✓ Manpower
- ✓ Machinery
- ✓ Methods
- ✓ Materials

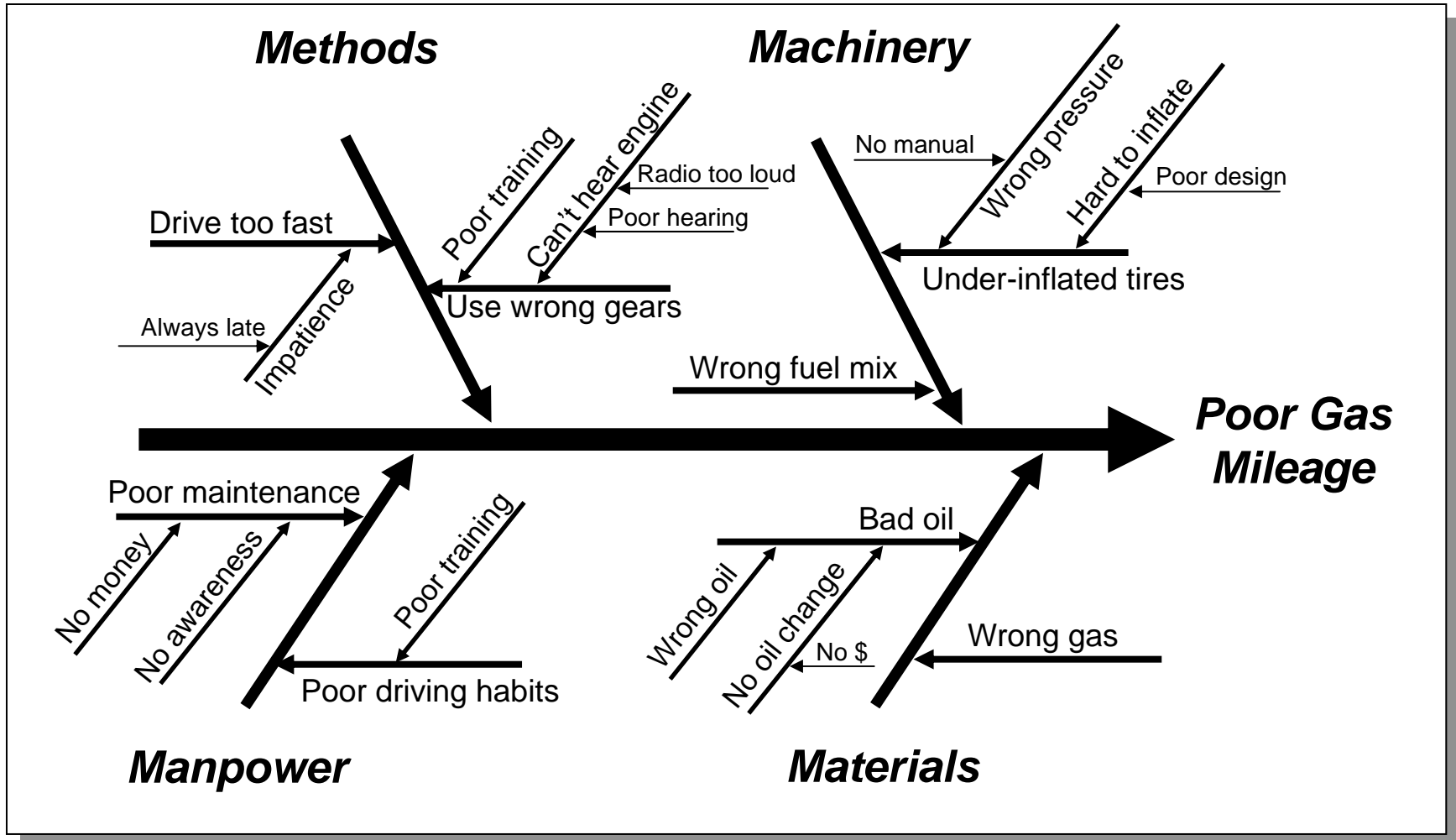
*These “main bones” are only suggestions. For each specific analysis you must use the major factors that describe the types of causes best.*

## External Example: Why is your car getting poor gas mileage?

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## External Example: Why is your car getting poor gas mileage?

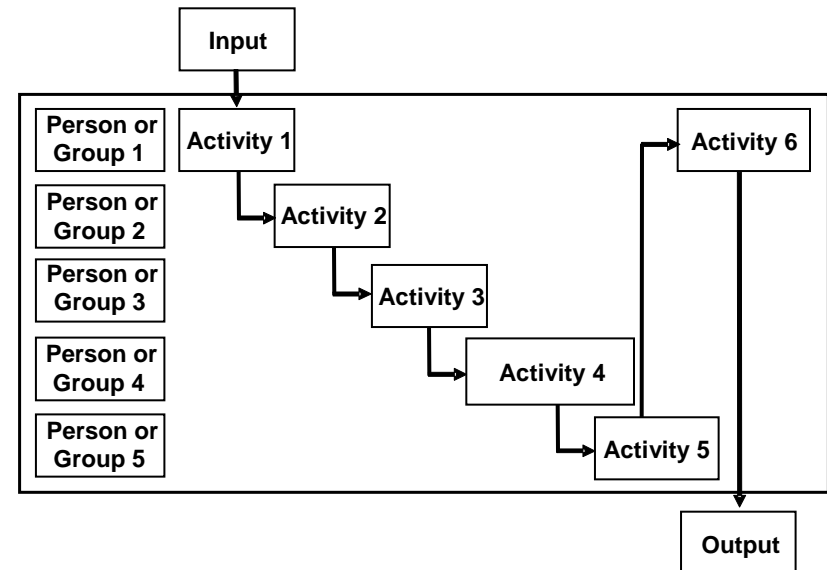


## Process Mapping Definition

**Definition:** *A process map is a diagram of a business process. It helps define and understand dependencies and handoffs.*

### Typical Components

- Overall inputs and outputs
- Responsible parties
- Activities performed
- Activity inputs and outputs
- Activity dependencies
- Timeline

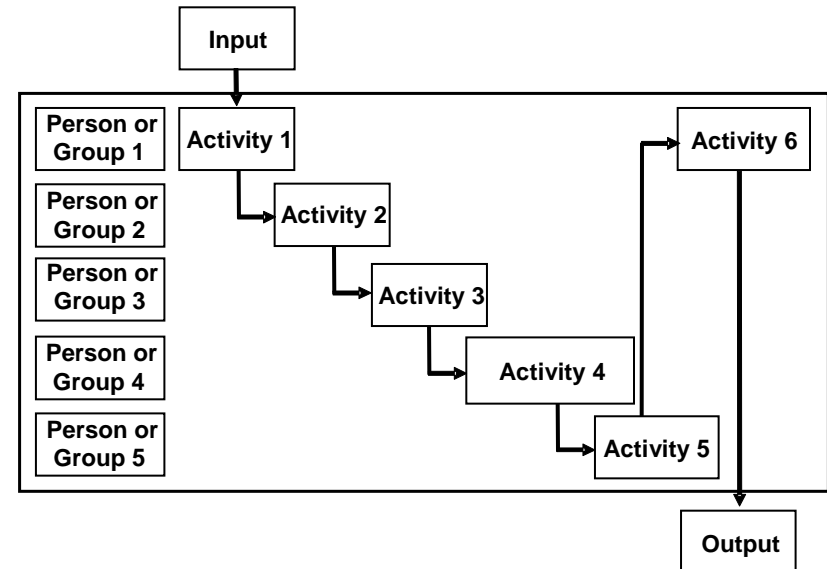


## Process Mapping Creation

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### *How to Draw a Process Map*

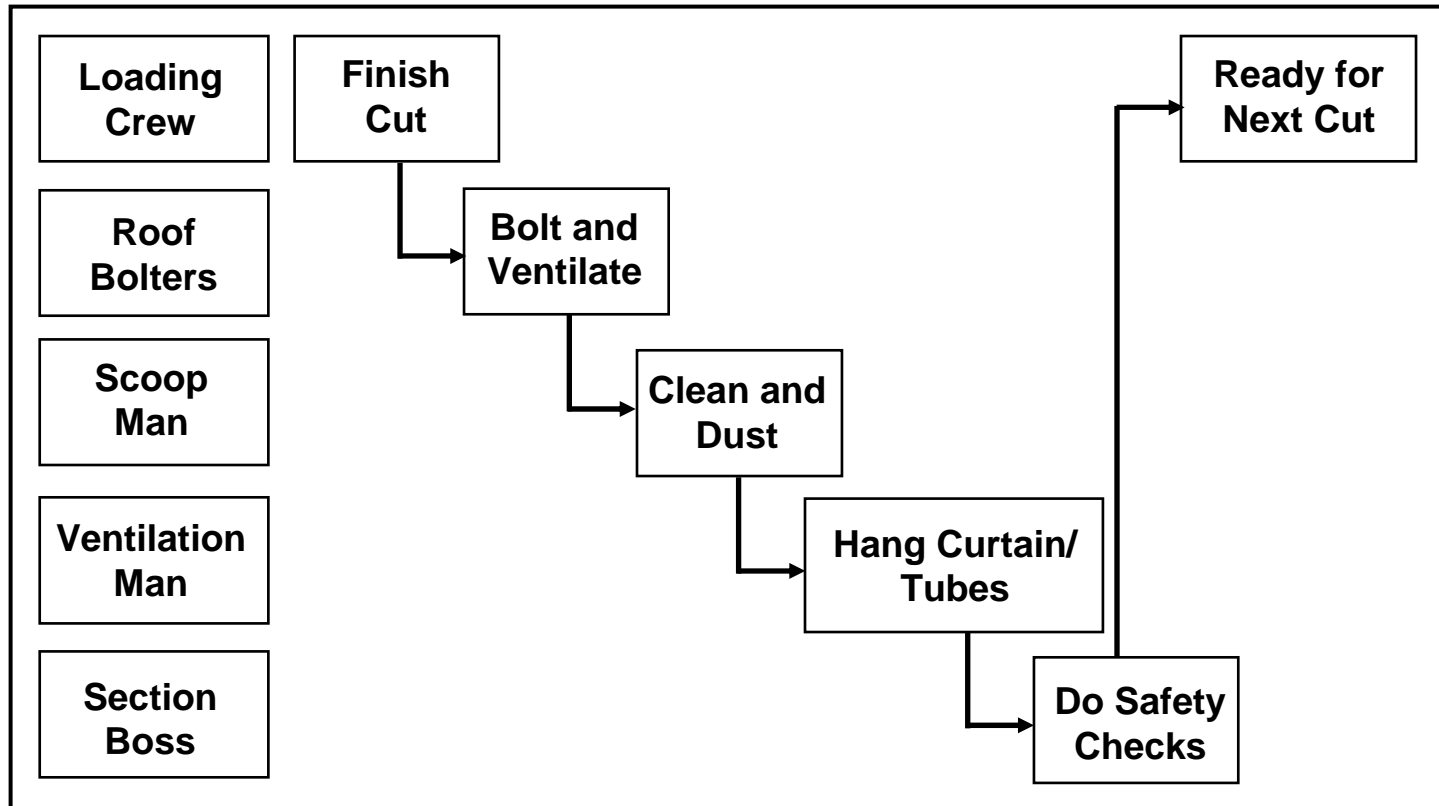
- Identify overall process input(s) and output(s)
- Identify and draw each activity (in sequential order) that contributes to creation of the output(s)
- Identify the responsibly party
- Identify the input(s) and output(s) for each step



## Process Mapping Example

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### *Illustrative Example of Preparation Sub-Process*

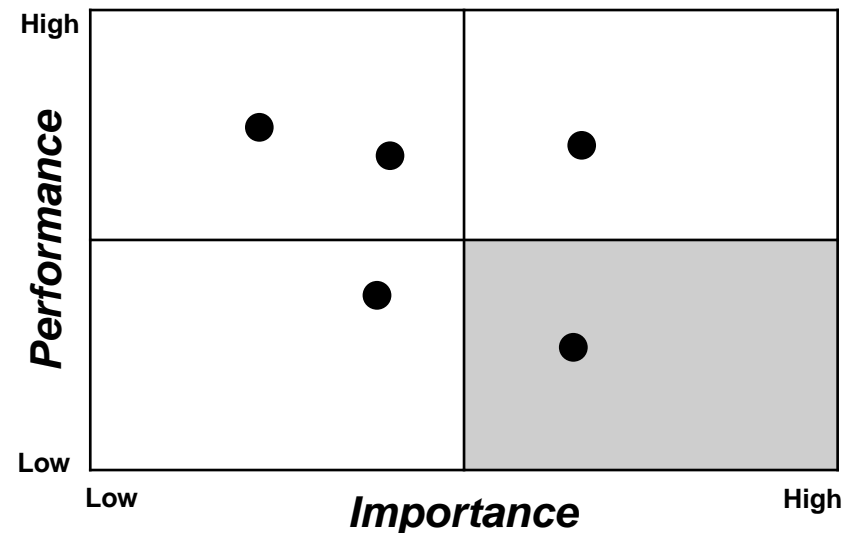


## Importance / Performance Matrix Definition

**Definition:** *An importance/performance matrix is a chart used to identify areas for improvement. Each point represents a specific item that has been rated on importance and performance.*

### Typical Layout

- Importance is represented on the horizontal axis
- Performance is shown on the vertical axis
- The highlighted quadrant shows the priority areas for improvement

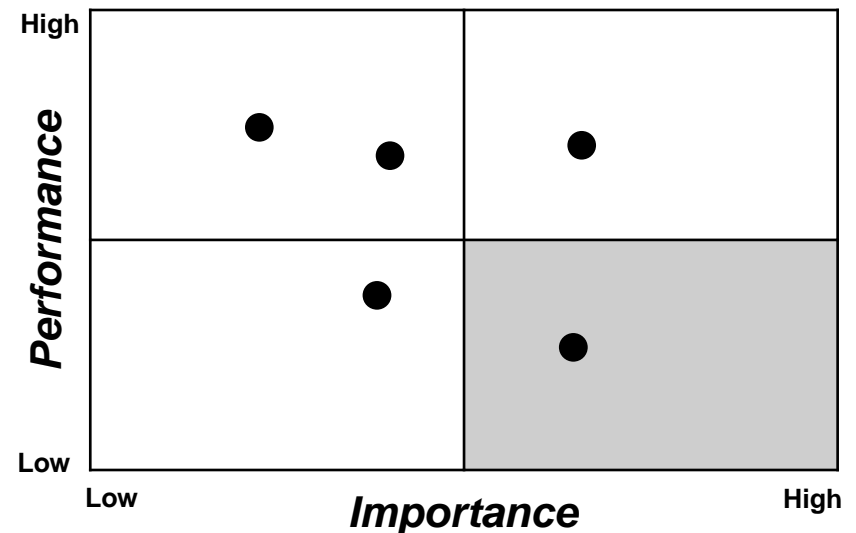


## Importance / Performance Matrix Creation

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### *How to Draw an Importance / Performance Matrix*

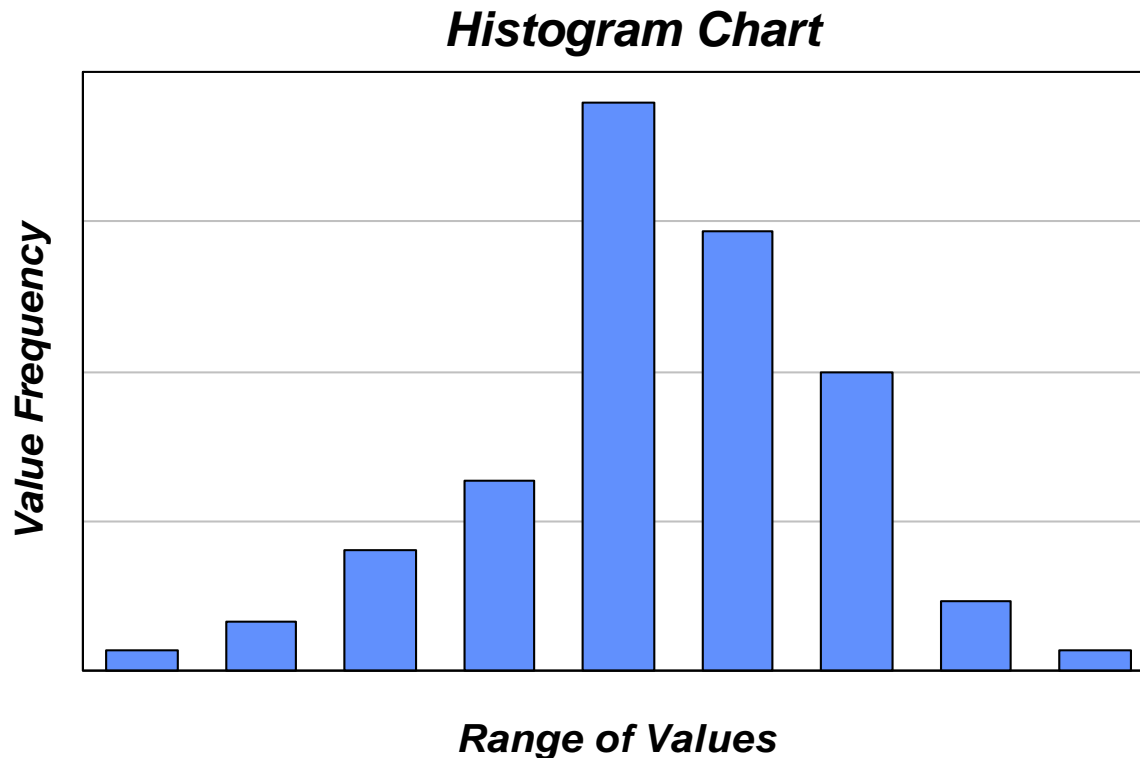
- Quantify the average performance and importance for each item to be shown
- Draw the box and add a scale to the axes
- Add performance average to the chart
- Add the importance average to the chart
- Plot each item on the chart



## Histogram Chart Definition

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**Definition:** *A histogram chart shows how frequently different values occur in a large data sample. Histograms make it easier to interpret / analyze large volumes of data.*



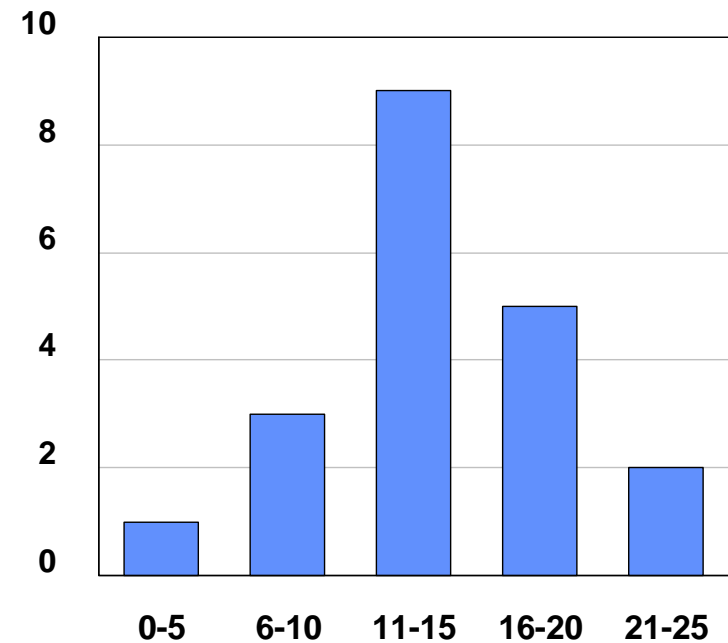
## Histogram Chart Creation

### *How to Draw a Histogram*

- Collect data (at least 30 to 50 data samples)
- Determine data points or ranges for horizontal axis
- Total the data samples within each range
- Draw the histogram based on the totals

Range	Tally	Total
0 - 5	/	1
6 - 10	///	3
11 - 15	//// //	9
16 - 20	////	5
21 - 25	//	2

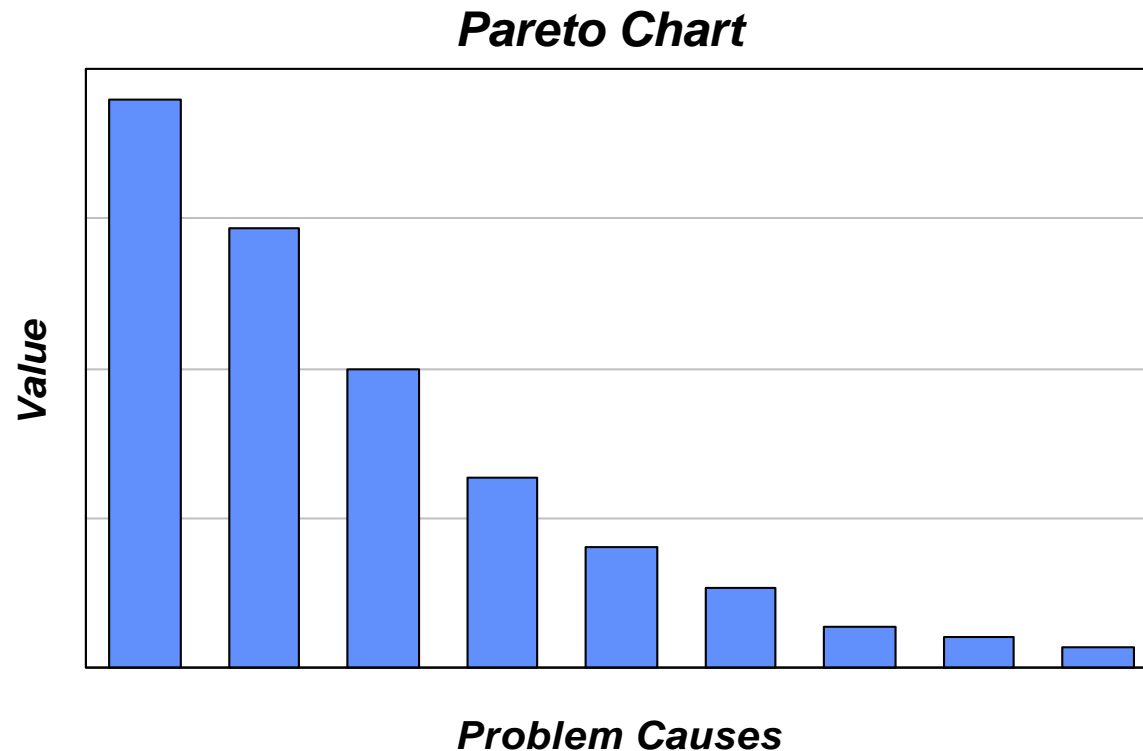
***Histogram***



## Pareto Chart Definition

---

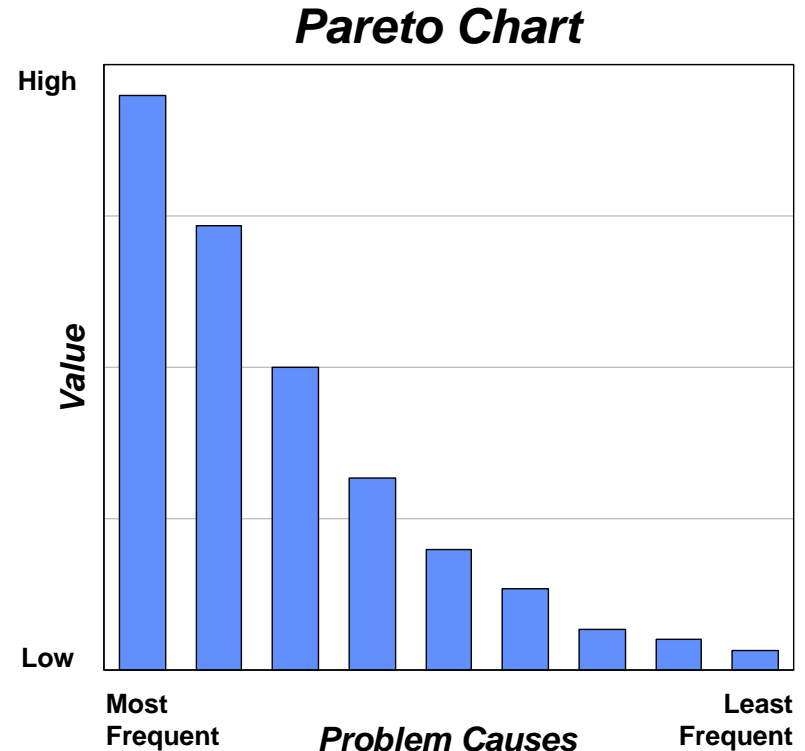
**Definition:** *A Pareto chart is a vertical bar chart that ranks problem causes from most to least important. It is used to identify the most important causes of a problem.*



## Pareto Chart Creation

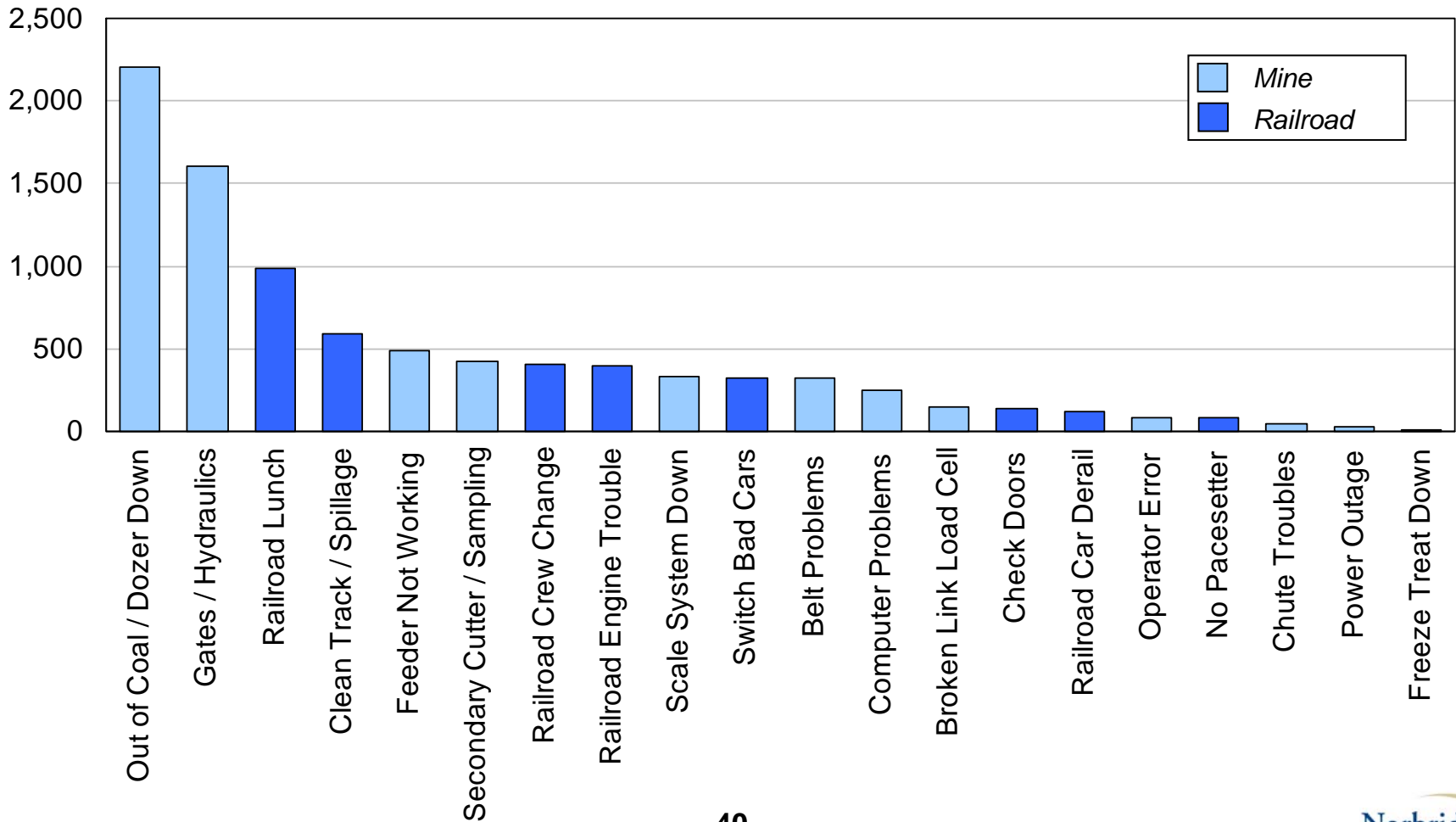
### *How to Draw a Pareto Chart*

- Identify the problem to be studied
- List the problem areas / causes for which data is to be gathered
- Collect the data for each problem area / cause
  - Be consistent with the time frame
  - Use the same units of measure (such as number of occurrences, cost, etc.)
- Construct the Pareto chart with the problem areas / causes listed in descending order



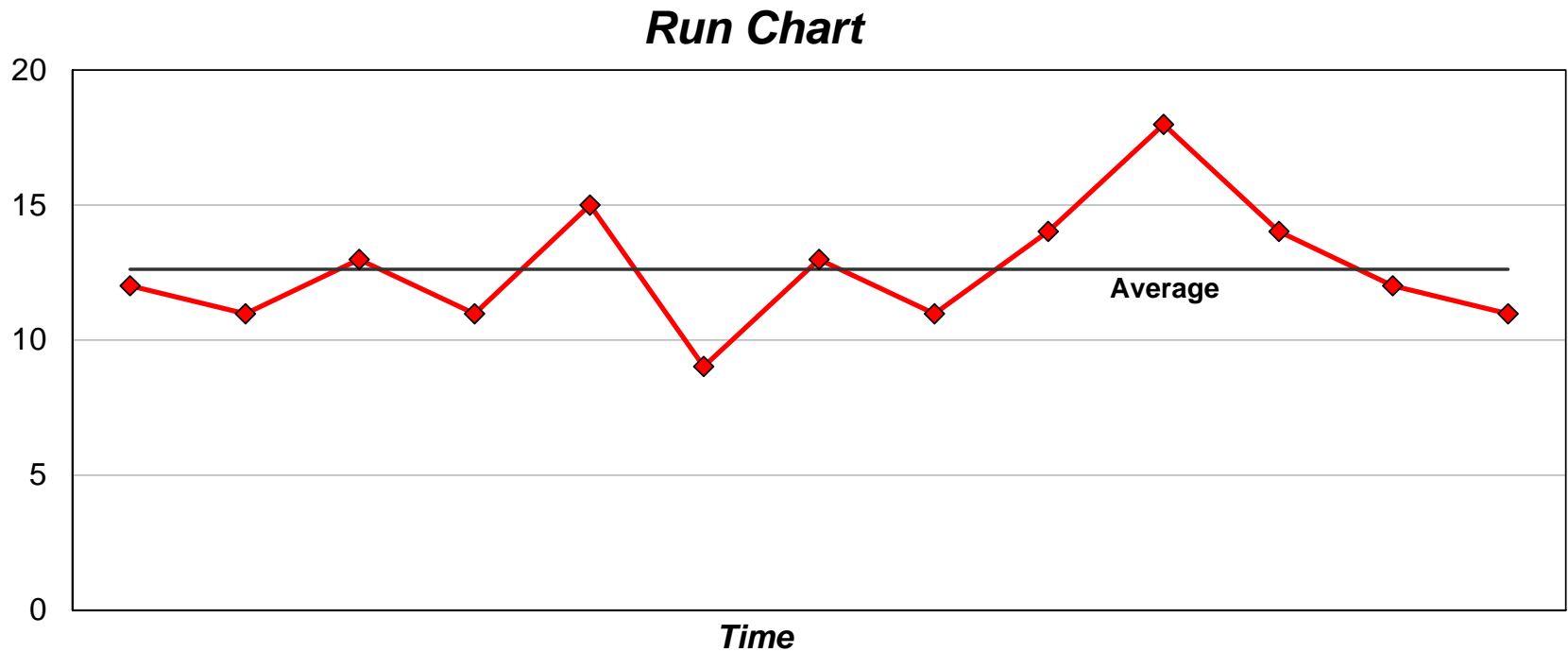
## Pareto Chart Example

**Minutes Lost due to Loadout Delays by Problem**



## Run Chart Definition

**Definition:** *A run chart shows data in time-ordered sequence. It tracks the performance of a process over time, and can visually show if the long-term average is changing.*

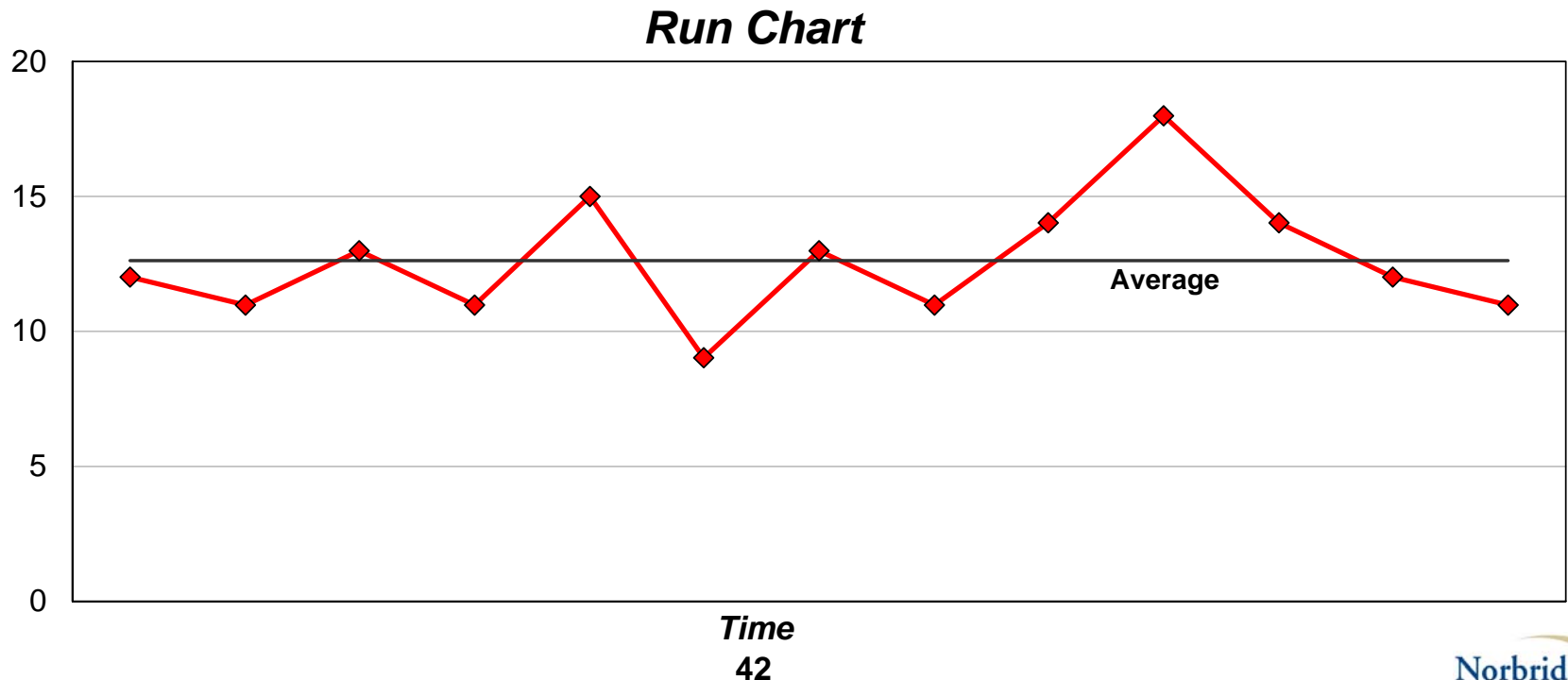


## Run Chart Creation

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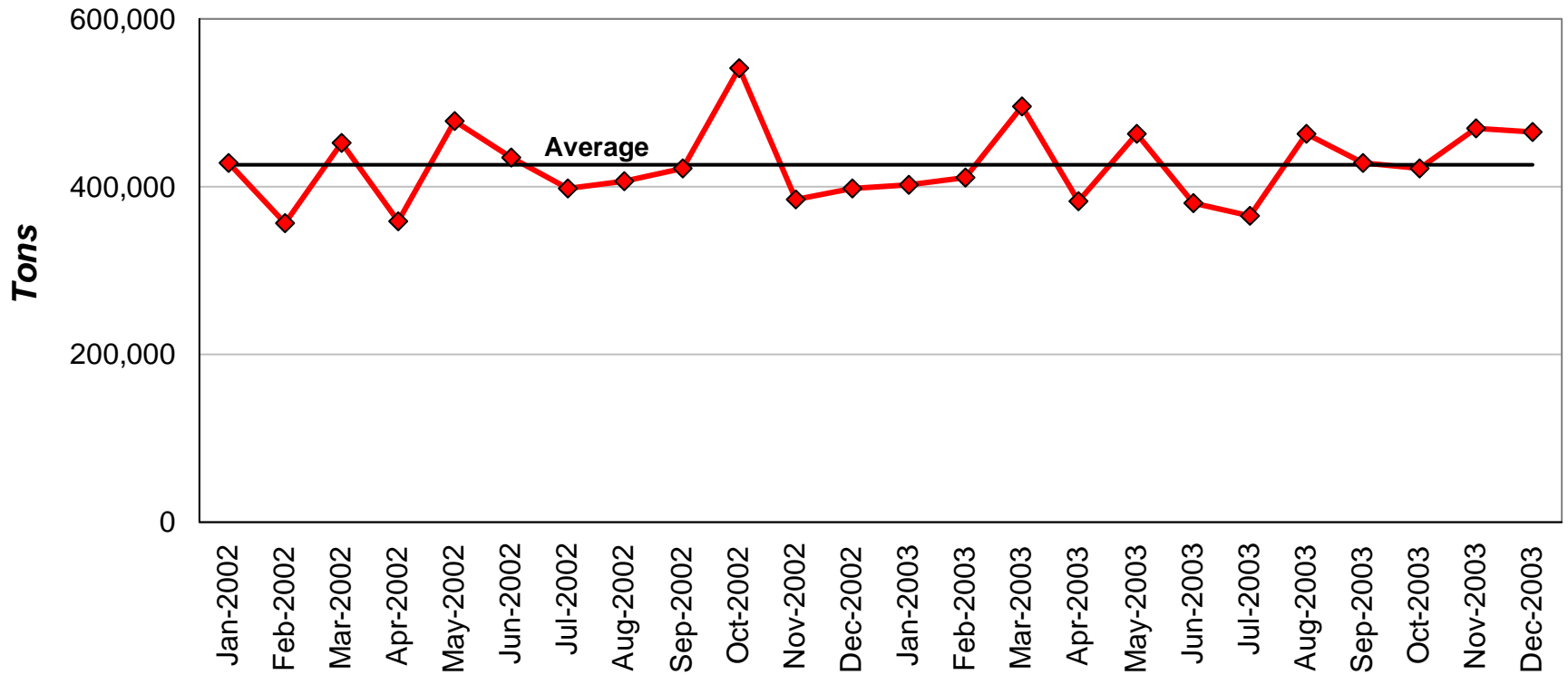
### *How to Draw a Run Chart*

- Collect data and order them in chronological order
- Draw a graph with time on the horizontal axis and units of measure on the vertical axis
- Plot each point and connect adjacent points
- Calculate the average and graph it with a solid line



## Run Chart Example

***Tons Loaded Per Month***

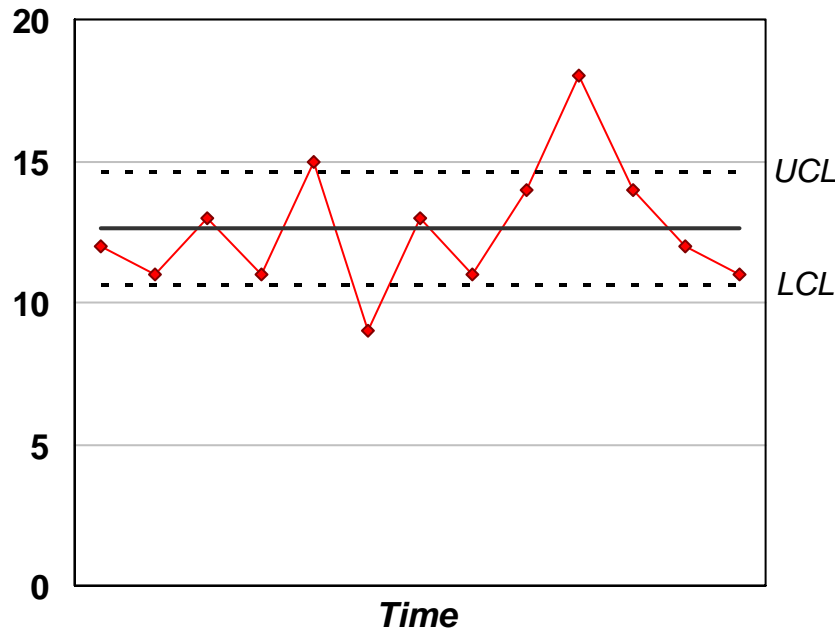


## Control Chart Definition

**Definition:** *A control chart is similar to a run chart, but includes upper and lower control limits. It shows whether a process is stable over time by determining if the associated measure falls within the control limits.*

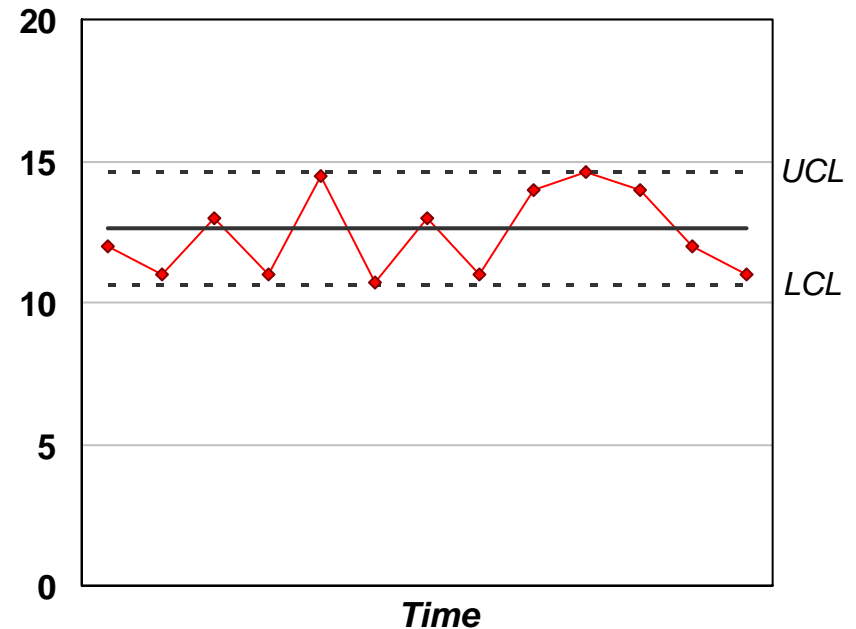
### Unstable Process

(Several Points Fall Outside the Control Limits)



### Stable Process

(All Points Fall Within the Control Limits)



## Flowchart Definition

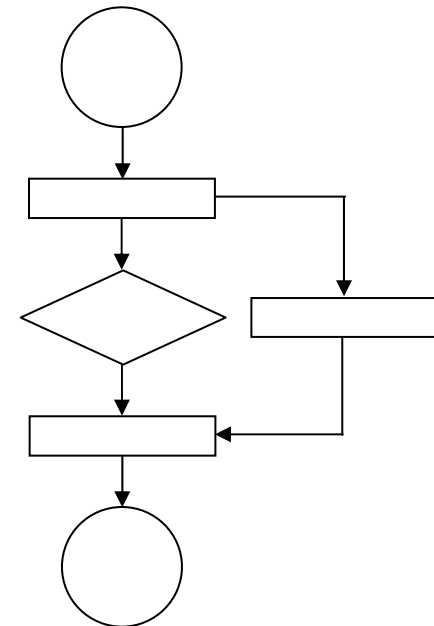
**Definition:** *A flowchart is a picture of the activities performed within a process. Flowcharts use standard symbols, and show activities and decisions in sequential order.*

### Typical Flowchart Uses

- Understand how an activity is performed
- Determine where or why bottlenecks occur
- Design new processes

#### **Flowcharts vs. Process Maps**

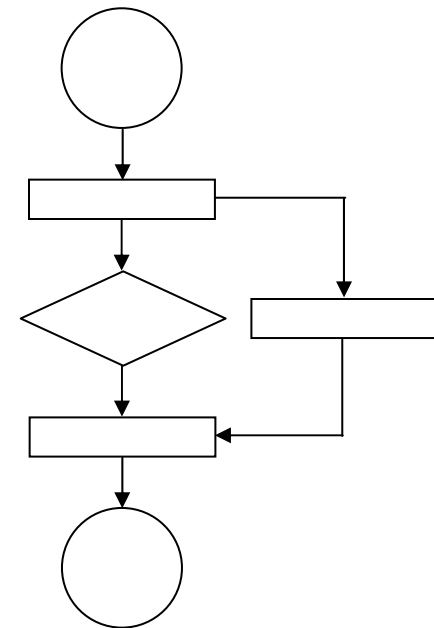
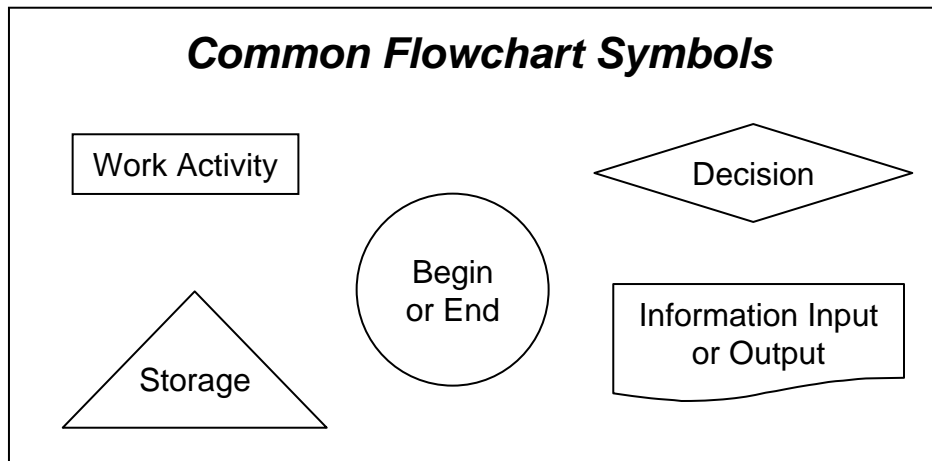
- Both help evaluate processes
- Process maps focus on inputs, outputs and handoffs
- Flowcharts focus on physical or information flows



## Flowchart Creation

### *How to Draw a Flowchart*

- Write a description of the activity
- Draw the symbols for the activity (see below)
- Connect each symbol with arrows

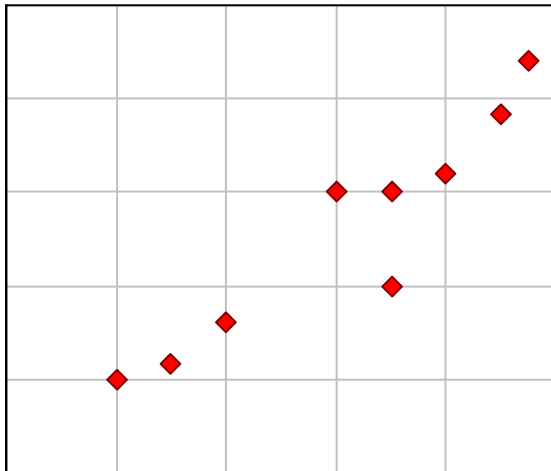


## Scatter Diagram Definition

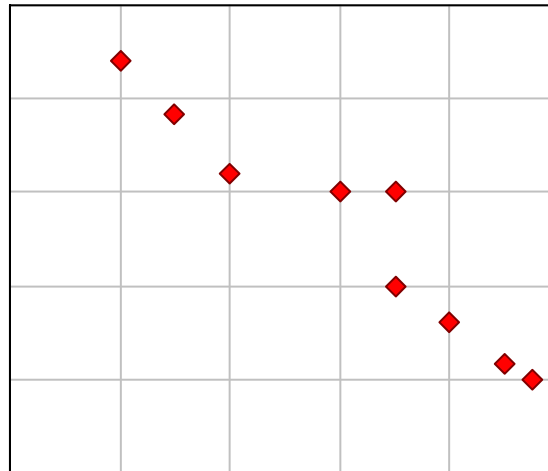
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**Definition:** *A scatter diagram shows the relationship between two variables by showing what happens to one variable when the other changes.*

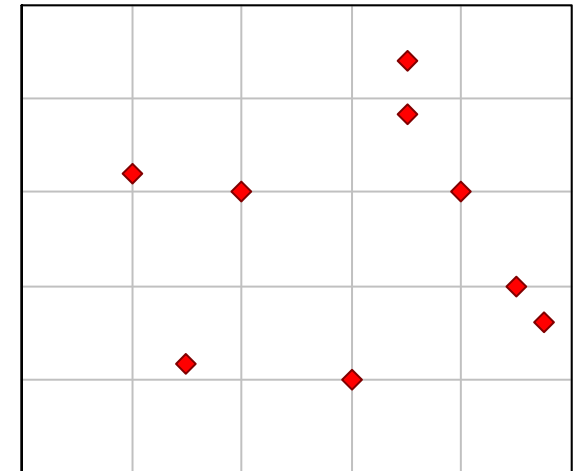
**Positive Correlation**



**Negative Correlation**



**No Correlation**

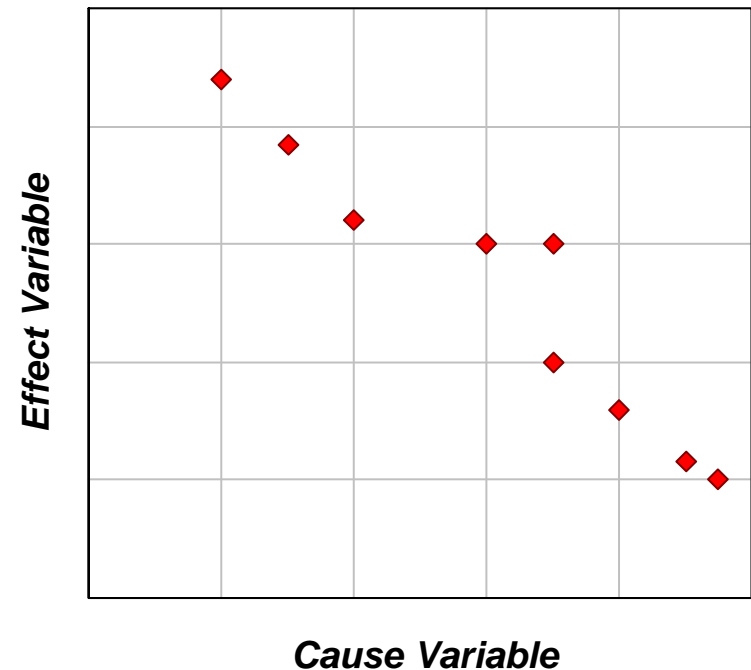


## Scatter Diagram Creation

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### *How to Create a Scatter Diagram*

- Identify at least 30 “paired” sample data points
- Label horizontal axis with variable believed to be the “cause” variable
- Label vertical axis with variable believed to be the “effect” variable
- Plot data on diagram

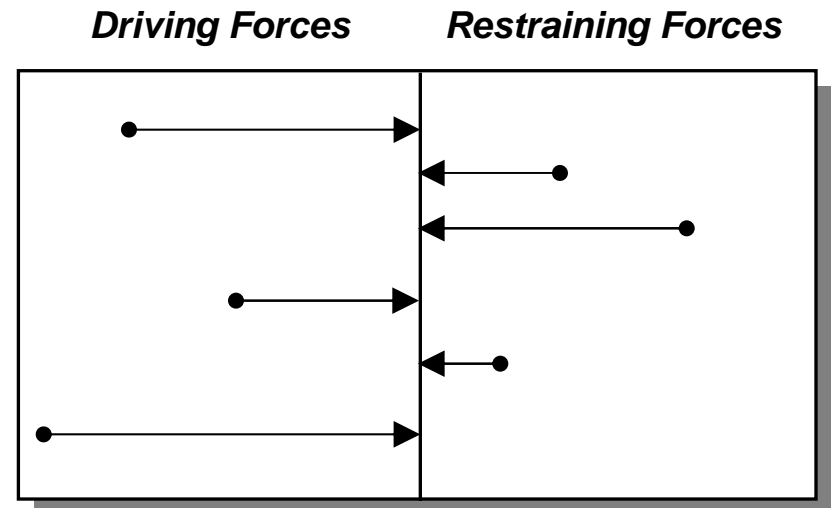


## Force Field Chart Definition

**Definition:** *A force field chart can help identify forces which will help or hinder root cause elimination.*

### Types of Forces

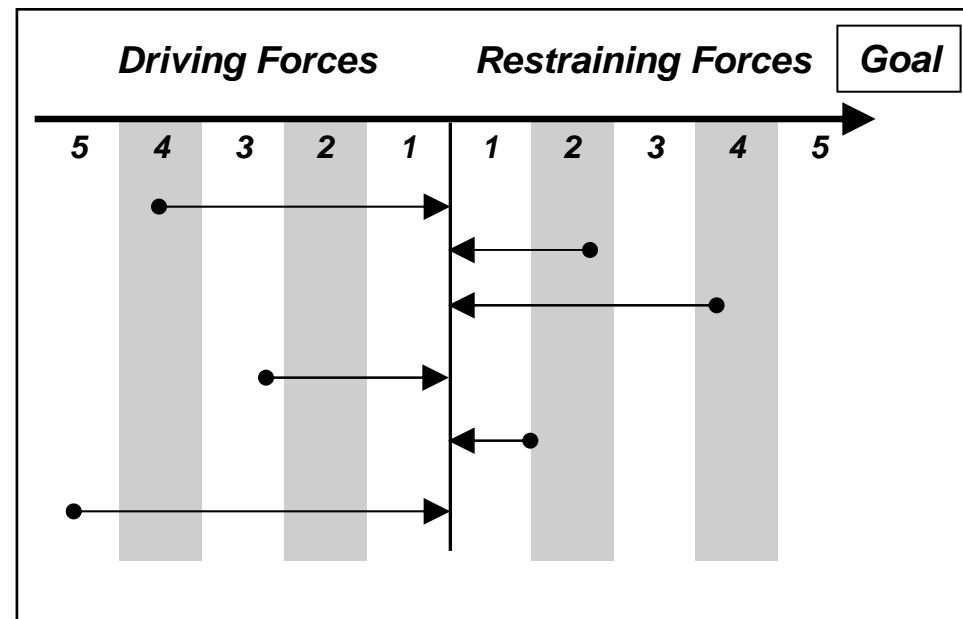
- Driving force: helps move toward the goal
- Restraining force: resists movement toward the goal



## Force Field Chart Creation

### How to Create a Force Field Chart

- State the solution or goal
- Brainstorm current forces impacting ability to achieve the goal
- Rate the strength of each force's influence on achieving the goal
  - 1 = no influence
  - 5 = highest level of influence
- Add labels and arrows
  - Driving forces on the left
  - Restraining forces on the right



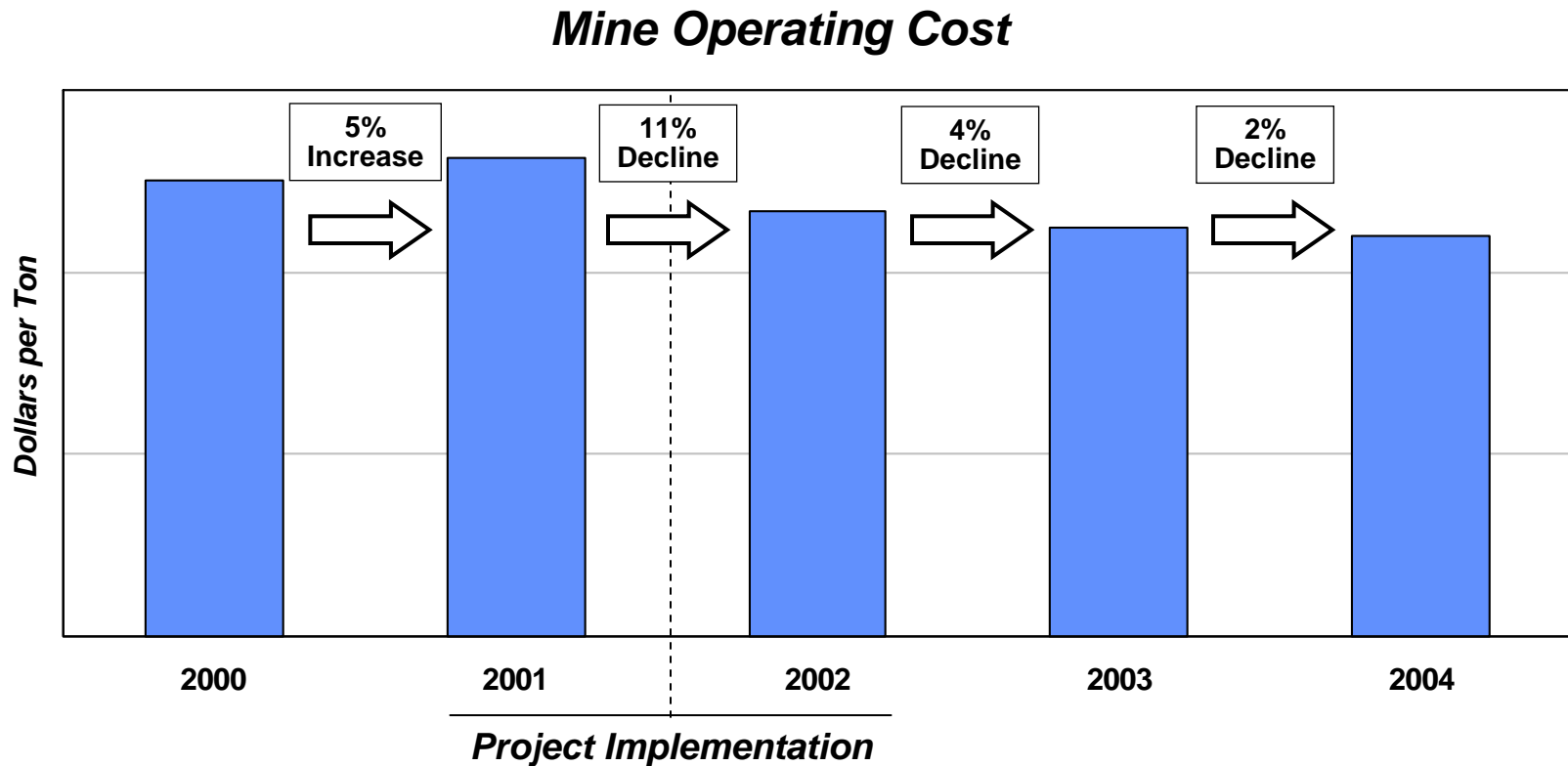
# Contents

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- Introduction
- What Processes and Issues are Typically Addressed?
- What is a Typical Project Like?
- What Tools and Techniques are Used?
- What Results Can be Achieved?
- Information about Norbridge

## Example of Results for Mining Project

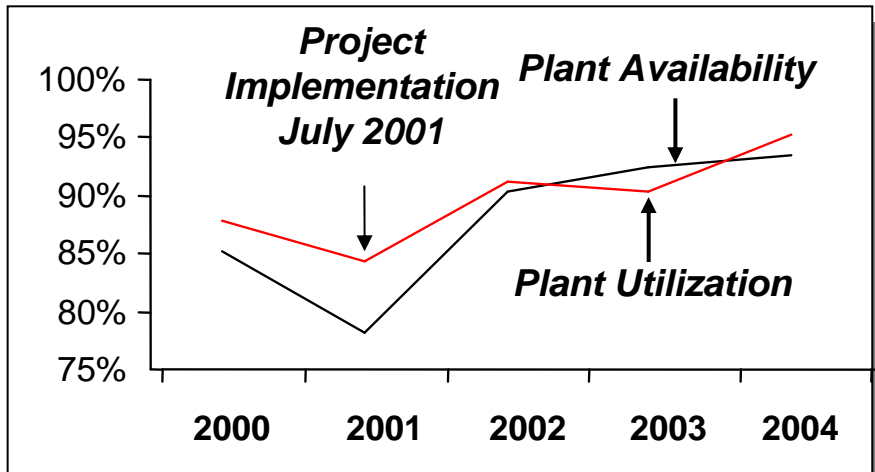
- After implementation, overall costs declined by 17%, and all cost categories were reduced.



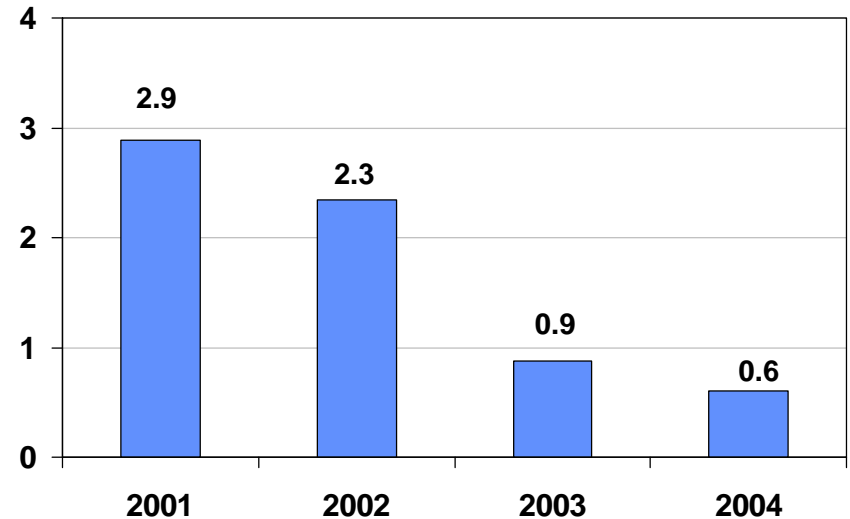
## Example of Results for Processing Project

- Plant availability rose significantly, even with rising throughput.
- Magnetite usage declined by about 70%, with annual savings over \$0.5 Million.

**Plant Availability and Utilization**



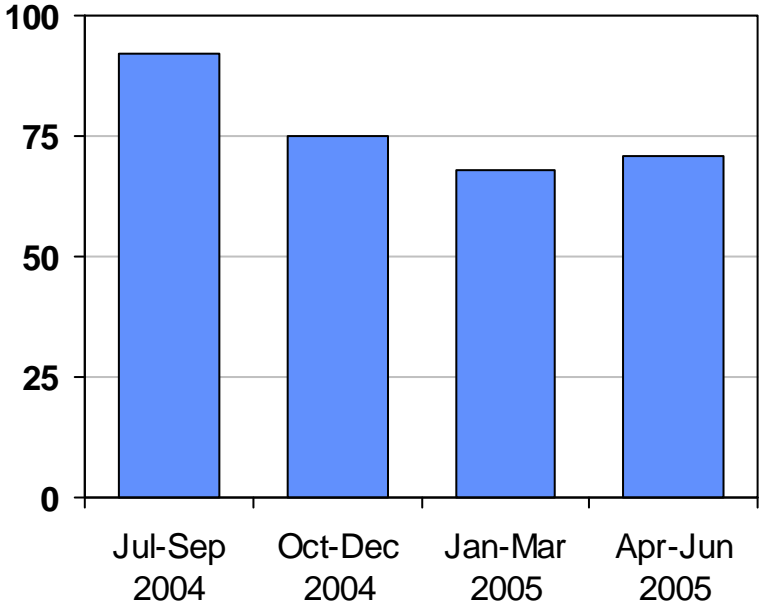
**Magnetite Usage (Lbs Per Raw Ton Processed)**



# Example of Results for Rail Loadout Project

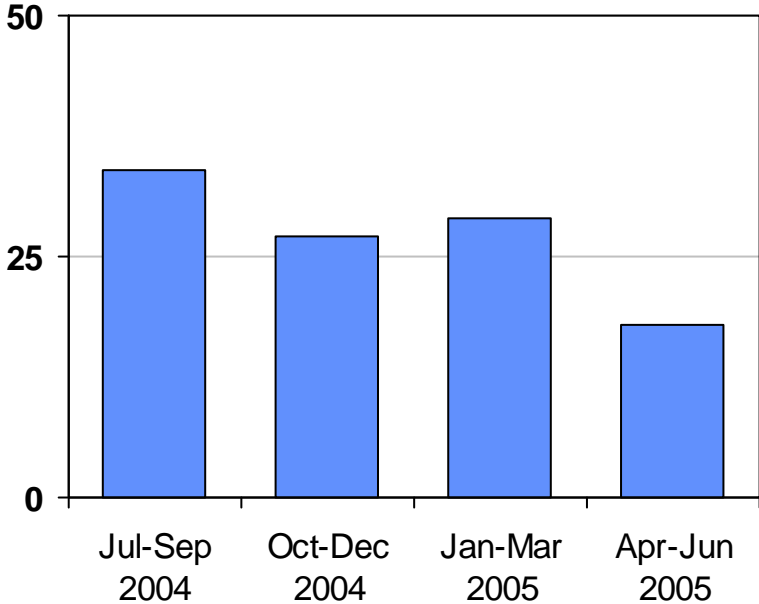
- The train arrival and loading processes have significantly improved.

***Average Minutes from Train Arrival to Loading***



**23% Decline from Q1 to Q4  
(Since Implementation)**

***Average Railroad-Related Delays Per Train (Minutes)***



**47% Decline from Q1 to Q4**

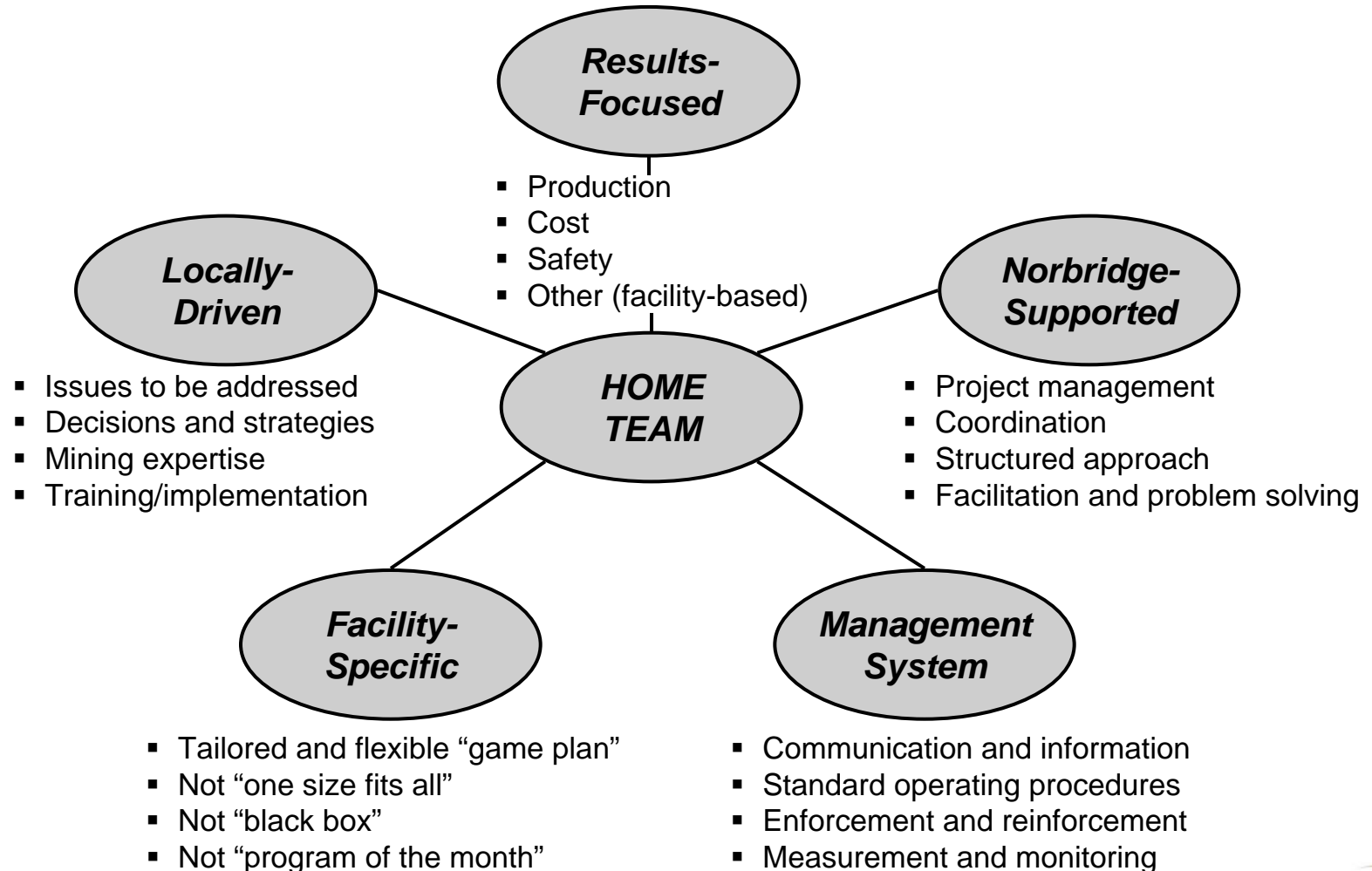
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**We leverage our process-driven approach, “HOME TEAM”, to support performance improvement in the mining industry.**

**Key Characteristics of “HOME TEAM” at Mines, Processing Plants and Loadouts**



## **Norbridge helps companies improve performance.**

---

### **Who we are**

- Consultants to mining, transportation, and utility industries
- Based in Boston, Chicago and Washington, D.C.
- Founded in 1993

### **What we do**

- We support senior management and project teams
- We are facilitators and coordinators
- We are rigorous researchers and analysts
- We surface issues and provide the structure to solve them
- We bring together the key players to identify solutions and make things happen
- We set up measurement systems to monitor results and make sure the solutions work
- We are team players and recognize that the answers are different for each client
- We work within the client's organizational style and culture

## **We are contributors to the mining community.**

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- **We have conducted projects for:**
  - Mines
  - Processing plants
  - Transportation loadouts
  - Facility safety
  - Root cause analysis
- **We conducted a benchmarking study on mining company performance**
  - Focused on performance improvement challenges, opportunities and results
  - Seventeen of the leading North American mining companies participated
- **We co-founded this conference in 2004 with the Penn State Mining Engineering Department on performance improvement in the mining industry**
- **We speak regularly at industry conferences – SME, Coal Marketing Days, Coal Market Strategies, Other**

**We provide a wide range of services.**

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***Norbridge Industry and Functional Focus***

***Core Industries***

- Mining
- Transportation
- Maritime and ports
- Electric utilities
- Pharmaceutical and medical products

***Functional Services***

- Operations improvement
- Process management
- Corporate and business unit development and planning
- Business modeling
- Market, product, and sales strategy
- eCommerce strategy
- Organization development
- Supply chain and logistics management
- Purchasing and procurement

***A broad range of general management consulting support for a select group of industries and clients***

## Norbridge frequently works at mining facilities – mines, processing plants, and transportation loadouts – to help improve performance.\*

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### *Norbridge's Facility-Specific Approach*

- **Our projects are highly results-driven.** We focus on achieving significant and sustained performance improvements in the areas that clients care about most: production, cost, safety, communication, teamwork and other areas.
- **Our Norbridge project teams are cost effective.** We do not send a large project team to "swarm" across mining operations, but rather work closely with the project team and tailor our efforts to do what needs to be done.
- **We are facilitators and problem solvers.** We do not come in, claim to be mining experts, and tell people what to do. Rather, we work closely with the project team to identify the problems, develop and implement the game plan to improve performance, and "make it stick".
- **We are not the program of the month.** The "game plans" that our project teams implement are strong, flexible, and designed to "stand the test of time".
- **We build teamwork and get employees involved.** To improve performance significantly and sustain strong results over the long-term, mining facilities need a strong management team and a workforce that feels they are an important "part of the team". The teamwork and communication when we finish a project is typically much stronger than when we arrive on site.
- **We build strong performance measurement systems.** To improve performance, we work with the project team to build an integrated performance measurement system including two types of measures: current performance measures and early warning measures. To manage mining operations most effectively, it is particularly important to have a measurement system for each facility which tells management what they need to know today, but also which highlights potential problems for the future that need to be addressed. Our measurement systems often track issues, problems or processes that have not been tracked by our clients in the past.

\* For more information about Norbridge, visit our website at [www.norbridgeinc.com](http://www.norbridgeinc.com)