

Module 5

CAUSE-AND-EFFECT DIAGRAM

What is a Cause-and-Effect Diagram?

A Cause-and-Effect Diagram is a tool that helps identify, sort, and display possible causes of a specific problem or quality characteristic (Viewgraph 1). It graphically illustrates the relationship between a given outcome and all the factors that influence the outcome. This type of diagram is sometimes called an "Ishikawa diagram" because it was invented by Kaoru Ishikawa, or a "fishbone diagram" because of the way it looks.

When should a team use a Cause-And-Effect Diagram?

Constructing a Cause-and-Effect Diagram can help your team when you need to

- Identify the possible root causes, the basic reasons, for a specific effect, problem, or condition.
- Sort out and relate some of the interactions among the factors affecting a particular process or effect.
- Analyze existing problems so that corrective action can be taken.

Why should we use a Cause-and-Effect Diagram?

A Cause-and-Effect Diagram is a tool that is useful for identifying and organizing the known or possible causes of quality, or the lack of it. The structure provided by the diagram helps team members think in a very systematic way. Some of the benefits of constructing a Cause-and-Effect Diagram (Viewgraphs 2) are that it

- Helps determine the root causes of a problem or quality characteristic using a structured approach.
- Encourages group participation and utilizes group knowledge of the process.
- Uses an orderly, easy-to-read format to diagram cause-and-effect relationships.
- Indicates possible causes of variation in a process.
- Increases knowledge of the process by helping everyone to learn more about the factors at work and how they relate.
- Identifies areas where data should be collected for further study.

What Is a Cause-and-Effect Diagram?

A graphic tool that helps identify, sort, and display possible causes of a problem or quality characteristic.

CAUSE-AND-EFFECT DIAGRAM

VIEWGRAPH 1

Benefits of Using a Cause-and-Effect Diagram

- Helps determine root causes
- Encourages group participation
- Uses an orderly, easy-to-read format
- Indicates possible causes of variation
- Increases process knowledge
- Identifies areas for collecting data

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VIEWGRAPH 2

How do we develop a Cause-and-Effect Diagram?

When you develop a Cause-and-Effect Diagram, you are constructing a structured, pictorial display of a list of causes organized to show their relationship to a specific effect. Viewgraph 3 shows the basic layout of a Cause-and-Effect Diagram. Notice that the diagram has a cause side and an effect side. The steps for constructing and analyzing a Cause-and-Effect Diagram are outlined below.

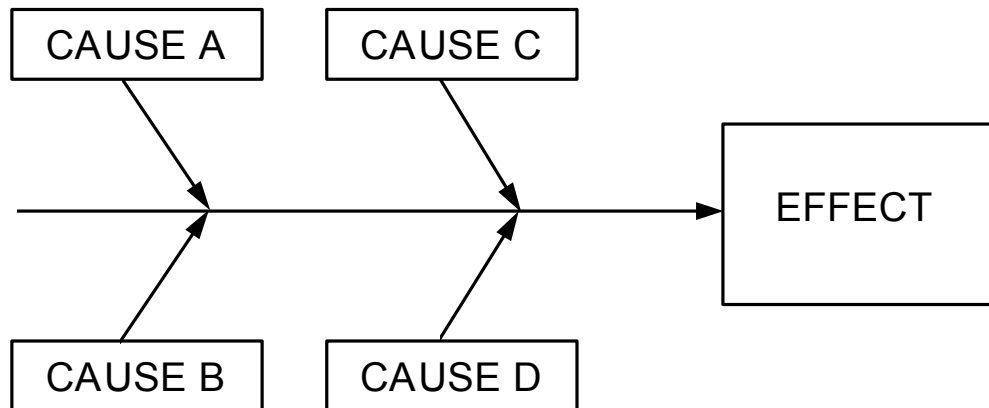
Step 1 - Identify and clearly define the outcome or EFFECT to be analyzed (Viewgraph 4).

- Decide on the effect to be examined. Effects are stated as particular quality characteristics, problems resulting from work, planning objectives, and the like.
- Use Operational Definitions. Develop an Operational Definition of the effect to ensure that it is clearly understood.
- Remember, an effect may be positive (an objective) or negative (a problem), depending upon the issue that's being discussed.
 - > Using a positive effect which focuses on a desired outcome tends to foster pride and ownership over productive areas. This may lead to an upbeat atmosphere that encourages the participation of the group. When possible, it is preferable to phrase the effect in positive terms.
 - > Focusing on a negative effect can sidetrack the team into justifying why the problem occurred and placing blame. However, it is sometimes easier for a team to focus on what causes a problem than what causes an excellent outcome. While you should be cautious about the fallout that can result from focusing on a negative effect, getting a team to concentrate on things that can go wrong may foster a more relaxed atmosphere and sometimes enhances group participation.

You must decide which approach will work best with your group.

NOTE: The EXAMPLE that is imbedded in the explanation of Cause-and-Effect Diagram construction and analysis on the next few pages is based on a chart in The Memory Jogger [Ref. 1, p. 28]. This diagram has been broken down into its component parts and expanded to illustrate the construction steps. Using this example, we will diagram the causes relating to a car's getting poor gas mileage.

Basic Layout of Cause-and-Effect Diagrams



CAUSE-AND-EFFECT DIAGRAM

VIEWGRAPH 3

Step 1 - Identify and Define the Effect

- Decide on the effect to examine
- Use Operational Definitions
- Phrase effect as
 - > positive (an objective) or
 - > negative (a problem)

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VIEWGRAPH 4

Step 2 - Using a chartpack positioned so that everyone can see it, draw the SPINE and create the EFFECT box.

- Draw a horizontal arrow pointing to the right. This is the spine.
- To the right of the arrow, write a brief description of the effect or outcome which results from the process.

EXAMPLE: The EFFECT is Poor Gas Mileage (Viewgraph 5).

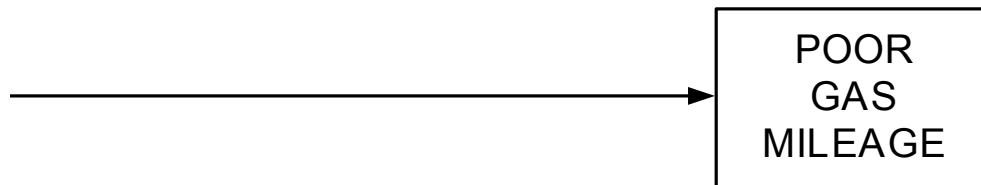
- Draw a box around the description of the effect.

Step 3 - Identify the main CAUSES contributing to the effect being studied. These are the labels for the major branches of your diagram and become categories under which to list the many causes related to those categories.

- Establish the main causes, or categories, under which other possible causes will be listed. You should use category labels that make sense for the diagram you are creating. Here are some commonly used categories:
 - > 3Ms and P - methods, materials, machinery, and people
 - > 4Ps - policies, procedures, people, and plant
 - > Environment - a potentially significant fifth category
- Write the main categories your team has selected to the left of the effect box, some above the spine and some below it.
- Draw a box around each category label and use a diagonal line to form a branch connecting the box to the spine.

EXAMPLE: Viewgraph 6 uses the 3Ms and P to start developing the diagram we began in Step 2.

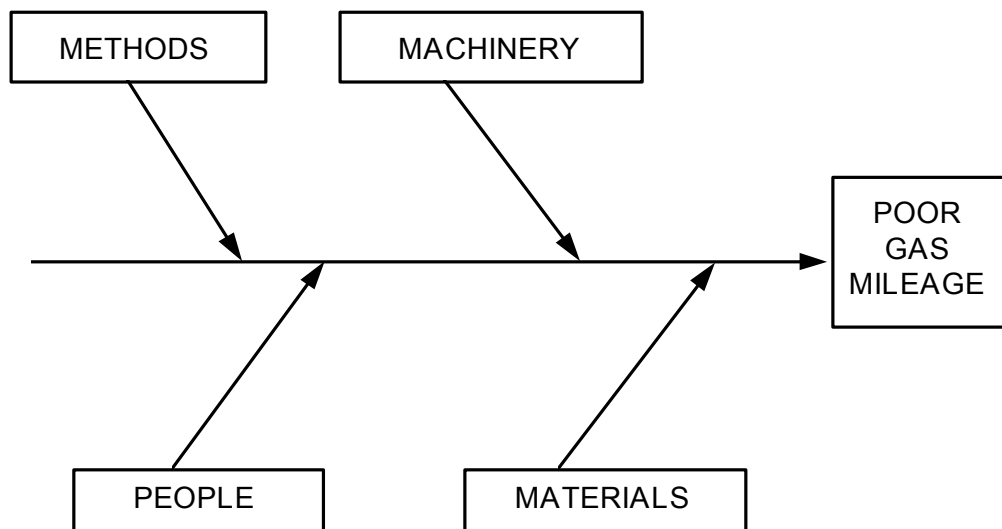
Step 2 - Fill in the Effect Box and Draw the Spine



CAUSE-AND-EFFECT DIAGRAM

VIEWGRAPH 5

Step 3 - Identify Main Categories



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VIEWGRAPH 6

Step 4 - For each major branch, identify other specific factors which may be the CAUSES of the EFFECT [Ref. 5, p. 20].

- Identify as many causes or factors as possible and attach them as subbranches of the major branches.

EXAMPLE: The possible CAUSES for Poor Gas Mileage are listed under the appropriate categories in Viewgraph 7:

- Fill in detail for each cause. If a minor cause applies to more than one major cause, list it under both.

Step 5 - Identify increasingly more detailed levels of causes and continue organizing them under related causes or categories. You can do this by asking a series of why questions.

EXAMPLE: We'll use a series of why questions to fill in the detailed levels for one of the causes listed under each of the main categories.

Q: Why was the driver USING THE WRONG GEAR?

A: The driver couldn't hear the engine.

Q: Why couldn't the driver hear the engine?

A: The radio was too loud.

A: Poor hearing

Q: Why were the TIRES UNDERINFLATED?

A: No record of tire pressure

A: Difficult air stems

Q: Why were the air stems difficult?

A: Poor design

Q: Why was MAINTENANCE POOR?

A: Lack of money

A: No awareness

Q: Why was WRONG OCTANE GAS used?

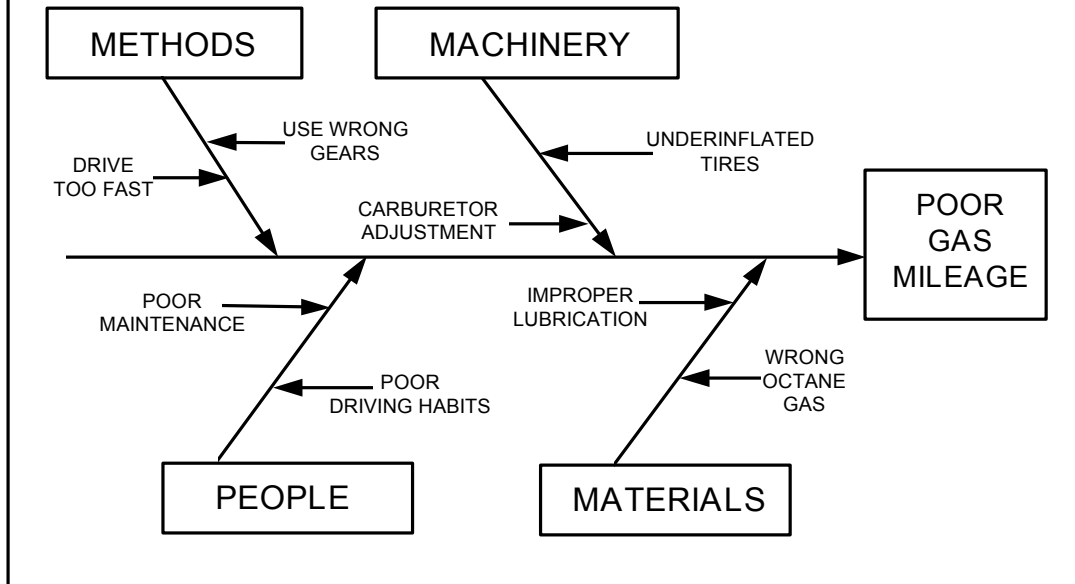
A: Didn't know recommended octane

Q: Why wasn't recommended octane known?

A: No owner's manual

Viewgraph 8 shows how the diagram looks when all the contributing causes that were identified by the series of why questions have been filled in. As you can see, there may be many levels of causes contributing to the effect.

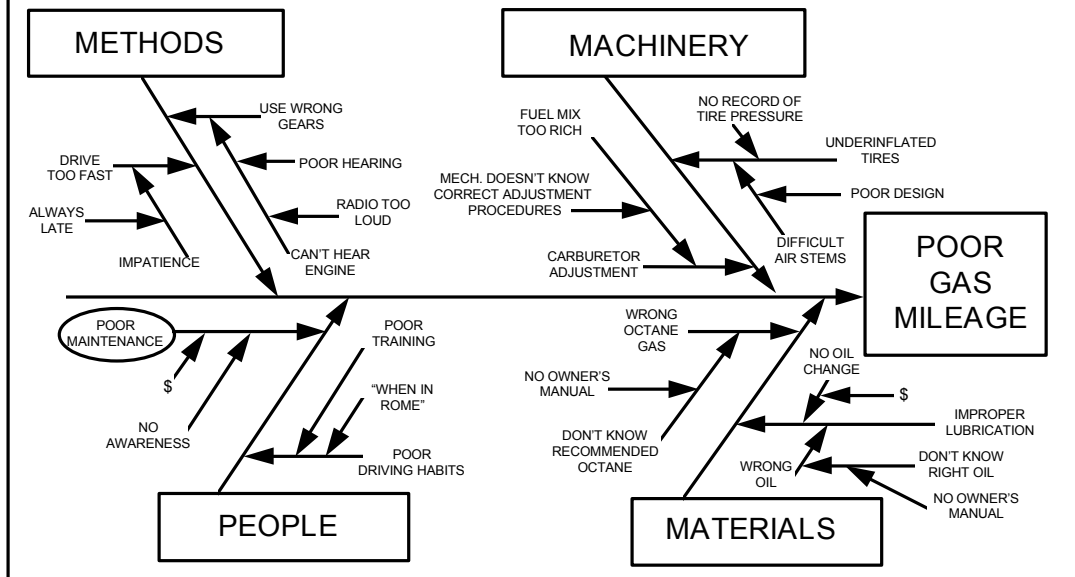
Step 4 - Identify Causes Influencing the Effect



CAUSE-AND-EFFECT DIAGRAM

VIEWGRAPH 7

Step 5 - Add Detailed Levels Step 6 - Analyze the Diagram



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VIEWGRAPH 8

NOTE: You may need to break your diagram into smaller diagrams if one branch has too many subbranches. Any main cause (3Ms and P, 4Ps, or a category you have named) can be reworded into an effect.

Step 6 - Analyze the diagram. Analysis helps you identify causes that warrant further investigation. Since Cause-and-Effect Diagrams identify only possible causes, you may want to use a Pareto Chart to help your team determine the cause to focus on first.

- Look at the “balance” of your diagram, checking for comparable levels of detail for most of the categories.
 - > A thick cluster of items in one area may indicate a need for further study.
 - > A main category having only a few specific causes may indicate a need for further identification of causes.
 - > If several major branches have only a few subbranches, you may need to combine them under a single category.
- Look for causes that appear repeatedly. These may represent root causes.
- Look for what you can measure in each cause so you can quantify the effects of any changes you make.
- Most importantly, identify and circle the causes that you can take action on.

EXAMPLE: Let's analyze the diagram we have been constructing.

- > The level of detail is pretty well balanced.
- > No causes are repeated.
- > Poor Maintenance appears to be a cause for which you could develop measurements.
- > Moreover, Poor Maintenance appears to be a cause that you can take action on. It is circled in Viewgraph 8 to earmark it for further investigation.

How can we practice what we've learned?

Some practical exercises will enable your team to practice constructing and analyzing Cause-and-Effect Diagrams. The first exercise is sketched out in detail. When you have completed that, you can try your hand with one or two other topics from the list that follows the detailed exercise.

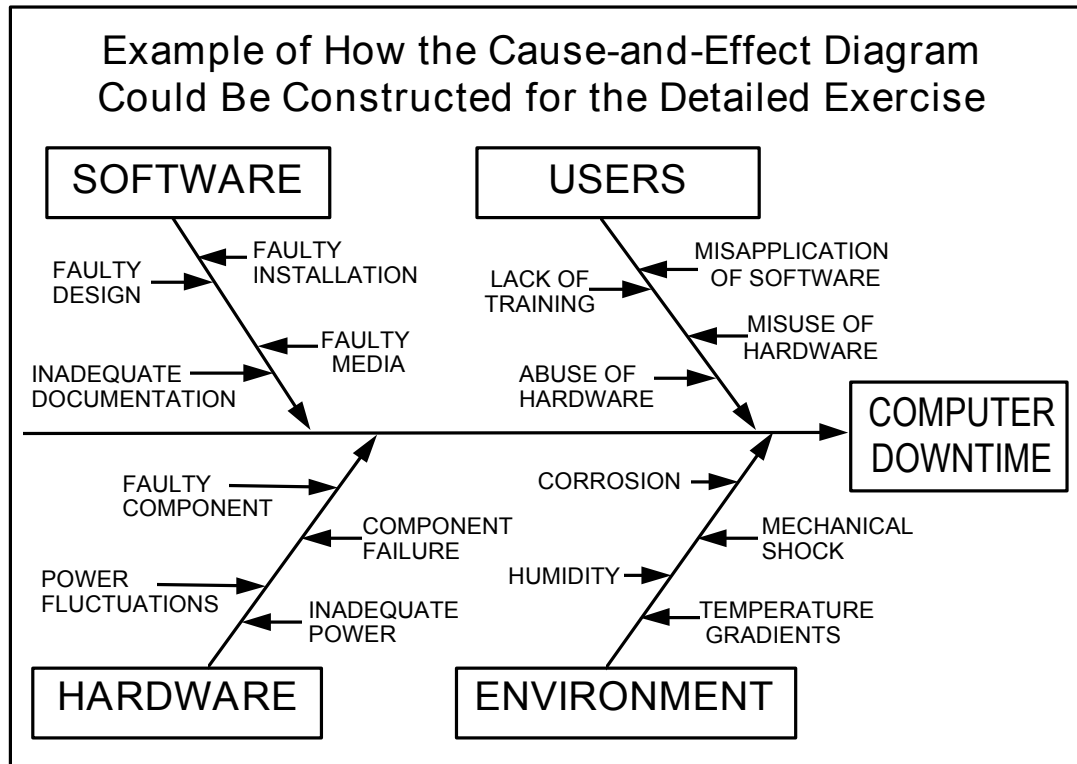
DETAILED EXERCISE: Construct a Cause-and-Effect Diagram to identify the causes of computer downtime in your organization.

- Draw a horizontal arrow to the right, write the effect (computer downtime), and draw a box around it.
- Identify the main causes contributing to the effect.
- Draw boxes around the main categories and connect the boxes to the horizontal arrow with diagonal arrows to form the fishbone.
- For each branch, identify specific factors which may be the causes of the effect.
- Add increasingly detailed levels of causes.
- Analyze the diagram and circle causes that you can take action on.

Viewgraph 9 shows one way the completed diagram could be drawn.

OTHER EXERCISE TOPICS:

- > What is causing the poor state of readiness of the fire control systems?
- > What is causing our ship to drag anchor in heavy weather?
- > What is causing us to fail our corrosion-control inspections?
- > What factors affect the proper disposal of recyclable material on the base?
- > What things do we need to consider in planning a perfect meeting?
- > What factors affect the flow of information within our organization?
- > What is causing the organization's vehicles to get poor gas mileage?
- > What factors contribute to slow prescription service at the pharmacy?
- > What will ensure that we have a successful unit Christmas party?



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VIEWGRAPH 9

REFERENCES:

1. Brassard, M. (1988). The Memory Jogger, A Pocket Guide of Tools for Continuous Improvement, pp. 24 - 29. Methuen, MA: GOAL/QPC.
2. Department of the Navy (November 1992). Fundamentals of Total Quality Leadership (Instructor Guide), pp. 6-25 - 6-29. San Diego, CA: Navy Personnel Research and Development Center.
3. Department of the Navy (September 1993). Systems Approach to Process Improvement (Instructor Guide), pp. 5-15 - 5-27. San Diego, CA: OUSN Total Quality Leadership Office and Navy Personnel Research and Development Center.
4. Department of the Navy (November 1992). Team Skills and Concepts (Instructor Guide), pp. 5-47 - 5-56. Washington, DC: OUSN Total Quality Leadership Office.
5. Ishikawa, Kaoru (1968). Guide to Quality Control. Tokyo, Japan: Asian Productivity Organization.
6. U.S. Air Force (Undated). Process Improvement Guide - Total Quality Tools for Teams and Individuals, p. 33. Air Force Electronic Systems Center, Air Force Materiel Command.

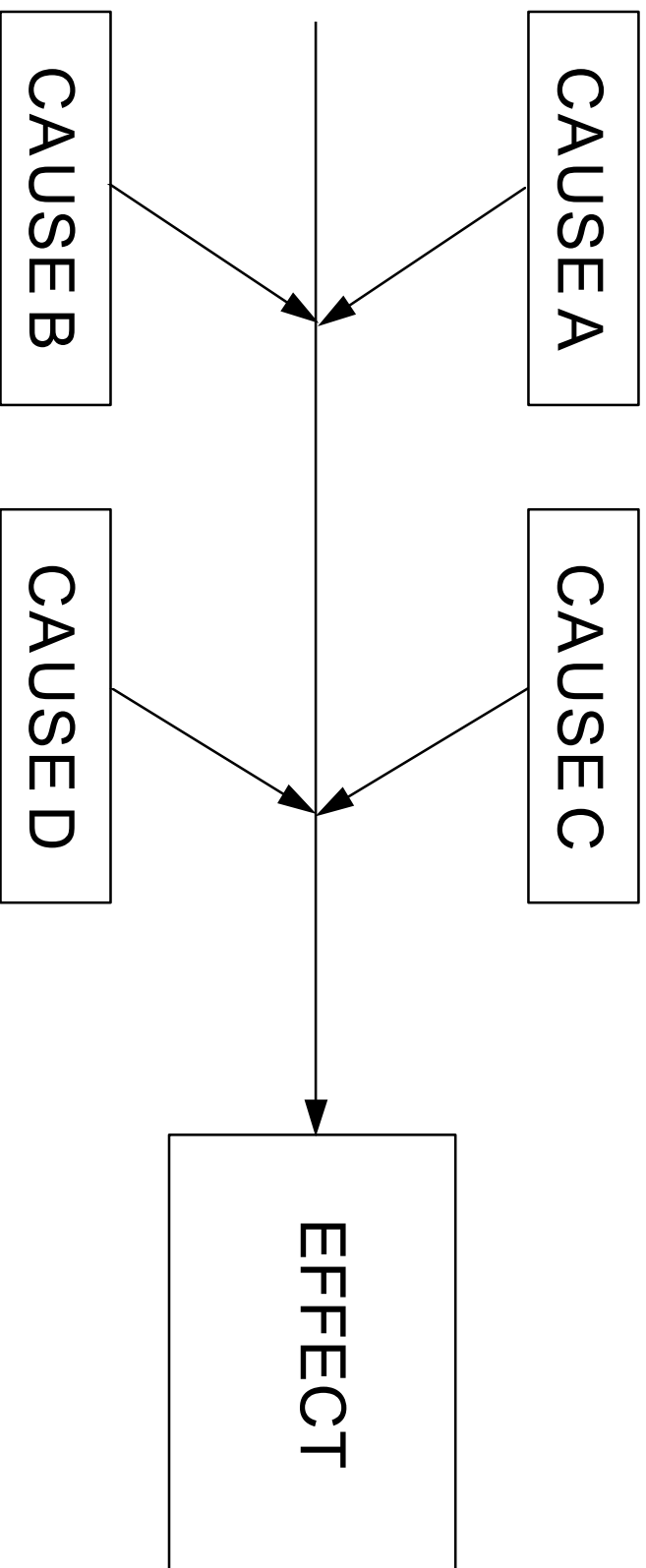
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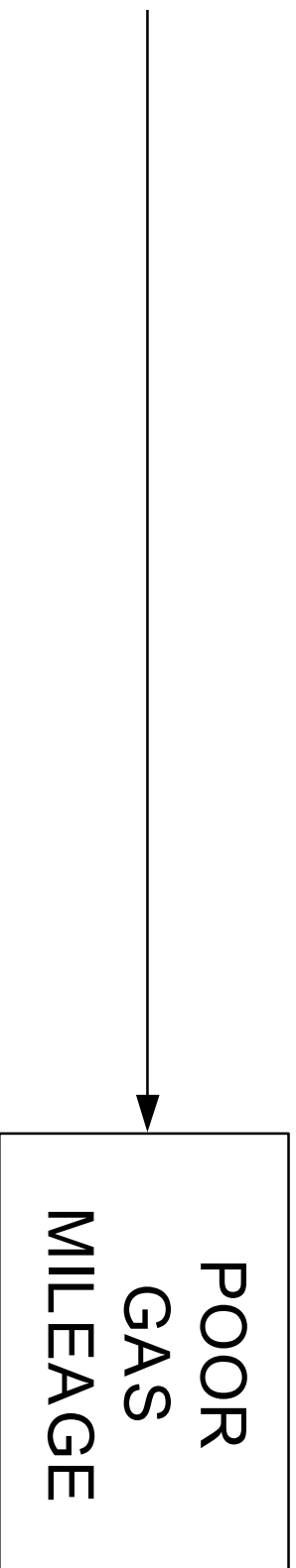
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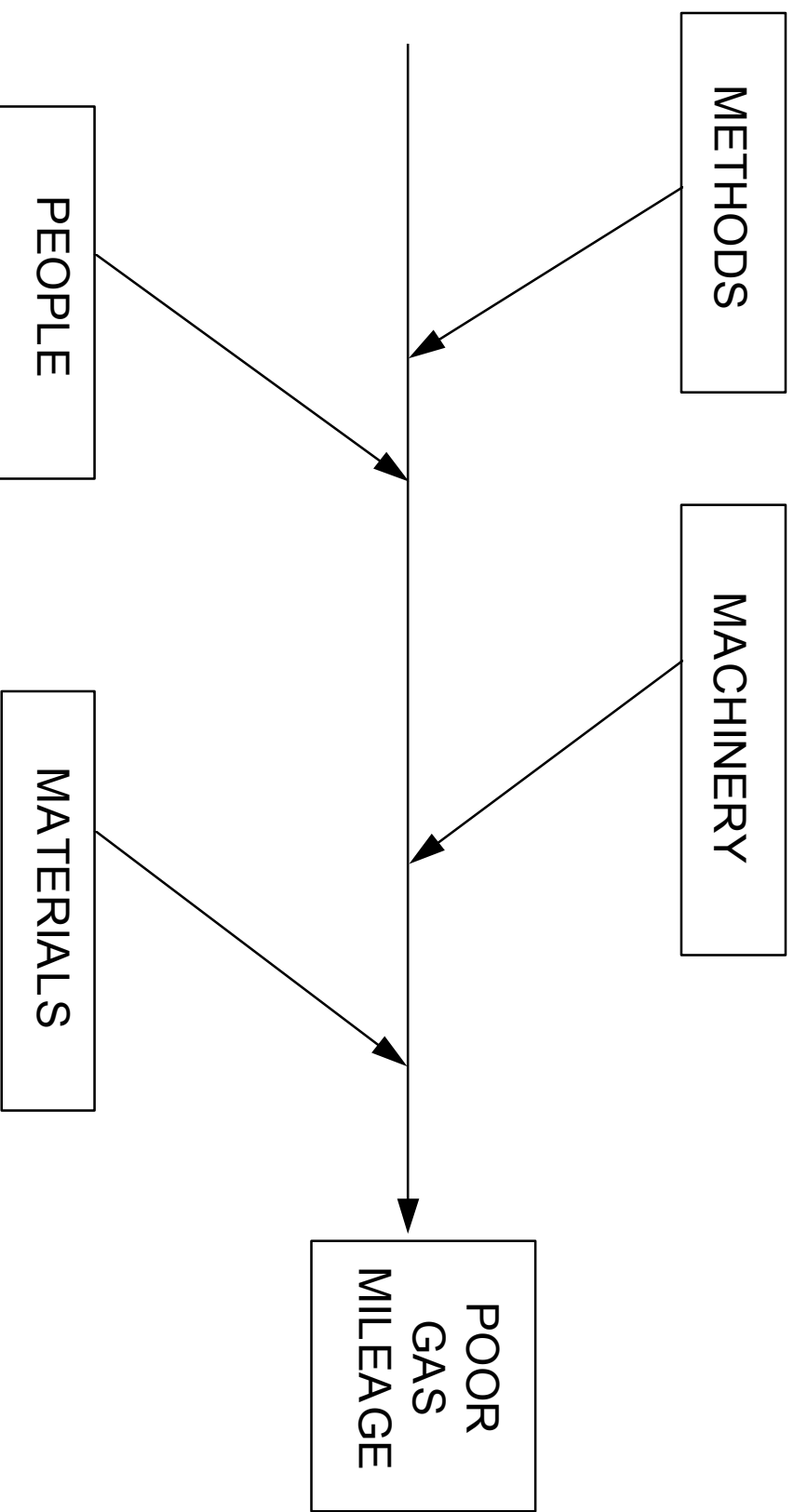
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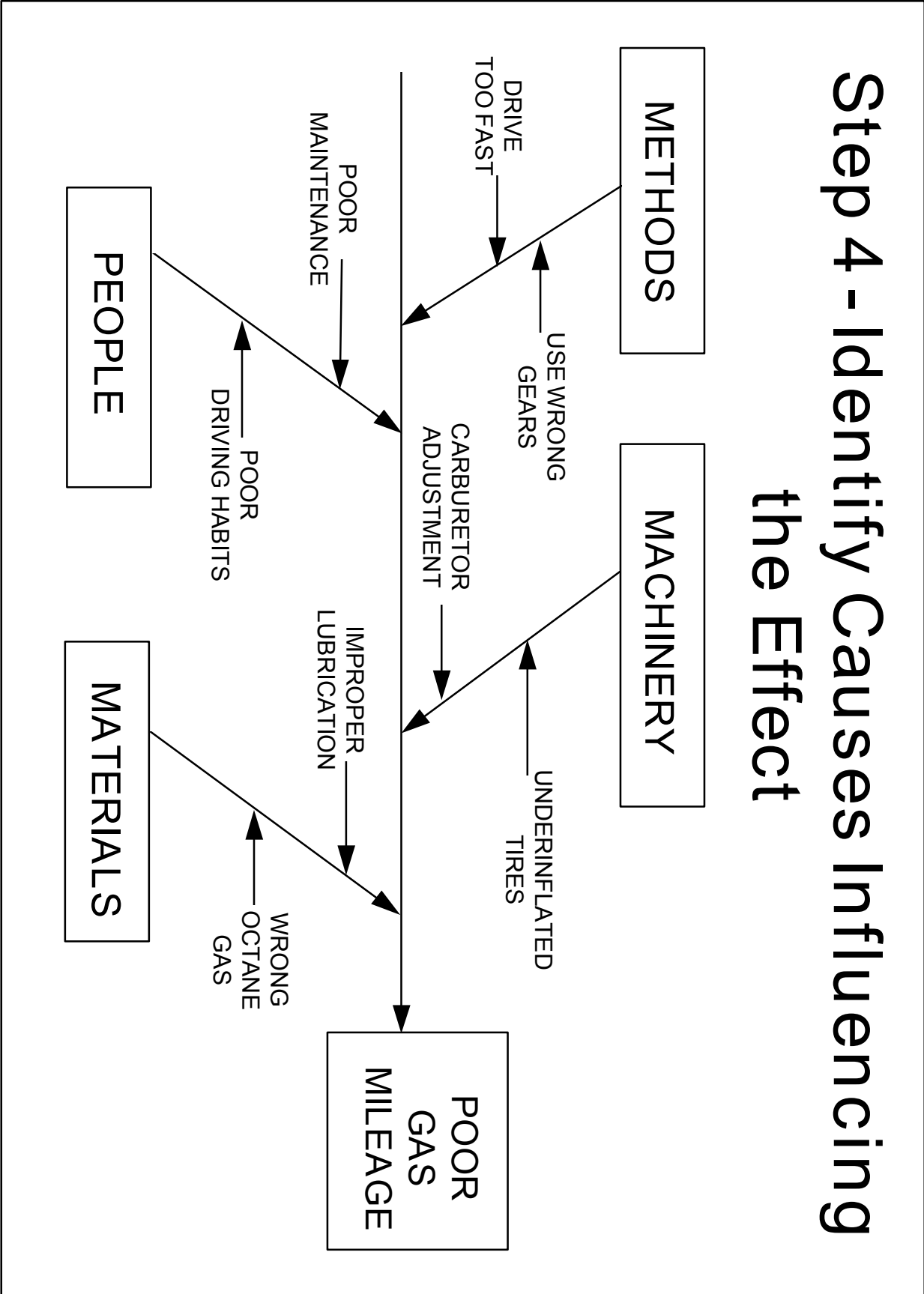
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Step 3 - Identify Main Categories



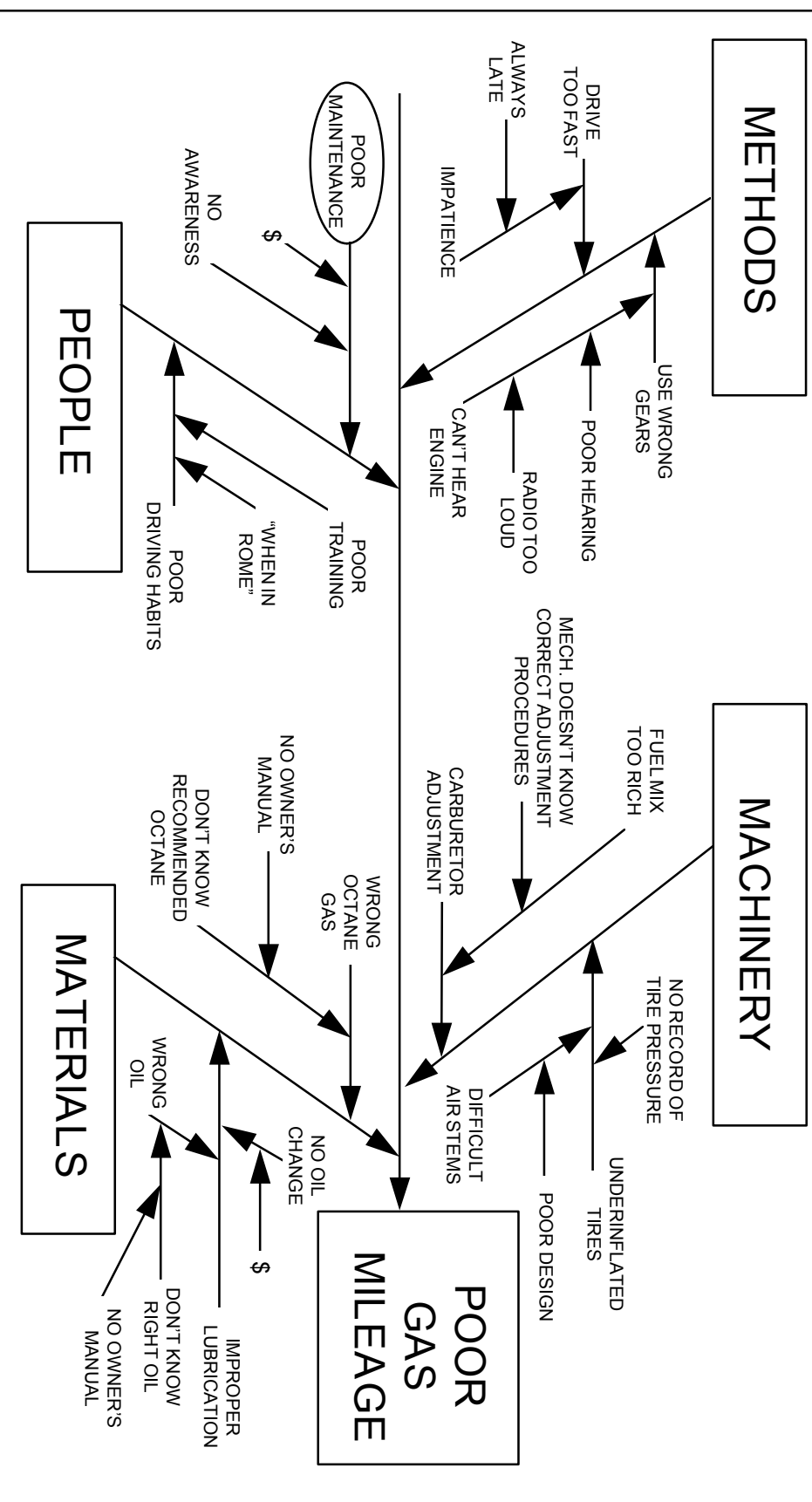
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Step 5 - Add Detailed Levels

Step 6 - Analyze the Diagram



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VIEWGRAPH 8

Example of How the Cause-and-Effect Diagram Could Be Constructed for the Detailed Exercise

