

# Cause-and-Effect Diagrams (Fishbone Diagrams)

It is difficult if not impossible to solve complicated problems without considering many factors and the cause-and-effect relationships between those factors. Defining and displaying those relationships helps. The first such cause-and-effect diagram was used by Kaoru Ishikawa in 1943 to explain to a group of engineers at the Kawasaki Steel Works how various work factors could be sorted and related. In recognition of this, these diagrams sometimes are called Ishikawa diagrams. They are also called fishbone diagrams, because they look something like fish skeletons.

## What can it do for you?

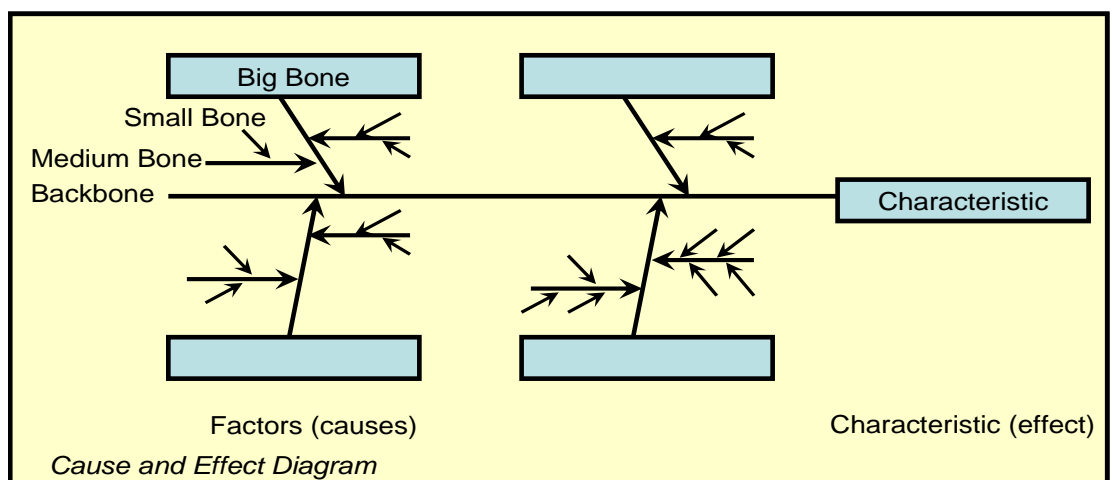
Quality problems are typically not simple. They often involve the complex interaction of several *causes*. A cause-and-effect diagram will help you:

- Define and display the major causes, sub-causes and root causes that influence a process or a characteristic.
- Provide a focus for discussion and consensus.
- Visualize the possible relationships between causes which may be creating problems or defects.

Cause-and-effect diagrams are particularly useful in the *measure* and *improve* phases of Lean Six Sigma methodology.

## How do you do it?

1. Decide which quality characteristic, outcome or effect you want to examine. You might consider Pareto analysis to help you focus on the most important issue.
2. Write your chosen effect on the right side of a paper, board or flipchart and draw a box around it. If you think of this as a fishbone diagram, this is the fish's head.
3. Draw a straight line to the left, the fish's backbone.
4. For each primary cause or category of causes, draw a diagonal line slanting from left to the centerline. Alternate these *ribs* on the top and bottom of the *backbone*. Label the end of each rib and draw a box around the label.
5. Draw a horizontal line intersecting the appropriate diagonal line and label it to describe each secondary cause that influences a primary cause. Alternate these *medium sized bones* to the left and right of each *rib*.
6. In a similar way, draw and label diagonal lines for third level or root causes, *small bones*, intersecting the secondary cause lines, *medium sized bones*.
7. Examine the diagram. If certain causes seem to have a significant effect on the characteristic you are examining, mark them in a special way.

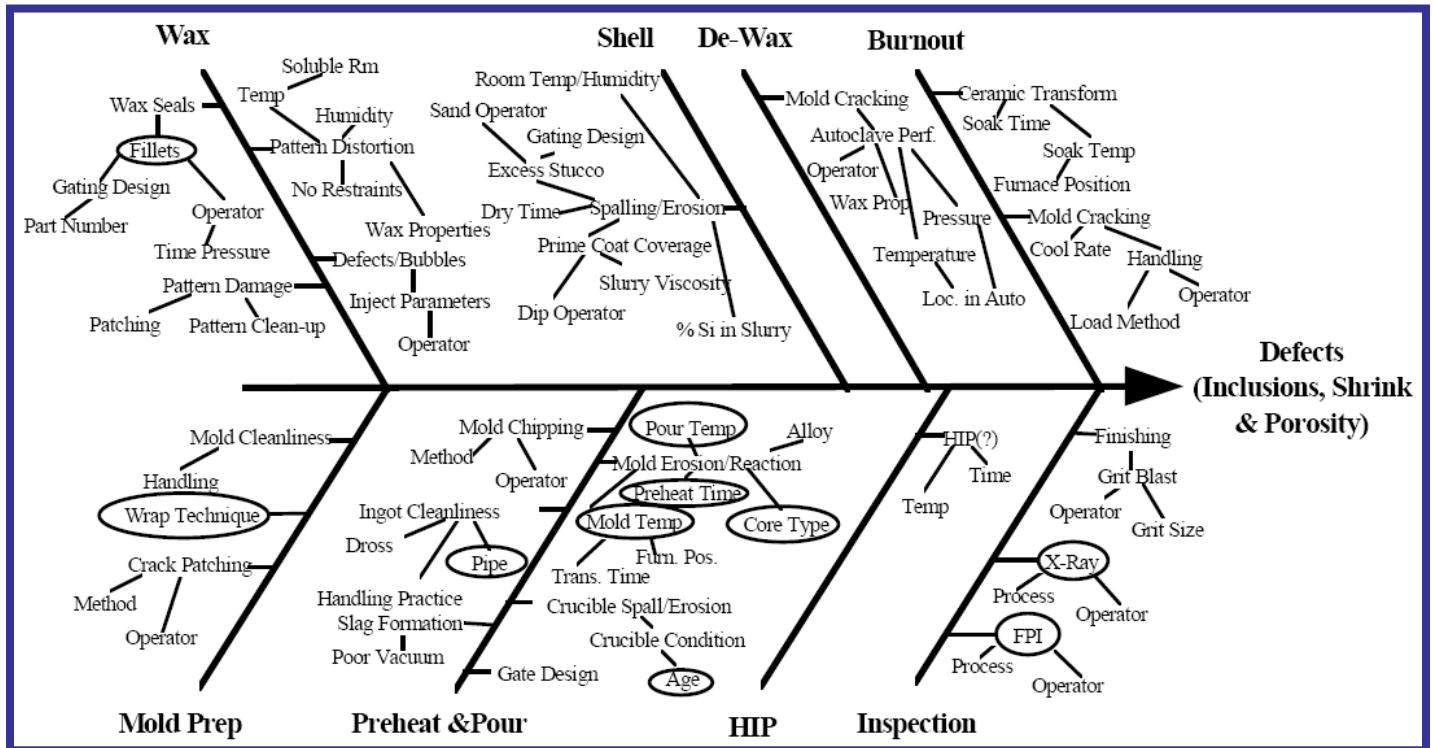


### Variation 1: Cause Enumeration

Sometime it may be very difficult to determine the primary causes to be included in your diagram. If that is the case, after you have determined the characteristic or effect you are examining, follow these steps:

- Use brainstorming to create a list of all the possible causes. The list will contain a mixture of primary, secondary and tertiary (or *big bone*, *middle sized bone* and *small bone*) causes.
- Sort the list by grouping causes that are related.
- Identify or name each major grouping and make your cause-and-effect diagram.
- *Machine, Manpower, Material, Measurement, Method* and *Environment* are frequently used major causes that can apply to many processes.

The advantage of the cause enumeration technique is that you stand a much better chance that all causes will be listed, especially hidden ones, and your diagram will be a complete and useful picture. The disadvantage is that it may be difficult to relate all the causes clearly to the result, making the diagram hard to draw.



### Variation 2: Process Classification

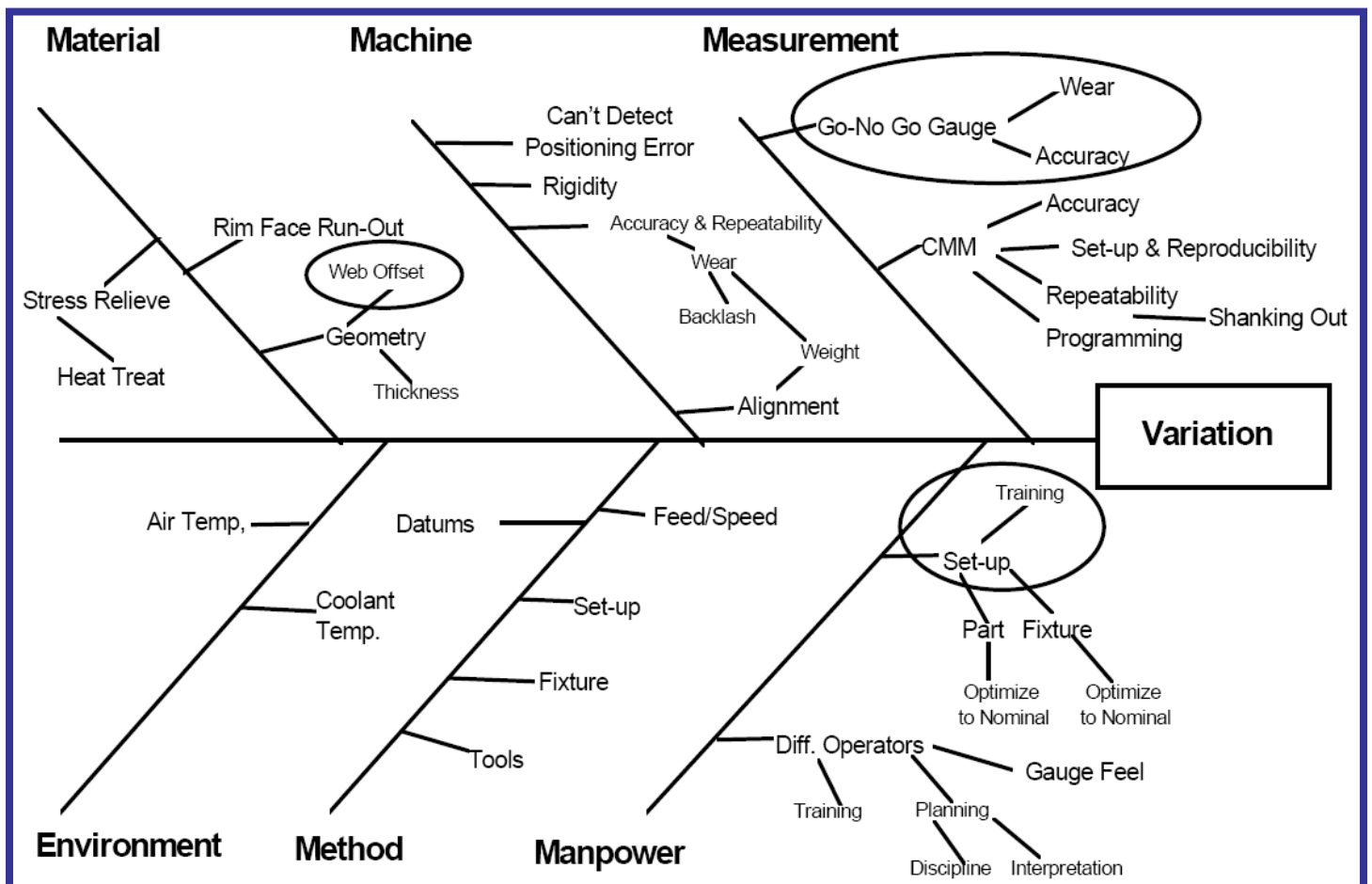
Sometimes it is more helpful to look at causes in the sequence in which they occur instead of considering overarching logical categories. With this approach, the center line or *backbone* follows the sequence of the process.

- Instead of primary causes as the *ribs*, show the major process steps from left to right.
- Construct your cause-and-effect diagram as before.

The advantage of this technique is that, since it follows the sequence of the process, it will be easy for everyone to understand. The disadvantages are that similar causes will appear again and again, and causes due to a combination of factors will be difficult to show.

## Hints for Making Good Diagrams

1. Get input from many people involved in the process. Not only will this make for a more accurate diagram, everyone taking part will gain new knowledge.
2. Make one cause-and-effect diagram for each Critical-To-Quality (CTQ) characteristic you are considering. Trying to include all CTQs on one diagram will make it too large and complicated to be of much use as a problem solving tool.
3. Avoid generalities. Express each cause as concretely as possible.
4. Since you will use your diagram to direct the examination of specific cause-and-effect relationships with data, the characteristic you are considering and all the causal factors should be measurable. If they are not, try to make them measurable or find substitutes.
5. The objective of the cause-and-effect diagram is action. Be sure your causes are broken down down to the level at which they can be acted on.



## Now what?

- Use your diagram to develop a common understanding of the factors potentially influencing or causing a quality problem.
- Use your diagram as a road map for collecting data to verify the causal relationship of various factors to the characteristic.
- Continue to annotate and modify your diagram as you verify relationships and learn more.

Using a cause-and-effect diagram this way will help you to see which factors in your process need to be checked, modified or eliminated.



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