Cause & Effect "Fishbone" Diagram

Background

The Cause & Effect, or fishbone diagram, was first used by Dr. Kaoru Ishikawa of the University of Tokyo in 1943 - hence its frequent reference as a "Ishikawa Diagram". This diagram is used to identify all of the contributing root causes likely to be causing a problem. This methodology can be used on any type of problem, and can be tailored by the user to fit the circumstances. Use of this tool has several benefits to process improvement teams:

- Straightforward and easy to learn visual tool.
- Involves the workforce in problem resolution - preparation of the fishbone diagram provides an education to the whole team.
- Organizes discussion to stay focused on the current issues.
- Promotes "System Thinking" through visual linkages.
- Prioritizes further analysis and corrective actions.

How to Get Started

This tool is most effective when used in a team or group setting.

1) Use a white board, butcher-block paper, or a flip chart to get started. You may choose to use "Post-it" notes to move causes around as you decide on categories.

2) Write the problem to be solved (the EFFECT) as descriptively as possible on one side of the work space, then draw the "backbone of the fish", as shown below. The example we have chosen to illustrate is "Missed Free Throws" (an aquaintance of ours just lost an outdoor three-on-three basketball tournament due to missed free throws).

3) The next step is to decide how to categorize the causes. There are two basic methods: A) by function, or B) by process sequence. The most frequent approach is to categorize by function. In manufacturing settings the categories are often: Machine, Method, Materials, Measurement, People, and Environment. In service settings, Machine and Method are often replaced by Policies (high level decision rules), and Procedures (specific tasks). In this case, we will use the manufacturing functions as a starting point, less Measurement because there was no variability experienced from measurements (its easy to see if the ball goes through the basket).

4) You can see that this is not enough detail to identify specific root causes. There are usually many contributors to a problem, so an effective Fishbone Diagram will have many potential causes listed in categories and sub-categories. The detailed sub-categories can be generated from either or both of two sources:

- Brainstorming by group/team members based on prior experiences.
- Data collected from check sheets or other sources.

A closely related Cause & Effect analytical tool is the "5-Why" approach, which states: "Discovery of the true root cause requires answering the question 'Why?' at least 5 times". See the **5-Why feature** of the Toolbox. Additional root causes are added to the fishbone diagram below:

5) The usefulness of a Fishbone Diagram is dependent upon the level of development - moving past symptoms to the true root cause, and quantifying the relationship between the Primary Root Causes and the Effect. You can take the analysis to a deeper level by using **Regression Analysis** to quantify correlation, and **Designed Experiments** to

quantify causation. As you identify the primary contibutors, and hopefully quantify correlation, add that information to your chart, either directly or with foot notes.

The following chart has the top five primary root cause contributors highlighted in gold. The note "MC" (for Mathematical Correlation) attached to air pressure indicates that strong correlation has been established through statistical analysis of data (the lower the air pressure, the less bounce off the rim). If you have ever tried to shoot baskets at a street fair or carnival to win a prize, you know that the operator always over-inflates the ball to lower your chances. Pick any system that works for you - you could circle instead of highlighting. The priority numbers can carry over to a corrective action matrix to help organize and track improvement actions.

6) After creating your chart on a flip-chart or white board, you can replicate it using most processing programs or spreadsheets (Microsoft Excel, IBM Lotus).

Indented Hierarchy Fishbone

An alternate format for a Cause and Effect diagram is the "indented hierarchy fishbone". This format may be easier to use as it can be easily executed in a word processing or spreadsheet program. Following is an example of our Free-throw example using the indented hierarchy method:

Effect - Made (Missed) Free Throws

Cause -

1) Method - Shooting Mechanics
    1) Balance
    2) Bend Knees
    3) Aiming Point
    4) Hand Position
    5) Follow-through
2) Material - Ball
    1) Size of Ball
    2) Air Pressure
    3) Grain/Feel/Grip
    4) Lopsidedness
3) Man - Shooter (Closely related to method in this example)
    1) Concentration
    2) Motivation
    3) Training
        1) Conditioning
        2) Consistency (Muscle Memory)
        3) Adjustment to Other Variables
4) Environment - Weather
    1) Wind Gusts / Sun / Rainl
        1) Outside vs. Inside
5) Machine - Hoop and Backboard
    1) Rim Height
    2) Rim Size
    3) Rim "Play" - Rigidity
    4) Rim Alignment
    5) Backboard Stability

Resources: Guide to Quality Control
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