FLORIDA POLYTECHNIC UNIVERSITY

Six Sigma: Week 5

John Fico, Adjunct Professor
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Agenda: Week 5

- ✓ Review advanced Pareto chart techniques
- ✓ Hypothesis testing (continued)
  - ✓ 1 sample t-test
  - ✓ 2 sample t-test
  - ✓ Analysis of Variance (ANOVA)
    - ✓ Including Tukey Comparison test
- ✓ Dr. Doug Holton, Director of Teaching & Learning
  - ✓ Early course assessment
- Will begin to refer to Lean Sigma (LS) text by Ian Wedgwood in Week 6
  - Week 6 topics will include:
    - Cause and Effect (Fishbone) Diagram
    - Cause and Effect Matrix
- Looking ahead: Case Studies #1 and Article #3

Cause and Effect (Fishbone) Diagram

- Use Cause-and-Effect Diagram to organize brainstorming information about the potential causes of a problem.
- Developing a cause-and-effect diagram with your team can help you compare the relative importance of different causes.
- A cause-and-effect diagram is also called a C&E diagram, a fishbone diagram, or an Ishikawa diagram.
- Review examples from Minitab and LSSM text

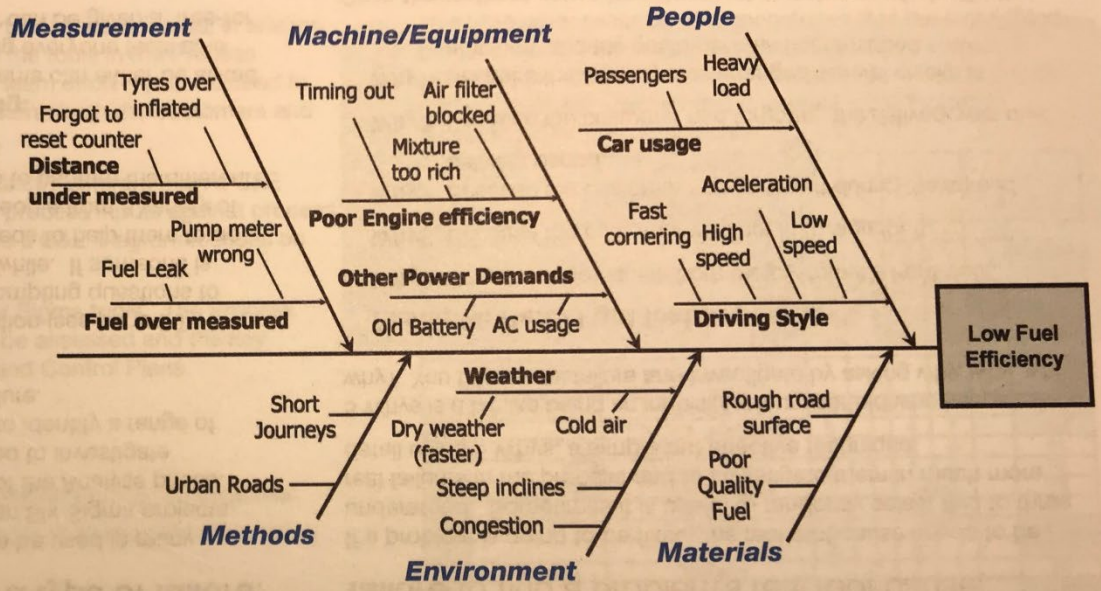
Cause and Effect (Fishbone) Diagram

Fishbone diagrams are usually used during brainstorming, to identify root causes. However, they can be also be used throughout the Analyse phase as a great tool for structuring a team's thoughts.

Fishbone diagrams are an effective tool to help facilitate brainstorming sessions. The example shown here is the output of a brainstorming session on the causes of low fuel efficiency in a car.

Categories on Fishbone diagrams:
There are many different versions of Fishbone diagrams – with different branch names (people, methods etc). This is because there are no right or wrong ones; just use those that are appropriate to your project, or create your own.

Other uses of Fishbone diagrams:
As projects move into the Analyse phase, they usually start to have several specific areas of investigation. Although not technically being used for 'root cause analysis', a Fishbone diagram can provide clarity by being used to document the structure of the project, with each area of investigation represented by a different branch.



How to document a Fishbone diagram:
The best way to start a Fishbone diagram is with a large piece of paper on the wall or a white board (a pretty Fishbone diagram is not your first objective!). Companion by Minitab can also be used to document your results and has a brainstorming function too, which works alongside the Fishbone tool – see the Manage section of this guide for more detail.

Cause and Effect (C&E) Matrix

- Purpose: to identify the few key process input variables in relation to customer requirements
- Used in Improve phase to pinpoint the focus of improvement efforts
- Steps to create C&E Matrix
  - Assign a priority score to each output according to importance to customer
    - Usually on a 1-10 scale; 10 = most important
  - Identify all process steps & key inputs from process map and list these in left column on matrix
  - Rate each input against each output based on the strength of their relationship
    - Blank = no correlation; 1 = remote correlation; 3 = moderate correlation; 9 = strong correlation
  - Cross-multiply correlation scores with priority scores and add across for each input (Use sumproduct formula in Excel)
  - Create a Pareto chart & focus on the variable relationships with the highest total scores

C&E Matrix allows visibility to the effects that various inputs and outputs have on ranked customer priorities.

Cause and

			1	2	3	
		Rating of importance to customer	8	8	10	
		Key Process outputs	Meet product specifications	Meet the delivery data	Waste	
	Process step	Process input				Total
2	get customer orders	tolerances	9	9	9	**234**
3	planning for cutting and send the order to the cutting warehouse	customer orders' specifications	9	9	9	**234**
5	prioritize the orders	customer orders to be processed	9	9	9	**234**
8	check availability of product type in the stock	stock data available on the information system	9	9	9	**234**
9	get the tubes from the stock	order available to be executed	3	9	9	**186**
12	cut the tubes in fixed lengths	long tubes to be cut	9	3	9	**186**
18	evaluate the waste (store it for future orders or throw it away)	waste data	9	3	9	**186**
19	evaluate the waste (store it for future orders or throw it away)	customer orders	9	3	9	**186**
11	cut the tubes in fixed lengths	cutting machine set up	9	1	9	**170**
4	planning for cutting and send the order to the cutting warehouse	order management policy	0	9	9	**162**
6	prioritize the orders	operators' knowledge/experience	3	3	9	**138**
15	register data	order data	3	3	9	**138**
17	evaluate the waste (store it for future orders or throw it away)	waste	3	3	9	**138**
20	evaluate the waste (store it for future orders or throw it away)	operators' knowledge/experience	3	3	9	**138**
14	evaluate the waste	remaining material	0	3	9	**114**
1	get customer orders	customer specifications	9	3	3	**126**
7	check availability of product type in the stock	priority order	3	9	3	**126**
16	register data	waste data	1	1	9	**106**
13	evaluate the waste	tube cut in fixed lengths according to be specifications	0	0	9	**90**
10	cut the tubes in fixed lengths	cutting machine available	1	3	1	**42**
Total			**808**	**760**	**1600**	

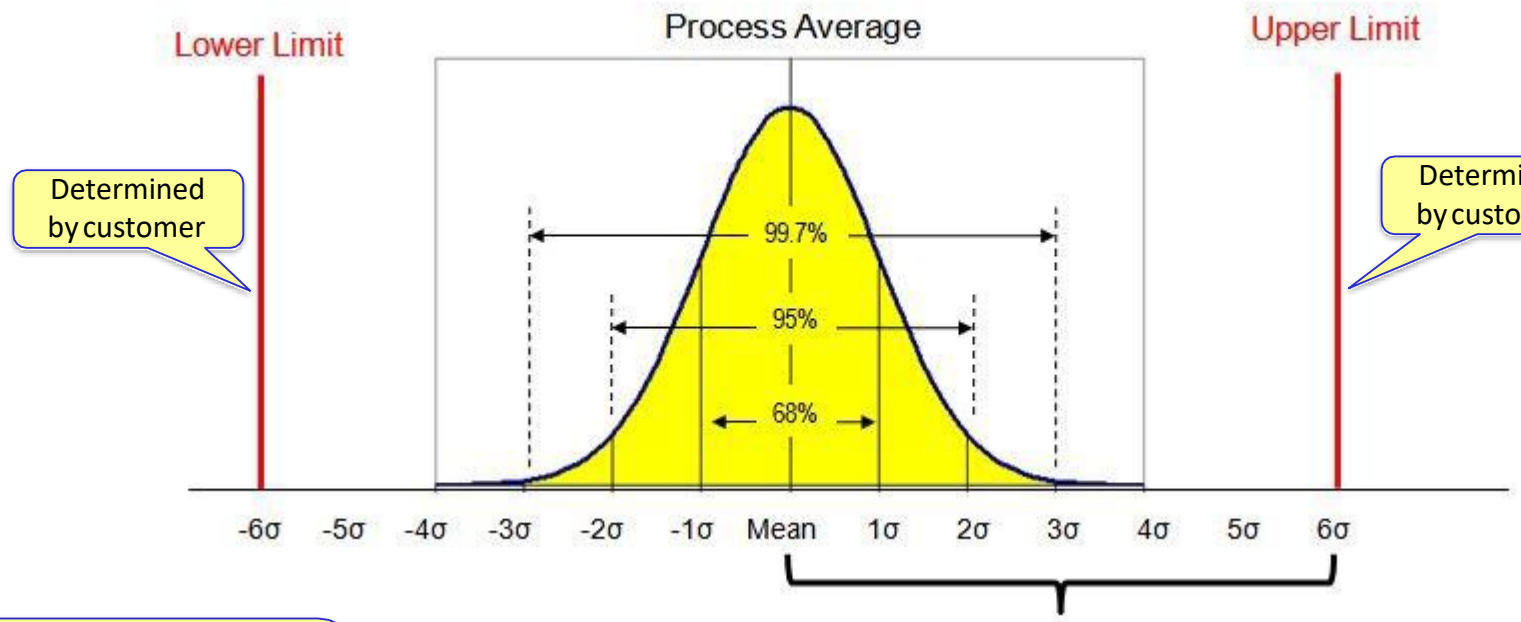
Assign score of 1-10 for each output

Areas of focus

Assign score of Blank, 1, 3, or 9 for each input

Hypothesis testing will be used to validate if the correct focus areas were identified.

Six Sigma Defined Visually (cont'd)



Example: In a 2 Sigma process, 95% of the measured values taken in a process will be within two standard deviations from the process average.

Within in a standard normal distribution:
- 68% of the data points will fall within ± one standard deviation from the mean
- 95% will fall within ± two standard deviations
- 99.73% of the data points will fall within ± three standard deviations from the mean

Initially deployed at Motorola in 1986. Adopted at GE at a global scale in 1990s; inspiring many other companies to follow.

σ = Standard Deviation