PF / CE / CNX / SOP

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PF/CE/CNX/SOP

- In this session, we will discuss:
  - Baselining a process
  - The consequences of excessive variation
  - What is PF/CE/CNX/SOP?
  - How to apply PF/CE/CNX/SOP for reducing variation

Take Note

- A list of supplemental material and additional practice/review questions for this session are provided at the end of this presentation
- You can download the pdf of this presentation, along with any supporting data files, on the site where you are accessing this course

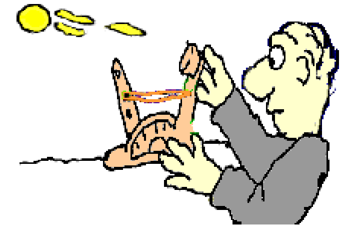
Baselining a Process ("Current State")

- Before improving a process, it is important to understand and capture the current state ("as-is" process)

Gemba: A Japanese term for "the actual place"

- Baselining requires us to
  1. **Observe** the process (Go to the Gemba)!
     - How is the work performed?
     - Talk with those who do the work (to learn as much as we can)
  2. **Gather** baseline data
     - Data must be representative of the current process
     - Determine a sampling plan
       - Does data exist, or will you need to gather it?
       - How much data is necessary to get good estimates?
  3. **Summarize** your data
     - Graphical and numerical summaries

Baselining a Process - Statapult® Launching



- In a previous live training session, teams were given an exercise using the Statapult-Catapult device
- The statapult is launched by pulling the arm back to a set angle and releasing to launch a small rubber ball. The distance of the launch is an important customer performance characteristic.

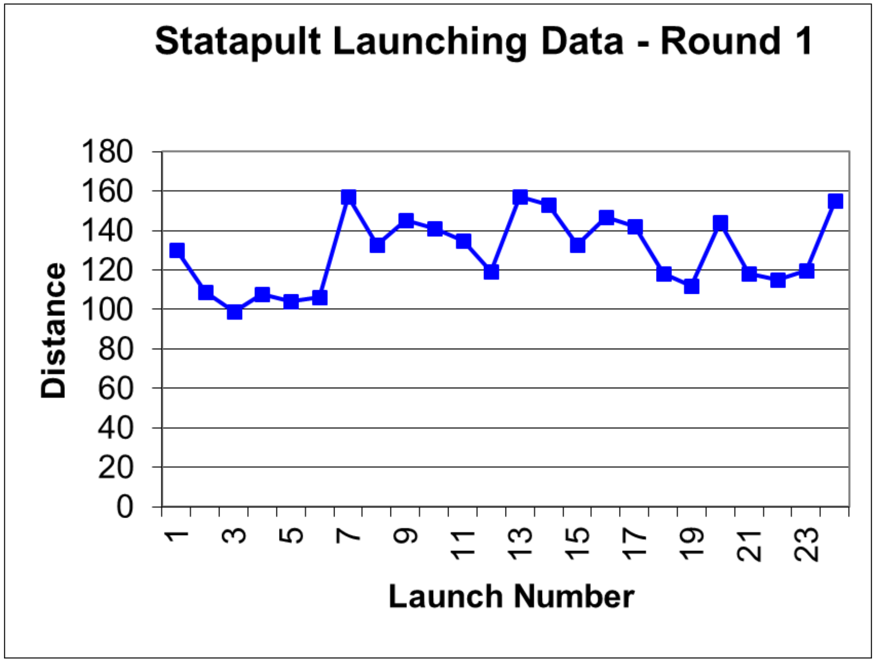
- The rules of engagement were:
  - All members of the team must launch 4 times
  - Every launch should use a pull back angle of 177 degrees
  - All other statapult device settings (cup position, front pin, etc.) should remain constant
  - There is a time limit of 15 seconds between successive launches
  - The distance for each launch should be measured and recorded in inches, from the back base of the statapult to the first point of impact
  - No practice shots are allowed

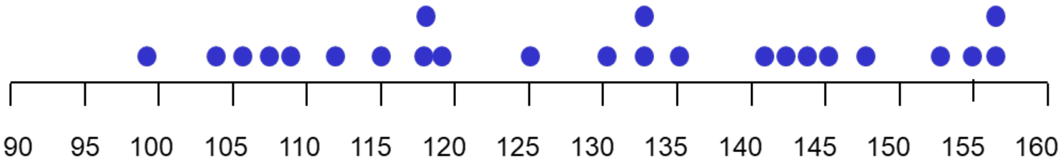
Round 1 (Baseline) Results

- The results for a 6-person team are shown

Launch Number	Distance	
1	130	
2	109	
3	99	
4	108	
5	104	
6	106	
7	157	
8	133	
9	145	
10	141	
11	135	
12	119	
13	157	
14	153	
15	133	
16	147	
17	142	
18	118	
19	112	
20	144	
21	118	
22	115	
23	120	
24	155	
Maximum	157	inches
Minimum	99	inches
Range (delta)	58	inches

Data file: statapult exercise.xlsx

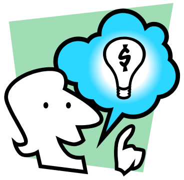




Impact of Excessive Variation

- Excessive variation in our data can cause of lot of problems
  - Makes it difficult to meet customer requirements
    - We may have a lot of scrap or rework, which costs us time and money
  - Causes uncertainty
    - Can we easily predict where the next launch will land?
  - Makes it hard to see real changes and difficult to make good decisions
  - Requires larger sample sizes to make good decisions

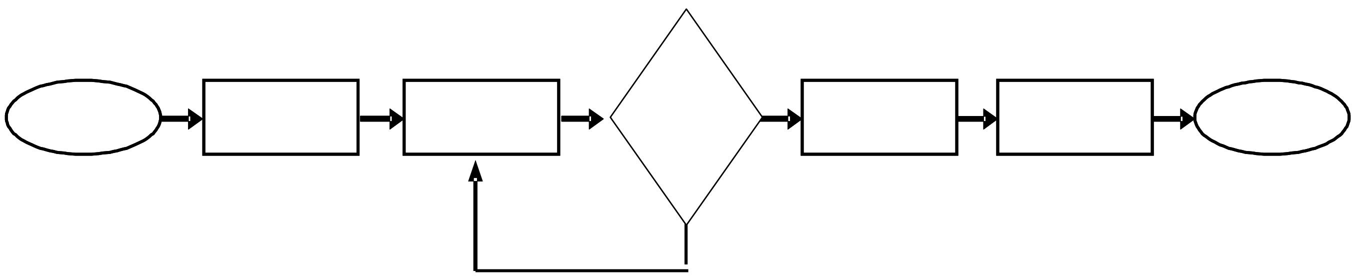
How to Reduce Variation and Turn an Art into a Science

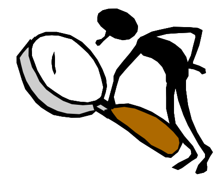


PF / CE / CNX / SOP

Removes waste, reduces variation, and decreases cycle time

(1) PROCESS FLOW (PF) or PROCESS MAP



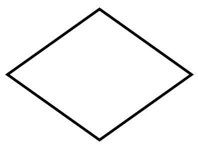
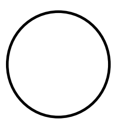
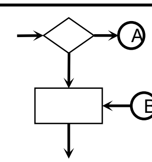
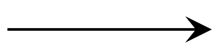
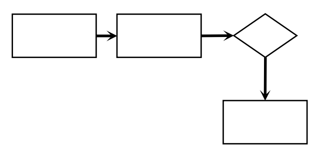


- A visual representation of the major steps and decision points in a process which helps to:
  - Gain a better understanding of the process
  - See potential problem areas and opportunities for improvement
  - Identify data collection points
  - Review the sequence of steps and look for missing or unnecessary (non-value added) steps
  - Highlight the Diamond (“loops”) . . . which can lead you to defects, bottlenecks, cycle time drains, dollars, etc.

For video instruction on generating process flow (PF) diagrams, go to: https://airacad.com/our-insights/training-videos/spc-xl/

Process Flow Diagram

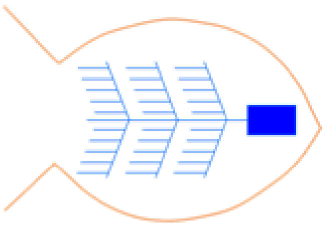
- Visual representation of all the major steps in a process
- Standard symbols

This Symbol…	*Represents…*	*Some Examples are…*
	**Start/Stop**	**Receive Trouble Report** **Machine Operable**
	**Decision Point**	**Approve/Disapprove** **Accept/Reject** **Yes/No** **Pass/Fail**
	**Activity**	**Drop Off Travel Voucher** **Open Access Panel**
	**Connector (to another page or part of the diagram)**	
	**Represents direction of flow**	

Process Flow Diagram Symbols (KISS)

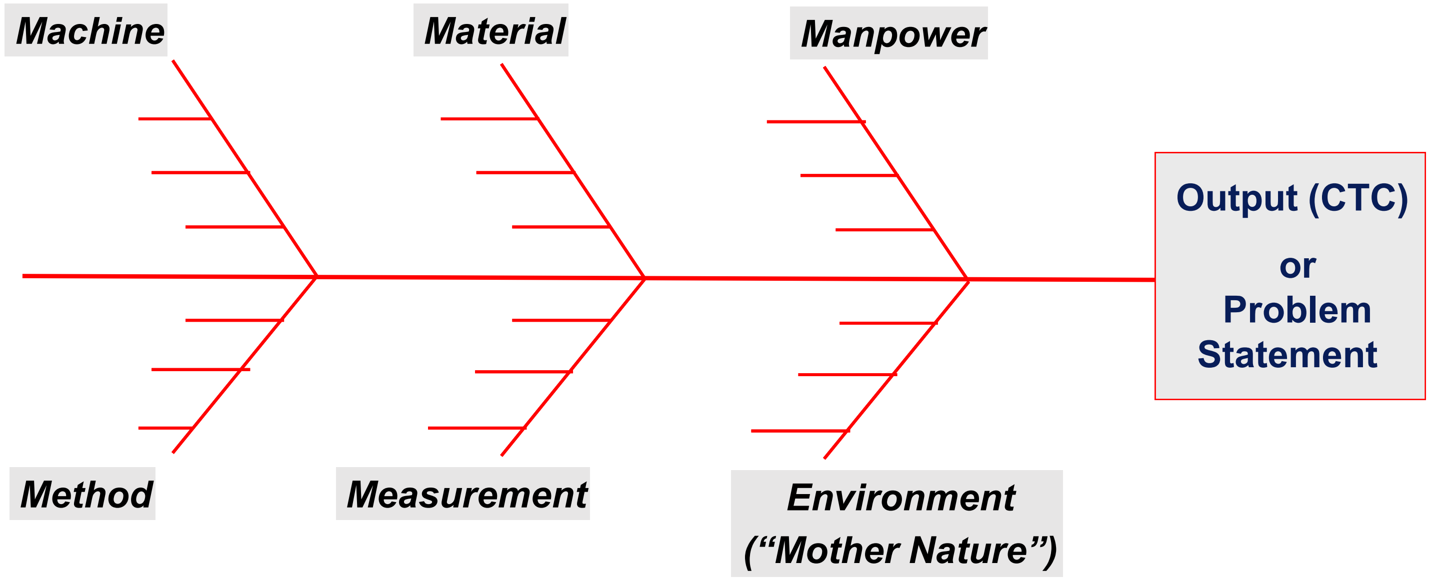
How to Reduce Variation and Turn an Art into a Science (cont.)

PF / CE / CNX / SOP



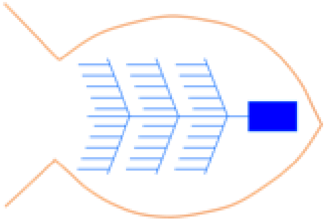
(2) CAUSE AND EFFECT (CE) (a.k.a. "Fishbone")

Brainstorm all the possible causes of the problem (sources of variation that may affect the output)



Steps for Creating a Cause and Effect (CE) Diagrams

- Start by placing the CTC (output), or problem statement, at the “head” of the cause and effect (fishbone) diagram

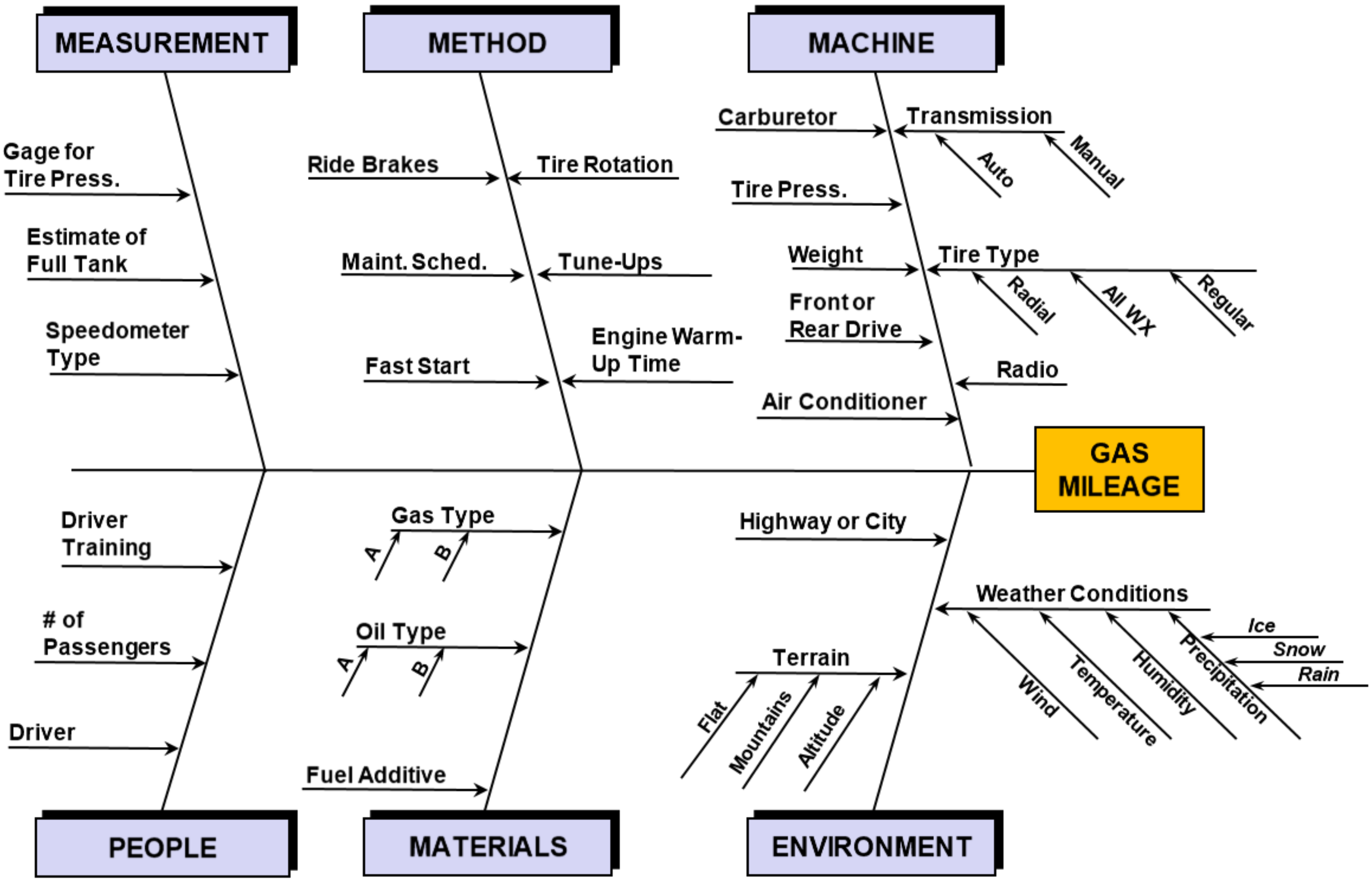


- Then, use one of two methods
  - **Method 1** (start with categories)
    1. Determine appropriate cause categories (the major “bones”)
       - Manufacturing: 6Ms: Manpower, machine, materials, methods, measurement, mother nature
       - Admin/Service: 6Ps: People, Policies, Procedures, Plant, Process, Product
       - Process steps
       - Any other categorization that makes sense for your application
    2. Brainstorm potential causes (sources of variation) within each category, which may affect the CTC or contribute to the problem. Place on the diagram
  - **Method 2** (brainstorm first, then categorize)
    1. Brainstorm potential causes (sources of variation) which may affect the CTC or contribute to the problem
    2. Cluster the causes into related groups and name the groups. Use the group names as the major “bones” on the cause and effect diagram and place the causes within each group.

Goal is to get as many variables as possible identified.
More variables = More likely to discover the real root causes

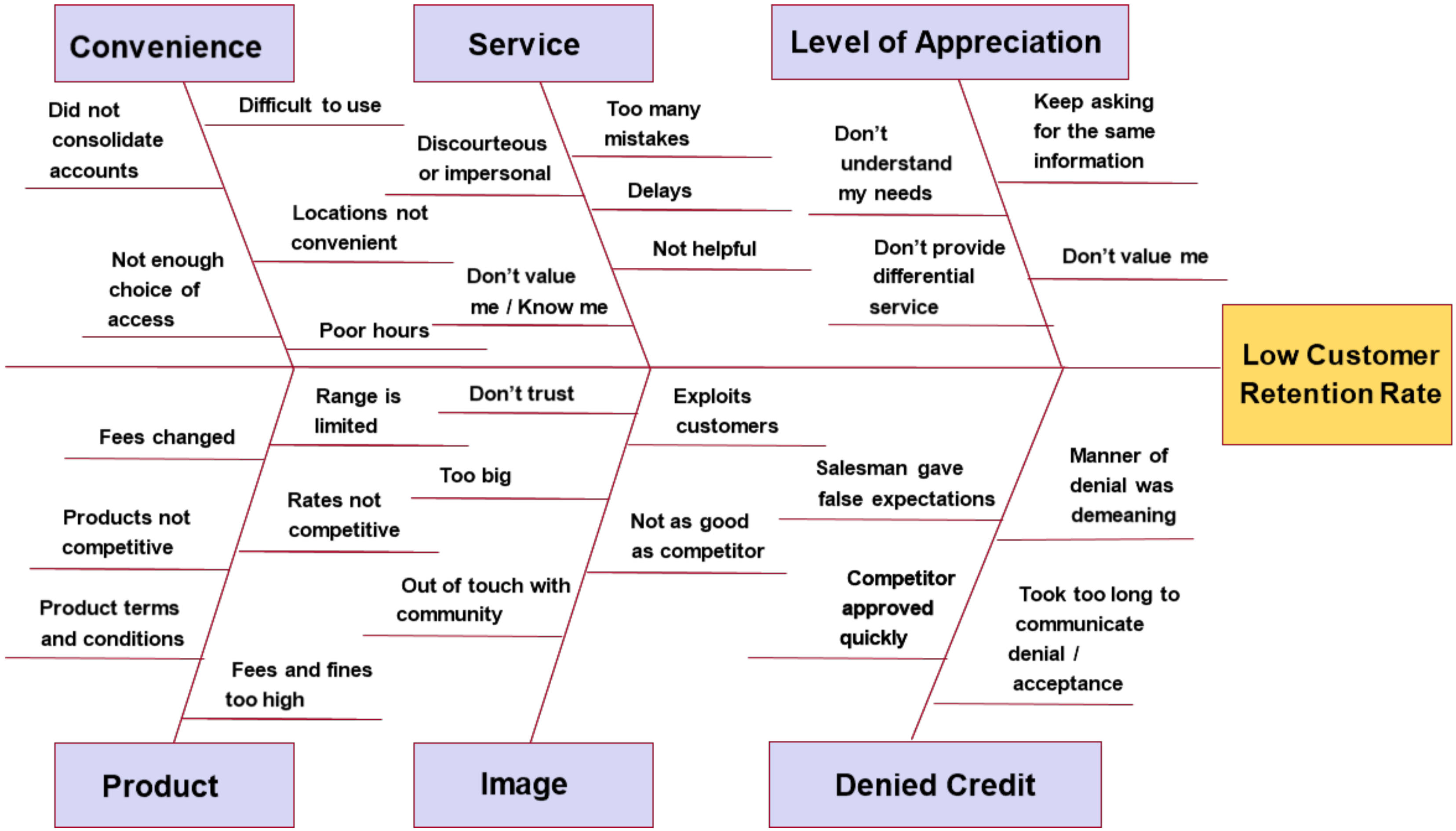
CE Example (Gas Mileage)

- Brainstorming the variables that may affect gas mileage . . .



CE Example (Customer Retention)

- Brainstorming the possible contributors to low customer retention rates for a bank



How to Reduce Variation and Turn an Art into a Science (cont.)

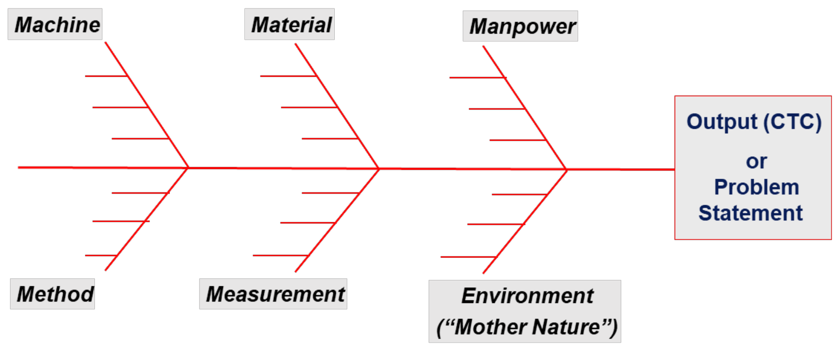
PF / CE / CNX / SOP

(3) PARTITION THE VARIABLES (CNX)

C = Controlled (constant) (via SOPs)

N = Noise (noisy, uncontrolled)

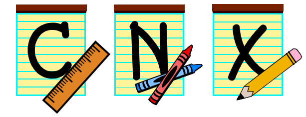
X = eXperimental



(4) IDENTIFY STANDARD OPERATING PROCEDURES (SOPs) FOR EACH "C"

- Detail the action and work sequence of the process/worker
- Provide a routine to achieve consistency of an operation / procedure
- Specify the best process/settings we currently know and understand for controlling variation
- Provide a basis for future improvements
- Employees should be trained and motivated to follow the SOPs

Partitioning the Variables



C = Constant

- To hold a variable as Constant as possible requires controlling the variable via Mistake Proofing and SOPs to eliminate errors and reduce variation.
- Holding a variable constant doesn't just happen. It must be engineered into the process.
- Mistake Proofing: The process of eliminating conditions (errors) that lead to variation in the CTCs and ultimately cause defects.

N = Noise

- Noise variables are those that are not being controlled or held as constant as possible.
- Mistake Proofing is needed to change an "N" variable to a "C" variable.

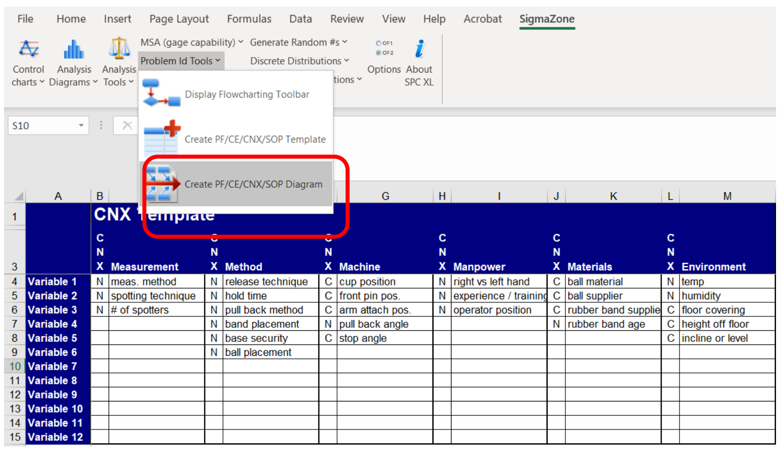
X = Experimental

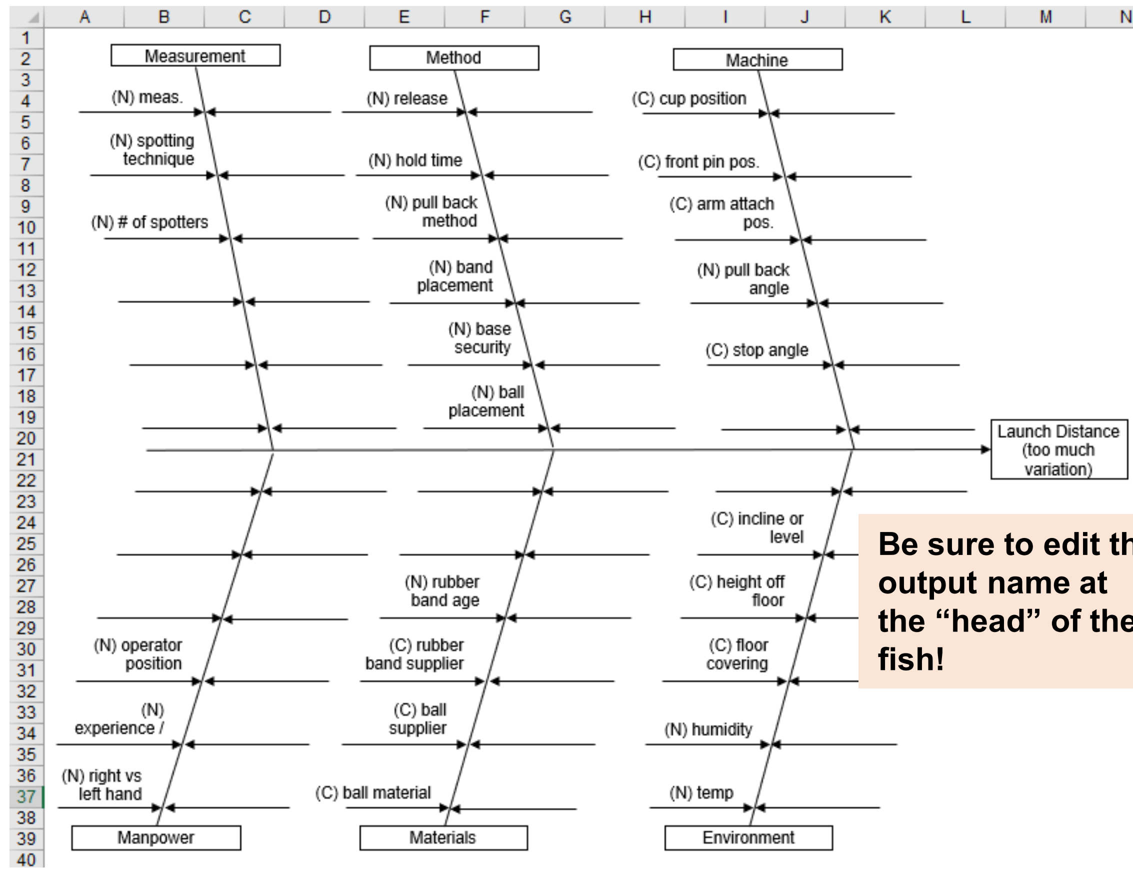
- These are key process (experimental) variables to be tested to determine what effect each has on the output and what their optimal settings should be to achieve customer-desired performance.

PF/CE/CNX/SOP alone can reduce up to 60-70% of extraneous process variation

Using SPC XL to Construct the Cause and Effect Diagram

- From the SigmaZone (SPC XL) ribbon:
  1. Create the template first (**Problem Id Tools / Create PF/CE/CNX/SOP Template**)
  2. Create the diagram (**Problem Id Tools / Create PF/CE/CNX/SOP Diagram**)





Be sure to edit the output name at the "head" of the fish!

Data file: statapult exercise.xlsx

Note

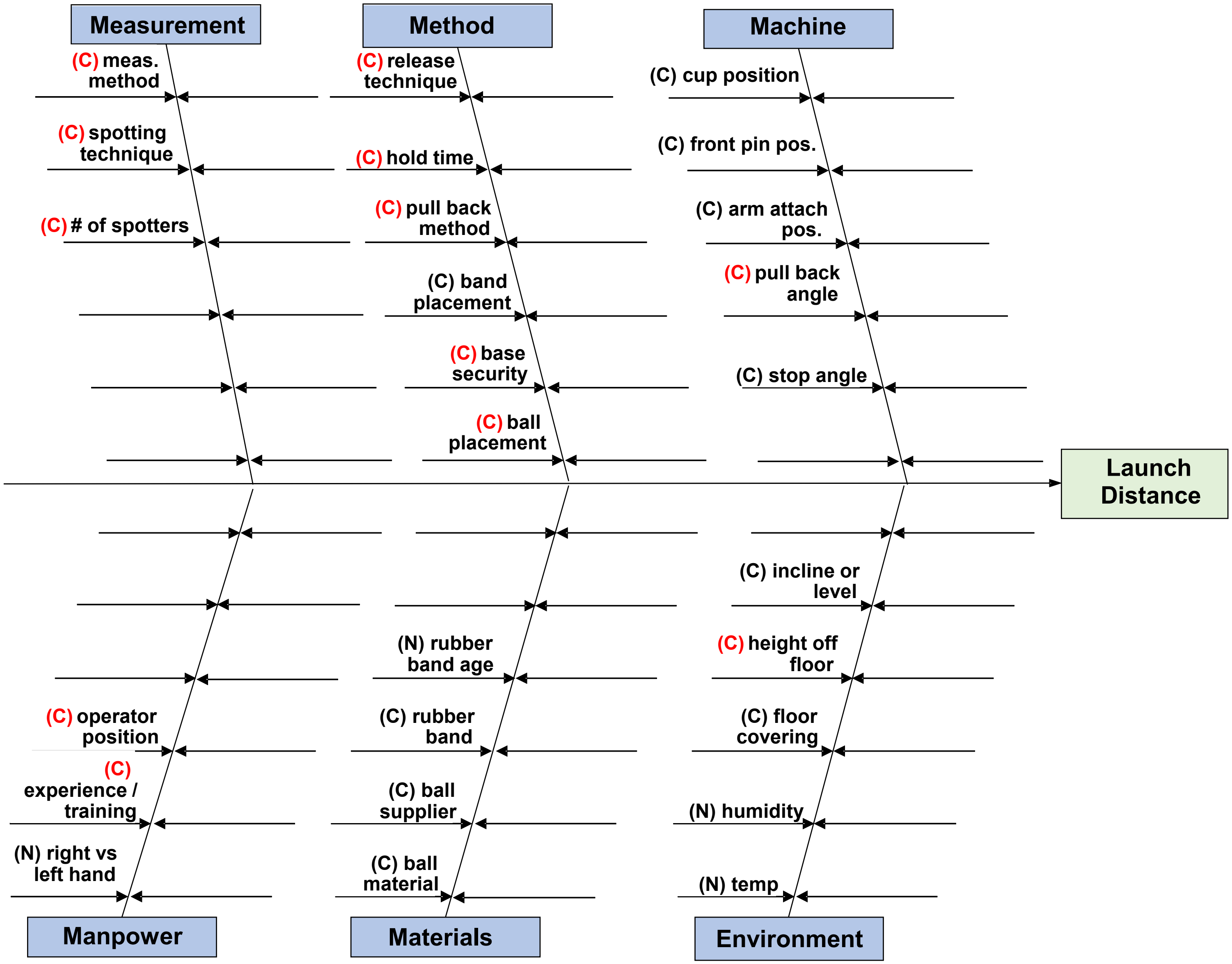
For video instruction on generating CE diagrams with CNX, go to: https://airacad.com/our-insights/training-videos/spc-xl/

Statapult Launching (Round 2)

(using PF/CE/CNX/SOP to reduce variation)

- Teams were given 1 hour to apply PF/CE/CNX/SOP
- They discussed and mapped their current state (“as-is”) process and discovered that not every team member was doing the same thing
- The team completed a cause and effect diagram
- They discussed each of the causes (input variables) and labeled as a C or N
- For each N, they discussed possible ways to control and keep constant using SOPs, and worked to turn as many Ns into Cs
- Some of the SOPs they created:
  – Secure the base of the statapult to a table with C-clamps to prevent movement, and mark all positions
  – Use aluminum foil, shiny side down, to aid the measurements
  – Use a C-clamp to fix the set position for the pull back angle
  – Use a standard method for holding and pulling back the statapult arm
  – Hold for the count of 3 seconds after pulling back the arm before release

Updated Cause and Effect (Statapult Launching)



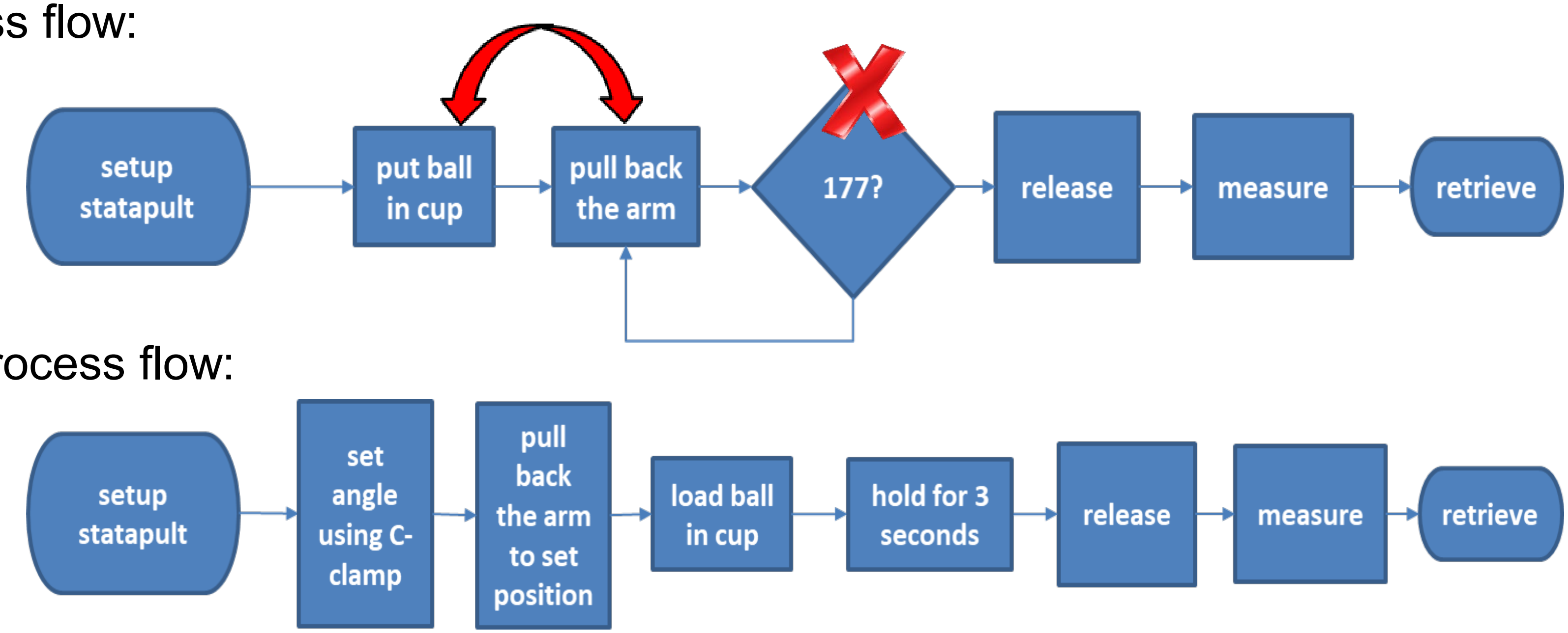
- Cs in red were previously Ns (or in one case, a C). The team created new or revised SOPs for these.

Statapult Launching (Round 2) (cont.)
(using PF/CE/CNS/SOP to reduce variation)

- As a team worked on SOPs and discussed their process flow, they determined that loading the ball in the cup prior to pulling back the arm was not a good idea, and a new process flow was agreed to

- Old process flow:

- Revised process flow:



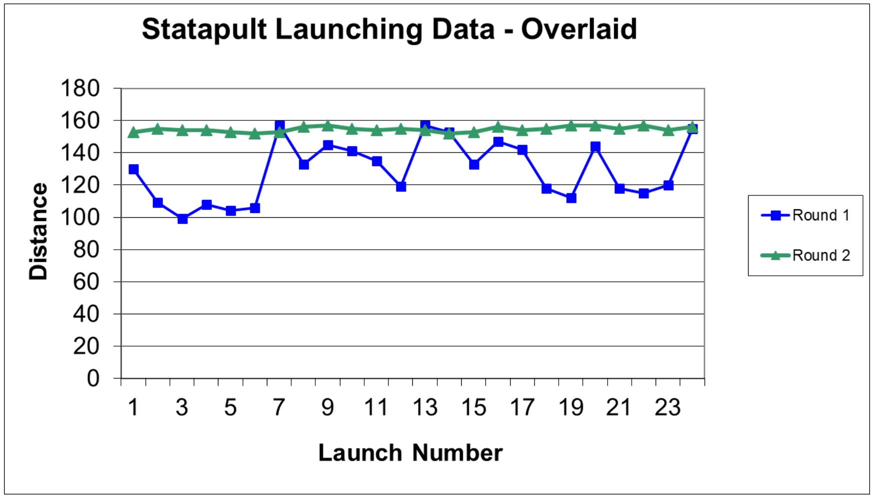
- The team completed a thorough walk through of all of the SOPs and process steps, and conducted training for all team members

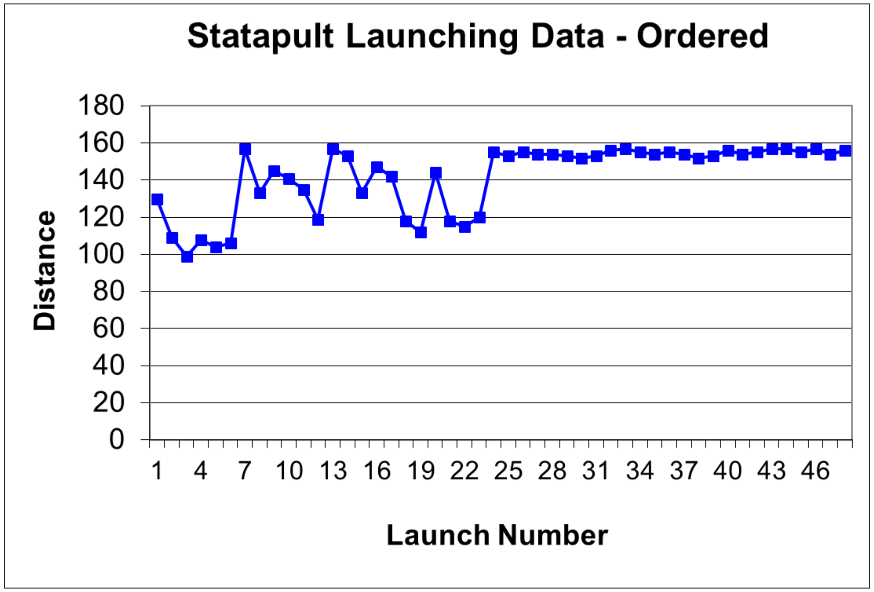
Round 2 Results (after applying PF/CE/CNX/SOP)

- The results for the same 6-person team are shown

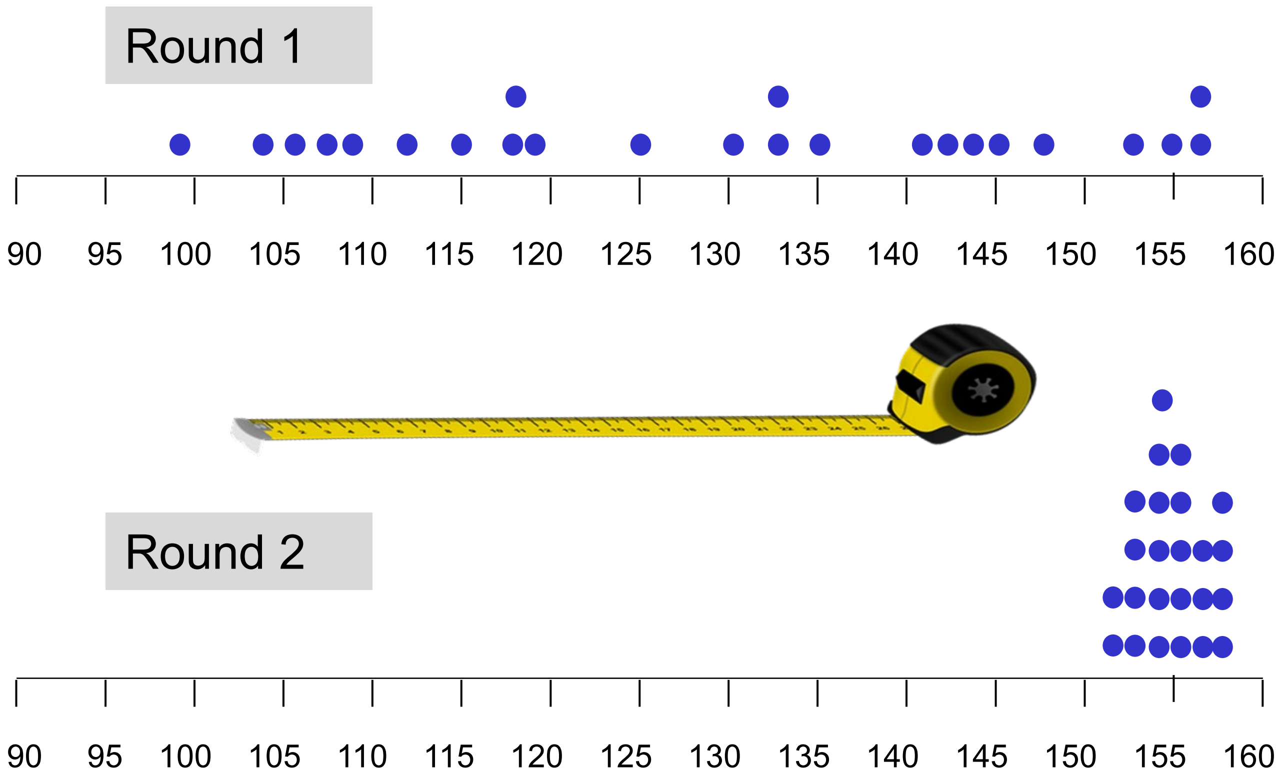
Launch Number	Distance	
1	153	
2	155	
3	154	
4	154	
5	153	
6	152	
7	153	
8	156	
9	157	
10	155	
11	154	
12	155	
13	154	
14	152	
15	153	
16	156	
17	154	
18	155	
19	157	
20	157	
21	155	
22	157	
23	154	
24	156	
Maximum	157	inches
Minimum	152	inches
Range (delta)	5	inches

Data file: statapult exercise.xlsx

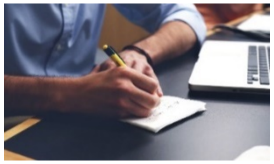




Visualizing the Results



Key Takeaways



- As a review, you may want to pause the video at this point and summarize the key learnings from this session, at least from a high-level view. When you are finished, resume the video.

Key Takeaways

- PF/CE/CNX/SOP is a powerful method for getting rapid improvement
- It gets teams engaged, and can be applied easily without the need for complicated training
- Used properly and consistently, the combination of these tools is critical to help:
  - Reduce excessive variation
  - Reduce the cost of waste
  - Reduce the cost of poor quality
- **PF** – **P**rocess **F**low . . . map the steps in the process
- **CE** – **C**ause and **E**ffect . . . brainstorm potential variables that may affect the outcome (the possible "causes" of the problem)
- **CNX** – **C**onstant, **N**oise, e**X**perimental . . . partition the variables
- **SOP** – **S**tandard **O**perating **P**rocedures . . . create and use detailed standards for each "C", to keep as constant as possible

Just remember these 10 letters….
PF/CE/CNX/SOP

Supplemental Material

- Suggested Reading:
  - ***Lean Six Sigma: A Tools Guide*** by Adams, Kiemele, Pollock and Quan (pp. 55-61, 89-93, 169-171)
  - ***Basic Statistics – Tools for Continuous Improvement*** by Kiemele, Schmidt and Berdine, 4th edition (pp. 2-4 – 2-14)
  - ***Design for Six Sigma: The Tool Guide for Practitioners*** by Reagan and Kiemele (pp. 57-62)
  - Air Academy's app: ***Six Sigma Quick Tools***

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- SPC XL™ software training tutorials:
  - https://airacad.com/our-insights/training-videos/spc-xl/

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Additional Practice / Review Questions

1) When baselining a process, what are some things that need to be accomplished?

2) PF/CE/CNX/SOP alone can reduce extraneous variation by as much as (what) percent?

3) What the two main methods used for creating a cause and effect (CE) diagram?

4) Construct a cause and effect diagram where commute time to work is the output or response (performance) measure. Be sure to label each input variable with either a C, N, or X, based on how you are controlling these variables today. Suggest possible changes, including SOPs, that will reduce the variability of the input variables and consequently improve the performance measure.

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