Card Drop - Rolled Throughput Yield

OVERVIEW

This exercise is an extension of the Card Drop Exercise, also in the Measure phase of DMAIC. This exercise builds on the demonstration of over-control and tampering in response to common cause variation, and adds the impact of these factors on a multistep process. The exercise is quick and easy to perform, and requires minimal materials.

TIME NEEDED: 30 minutes

APPLICATION: Rolled Throughput, Common Cause Variation, Over-control

NOTE: Some cultures may be offended by playing cards. Business cards can be substituted.

## RUNNING THE EXERCISE

MATERIALS NEEDED:
- Pack of playing cards or business cards
- 3 Large poster boards or 3 sheets of flip chart paper marked with target

INSTRUCTIONS:

1. On three large pieces of flipchart paper, draw two concentric circles. The inner circle should have a diameter of about 10 inches, and the outer should have a diameter of about 20 inches.

2. Place the sheets on the floor and have a student stand next to each sheet. Have the first student hold their arm stretched straight out over their 'bulls eye' circle. Have them hold a card on edge (so the card is vertical), aim carefully (you can emphasize this to make sure they overcompensate after each drop), and drop the card towards the target. *Note the vertically held card. This is critical in the first run to make the cards flutter off target.*

3. The card will flutter around and almost always miss the target. Repeat 10 times and watch the student closely – are they moving their arm each time to compensate for the last drop?

4. Almost all students will re-aim after each drop, trying to compensate for the last direction the card fluttered.

5. After the first student has completed dropping the 10 cards, take only the cards that have fallen into the green circle (you may have to expand that to the red circle, or even the flipchart paper itself to have even 1 or 2 cards to pass on to the next student) and pass these "Good" outcomes to the second student. NOTE: The photo
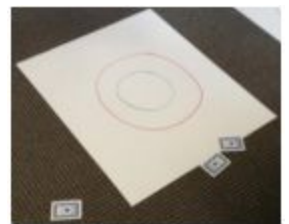
shows a typical result. Most of the cards entirely missed the flip chart sheet, and only one or two will make it into the circles. In this picture, we took all three cards that landed on the first sheet and passed them to the second student.

6. Have the second student perform the same steps with the few cards that made it through the first step. Repeat with the "Good" outcomes of the second step, allowing the third student to try and hit their target. Typically, only 1 or 2 cards will make it to the third step in this process, and often no cards will make it completely through all three steps.

The second student had three cards to drop. Only two of them ended up touching the flip chart paper, so in this case, we allowed those to be considered "good," and passed them to the third student. The third student had one card barely hit the edge of the flip chart sheet. With the most generous definition of "good" (just touching the flipchart), this process was only able to produce 1 good output.

DEBRIEF

- Ask the class what they saw. Did they notice the student re-aiming between each drop? Almost all students will tamper with the process and attempt to aim the drop based on the outcome of the previous drop.
- Ask the class if the fluttering of the card is something that can be controlled in the 'process'? The answer is no, it is common cause variation.
- Explain the concept of common and special cause variation. Point out that tampering with a process in response to common cause variation will almost always increase the variation in the process, not reduce it.
- Explain the concept of Rolled Throughput Yield. In our example run above, the RTY calculation would be 0.3 x 0.67 x 0.5 = 0.1, which corresponds to the 1 "good" card that made it through the process from the 10 we started with.

KEY LEARNING POINTS

- At this point, you can also begin the discussion of process capability. Is this process capable? Probably not, but that is dependent on the customer specifications. How many cards does the customer expect in the inner or outer circles?

- If the process is not capable of meeting customer expectations, is any amount of tampering with the process going to improve the outcome? Most likely not.

- This process only has 3 steps - what about a process with 10 or 100 steps. Show the calculation - 10 steps at 90% = 0.9^{10} = 0.34 or 34% yield. 100 steps at 99% = 0.99^{100} = 37%. So, even with each process step at 99%, the 100 step process only yields 37% "good" products. How many steps are there in assembling a car, or a piece of software, or an operation in a hospital (from patient prep all the way through post-op care)?

- Ask the class: If we were to look at the process, what improvements could be made to make this process more capable? The improvement is to hold the card horizontally, not vertically. When held horizontally, the card will fall almost perfectly straight to the target. With the improvement, the process becomes capable and there is no longer a desire to tamper with the process.

The left technique is not too accurate for release of the horizontal card. The card often dips as it is dropped.

The technique in the right picture, holding the card from above, results in the most accurate drop and the best process improvement.

This is the typical result after the improvement is implemented.