Continuous Improvement Toolkit

Process Yield Measures
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- An ideal process must produce without defects or rework.
- You should have the appropriate performance metrics to measure the process yield.
- These metrics should be able to expose even the smallest inefficiencies in a process.
- They should enable operations to understand their true process yield in order to set realistic improvement targets.
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- Many companies utilize two measures of process yield:
  - *First time yield.*
  - *Final yield.*

- They represent the classic approach for calculating process yield.

- They don’t account for the hidden factory.
First Time Yield (FTY):
- Obtained by dividing the good product or service units (including reworked units) by the number of total units that entered the sub-process.

**Example:**
- FTY of an individual sub-process that processed 100 units and produced 90 good units would be 90%.
Final Yield (FY):

- The probability that a unit will successfully pass all steps assessed at the end of the process.
- Obtained by counting the good units that made it through until the last process step divided by the total number of units that entered the process.
- If there are the same amount of units at the end of the process as there were at the beginning, then the final yield would be 100%.
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Final Yield (FY):

- Consider the following 3-step process:

100 Inputs ➔ A ➔ B ➔ C ➔ 90 Outputs

Final Yield = 90%

Is this the whole story?
First Time Yield and Final Yield:

- They don’t reflect the actual defect rates and ignore the hidden factory.
- They are not sensitive to product complexity.
- They only look at the volume of the produced units.
- Corrective actions are often taken on spot when mistakes are discovered and rework are not recorded in quality logs.
- Process yield rates look better than what they really are.

A

P/F

100

100

Inputs

Outputs

- FY = 100%
- No scrapped units were generated

FTY = 100%

FTY = 100%
Throughput Yield (TPY):

- The probability that all defect opportunities produced at a particular step will conform to their respective performance standards.
- Only considers the good units that passed through a process step right the first time and error-free.
- A reworked unit that passed the test is not added to the throughput yield but to the first time yield.
- The difference between the two metrics should highlight the quality risk due to rework.
- This should lead to the pursuit of process improvement.
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Rolled Throughput Yield (RTY):

- Represents the probability of passing all performance standards through the entire process defect-free.
- It is calculated by multiplying the individual throughput yield values of each process step:

\[
RTY = \text{Throughput Yield of process step 1} \times \text{Throughput Yield of process step 2} \times \ldots \times \text{Throughput Yield of process N}.
\]
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Rolled Throughput Yield:

- Quantifies the cumulative effects of inefficiencies found throughout the process.
- Provides a better insight of the rates of errors and rework.
- Allows companies to be much more accurate when assessing the performance of their industrial or commercial processes.
- Calculations are done at each process step.
- Substantially less than final yield.
Example – Low Complexity Process:

- **A**: TPY = 94%
- **B**: TPY = 91%
- **C**: TPY = 92%

**Inputs**: 100

**Outputs**: 89

**Rework**: 2

**Scrap**: 5, 4

**RTY** = TPY(A) * TPY(B) * TPY(C) = 94% * 91% * 92% = 78.7%

**RTY** is a true reflection of the process performance
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Example – High Volume Process (High Volume Process):

Cupper Count 99.54%
Formed Can Count 99.11%
Trimmed Can Count 99.77%
Washed Can Count 98.34%
Printed Can Count 98.18%
Palletized Can Count 98.89%
Light Inspected Can Count 97.88%
Internally Sprayed Can Count 98.88%
Coated Can Count 99.26%

RTY = 90.28%
The probability of manufacturing a can that meets all specs is 90.28%
**Example** – High Volume and Low Complexity:
- What is the RTY of a process that involve 5 steps and produces 30,000 units per hour, knowing that the throughput yield for each process step is 95%?

- RTY = (0.95)^5 = 77.4%.
- Throughput Yield per hour = 0.7738 * 30,000 = 23,213 TPY per hour.
- i.e. 6787 non-conforming units per hour (22.6%).
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Example – Low Volume and High Complexity:

- What is the RTY of a process that involves 30 steps and produces 10 units per hour, knowing that the throughput yield for each process step is 95%?

- RTY = (0.95)^30 = 22.5%.
- Throughput Yield per hour = 0.2146 * 10 = 2.15 TPY per hour.
- i.e. 8 non-conforming units per hour (77.4%) and only 21.5% will be shipped without rework.
Further Information

- Using of a process map as a guide in the process yield evaluation is a good practice and can be very helpful.
- Throughput yield is sensitive to the number of critical-to-quality characteristics (CTQs) in a product (product complexity).
- Rolled throughput yield is sensitive to the number of CTQs, the effectiveness of the process, and the number of process steps (process complexity).
- Simplification of the process needs to be considered to improve the process yield rate.