Continuous Improvement Toolkit

Process Yield Measures
Process Yield Measures

An ideal process must produce without defects or rework
Process Yield Measures

A **defect** is a failure to conform requirements (include scrap & rework)

A **rework** is an additional work required to conform requirements
Process Yield Measures

You should have the appropriate **metrics** to measure process yield.

These metrics should be able to reveal even the **smallest inefficiencies** in a process.
Process Yield Measures

You should have the appropriate metrics to measure process yield.

They should enable operations to understand their true process yield in order to set realistic improvement targets.
Many companies use **two measures** for process yield:

- **First time yield (FTY)**
- **Final yield**

They represent the **classical approach** for calculating process yield.
Process Yield Measures

First Time Yield (FTY)

Obtained by dividing the good product units by the number of total units that entered the process at a given process step

The reworked units are included in the calculation of FTY
Process Yield Measures

First Time Yield (FTY)

Question:

Find the FTY for a process knowing that the second process steps has produced 90 good units from 100 processed units.
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First Time Yield (FTY)

Not sensitive to product complexity and only looks 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 making the process yield rate looks better than what it really is.
Process Yield Measures

Final Yield (FY)

The probability that a unit will successfully pass all steps inspected at the end of the process

Another widely used yield metric that is easy to calculate
Process Yield Measures

Final Yield (FY)

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.
Process Yield Measures

Final Yield (FY)

Find the final yield in the following 3-step process . . .

100 Inputs  →  A  →  B  →  C  →  90 Outputs
Process Yield Measures

First Time Yield and Final Yield

Don’t reflect the actual **defect rates** and ignore the hidden factory

Not sensitive to **product complexity**

Only look at the **volume** of the produced units

Corrective actions are often taken **on spot** when mistakes are discovered

Process yield rates often look **better** than what they really are

100 Inputs

A

FTY = 100%

P/F

B

FTY = 100%

P/F

100 Outputs

- FY = 100%
- No scrapped units were generated
Process Yield Measures

More Process Yield Measures

- First Time Yield
- Throughput Yield
- Final Yield
- Rolled Throughput Yield

+ Accuracy
- Cumulative
Process Yield Measures

Throughput Yield (TPY)

The probability that a product or service unit will pass through a given process step defect-free

Sometimes referred to as First Pass Yield
Process Yield Measures

Throughput Yield (TPY)

The number of units coming out a given process step divided by the number of units going into that process step over a specified period. Only good units with no rework or scrap are counted.
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**Throughput Yield vs. First Time Yield**

The difference between the two metrics is due to the inclusion of reworked units.

A reworked unit that passed the process step will not be considered in the calculation of throughput yield.

A reworked unit is considered in the calculation of the FTY.
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Rolled Throughput Yield (RTY)

The probability of passing all performance standards through the entire process defect-free

RTY is a true reflection of the process performance
Rolled Throughput Yield (RTY)

It is calculated by multiplying the individual throughput yield values of each process step.

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

 Rolled Throughput Yield (RTY)

- Calculations are done at each process step
- Substantially less than final yield
- Quantifies the cumulative effects of inefficiencies found throughout the process
- Provides a better insight of the rates of defects and rework
- Allows companies to be much more accurate when assessing the performance of their industrial or commercial processes
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Rolled Throughput Yield (RTY) – Example

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

FY = 89%

Not equal!
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Rolled Throughput Yield (RTY) – Example

100 Inputs → A (TPY= 94%) → B (TPY= 91%) → C (TPY= 92%) → 89 Outputs

RTY = \(78.7\%\)

This means that even if the 3 process steps are performing well, one out of every 5 units will not make it through the process without being reworked or scrapped.
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Example – Can Making Process

The probability of manufacturing a can that meets all specifications is 90.28%
**Process Yield Measures**

**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%?

\[
\text{RTY} = (0.95)^5 = 77.4\%
\]

Throughput Yield / hour = 0.7738 * 30,000 = 23,213 TPY / hour

i.e. 6787 non-conforming units / 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 / hour = 0.2146 * 10 = 2.15 TPY / hour

i.e. 8 non-conforming units / hour (77.5%)
A best practice is to use a process map as a guide in the process yield evaluation.
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Further Information

TPY is **sensitive** to the number of critical-to-quality characteristics (CTQs) in a product (product complexity).

<table>
<thead>
<tr>
<th>First Time Yield</th>
<th>Final Yield</th>
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</thead>
<tbody>
<tr>
<td>Throughput Yield</td>
<td>Rolled Throughput Yield</td>
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RTY is **sensitive** to the number of CTQs, and the number of process steps (process complexity).

**Simplification** of the process needs to be considered to improve the process yield rates.
Some process yield measures can be \textit{averaged} together to measure the entire production flow.

This provides a sense of the overall \textit{flow performance}. 
Process Yield Measures

Further Information - Other Yield Measures

**Rolled throughput yield loss** is the inverse of RTY

**Average completion rate** is the output of a process over a defined period

**Normalized yield** is the average throughput yield result at any given step