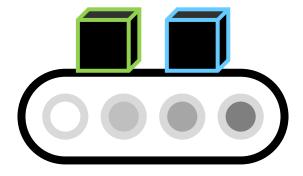
Continuous Improvement Toolkit

Process Yield Measures

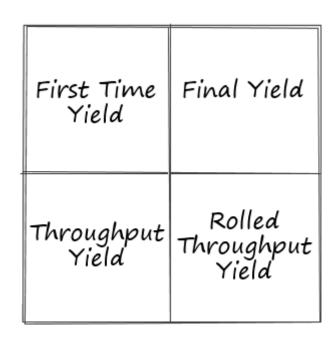


The Continuous Improvement Map

Managing	Decidin	g & Selecting	Planning & Project Management*
Risk PDPC	Decision Balance Sheet	Importance-Urgenc	cy Mapping Daily Planning PERT/CPM
FMEA RAID Log*	Force Field Analysis	Cost Benefit Analy <mark>s</mark> i	MOST RACI Matrix Activity Networks
Risk Assessment*	Break-even Analysis \	oting TPN Analy <mark>si</mark>	SWOT Analysis Stakeholder Analysis
Fault Tree Analysis De	ecision Tree Pick Chart	Four Field Matri <mark>x</mark>	Project Charter Improvement Roadmaps
Traffic Light Assessment	Critical-to Tree QFD	Portfolio Matrix	PDCA Policy Deployment Gantt Charts
Lean Measures Kan	no Analysis Matrix Diagram	Paired Comparison	DMAIC Kaizen Events Control Planning
Bøttleneck Analysis**	cost of Quality* Pugh Matrix	Prioritization Matrix	A3 Thinking Standard work Document control
Process Yield OE	E KPIs Pareto Analy		erstanding Cross Training Implementing
	scriptive Statistics ANOVA	Chi-Sauara	se & Effect Value Analysis Solutions**
Pr Gap Analysis*	robability Distributions Hypo	othesis Testing Desig	gn of Experiment Mistake Proofing Ergonomics
Histo Reliability Analysis	ograms & Boxplots Multi va	ri Studies Confiden	nce Intervals Simulation TPM Automation
Understanding Gra	aphical Analysis Scatter Pl	ots Correlation _F	Regression Pull Flow Just in Time
Performance MSA	Run Charts 5 Whys	Root Cause Analysis	Data Snooping Visual Management 5S
Benchmarking** Co	ontrol Charts Fishbone	Diagram Tree Diagra	m* SIPOC* Waste Analysis Quick Changeover
Data collection planner* Sampling Morphological Analysis How-How Diagram** Process Redesign Time Value Map			
Check Sheets Interviews Brainstorming SCAMPER** Attribute Analysis Spaghetti Diagram Value Stream Mapping			
	Groups Affinity Diagram	Relationship Mappi	
Data Collection Observ	Mind Mapping*		Flowcharting IDEF0 Process Mapping
Collection Observ	Suggestion systems	Creating Ideas	Designing & Analyzing Processes

- 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.

- 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.

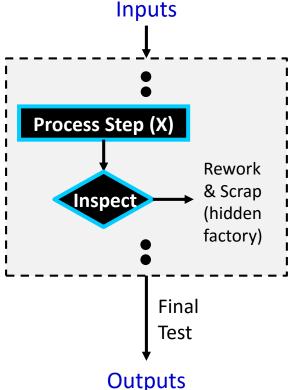


First Time Yield (FTY):

 Obtained by dividing the good product or service units (including reworked units) by the number Interest
 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%.

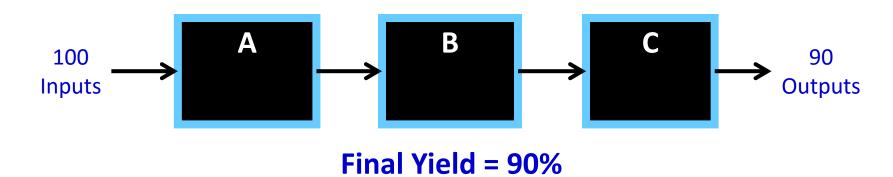


Final Yield (FY):

- 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%.

Final Yield (FY):

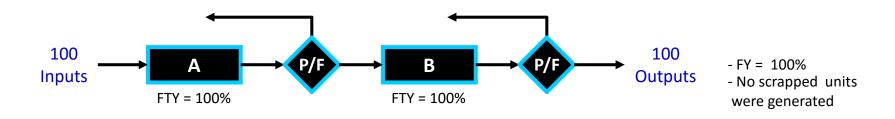
□ Consider the following 3-step process:



Is this the whole story?

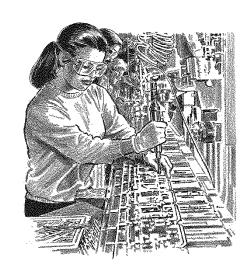
First Time Yield and Final Yield:

- 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.



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.

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:

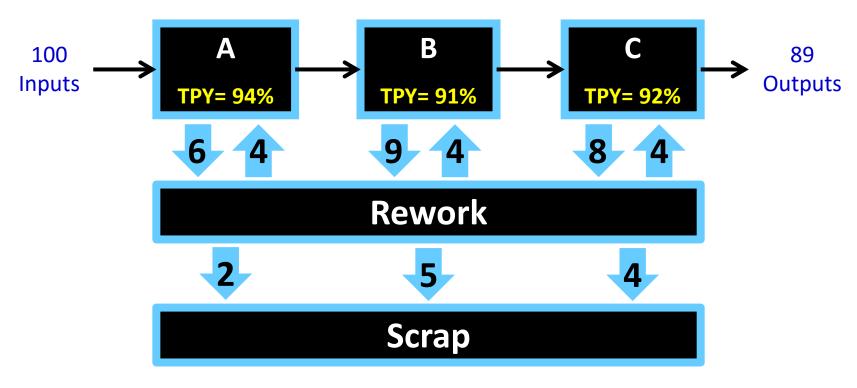
RTY = Throughput Yield of process step 1 * Throughput Yield of process step 2 * ... * Throughput Yield of process N.

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.



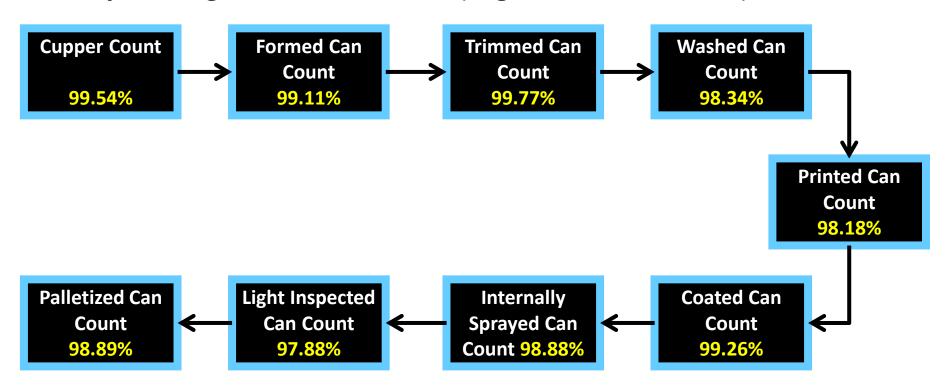
Example – Low Complexity Process:



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

RTY is a true reflection of the process performance

Example – High Volume Process (High Volume Process):



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%?
- \square 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%).

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%?
- \square 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.