#### Continuous Improvement Toolkit

### **Process Yield Measures**



#### The Continuous Improvement Map

Managing	Selecting & Decision Making Planning & Project Management*
Risk PDPC	Break-even Analysis Importance Urgency Matrix Daily Planning PERT/CPM
FMEA RAID Log*	Quality Function Deployment Cost Benefit Analysis MOST RACI Matrix Activity Networks
Risk Analysis*	Payoff Matrix Delphi Method TPN Analysis SWOT Analysis Stakeholder Analysis
Fault Tree Analysis	Decision Tree Pick Chart Voting Four Field Matrix Project Charter Improvement Roadmaps
Traffic Light Assessmer	nt Critical-to X Force Field Analysis Portfolio Matrix PDCA Policy Deployment Gantt Charts
Lean Measures OEE	Kano Decision Balance Sheet Paired Comparison DMAIC Kaizen Events Control Planning
Process Yield	Cost of Quality* Pugh Matrix Prioritization Matrix A3 Thinking Standard Work Document control
Projec	ct KPIs KPIs Pareto Analysis Matrix Diagram
Capability Indices Des	criptive Statistics Chi-Square Nonparametric Cause & Effect TPM Automation Solutions***
	Probability Distributions Hypothesis ANOVA DOE Mistake Proofing Health & Safety
Bottleneck Analysis	stograms Normal Distribution Multivariate Multi-vari Studie <mark>s Simulation Just in Time 5S</mark>
Reliability MSA G	raphical Methods Scatter Plots Correlation Regression Quick Changeover Visual Management
Understanding	Run Charts 5 Whys Root Cause Analysis Data Mining Product Family Matrix Flow Pull
Benchmarking***	ontrol Charts Fishbone Diagrams Relations Mapping SIPOC* Spaghetti** Process Redesign
Data collection planner*	Sampling How-How Diagram*** Tree Diagram* Waste Analysis** Value Stream Mapping**
Check Sheets** Intervie	ews Brainstorming SCAMPER*** Attribute Analysis Value Analysis** Process Mapping
Questionnaires Focu	s Groups Affinity Diagrams Morphological Analysis Flow Process Charts** Time Value Map**
Data Obse	rvations Mind Mapping* Lateral Thinking Flowcharting IDEF0 Service Blueprints
Collection Su	ggestion Systems Five Ws Group Creativity Designing & Analyzing Processes

# An ideal process must produce without **defects** or **rework**



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



A **rework** is an additional work required to conform requirements



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



These metrics should be able to reveal even the **smallest inefficiencies** in a process

# 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



They represent the classical approach for calculating process yield

#### 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

#### 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.

# $\bigcirc -\blacksquare - \bigcirc -\blacksquare - \bigcirc \bigcirc$

#### **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.

### 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

#### 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



#### Final Yield (FY)

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



#### 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



- FY = 100%
- No scrapped units were generated

#### **More Process Yield Measures**



#### Throughput Yield (TPY)

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



Sometimes rereferred to as First Pass Yield

### **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

#### 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



#### 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



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

#### **Rolled Throughput Yield (RTY)**

Calculations are done <b>at each</b> <b>process step</b>	Substantially <b>less</b> than final yield
Quantifies the <b>cumulative effects</b> 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

#### **Rolled Throughput Yield (RTY) – Example**



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

#### **Rolled Throughput Yield (RTY) – Example**



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

#### Example – Can Making Process



**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 / hour = 0.7738 \* 30,000 = 23,213 TPY / hour

i.e. 6787 non-conforming units / 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**%?

 $RTY = (0.95)^{30} = \frac{22.5\%}{22.5\%}$ 

Throughput Yield / hour = 0.2146 \* 10 = 2.15 TPY / hour

i.e. 8 non-conforming units / hour (77.5%)

#### **Further Information**

A best practice is to use a **process map** as a guide in the process yield evaluation.



#### **Further Information**

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

First Time Yield	Final Yield
Throughput Yield	Rolled Throughput Yield

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

#### **Further Information**

Some process yield measures can be **averaged** together to measure the entire production flow



This provides a sense of the overall flow performance

#### **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

