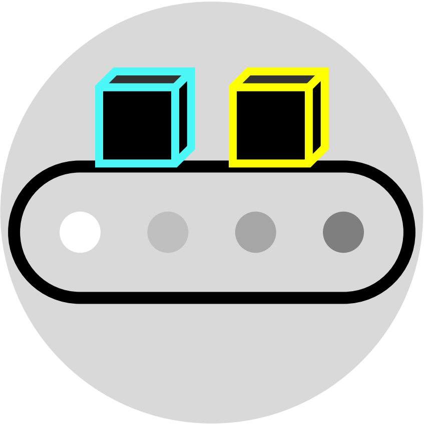
Continuous Improvement Toolkit

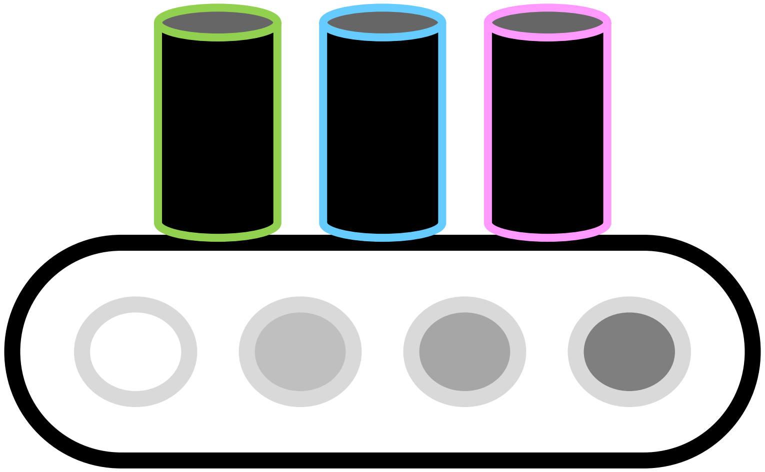
Process Yield Measures



The Continuous Improvement Map

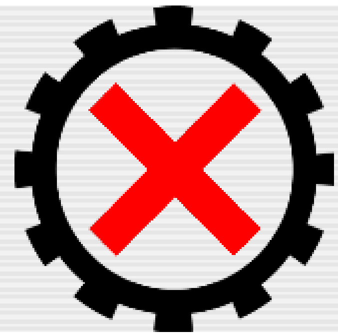
Process Yield Measures

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

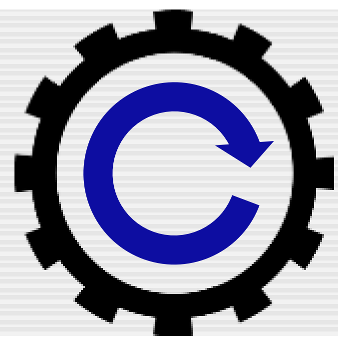


Process Yield Measures

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

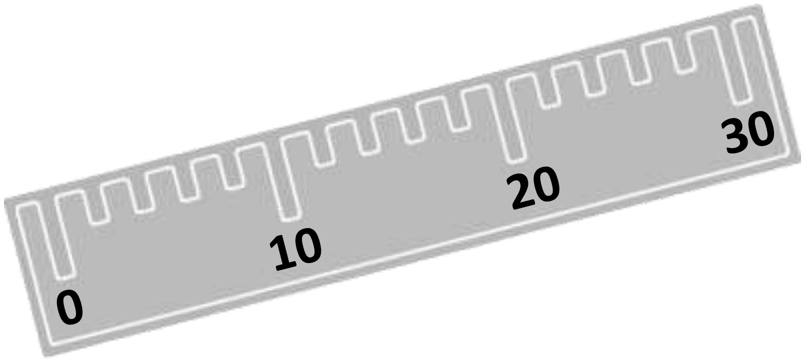


A **rework** is an additional work required to conform requirements



Process Yield Measures

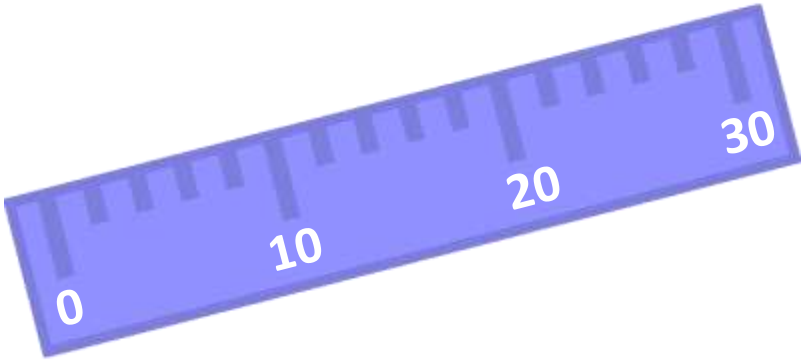
You should have the appropriate **metrics** to measure process yield



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**

Process Yield Measures

Many companies use **two measures** for process yield

First time yield (FTY)

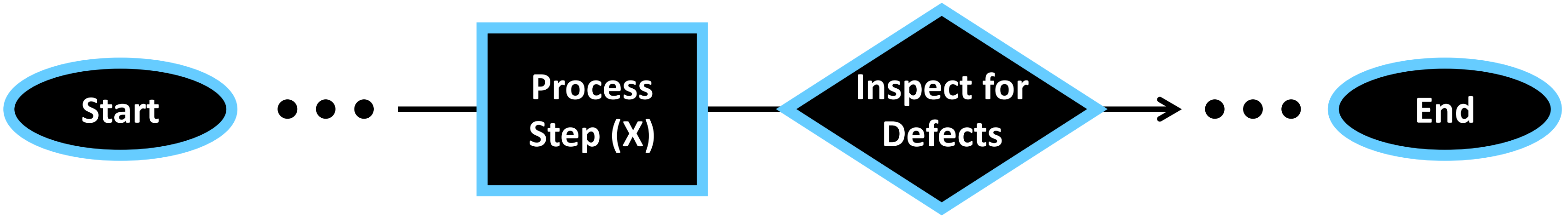
Final yield

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



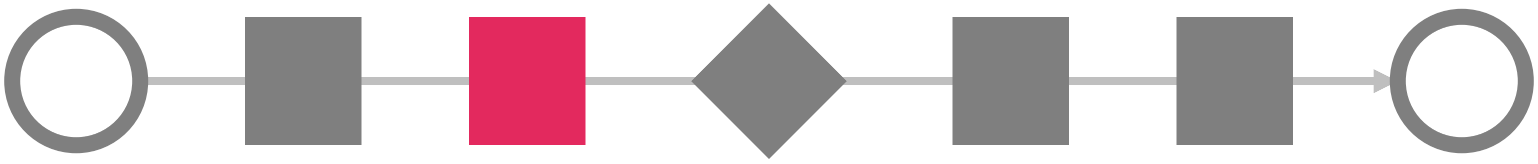
The **reworked units** are included in the calculation of FTY

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.



Process Yield Measures

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)

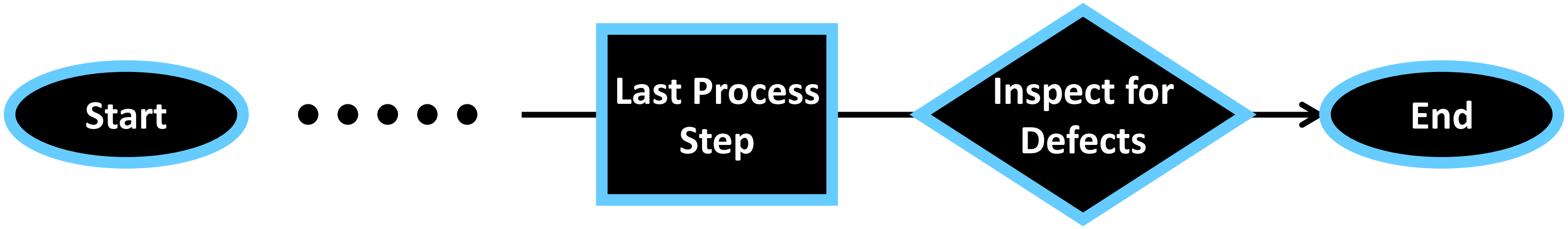
The probability that a unit will successfully pass all steps inspected at the **end of the process**

Another widely used yield metric that is easy to calculate

Process Yield Measures

Final Yield (FY)

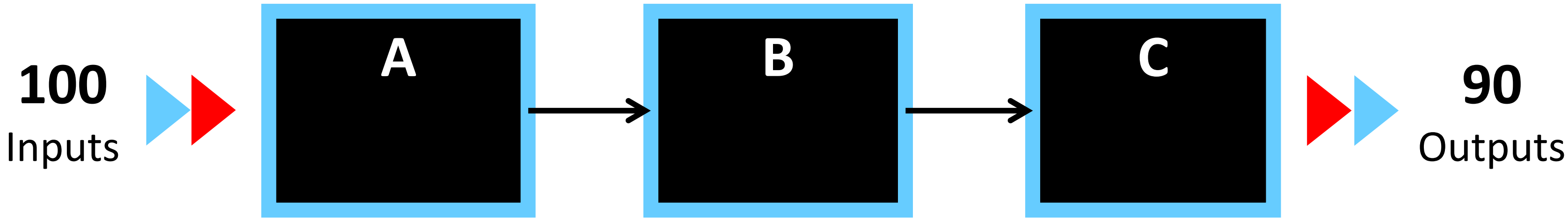
Obtained by counting the good units that made it through until the last process step divided by the total number of units that entered the process



Process Yield Measures

Final Yield (FY)

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



Process Yield Measures

First Time Yield and Final Yield

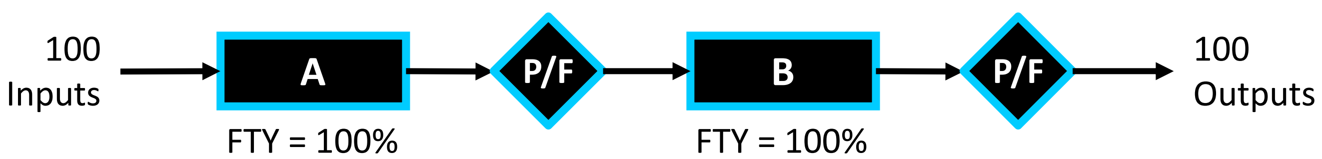
Don’t reflect the actual **defect rates** and ignore the hidden factory

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

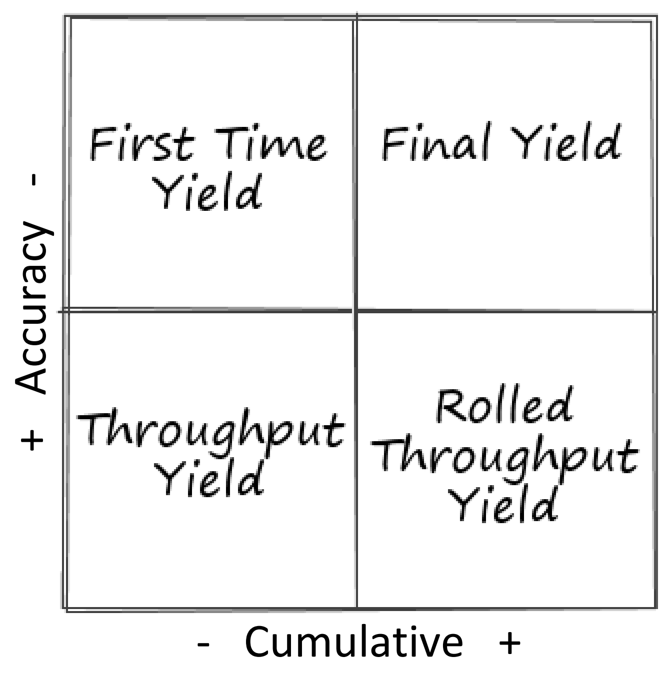
Process yield rates often look **better** than what they really are



- FY = 100%
- No scrapped units were generated

Process Yield Measures

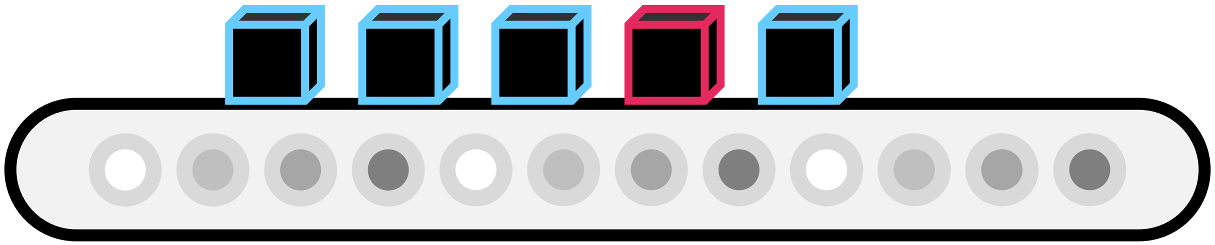
More Process Yield Measures



Process Yield Measures

Throughput Yield (TPY)

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

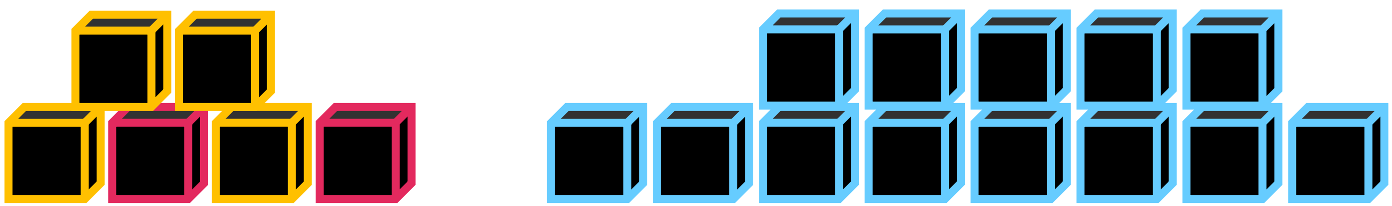


Sometimes rereferred to as **First Pass Yield**

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

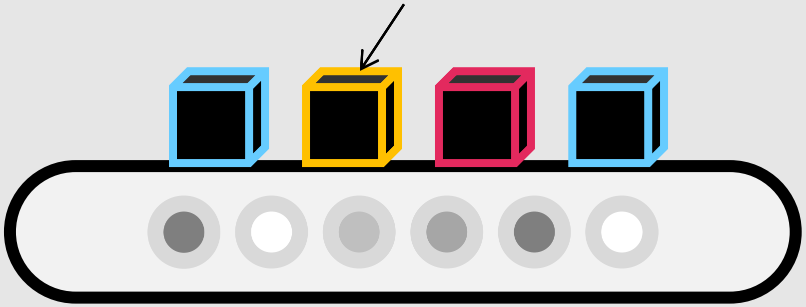
Process Yield Measures

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

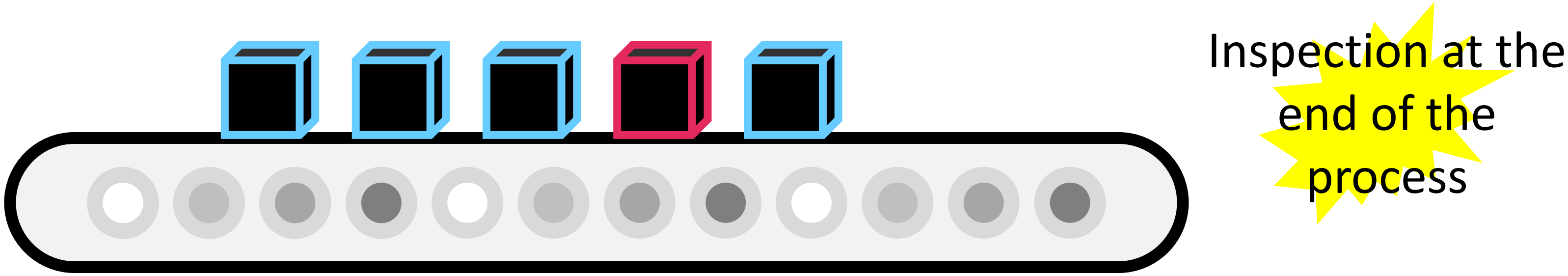
A reworked unit is considered in the calculation of the FTY



Process Yield Measures

Rolled Throughput Yield (RTY)

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

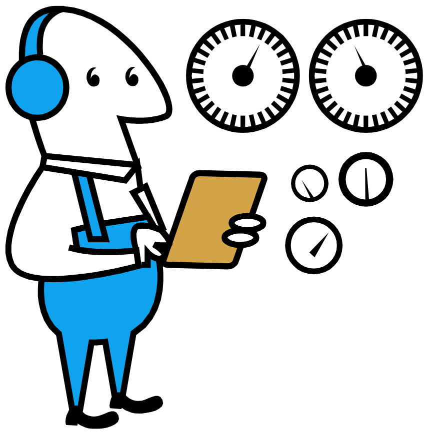


RTY is a true reflection of the **process performance**

Process Yield Measures

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.

Process Yield Measures

Rolled Throughput Yield (RTY)

Calculations are done **at each process step**

Substantially **less** than final yield

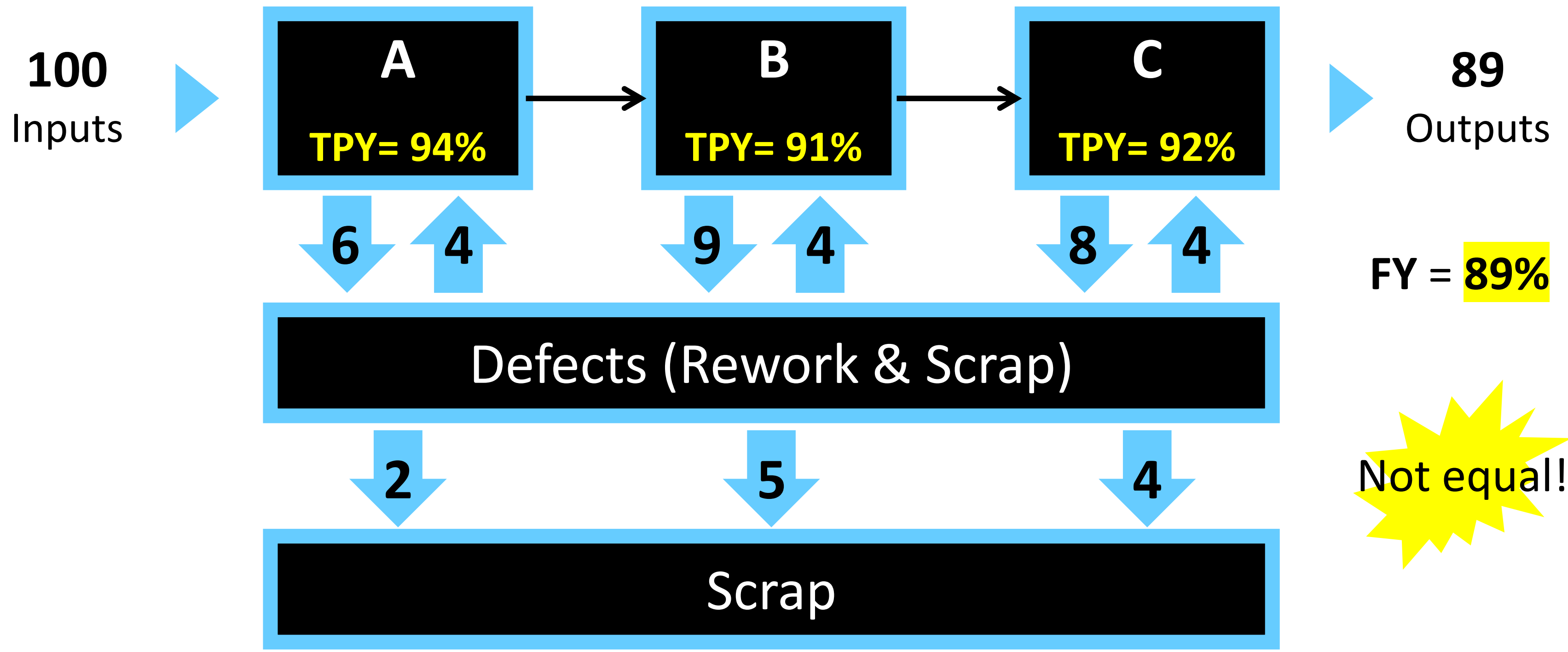
Quantifies the **cumulative effects** of inefficiencies found throughout the process

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

Process Yield Measures

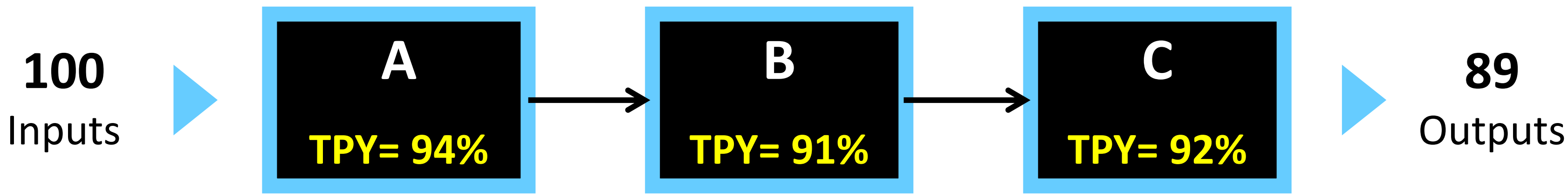
Rolled Throughput Yield (RTY) – Example



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

Process Yield Measures

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

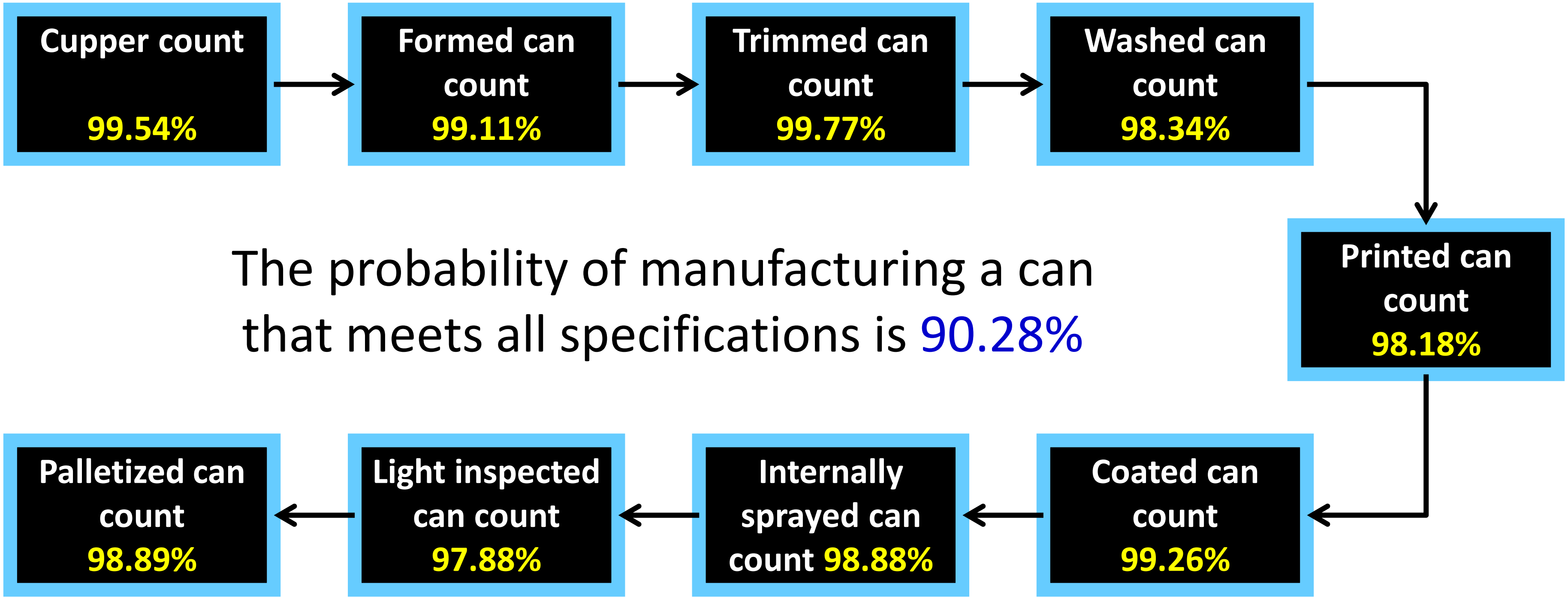


RTY = **78.7%**

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

Process Yield Measures

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%**?

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%)

Process Yield Measures

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%

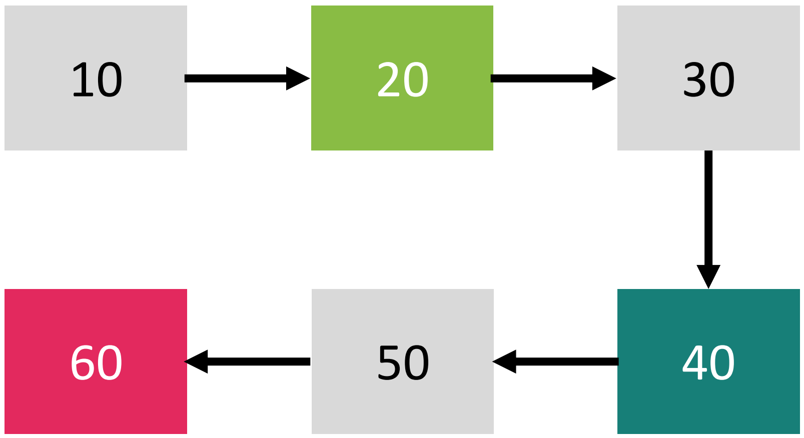
Throughput Yield / hour = 0.2146 * 10 = 2.15 TPY / hour

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

Process Yield Measures

Further Information

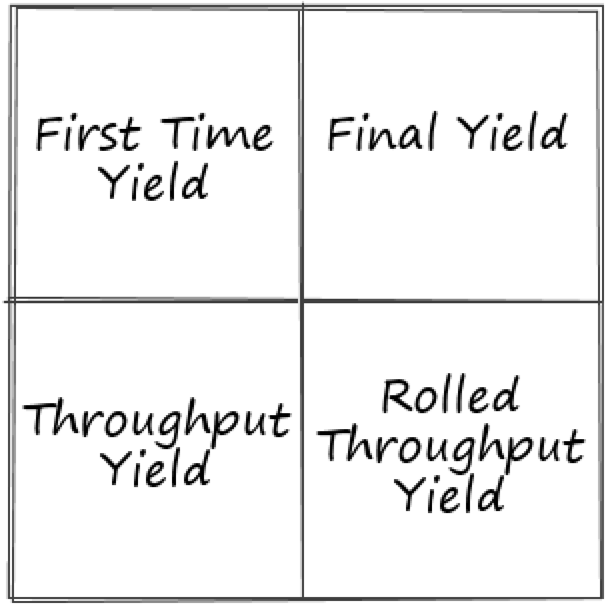
A best practice is to use a **process map** as a guide in the process yield evaluation.



Process Yield Measures

Further Information

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



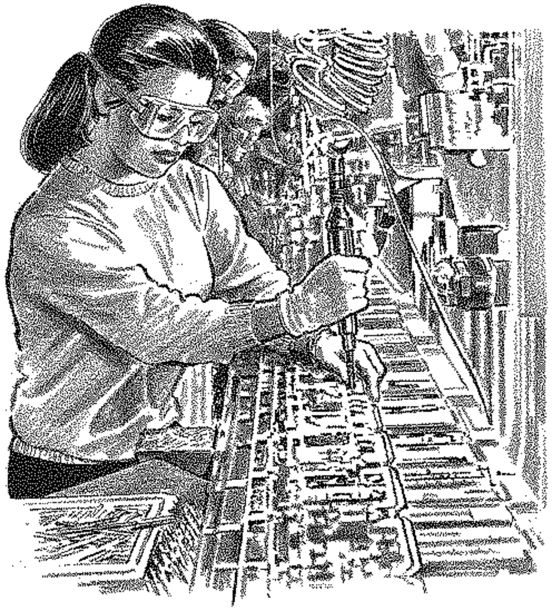
RTY is **sensitive** to the number of CTQs, and the number of process steps (process complexity).

Simplification of the process needs to be considered to improve the process yield rates

Process Yield Measures

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**

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