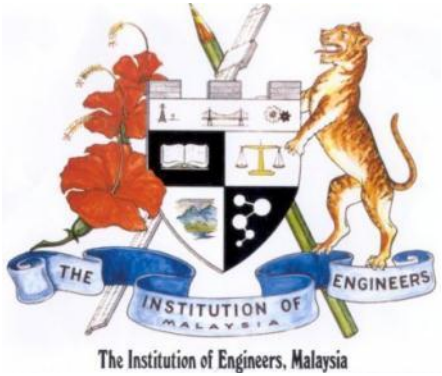


Electrical Engineering Technical Division

Simpler Industrial and Business Process Redesign.

By

Mike Sondalini

Lifetime Reliability Solutions

Biography

Qualifications:

Tradesman Fitter Machinist
Professional Mechanical Engineer (1st Class Honours)
Project Engineer
Maintenance Engineer
Master Business Administration
Maintenance Manager

Engineering and Business Work History:

Nova Machinery – *Manufacturer Press Brakes & Guillotines*

Swan Brewery – *Beverage*

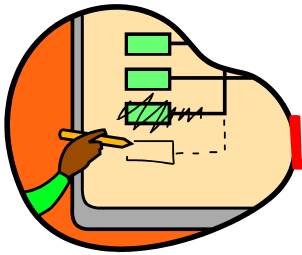
Riverton Engineering – *Sheet Metal Fabrication*

Coogee Chemicals – *Mining & Agricultural Chemicals Manufacture*

Lifetime Reliability Solutions – *Lean, Life Cycle Asset Management, ISO 9001 Quality Consulting*

- Three universal problems in business…

1. ***Wasted effort***  ***and wasted resources***

2.  ***Wrong business process for the purpose***

3. ***Wide and out-of-control process variation*** 

- Process redesign means finding highly effective solutions that address them.

Need to Achieve Process Control **and** Capability

In control and capable

In control but not capable

Out of control

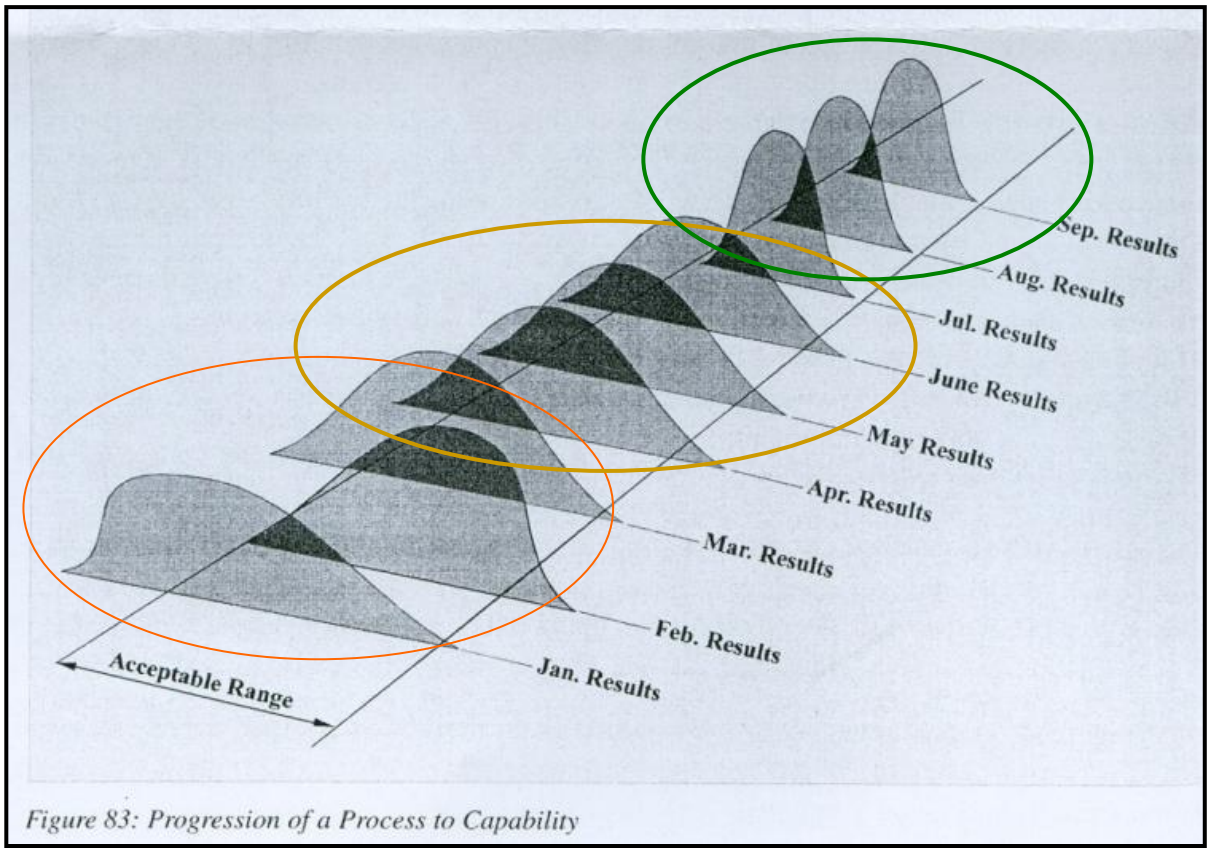
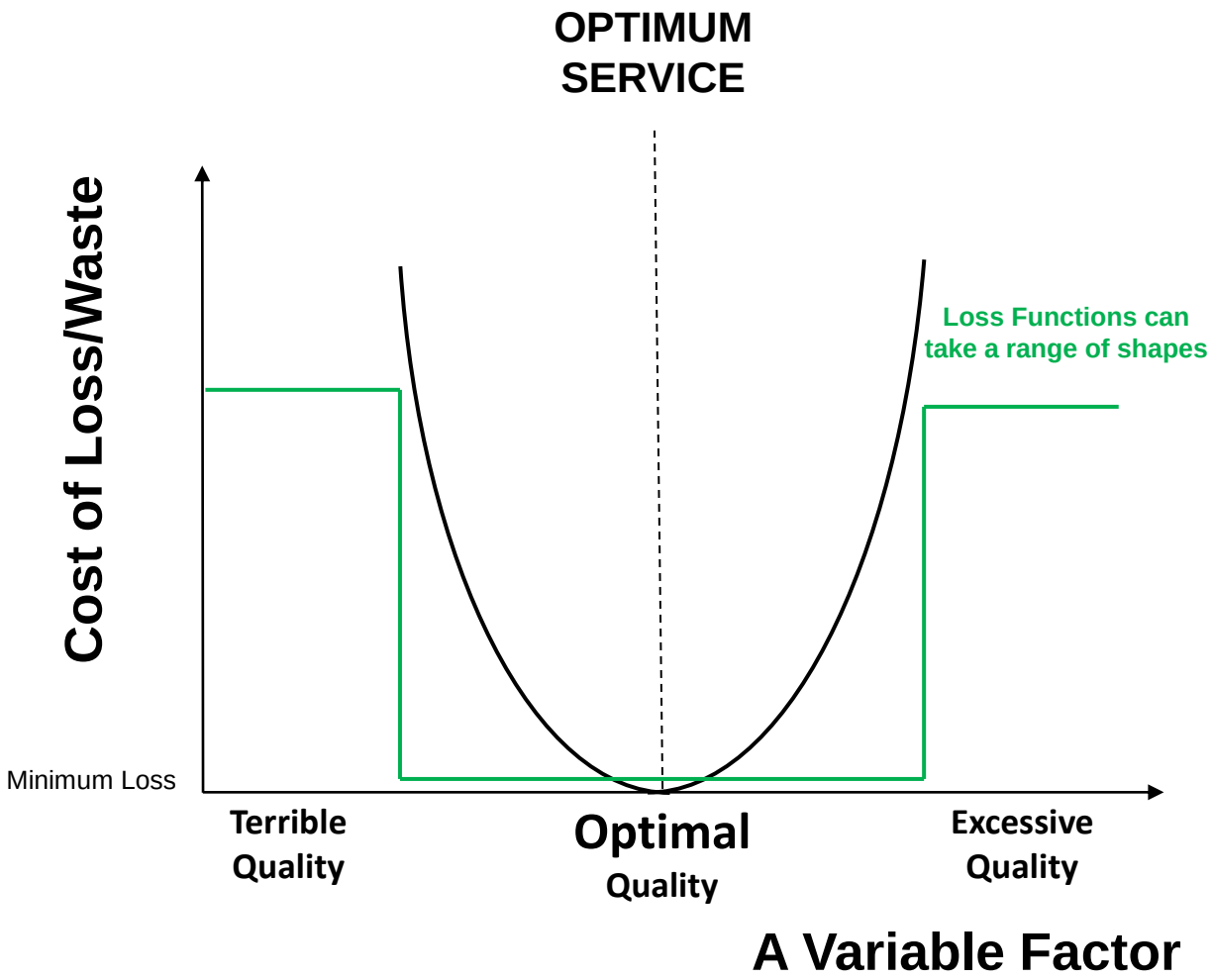
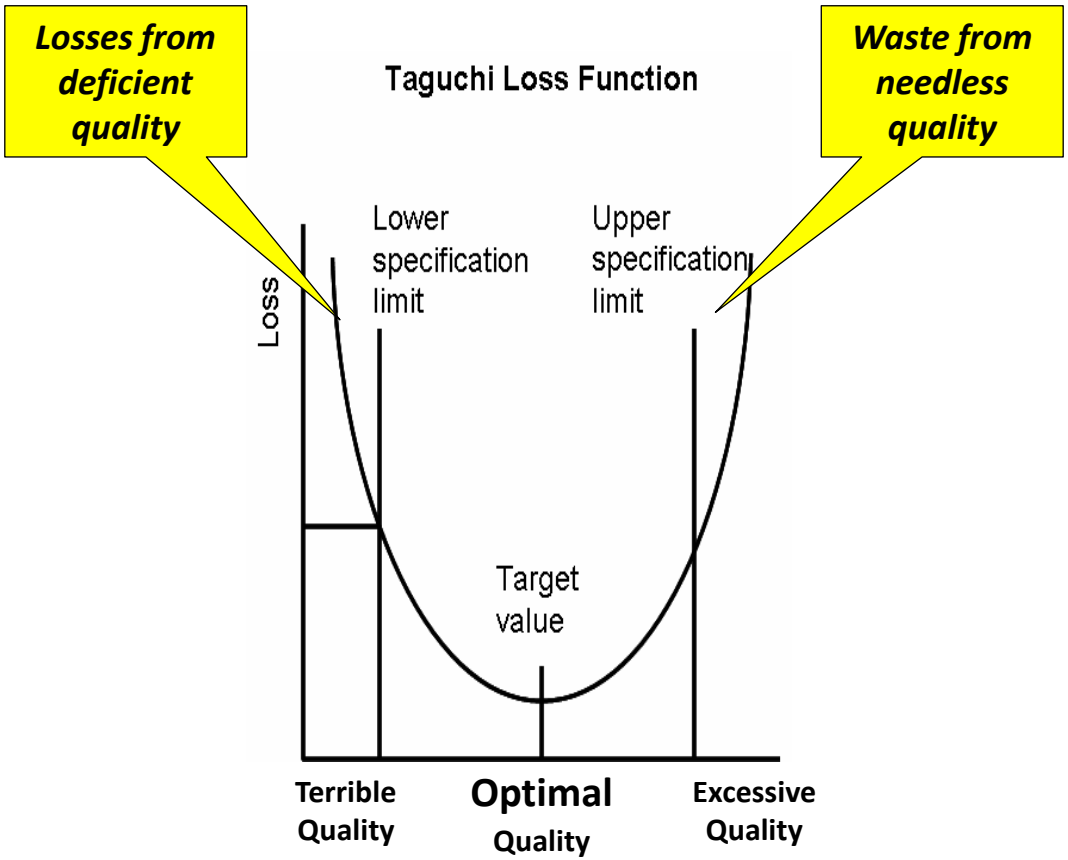


Figure 83: Progression of a Process to Capability

The Concept of a Quality Loss Function

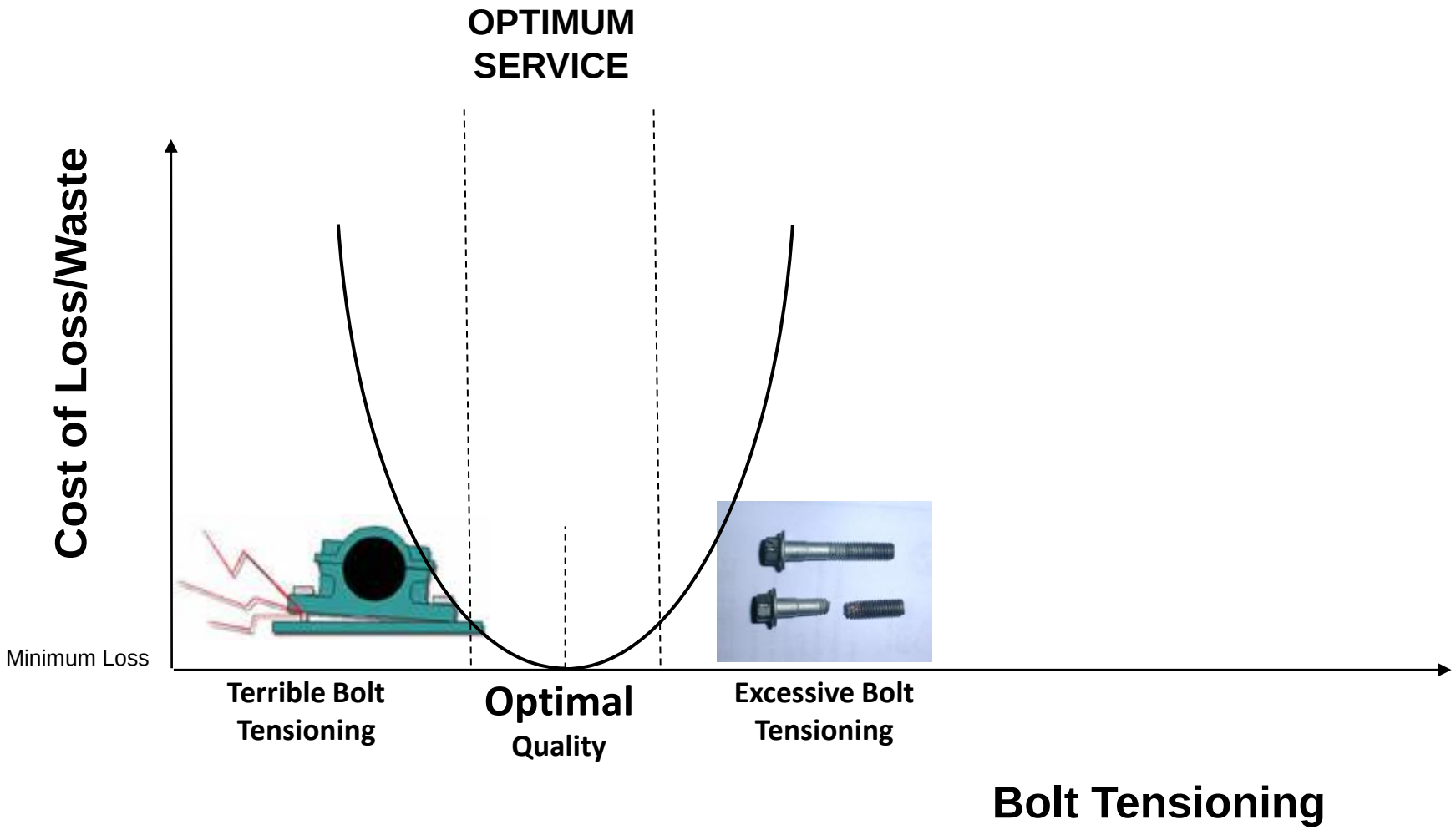


Taguchi 'Loss to Society' Function



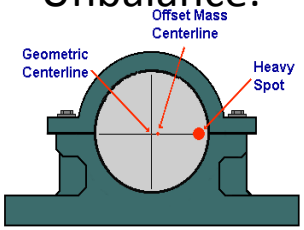
Concept First Developed in 1960

Bolt Tensioning Loss Function



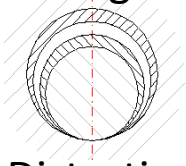
The ‘Loss to Society’ of Poorly Kept Machines

Unbalance:

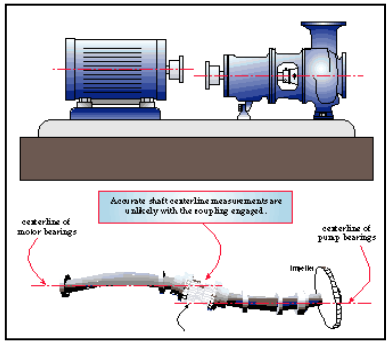


Contamination

Wrong Fit:

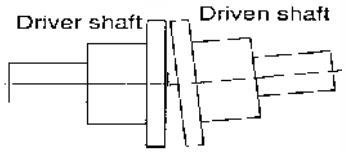


Distortion:

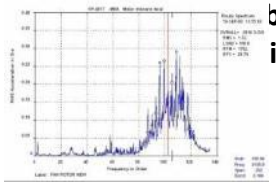


Bad Practice:

Misalign:



Vibration:



Losse… def… qu…

…guchi Loss Function

Waste from needless quality

Lower specification

Upper specification limit

$

LOST VALUE

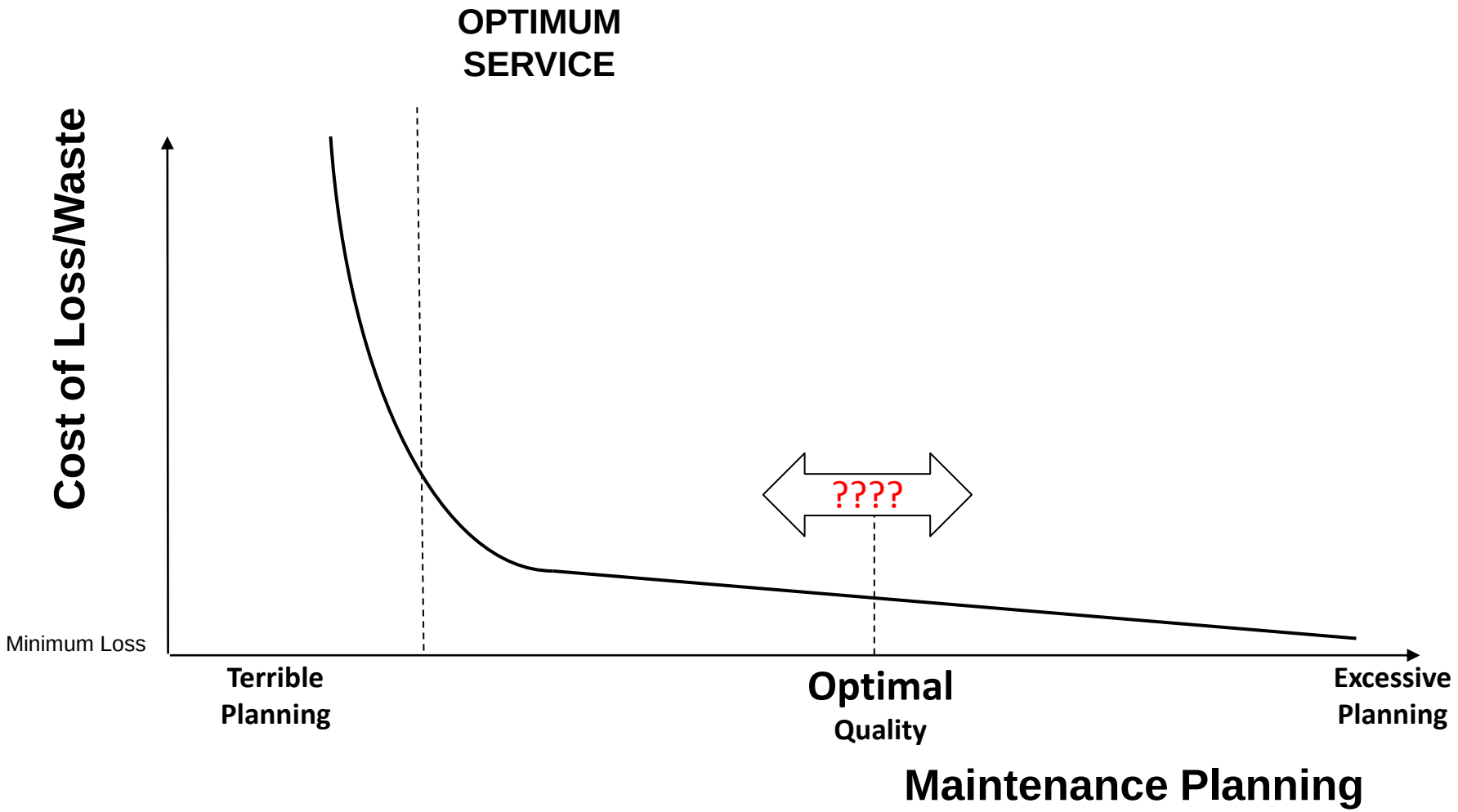
Target value

…ble …ity

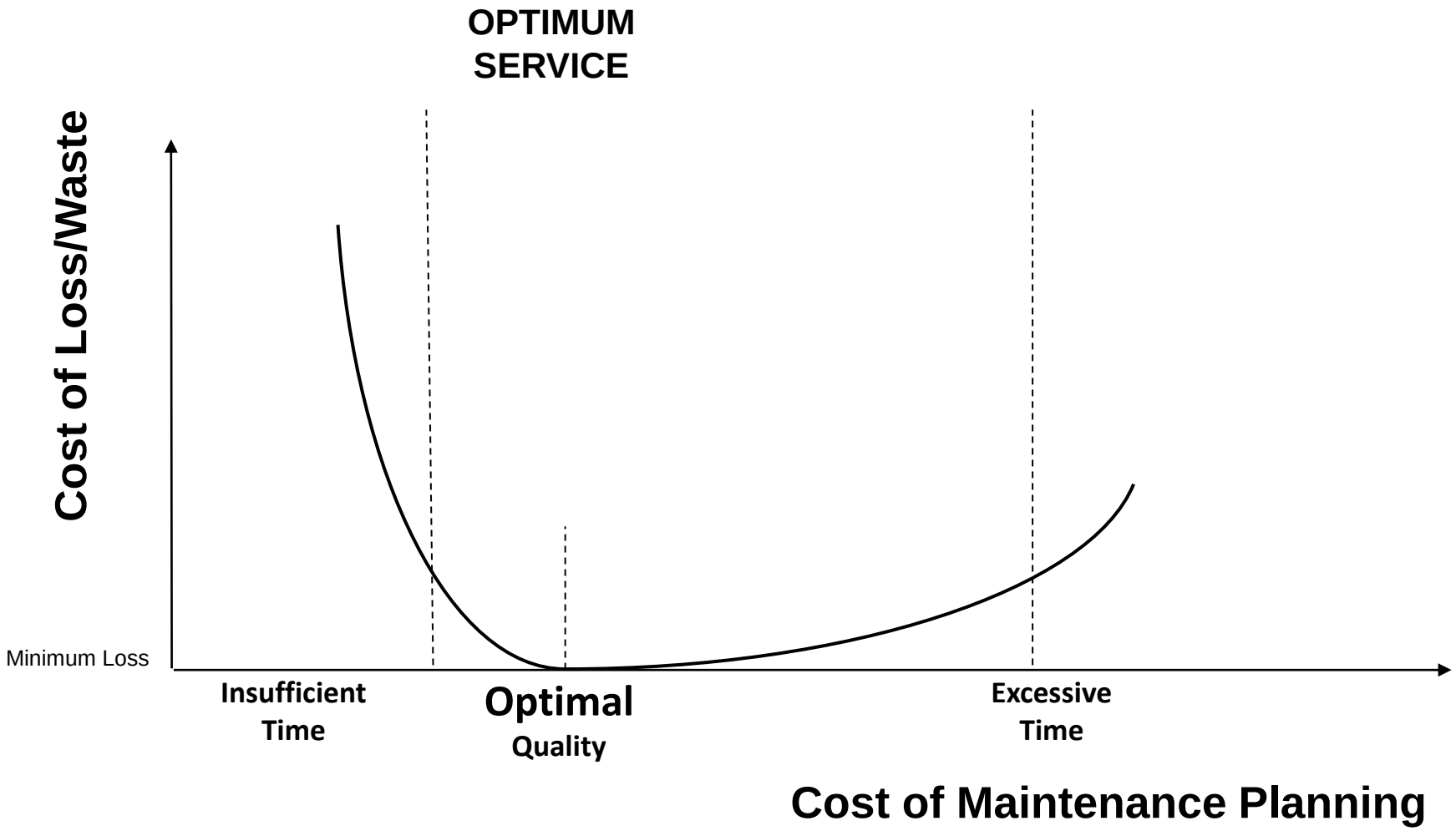
Optimal Quality

Excessive Quality

Maintenance Planning Loss Function

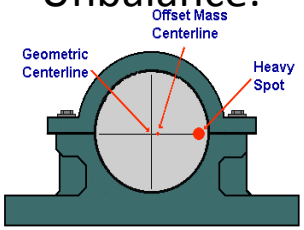


Maintenance Planning Cost Loss Function



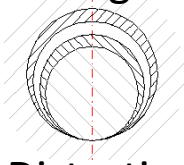
Distribution of Work Quality Performance

Unbalance:

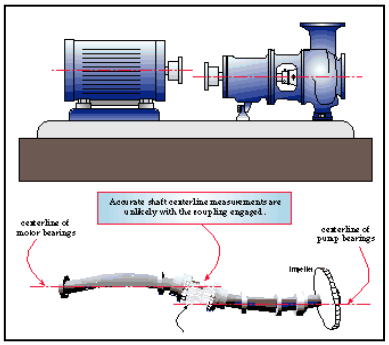


Contamination

Wrong Fit:



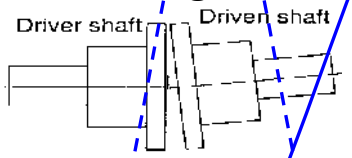
Distortion:



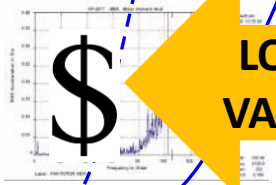
Frequency of Outcome

Bad Practice:

Misalign:



Vibration:



$

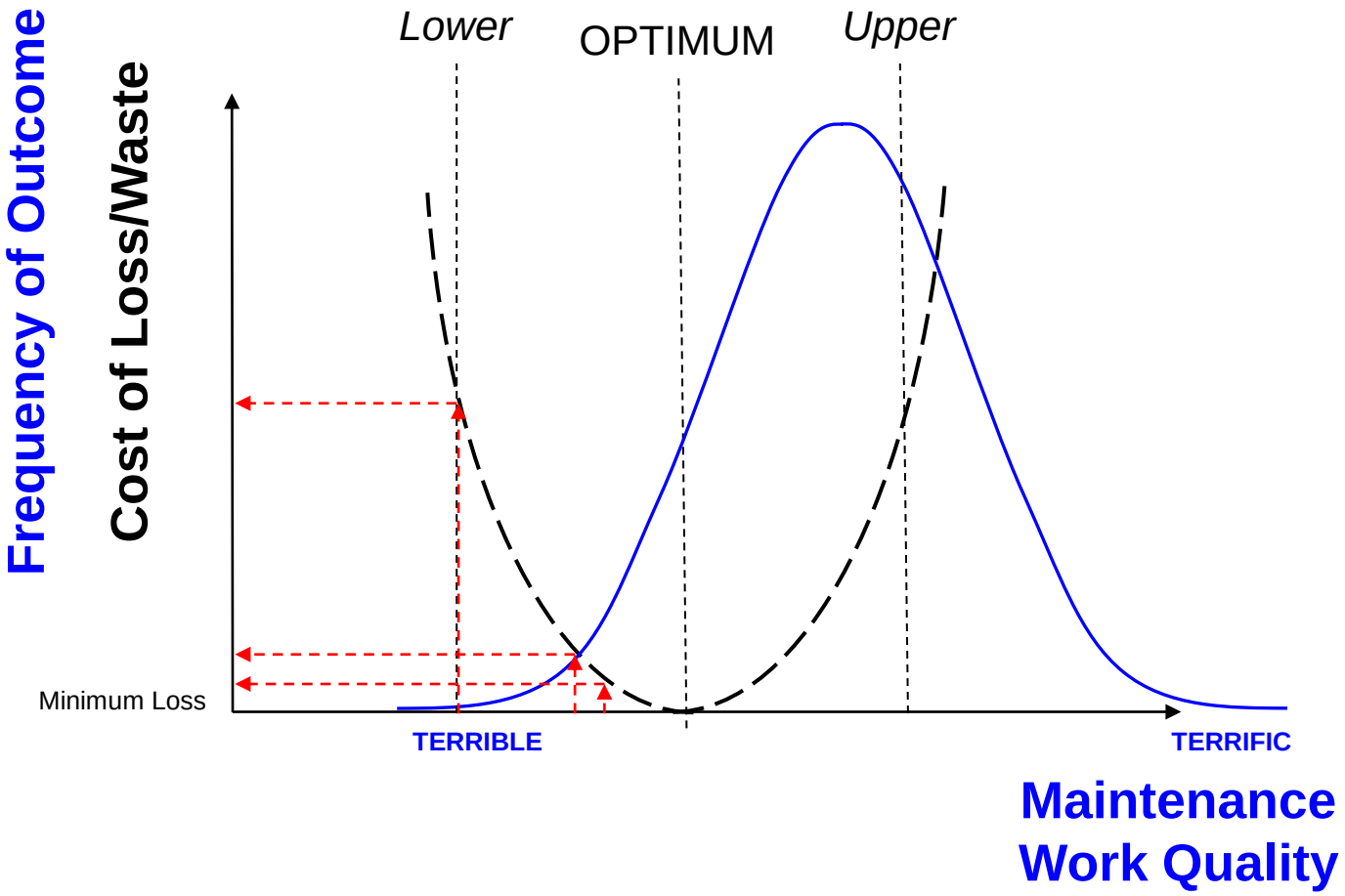
LOST VALUE

TERRIBLE RELIABILITY (Early Life Breakdowns)

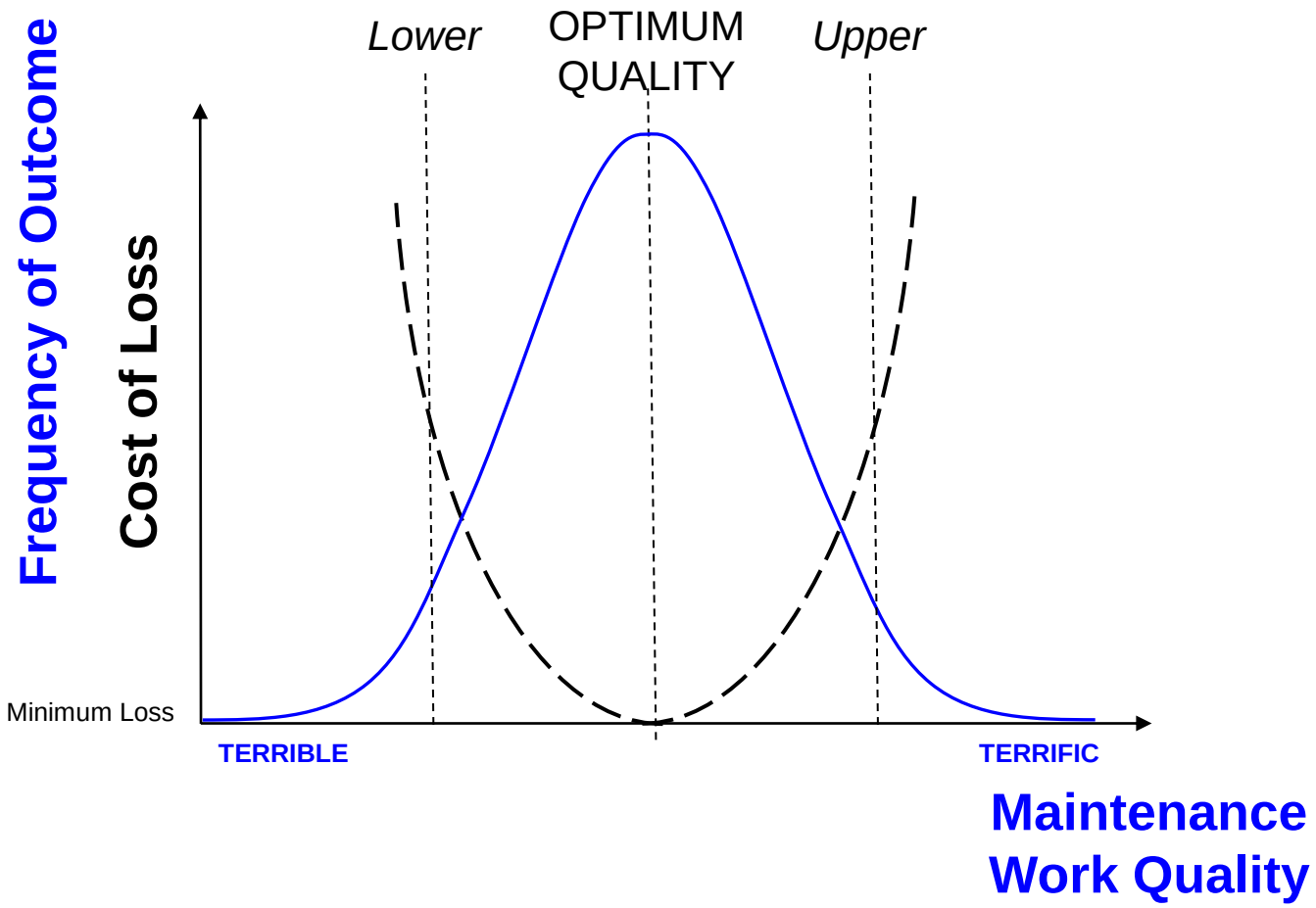
TERRIFIC RELIABILITY (Exceptional Service Life)

Maintenance Work Quality

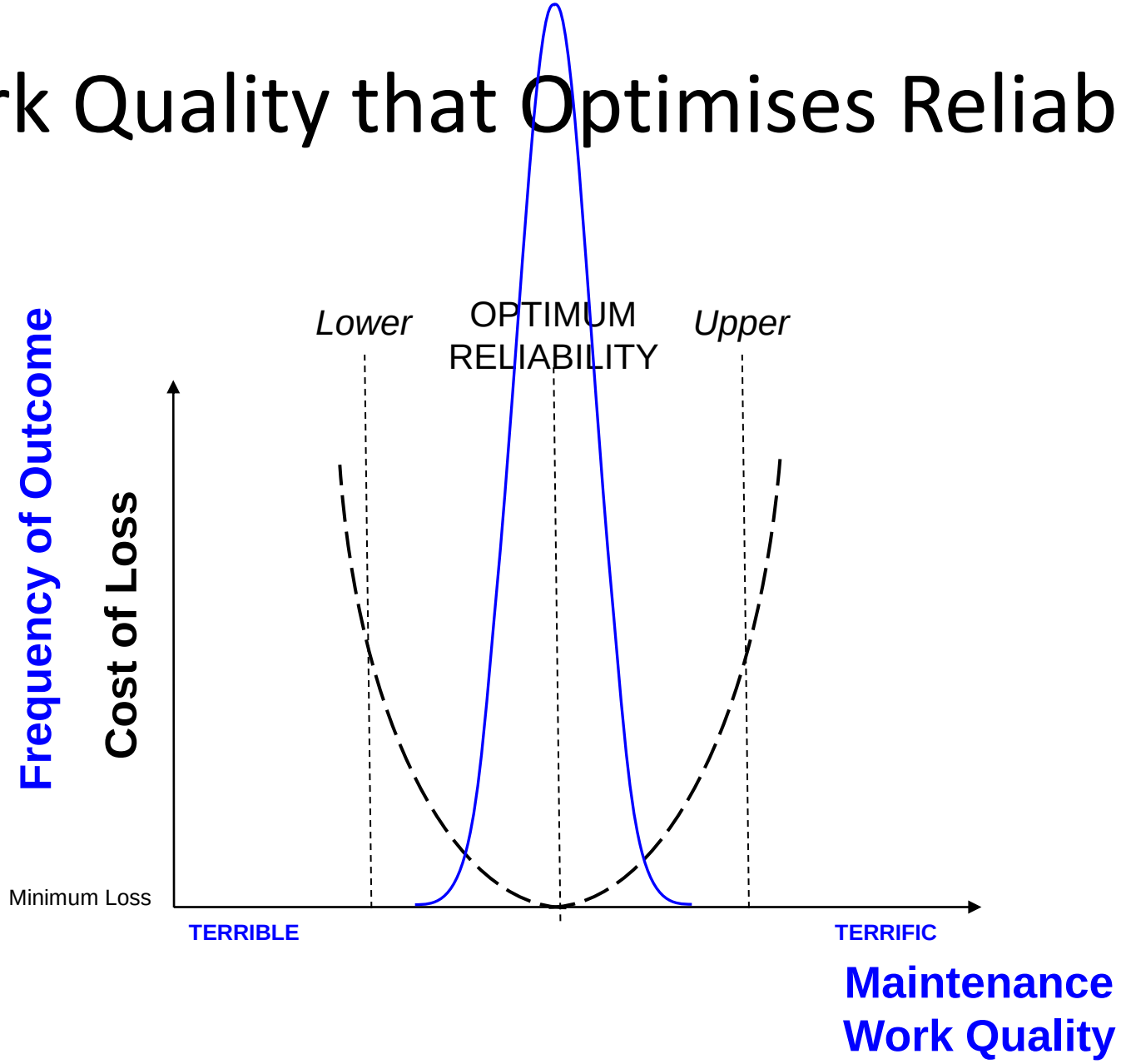
Combining Work Quality and Loss Function



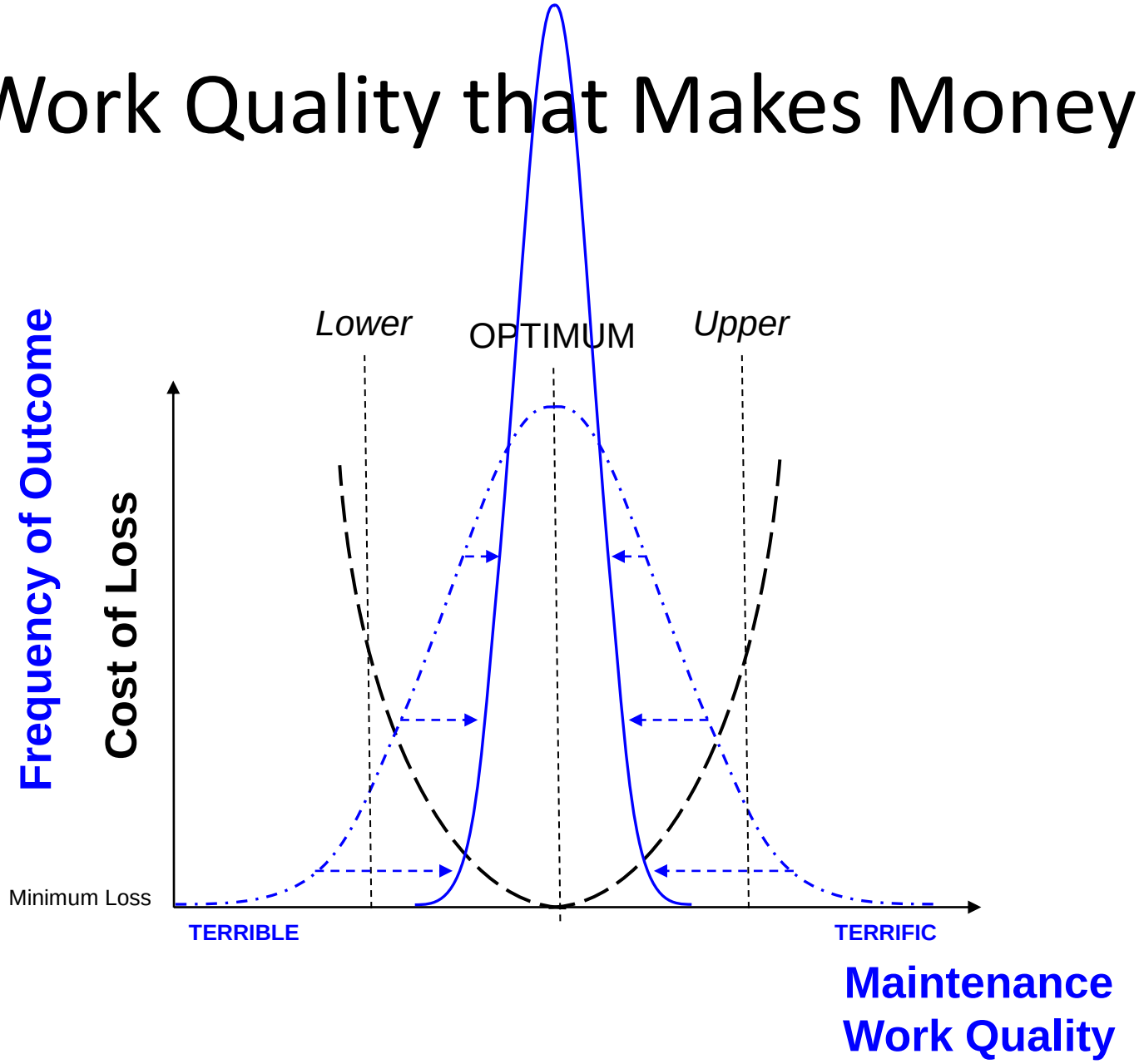
Work Quality that Minimises Loss and Waste



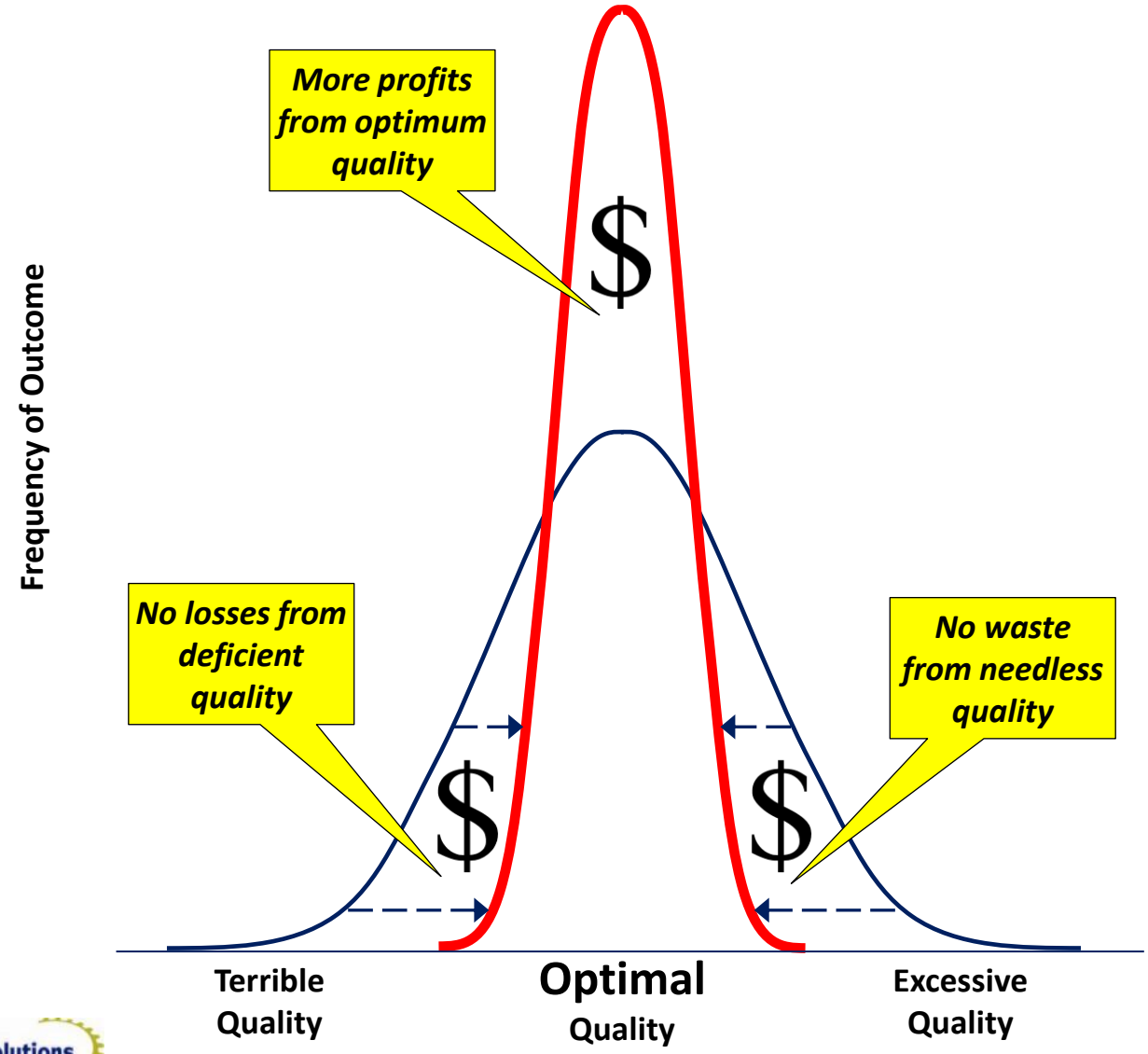
Work Quality that Optimises Reliability



Work Quality that Makes Money

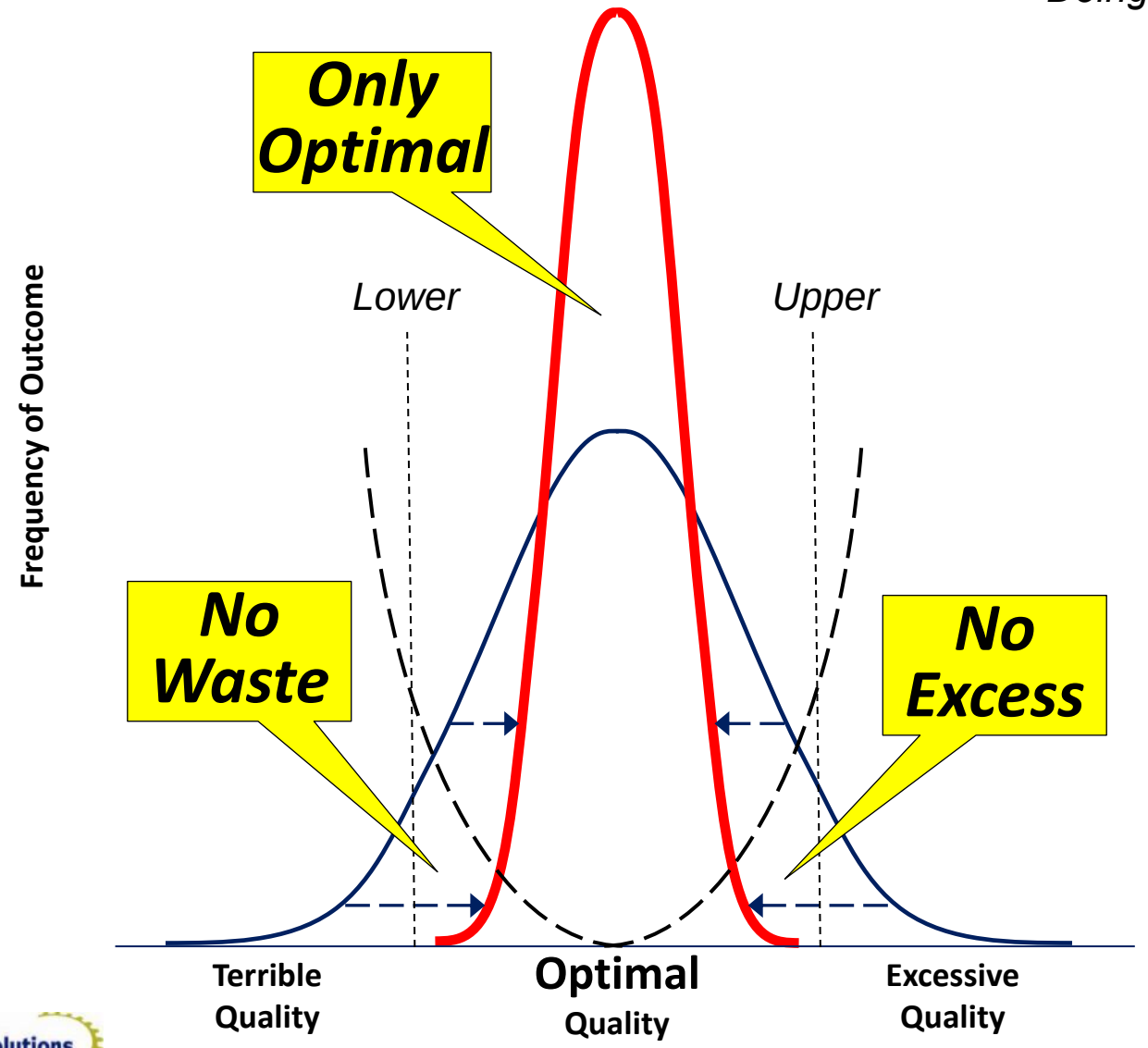


Where the Money is in 'Quality'



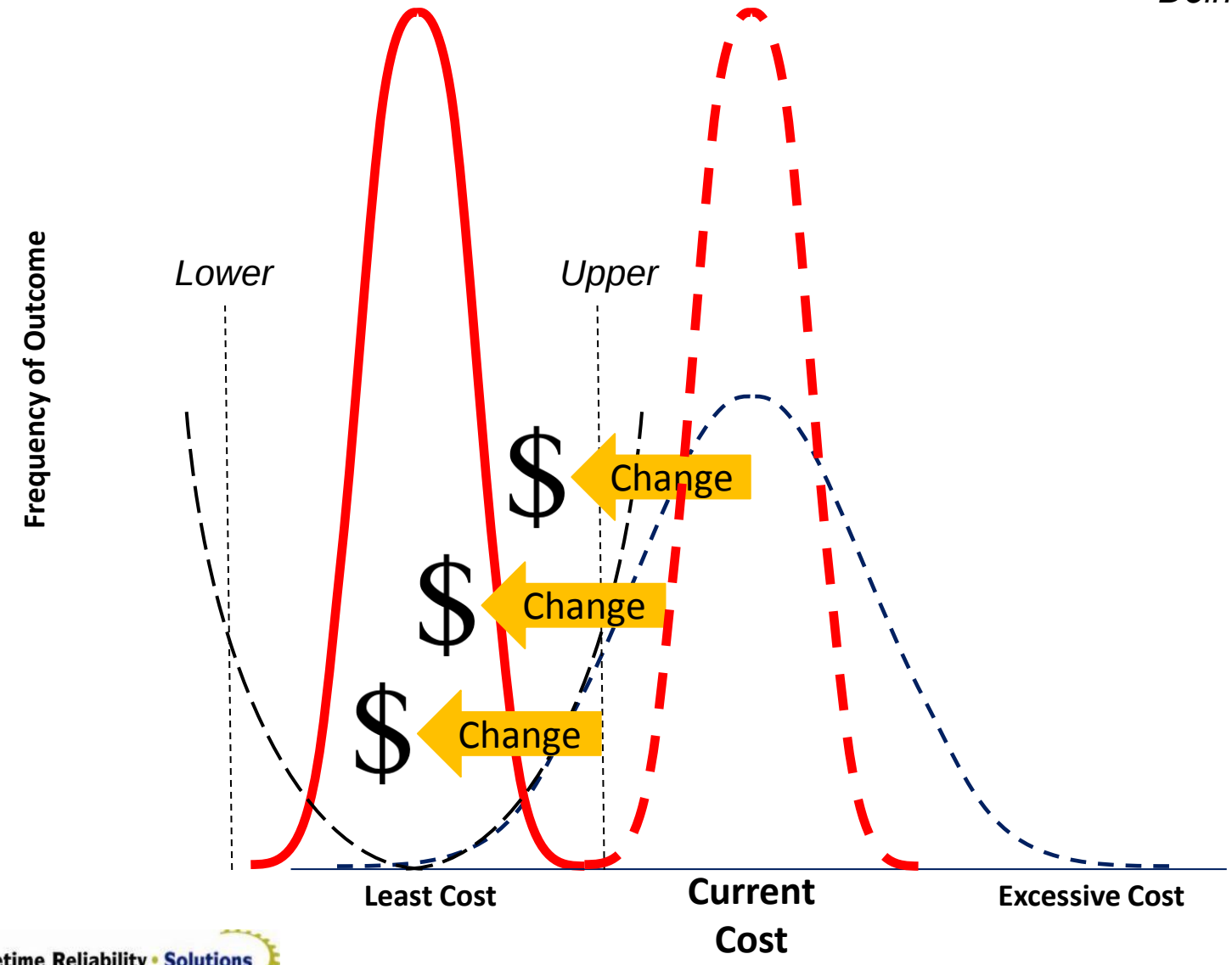
Process Redesign to Improve Efficiency

"Doing things right."



Process Redesign to Improve Effectiveness

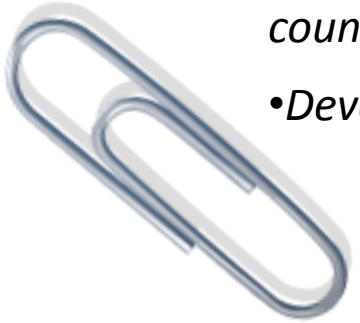
"Doing right things."

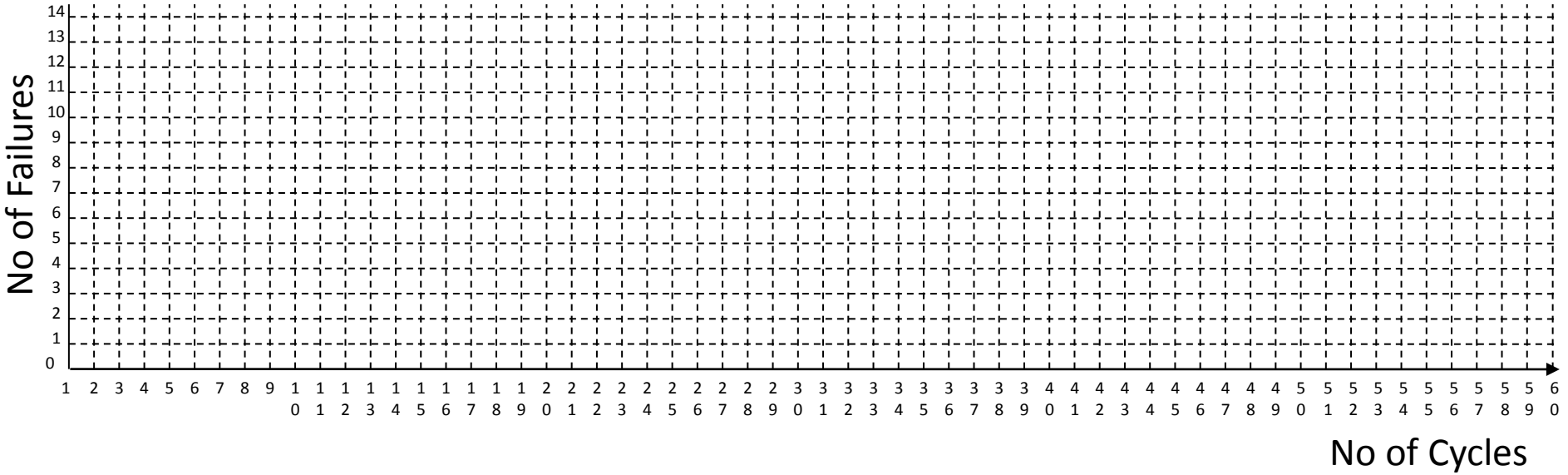


Changing Process Variation and Outcomes

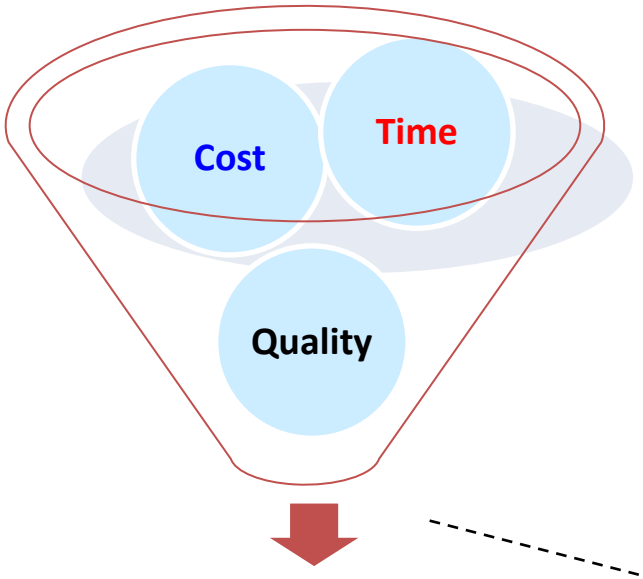
Distribution Curve of Variation in a Process

- *Uncoil a paper clip and bend it as instructed by the Presenter. Carefully count the number of cycles until it breaks.*
- *Develop a distribution of the count of the number of cycles to failure.*



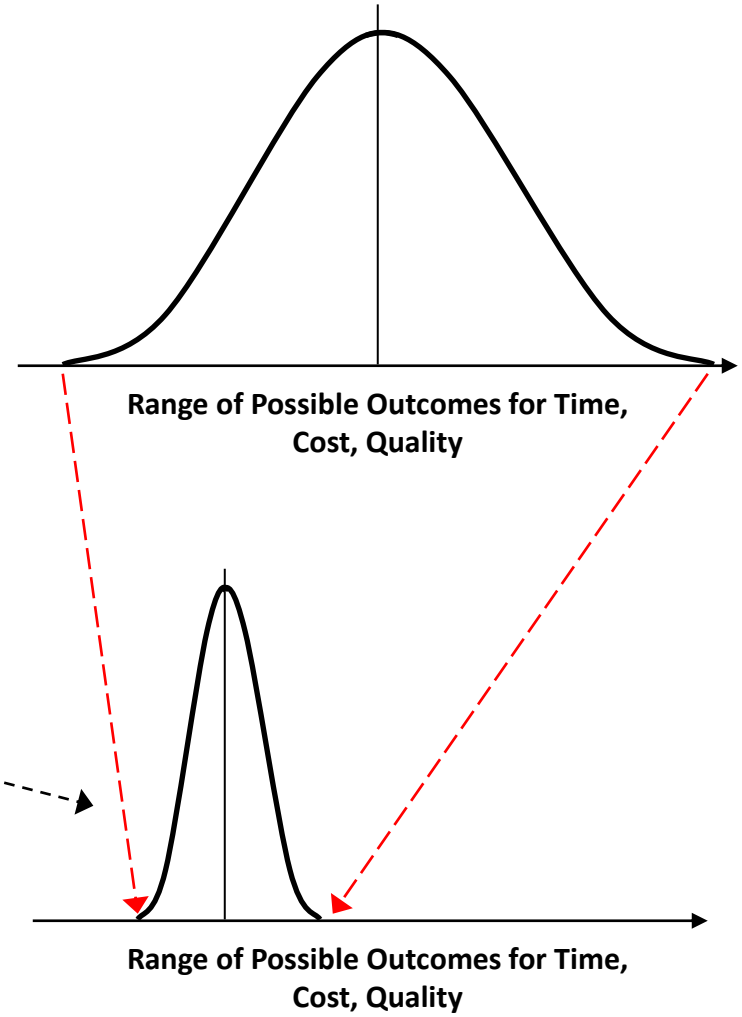


Standardised Work Sets Process Outcomes



Standardised Work means…

'developing the one best way'

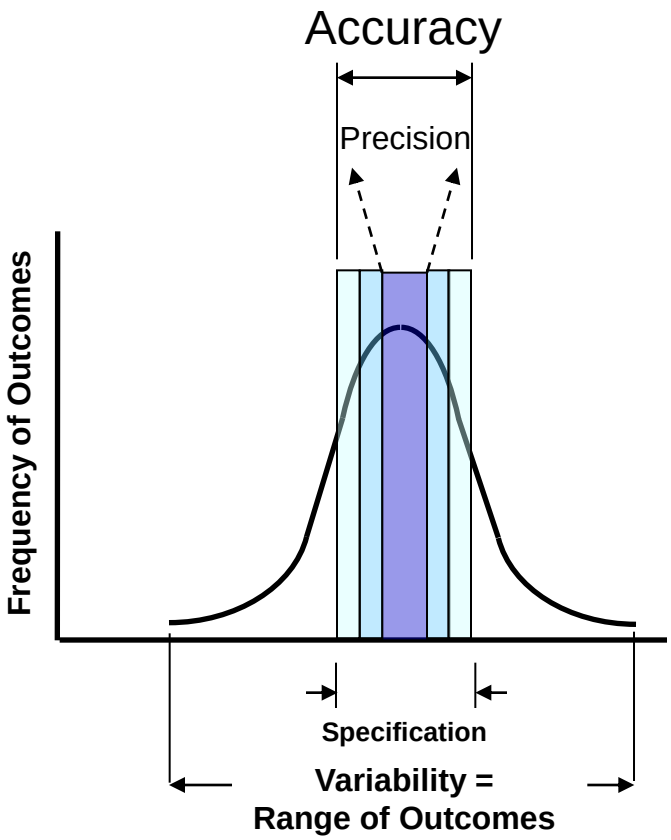


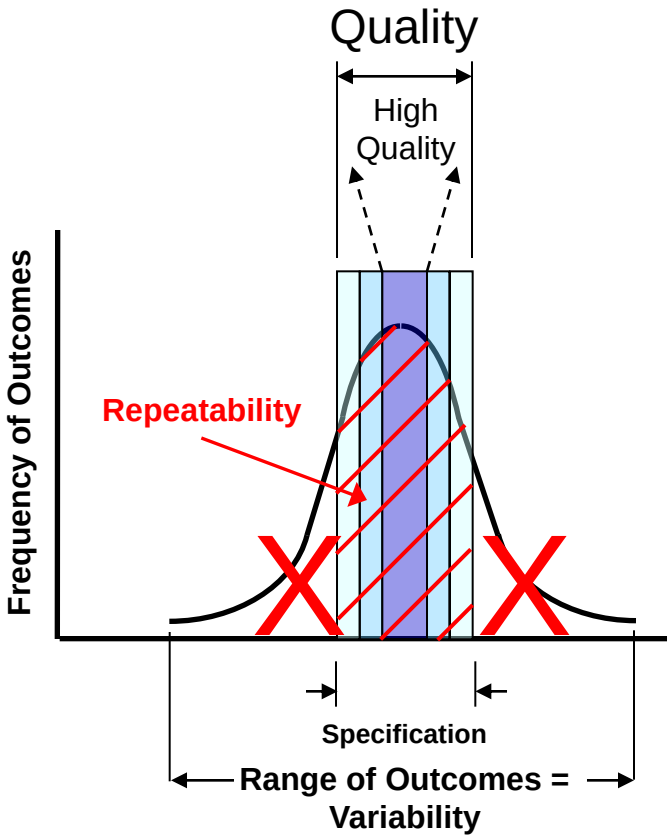
We all need clear Targets that we can SEE.

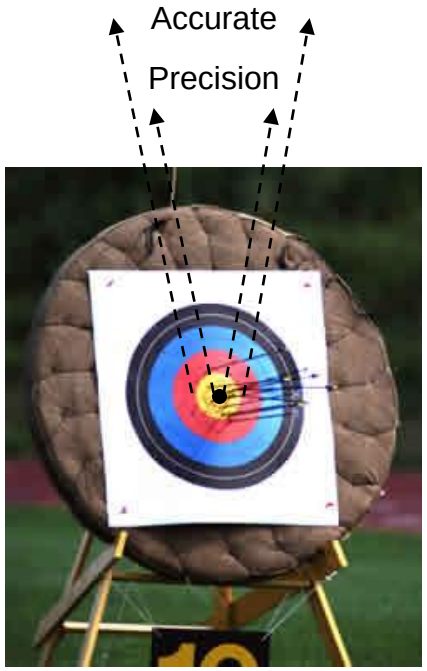
How do You know You have got full marks?

What do we mean by….

Quality, Precision, Repeatability, Variability







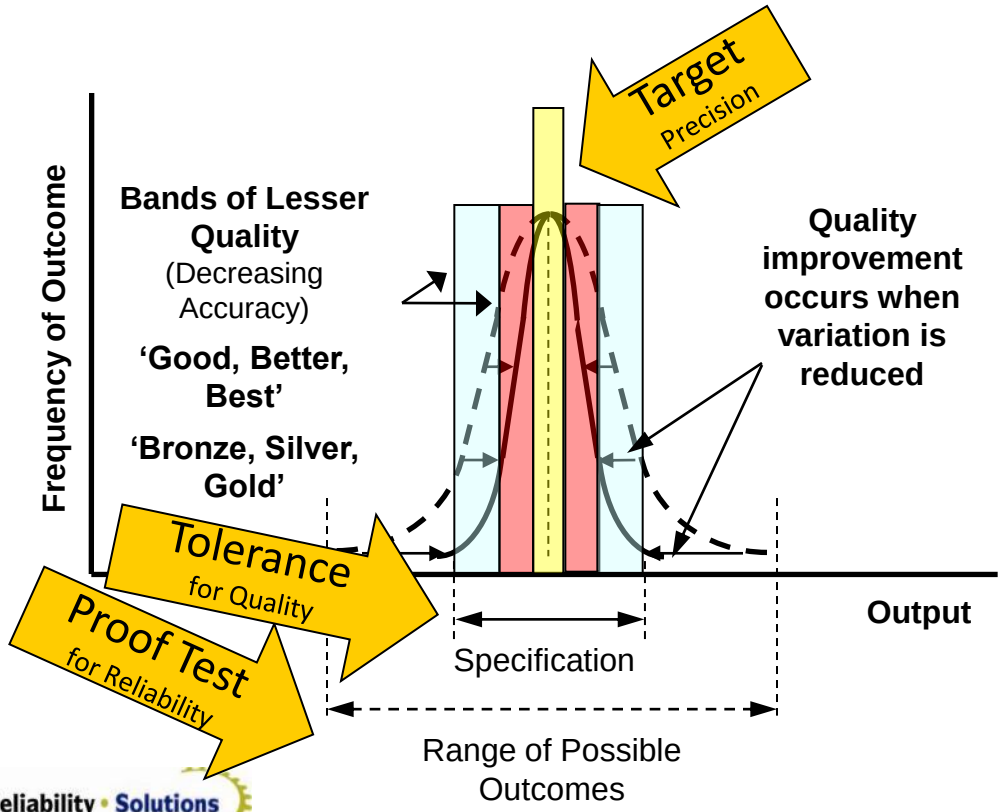
Repeatability is low in this process

X **Unwanted Variability = Unwanted Outcomes**

Reliability Creating 3T Error Proof Procedures

Build Mistake Proofing into SOPs

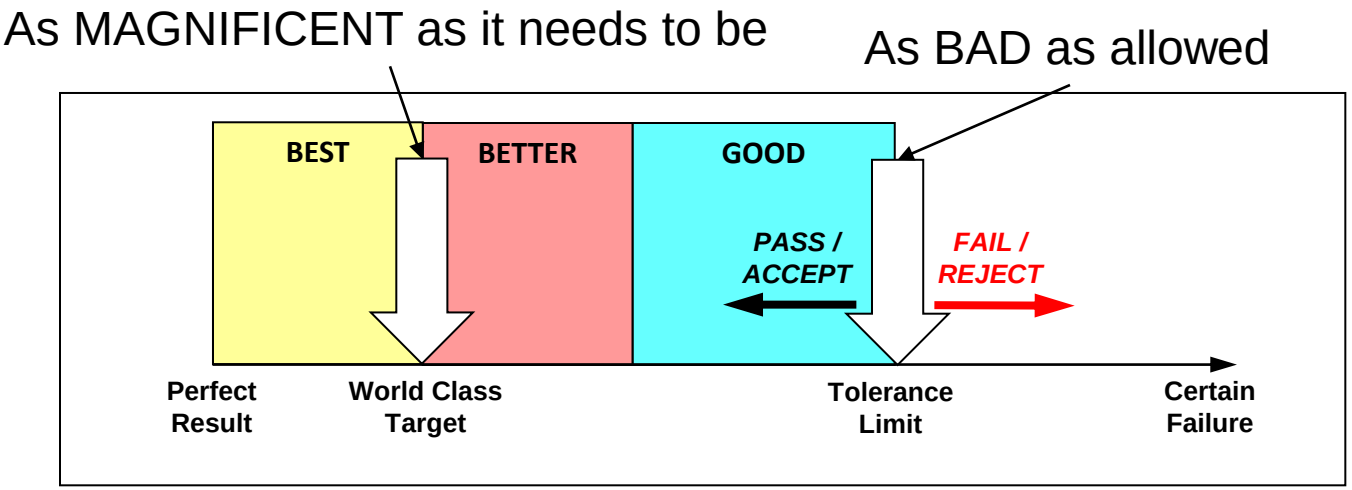
- Set a target for each task.
- Specify the acceptable tolerance.
- Do a test to prove accuracy.



3Ts of Failure Prevention -
. Target
. Tolerance
. Test

Lifetime Reliability • Solutions

3T's: target for quality workmanship

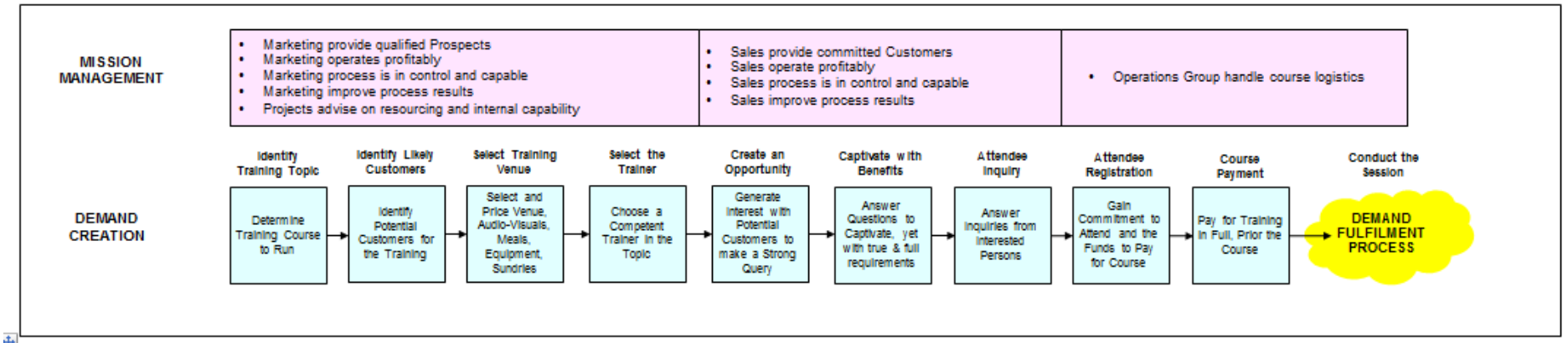


Each person do Good / Better / Best for a clock

Redesigning Processes for Intended Outcomes

Promote Attendance at EETD Sessions

PURPOSE: Provide well attended and successful technical sessions in a selected topic.



Process Steps	Identify Training Topic	Identify Likely Customers	Select Training Venue	Select the Trainer	Create an Opportunity	Captivate with Benefits	Attendee Inquiry	Attendee Registration	Course Payment	Conduct the Training Course
Effect of Total Failure	☹	☹	😐	☹	😐	☹	☹	😐	😐	☹
TARGET	High interest topic to many people	People are excited by the topic								
TOLERANCE	General interest topic to many people	People want to know more about the topic								
TEST	Survey results confirm interest	People get value by attending								
RISK ASSESSMENT Risk = Consequence x (Opportunity x [1-Chance of Success at each Opportunity])	Do not know what interests people	People are too busy to attend	Customers cannot get to venue							
	Small number of people interested	Not enough people on mailing list								
	Topic is out-of-date	Go to the wrong people								
RISK CONTROLS	Survey topics with 20 likely Customers									
	Survey indicates high interest									
	Survey indicates high relevance									
Chance of Success Range	>80%									

Lean and Six Sigma fails Business when they are used for point solutions. For lasting success you need systemic solutions.

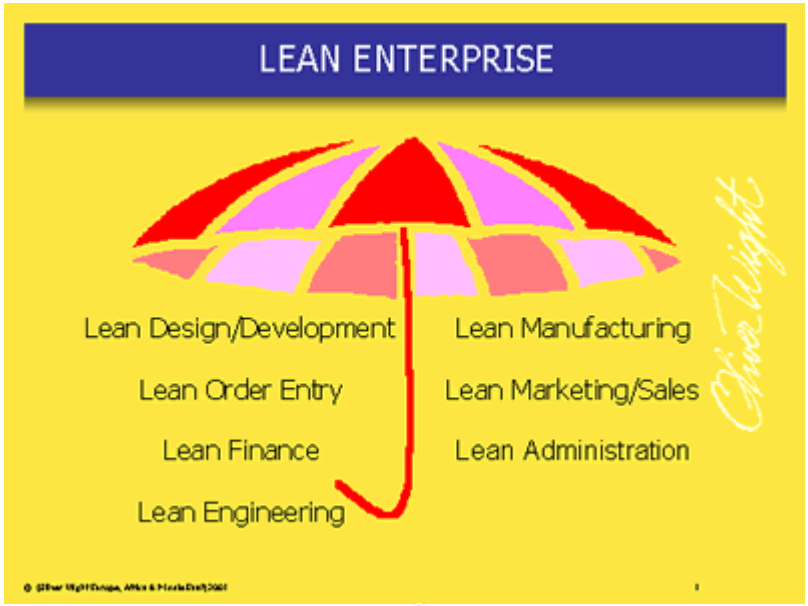
The aim of using Lean and Six Sigma practices

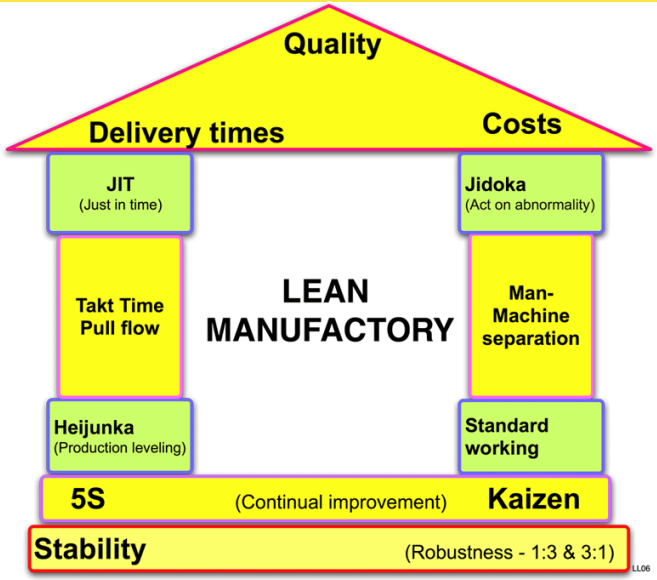
- Lean
  - Used to improve Effectiveness : are we doing the right things!
    - 7 Wastes
    - The 'Hidden Factory'
    - Lean Thinking/Practices
    - Lean Tools
      - Value Stream Mapping
      - 5S: Workplace Management
      - Kaizen

- Six Sigma
  - Used to improve Efficiency: are we doing things right!
    - 6σ accuracy
    - Sigma Levels
    - The Variation Problem
    - Six Sigma Tools
      - DMAIC Process
      - 7 QC Analysis Methods
      - Visual Management

The Lean Concepts

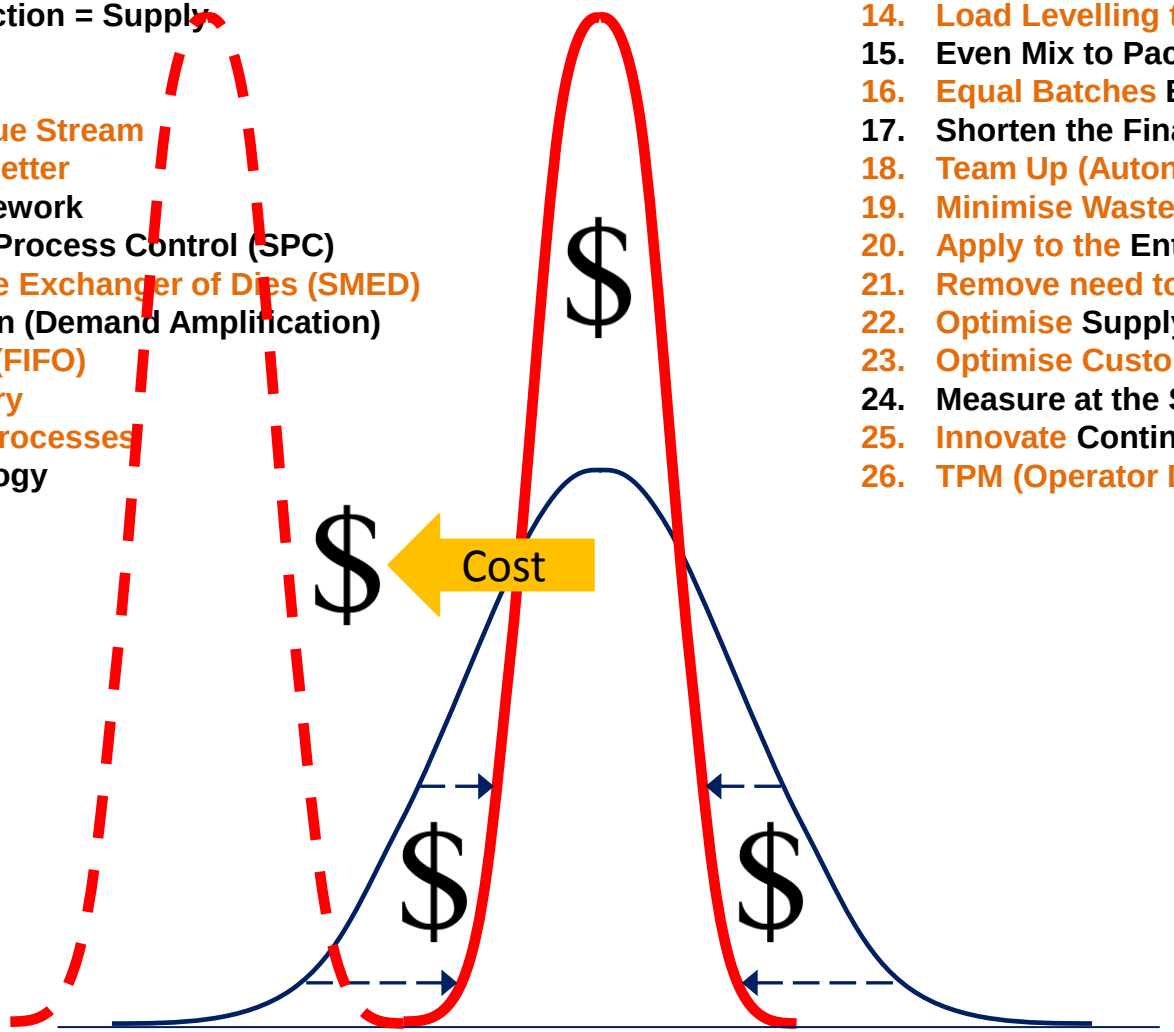
1. Demand = Production = Supply
2. Continuous Flow
3. Use Pull Flow
4. Maximise the Value Stream
5. Demand to Pacesetter
6. Prevention not Rework
7. Apply Statistical Process Control (SPC)
8. Use Single Minute Exchanger of Dies (SMED)
9. Minimise Variation (Supply Chain Demand Amplification)
10. First In First Out (FIFO)
11. Minimise Inventory
12. Link and Match Processes
13. Use 5S Methodology
14. Load Levelling to Capacity
15. Even Mix to Pacesetter
16. Equal Batches Every Time (EBIT)
17. Shorten the Financial Reporting Cycle
18. Team Up (Autonomous Work Teams)
19. Minimise Waste
20. Apply to the Entire Supply Chain
21. Remove need to Sequence Products
22. Optimise Supply (JIT)
23. Optimise Customer Response
24. Measure at the Source
25. Innovate Continuously
26. TPM (Operator Driven Reliability)





Lean for Process Redesign

1. Demand = Production = Supply
2. Continuous Flow
3. Use Pull Flow
4. Maximise the Value Stream
5. Demand to Pacesetter
6. Prevention not Rework
7. Apply Statistical Process Control (SPC)
8. Use Single Minute Exchange of Dies (SMED)
9. Minimise Variation (Demand Amplification)
10. First In First Out (FIFO)
11. Minimise Inventory
12. Link and Match Processes
13. Use 5S Methodology
14. Load Levelling to Capacity
15. Even Mix to Pacesetter
16. Equal Batches Every Time (EBIT)
17. Shorten the Financial Reporting Cycle
18. Team Up (Autonomous Work Teams)
19. Minimise Waste
20. Apply to the Entire Supply Chain
21. Remove need to Sequence Products
22. Optimise Supply (JIT)
23. Optimise Customer Response
24. Measure at the Source
25. Innovate Continuously
26. TPM (Operator Driven Reliability)



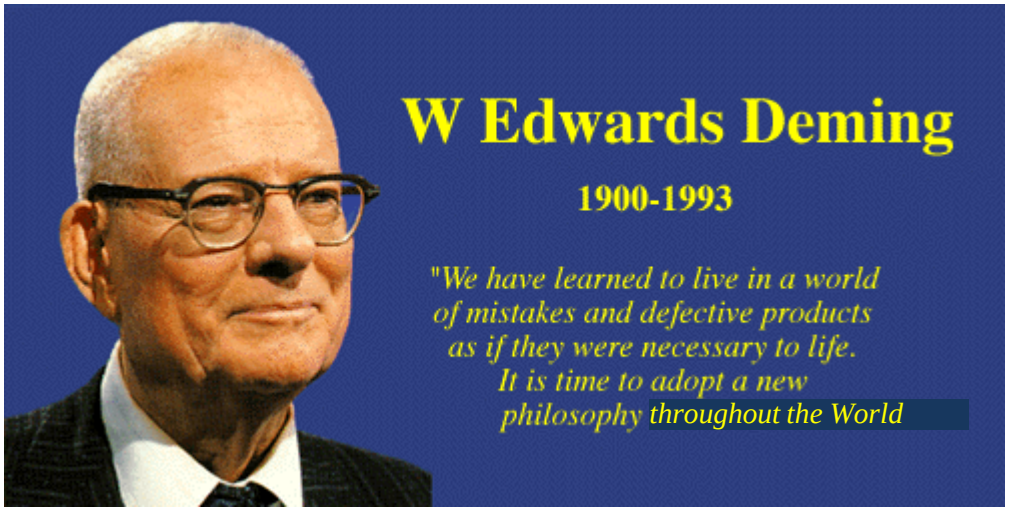
Cost Reduction

Variation Reduction

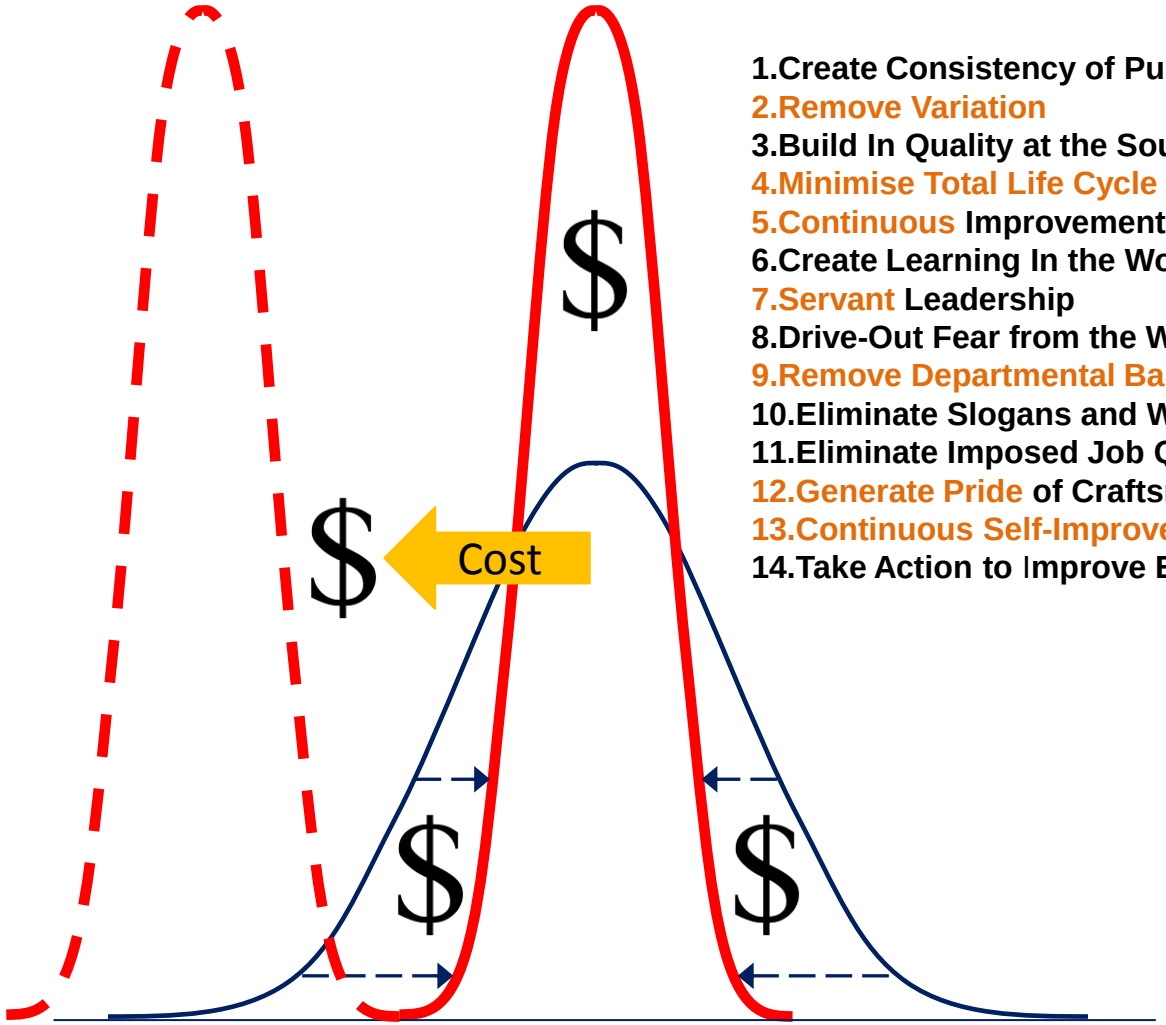
Lifetime Reliability • Solutions

Deming's 14 Points for a Quality Culture

1. Create Consistency of Purpose
2. Remove Variation
3. Build-In Quality at the Source
4. Minimise Total Life Cycle Cost
5. Continuous Improvement
6. Create Learning In the Workplace
7. Servant Leadership
8. Drive-Out Fear from the Workplace
9. Remove Departmental Barriers (Team-Up)
10. Eliminate Slogans and Work Targets
11. Eliminate Imposed Job Quotas and Goals
12. Generate Pride of Craftsmanship
13. Continuous Self-Improvement through Training
14. Take Action to Improve Every Process



14 Points Process Redesign

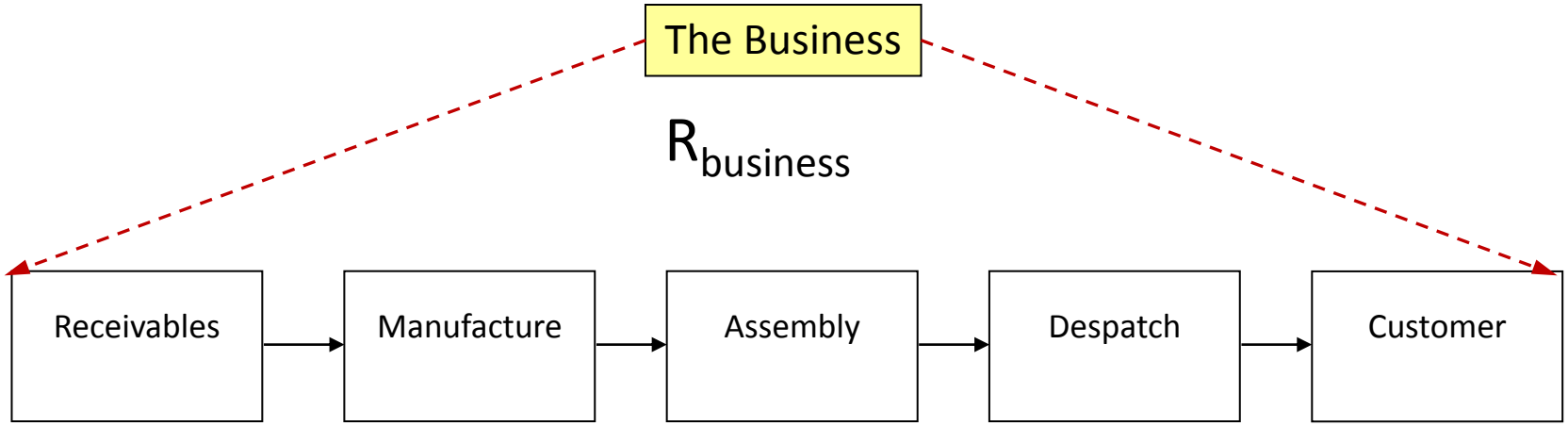


1.Create Consistency of Purpose
2.Remove Variation
3.Build In Quality at the Source
4.Minimise Total Life Cycle Cost
5.Continuous Improvement
6.Create Learning In the Workplace
7.Servant Leadership
8.Drive-Out Fear from the Workplace
9.Remove Departmental Barriers (Team-Up)
10.Eliminate Slogans and Work Targets
11.Eliminate Imposed Job Quotas and Goals
12.Generate Pride of Craftsmanship
13.Continuous Self-Improvement through Training
14.Take Action to Improve Every Process

Cost Reduction

Variation Reduction

All Our Businesses are Processes in Series



$$R_{business} = R_{process1} \times R_{process2} \times R_{process3} \times \ldots \times R_{process'n'}$$

*Reliability 'R' is the **chance** of success.*

How to Reduce the Chance of Failure

Chance of Failure = 1 – Chance of Success

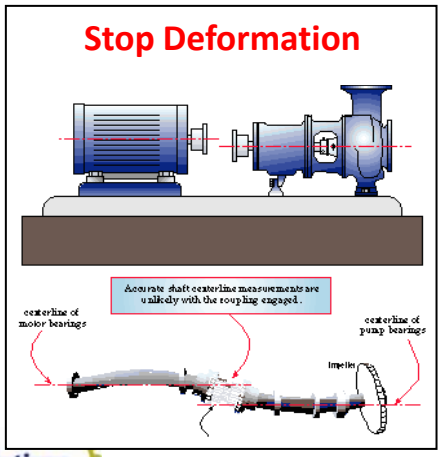
Chance of Failure = 1 – Reliability

***Risk** = Consequence $ x Chance /yr*

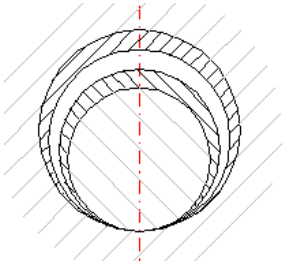
***Risk** = Consequence $ x [Freq of Opportunity /yr x Chance of Failure at Each Opportunity]*

***Risk** = Consequence $ x [Freq of Opportunity /yr x {1 – Reliability}]*

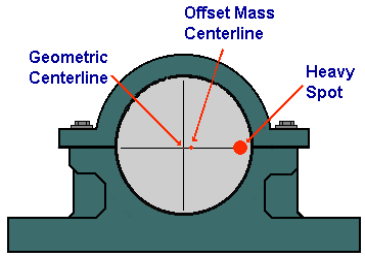
Excellent Lubricant Cleanliness



Correct Fastener Torque



Proper Fits and Tolerance



No Unbalance

Here are some opportunities…

The full Risk Equation is more Meaningful for examining Risk of Process Failure

[← *Failure Frequency* →]

Risk=[Consequence] x [Opportunity to Fail x Chance of Failure]

Risk=[Consequence] x [Opportunity to Fail x (1-Reliability)]

Risk=[Consequence] x [Opportunity to Fail x (Unreliability)]

1-reliability = unreliability = $P(T \leq t)$ at every opportunity for failure = failures/opportunity

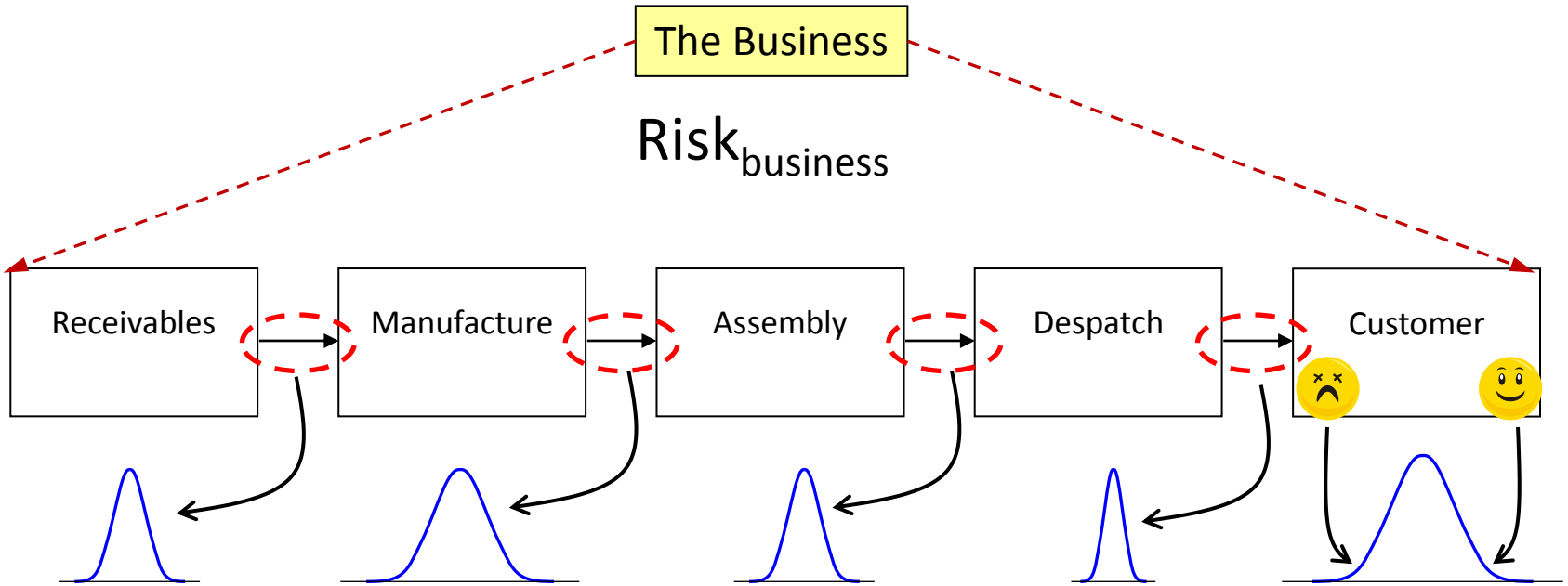
opportunity =opportunities/time

consequence = cost/failure

- **Risk = cost/time**
- **Reliability = Chance** of success

That means that maximizing reliability is not the best business objective. From a business standpoint we want to minimize risk.

Business Risk is the Sum of Process Risks



$$Risk_{process1} + Risk_{process2} + \ldots + Risk_{process'n'} = Risk_{business}$$

We have three ways of minimising Risk

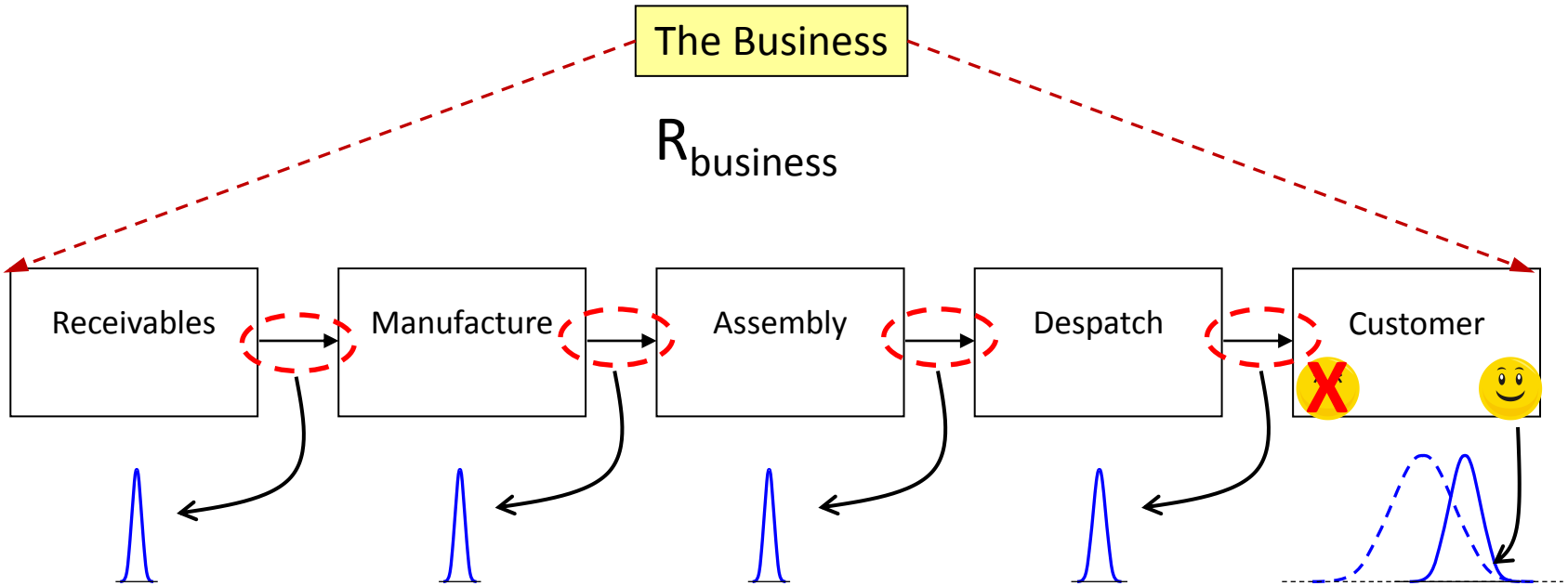
Risk= [← *Reduce Failure Frequency* →]

[**Reduce** consequence] x [opportunity to fail x (unreliability)]

[CONSEQUENCE REDUCTION] [CHANCE REDUCTION]

1. **Increase reliability = Decrease unreliability = Fewer failures/opportunity**
2. **Reduce opportunity to fail = Fewer opportunities/time**
3. **Reduce consequence of failure = Less cost/failure**

Reducing Businesses Process Risk



$$Risk_{process1} + Risk_{process2} + \ldots + Risk_{process'n'} = Risk_{business}$$

Risk Reduction – Reduce Chance, Opportunity or Consequence?

Risk ($/yr) = Consequence of Failure x Frequency of Failure

Risk = Consequence of Failure x [Opportunity to Fail x (1 – Chance of Failure)]

Consequence of Failure Reduction Strategies

Strategies presume failure event occurs and act to minimise consequent losses

- Preventive Maintenance
- Shutdown Maintenance
- Predictive Maintenance
- Non-Destructive Testing
  - Vibration Analysis
  - Oil Analysis
  - Thermography
  - Motor Current Analysis
- Total Productive Maintenance (TPM)
- Prognostic Analysis
- Criticality Analysis
- Emergency Management
- Computerised Maint Mgmt Syst(CMMS)
- Key Performance Indicators (KPI)
- Risk Based Inspection (RBI)
- Operator Watch-keeping
- Value Contribution Mapping (Process step activity based costing)
- Logistics, stores and warehouses
- Defect and Failure True Cost (DAFTC)
- Maintenance Engineering

Opportunity to Fail Reduction Strategies

Strategies prevent opportunities for a failure event arising

- Engineering / Maintenance Standards
- Statistical Process Control
- Degradation Management
- Reliability Growth Cause Analysis (RGCA)
- Lubrication Management
- Hazard and Operability Study (HAZOP)
- Hazard Identification (HAZID)
- Failure Design-out Maintenance
- Failure Mode Effects Analysis (FMEA)
- Hazard and Operability Study (HAZOP)
- Root Cause Failure Analysis (RCFA)
- Precision Maintenance
- Training and Up-skilling
- Quality Management Systems
- Planning and Scheduling
- Continuous Improvement
- Supply Chain Management
- Accuracy Controlled SOPs (ACE 3T)
- Design, Operation, Cost Total Optimisation Review (DOCTOR)
- Reliability Engineering

Chance to Fail Reduction Strategies

Strategies reduce probability of failure initiation if failure opportunity present

- Training and Up-skilling
- Oversize / De-rate Equipment
- Hardier Materials of Construction
- Personal Protective Equipment (PPE)
- Segregation / Separation
- Controlled Atmosphere Environment e.g. +ve / -ve pressures, explosion proof atmos

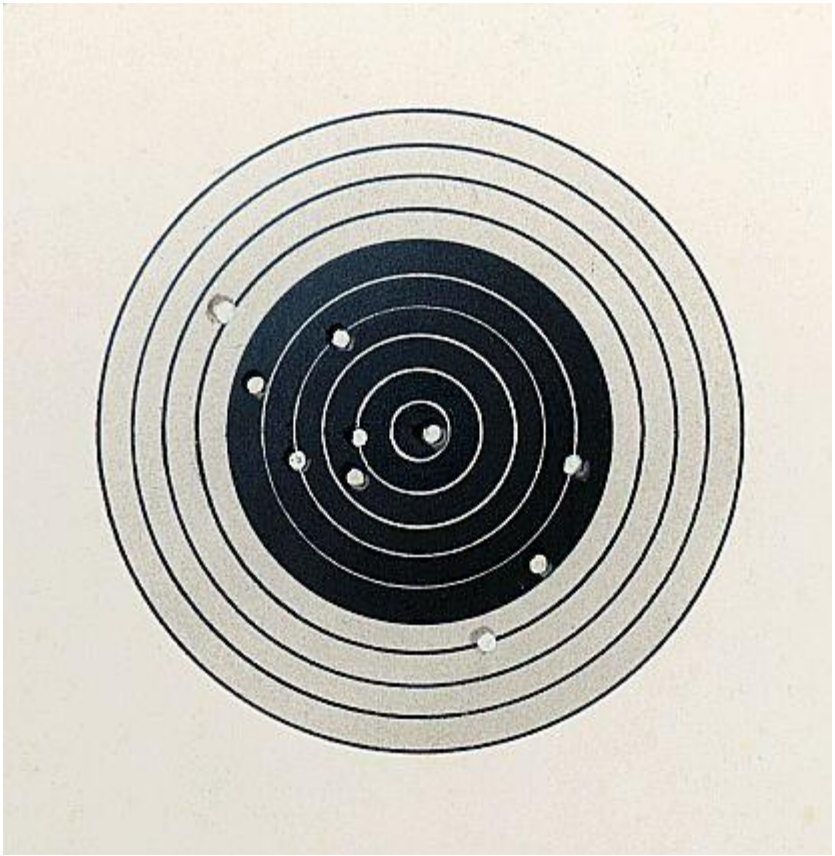
Interestingly, Chance Reduction choices are best made during design.

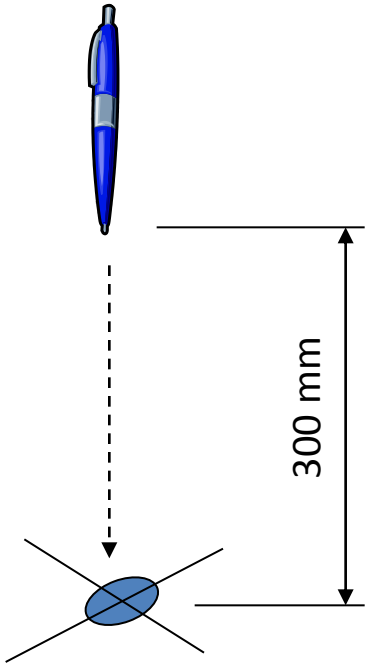
Done to reduce the cost of failure

Done to reduce the frequency of failure

The Cross-Hair Game:

Observing Business Process Outcomes

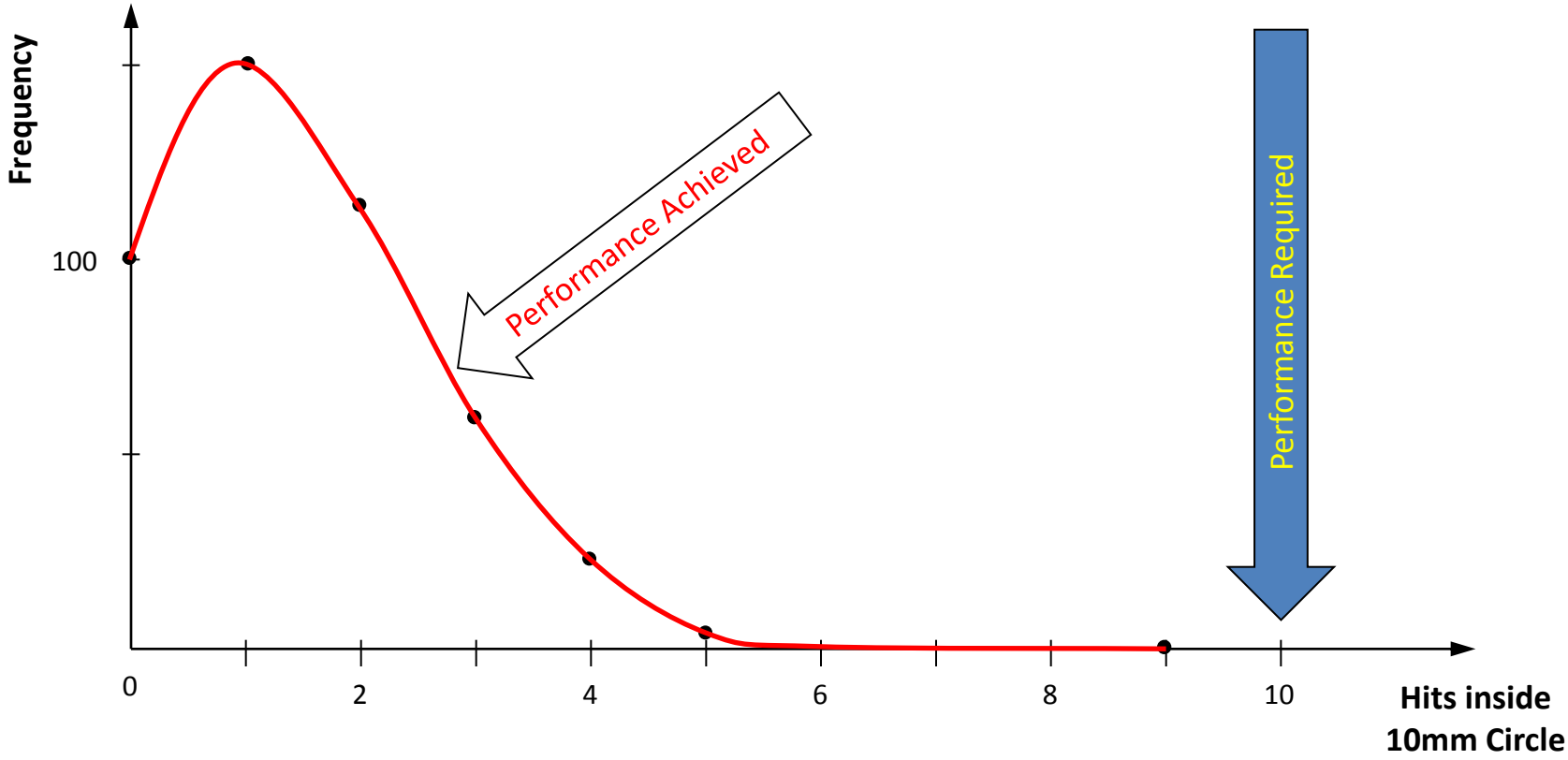




Cross-hairs and
10 mm diameter
circle

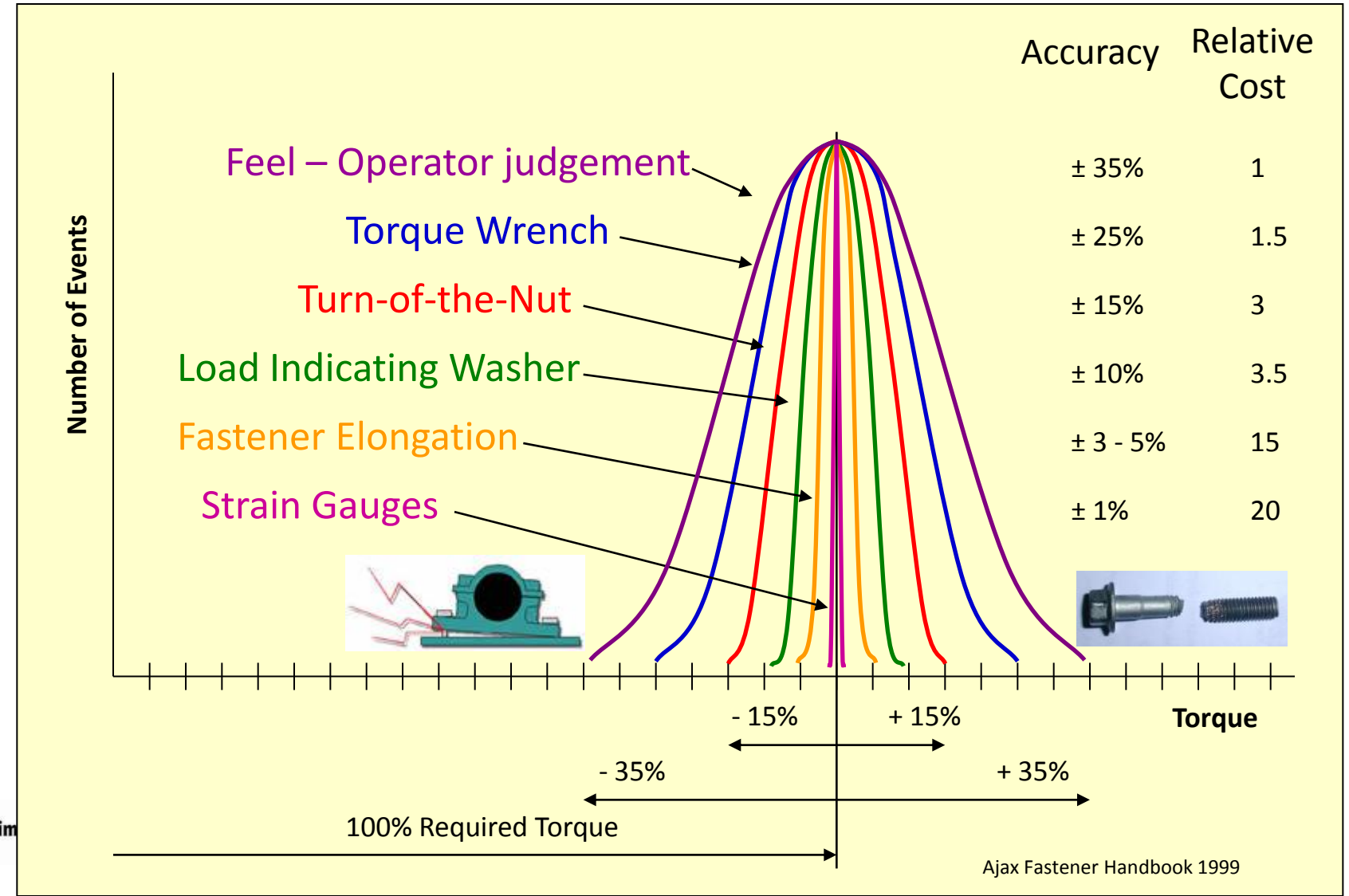
How do you hit the bulls-eye every time?

‘Cross Hair’ Production Process Distribution

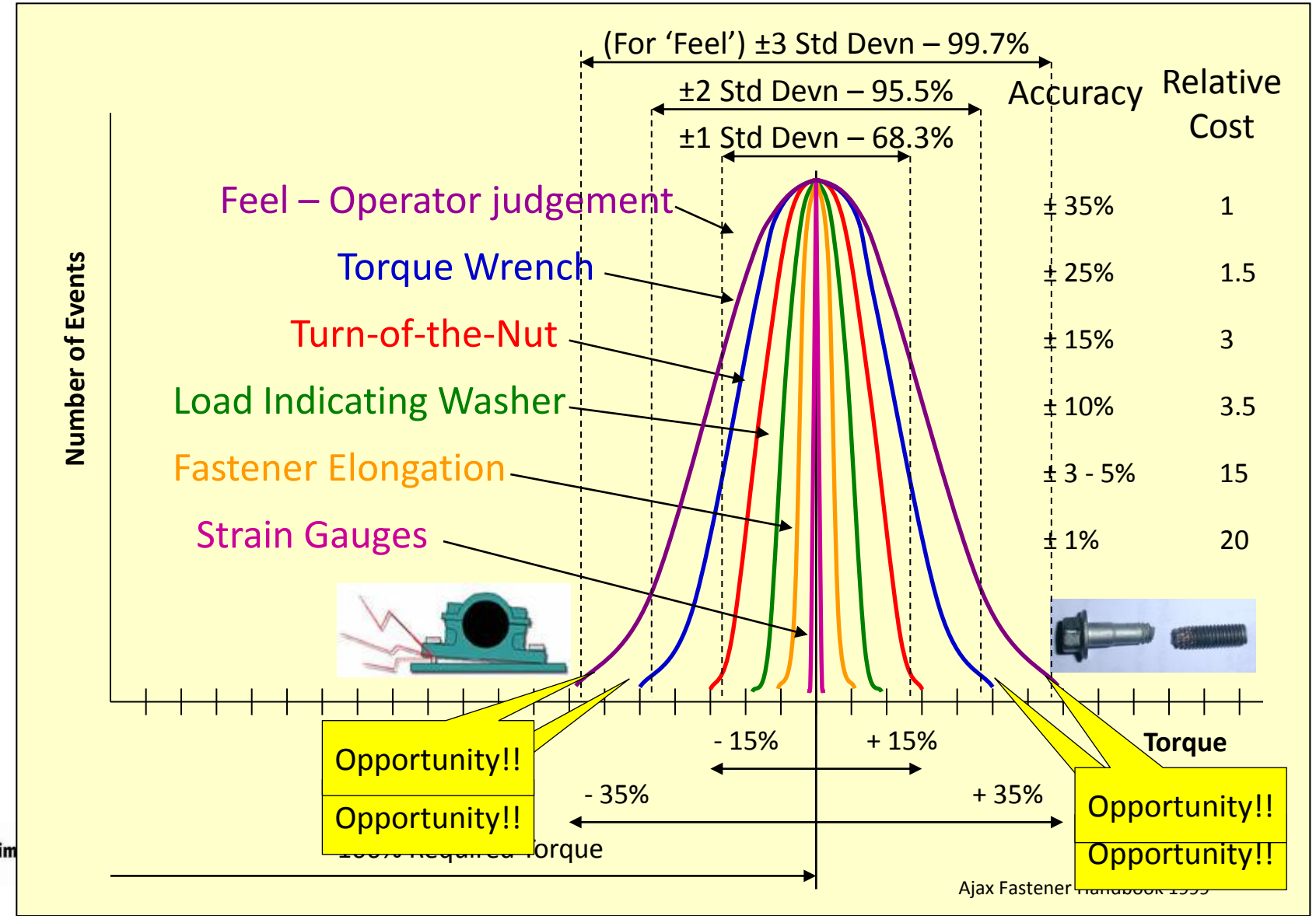


Where does Failure Start in a Process?

Problems start with 'chance' variation *... for example*



How Chance Tricks Us so We think 'Feel' is Fine



Risk from Fastening Process Choice Variation

Risk=[Consequence^3] x [Frequency]

Risk=[Consequence] x [Opportunity to Fail^2 x Chance of Failure at Opportunity]

Risk=[Consequence] x [Opportunity to Fail x (1-Reliability)]

Risk from Fastener Tensioning Method Process Variation

No	Tensioning Method	Distribution	Reliability	Unreliability (Area outside ± 10% of 'Feel')	At Risk Fasteners per 100 Bolt/Nut Sets[2] R = C x [O x (1-R)]	Opportunity of Error
1	Operator Feel	± 35%	0.65	0.35	35	1) From outer distribution of tensioning method choice 2) Other events not related to tensioning method choice
2	Torque Wrench	± 25%	0.8	0.2	20	1) From outer distribution of tensioning method choice 2) Other events not related to tensioning method choice
3	Turn of Nut	± 15%	0.95	0.05	5	1) From outliers of tensioning method choice 2) Other events not related to tensioning method choice
4	Loading Indicating Washer	± 10%	1[1]	0	0	1) From extreme outliers of tensioning method choice 2) Other events not related to tensioning method choice
5	Fastener Elongation	± 5%	1[1]	0	0	Other events not related to tensioning method choice
6	Strain Gauges	± 1%	1[1]	0	0	Other events not related to tensioning method choice

Note 1: Based on research of tension method performance, at around ± 10% of required fastener tension there is substantial reduction in connection failures.
Note 2: Each bolted fastener is an opportunity to be incorrectly tensioned
Note 3: Consequence is presumed to remain the same for each event (mostly not true, which is why determining Criticality first is vital for good maintenance decisions.

Lean and Six Sigma fails Business if they do not change the Business System.

THANK YOU.

Mike Sondalini

Lifetime Reliability Solutions