Total Productive Maintenance

A strategic success factor

Purpose:

To understand the basics of Total Productive Maintenance

In a way that an appreciation is developed as to its sophistication

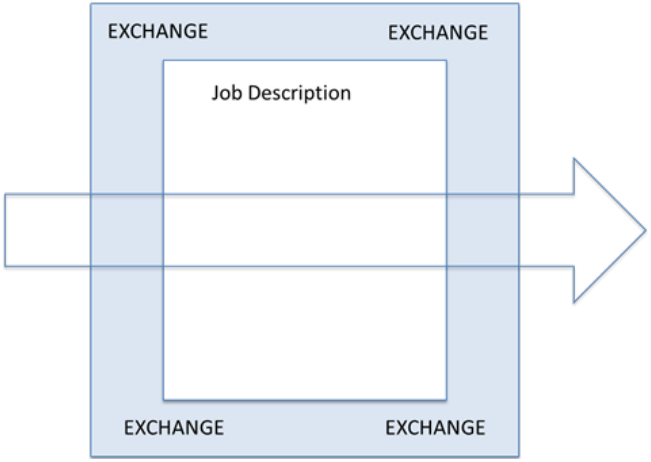
So that you can decide if it is strategically important to your success.

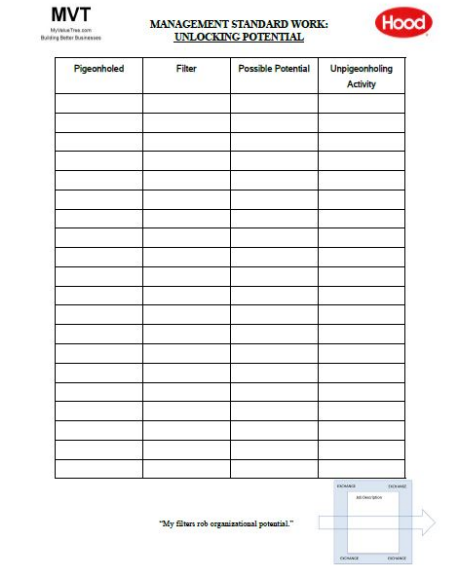
Products:

1. Know the philosophy
2. Know the standard
3. Know how to do it
4. Develop assessment skills
5. Decide its importance

Our Journey so Far

"My filters rob organizational potential."





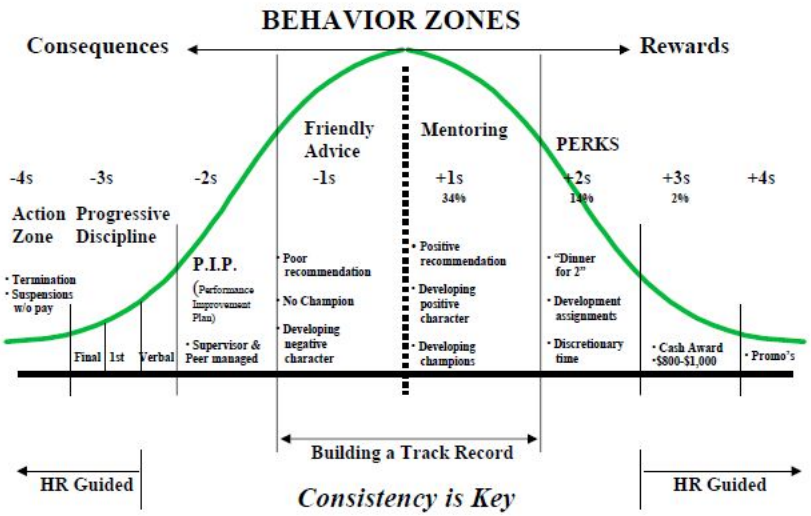
MVT

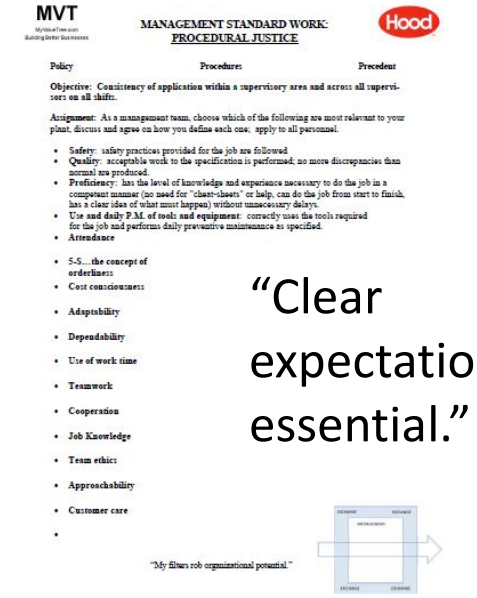
MANAGEMENT STANDARD WORK:
UNLOCKING POTENTIAL

Hood

Pigeonholed	Filter	Possible Potential	Unpigeonholing Activity

"My filters rob organizational potential."





MVT

MANAGEMENT STANDARD WORK:
PROCEDURAL JUSTICE

Hood

Policy Procedure: Precedent

Objective: Consistency of application within a supervisory area and across all supervisors on all shifts.

Assignment: As a management team, choose which of the following are most relevant to your plant, discuss and agree on how you define each one; apply to all personnel.

- **Safety:** safety practices provided for the job are followed
- **Quality:** acceptable work to the specification is performed; no more discrepancies than normal are produced.
- **Proficiency:** has the level of knowledge and experience necessary to do the job in a competent manner (no need for "chart-ubeen" or help, can do the job from start to finish, has a clear idea of what must happen) without unnecessary delays.
- **Use and daily P.M. of tools and equipment:** correctly uses the tools required for the job and performs daily preventive maintenance as specified.
- **Attendance**
- **5-S…the concept of orderliness**
- **Cost consciousness**
- **Adaptability**
- **Dependability**
- **Use of work time**
- **Teamwork**
- **Cooperation**
- **Job Knowledge**
- **Team ethics**
- **Approachability**
- **Customer care**
-

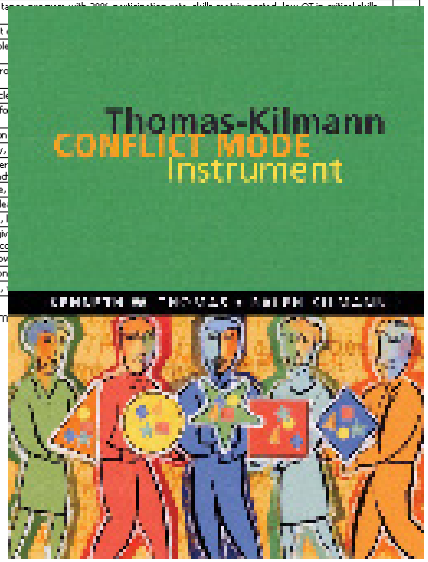
"My filters rob organizational potential."

"Clear expectations are essential."

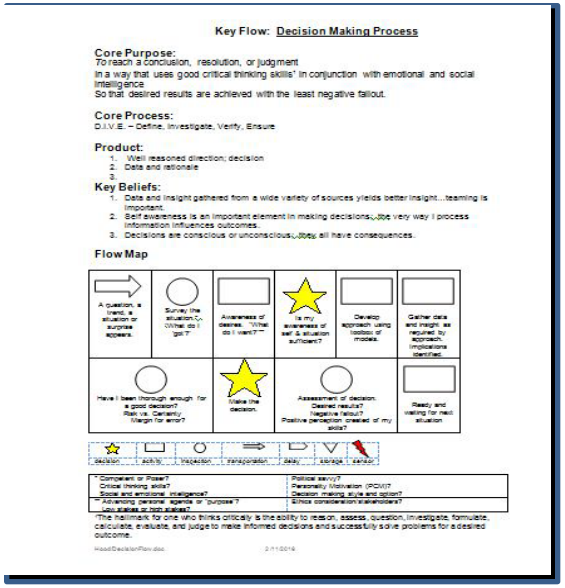
Workforce Health Audit date

Attribute	Description	Rating (0 low – 5 high)
Communication	Notice boards, notification of visitors, agendas posted, metrics posted, photos, names visible, meeting areas, informed people, open and honest conversations	
Time keeping	Punctuality, disciplined start and stop times, disciplined equipment start-up and shut-down times, adequate and proper time keeping systems, audit trail of plant entries and exits	
Time management	On-time corrective action reports, on-time projects, low salary OT, punctuality	
Direction	Schedules visible, planning charts, budgets known, visible production meetings, priorities understood, commitments met	
Goals	Goals visible, logically set, understood by people	
Quality/Reject issues	Low scrap, rework, low warranty, no escapes, no cribs	
Absenteeism	Less than 2%, sick days unused	
Accidents/safety	Safety audits in use with continually improving scores, safety metrics posted and improving	
Housekeeping	5-S in use with continually improving scores, pleasant work environment, tidy exterior	
Workforce attrition	Voluntary attrition rate around 3% annually…learned-out organization with fresh insights coming in, no involuntary layoffs	
Costs	Meeting goals, improving trends, people getting raises, improving ROIC, displayed, "open-book management" approach with employees	
Personal grievances	Common themes understood, tracked for significance, surveys taken, upward assessments	
Training & education	> 40hrs/person delivered, educational assistance [illegible]	
	areas, processes not individual dependant	
Rumoring	Personal drama, low coverage ☹ Plant	
Job satisfaction	Spirit and will, smiles, body language, people	
	give discretionary effort, ability to surge	
Suggestions	Ideas are shared, openness in discussing pro	
	action items with ability to implement	
Vehicles in parking lot	No oil pools on pavement, newer vehicles, cle	
Management turnover	Business unit manager and above in place fo	
	loyalty to company, excited about product	
Support staff attrition	Seasoned engineers, supervisors, production	
Business name	Stability in name, recognized by community,	
People	Pride in appearance, good attire, positive per	
	work/life balanced, upbeat attitude, approac	
Personal opportunities	Growth opportunities exist and are available,	
Equipment availability	TPM program in use, equipment running, cle	
Plant layout	Logical, understandable, "no-hunt" signage,	
Management style	Yelling not tolerated, explanations readily giv	
	attentive to issues, attempts are made to acc	
Performance mgmt.	System in place and used, expectations know	
Policy administration	Time & attendance, OT distribution, vacation	
Work instructions	Available, clear, complete, success oriented,	

Sum



"My thinking impacts the workforce."



Key Flow: Decision Making Process

Core Purpose:
To reach a conclusion, resolution, or judgment
In a way that uses good critical thinking skills* in conjunction with emotional and social intelligence
So that desired results are achieved with the least negative fallout.

Core Process:
D.I.V.E. – Define, Investigate, Verify, Ensure

Product:
1. Well reasoned direction; decision
2. Data and rationale
3.

Key Beliefs:
1. Data and insight gathered from a wide variety of sources yields better insight…teaming is important.
2. Self awareness is an important element in making decisions…[illegible] very way I process information influences outcomes.
3. Decisions are conscious or unconscious…[illegible] all have consequences.

Flow Map

A question, a trend, a situation or surprise appears.	Survey the situation (>> What do I [illegible]?)	Awareness of desires. "What do I want?"	Is my awareness of self & situation sufficient?	Develop approach using tactics of models.	Gather data and insight, as required by approach. Implications identified.
Have I been through enough for a good decision? Risk vs. Certainty. Margin for error?		Make the decision.	Assessment of decision. Desired results? Negative fallout? Positive perception created of my skills?		Ready and waiting for next situation

decision | activity | inspection | transportation | delay | storage | sensor

* Competent or Poser? Critical thinking skills? Social and emotional intelligence?	Political savvy? Personality Motivation (PCM)? Decision making style and option?
** Achieving personal agenda or "purpose"? Low stakes or high stakes?	Ethics consideration stakeholders?

*The hallmark for one who thinks critically is the ability to reason, assess, question, investigate, formulate, calculate, evaluate, and judge to make informed decisions and successfully solve problems for a desired outcome.

HoodDecisionFlow.doc 2/11/2016

5-S

Item # and description	5S Evaluation Form	Item Score (0 - 5)	What is the team doing to improve to next level? Pg 1 of 2
1. Removing unnecessary items	All items not required for performing operations are removed from the work area, only tools and products are present at work stations		
2. Storage of cleaning equipment	All cleaning equipment is stored in a neat manner; handy and readily available when needed.		
3. Floor cleaning.	All floors are clean and free of debris, oil and dirt. Cleaning of floors is done routinely – daily at a minimum – posted schedule		
4. Bulletin boards.	All bulletins are arranged in a neat and orderly manner. No outdated, torn or soiled announcements are displayed.		
5. Emergency access	Fire hoses and emergency equipment are unobstructed and stored in a prominent easy-to-locate area. Stop switches and breakers are marked or color-coded for visibility.		
6. Items on floor	Work-in-process, tools and any other material are not left to sit directly on the floor. Large items such as tote boxes are positioned on the floor in clearly marked areas, identified by painted lines.		
7. Aisleways - markings	Aisles and walkways are clearly marked and can be identified at a glance; lines are straight and at a right angles with no chipped or worn paint.		
8. Aisleways - maintenance	Aisles are always free of material and obstructions; nothing is placed on the lines, and objects are always placed at right angles to the aisles.		
9. Storage and arrangement	Storage of boxes, containers and material is always neat and at right angles. When items are stacked, they are never crooked or in danger of toppling over.		
10. Equipment - painting	All machines and equipment are neatly painted; there are no places in the plant less than six feet high that are unpainted.		
	Subtotal pg 1		

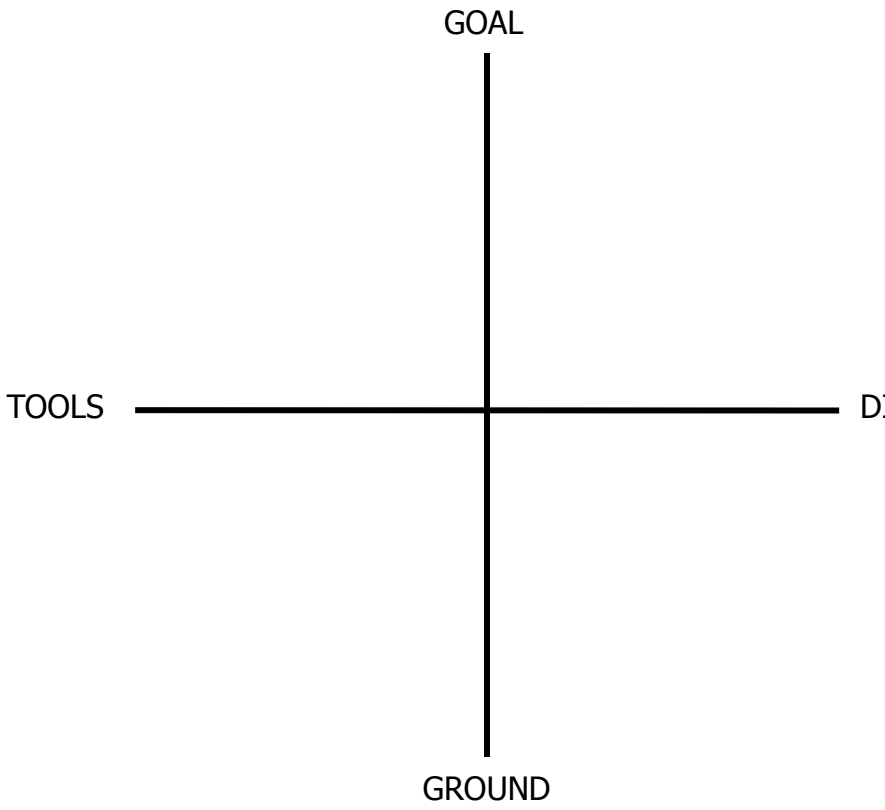
The BST assessment highlights areas of management practice

Perceived Organization Support	Management Credibility
• Basic Principles (Boss 1 & Boss 2) • Interaction Skills / Listening • Giving feedback • Coaching workshop.	• Building healthy workforces • Respect audit • Causes of unhealthy workforces - Conflict style/decision style - Work Preference styles • Understanding finance
Procedural Justice	**Leader – Employee Exchange**
• Behavior zones • Signs of poor performance • Behaviors and consequences • Standards being administered	• My filters rob organizational potential • LEX defined • In-group / out-group • Least preferred co-worker • Case study

2018

Perceived Organization Support	Management Credibility
Orderliness Focus • 5-S workshop • TPM audit	**EHS Focus** • What evidence would convict you in court that safety is important to you? • "Kill Me" hazard audit
Procedural Justice	**Leader – Employee Exchange**
Continuous Improvement Focus • Ping-Pong Factory • The 7-Deadly Wastes Audit • How much are we losing each month?	**Talent Focus** • Belief check: Pursuit of the four BST items has a positive impact on talent. • Skills matrix creation

Ever-increasing Rate of Benchmarkable Solutions



Learning

Sustainable Behaviors Driving Breakthrough Results

Personal Standards of Excellence

Maintenance Philosophy

- “I operate, you fix”
- Breakdowns are inevitable
- Defects are inevitable

- “I am responsible for my own equipment”
- Zero breakdowns
- Zero defects

The Business Case For Maintenance

- Quality begins at the source
- The equipment is “the source”

- How do machine issues impact product quality?

The World's Top-Selling Ice Cream Brands

Yehong Zhu, CONTRIBUTOR *I write about business news in retail, technology, and market trends.* June 21, 2016

When you reach into the freezer case for ice cream this summer, there's a good chance that you'll be handing your money over to Unilever. From the velvety luxury of Magnum to the chocolatey crunch of Cornetto to the fun-filled decadence of Ben & Jerry's, Unilever dominates our list, with eight of the 15 top-selling ice cream brands in the world and a 22% share of the global market.

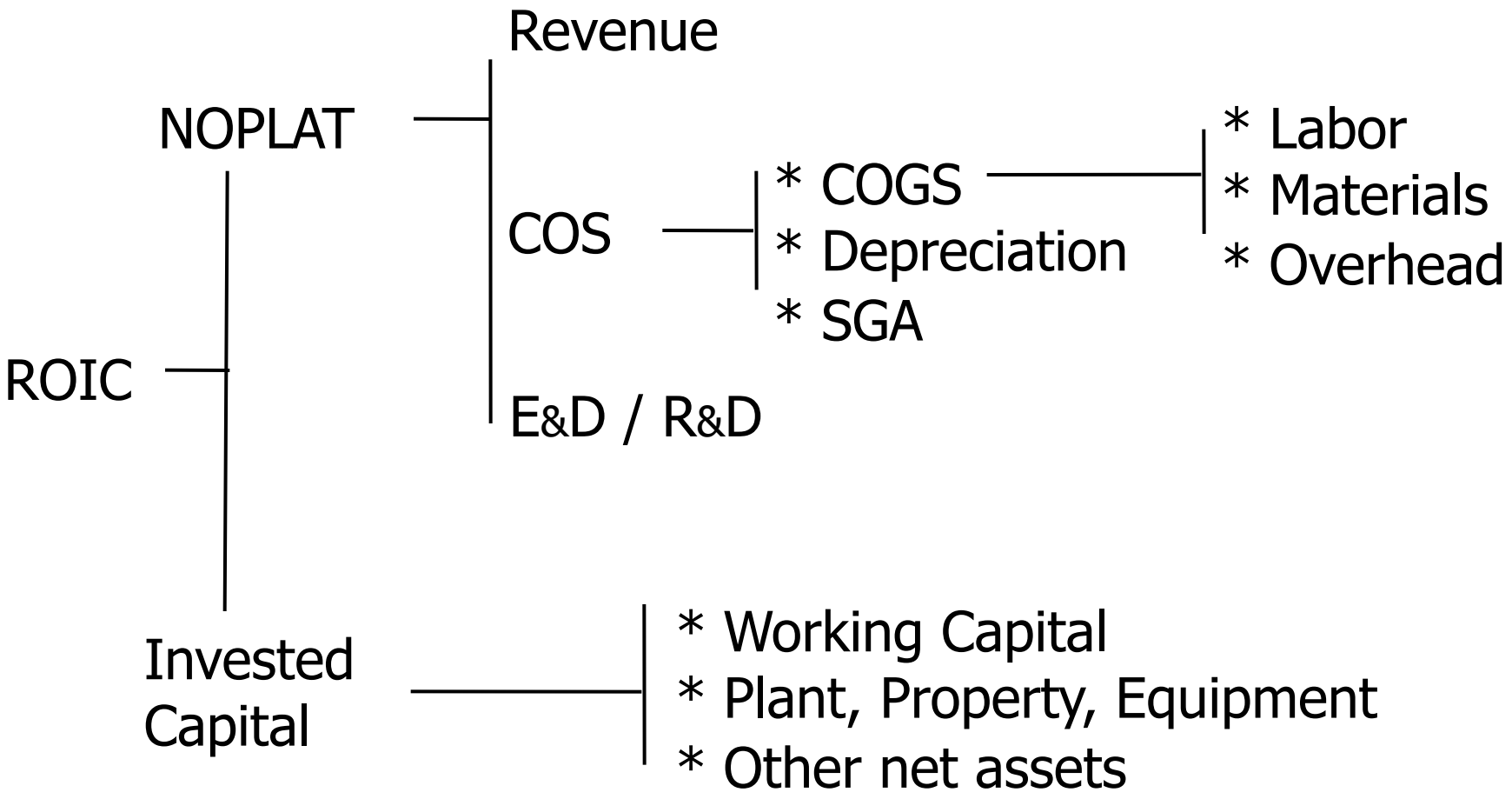
In first place: Magnum. According to Euromonitor, which supplied the data for our list, the brand's Belgian chocolate-drenched ice cream bars racked up $2.54 billion in sales in 2015. That's up 8% over 2014 and some $450 million more than second-place Häagen-Dazs. For 2016, Euromonitor projects that Magnum will hit $2.69 billion in sales, up roughly a third from 2011 in constant value terms, as Unilever has expanded distribution of the brand from its stronghold of Europe into the U.S., China and India. Marketed as an adult indulgence with a touch of sex appeal, Unilever has built up a far-reaching distribution network for the premium bars, with a nearly ubiquitous presence in the freezer cases of European independent stores, right in front of the cashier.

What is the connection between equipment maintenance and market position?

TPM Research by Mobley, 2002

The average maintenance costs in the food industry are about 15% of the cost of the food & drink produced.

TheValueTree



Machine Losses

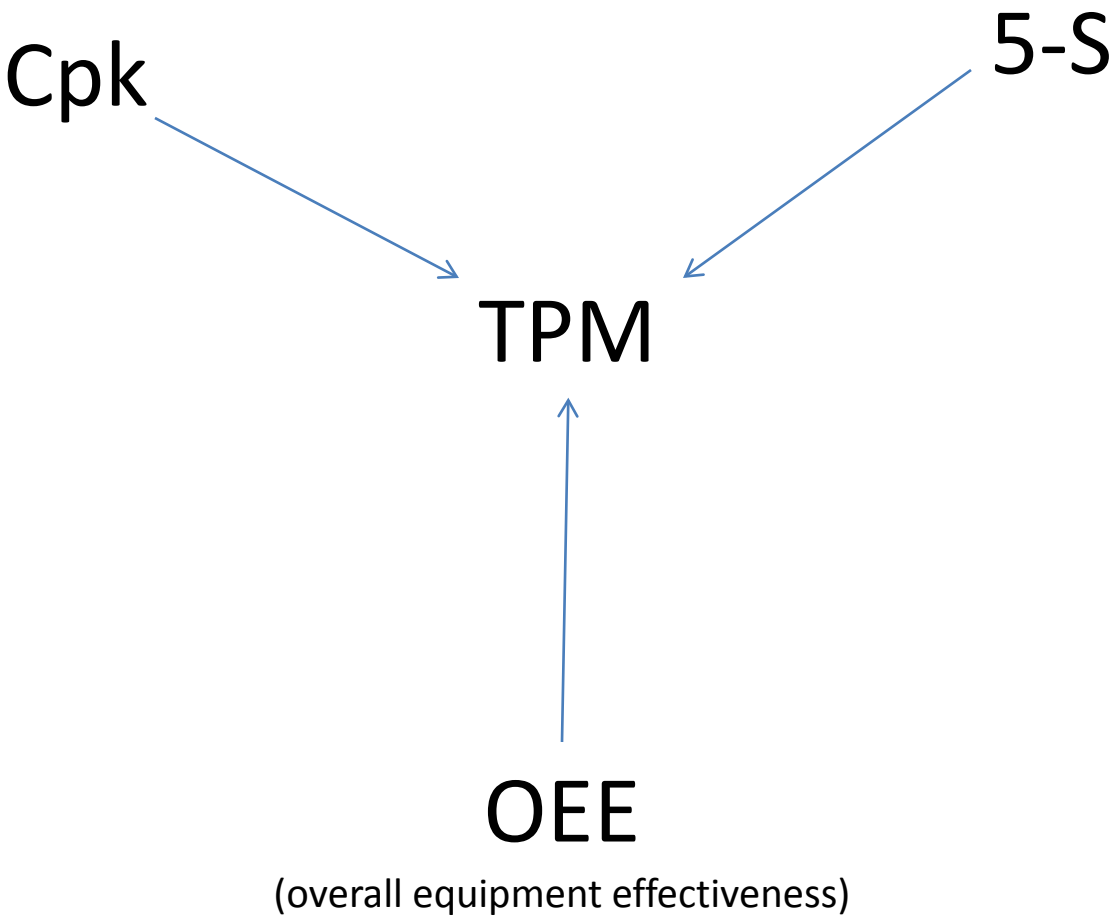
Loss	Target	Description
Breakdown	Zero	Breakdown loss must be reduced to zero for all equipment
Setup/adjustment	< 10minutes	Minimize setup/adjustment loss by employing SMED techniques
Speed	Zero	Eliminate all differences between the actual and designed conditions of the equipment
Idling and minor	Zero	Idling and minor stoppages must be completely eliminated in all equipment
Quality defects and rework	Zero	Keep loss within a 6-sigma range… 3.4 defects/million
Start Up	Minimize	The amount of time cycling-up the machine

Maintenance Effectiveness Survey

Philosophy

Maintenance is inseparable from production. It must become a tool to raise productivity and improve quality.

- **Unplanned Maintenance**
- **Planned Maintenance**
- **Periodic Maintenance**
- **Predictive Maintenance**
- **Preventive Maintenance**
- **Productive Maintenance**


Cpk
5-S
TPM
OEE
(overall equipment effectiveness)

Equipment Reality

- As specified
- As designed
- As installed
- As maintained
- As operated

The six factors

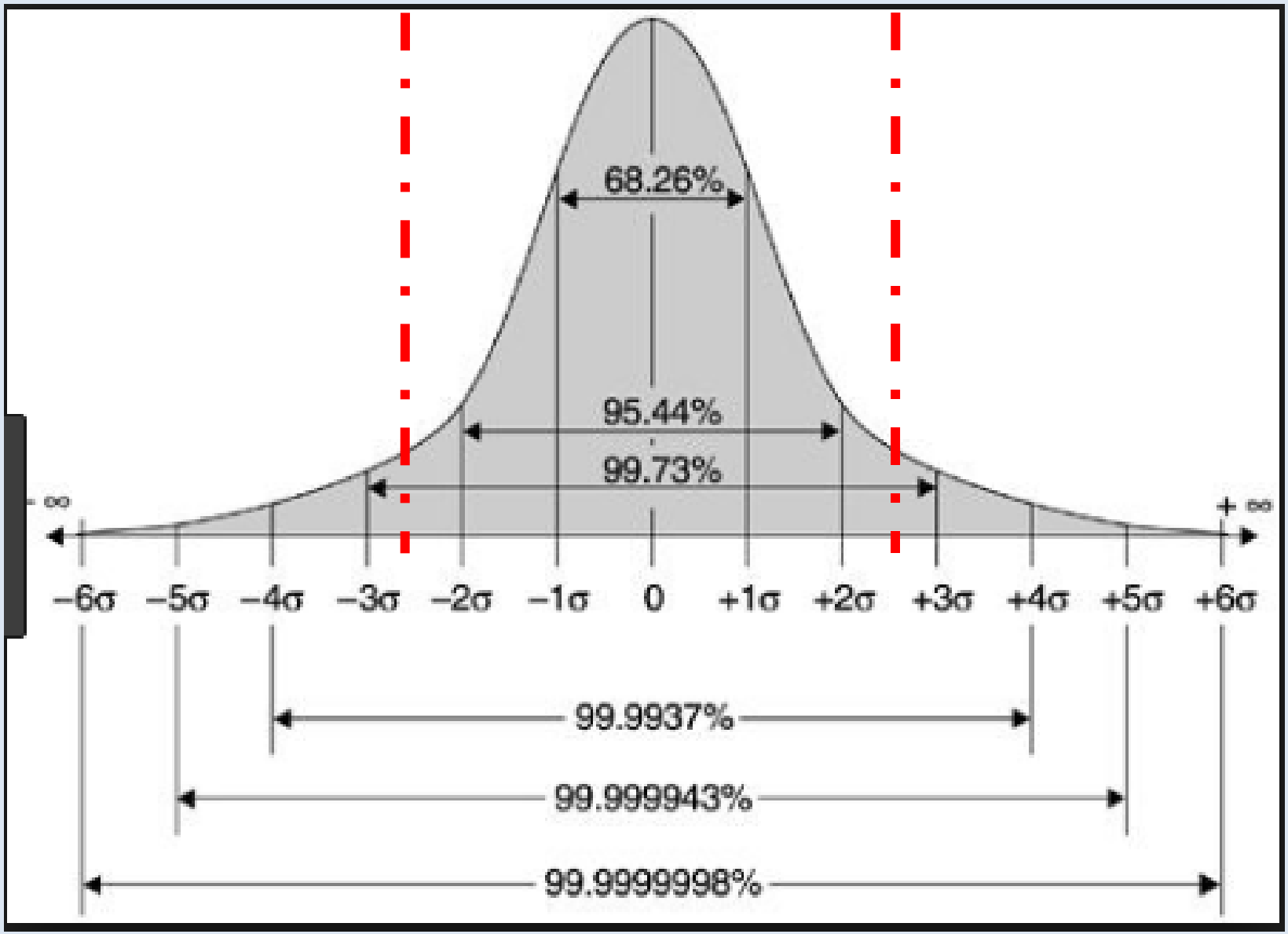
These are the factors that are generally regarded as causing variation in capability measurements:

- **Machine** (e.g. degree of wear and choice of tooling);
- **Measurement** (e.g. resolution and spread of measuring instrument);
- **Operator** (e.g. how experienced and careful he/she is);
- **Material** (e.g. variations in surface smoothness and hardness);
- **Environment** (e.g. variations in temperature, humidity and voltage);
- **Method** (e.g. type of machining operation).

The Shooting at a Target Analogy

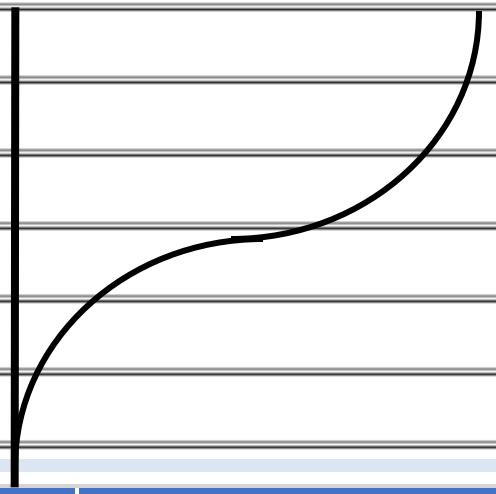
A good analogy is shooting at a target. If the rounds form a good cluster or grouping in the same spot anywhere on the target you have a high C_p value. When the you have a tight group of shots that is landing on the bulls eye, you now have a high C_{pk}

Standard Distribution



Examples

Sigma Performance Levels – One to Six Sigma	
Sigma Level	**Defects Per Million Opportunities (DPMO)**
1	690,000
2	308,537
3	66,807
4	6,210
5	233
6	3.4



Sigma Level	Defects Per Million	% Defect Free (Yield)	Time without Power
6.0	3.4	99.9997%	Less than 2 minutes a YEAR
5.5	30	99.997%	15 minutes a YEAR
5.0	230	99.977%	10 minutes a MONTH
4.5	1,300	99.87%	13 minutes a WEEK
4.0	6,200	99.38%	60 minutes a WEEK
3.5	22,700	97.73%	4 hours a WEEK
3.0	66,800	93.32%	1.5 hours a DAY
2.5	158,700	84.13%	4 hours a DAY
2.0	308,500	69.15%	Almost 20 mins every HOUR

Cpk explained by Professor Cleary

April Quality Quiz

Presented by

Michael J. Cleary, Ph.D.
President
Professor *emeritus*
Wright State University

0:00 / 6:35

Measurement of Equipment Effectiveness and Productivity

OEE

Overall Equipment Effectiveness

OEE = (Equipment availability) x (Performance Efficiency) x (Rate of Quality)

Equipment Utilization

24 hours or 1440 minutes/day

Planned downtime

1. No 3rd shift = 390 min.
   Lunch (3 shifts) = 90 min.
   Dept. meetings = 30 min.
   Total = 510 min.
2. 1440 min. – 510 min. = 930 min. available to run
3. 930/1440 = 64.6% Equipment utilization

Planned Availability

930 min. available time

-150 min. set-up

780 Planned availability (operating time)

780/930 = 83.9% Planned availability

Uptime

780 min. planned availability (operating time)

-150 min. unplanned downtime* (breakdowns)

630 min. Net operating time

630/780= 80.1% Uptime

* 75% caused by contamination & lack of lubrication

Performance Efficiency

630 min. net operating time

-210 min. minor stoppages (inserts, jams, restarts, speed loss)

420 min. usable operating time

420/630 =66.7% Performance efficiency

Rate of Quality

420 min. usable operating time

- 46 min. time used producing defective product

374 min.

374/420 =89% Rate of Quality

Availability

Planned Availability	X	Uptime	=	Availability
83.9%	X	80.1%	=	67.3%

Overall Equipment Effectiveness

Planned Availability x Uptime

Availability x Performance Efficiency x Rate of Quality

67.3% X 66.7% X 89% =

40% OEE

Equipment effectiveness when equipment is planned to run

Overall Equipment Effectiveness Benchmark

Planned Availability x Uptime

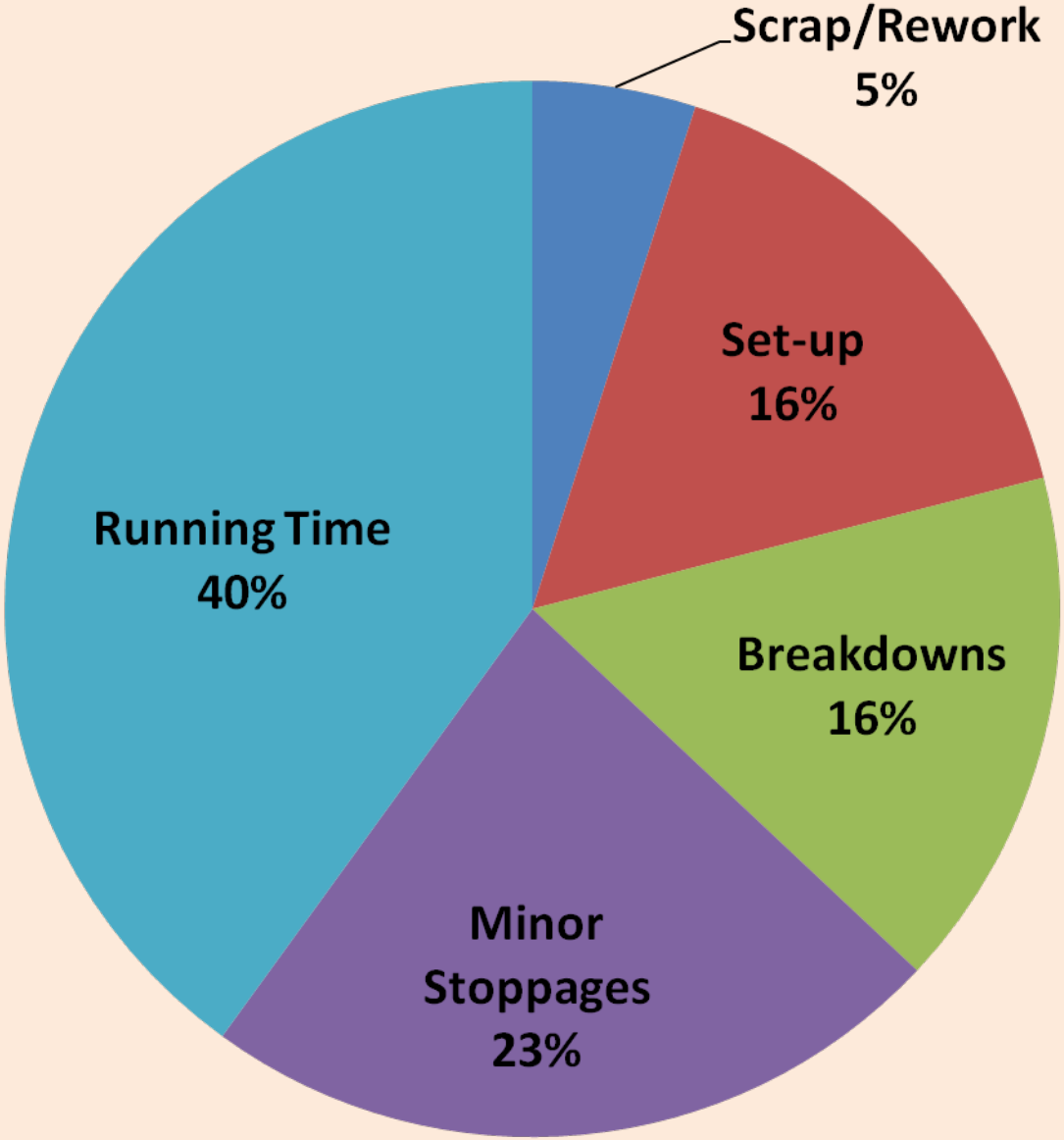
Availability x **Performance Efficiency** x **Rate of Quality**

> 90% X > 95% X > 99% =

85% OEE

Equipment effectiveness when equipment is planned to run

Typical Distribution OEE



- **Unplanned Maintenance**
- **Planned Maintenance**
- **Periodic Maintenance**
- **Predictive Maintenance**
- **Preventive Maintenance**
- **Productive Maintenance**

Predictive Maintenance

- Ultrasonic
  - Bearings
  - Steam traps
  - Valves
- Infrared Thermography
  - Bearing overheating
  - Lack of oil
- Spectrographic oil analysis
  - Lubrication failure
  - Gearbox wear
- Laser alignment

Clean to Inspect

Inspect to Detect

Detect to Correct

Correct to Perfect

Maintenance Strategic Thinking

Maintenance is focused on keeping facilities, equipment and machine tools in a constant state of readiness for our production.

Key Pursuits

- Continue the drive to operate in a non-reactive mode…"Establish p.m. mentality as a way of life."
- Become increasingly systematic in how we carry out maintenance. Put systems in place to do the work effectively and measure our performance.
- Continue building the capabilities of our workforce to assume more accountability for TPM activities

To the shop!

Purpose:

To understand the basics of Total Productive Maintenance

In a way that an appreciation is developed as to its sophistication

So that you can decide if it is strategically important to your success.

Products:

1. Know the philosophy
2. Know the standard
3. Know how to do it
4. Develop assessment skills
5. Decide its importance