List of Content

TPM Manual
Chapter 1
TPM An Overview

JIPM-Solutions Co. Ltd.

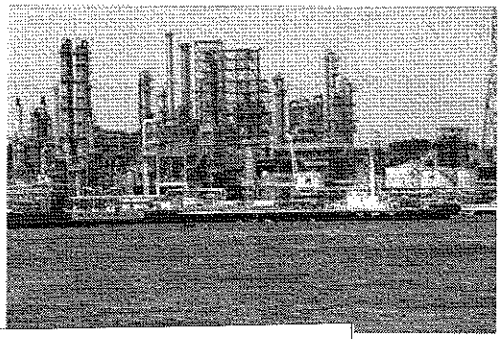
What is TPM?

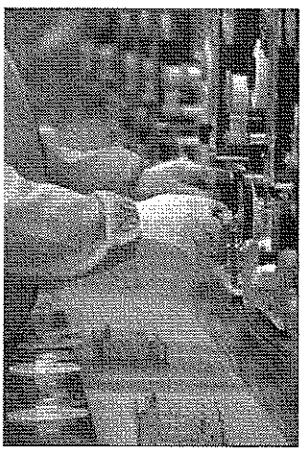
TPM (Productive Maintenance Involving All Employees)

T --- Total

P --- Productive

M --- Maintenance



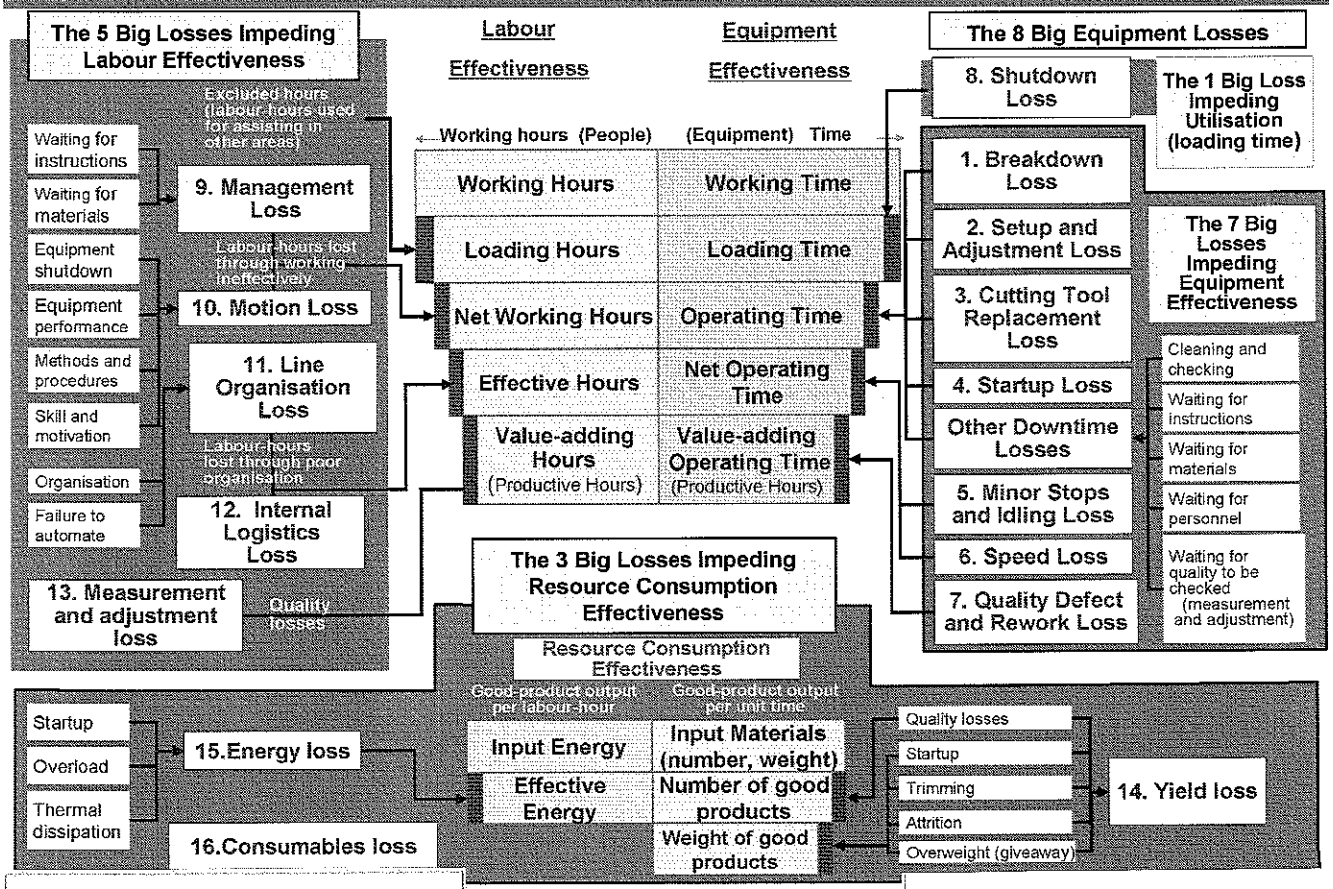


The Harsh Business Environment and the Need for TPM

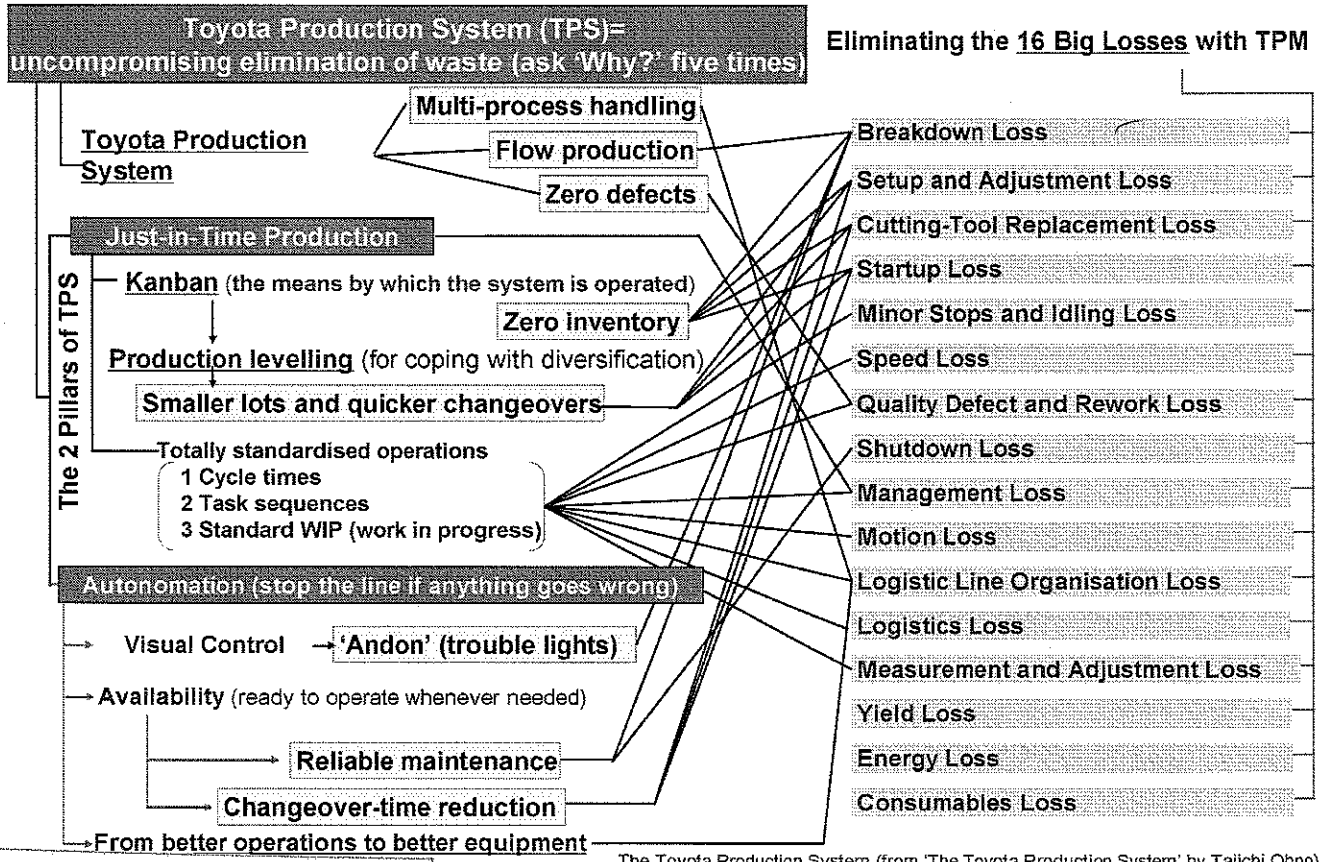
Business Environment	Equipment (Production) Strategy
Lower costs (essential for survival)	**Reduce costs dramatically by maximising equipment/production efficiency**
-High quality, low price -More expensive equipment	-Increase equipment efficiency (OEE) -Raise labour efficiency -Improve resource consumption efficiency Eliminate the 16 Big Production Losses
Stringent demands on quality	**Establish and maintain zero-defect conditions**
-Zero defects	-Quality-Hozen (Quality Maintenance)
More diverse requirements Shorter delivery times	**Minimal changeover times Right-first-time startup Stockless production**
-High variety, small lots	-8 Big Equipment Losses
Pressure on resources (people and equipment)	**Build a flexible production system, responsive to demand**
-Uncertain demand -End of the 'We can sell whatever we make' era	-Better collaboration between production department and support departments

The Goals of TPM

How The Losses Inherent in Production Systems (The 16 Big Losses) Are Structured

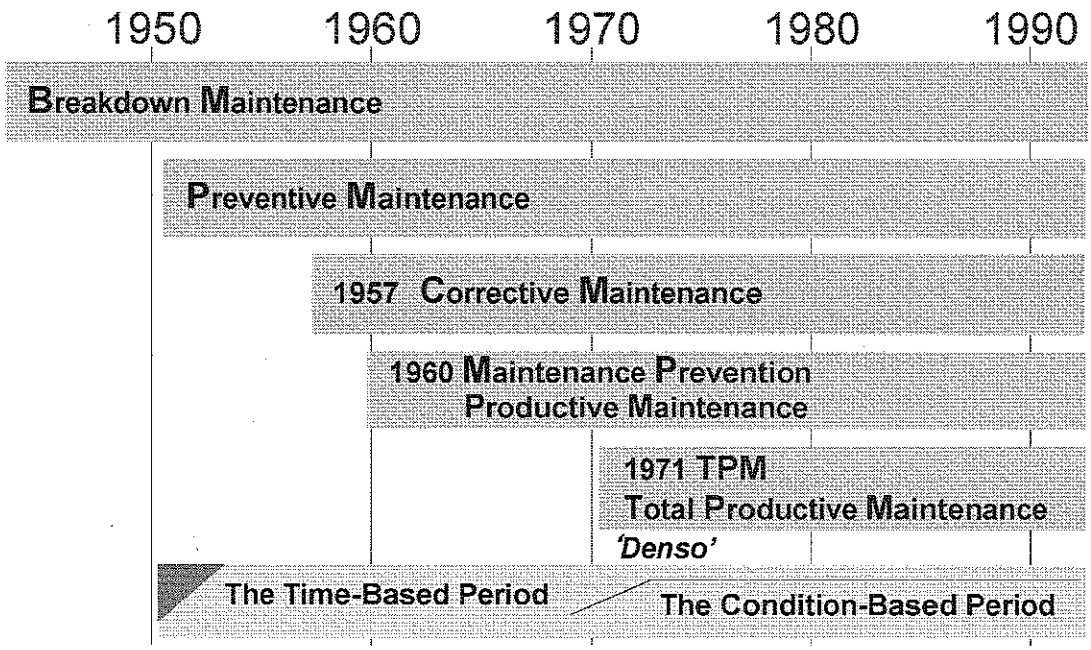


The Relationship Between TPS (JIT) and TPM



The Toyota Production System (from 'The Toyota Production System' by Taiichi Ohno)

Figure 1-5 How Maintenance Evolved in Japan



Evolution of line-based team activities →

* QC Circles(1962)
* ZD (Zero Defect) Groups (1965)
* JK ('Jishu Kanri', or Self-Management) programmes (1969)
* Zero-accident campaigns (1973)

TPM's 5 Basic Precepts

1. **Build a profitable operation**
   ---- Make production more economical by eliminating accidents, quality defects and breakdowns.

2. **Practise prevention rather than cure**
   ---- Practise MP, PM and CM.

3. **Involve everyone (practise participatory management, and treat everyone with respect).**
   ---- Organise the workforce into a pyramid of overlapping small groups, and have operators carry out Jishu-Hozen (AM).

4. **Use the hands-on, shop-floor approach**
   ---- Bring the equipment into its ideal state, introduce extensive Visual Control, and create clean, uncluttered, well-organised workplaces.

5. **Create a virtuous circle of workplace expertise**
   ---- Develop a self-sustaining, continuously-evolving culture of self-directed workplace management

The Purpose of TPM

Improve the company by improving its people and its equipment

Improving the **People**	---- Develop people with the skills required for today's highly-automated factories---- 1. Operators: Do Jishu-Hozen (AM) 2. Maintenance staff: Do advanced, specialised maintenance 3. Production engineers: Plan maintenance-free equipment

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Improving the **Equipment**	1. Raise OEEs by improving the equipment currently in use 2. Design new equipment for minimum life-cycle cost and vertical startup

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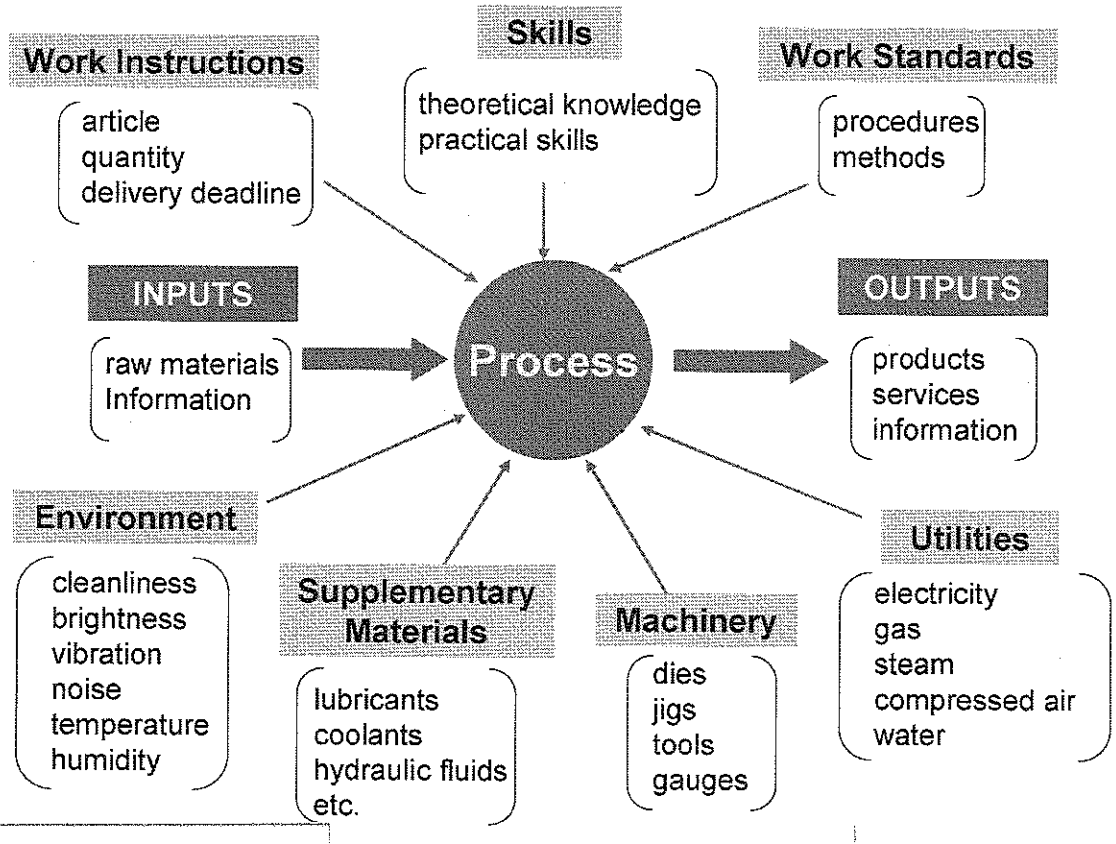
Improve The Company

The Definition of TPM (Enterprise-Wide TPM)

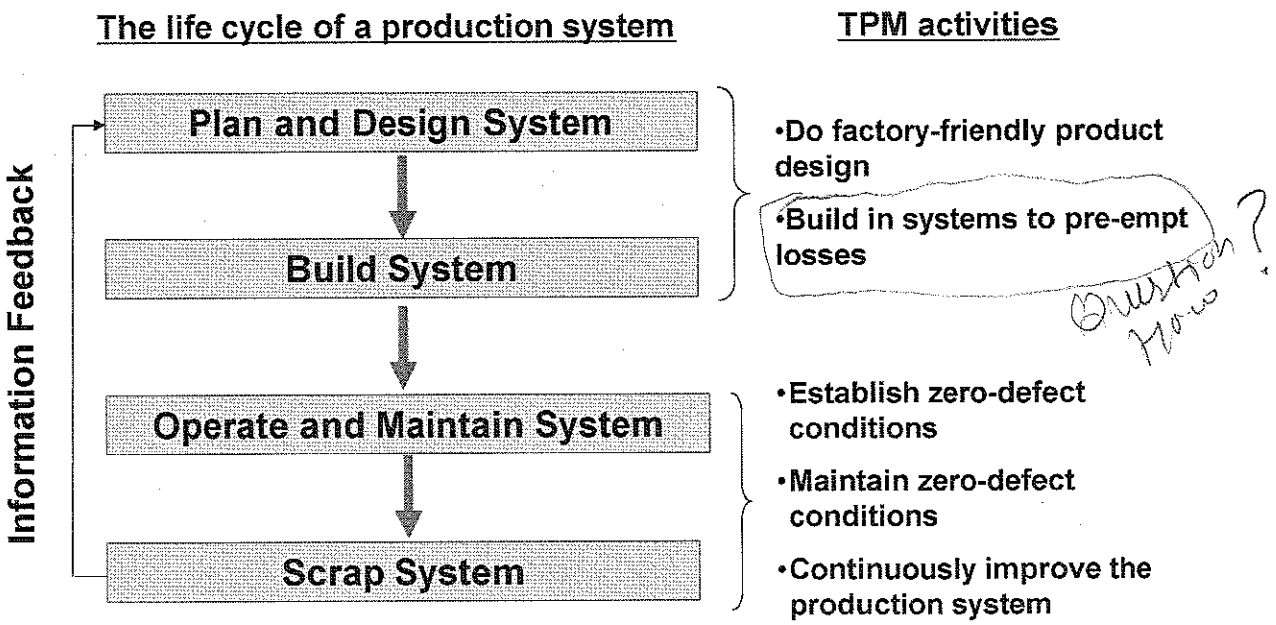
TPM is defined as a programme that:

1. Aims to create a culture and environment that constantly tries to maximise the effectiveness of the entire production system (in other words, to increase its OEE);
2. Uses a hands-on approach to build a 'zero accident, zero defect, zero breakdown' system designed to pre-empt losses of all types throughout the life cycle of the production system;
3. Includes development, sales, administrative and other departments as well as production;
4. Involves everyone at every level of the organisation, from top management to front-line employees;
5. Uses overlapping small-group activities to attain the target of zero losses.

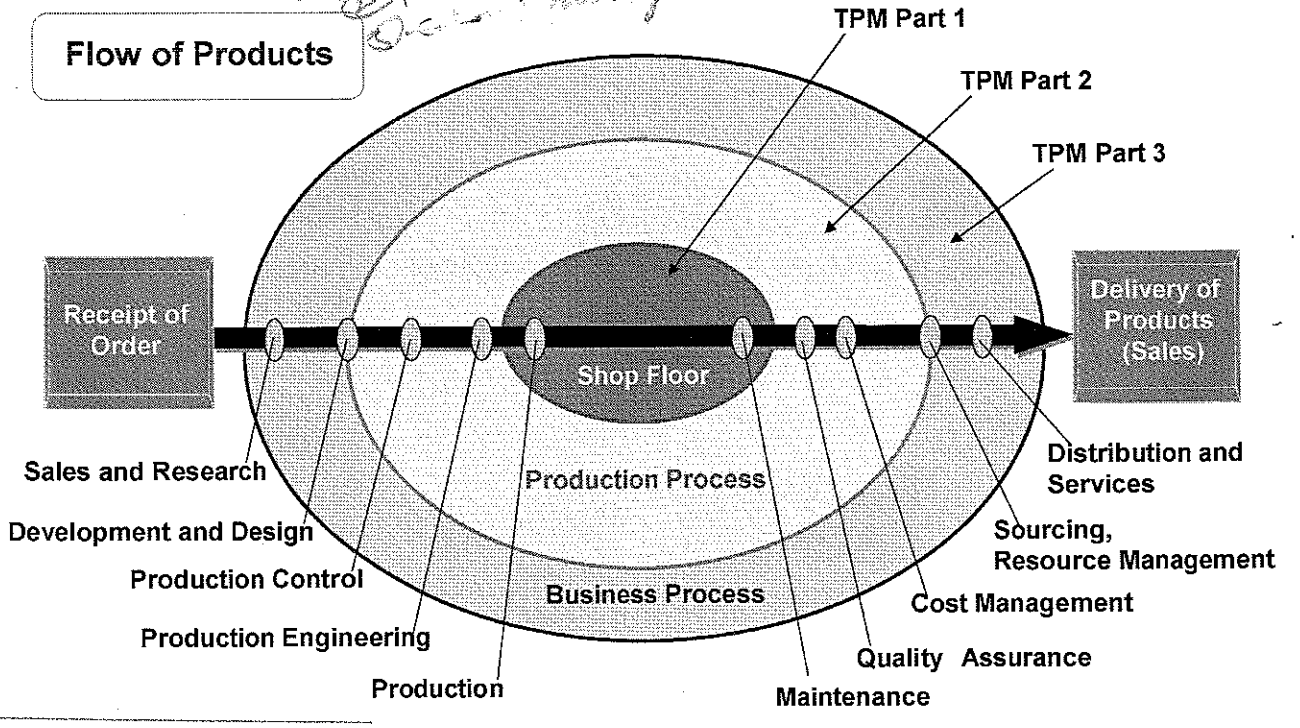
A Structural Model of a Single-Process Production System



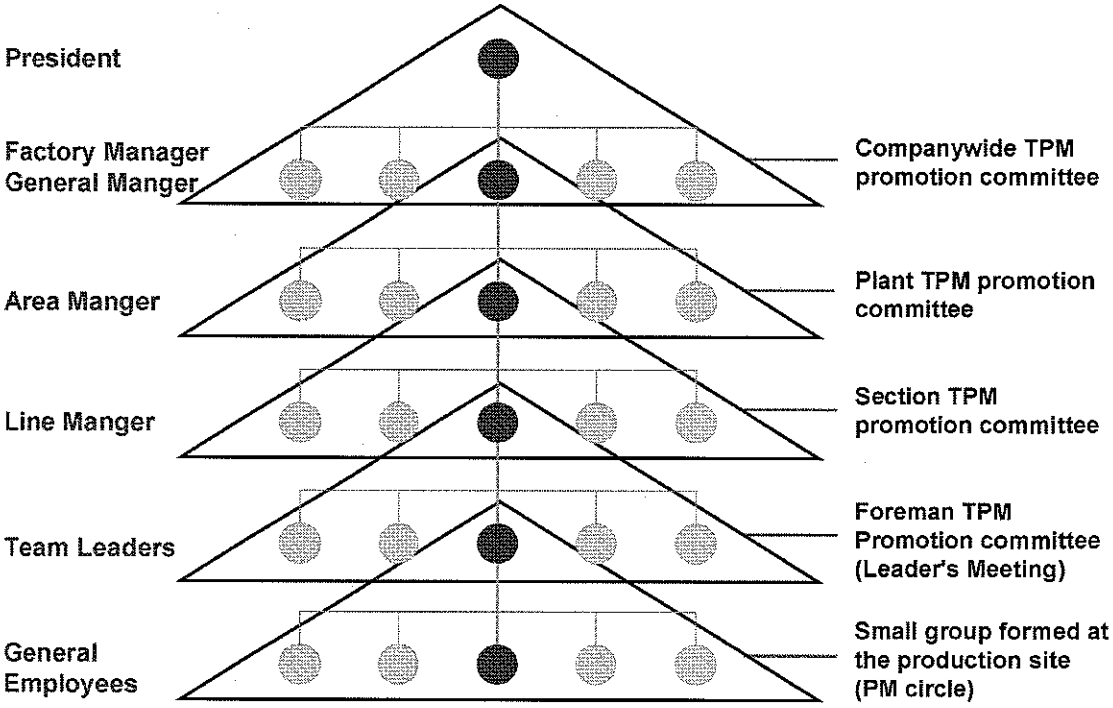
The Relationship Between TPM and the life Cycle of a Production System



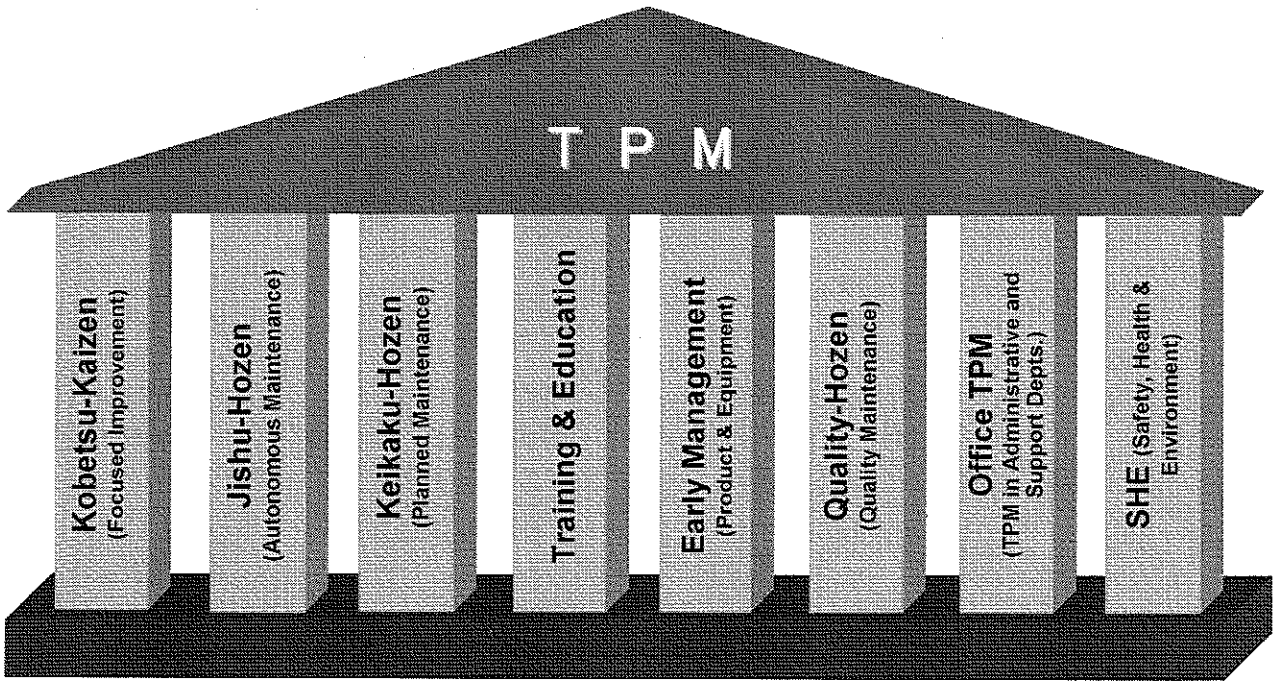
From TPM in Production to TPM Companywide



Overlapping Teams



The 8 Pillars of TPM



The 8 TPM Pillars

The 8 Pillars	A System for Maximising Production Effectiveness				Early Management	Quality-Hozen (Quality Maintenance)	Office TPM (TPM in Administrative and Support Depts.)	SHE (Safety, Health & Environment)
	Kobetsu-Kaizen (Focused Improvement)	Jishu-Hozen (Autonomous Maintenance)	Keikaku-Hozen (Planned Maintenance)	Training & Education				
Goals	- Eliminate breakdowns, quality defects and every other kind of loss - Achieve the ultimate in production effectiveness	-Develop equipment-competent operators Empower operators to look after their own equipment	-Improve the effectiveness of the maintenance department to the point where the 8 Big Losses are no longer generated	-Boost the expertise of operators and maintenance personnel	-Reduce product development and prototyping lead times -Reduce equipment development, design and fabrication lead times -Achieve stable commissioning of new products and equipment 'vertical startup'	-Achieve zero quality defects by sustaining correct equipment conditions	-Achieve zero functional losses -Create highly-efficient offices -Provide effective service and support to the production department	-Achieve and sustain zero accidents -Create healthy, rewarding and pleasant workplaces
Responsibility	-Technical Staff -Line Leaders	-Operators -Line Leaders	-Staff, Team Leaders and Personnel from the Maintenance Department	-Operators -Maintenance Personnel	-Research and development staff -Production engineering staff -Maintenance staff	-Quality assurance Staff -Production engineering staff -Line Leaders	-Team leaders and team members in sales and other indirect departments	-SHE managers and committee members -SHE staff
Actions	- Identify the 16 Big Losses - Calculate and set targets for OEE and unit resource consumption - Analyse problems and review possible causes - Perform P-M Analyses - Ruthlessly pursue the ultimate in equipment and production systems	-Implement the 7 Jishu-Hozen Steps 1. Initial Cleaning 2. Contamination Sources and Hard-to-Access Areas 3. Provisional Standards 4. General Inspection 5. Autonomous Inspection 6. Standardisation 7. Full Self-Management	Day-to-day actions Keikaku-Hozen Predictive maintenance Improvements to extend equipment life Spare-parts management Failure analysis and recurrence prevention Lubrication Management	Basic maintenance Fitting of nuts and bolts Key fitting Axle maintenance Maintenance of transmission components Leak prevention Maintenance of hydraulic and pneumatic equipment Maintenance of electrical control equipment	-Set development and design targets -Manufacturability -Quality assurability -Operability -Maintainability (Utilise for MP Design) -Reliability -Life-cycle costing -Eliminate problems at design, drawing, prototyping, fabrication, test running and startup states -Perform design reviews	-Check quality characteristics and standards; investigate existing quality defect phenomena and results -Check quality assurance conditions, and conditions prevailing in processes, raw materials, equipment and methods -Identify, analyse and improve unsatisfactory conditions -Establish correct 3M conditions and inspection criteria -Set observable standards and monitor trends	-Jishu-Hozen (AM) for the office: 1. Do initial cleaning (of immediate surroundings) 2. Perform task review 3. Implement solutions 4. Standardise 5. Raise level of self-management -Do specific project-based improvements, e.g.: 1. Reduce lead-time for finalising accounts 2. Improve logistics 3.Raise efficiency of purchasing and subcontracting 4. Revamp Production management system	-Make equipment safer -Make work safer -Improve working environments (e.g. reduce noise, vibration, dirt) -Prevent pollution -Improve employee's health -Promote wholesome activities

The 8 TPM Pillars 1

The 8 Pillars	A System for Maximising Production Effectiveness			
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Responsibility	-Technical Staff -Line Leaders	-Operators -Line Leaders	-Staff, Team Leaders and Personnel from the Maintenance Department	-Operators -Maintenance Personnel
Actions	- Identify the 16 Big Losses - Calculate and set targets for OEE and unit resource consumption - Analyse problems and review possible causes - Perform P-M Analyses - Ruthlessly pursue the ultimate in equipment and production systems	- Implement the 7 Jishu-Hozen Steps 1 Initial Cleaning 2. Contamination Sources and Hard-to-Access Areas 3. Provisional Standards 4. General Inspection 5. Autonomous Inspection 6. Standardisation 7. Full Self-Management	- Day-to-day actions - Keikaku-Hozen - Predictive maintenance - Improvements to extend equipment life - Spare-parts management - Failure analysis and recurrence prevention - Lubrication Management	- Basic maintenance - Fitting of nuts and bolts - Key fitting - Axle maintenance - Maintenance of transmission components - Leak prevention - Maintenance of hydraulic and pneumatic equipment - Maintenance of electrical control equipment

The 8 TPM Pillars 2

The 8 Pillars	Early Management	Quality-Hozen (Quality Maintenance)	Office TPM (TPM in Administrative and Support Depts.)	SHE (Safety, Health & Environment)
Goals	-Reduce product development and prototyping lead times -Reduce equipment development, design and fabrication lead times -Achieve stable commissioning of new products and equipment 'vertical startup'	-Achieve zero quality defects by sustaining correct equipment conditions	-Achieve zero functional losses -Create highly-efficient offices -Provide effective service and support to the production department	-Achieve and sustain zero accidents -Create healthy, rewarding and pleasant workplaces
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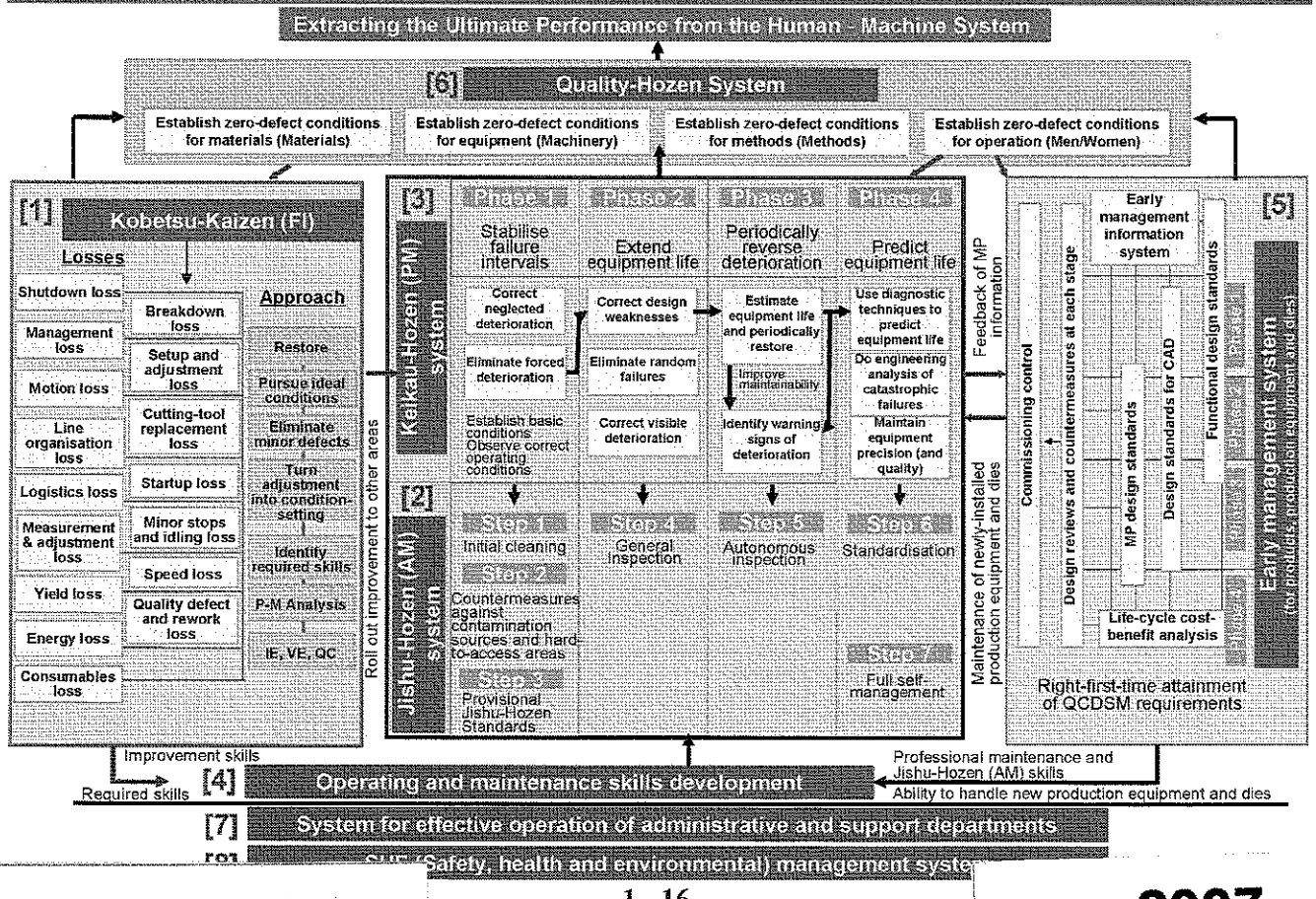
Example of a system for Maximising Production Effectiveness



The 12-Step TPM Development Programme

Phase	Step	Key Point
Preparation	1. Top Management declares its commitment to introducing TPM.	* Announce to Board of Directors and Heads of Department. * Announce at in-house TPM seminars.
	2. A publicity campaign is mounted, and TPM orientation sessions are held.	* Senior managers attend grade-specific residential courses or the JIPM's TPM course for executives. * Others attend video training, team-leader courses, or briefing sessions.
	3. The site's basic TPM policy and targets are set.	* Clearly set out business objectives, TPM programme objectives and policies. * Survey losses to establish baselines and find out what improvements are needed.
	4. A TPM promotion organisation is established, and management-led pilot models are commenced.	* Set up Steering Committee, Pillar Sub-Committees and TPM Office. * Begin management pilot models.
	5. The TPM Master Plan is prepared.	* Formulate 3-year Master Plan. * Develop annual and quarterly action plans and monthly schedules.
Kick Off	6. The TPM programme is officially kicked off.	* Top management publicly reaffirms its commitment to TPM in front of invited outside parties such as customers and suppliers.
Roll-Out	7. A system for maximising production effectiveness is developed, by introducing the following 8 TPM Pillars:	* Aspire to the ultimate in production effectiveness.
	7.1 Kobetsu-Kaizen (Focused Improvement)	* Deploy shop-floor teams and special project teams.
	7.2 Jishu-Hozen (Autonomous Maintenance)	* Proceed step-by-step, conducting audits and issuing pass certificates at each step.
	7.3 Keikaku-Hozen (Planned Maintenance)	* Do corrective, periodic and predictive maintenance.
	7.4 Training & Education	* Train groups of team leaders who then pass on their knowledge to their team members.
	8. Early Management (Product & Equipment)	* Develop easy-to-manufacture products and easy-to-handle equipment.
	9. Quality-Hozen (Quality Maintenance)	* Establish and sustain zero-defect conditions.
	10. TPM in Administration and Support Departments	* Support the production department, increase own efficiency and develop more effective office equipment.
	11. SHE (Safety, Health and Environment)	* Create a zero-accident, zero-pollution environment.
Consolidation	12. TPM is fully implemented and upgraded	* Aim for even higher targets than are required for winning the TPM Prize.

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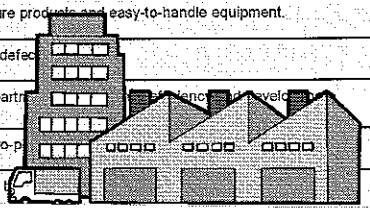
Consolidation	12. TPM is fully implemented and upgraded	* Aim for even higher targets than are required for winning the TPM Prize.

Aim for maximum output in
P: Productivity
Q: Quality
C: Cost-Effectiveness
D: Delivery
S: Safety
M: Motivation

At minimum input in
***Materials**
***Machinery**
***Men/Women**
***Money**



How TPM Has Spread to All Types of Industry

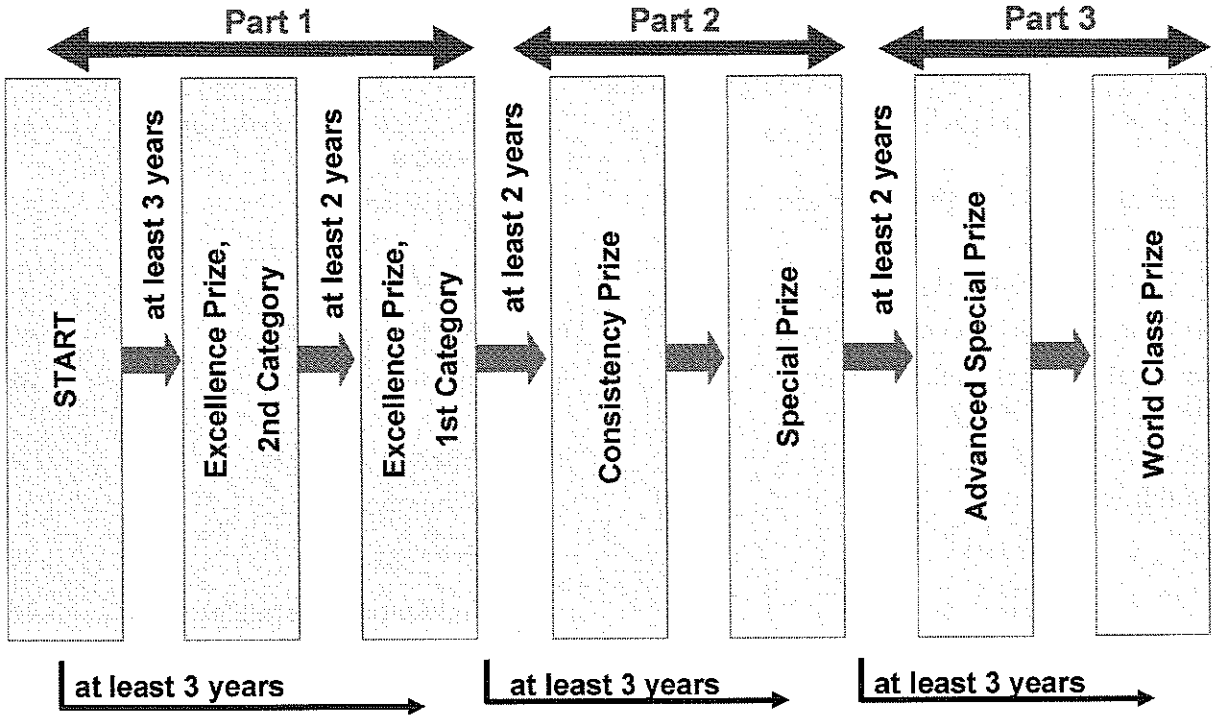
Fabrication and Assembly Industries		Process Industries	
Automobiles and rolling stock	(74)	Ferrous and non-ferrous metals	(129)
Automobile components and transportation equipment	(447)	Chemicals	(241)
Machinery (general and precision)	(93)	Textiles	(82)
Semiconductors and electronics	(191)	Rubber and plastics	(149)
Electrical products (domestic and telecommunications)	(74)	Food	(269)
Metal products	(79)	Pharmaceuticals	(14)
Construction	(30)	Paper and pulp	(47)
		Printing	(70)
		Cement and ceramics	(68)
		Electricity, gas, oil and coal	(36)
	Total 988		Total 1105
Other			(55)

NB: The figures in brackets are the number of sites that won a TPM Award for Excellence (formerly the PM Prize – between 1971 and 2005 – a total of 2,148)

The Aims of TPM in Different Industries and Production Regimes

Type of Industry	Production Regime		Aims of TPM
PROCESS food, textiles, paper and pulp, chemicals, oil, rubber, glass, ferrous and non-ferrous metals, etc.	Continuous	distillation continuous cooking continuous casting, etc.	• Extend number of days' continuous production • Improve efficiency of shutdown operations • Save energy and improve profitability
	Batch	pharmaceuticals rolling packaging, etc.	• Raise OEE (eliminate the 8 Big Losses) • Sustain quality
FABRICATION AND ASSEMBLY machinery, metal products, electrical products, automobiles, precision instruments, etc.	Repeated Lot	press lines transfer lines automatic assembly lines, etc.	
	Manual	processing inspection assembly, etc.	• Improve work efficiency • 5-S the workplace • Streamline the workflow
	One-off	heavy electrical machinery shipbuilding process columns and storage tanks, etc.	• MP Design of new equipment; Early Management (Product & Equipment) • Well-documented specifications, drawings, and operating manuals • Technical training and maintenance services

The Prizes and TPM Parts 1, 2 and 3

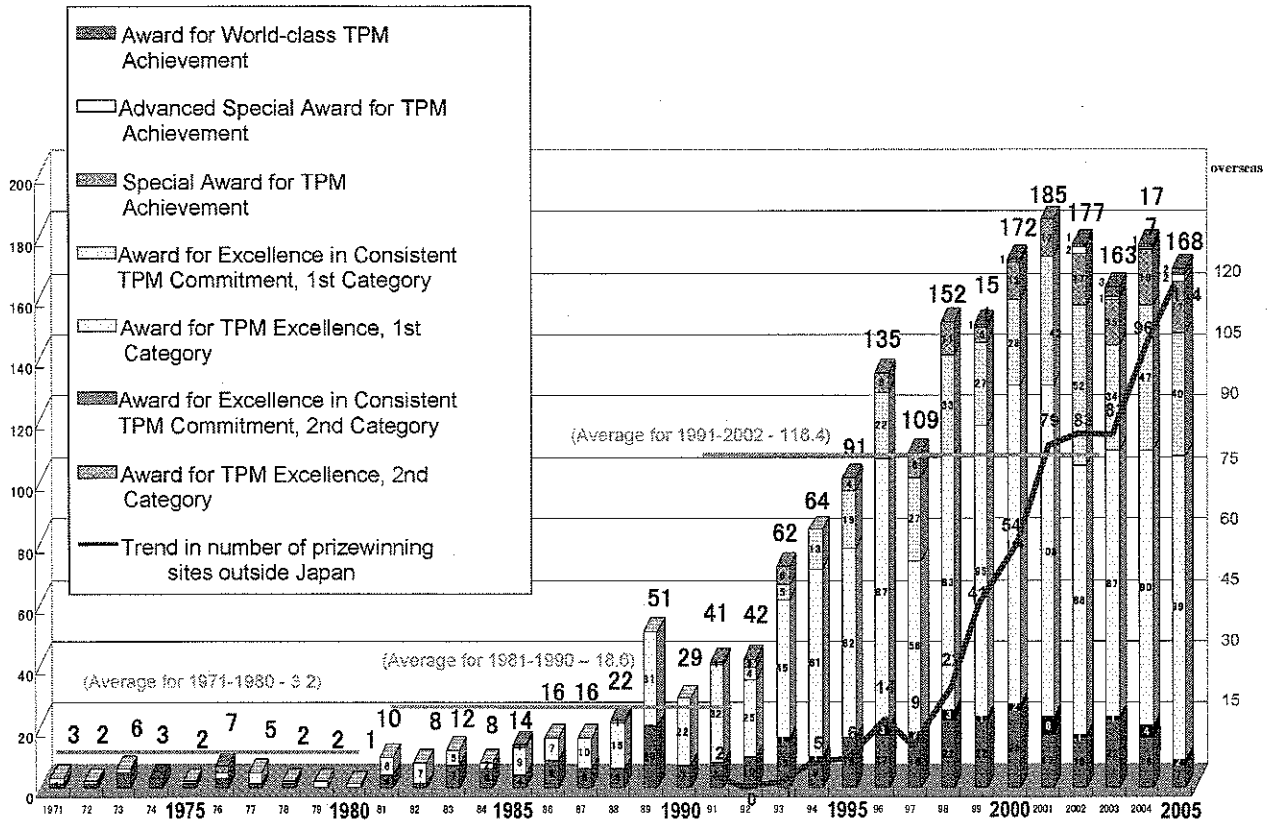


Notes: 1. Sites are defined as First or Second category in the same way as before
2. Second-category sites can attempt First-category awards directly if they wish
3. An Award for Excellence in Consistent TPM Commitment (Consistency Prize) is not an end in itself, but a milestone on the way to the next higher award

TPM – A Conceptual Guide

TPM Part	Part 1 Prize for TPM Excellence - Strengthen the factory's internal environment -	Part 2 Special Prize for TPM Achievement - Establish the ability to respond effectively in new arenas of business competition -	Part 3 Prize for World-Class TPM Achievement - Develop the ability to meet the conditions required for the company to prosper -
Aims	1. Reduce production costs Identify and eliminate constraints and losses impeding the reduction of production costs. 2. Use these activities to create a strong, highly-profitable production floor.	1. Reduce total product costs Identify and eliminate constraints and losses impeding the reduction of total product costs. 2. Implement programmes designed to create added value. 3. Use these activities to establish the ability to respond effectively to new business challenges.	1. Utilise resources with maximal efficiency Identify and eliminate constraints and losses impeding the improvement of the company's overall cash flow. 2. Achieve industry world-beating results in one or more output indicators. 3. Use these activities to develop a solid foundation for continued corporate prosperity.
Key Activities	1. Increase the basic capabilities of the production floor in such a way as to contribute to better business results. 2. Bolster the production floor's QCD performance. • Eliminate identifiable losses 3. Build effective systems for managing the development of new products and equipment • Achieve vertical startup of new products and equipment. • Construct basic systems for managing development projects. 4. Create safe, pleasant working environments.	1. Establish systems for continuing to strengthen and enhance the production floor's basic capabilities. 2. Establish QCD in development, production and marketing. • Conduct programmes for eliminating identified and as-yet-unidentified losses. • Extend TPM from the production department to all departments. 3. Carry out Kobetsu-Kaizen (FI) designed to increase added value. • Develop new, improved products. • Build new, improved production systems. 4.Promote environmental protection programmes.	1. Make continuing to strengthen and sustain the production floor's basic capabilities a way of life. 2. Establish QCD in R&D and in prototyping and pre-production. • Keep actual and potential losses at minimal levels. • Pre-empt all types of loss. 3. Strengthen and enhance activities designed to create added value for the company as a whole. • Develop innovative new products. • Build innovative new production systems. 4. Conduct resource conservation programmes.
Relevant TPM Pillars	1. Implement the 8 TPM Pillars in a structured, systematic way. * The 8 Pillars are the basis of any TPM programme and must be continued throughout Parts 1, 2 and 3.	1. Continue to reinforce and enhance the 8 TPM Pillars. 2. Implement ground-breaking TPM programmes. * The company contending for the TPM Award should decide its own programme (from the perspective of achieving its business goals).	1. Make the 8 TPM Pillars a way of life. 2. Implement creative TPM programmes. * The company contending for the TPM Award should decide its own programme (from the perspective of achieving its business goals).

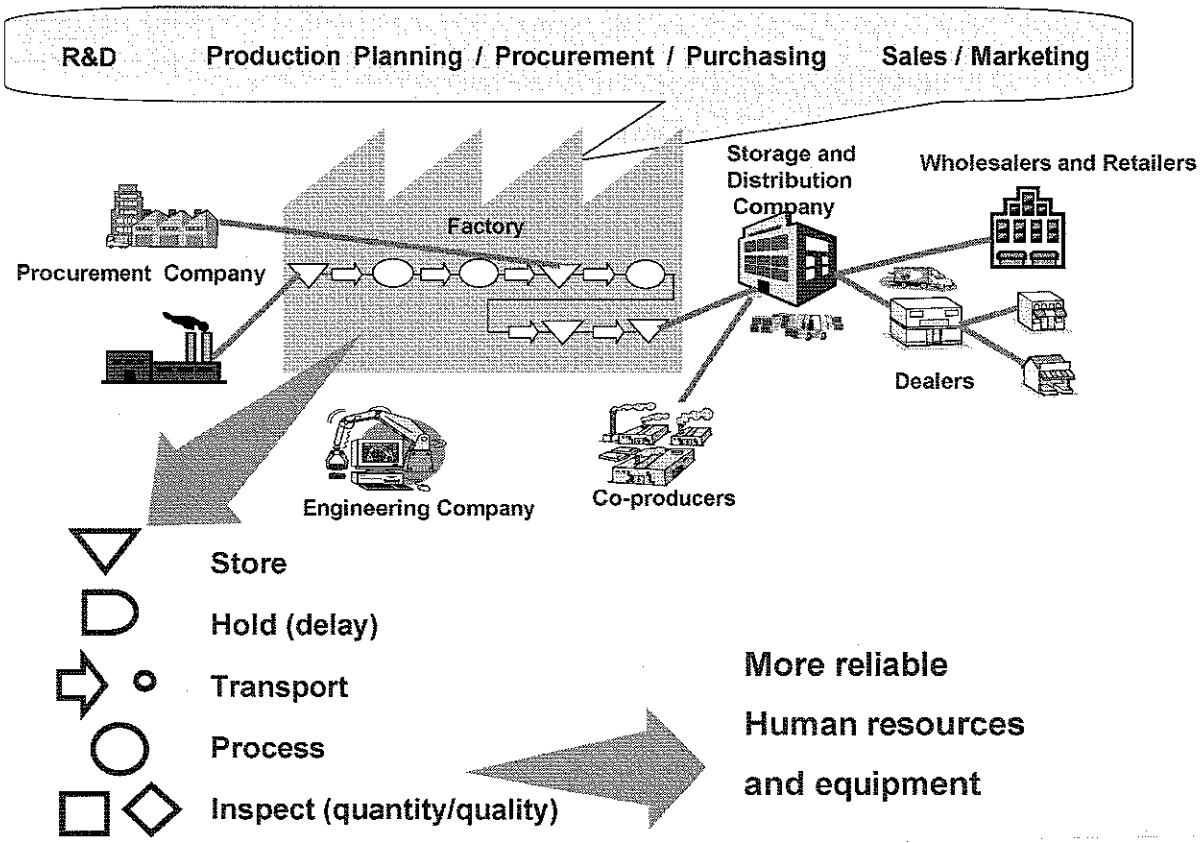
Development in Number of TPM Prizewinning Sites



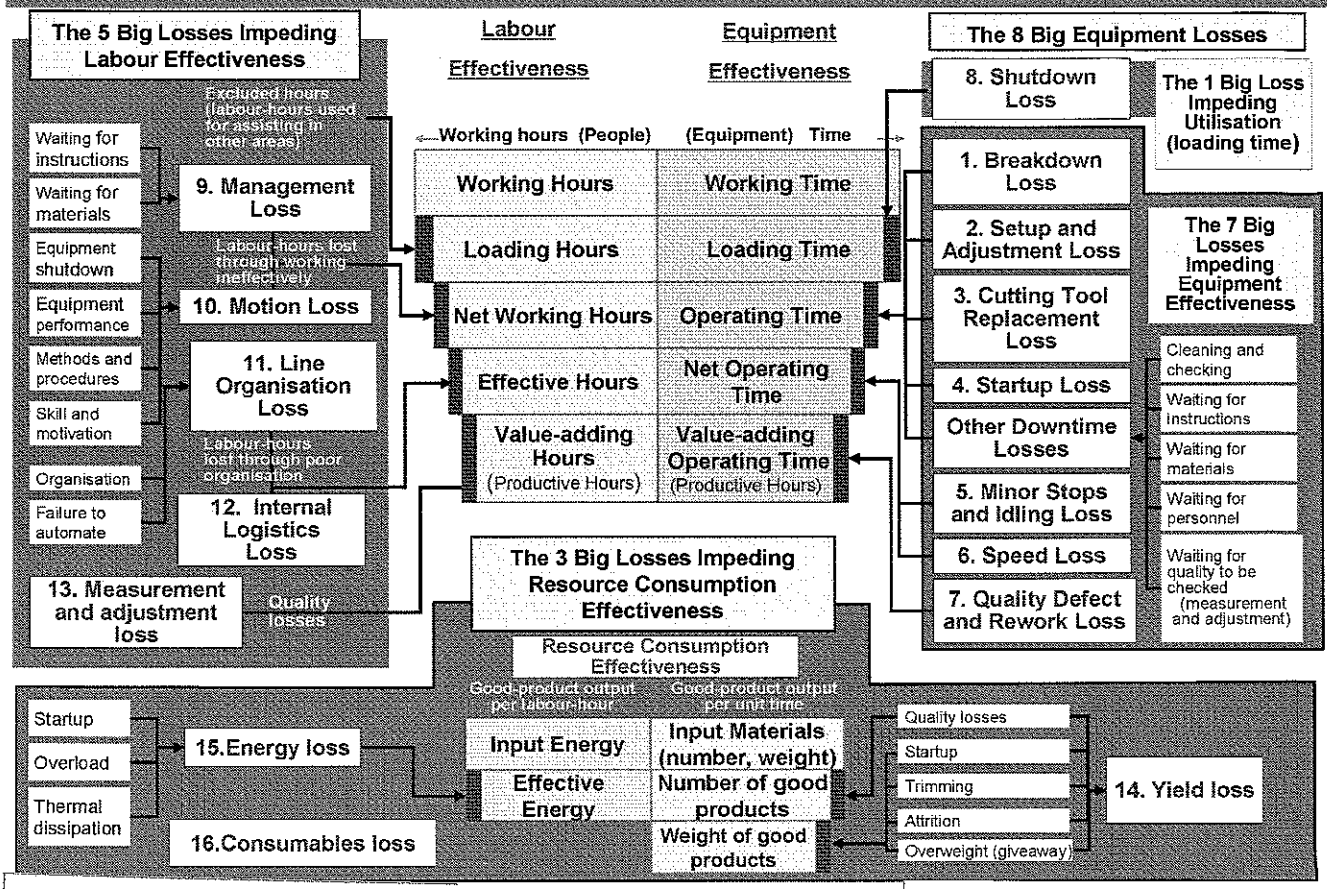
TPM Manual Chapter 2 Losses, Costs and Efficiency

JIPM-Solutions Co. Ltd.

From Production System Losses to Processes and Equipment Losses



How The Losses Inherent in Production Systems (The 16 Big Losses) Are Structured



Definitions of the 8 Big Equipment Losses

	Type of Loss	Definition	Units
1	**Breakdown Loss**	A breakdown is a loss of or reduction in a machine's capacity to function. Breakdown loss is the time losses (reduction in output) and physical losses (increase in defectives and rework) arising from sporadic or chronic failures.	Time (minutes)
2	**Setup and Adjustment Loss**	The time losses (reduction in output) incurred from when the last good product of the previous run comes off the line until changeover, adjustment and test processing are completed and the first good product of the next run emerges, together with the physical losses (defectives and rework) created by test processing.	Time (minutes)
3	**Cutting-tool Replacement Loss**	The loss incurred by stopping a machine in order to change a cutting tool such as a grindstone, saw blade, cutter wire or lathe tool when it has become worn out or damaged.	Time (minutes)
4	**Startup Loss**	The loss incurred when production starts, throughout the run-up to steady-state operation until processing conditions have stabilised.	Time (minutes)
5	**Minor Stops and Idling Loss**	Unlike breakdown losses, these are the losses resulting from stopping-and-starting, and transient problems, which require a machine to be paused or idled for short periods.	Time (minutes), number
6	**Speed Loss**	The loss arising from the difference between the equipment's design speed and the speed at which it actually operates.	Speed, ratio
7	**Quality Defect and Rework Loss**	The physical losses (defectives and rework) and time losses (the time lost by having to reprocess defective product to make it acceptable) created by defectives and rework.	Quantity, time, money
8	**Shutdown Loss**	The time losses (reduction in output) incurred by shutting equipment down deliberately for maintenance, and the physical losses (defectives and rework) arising when the equipment is started up again.	Time, quantity

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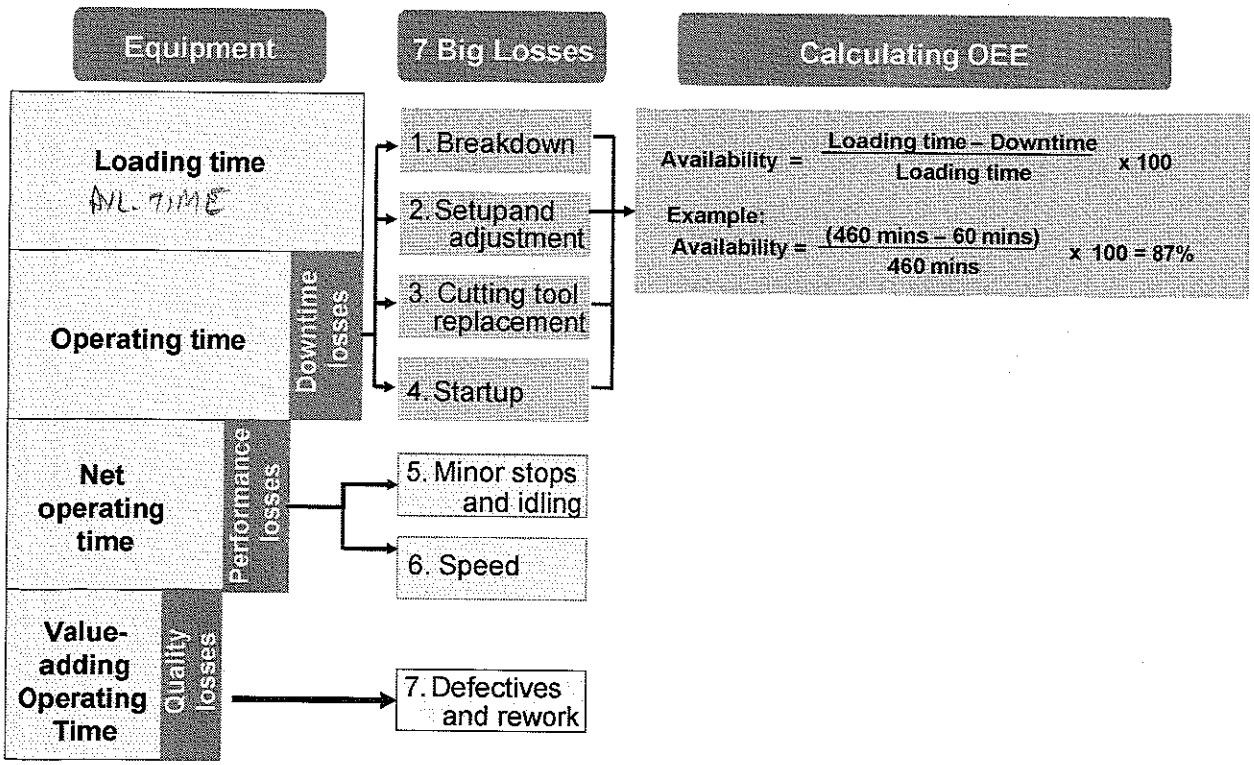
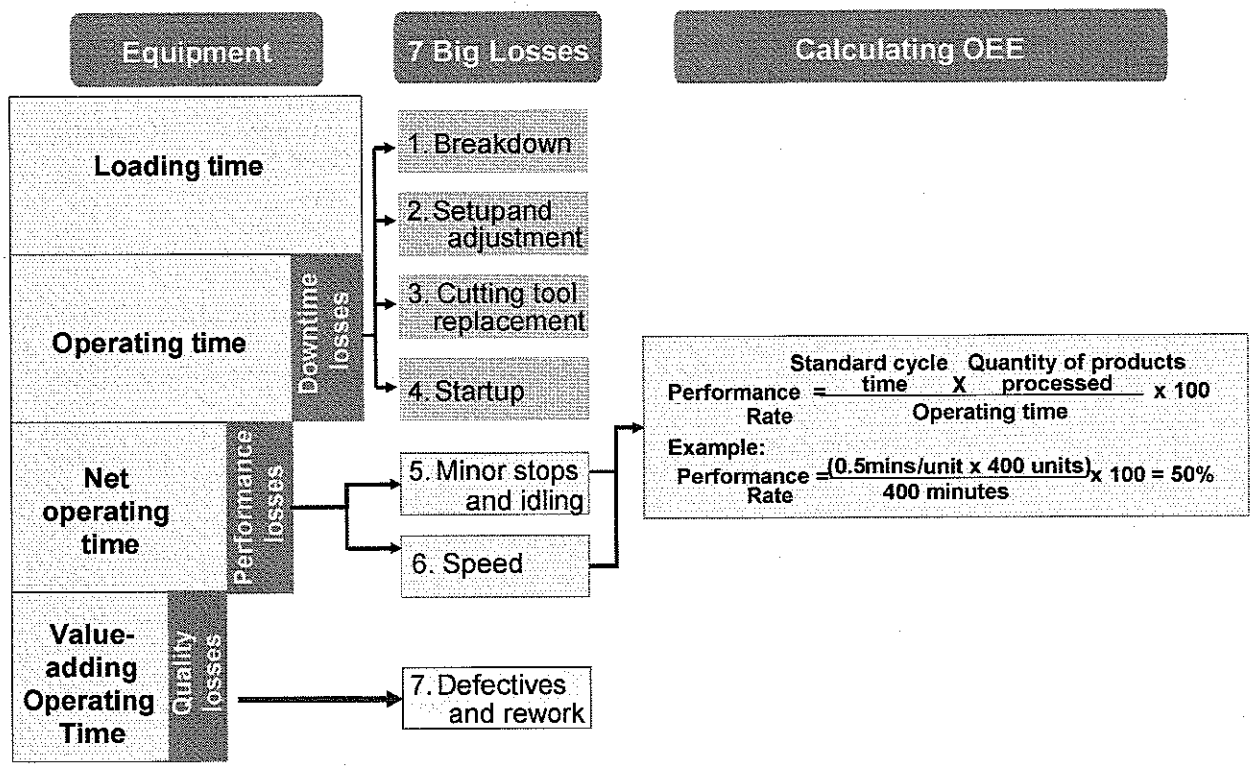
5	**Minor Stops and Idling Loss**	Unlike breakdown losses, these are the losses resulting from stopping-and-starting, and transient problems, which require a machine to be paused or idled for short periods.	Time (minutes), number
6	**Speed Loss**	The loss arising from the difference between the equipment's design speed and the speed at which it actually operates.	Speed, ratio
7	**Quality Defect and Rework Loss**	The physical losses (defectives and rework) and time losses (the time lost by having to reprocess defective product to make it acceptable) created by defectives and rework.	Quantity, time, money
8	**Shutdown Loss**	The time losses (reduction in output) incurred by shutting equipment down deliberately for maintenance, and the physical losses (defectives and rework) arising when the equipment is started up again.	Time, quantity

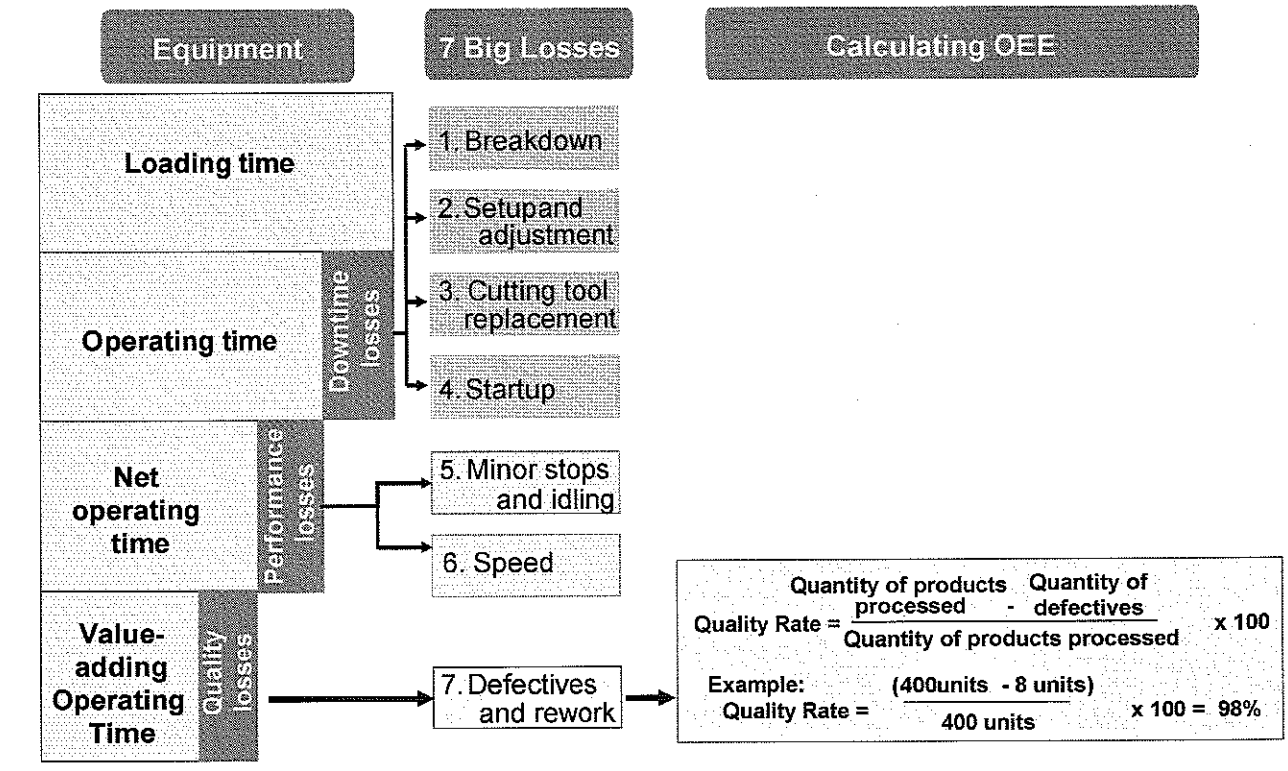
The Relationship between The 7 Big Equipment Losses and Availability



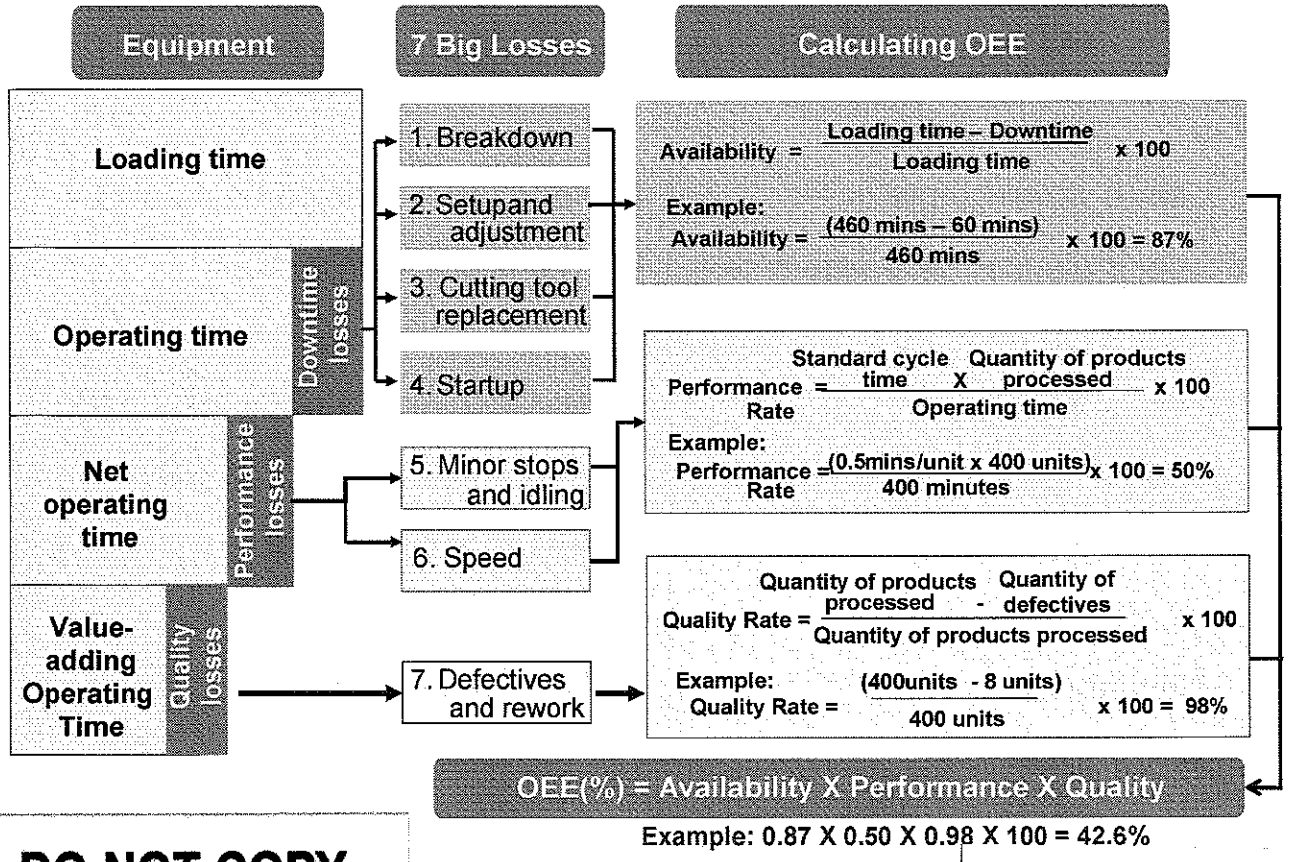
The Relationship between The 7 Big Equipment Losses and Performance Rate



The Relationship between The 7 Big Equipment Losses and Quality Rate



The Relationship between The 7 Big Equipment Losses and OEE



Start Calculating OEE on Critical Eqpt.

Worksheet 1 Calculating OEE (Exercise 1)

Exercise 1 Given the following conditions, calculate the OEE

1 day's operation time.....8 h (480 min.)

1 day's planned stoppage time...10 min. (morning meeting + startup checks)

1 day's downtime.....30 min. (breakdown) + 40 min. (changeover) + 10 min. (adjustment)

1 day's output.....600 units

Number of defectives.....15 units

Standard cycle time.....0.5 min./unit

Actual cycle time.....0.65 min./unit

Worksheet 1 Calculating OEE (Exercise 1)

(Calculate OEE to 1 decimal place)

A: 1 day's working time =

B: 1 day's planned stoppage time =

C: 1 day's loading time = A-B =

D: 1 day's downtime =

E: 1 day's operating time = C-D =

G: 1 day's output =

H: Quality Rate =

I: Standard cycle time =

J: Actual cycle time =

F: Actual processing time = J x G =

T: Availability = E/C x 100=

M: Speed Operating Rate = I/J x 100=

N: Net Operating Rate = F/E x 100=

L: Performance Rate = M x N x 100 =

OEE: T x L x H x 100 = _____%

Worksheet 1 Calculating OEE (Exercise 2)

Exercise 2 Given the following conditions, calculate the OEE

Calculate the percentage increase in OEE after changeover, adjustment, breakdowns and cycle time have been improved

1 day's operation time.....8 h (480 min.)

1 day's planned stoppage time...10 min. (lineside meeting + startup checks)

1 day's downtime (before improvement)...30 min. (breakdown) + 40 min. (changeover) + 10 min. (adjustment)

1 day's downtime (after improvement)...10 min. (breakdown) + 20 min. (changeover) + 5 min. (adjustment)

1 day's output (before improvement).....600 units

1 day's output (after improvement).....725 units

Number of defectives (before improvement).....15 units

Number of defectives (after improvement).....5 units

Standard cycle time.....0.5 min./unit

Actual cycle time (before improvement).....0.65 min./unit

Actual cycle time (after improvement).....0.6 min./unit

Worksheet 1 Calculating OEE (Exercise 2)

(Calculate OEE to 1 decimal place)

A: 1 day's working time =

B: 1 day's planned stoppage time =

C: 1 day's loading time = A-B =

D: 1 day's downtime =

E: 1 day's operating time = C-D =

G: 1 day's output =

H: Quality Rate =

I: cycle time =

J: Actual cycle time =

F: Actual processing time = J x G =

T: Availability = E/C x 100=

M: Speed Operating Rate = I/J x 100=

N: Net Operating Rate = F/E x 100=

L: Performance Rate = M x N =

OEE: T x L x H =

Increase in OEE: After improvement

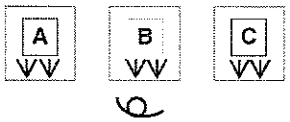
- before improvement_____%

How to Work out OEE for Different Equipment Configurations

Fully-Automated Equipment

(1) One operator in charge of several machines

* Equipment: A process consisting of several fully-automated machines.
* Operators: One operator looks after several machines.

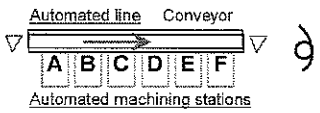


Examples of work done by the operator
Moving raw materials and product
Feeding raw materials into the process and removing product
Monitoring the process and dealing with problems
Setting up and adjusting

* The OEE should be calculated separately for each machine.
* This means that the downtime should also be calculated separately for each machine.
* A separate standard cycle time should be established for each machine. If two or more machines are producing the same product, using the same process, their standard cycle times should be the same.
* The OEE of a group of machines should be calculated as the weighted average of all the machines' OEEs.

(2) Fully automated line

* An automated line formed from several fully-automated machines.
* The products pass automatically one by one from one machine to the next.



Examples of work done by the operator
Transporting raw materials and product
Feeding raw materials into the process and removing product
Monitoring the process and dealing with problems
Setting up and adjusting

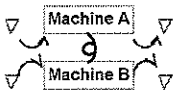
* The OEE should be calculated for the line as a whole
* A set 'tact time' (the cycle time of the slowest machine + the transportation time) should be used as the standard cycle time.
* All of the line downtime must be identified.
* 12 occasions where the workpiece failed to be correctly installed (stations A, B, E and F, three times each) – total 50 minutes.
* 12 tool replacements (2 for each station) – total 60 minutes.
* 4 occasions on which workpiece dimensions had to be corrected (stations D and E, twice each) – total 20 minutes.
* 2 breakdowns (stations A and C, once each) – total 30 minutes.

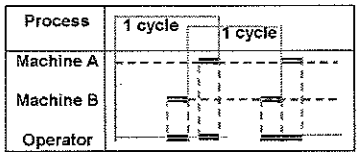
How to Work out OEE for Different Equipment Configurations

Semi-Automated Equipment

(1) One operator in charge of several stand-alone machines

* A process consisting of several semi-automated machines.
* One operator looks after several machines, supplying materials and removing products by hand.



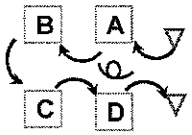


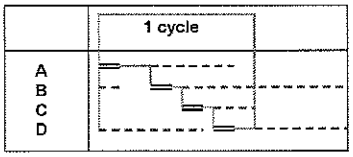
Manual (attaching and removing workpieces) - - - Automatic

* The OEE should be calculated separately for each machine.
* If machines A and B are producing the same product by the same process, their standard cycle times should be the same; if not, the cycle times should be worked out separately for each machine (as machining time + handling time), or a set standard time should be used for each.

(2) Several machines working as a line, operated by one person

* Several semi-automated machines are laid out as a line.
* Operator: The operator moves to the next machine after each cycle.
* Products: The products move from one machine to the next one after the other, in sequence.



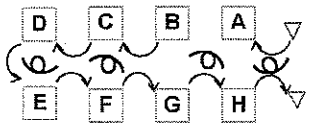


Walking — Manual working - - - Automatic

* The OEE should be calculated for the line as a whole.
* Downtime should be the time for which the line stops (as with a fully-automated line).
* The standard cycle time should be set as in the diagram, or a set standard cycle time should be used.

(3) Several machines working as a line, operated by several people

* Several semi-automated machines are laid out as a line, manned by several operators.
* The products move from one machine to the next one after the other, in sequence.



* The OEE should be calculated for the line as a whole.
* Downtime should be the time for which the line stops (as with a fully-automated line).
* The standard cycle time varies with the month's or day's production volume, and should be calculated as shown in Figure II-6.

How to Calculate Cycle Time when Several Machines are operated by Several Operators

Set the daily production volume, based on the production target

↓ Daily production volume

Establish the tact time

↓ Determine the tact time (the pace of the line, i.e. the average time per unit)

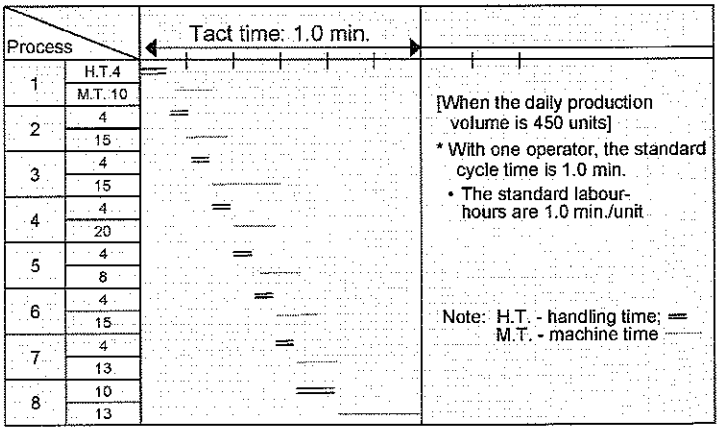
Work out the manning levels required

↓
* Draw up a man-machine chart
* Are the machines or the operators the bottleneck?
* How many operators are needed to meet the tact time?

Establish a standard cycle

↓
* When the operators are the bottleneck, take one cycle as the standard
* When the machines are the bottleneck, take the machine time plus the handling time as the standard for one cycle

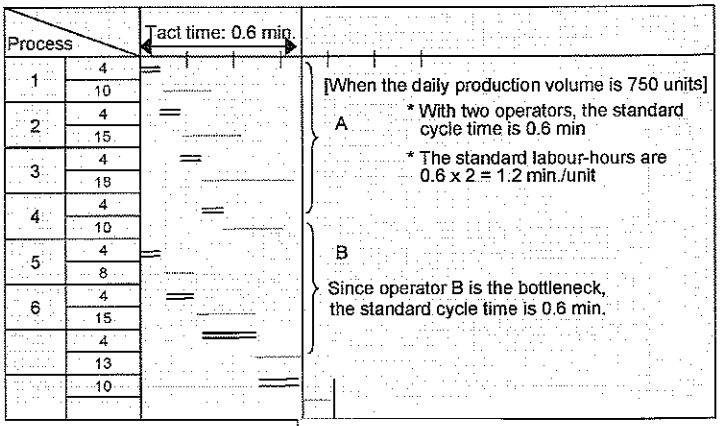
1 Set the standard labour-hours per unit of product



[When the daily production volume is 450 units]

* With one operator, the standard cycle time is 1.0 min.
* The standard labour-hours are 1.0 min./unit

Note: H.T. - handling time; M.T. - machine time



[When the daily production volume is 750 units]

A
* With two operators, the standard cycle time is 0.6 min
* The standard labour-hours are 0.6 x 2 = 1.2 min./unit

B
Since operator B is the bottleneck, the standard cycle time is 0.6 min.

Definitions and Examples of the 8 Big Process Plant Losses

	Loss	Definition	Unit	Examples
1	**Shutdown**	Time lost when production stops for planned annual shutdown maintenance or periodic servicing.	Days	Shutdown maintenance, periodic overhauls, statutory inspections, autonomous inspections, general repair work, etc.
2	**Production adjustment**	Time lost when changes in demand require adjustments to production plans.	Days	Shutdown to accommodate reduced demand, to run down existing stocks, etc.
3	**Equipment failure**	Time lost when equipment suddenly stops working.	Hours	Failed pumps, burned-out motors, damaged bearings, broken shafts, etc.
4	**Process failure**	Time lost for reasons other than equipment failure, e.g. changes in chemical or physical properties of materials being processed, operating errors, or defective raw materials.	Hours	Leaks, spills, blockages, corrosion, erosion, dust ingress, misoperation, etc.
5	**Normal production**	Rate and time losses at plant startup, shutdown, and changeover.	Rate decrease, hours	Production rate reductions during warmup, cooldown and changeover.
6	**Abnormal production**	Losses due to having to lower the plant's production rate as a result of malfunctions and abnormalities.	Rate decrease	Low-load or low-speed operation at less than the standard production rate.
7	**Quality defect**	Time and material losses due to producing product that has to be scrapped, and financial losses due to product downgrading.	Hours tons, money	Time and material wasted through making product that fails to satisfy quality standards.
8	**Reprocessing**	Losses caused by having to send defective product back through the process	Hours, tons, money	Recycling defective product through a previous process to make it acceptable.

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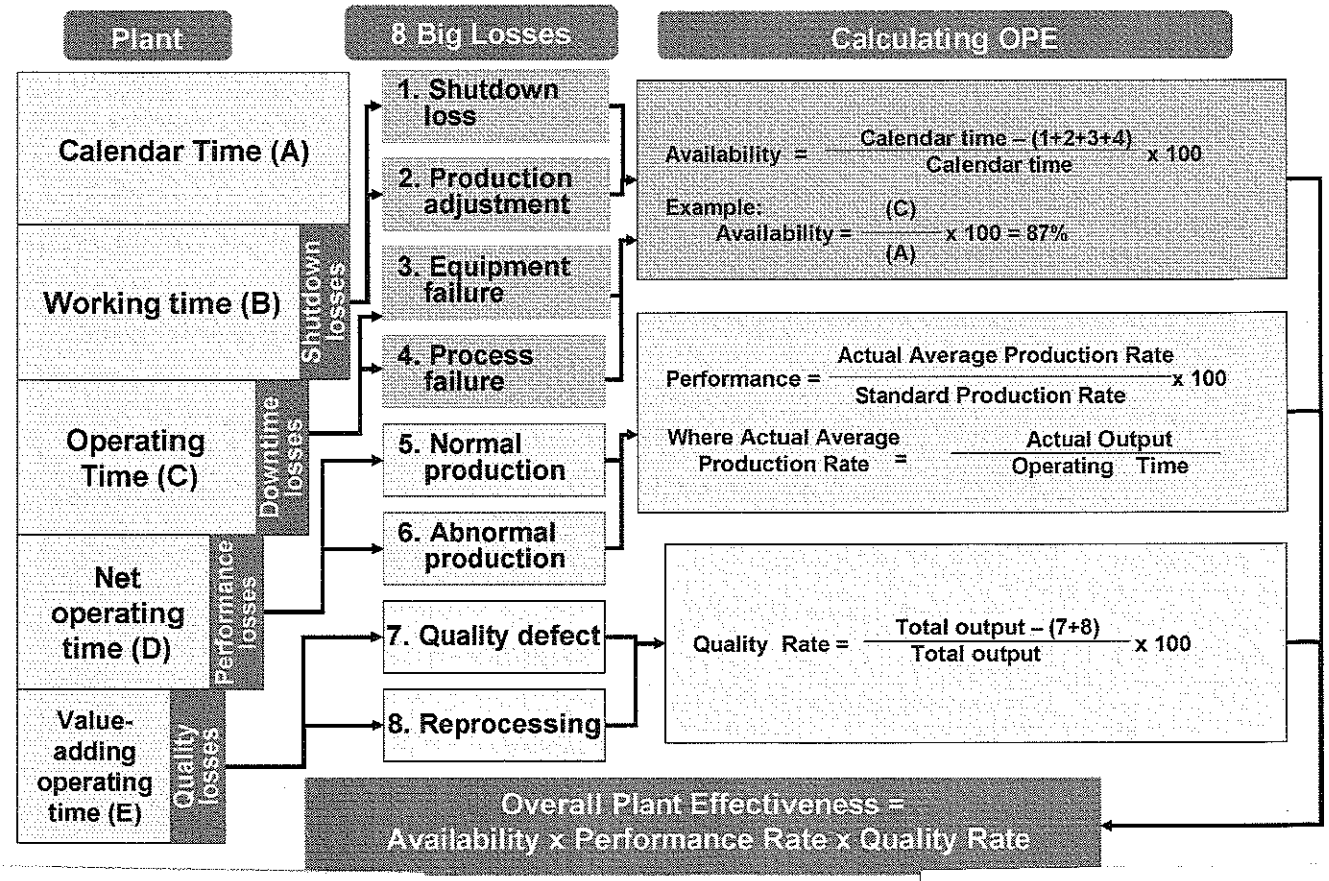
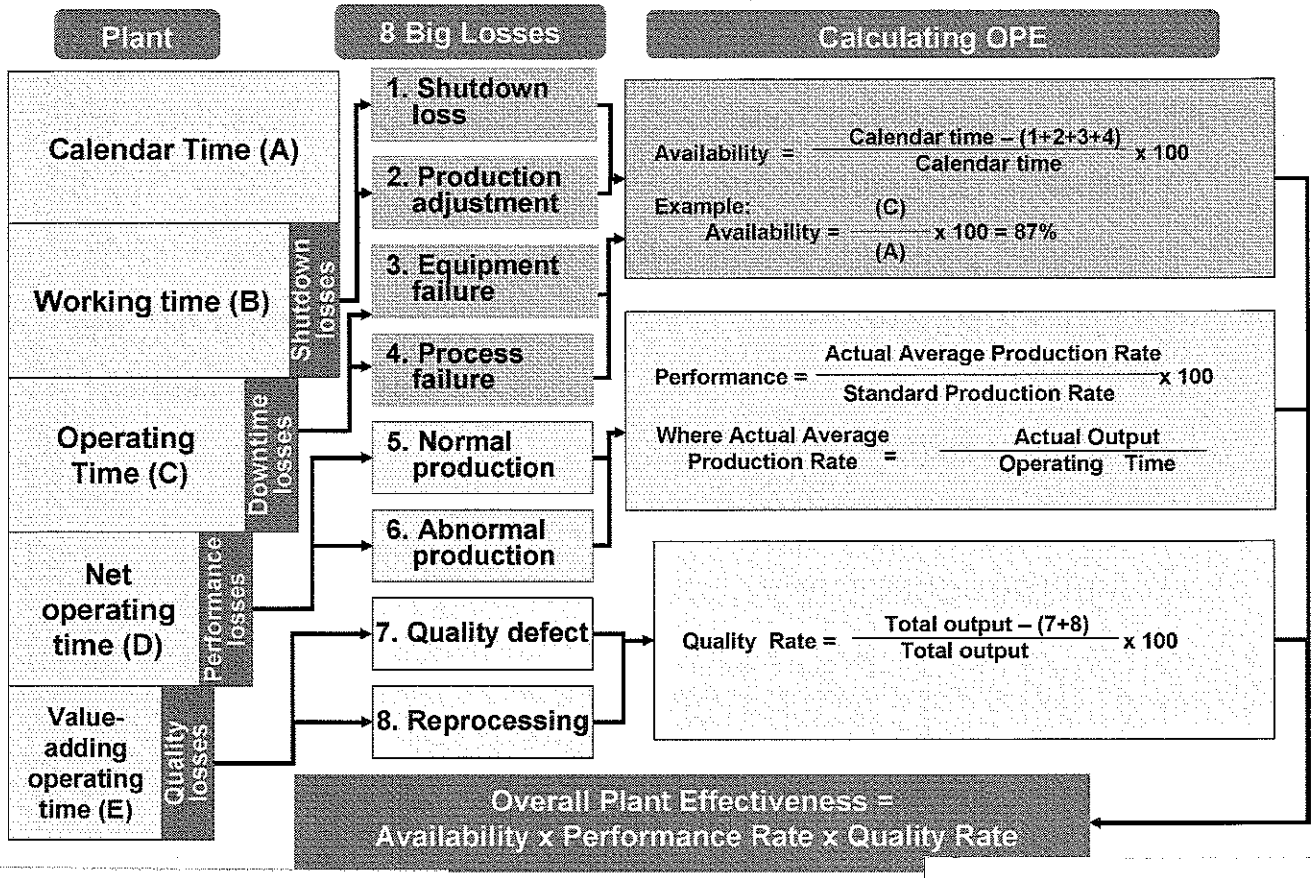
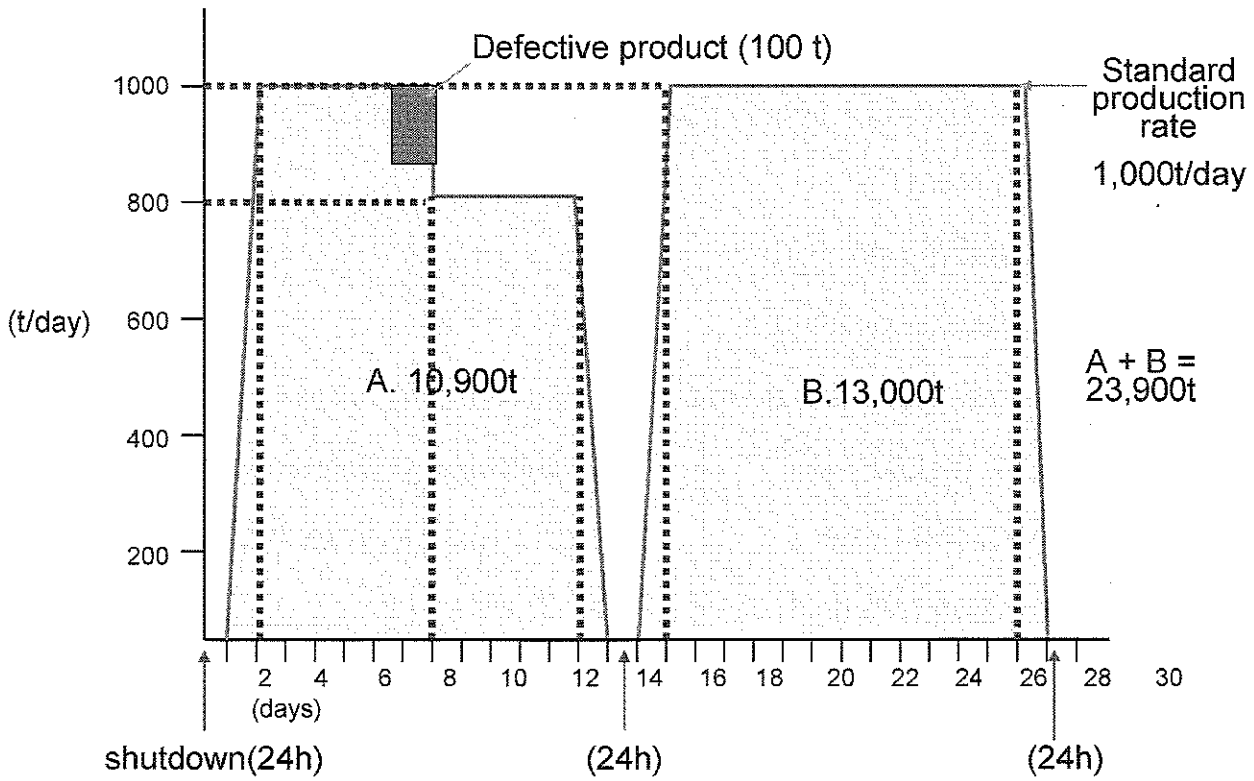
How to Calculate OPE



How to Calculate OPE



OPE Calculation Example



Worksheet 2 Calculating OPE

Exercise 1 Given the following conditions, calculate the OPE

1 month's calendar time.....24 h x 30 days = 720 h

1 month's planned shutdown time...24 h x 2 days = 48 h

1 month's downtime.....24 h (equipment failure)
+ 30 h (process failure)

1 month's defective product.....15 t

Standard production rate.....25 t/h

Actual production rate.....24 t/h

Worksheet 2 Calculating OPE

A: calendar time =

B: working time = calendar time – planned shutdown time =

C: operating time = B-D =

D: 1 month's downtime =

E: 1 month's defective product =

F: 1 month's output = operating time x actual production rate = C x J =

H: Quality Rate = (F-E)/F =

I: Standard production rate =

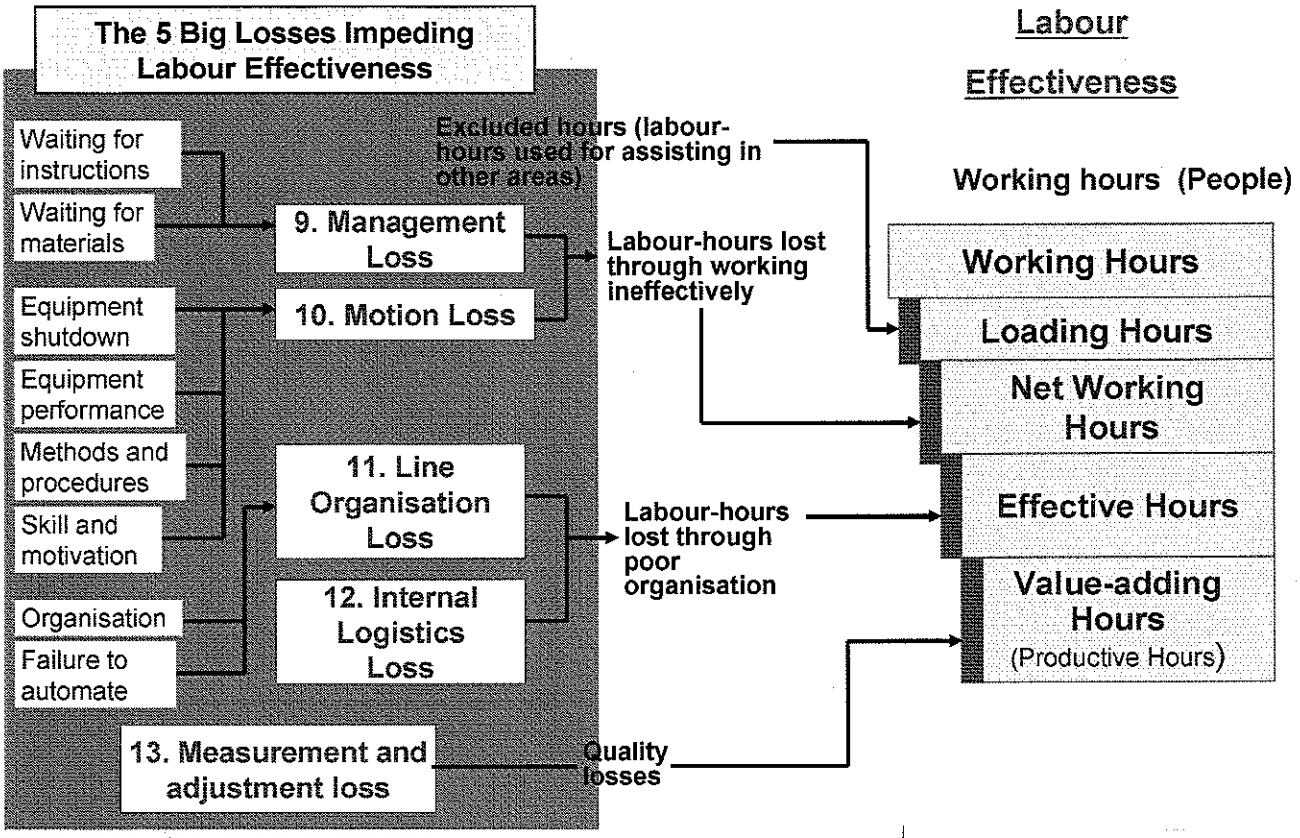
J: Actual production rate =

T: Availability = C/A x 100=

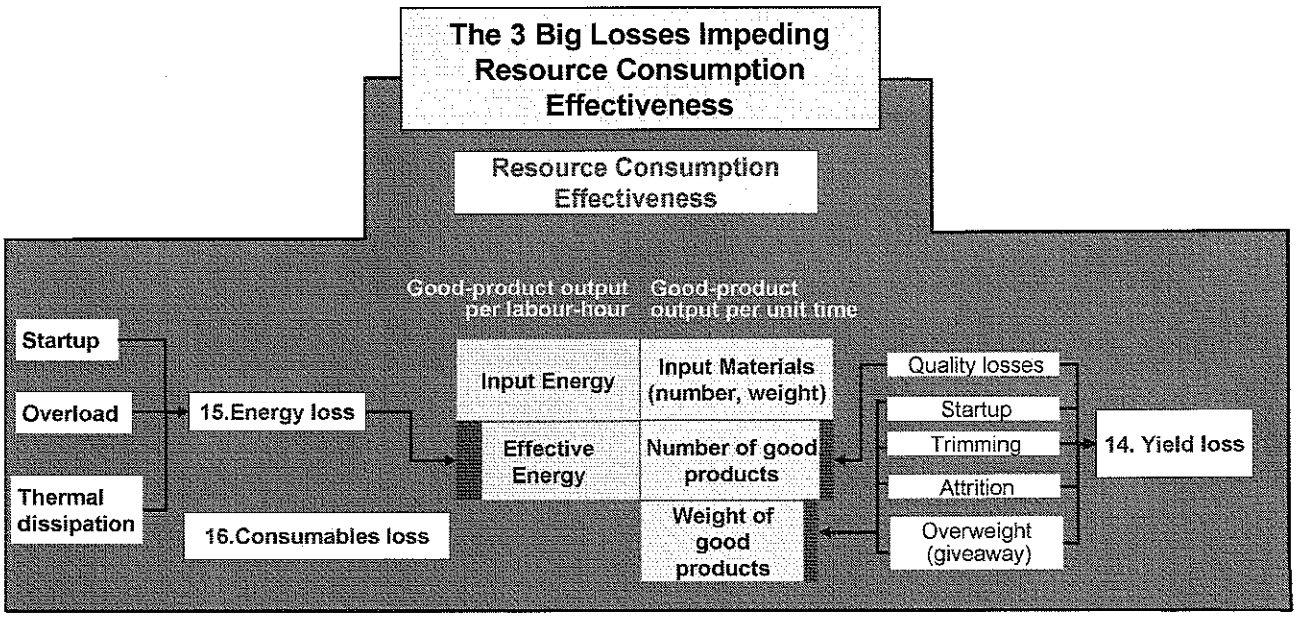
L: Performance Rate = J/I x 100 =

OPE: T x L x H = _____%

The 5 Big Losses Impeding Labour Effectiveness



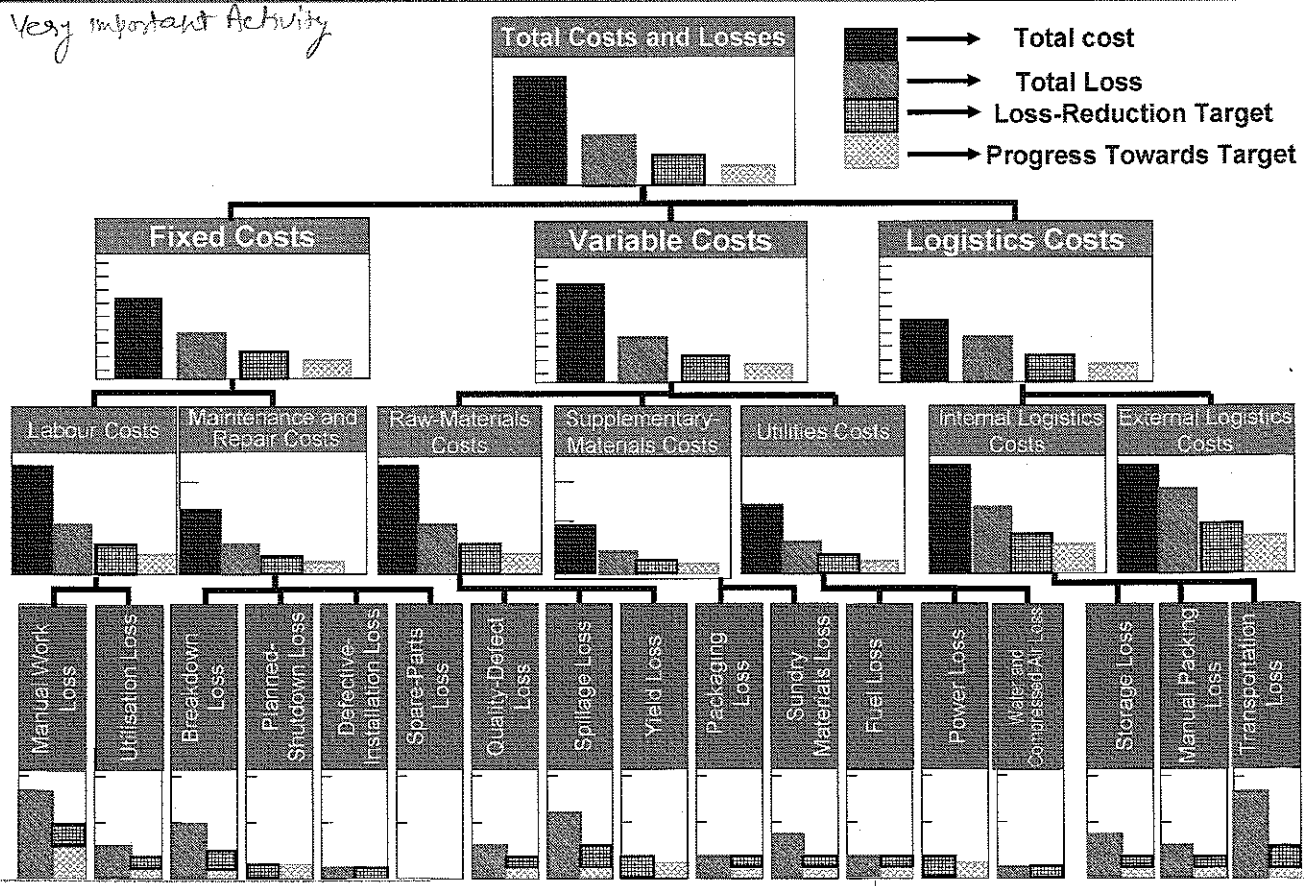
The 3 Big Losses Impeding Resource Consumption Effectiveness



A Loss-Cost Matrix (Example)

Loss Structure		Cost Structure: Total Manufacturing Costs											
		Production Costs: Fixed Costs				Production Costs: Variable Costs				General Administrative Costs			
		Raw Material Cost	Fuel Costs	Power Costs	Consumables Costs	Direct Labor Costs	Indirect Labor Costs	Die costs	Maintenance and repair costs	Interest Changes	Administrative Costs	Logistic Costs	Total Loss (Million Yen)
Equipment Effectiveness: Downtime Losses	Planned Shutdown Loss					◎							130
	Breakdown Loss					◎			○				250
	Setup and Adjustment loss	○				◎							370
	Startup Loss					◎							25
Equipment Effectiveness: Performance Losses	Minor Stops Loss			○		◎			○				30
	Speed Loss			○		◎							25
	Idling Loss			○		◎							45
Equipment Effectiveness: Quality Losses	Quality Defect Loss	◎	○	○	○	◎				○			35
	Rework Loss	◎	○	○	○	◎							15
	Replanning Loss					○	◎					○	20
Labor Effectiveness	Management Loss					○	◎			○	○	○	150
	Motion Loss					◎							95
	Line Balance Loss					◎							130
	Non-Automation Loss					◎							75
	Adjustment Loss	○	○	○		◎							85
Resource Consumption Effectiveness	Inventory Loss								○	◎	○	○	8
	Energy Loss		◎	◎									15
	Consumables Loss				◎								10
	Yield Loss	◎	○	○	○	○	○	○	○				35
												Total Loss	1548

A Loss-Cost Tree



Examples of Losses Additional to the 16 Big Losses

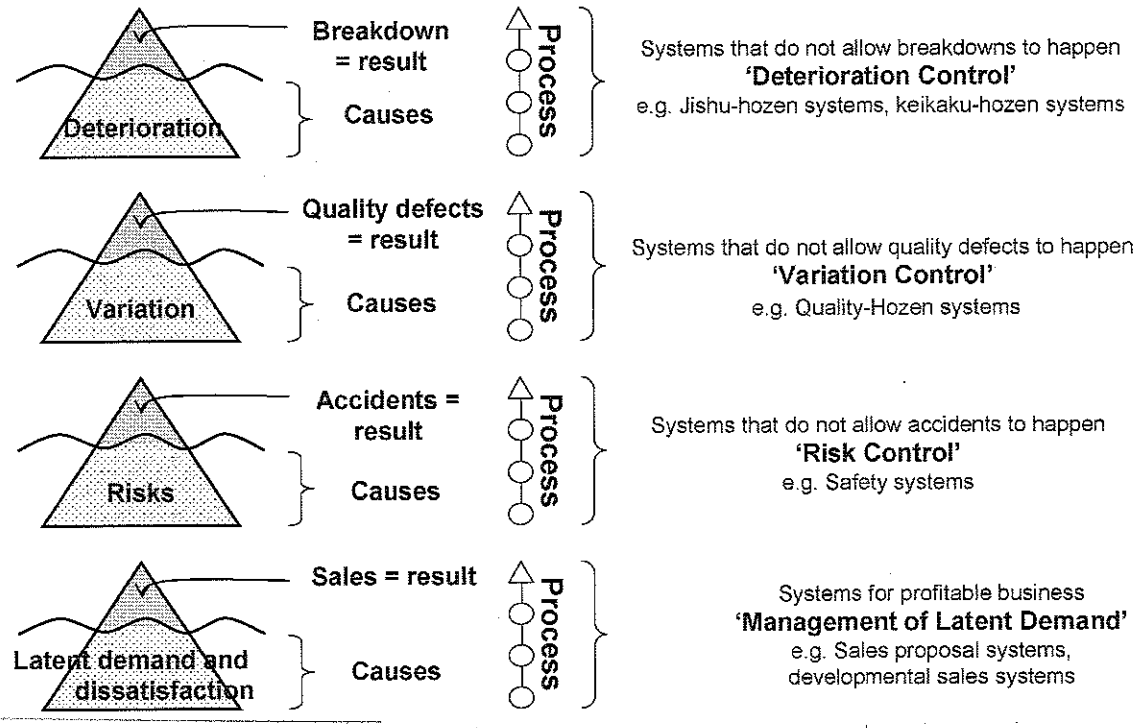
To be targeted LH SR

Type of Loss	Loss	Description
Equipment	Defectives, rework and complaints loss	Cost of dealing with scrap, rework and customer complaints.
	Management loss	Equipment downtime due to late delivery of materials and/or parts.
	Cleaning loss	Equipment downtime due to cleaning during working hours.
	No-load loss	Equipment downtime due to lack of demand.
Labour	Motion loss	Setup and adjustment time discrepancies due to skill differences.
	Labour allocation loss	Standby time losses arising when equipment or people are left idle.
	Measurement loss	Production time lost by taking measurements, performing incoming inspections, etc.
	Accident loss	Losses arising when necessary work cannot be done because of non-lost-time accidents.
Resource computation	Yield loss	Losses due to a high proportion of incoming material not being used in final product (off-cuts, for example).
	Energy loss	Wasteful use of electricity, water, and gas; leakage of compressed air, etc.
	Maintenance loss	Time and money spent on maintaining equipment because of poor design, forced deterioration, etc.
	Waste treatment loss	Costs of treating discarded paint and other forms of industrial waste.
Management	Order loss	Losses arising from lack of information relating to customer requirements and developments.
	Outsourcing loss	Additional costs due to outsourcing work that should really be done in-house.
	Investment loss	Difference between current capability of equipment and original capability when investment was made.
	Inventory loss	Cost of restoring or scrapping stocks that have deteriorated in storage.
	Logistics loss	Time wasted in restacking materials, and losses arising through forgetting to load products, having to arrange separate transport to meet delivery deadlines, etc.
	Design loss	Cost of designing unnecessarily high quality into products, prototyping jigs, etc., additional costs arising owing to insufficient process capability.
	Estimate loss	Losses due to purchasing items more expensive than originally estimated.
	Instruction loss	Costs due to mis-communication with other departments.
	Information processing loss	Losses due to transcribing information, re-doing administrative tasks, data entry errors, etc.

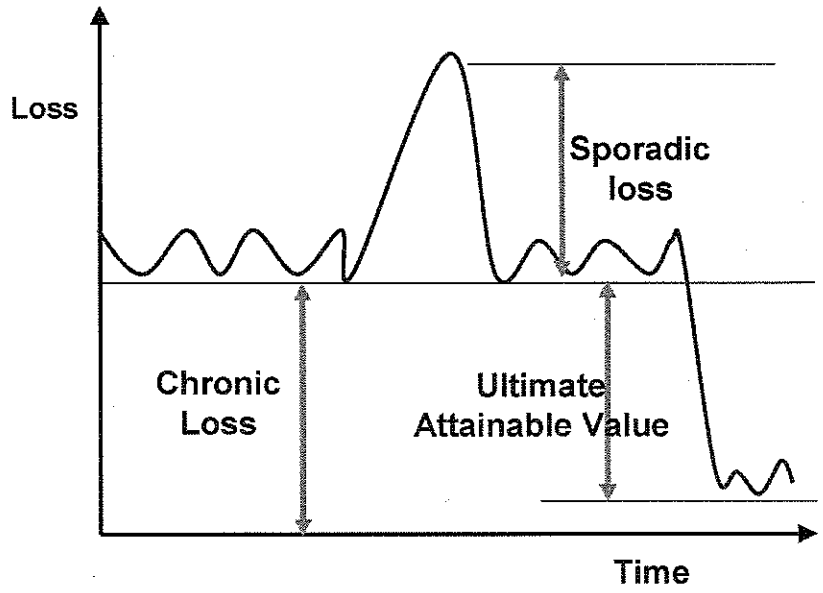
The Preventive, Zero-Focused Mindset

Working profitably = cause control + process control

(The philosophy of prevention – stop problems happening in the first place)

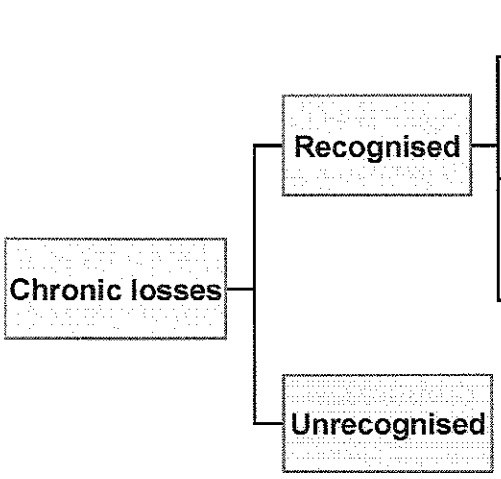


Sporadic Losses and Chronic Losses



- Requires restorative action to return to previous level
- Requires innovative action to reduce to lowest possible level

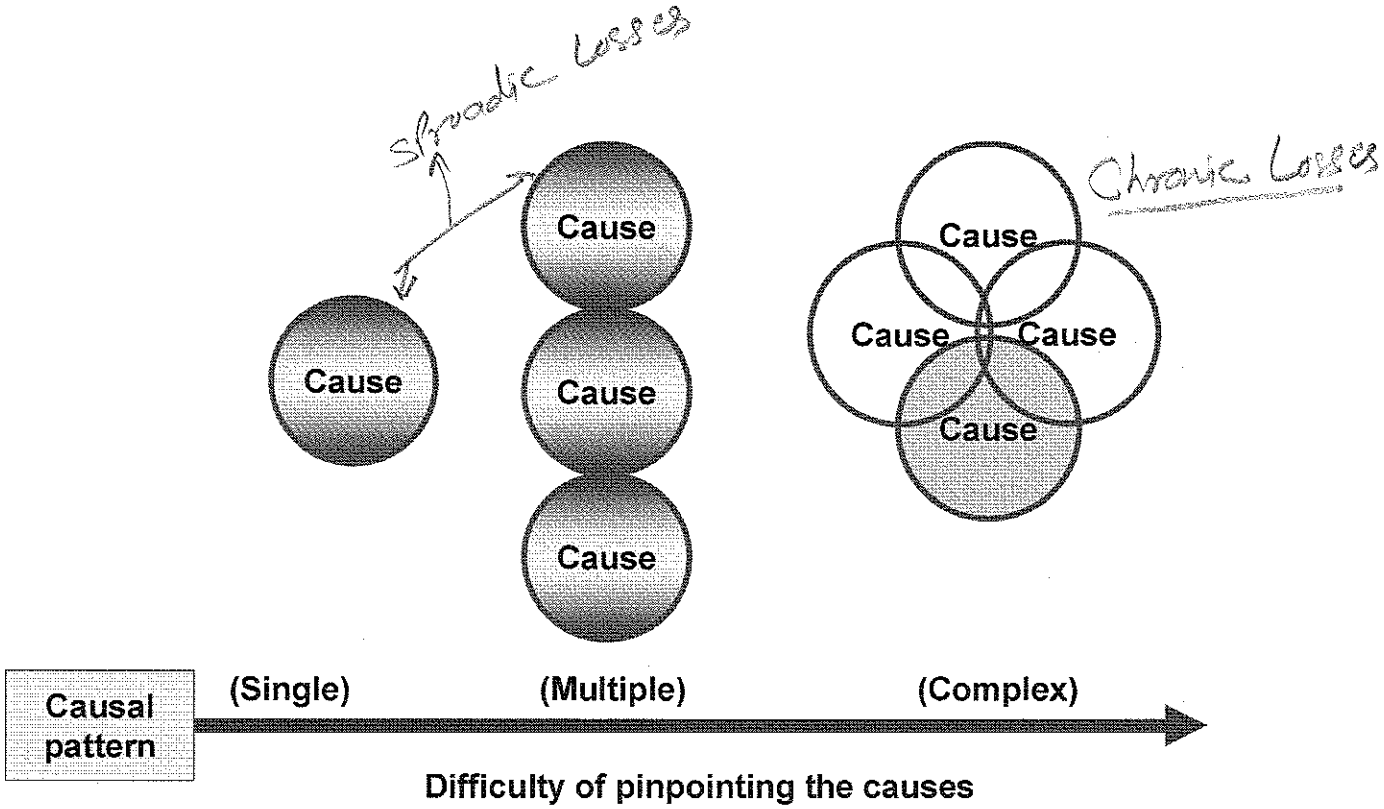
Why Chronic Losses Persist



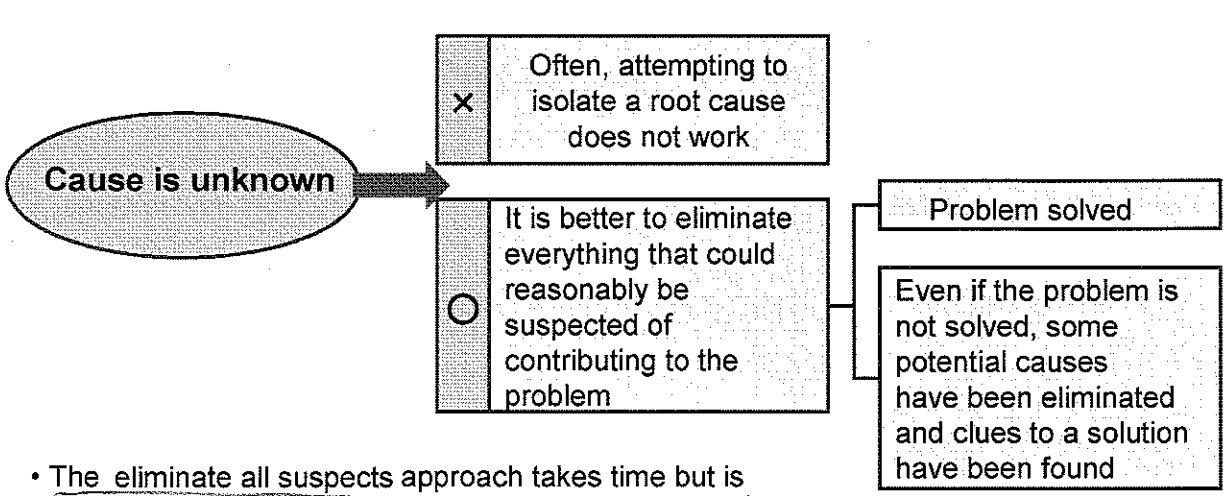
A	Action taken	•Situation shows no sign of improving •Discouragement and resignation set in
B	Action impossible	•Only stopgap measures are applied; no fundamental solutions are implemented
C	Action possible, but not taken	•Size of loss remains unrecognised because it has not been measured •Occurrence of problem is underestimated

Chronic loss is unrecognised and unnoticed (common with minor stops, speed losses, rework and startup)

The Causal Structure of Chronic Losses



Eliminating Chronic Losses



- The eliminate all suspects approach takes time but is very effective
- The hypothesis-proof approach can be quick and effective but does not work for multiple small causes

How to Tackle Chronic Losses

(1) Analyze the phenomena

(2) Review the causal system

→ Use the P-M Analysis approach

(3) Identify all deficiencies in the causal system

- To identify the deficiencies:
  - Consider optimal conditions
  - Pay close attention to minor defects
- To eliminate minor equipment defects:
  - Painstakingly restore the equipment

The Fundamentals of Equipment Efficiency

Restoration

Returning something to its original, correct state

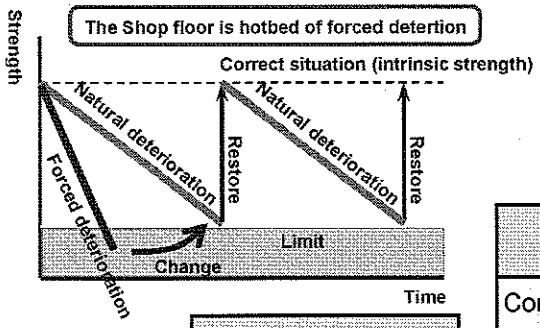
Minor Deficiency

An imperfection that cannot be further subdivided

Ideal State:

The conditions which enable the equipment to function and perform optimally at all times

Restoration



Restoration

Return to original, correct state

Correct state

Conditions required to sustain equipment functions

- What is the correct state?
- Eliminate gap between current state and correct state
- Equipment changes with time
  - Natural deterioration
  - Forced deterioration
- Detect deterioration as soon as possible

Detection methods

- Cleaning
- Standards
- Inspection method
- Measuring method
- Appropriate condition
- Prediction method

How to restore properly

- First restore, then improve
- Partial restoration is as bad as no restoration

How Major, Moderate and Minor Equipment Defects Relate to Chronic Losses

Major Equipment defects

Lead to major breakdowns if neglected

Moderate equipment defects

Cause quality defects, Minor Stops, etc.

Minor equipment defects

So small they cannot be subdivided any further commonly thought (wrongly) to have little effect on machine reliability and product quality. Include dust, dirt, scratches, deformation, etc.

(1) Tend to receive the most attention, while minor defects tend to be neglected.
(2) Focusing on these may be effective and can give quick results in the early failure period;
(3) But it will not usually eliminate chronic losses, since these are mainly due to minor equipment defects.

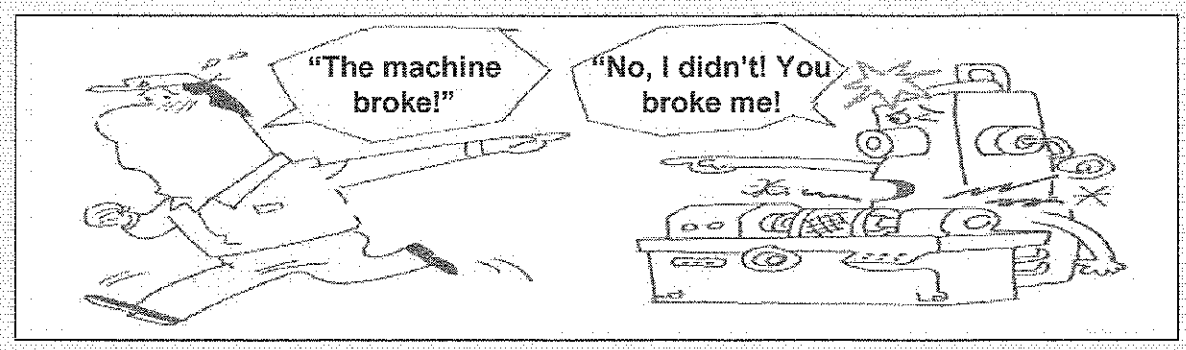
(4) It would be no exaggeration to say that chronic losses result from neglecting minor equipment defects!

The Definition and Origin of 'Failure'

Definition: 'Failure' is defined in Japanese Industrial Standard JIS Z8141-6108 as being any one of the following changes to a machine:

a. losing any of its specified functions
b. becoming unable to achieve its specified performance
c. becoming unable to produce products or actions of the specified quality

Origin: The literal meaning of the Japanese word for 'failure' is 'deliberate damage'.



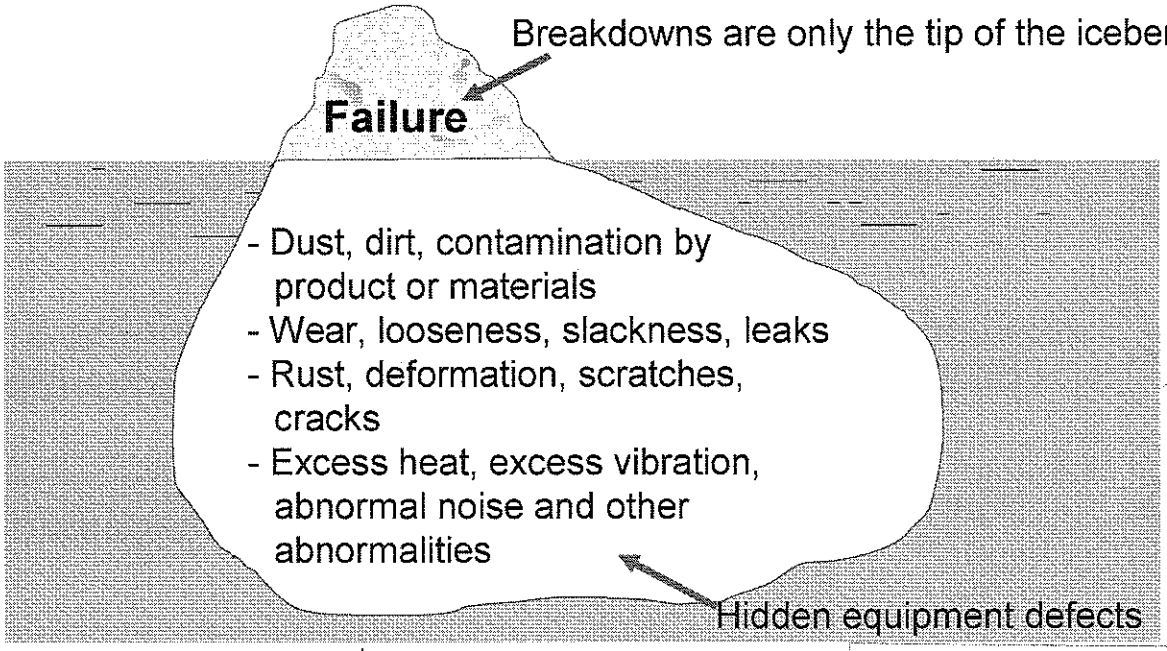
The Basic Approach to Zero Failure

- Equipment does not go wrong by itself: people make it go wrong;
- By changing the way people think and act, equipment can be made completely failure-free;
- People must stop thinking about equipment as something that goes wrong, and start thinking about themselves as agents who can stop it from going wrong, and eventually get rid of failure for good.

The Principles Behind Zero Failure

Bring hidden equipment defects to light and nip them in the bud!

(Preventing Breakdowns)



The Two Types of Hidden Equipment Defect

Physical

Equipment defects neglected because they are normally invisible:

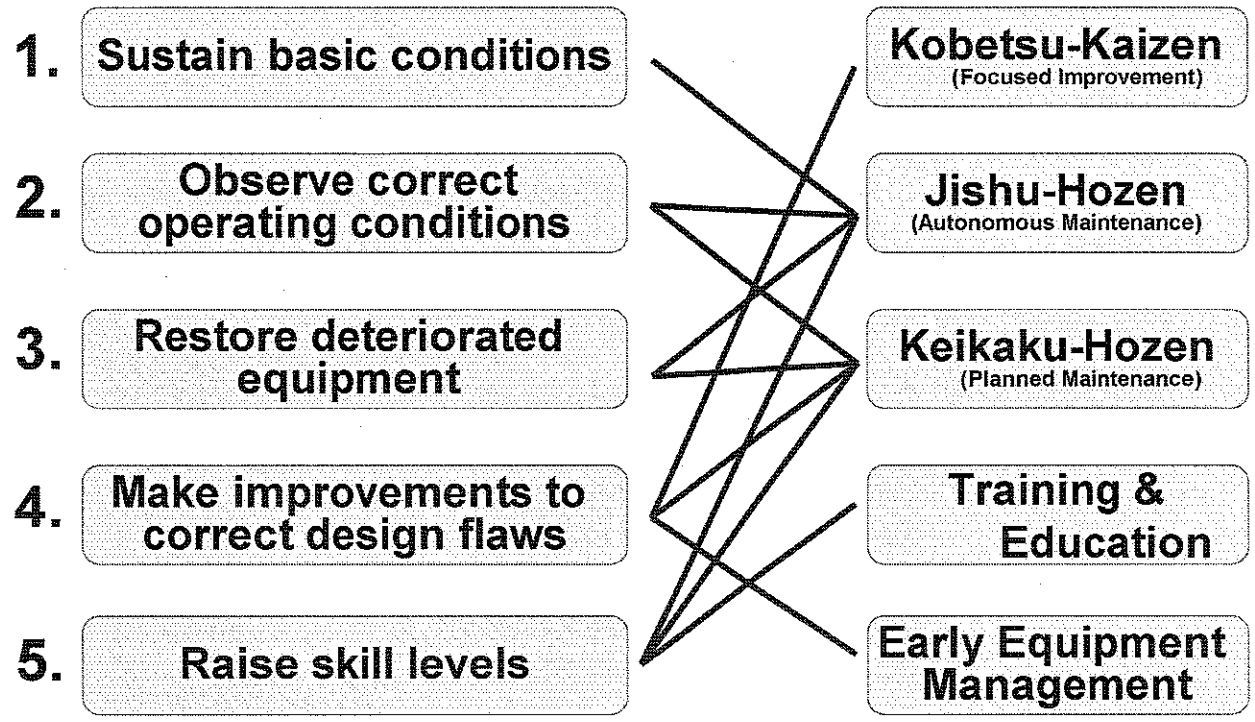
- Defects only apparent after disassembling the equipment.
- Defects normally invisible because of their position.
- Defects obscured by dust and dirt.

Psychological

Equipment defects neglected because of lack of awareness or skill on the part of the maintenance technician or operator:

- Equipment defects that pass unnoticed owing to lack of interest in finding them.
- Defects ignored through assuming they are too minor to matter.
- Defects overlooked because they are not recognised.

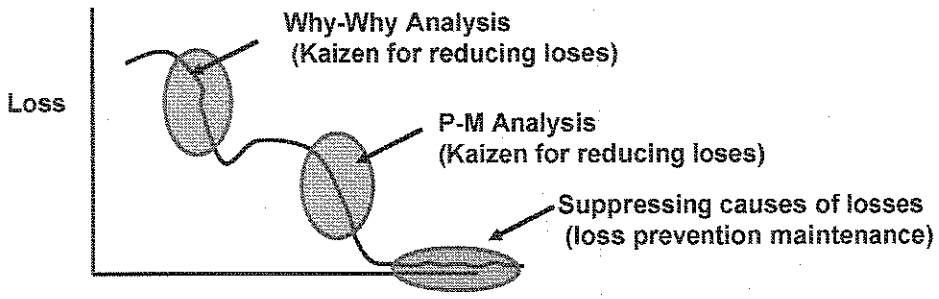
The 5 Zero-Breakdown Countermeasures

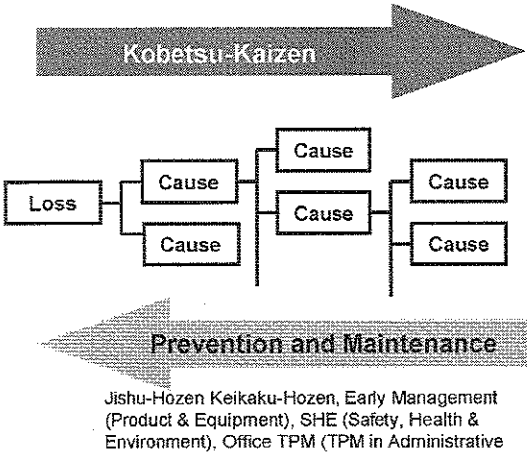


TPM Manual
Chapter 3
Kobetsu-Kaizen
(Focused Improvement)

JIPM-Solutions Co. Ltd.

How the Balance between Sustainment and Improvement (and Radical Change) Varies with Position on the Corporate Ladder

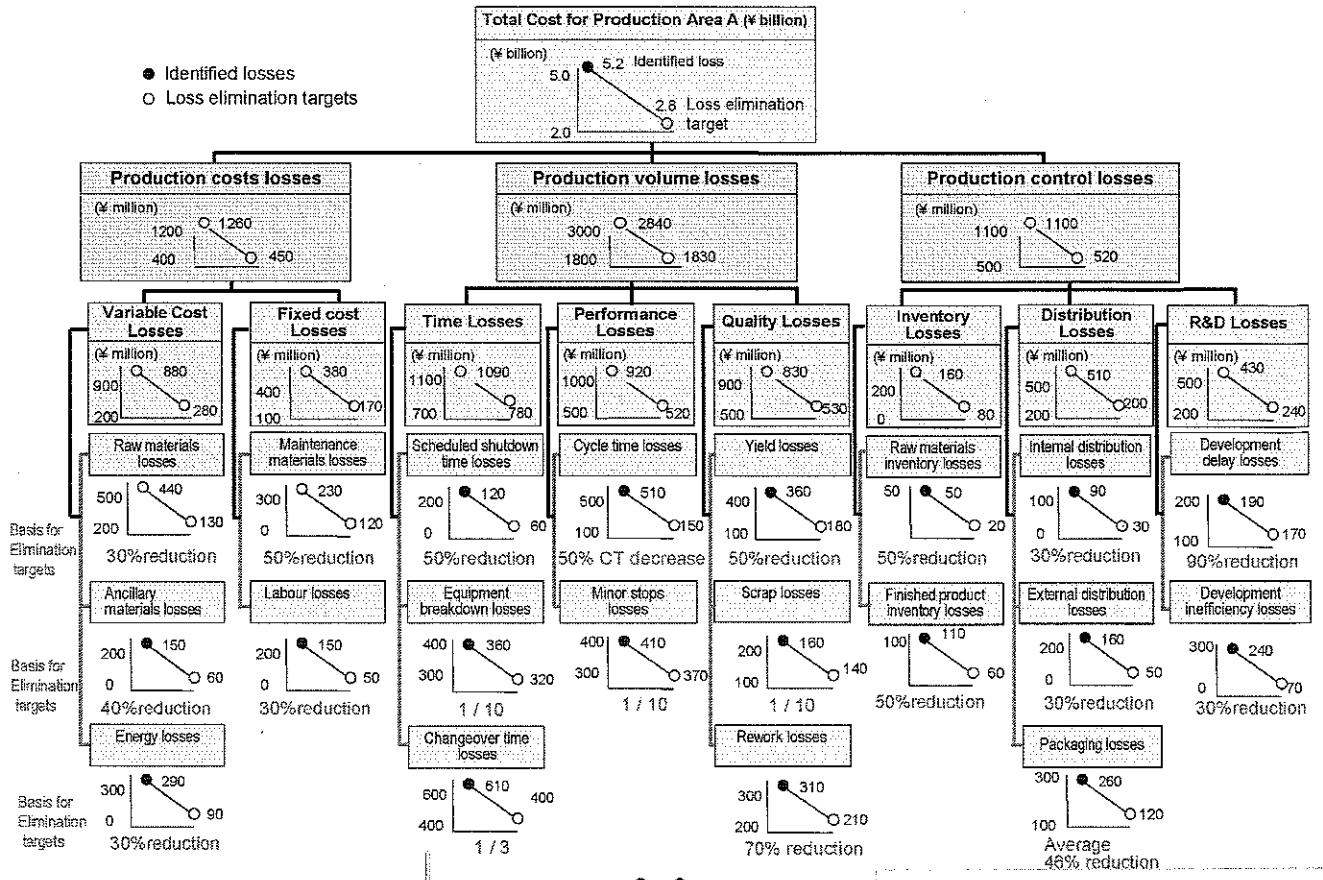




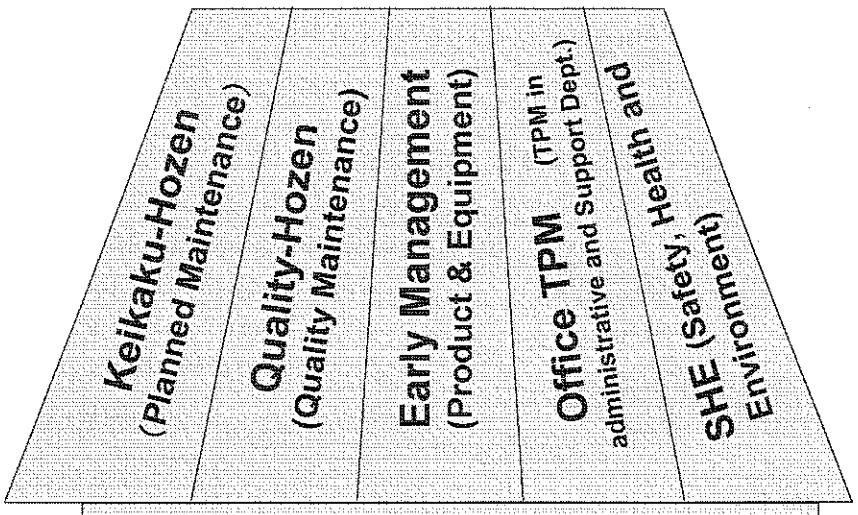
Jishu-Hozen Keikaku-Hozen, Early Management (Product & Equipment), SHE (Safety, Health & Environment), Office TPM (TPM in Administrative and Support Depts.), Quality-Hozen, Training &

Level	Type of Work
Top	Radical Change
Department or Area Manager	Improvement
Supervisor or Team Leader	Sustainment
General Employee	

A Typical Loss Tree



How Kobetsu-Kaizen Fits with the Other TPM Pillars



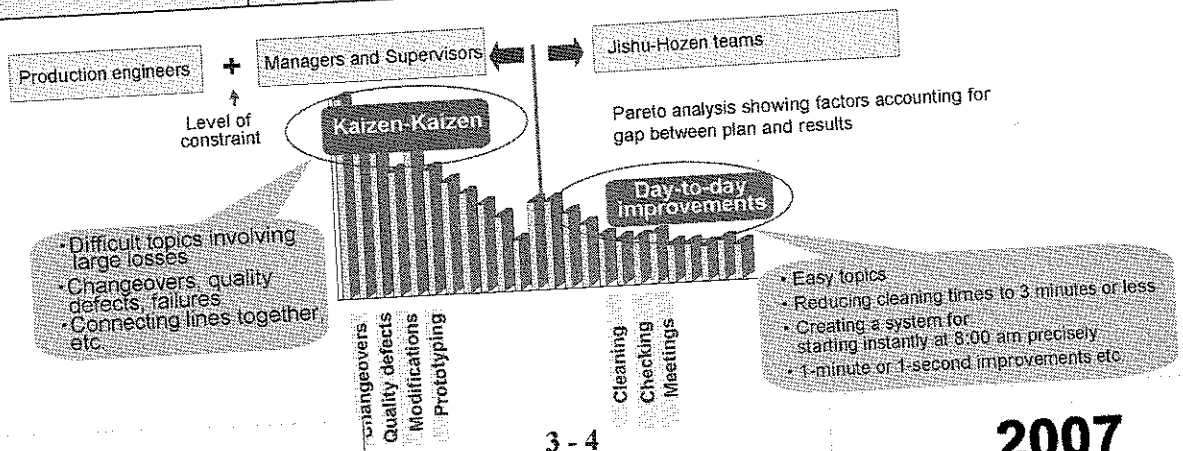
Kobetsu-Kaizen
(Focused Improvement)

Jishu-Hozen
(Autonomous Maintenance)

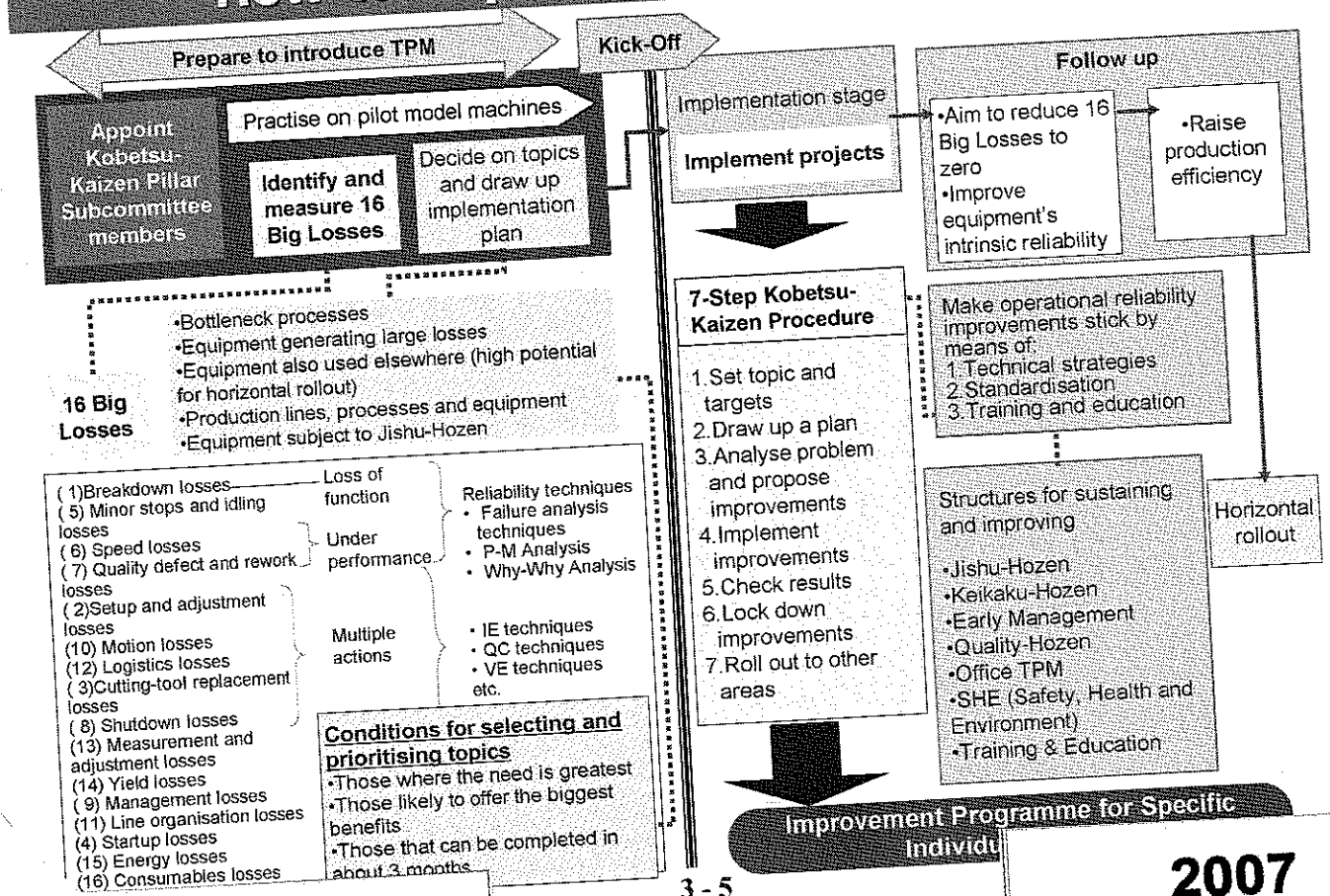
Training and Education
(in operating and maintenance skills)

Who Should Tackle What Type of Topic

People	Topics to be tackled
Department and area managers	Difficult individual topics: right-first-time rate, productivity, startup losses, speed losses
Supervisors	Moderately difficult topics: failures, quality defects, minor stops, changeover losses
Technical staff	Difficult topics requiring specialised knowledge and skills: achieving right-first-time startup, developing new manufacturing methods, prolonging the service life of cutting tools, eliminating startup losses
Special project teams	Difficult, broad-ranging topics encompassing an entire production line or work area: changing process sequences, layouts, or processing methods, or commissioning new equipment
Jishu-Hozen teams	Easy topics: failures, quality defects, minor stops, changeovers, etc.



How to Implement Kobetsu-Kaizen



A Typical Kobetsu-Kaizen Plan

Name of line, process, equipment, or job			Major topics				Medium-scale topics				Minor topics				Implementation plan				
Category	Name	Quantity	Title	Baseline value	Target	Current status	Title	Baseline value	Target	Current status	Title (type of loss)	Baseline value	Target	Current status	Person in charge	Start date	Completion date	State of progress	Attainment ratio
	XX Line	1	OEE Improvement				Improve availability				Breakdown losses	No./ mth, h/ mth							
											Setup and adjustment losses	No./day, min/day							
											Cutting-tool replacement losses	No./day, min/day							
											Startup losses	No./day, min/day							
											Other losses	No./day, min/day							
							Improve performance rate				Minor stops and idling losses	No./day, min/day							
											Speed losses	Tact time (min)							
							Improve quality rate				Quality defects and rework	Units per month, %							
			Reduce resource consumption				Improve raw materials yield				Cutting losses								
							Reduce consumption of cutting				Cutting-tool consumption loss								
							Save energy				Waste-heat loss								
			Improve labour productivity	(Units per person) (No. of people) (Units per month)			Improve OLE (Overall Labour Effectiveness)	%			Operation supervision losses	h/shift							
											Logistics losses	h/shift							
											Logistics losses	h/shift							

Take each pilot model machine or product as a separate item

Uncompleted: Red
Completed: Yellow
Target Achieved: Green

Improvement Project Selection and Registration (Example)

Improvement Project	Assembly Line A (Main Line) Breakdown Reduction	Pillar	Effective Maintenances
Type of Target	Breakdown Recurrence Prevention	Target Value	0 Breakdowns

◎ — Ahead of schedule △ — Somewhat behind schedule
○ — On schedule △ — Very behind schedule

Category	No.	Topic (work item)	Reason for stoppage	Down time (min)	Time scale (months)	Pillar Responsible	Project Leader		1	2	3	4	5	6	7	8	9	10	11	12	Progress	Remarks
Control	1	Eliminate malfunction of U-bender datum-line cylinder	Sequence input 310 from FXD die came on	19	3.5	Kaikaku-Hozen	Smith	Plan														
								Actual														
Control	2	Eliminate malfunction of filter valve for U-bender FXD die	'On' signal was applied to both sides of solenoid valve during operation	28	3.5	Kaikaku-Hozen	Smith	Plan														
								Actual														
Control	3	Eliminate mis-initiation of U-bender replacement head	On initiation, replacement head failed to return to start point	5	3.5	Kaikaku-Hozen	Hillman	Plan														
								Actual														
Control	4	Eliminate front and rear spot-welder pressurising defect	Thyristor timer (CPU board, thermal) malfunctioned	175	5	Kaikaku-Hozen	Lewis	Plan														
								Actual														
Hydraulics	5	Eliminate leakage from U-bender hydraulic system	Hydraulic fluid leaked from pressure gauge	6	3.5	Jishu-Hozen Kaikaku-Hozen	Baker Hillman	Plan														
								Actual														
Drives	6	Improve bearings in U-bender out-take rollers	Needle bearings became deformed	9	4	Kaikaku-Hozen	Lewis	Plan														
								Actual														
Drives	7	Eliminate malfunction of U-bender depth end bearings	Bearings sagged as a result of mis-installation of tool	114	3	Jishu-Hozen Kaikaku-Hozen	Baker Jones	Plan														
								Actual														
Hydraulics	8	Prevent puncturing of short-radius bender hydraulic pipework	Vibration of hose caused pinholes to form in weld	23	3	Jishu-Hozen	Smith	Plan														
								Actual														
Drives	9	Improve bearings in U-bender infeed rollers	Needle bearings became deformed	9	4	Kaikaku-Hozen	Lewis	Plan														
								Actual														
Welding	10	Improve method of fixing 13-point spot welder cooling hose	Cooling hose became detached from bracket	11	4	Jishu-Hozen Kaikaku-Hozen	Jones Smith	Plan														
								Actual														
Pneumatics	11	Eliminate malfunction of short-radius bender front stopper	Front stopper became jammed	9	4	Kaikaku-Hozen	Hillman	Plan														
								Actual														
Electrics	12	Improve motor brake circuit on short-radius bender	Magnetic contacts used for brake fused together	83	5	Kaikaku-Hozen	Smith	Plan														
								Actual														
Drives	13	Improve conveyor-shaft bracket on long-radius bender	Shaft fixing bracket broke	9	6	Jishu-Hozen Kaikaku-Hozen	Baker Hillman	Plan														
								Actual														
Drives	14	Improve U-bender servo-motor connecting pins	Product depth dimension went out of spec because connecting pin broke	10	3	Kaikaku-Hozen	Hillman	Plan														
								Actual														
Wiring	15	Prevent severing of lead to discharge pusher sensor on baseplate spot welder	Cable was tugged by cylinder until it broke	53	3	Kaikaku-Hozen	Smith	Plan														
								Actual														

Example of Chart for Monitoring Kobetsu-Kaizen

Team Leader's Name	Major Topic				Medium-scale Topics					Minor Topics								Degree of attainment	Future Plan
	Name of Equipment	Item Name	Baseline value	Result	Target	KPI	Baseline Value %	Result %	Target %	Result Improved value / Baseline value %	Loss	Baseline value	Result	Target	State of Progress: Person in charge	Schedule: Start	Schedule: Complete	Status	Target result %	
XXXX	N-Line (P-1018, P-1014) (Pilot Model)	Improve OEE %	22.0	30.4	75.0	Availability	80.1	88.7	79.7	1.11	Changeover Losses (min./changeover)	30*48	38*48	10*80	Brown	Sep	Nov	Completed	XX	
											Tool Replacement and adjustment losses (min)	0	70	0	Lee	Aug	Nov			
											Equipment breakdowns losses (min./failure)	1580	58*10	50*2	Brown		Nov	Ongoing	XX	
											Transfer losses (min)	100	55	100	Dunn	Aug	Nov			
											Other losses (min.)	0	158	0	Dunn	Sep				
		Reduce total cycle time (sec.)	9.09	8.58	2.53	Performance rate	38.7	45.7	95.3	1.24	Minor stop losses (min.)	2952	2888	147	Brown		Nov	Ongoing	XX	
											Cycle time losses (min.)	2.00	2.00	2.00			Nov			
						Quality rate	100.0	98.8	100.0	1.00	Quality defect and rework losses (no. of sheets)	20	155	0	Lee	Sep	Nov			
		Improve OLE (sheets/per son-hour) (_persons) (sheets/month)	396.0 0.8 51241	548.7 0.8 72795	1368.0 0.4 90000	Headcount reduction (person/shift)	2.0	2.0	1.5	1.00	Restock Parts feader				Brown	Apr	Mar	Ongoing	XX	
XXXX	N500T (P-1014)	Improve OEE %	29.1	36.2	60.0	Availability	30.9	91.2	91.4	1.13	Changeover losses (min./changeover)	21*20	26*20	10*40	Brown					
											Tool replacement and adjustment losses (min.)	0	0	0	Lee					
											Equipment breakdown losses (min./failure)	480	94*3	0	Brown					
											Transfer losses (min.)	55	45	0	Dunn					
											Other losses (min.)	0	95	0	Dunn					
		Reduce total cycle time (sec.)	15.45	12.41	7.50	Performance Rate	38.0	39.8	65.7	1.11	Minor stop losses (min.)	2590	5805	14.50	Brown					
											Cycle time losses (sec.)	4.50	4.50	4.50						
						Quality Rate	100.0	99.9	100.0	1.00	Quality defect and rework losses (no. of sheets)	6	44	0	Lee					
		Improve OLE (sheets/per son-hour) (_persons) (sheets/month)	15.45 0.5. 1940.	290.1 1.1 51131	460.0 0.5 37000	Headcount reduction (person/shift)	1.0	1.0	1.0	1.00										

7-Step Procedure for Kobetsu-Kaizen

	Step	Description
At the implementation stage	**Step 1** **Set topic and targets**	Decide on the improvement topics, based on an assessment of the current situation. Use zero-loss thinking to set challenging targets and time-frames. Decide who will be responsible for tackling each loss.
	Step 2 **Draw up a plan**	Draw up an action plan, showing the schedule for analysing the problems, devising and implementing the countermeasures, and so on. Have the plan reviewed by higher management.
	Step 3 **Analyse problem and propose improvements**	Use all available analyses, studies, experiments and other techniques, together with specific engineering knowledge, to formulate and evaluate improvement proposals. Work up each proposal to the point where it is virtually certain the targets will be attained. Present the proposals to senior management or others, and make any final alterations.
	Step 4 **Implement improvements**	Obtain the necessary funds. Implement the proposed improvements.
	Step 5 **Check results**	Check how far each loss has been reduced since implementing the improvements. If the benefits turn out to be insufficient, go back to Step 3 and review the situation.
	Step 6 **Lock down improvements**	Make any technical modifications required to ensure that the improvements stay locked in place. Establish the necessary operating and maintenance standards. Give operators the training required to ensure that the same problems do not recur. Carry out a senior-management review.
	Step 7 **Roll out to other areas**	Roll out the improvements to similar lines, processes and equipment. Choose the next line and start the next round of improvements.
	Note: Although each member of the project team is assigned to work on a particular loss, he or she should also help the rest of the team carry out technical analyses, reviews and improvements aimed at eradicating other losses.	

The 4 Levels of Setup and Adjustment Loss 1

	Set up and adjustment losses			
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** **(improvements, backed up by theory, are being implemented)**	**Level 4** (Losses have been minimised)
Contents	1. Everything is left up to the operators, setup and adjustment losses are completely uncontrolled. The level of losses is very high. 2. Changeover times vary widely.	1. Standard procedures have been established, and internal and external tasks have been separated. 2. The current state of changeover has been ascertained, and the need to eliminate wasted time and effort has been made clear. ·Individual actins are observed using the IE approach. ·The purpose of each action, and the function of the section of the equipment involved, are investigated. ·Non-uniform, wasteful actions, and actions involving excessive strain, are identified. Best practice has been identified and time variations are being minimised through training and practice	1. Time is being saved by externalising internal tasks. Techniques such as presetting, the use of gauge blocks and preheating have enabled some changeovers **to be shortened to single figures** (9 minutes or less) 2. Time has been saved by improving internal tasks. ·The positioning dimension-setting and installation/removal of workpeieces have been reduced to single actions. ·Tasks are now performed in parallel. Time has been saved by eliminating the need for adjustment. ·The reasons for adjustments, the procedures and techniques used, and the principles involved have been established. ·Items needing adjustment have been identified and improved.	**1. Single-minute changeovers are common.** 2. Adjustment has been eliminated, and defect-free products are now turned out form the word 'go'

The 4 Levels of Setup and Adjustment Loss 2

	Level 1	**Level 2**	**Level 3**	**Level 4**
Contents	Adjustment accounts for a high proportion of changeover losses (setup<adjustment) Documented change over procedures are not-existent or unworkable	Setup time and adjustment time are now in equal proportion (setup>>adjustment) It is now clear what needs to be done next	Adjustment time accounts for only a small proportion of change over losses (setup >= adjustment) ·Adjustment mechanisms and what to do about them are fully understood.	Changeover standards are being monitored and sustained. ·Changeover standards documents are used. ·Optimal-condition-setting sheets are used. ·Skills training is implemented.
Operating Department	Work procedures vary between individuals.	Procedures have been standardised, and tools and changeover parts are stored in handy locations.	Improvements are being made to reduce setup and adjustment times.	Frequent changeovers have reduced inventory levels. Single-minute changeovers have been achieved, and progress is being made towards 'at-a-touch' changeovers (lasting only 5 or 6 seconds).
Maintenance Department	Changeover improvement is not regarded as the maintenance department's responsibility.	Data analysis has demonstrated the need to shorten changeover times, and investigations have started.	Auxiliary setup devices are being researched and tested.	Changeover times have been reduced by standardising procedures to eliminate adjustments and introducing auxiliary setup devices.
Production Engineering Department	No thought is given to changeover when designing production equipment.	Equipment designs now take changeover into account.	Equipment is now designed for single-minute changeover. Standard techniques for reducing adjustment have been developed, and fast, frequent changeovers have been achieved	Research into automatic changeover has produced good results.

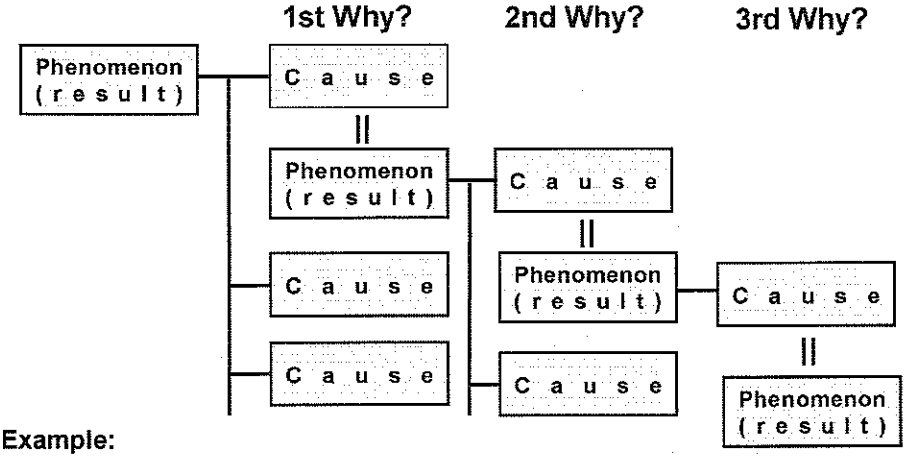
The 7 Steps to Zero Setup and Adjustment Loss 1

Step 1: Find out what is happening at present	
« Analyse the changeover documentation « Study the features of the equipment « Analyse the changeover operation itself	· Determine the mechanism, system, characteristics, pattern and scope of the changeover. · Ascertain the relationship with auxiliary equipment, and find out the mechanism, shape and precision of the dies, jigs and other parts used. · Identify the setup and adjustment methods and procedures followed (the purpose of each task, the section of the equipment involved, what is done, the parts used, the tools and equipment used, the checks carried out, the time required for each task, and the usefulness of each task).
Step 2: Set improvement targets Set targets that take into account:	
« Equipment constraints « Equipment improvements	
Step 3: Eliminate waste	
« Eliminate wasteful actions and unnecessary objects « Study preparations required « Establish standard procedures for external tasks	Ensure that: · No time is wasted looking for things unnecessarily; · No unnecessary movements are made; · Nothing is used unnecessarily; · No tools are surplus to requirements (in type or quantity); · Space is used and objects are stored in a rational and economical way; · Tools and parts are kept in defined locations; · Work procedures create no wasted time or effort.
Step 4: Separate external tasks from internal ones, and standardise the external ones	
« Identify internal tasks (tasks that can only be done when the machine is stopped) « Identify external tasks (tasks that can be carried out while the machine is still working)	· Check, pre-heat and pre-install dies, jigs and other parts. · Use gauge blocks for setting up. · Specify the methods, timings, parts and tools to be used, and train operators thoroughly.

The 7 Steps to Zero Setup and Adjustment Loss 2

Step 5: Make internal tasks more efficient	
« Establish standard procedures for internal tasks « Stabilise internal-task times « Reduce the time required for internal tasks	• Raise time-target attainment rates, and reduce time variation and quality problems. • Increase startup stability, and list problems (mechanical, human and method-related). • List necessary improvements. • Improve the way operators work (standardise methods, and review task allocation, task usefulness, simplification, making assembly easier, combining tasks, integrating tasks, eliminating tasks, carrying out tasks in parallel, assignment of personnel). • Examine dies, jigs and other parts (review tightening methods, number of tightening tools used, mechanisms and shapes, use of intermediate jigs, standardisation, interchangeability, weight, etc.). • Turn variables into constants (e.g. use fixed positioning, dimension-setting, reducing tasks to a single action, attaching and removing workpieces in a single motion, bolt-free assembly, and automatic clamping).
Step 6: Eliminate the need for adjustment, ensure right-first-time startup, and check results	
« Analyse adjustment effectiveness and eliminate unnecessary work « Make it possible for defect-free products to be produced from the word 'go'	• Study the purpose of each adjustment, and find out what is involved and why the adjustment is necessary in the first place. • Identify principles of adjustments, and look into the possibility of eliminating them. • Implement improvements (accommodate unavoidable adjustments). • Eliminate test-processing.
Step 7: Eliminate waste	
« Standardise changeover procedures and drill the actions involved	• Draw up changeover standards. • Drill the actions involved (work to the clock, or to music, etc.).

Why-Why Analysis



Analysis continues until the final cause is found (often something to do with human behaviour)

Example:

Hydraulic cylinder not working properly

Why?	Because:	Action
Why is the cylinder not working properly?	Because the holes in the strainer are clogged up.	Clean the strainer
Why did the holes in the strainer get clogged up?	Because the hydraulic fluid was dirty.	Remove the fluid and clean it.
Why was the fluid dirty?	Because dirt had got inside the tank.	Prevent cutting debris and cutting fluid from flying around.
Why did the dirt get inside the tank?	Because the tank's lid had a hole in it, and did not fit properly, leaving gaps around it.	Block the hole and make the lid fit properly, leaving no gaps.
Why did the lid have a hole in it, and not fit properly, leaving gaps around it?	Because it was not maintained properly.	Standardise and train out the repair procedure.

Format from Y-SAN. To be Jaken.

A Typical Why-Why Analysis (1)

Diagram: Why-Why Analysis Sheet for the 'First Principles' Approach

Why-Why Analysis:
Study the facts of the breakdown, quality defect, minor stop or other problem; examine the evidence while doing the analysis.

Customer		Date on which problem arose	February 14, ___	Occurrence category	First occurrence	Supervisor's comments	Item	Required?	Description	Date	Verdict								
Part name		Date of analysis	/ /		Repeat occurrence		Draw up one-point lesson	Y / N	Teach correct tightening torque, etc	March 14									
							Standardise	Y / N	Draw up new standard	March 31									
Analysis sheet						Area manager's comments	Roll out to other areas	Y / N											
Description of problem	Toothed drive belt broke (snapped)	Action	Belt replaced	Process where problem occurred			Issue MP information sheet	Y / N											
							Notes on analysing equipment problems: (1)Study structure, function, correct usage and correct procedure; (2)Continue asking 'Why?' until you trace the cause, even down as far as materials and methods.										

Description of phenomenon	Why 1	Why 2	Why 3	Why 4	Why 5	Why 6	Why 7	Why 8	Verdict	Countermeasures (to prevent recurrence)	Person responsible	Deadline	Date completed
Toothed belt became worn and damaged, ⇩ leading to faulty shaft rotation, ⇩ eventually causing belt to snap	Belt came into contact with edge of pulley	Pulley was not turning							OK				
		Pulley was not centred	Pulley slipped out of position	Pulley fixing bolts worked loose					OK				
				Bolts were loose from outset					OK	•Operators given guidance in the form of a one-point lesson7	Tegelaar	Mar. 14	Mar. 14
How phenomenon developed (sketch)			Motor leaned over	Motor fixing bolts worked loose	Bolts had not been properly tightened	Correct tightening torque was not known	Necessary training had not been provided		NG				
Got damaged ⇨ Became worn ⇨ Snapped				Bolts were loose from outset					NG	* Adjust fixing of motor	Pauwels, Tegelaar	Feb. 14	Feb. 14
			Bracket leaned over	Bracket fixing bolts worked loose					OK				
				Bolts were loose from outset					OK				
Motor, Rounding machine, Toothed belt, Chute		Belt was snaking	Belt was not tight enough	Correct tension was not known					NG				
			Toothed part was not in groove	Toothed part wore down	It was worn away by pulley groove	Foreign material was lodged in pulley groove	Nothing to stop foreign materials getting in	No cover was fitted	NG	* Make a cover, install it, and inspect and clean the equipment.	All	Mar. 7	Mar. 31

A Typical Why-Why Analysis (2)

Why-Why Analysis:
Study the facts of the breakdown, quality defect, minor stop or other problem; look at the evidence while doing the analysis.

Notes on analysing equipment problems:
(1)Study structure, function, correct usage and correct procedure;
(2)Continue asking 'Why?' until you trace the cause, even down as far as materials and methods.

Area Manager	Supervisor	Chairman of QC

Facts and figures

Line: sheet slide	Equipment Name: Measurement Process 2	Equipment serial no.		Operator	Loska
Date and time of occurrence	Dec 15, 1995 (Mon.) 19:00	Date corrected	Jan 15, 1996 (Mon.)20:00		
Production downtime:	___ hours. __ minutes	Number of quality defects arising	0	Number of items reworked	0

Description of problem	Broken electrical lead to contact switch used to detect front of workpiece	Action	Contact switch replaced	Process where problem occurred

Layout: Press-fitting of slider; Greasing; Roller assembly; Slide resistance measurement; Embossing and sealing; Measurement Process 2; Measurement Process 1; Embossing and sealing; Winding; Riveting and sealing

Occurrence category: First occurrence / Repeat occurrence

Action	Required?	Description	Person responsible	Deadline	Date completed
Draw up one-point lesson	Y/N				
Standardise	Y/N				
Error-proof	Y/N				
Do corrective maintenance	Y/N	Install fixing jig for lead	Kamler	15/1	15/1
Issue MP information sheet	Y/N	Method of fixing leads to moving pa	Kamler	17/1	17/1
Replicate to other areas	Y/N	Do on both sides	Kamler	15/1	15/1

Description of phenomenon	Item examined	Verdict	Why 1	Why 2	Why 3	Why 4	Why 5	Verdict	Countermeasures (to prevent recurrence)	Person responsible	Deadline	Date completed
The proximity switch lead gets trapped between the rail and the die during changeover, and breaks when the robot reaches its starting position.	Length of wire	OK										
	Routing of wire	NG	Lead is liable to get trapped during changeover	Lead is drooping	Connector is positioned underneath			NG	Connector repositioned on top	Magyar	25/12	25/12
What phenomenon looks like												
Measurement Process 2 Sketch: Broken electrical lead to proximity switch for detecting front of workpiece	Securing of wire	NG	Lead has not been secured, because it needs to be left free to allow changeovers	Because it has to be changed together with the jig, the wire is never secured				NG	Plug-type lead fixture installed	Okazaki	15/1	16/1
	Changeover method	OK										

Loska

Engineering Department's comments (to be completed only in the event of a breakdown): This is a minor equipment defect that has been around since the machine was originally installed. It is not an easy problem to solve, but we now know exactly how it is being caused, and will continue to work on a solution.

Department manager

Area manager's comments: This is the worst line in the factory for breaking down. Electrical breakdowns happen particularly frequently, so please draw up a Keikaku-Hozen (planned maintenance) schedule, and make some improvements to stop the problem recurring.

Supervisor's comments: Thanks for your hard work on the Why-Why Analysis. The slide assembly line is prone to frequent electrical breakdowns, so please work with the Engineering Department to improve the situation.

Reporting route: Filled out by issuing department → Checked (by Engineering Department - in the event of breakdown only) → Checked and distributed (by Admin. Office) = Issuing department (original), Engineering Department (copy)

What Is P-M Analysis?

P-M Analysis is
an approach to analysing the causes of problems which
Physically analyses
Phenomena
to understand their
Mechanisms
and identify the relationships of these mechanisms to

the 4 Ms (Men/women,
Machines,
Materials and
Methods)

P

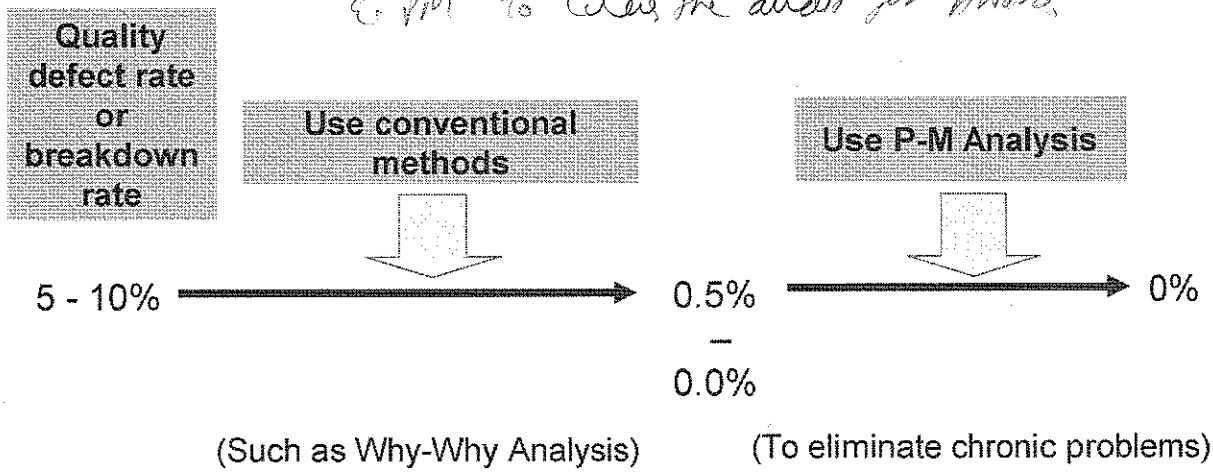
M

Analysis

The P and the M of P-M Analysis stand for all of the above (Physical, Phenomenon, Mechanisms, 4 Ms)

When to Use P-M Analysis

Require atleast 10 examples of why-why & PM to clear the audit for award



The Eight P-M Analysis Steps

1. Clarify Phenomenon	Stratify the phenomena thoroughly.
2. Do Physical Analysis of Phenomenon	•Draw diagrams of relevant mechanisms and structures. •Analyse the selected phenomenon from the physical perspective and explain it in terms of first principles.
3. Identify Contributing Conditions	Identify all the conditions which, if satisfied, would consistently give rise to the phenomenon.
4. Study 4-M Correlations	Work out the relationships with the 4 Ms required to establish the contributing conditions, and list all conceivable causes.
5. Revise Optimal Conditions (Standards)	Set standard values by which to judge whether the conditions are satisfactory or not.
6. Investigate Measurement Methods	Decide what methods will be used to examine the potential causes.
7. Identify Deficiencies	List the ways in which conditions deviate from the ideal, including slight equipment imperfections and all other issues.
8. Restore, Improve and Sustain	•Draw up proposals for addressing the deficiencies. •Decide on the best solutions and carry them out.

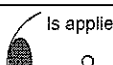
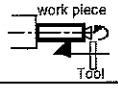
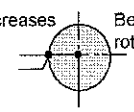
Step 1 Clarify Phenomenon

WHEN	Tendency, time, season	Continuous, intermittent, rarely, at startup, seasonally (summer, winter, rainy season), after changeover
WHO	People	Day shift, night shift, new worker, temporary worker
WHAT	Materials	Lot, die number
WHERE	Location	Section, area, process, machine
WHICH	Trend	Direction (+, -, forward, backward, left, right), increasing, decreasing
HOW	State	Precision (dynamic and static) of equipment, jigs and tools Processing conditions

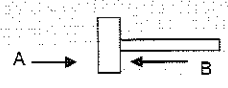
Step 2 Do Physical Analysis of Phenomenon

Understand the principles and parameters of the process, think what physical quantities might have changed, and consider on the basis of what conditions those physical quantities are established (elucidate the mechanism by which the phenomenon is produced).

Pattern 1 The physical quantity X of condition A and condition B becomes α

Phenomenon	Physical Quantity	State of Change	Condition A	Condition B
Golf ball is sliced	A rotational force	Is applied to the right 	By the movement of the head	And the movement of the club
Diameter of cylinder being machined on lathe sometimes increases 	Distance	Sometimes increases 	Between centre of rotation of cylinder	And tip of cutting tool

Pattern 2 Result A/B (phenomenon occurs as a result of the size of the action of A and B

Phenomenon	
Fishing net gets torn 	The strength of the net (A) is less than the force acting on the net (B) A < B
Piston does not reach end of stroke 	Force pushing piston (A) is less than or equal to resistance force (B) A < B 

Pattern 3 Express as a mathematical formula or chemical reaction formula

Note: There can only ever be one physical analysis per phenomenon. If there is more than one, it means that the phenomenon has not been stratified in sufficient detail.

Step 3 Identify Contributing Conditions

Based on a physical analysis of what has actually happened, identify the conditions that produce the phenomenon

Pattern 1

1 – 1 Separate the conditions A and B
The physical quantity of A becomes ○○
The physical quantity of B becomes □□

1 – 2 Separate the physical quantities
The physical quantity X between A and B becomes ○○
The physical quantity Y between A and B becomes □□
e.g. frictional resistance = μ F
coefficient of friction μ between shoe and floor becomes small
force F between shoe and floor becomes large

Pattern 2

When the phenomenon arises from the balance between A and B, separate A and B
The action of A becomes ○○
The action of B becomes □□

Pattern 3

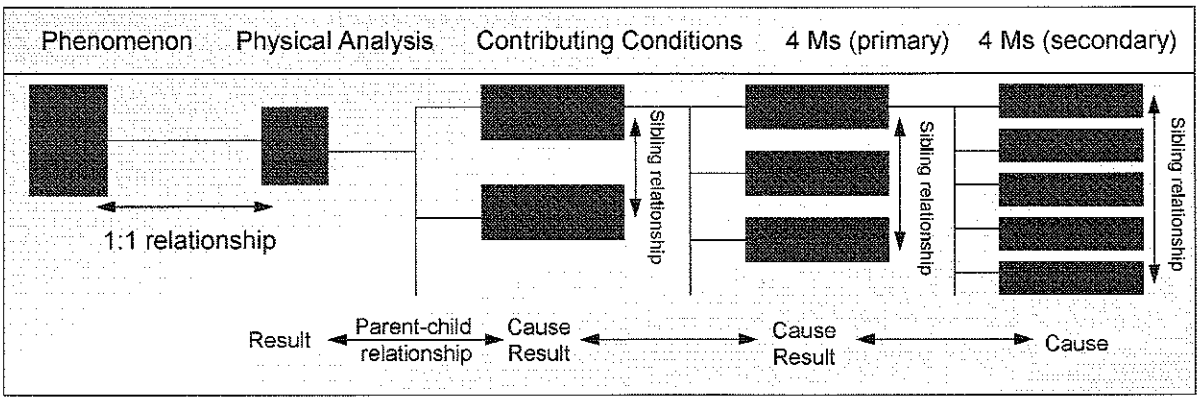
Take the formula apart

Pattern 4

Split the machine into units, and if there is a possibility of the phenomenon occurring when a unit deviates from its ideal condition, express the state of that unit. Also investigate any deficiencies in the working methods or the quality of upstream and downstream processes.

Step 4 Study 4-M Correlations

Identify everything that could logically be conceived as the elements of which each contributing condition must be composed in order for it to be established.



* Do not give any importance to the degree of contribution or effect

* When equipment, jigs or tools are involved,

start from the tip of the phenomenon (the processing point) and sequentially trace the mechanisms and structures that establish the contributing conditions back to the base that supports that point.

* List all items that can be thought of by reasoning about materials, methods and people also.

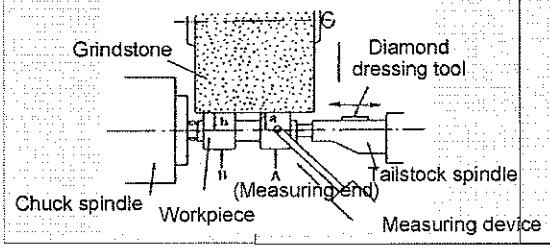
* If a listed items occurs, read whether or not conditions will really become contributing conditions to check a match.

A Typical P-M Analysis (1)

P-M Analysis Table (Example 1)

Part name	Wet-type solenoid valve spool
Equipment name	Cylindrical grinder
Quality defect item	Outer diameter discrepancy

Phenomenon	Physical analysis	Contributing Conditions	4-M Correlations (relationships with equipment, jigs, materials and methods)
At morning and noon startup, there is a large discrepancy between Diameter A (at the measuring end) and Diameter B (at the chuck end). (Diameter B starts off between 5 and 6 micrometers greater than Diameter A and decreases over time)	The axis of rotation of the workpiece is not parallel to the surface of the grindstone. (The relationship between the distances a and b from the axis of rotation of the workpiece to the surface of the grindstone at the respective ends varies according to the formula $b > a \rightarrow b \approx a$)	1. The axis of rotation of the workpiece is not parallel to the grindstone shaft.	1-1 The grindstone shaft is thermally displaced. 1-2 The workpiece spindle is thermally displaced. 1-3 The tailstock spindle is thermally displaced. 1-4 The table is thermally displaced.
		2. The surface of the grindstone is not parallel to the grindstone shaft.	2-1 The lateral movement of the table is not parallel to the grindstone shaft during dressing. 2-2 The back-and-forth movement of the grindstone stand is not perpendicular to the table. 2-3 The table is thermally displaced.



A Typical P-M Analysis (2)

P-M Analysis Table (Example 2)

Misalignment of electron beam in vacuum evaporation device

Date		
Semiconductor Manufacturing Department Production Engineering Section		
Approved	Checked	Drawn up by

Phenomenon	Physical Analysis	Contributing Conditions		Primary 4-M Correlations		Secondary 4-M Correlations	
		Item (include diagram)	Tolerance	Item (include diagram)	Tolerance	Item (include diagram)	Tolerance
Electron beam wanders away from centre of aluminium ingot (Beam consistently moves in direction of X-axis coil.)	Angle of deflection of beam changes	1. Drop in electron beam acceleration voltage	10 KV DC ±2%	1-1 Faulty high-voltage supply	10 KV DC ±2%	1-1-1 Drop in input voltage (100 V AC) 1-1-2 Drop in output voltage (10 KV DC) 1-1-3 Power-supply component damaged or deteriorated	± 5% ± 2% ———
				1-2 Defective insulation of high-voltage input terminal	1000 MΩ or over	1-2-1 High-voltage input terminal installed incorrectly 1-2-2 Metallic film on insulation of high-voltage input terminal 1-2-3 Foreign matter inside high-voltage input terminal	——— ——— ———
				1-3 Defective insulation of beam emitter	1000 MΩ or over	1-3-1 Filament distorted 1-3-2 Not enough space between beam former and filament 1-3-3 Loose screw	0.5 ± 2% mm
		2. Weak electron beam polarisation field	80 Gauss ±2%	2-1 Parts around hearth assembled wrongly	No gaps anywhere	2-1-1 Gap between hearth and hearth deck 2-1-2 Hearth deck distorted 2-1-3 Loose X-axis coil mounting screw	No gaps anywhere
				2-2 Drop in current flowing in X-axis coil	2.8A ±1%	2-2-1 Drop in magnet controller input voltage 2-2-2 Drop in magnet controller output voltage	AC200V±5% DC10V MAX
				2-3 Effective length of X-axis coil winding insufficient	———	2-3-1 Deterioration in insulation between X-axis coil wires	500 MΩ or over
				2-4 Equivalent resistance produced parallel to X-axis coil	———	2-4-1 Defective insulation of X-axis coil terminal 2-4-2 Defective insulation between X-axis coil winding and core 2-4-3 Deterioration in coating of coil wiring 2-4-4 Deterioration in insulation of coil wiring input terminal	500 MΩ or over 500 MΩ or over ——— 500 MΩ or over

Angle of deflection (C) between electron beam (A) and aluminium ingot (B) varies (D).

Typical Problem-Solving Techniques

Principal techniques and approaches \ The Improvement story (The QC Story)	1	2	3	4	5	6	7
Why-Why Analysis	▒			■			
P-M Analysis				■			
Processing-Point Analysis		▒		■	▒	▒	■
From-To Analysis				■	▒		
Motion Study		■		■			
Process Analysis	■	■					■
Operation Analysis	■	▒					
Work-Element Analysis		■		■			▒
Worker-Machine Charts	■			▒			■
Pitch Diagrams		■		▒			■
P-Q Analysis		■					
Fishbone Diagrams				■	▒		
Pareto Charts	■	▒		▒		▒	
Graphs	▒	■	■	■	▒	■	▒
Checksheets	▒	▒		▒		▒	■
Control Charts	▒	▒		■		■	■
Histograms	▒	▒		■	▒	■	▒
Scatter Diagrams		▒		■			
Estimation and Test of Hypothesis				■	▒	▒	
Design of Experiments				■	▒		
Correlation Analysis				▒	▒		
Regression Analysis				■			
Orthogonal Polynomials				▒	▒		

Principal techniques and approaches \ The Improvement story (The QC Story)	1	2	3	4	5	6	7
Binomial Probability Paper				▒	▒		
Simple Statistical Analysis				▒	▒		
Multivariate Analysis				■	▒		
Optimisation Techniques				▒	▒		
Relations Diagrams	■	▒		▒			
Tree Diagrams				■	■		
Matrix Diagrams				■	▒		
Affinity Diagrams		▒			■		
Arrow Diagrams					■		
Process Decision Program Charts					■		
Matrix Data Analysis		▒		▒	▒		
Sampling Techniques		▒		▒	▒		
Sampling Inspection		▒		▒	▒	▒	
Sensory Testing		▒		▒	▒	▒	
FTA (Fault Tree Analysis)				■	▒	▒	
FMEA (Failure Mode and Effects Analysis)		▒		▒	■	▒	
VE (Value Engineering)					▒		
OR (Operations Research)				▒	▒		
Creativity Engineering					▒		

■ Particularly useful
▒ Useful

1. Select a topic
2. Ascertain the facts and set targets
3. Draw up an activity plan
4. Analyse the problem and identity the causes
5. Work out and implement countermeasures
6. Check the results
7. Standardise, and establish controls

The 4 Levels of Breakdown Loss 1

	Breakdown Losses			
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Breakdowns occur so frequently that it is impossible to tell which are sporadic and which are chronic.	1. Sporadic breakdowns have been distinguished from chronic ones. Sporadic breakdowns have decreased slightly, but chronic ones have not.	**1. The number of breakdowns has fallen to 1/10 of the original level or less. In some cases, 3 months have passed without one, and recurring breakdowns have been eliminated.**	1. The number of breakdowns is consistently less than or equal to 1/10 of the original level.
	2. Breakdown maintenance makes up a high percentage of all maintenance carried out (breakdown maintenance > preventive maintenance).	2. The ratio of breakdown maintenance to preventive maintenance is about fifty-fifty (breakdown maintenance = predictive maintenance).	2. The level of breakdown maintenance has fallen below that of preventive maintenance (breakdown maintenance < preventive maintenance).	2. Preventive maintenance makes up a very high percentage of all maintenance carried out.
	3. Breakdown losses are high (occurring frequently and lasting a long time).	3. Breakdown losses are still high (only sporadic losses are on the downturn).	3. Breakdown losses have fallen to 1% or lower.	3. Breakdown losses are between 0.1% and zero.
	4. The Jishu-Hozen system is inadequate and feeble, and forced deterioration is evident throughout the equipment (forced deterioration > natural deterioration).	4. An Jishu-Hozen system is in place; minor irregularities in equipment are being detected and corrected; improvements are being vigorously pursued (natural deterioration > forced deterioration).	4. Jishu-Hozen is actively performed, raising the standard of daily checks and periodic checks.	4. The Jishu-Hozen system is being steadily improved. -Checks based on Jishu-Hozen standards are strictly enforced, and trends are monitored.

The 4 Levels of Breakdown Loss 2

	Breakdown Losses			
	Level 1	Level 2	Level 3	Level 4
Contents	5. The service life of parts varies widely. 6. The weak points of the equipment are not clear. 7. No equipment housekeeping standards (for cleaning, checking and lubricating) have been prepared. 8. Breakdown record sheets are inadequate or non-existent, and the true extent of the breakdown losses has not been measured.	5. The service life of parts varies less widely. 6. The weak points of the equipment have become obvious. 7. Provisional standards for cleaning, checking and lubricating have been established and are in regular use. 8. Breakdown mechanisms are being investigated, and measures to prevent recurrence are being considered. -Breakdown phenomena, locations and parts are stratified. -Why-Why Analyses are performed. -Broken parts are used to deepen everyone's understanding of the equipment's functions, its structure, and the correct way to use it. -Both mechanical and operational reasons for breakdowns are sought. 9.Corrective maintenance is being implemented.	5. The service life of parts is being estimated and maximised. 6. The maintenance department has a comprehensive maintenance calendar and implements it systematically. 7. Breakdown analysis capability has increased, and P-M Analyses and phenomenon analyses are carried out. 8. A time-based maintenance system has been established.	5. The maintenance department uses precision diagnostics to predict the remaining service life of parts. 6. Based on corrective maintenance, reliability and maintainability are factored into new equipment designs, and breakdown maintenance has been eliminated. 7. A condition-based maintenance system has been established.

The 4 Levels of Breakdown Loss 3

	Breakdown Losses			
	Level 1	Level 2	Level 3	Level 4
Operating Department	Breakdowns are blamed on the service company or manufacturer.	Equipment is operated in such a way as to avoid forced deterioration.	A sustainment system including cleaning, inspection and lubrication has been established, and is being practised.	Condition monitoring and trend monitoring are carried out using simple diagnostic tools.
Maintenance Department	Sporadic breakdowns are handled on a 'firefighting' basis. The necessary spare parts are not always in stock, leading to long periods of downtime.	Surveys are being carried out to find out the MTBFs of parts. A system for managing spare parts has been established.	Maintenance is carried out according to a schedule. Fault-prone sections of the equipment are targeted for improvement.	Precise diagnostic tools are used to measure deterioration, predict the remaining service life of parts, and plan the maintenance task.
Production Engineering Department	No thought is given to building reliability into equipment design.	MP information is being collected.	MP information is utilised.	FMEA and similar tools are used at the equipment planning and design stages to ensure reliability.

The 7 Steps to Zero Breakdown Losses 1

The 7 Steps to Zero Breakdown Losses	What the operating department must do	What the maintenance department must do
Step 1: Classify past breakdowns by:		
• Line and equipment • Section of equipment involved • Failure mode • Cause • Whether they are sudden breakdowns or recurrences • How difficult it is to prevent them (whether they can be prevented by Autonomous Maintenance)	• Find out which breakdowns are caused by the manufacturing department itself (e.g. due to operational errors), and take corrective measures (by providing training, error-proofing, etc.). • Study those breakdowns that can be handled by Autonomous Maintenance (decide which sections of the equipment should be inspected, and plan and prepare training in the skills needed).	• Search maintenance records to identify recurring breakdowns. • Devise permanent solutions for problems that have until now only been tackled on a stopgap basis (i.e. breakdowns whose causes are known, but which have not yet been addressed owing to lack of time, expertise or other resources).
Step 2: Analyse breakdowns and perform General Inspection		
• Re-analyse recurrent breakdowns • Do an in-depth analysis of new breakdowns	• Analyse breakdowns on the understanding that they are 'our own problem'. • Do Why-Why Analysis. • Inspect similar equipment and similar sections of the same equipment, and rectify any minor equipment defects.	• Carry out in-depth analyses and provide thorough training. • Check for repair errors and address any that are found (by providing training and practice in maintenance skills).
Step 3: Eliminate forced deterioration and reverse neglected deterioration		
	• Detect and rectify minor equipment defects in the course of cleaning. • Establish and sustain basic conditions. • Learn and uphold correct operating conditions.	• Rectify minor equipment defects and provide training and guidance in the same for operators. • Establish correct operating conditions and train operators to observe them. • Eliminate forced deterioration in out-of-sight areas of the equipment.

The 7 Steps to Zero Breakdown Losses 2

Step 4: Study and correct weaknesses (corrective maintenance)		
	• Carry out improvements that make it easier to sustain basic conditions (address sources of contamination and hard-to-access areas). • Implement visual controls. • Perform general equipment inspections.	• Identify and rectify equipment weaknesses. • Consider measures to prolong the service life of the equipment. • Improve equipment mechanisms.
Step 5: Sort out existing standards and draw up new ones (including those designed to prevent quality failures)		
	• Formulate Autonomous Maintenance standards. • Carry out checklist-based inspections, and reverse deterioration.	• Draw up periodic inspection standards. • Ascertain the service life of each item of equipment and each component. • Ascertain deterioration patterns (whether the failure rate is increasing, constant or decreasing). • Clarify the relationships between the equipment's precision and the product's quality characteristics.
Step 6: Make maintenance more efficient		
	• Raise the level of visual management.	• Improve maintainability. • Raise the efficiency of maintenance investigations, preparation, procedures, etc. • Improve the management of spares. • Sort and store drawings better.
Step 7: Introduce predictive maintenance		
	• Use simple diagnostic tools to monitor conditions and trends.	• Use precise diagnostic equipment to measure deterioration and predict remaining service life.

The 4 Levels of Cutting-Tool Replacement Loss 1

Cutting-Tool Replacement Losses				
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Replacement locations and frequencies vary widely. • The magnitude of the losses has not been noticed.	1. The variation in the service life of cutting tools has been recognised, and the problems are being addressed.	**1. There is little variation in cutting tool service life.**	1. Cutting-tool service life has been maximised, and the improvements are being systematically sustained, **making unattended operation possible.**
	2. The situation is totally uncontrolled, and everything is left up to the operators. There are no standards or set procedures for changing cutting tools.	2. he facts about cutting-tool service life are investigated, with a focus on: • Determining how service life relates to tool usage, amount of wear, and surface precision. • Finding out how often tools get chipped or broken. Clarifying the current replacement standards.	2. Machining theory is being used to help find solutions to the problems identified in the studies described in the previous column. The benefits are measured, with a special focus on: • Determining cutting tool service life by experiment. • Establishing the relationships between the number of times a tool has been used, the amount of wear, and the surface precision. • Finding out the situation regarding chipping and breakage. Extending tool service life by measuring vibration levels.	2. Cutting tools can now be changed in a matter of seconds, and good-quality product is produced right from the start.
	3. The need to make dimensional adjustments after replacing cutting tools is taken for granted.	3. Cutting-tool replacement times have been quantified. 4. Tools are now pre-set.	3. Ways of making it easier to replace cutting tools are being explored and implemented.	

The 4 Levels of Cutting-Tool Replacement Loss 2

Cutting-Tool Replacement Losses				
	Level 1	**Level 2**	**Level 3**	**Level 4**
Contents		5. Current machining conditions and the precision of equipment and jigs are being studied, with a particular focus on: • Cutting speeds, materials, coolants, etc. • Dynamic rigidity and fixing methods of tool holders. • Static and dynamic precision. 6. Problems have been identified in the categories of technology and management technique. • Cutting tool configurations, and coolant types and delivery methods, are studied. • Vibration analysis is used, and the role of load current is studied.		
Operating Department	Operators only change cutting tools when these become blunt.	Cutting conditions (and cutting tools) are being updated.	Vibration measurement and other research is in progress. • The roughness of cutting surfaces can be monitored.	Optimisation of cutting conditions is studied.
Production Engineering Department	Off-the-shelf tools are used as they are.	Ways of monitoring tools and lengthening their useful life are being studied.	Optimal tool materials and shapes are being researched. • Causes of blade-tip deterioration can be identified, and appropriate adjustments made.	Cutting tool service life has been maximised, and automatic replacement is being researched. • Causes of blade-tip deterioration have been eliminated.

The 7 Steps to Zero Cutting-Tool Replacement Losses 1

Step 1 Find out what is happening at present

Ascertain:

- ★ Current standards for changing cutting tools, and variation in the same
- ★ The amount of wear on cutting tools (the relationship between the number of times a cutting tool is used, and the amount of wear it sustains)
- ★ Whether cutting tools chip or break, and, if so, how frequently
- ★ Cutting-tool fitting methods and holder precision
- ★ The relationship between the amount of wear on the cutting tool, and the surface roughness

Step 2 Study the current cutting conditions

- ★ Study cutting speeds (initial cutting speeds and feed speeds)
- ★ Compare cutting standards with what actually happens at present
- ★ Examine cutting tools, their shapes, and the cutting debris (chips) produced
- ★ Examine the shape of chip breakers

Step 3 Study the precision of tool holders, etc.

- ★ Examine securing methods (tightening torque, flushness of contact surfaces)
- ★ Examine dynamic and static precision
- ★ Examine dynamic rigidity of arbour holders

Step 4 Technical Analysis 1 (general)

- ★ Review cutting-tool materials and shapes
- ★ Review coolant delivery methods and purification systems
- ★ Examine chip breakers
- ★ Revise process sequences
- ★ Review cutting conditions (experimentally)

The 7 Steps to Zero Cutting-Tool Replacement Losses 2

Step 5 Technical Analysis 2 (vibration measurement)

- ★ Examine raw waveforms
- ★ Analyse frequencies
- ★ Examine vibration of surrounding equipment
- ★ Calculate rotation frequencies and find peak values
- ★ Study other rotating sections of the equipment (motors, gears and their frequencies and peak values)
- ★ Check how the vibration characteristics change with the cutting conditions
- ★ Measure the equipment's natural vibration frequency
- ★ Study the rotation frequency and natural vibration frequency of the current cutting conditions, and check for resonance with other rotating parts
- ★ Identify the cutting conditions at which vibration is lowest

Step 6 Technical Analysis 3 (electric current)

- ★ Study motor ratings and loads
- ★ Identify the relationship between the number of times the cutting tool is used and the increase in electric current
- ★ Identify the relationship between the number of times the cutting tool is used and the effective power

Step 7 Implement countermeasures

- ★ Determine service life experimentally
- ★ Find out whether chipping is present
- ★ Identify the relationship between the number of times the cutting tool is used and the amount of wear and surface roughness
- ★ Check the correlation between vibration levels and quality characteristics

The Four Levels of Startup Loss 1

	Startup Losses			
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Startup is totally reliant on operators' experience and intuition. Workpiece dimensions vary considerably after starting up; corrections and adjustments are made, but not in accordance with any set procedure.	1. The facts about startup have been ascertained. These include: · Dimensional variation in workpieces. · Time taken until cycle time stabilises. · Number of dimensional adjustments and corrections made. · Amount of quality defects and rework. · Cp value.	1. Startup losses have been stratified, the mechanisms producing them have been elucidated, and action has been taken to eliminate them.	1. Automatic correction has been programmed in, eliminating the need for manual adjustment. Defect-free products are now produced immediately following startup.
	2. It takes some time for the cycle time to stabilise. · The equipment is idled, but there are no standards specifying for how long.	2. Startup times have been reduced.	2. Standard idling times required for stabilising thermal displacement have been established, and are adhered to.	2. Improvements designed to minimise thermal displacement have been implemented, and all startups can now be accomplished in under 10 minutes.
		3. The amount of thermal displacement is being measured. · Techniques for measuring parts of the equipment subject to thermal displacement have been researched and are used. · Temperature fluctuations, supply pressures and cleanliness of hydraulic fluids and lubricating oils are measured.	**3. The degree of thermal displacement in relevant parts of the equipment is being measured, and adjusting mechanisms have been built in.**	

The Four Levels of Startup Loss 2

	Startup Losses			
	Level 1	**Level 2**	**Level 3**	**Level 4**
		4. Corresponding sections of related equipment are being examined, with a focus on: • Components and their materials. • Lubrication systems. • Precision of parts.	4. Hydraulic systems and lubrication systems are being studied, and are maintained in their ideal condition.	
Operating Department	Operators simply warm up the machines.	Operators adjust and correct workpiece processing dimensions. • Hydraulic fluids and lubricating oils are properly controlled.	Hydraulic fluids and valves have been improved.	Operators are monitoring and sustaining the situation.
Maintenance Department	Everything is left up to the operators.	Adjustment mechanisms, and systems for heating and cooling hydraulic fluids and lubricating oils have been improved.	Improvements designed to stabilise thermal displacement have been carried out.	The machines are carefully maintained to minimise precision variation.
Production Engineering Department	Everything is left up to operators.	The facts regarding thermal displacement have been studied.	Mechanisms for stabilising fluid temperatures and counteracting thermal displacement are incorporated into new equipment designs.	The use of automatic compensation mechanisms and software in new designs is being studied.

The 7 Steps to Zero Startup Losses 1

Step 1 Find out what is happening at present (gather time-series data on startups)

In particular, examine:
- ★ Variations in workpiece dimensions
- ★ Times taken for cycle time to stabilise
- ★ Idling times
- ★ How often and by how much dimensions need to be adjusted and corrected
- ★ Whether or not tools are damaged
- ★ Cp values

Step 2 Set improvement targets

Set targets that take account of:
- ★ Equipment constraints
- ★ Equipment improvements

Step 3 Investigate hydraulic fluids and lubricating oils

In particular, examine:
- ★ Types used
- ★ Delivery pressures and temperatures of lubricating oils
- ★ Contamination
- ★ Relationships between fluid temperatures and cycle times

Step 4 Scrutinise relevant sections of the equipment

In particular, examine:
- ★ Components and what they are made of
- ★ Lubrication systems (for sliding surfaces)
- ★ Precision of parts

The 7 Steps to Zero Startup Losses 2

Step 5 Find out which parts of the equipment are affected by thermal displacement, and measure the amounts

- ★ Identify which sections of the equipment are affected
- ★ Set dial gauges on machines when they are shut down at the end of the day, and check the dimensional variations when they are started up in the morning
- ★ Investigate measurement methods (find out what types of sensor can be attached to the machines, and where they should be attached)
- ★ Plot thermal displacement curves

Step 6 Implement improvements and check the results

- ★ Establish standard idling times commensurate with stabilisation of thermal displacement
- ★ Programme in automatic correction
- ★ Restore the equipment to peak condition
- ★ Use trial and error to find the best lubrication pressures and temperatures, and the best types and viscosities of hydraulic fluid
- ★ Introduce better methods of minimising thermal displacement

Step 7 Standardise and sustain

- ★ Establish startup standards
- ★ Drill operating procedures
- ★ Provide measuring instruments and teach operators how to use them

The Four Levels of Loss Due to Minor Stops and Idling 1

Losses Due to Minor Stops and Idling				
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Everything is left to the discretion of the operators, and nobody knows how serious the minor-stop losses are.	1. Minor stops are quantified, with a focus on: • Where the problems arise, and how frequently. • The extent of the losses.	1. Phenomena are stratified and physically analysed. • The mechanisms by which the phenomena arise are elucidated. • P-M Analysis is used to track down root causes.	**1. Minor stops have been eliminated, making unattended operation possible.**
	2. Losses due to minor stops and idling have not been identified. • The location and frequency of the minor stops vary widely, and nothing has been done to collect data on them and put it in order.	2. Minor equipment defects are detected, corrected, and targeted for improvement.	2. Minor-stop problems are itemised and targeted for countermeasures, with positive results.	2. Jishu-Hozen is now in full-scale operation.
	3. Problems are dealt with by 'crisis management', and minor equipment defects are ignored.	3. The benefits of the measures described above have been demonstrated.	3. The minor-stop MTBF has increased to the point where **the equipment can be left to operate on its own during breaks.**	3. Design weaknesses have been subjected to improvement, with confirmed benefits, especially regarding: • Mechanisms, systems, (including detection), materials, etc. • Standardisation of inspections, and regular housekeeping.

The Four Levels of Loss Due to Minor Stops and Idling 2

Startup Losses				
	Level 1	**Level 2**	**Level 3**	**Level 4**
			4. Optimal conditions are being studied, with a focus on: • Ascertaining and reviewing current conditions. • Specifying optimal installation conditions, processing conditions and operating conditions.	
Operating Department	Being able to restart the equipment after a minor stop is regarded as a desirable skill.	Minor stop data is now being collected.	Improvements based on P-M Analysis are being implemented.	The situation is being systematically sustained.
Maintenance Department	Unlike breakdowns, minor stops are not seen as a problem, and are regarded as the operators' responsibility.	Minor stops and breakdowns are treated as equally important.	Jigs, tools, units and parts are being optimised.	Design weaknesses are being studied and subjected to improvement.
Production Engineering Department		Design conditions preventing minor stops have been ascertained.	Conditions preventing minor stops are designed-in as standard.	Standards are drilled and used properly.

The 7 Steps to Zero Minor Stops and Idling Losses 1

• Step 1 Find out what is happening at present	
★ Examine the phenomena and determine the facts	In particular, find out: • Where on the equipment each phenomenon occurs; • How many times each phenomenon has occurred; • How often each phenomenon occurs; • On which products each phenomenon occurs; • When each phenomenon occurs; • What exactly happens (including what happens in the software).
Step 2 Analyse the phenomena	
★ Stratify the phenomena ★ Carry out P-M Analysis ★ List all the minor equipment defects that could be contributing to each phenomenon	
Step 3 Identify and reverse minor equipment defects, and carry out improvements	
★ Clean and check more thoroughly ★ Tag and detag	• Tag the affected section of the equipment each time a phenomenon occurs. • Check the situation during Autonomous Maintenance sessions.
Step 4 Check the results	
★ Check the benefits ★ Modify the Autonomous Maintenance standards in the light of the results ★ List the topics that need to be addressed in order to eliminate the minor stops	

The 7 Steps to Zero Minor Stops and Idling Losses 2

• Step 5 Identify optimal conditions	
★ Compare actual conditions with design conditions ★ Improve inherently weak areas of the equipment	**In particular, consider:** • Timings; • Mounting angles; • Vacuum pressures. • Vibration; • Acceleration and deceleration timing; • Sensor responsiveness; • Sensor mounting; • Chute shapes; • Coolant condition; • Air blowers; • Positioning mechanisms; • Clearances; • Component precision; • Assembly precision; • Cutting debris and its disposal.
Step 6 Extend MTBF	
Carry out improvements on: ★ Short-lived units and components ★ Areas that tend to get dirty (devise ways of eliminating the need for cleaning)	
Step 7 Aim for completely unattended operation (with zero minor stops)	
★ Eliminate minor stops	• Make variables constant. • Predict changes. • Enable the equipment to reverse changes automatically.

The Four Levels of Speed Loss 1

	Speed Losses			
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Equipment specifications are unclear.	1. Tentative speed standards have been set for each product, and are sustained. • Problems that arose in the past when speeds were increased have been identified and categorised. • Minor stops, quality defects, Cp values etc. are being looked at.	**1. Speed losses have been greatly reduced.** • Mechanical and quality problems have been subjected to improvement, and results and remaining problems have been identified.	Improvements to the equipment have enabled it to operate at or above the speeds originally specified.
	2. No product-specific or machine-specific speed standards have been set.	2. Speed variations have been reduced, and speed-loss-related problems have been identified. • Mechanical problems have been identified. • Quality problems have been identified. • Strategies for reducing speed losses have been implemented and have given some benefits.	2. Provisional product-specific speed standards have been set and are sustained.	2. Definitive product-specific speed standards have been set and are sustained.
	3. Speed losses are considerable, but have not been identified.	3. Improvements to shorten cycle times have been formulated. • 'Air-cutting' distances have been reduced. • Time charts are used.	3. Discrepancies between machine cycle times and actual times for each product and process have been identified. • Relationships between product quality characteristics and the precision of each section of the equipment have been assessed, and improvements are in hand.	3. Outstanding problems have been resolved using P-M Analysis, and speed losses have been eliminated.

The Four Levels of Speed Loss 2

	Speed Losses			
	Level 1	**Level 2**	**Level 3**	**Level 4**
	4. The balance between the capabilities of the various processes has not been ascertained. This needs to be done by: • Comparing process cycle times with each other; • Comparing design and actual cycle times for each process; 5. Identifying the bottleneck machines and units within the production line.		4. Strategies for prolonging the service life of parts are being looked into. • This includes measuring the static and dynamic precision of the processing equipment and associated jigs.	
Operating Department	Operators alter the cutting conditions at will.	Improvements designed to reduce waste (air-cutting, etc.) are being implemented.	Cutting conditions are being improved.	Speed losses are being minimised through techniques such as vibration measurement.
Maintenance Department			Theoretical cycle times are being modified to match the equipment's improved performance.	
Production Engineering Department	Cutting conditions are specified according to manufacturers' catalogues.	Machines are 'stress-tested' to determine the maximum speeds they can handle.	The possibility of using compound cutting tools and parallel operation is being examined.	Ways of modernising the equipment are being looked into.

The 7 Steps to Zero Speed Losses 1

Step 1 Ascertain the capacity balance for each process

- ★ Compare the cycle times of the processes within the production line
- ★ Compare the cycle times taking the 7 Big Losses into account (the 'own-responsibility processing intensity times' – see below)
- ★ Clarify the bottleneck processes in the production line.

'own-responsibility processing intensity time' = $\frac{\text{Standard cycle time}}{\text{OEE}}$

Step 2 Plot cycle charts by measuring the actual cycle times

- ★ Measure the cycle time for each operation performed by each equipment unit
- ★ Measure the cycle times for fast feeds and slow feeds
- ★ Plot cycle charts
- ★ Compare these cycle charts with theoretical ones and those produced when the equipment was designed

Step 3 Identify problems that arose when the speed was increased on past occasions

- ★ Identify the problems that arose when equipment was speeded up in the past (minor stops, quality defects, Cp values, cutting-tool service life, vibration, etc.).
- ★ Find out what action was taken and what the results were.

The 7 Steps to Zero Speed Losses 2

Step 4 Shorten cycle times

- ★ Consider ways of reducing idling time
- ★ Reduce air-cutting time
- ★ Increase movement effectiveness
- ★ Speed up pace of movement and implement parallel motion
- ★ Investigate the possibility of using compound tools
- ★ Examine the possibility of using a visicorder (oscillograph recorder) to measure work volumes and reduce cycle times
- ★ Consider the possibility of using vibration measurement to shorten cycle times
- ★ Investigate Cp values
- ★ Survey the service life of tool tips
- ★ Review cutting sequences
- ★ Re-examine cutting conditions
- ★ Determine thermal capacities and compare with theoretical values
- ★ Establish optimal conditions

Step 5 Identify problems arising when processing is sped up (carry out stress testing)

- ★ Identify problems arising when cycle times are shortened and rotation speeds are increased (look at Cp values, quality defects, service life of cutting tools, vibration, service life of parts, etc.)
- ★ Experiment using the trial-and-error approach

Step 6 Check equipment precision and prolong service life of parts

- ★ Measure, check and restore the static precision of the equipment
- ★ Research ways of prolonging the service life of parts

Step 7 Address any remaining problems

- ★ Carry out P-M Analysis

The Four Levels of Quality Defect and Rework Loss 1

	Speed Losses			
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Chronic quality defects are largely neglected, and although some countermeasures have been devised, they are not proving effective. Many sporadic quality defects also occur.	1. The possible causes of chronic quality defects are being analysed. • Equipment structures, functions, principles and parameters are clarified. • P-M Analysis is used to elucidate relationships between phenomena and the 4Ms. • Loss-causing phenomena are stratified, the mechanisms by which they occur are analysed, and solutions are implemented.	1. Problems giving rise to chronic quality defects have been identified and addressed, with positive results.	**1. Quality defect and rework losses have been virtually eliminated.** • Quality defect losses are between 0.1% and zero.
	2. Not enough light has been cast on quality defect and rework losses, and their overall impact on the production lines is not known.	2. The quality defect situation has been quantified and stratified. • The locations, frequencies and sizes of problems have been ascertained. • Minor equipment defects spotted on the shop floor are corrected, and improvements are effected.	2. In-process detection of quality defects is being researched.	2. All the improvements to process conditions necessary to attain 100% defect-free production have been accomplished. • Inspection methods have been made easier (visual control is used extensively). • Inspection items have been consolidated.

The Four Levels of Quality Defect and Rework Loss 2

	Speed Losses			
	Level 1	**Level 2**	**Level 3**	**Level 4**
		3. The information gained is used to identify problems, and countermeasures are implemented.	3. The setting of zero-defect conditions is looked into. • Product and process standards, and process condition parameters, are investigated. • The boundaries between normal and abnormal conditions are clarified. • Parameters for which no standards exist are checked by experimentation. • **Zero-defect conditions are systematically sustained.** • The effects of various control parameters on product quality are investigated, and inspection intervals have been set. • Control parameters have been incorporated into Jishu-Hozen standards, the maintenance department's periodic maintenance standards, etc.	
Operating Department	Whole batches are sometimes defective. Quality defects are considered inevitable.	Data is being collected and improvements implemented. • Minor equipment defects are recognised as causing quality defects, and improvements are being carried out.	Improvements based on P-M Analysis are being carried out. The relationships between product quality and the equipment and production systems are understood, and appropriate action is being taken.	Zero-defect conditions have been established and are systematically sustained.

The Four Levels of Quality Defect and Rework Loss 3

Speed Losses				
	Level 1	**Level 2**	**Level 3**	**Level 4**
Maintenance Department	Sporadic quality defects are handled by addressing the symptoms rather than the causes. Basic equipment conditions are not understood or sustained, and operators are given no guidance. When quality defects arise, they are ascribed to faulty operation.	Error-proofing has been extended and upgraded. P-M Analysis and the 7-Step Method for Quality-Hozen are being studied, and operators and maintenance staff work together to carry out improvements on parts of the equipment implicated in causing quality defects. Concerted efforts are being made to reverse deterioration	Zero-defect conditions have been established and standardised. P-M Analysis is used to improve parts of the equipment implicated in causing quality defects, and variable factors are made constant or semi-constant.	Improvements to reduce the number of set conditions have been effected, decreasing the amount of time spent on sustaining them. Condition monitoring is actively used as a Quality-Hozen tool.
Quality Assurance Department	Quality assurance activities amount to no more than classifying quality defects after the fact. Sporadic quality defects are handled by addressing the symptoms rather than the causes.	The quality capabilities (Cp values) of principal processes have been assessed. Causes of quality problems in main products have been analysed, and improvements implemented.	The causes of quality defects are analysed, and the processes involved are improved. Standards are amended accordingly. $1.33 > Cp \geq 1.00$	Processing conditions that eliminate the causes of quality defects have been standardised and applied. $1.67 > Cp \geq 1.33$ Quality-Hozen activities are continually assessed and systems monitored.
Production Engineering Department	Volume production is embarked on without the technology having been properly established.	Processes and sections of the equipment giving rise to quality defects have been detected, and the jigs, tools and processing methods involved are being improved.	The production engineering department works with the operating and maintenance departments to analyse the causes of quality defects, and develop and implement new processing methods.	Staff frequently help shop-floor teams implement improvements using the Quality-Hozen approach. New condition monitoring and Quality-Hozen techniques are being developed, helping to minimise the cost of quality.

The 7 Steps to Zero Quality Defects and Rework 1

Step 1 Stratify quality defect phenomena

- ★ Clarify quality standards and characteristic values
- ★ Carefully stratify quality defect modes, using:
  - ABC analysis
  - Adjusted time-series data
  - Cp values
  - Unadjusted time-series data

Step 2 Identify processes and sections of the equipment giving rise to quality defects

- ★ Find out which processes and which sections of the equipment give rise to quality defects
- ★ Find out how equipment precision, methods and conditions relate to quality, focusing on:
  - Mechanisms
  - Jigs and tools
  - Changeover
  - Processing conditions
- ★ Do comparative research (compare with good products, other defective products, other machines in the same series, etc.)
- ★ Study equipment mechanisms

Step 3 Carry out 4-M analysis and devise countermeasures

- ★ List causes of quality defects, using fishbone diagrams and 4-M analysis sheets
- ★ List principal causes and propose improvements

The 7 Steps to Zero Quality Defects and Rework 2

Step 4 Implement improvements and check results
★ Draw up plans for implementing improvements ★ Implement improvements and establish zero-defect conditions ★ Check results ★ Stratify remaining quality-defect phenomena
Step 5 Carry out P-M Analyses
★ Do physical analyses of the remaining defect phenomena ★ Ascertain the conditions that produce these phenomena ★ Work out how these conditions relate to the 4Ms ★ Determine the desired scenario ★ Compare with the existing processing conditions
Step 6 Identify equipment defects and put them right
★ Decide on measurement methods ★ Determine the equipment's precision ★ Reverse minor equipment defects, and carry out improvements
Step 7 Check results and lock in benefits
★ Check the results ★ Decide on the degree of precision that needs to be sustained ★ Establish and apply control standards

The Four Levels of Shutdown Loss

	Shutdown Losses			
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Because periodic shutdowns are deliberately planned for sustaining equipment safety, reliability and quality, shutdown losses are not thought of as losses at all. 2. or they are recognised as losses, but nothing is done about them. 3. Material losses arising on startup are also ignored.	1. Monitoring the current status such as using MTBF of main-parts. 2. Standard working methods have been established, and pre-shutdown preparations (tools, etc.) are carried out in accordance with them.	1. Critical parts are being improved to extend their MTBFs. **2. Legally-mandated tasks have been improved and their critical path shortened, reducing the number of hours that need to be spent on the shutdown each day.**	1. Improvements designed to extend the intervals between shutdowns have been carried out; the theoretical rationale for this is being developed, and further ways of prolonging the service life of critical parts are being researched. 2. Improvements aimed at further shortening the work time are in progress.
Operating Department	Operators regard shutdowns as the responsibility of the service contractor.	The current situation is being investigated.	Time-critical tasks are being improved.	Working times are being shortened even further.
Maintenance Department	The Maintenance Department has not even considered extending the intervals between shutdowns.	The MTBFs of principal parts have been ascertained.	Improvements designed to extend the intervals between shutdowns are being carried out.	An MP (maintenance prevention) programme is being implemented.
Production Engineering Department	Engineers are completely uninterested in the issue of shutdown losses.	The facts have been ascertained.	The MP approach is being applied.	Full Early Management is practised, using MP information.

The Four Levels of Management Loss

	Management Losses			
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Management losses occur throughout the day, and nothing is done about them. 2. Time spent waiting for materials, instructions, repairs and so on is not regarded as a waste of labour.	1. Management losses have been measured and their causes have been analysed, but the situation has not yet improved. 2. Standards intended to prevent management losses have been set, but losses still tend to occur during non-routine work or unusual situations.	1. The current situation has been analysed and countermeasures have been implemented. Although the problems have been solved, the situation has not yet had time to settle down. 2. Standards have been extended to cover possible non-routine work and unusual situations, and are being upheld. **3. Waiting for materials: zero** **4. Minimize waiting time for instructions**	1. A year or more has gone by without any management losses. The situation has stabilised and seems likely to be sustainable indefinitely. 2. The situation is supported by fully-functional measures such as error-proofing and fail-safing designed to prevent problems occurring in system-critical areas. 3. Steps to optimise the situation - such as adjusting staffing levels to match fluctuations in production volume - have been taken. 4. An Early Management system has been established, and MP information is utilised to prevent losses arising when new equipment or products are introduced.
Operating Department	Waiting around for various reasons is thought to be unavoidable.	Waiting is now recognised as a loss, and relevant data is being collected.	The causes of irregular and abnormal work are being addressed.	The situation is being systematically sustained, ensuring long periods of loss-free operation.
Technical Department	Management losses are considered to be the operating department's fault.	The operating and maintenance departments work together to analyse non-routine work.	The root causes of management-loss problems are being addressed, and engineering strategies are being implemented to prevent their recurrence.	Engineering solutions are also implemented when production volumes fluctuate or new products are introduced.
Administration Department	Losses have neither been stratified nor quantified.	Individual losses are being quantified.	Problems are prevented from recurring by modifying management systems to incorporate the results of improvements.	The production management system can now respond quickly in the situations described above.

The Four Levels of Motion Loss

	Motion Losses			
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. The principles of motion economy are comprehensively ignored, not only in operating the machines but also in other routine and non-routine tasks such as handling materials, using tools and performing quality checks. 2. Walking losses occur as a result of poor workplace layout and poorly-designed materials-handling routes. 3. The people concerned have not been given the training and practice needed to raise their skills.	1. Motion losses and walking losses are being investigated and analysed, but the situation has not yet improved. 2. The relevant people are being systematically trained and drilled.	1. All kinds of motion loss are being analysed and improved; losses due to non-standard tasks have been eliminated, and other losses are being actively reduced by measures such as cooperative working. 2. **Walking losses have been eliminated** by improving workplace layout and materials-handling routes. 3. Training and practice have improved operators' skills and raised their morale.	1. Further improvements have been made, and **multi-machine handling and unattended operation have been introduced.** 2. An Early Management system has been established, and MP information is utilised to prevent losses arising when new equipment or products are introduced.
Operating Department	It is considered natural for work motions, walking distances and so on to vary from person to person - provided they stay within the normal range of standard working procedures - and they are therefore ignored.	Motion losses and walking losses are stratified, and relevant data is collected.	Operators take the initiative in carrying out improvements to eliminate losses.	Further improvements are being made with a view to achieving multi-machine handling and unattended operation.
Technical Department	Work losses and walking losses are not recognised as wasteful, and are neither stratified nor quantified.	The production engineering department works with the operating department to analyse and address problems.	Theoretical approaches are used to identify the causes of losses.	Technical solutions can now be implemented when production volumes fluctuate or new products are introduced.
Administration Department	No thought is given to modifying the production management system or training the operators to try to address the issues mentioned above.	Problems relating to layouts and routes have been ascertained, and thought is being given to improving operators' skills.	Quantitative standardisation systems have been established, and the relevant training and practice is taking place.	The production management system can now respond quickly in the situations described above.

The Four Levels of Line Organisation Loss

Line Organization Losses				
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Line organisation losses occur as a result of severe time wastage in multi-process and multi-machine handling. 2. Loss of line balance on production lines featuring conveyor work is also ignored. 3. Time is being lost for conveyance reasons, due to poor organisation of the movement of materials.	1. Time wastage in multi-process and multi-machine handling is being analysed, and efforts are being exerted to prevent it, but the situation has not yet improved. 2. Efforts are being made to analyse and combat loss of line balance on production lines featuring conveyor work, but the situation has not yet improved. 3. Efforts are also being made to analyse and combat materials movement (logistics) losses, but the situation has not yet improved.	1. Time wastage in multi-process and multi-machine handling has been reduced, and **line organisation losses are no longer an issue.** 2. Now that conveyor-work line balance has been improved, and cooperative working has been introduced, line organisation losses no longer arise. 3. Materials movement has been improved, eliminating conveyance losses.	**1. Production lines are now in a good position to accommodate fluctuations in demand.** 2. MP information continues to be utilised in the Early Management of new products and new equipment, producing tangible benefits.
Operating Department	Losses due to the way equipment is employed, and loss of line balance, are thought to be unavoidable.	Operators are examining the current state of affairs regarding loss of line balance and losses due to the way equipment is employed.	Waiting losses attributable to the way equipment is employed are being reduced, and loss of line balance is being tackled by introducing cooperative working.	Standards designed to eliminate line organisation losses are being upheld, and the situation is sustainable over the long term.
Technical Department	The losses described above are blamed on the operating department.	The production engineering department works with the operating department to stratify the losses and collect and analyse numerical data.	Equipment design, functions, structure and methods of use are being examined theoretically, and waiting losses are being reduced.	Production engineering can now respond nimbly to the introduction of new products and fluctuations in production volume.
Administration Department	Nothing is done about conveyance losses ascribable to the way materials movements are managed.	Conveyance losses are also examined and analysed from the management system perspective.	Conveyance losses are being reduced, mainly as a result of improvements to the movement of materials.	The management system can also respond nimbly to the introduction of new products and fluctuations in production volume.

The Four Levels of Non-Automation Loss

Non-Automation Losses				
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Materials and products are all loaded, unloaded and moved around by hand. 2. Operations that could have been automated or mechanised have not.	1. The need for automation and mechanisation is now understood. The current situation is being examined and analysed, and action is being taken, but as yet no real benefits have been obtained. 2. Jigs and tools are being improved, albeit still at a low level.	1. Automation and mechanisation are progressing, and the benefits are felt across the board; **staffing levels have been reduced.** 2. The benefits described above are being rolled out throughout the company.	1. MP information is used in the Early Management of new products and new equipment, and staffing reductions are achieved from the outset by automation and mechanisation. 2. Materials movements and layouts have been improved right across the company, and losses due to transfers between machines have been eliminated.
Operating Department	No thought is given to reducing the number of people required to do tasks currently done by hand.	The current situation is being examined with a view to improving the situation by automating manual work.	Staffing levels are being reduced by automating and mechanising manual work.	Improvements designed to achieve further reductions in staffing levels are in progress.
Technical Department	Improvement involving automation is regarded as the province of the operators.	The production engineering department works with the operating department to collect and analyse data with a view to automation.	The way the improvements mentioned above affect quality, etc. is being studied.	Staffing levels are also being reduced by utilising MP information when introducing new products.
Administration Department	Failure to automate or mechanise suitable tasks is not regarded as a loss.	The cost-effectiveness of automating or mechanising manual work is being looked into.	Production control systems incorporating the improvements mentioned above are being established.	Losses ascribable to transfers between machines are being tackled through materials-handling improvements throughout the company.

The Four Levels of Measurement and Adjustment Loss

Measurement and Adjustment Losses				
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Because process capability is low, quality defects are common, and 100% inspection is carried out to prevent them escaping downstream. This necessitates frequent measurement and adjustment, leading to labour losses. 2. Vast amounts of time and labour are spent on inspection, and this is thought to be unavoidable if quality is to be assured.	1. 100% inspection is now understood to be a loss, and there is a desire to raise process capability, although the situation has not yet improved. 2. The current situation is being examined and analysed, and some improvements are being effected, but sufficient progress has not yet been made.	1. Quality is improving, **and 100% inspection has been replaced by sampling inspection, greatly reducing measurement and adjustment losses.** 2. QM matrices have been drawn up, and standards have been established to ensure that improvements are sustained.	1. A system of building quality into the product by means of the process has been established, Quality-Hozen is being practised, and strict measures to prevent problems recurring are in place. 2. An Early Management system has been established, and MP information is used when introducing new products as well as new equipment.
Operating Department	Despite inadequate process capability, labour is being lavished on 100% inspection in order to assure quality.	The current situation is being examined and analysed with a view to improving process capability and reducing measurement and adjustment losses.	100% inspection has been replaced by sampling inspection, and measurement and adjustment losses are being reduced.	Process capability has been stabilised, and measurement and adjustment tasks have been reduced to single actions.
Technical Department	Making inspection more efficient is considered to be the operating department's responsibility.	The production engineering department works with the operating department to collect and analyse data, and explore countermeasures.	Efforts are made to obtain the required process capability and reduce measurement and adjustment tasks to single actions by converting quality-related variables to constants on quality-critical parts of the equipment.	The required process capability is obtained by utilising MP information when introducing new products as well as new equipment.
Administration Department	The idea of applying improvement to measurement and adjustment losses has not occurred to management.	Management has taken on board the idea of applying improvement to measurement and adjustment losses, and is examining the current situation.	A companywide control system designed to effect and sustain the above improvements is being established.	The above improvements are being taken even further.

The Four Levels of Yield Loss

Yield Loss				
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Materials yield losses corresponding to the difference between the weight of raw material and the weight of product (such as quality defect losses, cutting losses, attrition losses, excess material and giveaway losses) are not regarded as losses. 2. The above losses are not being quantified, and nothing is being done to increase resource consumption efficiency.	1. The current situation regarding materials yield losses is being examined and analysed, and some improvements are being effected, but sufficient progress has not yet been made. 2. Problems keep occurring despite standards and rules designed to prevent them. Rules are not always followed.	1. **Materials yield improvement measures such as acoustic emission techniques are in place and are starting to produce benefits.** Thanks to standardisation and discipline in following the rules, problems are prevented from recurring. 2. Resource consumption is monitored with the aim of reducing materials yield losses, and some improvements have been effected.	1. The concept of 'zero production waste' has been taken to heart and is being implemented throughout the company, delivering tangible benefits. 2. An Early Management system has been established, and MP information, VE (value engineering) techniques and so on are used when introducing new products.
Operating Department	Operators believe that nothing can be done about materials yield losses.	The current situation is being examined, quantified, analysed and addressed.	Improvements designed to reduce materials yield losses are progressing, and resource consumption is being monitored.	Further improvements are being made, and are being systematically sustained.
Technical Department	No thought is given to reducing materials yield losses through the design of products or production processes.	The idea of reducing materials yield losses through the design of products and production processes is being considered.	Theoretical research into improvements designed to reduce materials yield losses is being undertaken, and the use of techniques such as acoustic emission is being considered.	The situation has been improved through the use of MP information, VE and so on when introducing new products.
Administration Department	No thought is given to quantifying materials yield losses or monitoring resource consumption.	Materials yield losses are being quantified, and monitoring of resource consumption is being explored.	Production control systems incorporating the improvements mentioned above are being established.	Thanks to a companywide rollout of the new measures, production waste is on its way to being eliminated.

The Four Levels of Energy Loss

Energy Losses				
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. Failure to save energy in the form of electricity, fuel, steam, air, water etc. (by tackling setup and adjustment losses, overloading losses, heat dissipation losses, etc.) is not regarded as a loss. 2. The cost of energy used in processing and ancillary activities is thought to be an inevitable production cost, not a loss.	1. Saving energy is now thought to be necessary, and the current situation is being investigated, analysed and improved, but no tangible benefits have yet been obtained. 2. Raising the motivation of all employees is seen as important: a publicity campaign is being considered, and practical training is being planned and put into effect.	**1. Energy-saving initiatives are being rolled out, and improvement plans are in progress, delivering tangible benefits.** 2. Control of resource consumption is being explored and implemented as part of the energy-saving programme, and theoretical limits are becoming explicit.	1. Resource consumption is being rigorously controlled, and is approaching theoretical limits. 2. **An Early Management system has been established, and MP information is utilised** when introducing new products. Energy-saving measures are in place.
Operating Department	Energy costs are thought to be natural and necessary for production.	The current situation regarding energy-saving is being investigated and analysed.	Resource consumption control is now being applied to every item in the energy-reduction programme.	Activities capable of bringing resource consumption down close to theoretical limits are now in place.
Technical Department	The production engineering department is doing nothing to help save energy, and has no interest in doing so.	The production engineering and operating departments are now working together to stratify problems, collect data, carry out analysis, and implement countermeasures.	The above issues are now being examined from the theoretical standpoint.	MP information is utilised when introducing new products, and energy-saving measures are in place.
Administration Department	Management is also uninterested and inactive regarding these issues.	Management's role in resource consumption control is being investigated.	A companywide system for managing these issues is being established.	As above

The Four Levels of Consumables Loss

Consumables Losses				
	Level 1 (Losses are not even being monitored)	**Level 2** (Facts are being ascertained)	**Level 3** (Improvements, backed up by theory, are being implemented)	**Level 4** (Losses have been minimised)
Contents	1. The costs of fabricating and repairing the dies, jigs and other devices required for making the product, and the costs of supplementary materials, are not controlled. 2. All the above costs are thought to be natural and necessary for production, and are not regarded as losses.	1. These costs are now seen as losses, and the current situation is being examined and analysed with a view to improvement. However, no tangible benefits have yet been obtained. 2. A companywide publicity campaign and systematic training programme are raising everyone's awareness of the issues.	1. The costs are now being brought under control, and improvement plans are being implemented, delivering tangible benefits. **2. Measures to prolong the service life and shorten the fabrication time of dies and other devices are being considered and implemented.**	1. Improvements designed to reduce consumables losses are delivering substantial benefits. **2. An Early Management system has been established, and MP information is utilised when introducing new products. Losses incurred by fabricating and repairing jigs and dies are monitored and reduced.**
Operating Department	Consumables losses are regarded as natural and necessary for production. Improvement is thought to be the responsibility of the equipment manufacturers.	The current situation regarding fabrication and repairs costs is being examined and analysed.	Improvements are being progressed, and the possibility of in-house fabrication and repair is being considered.	The improved situation is being systematically sustained, and more and more of the work is done in-house.
Technical Department	It is thought that if there are any losses, they must be the fault of the operators.	The production engineering and operating departments now work together to collect data on the issues described above, and devise countermeasures.	The possibility of extending service life and reducing fabrication time is being considered in theory.	MP information is utilised when introducing new products, and improvements are being implemented.
Administration Department	The possibility of controlling consumables losses has not been considered.	Training programmes for raising operators' skills are being organised.	The consumption of consumables per unit of product produced is now controlled.	As above

TPM Manual
Chapter 4
Jishu-Hozen
(Autonomous Maintenance)

JIPM-Solutions Co. Ltd.

Who is Jishu-Hozen (Autonomous Maintenance) For?

Jishu Hozen

- Jishu Hozen for production
  - Workplaces with equipment
  - Assembly lines
  - Warehouses, distribution centres and other areas with few machines
- Jishu Hozen for administrative and indirect departments

The focus of this chapter

* For putting the workplace environment in order and making the work more efficient
* From Step 4 on, the ideal state of the work is constantly pursued, focusing on Visual control, increasing productivity and reducing inventory

Explained in the chapter on "Office TPM"

'Equipment-Competent' Operators

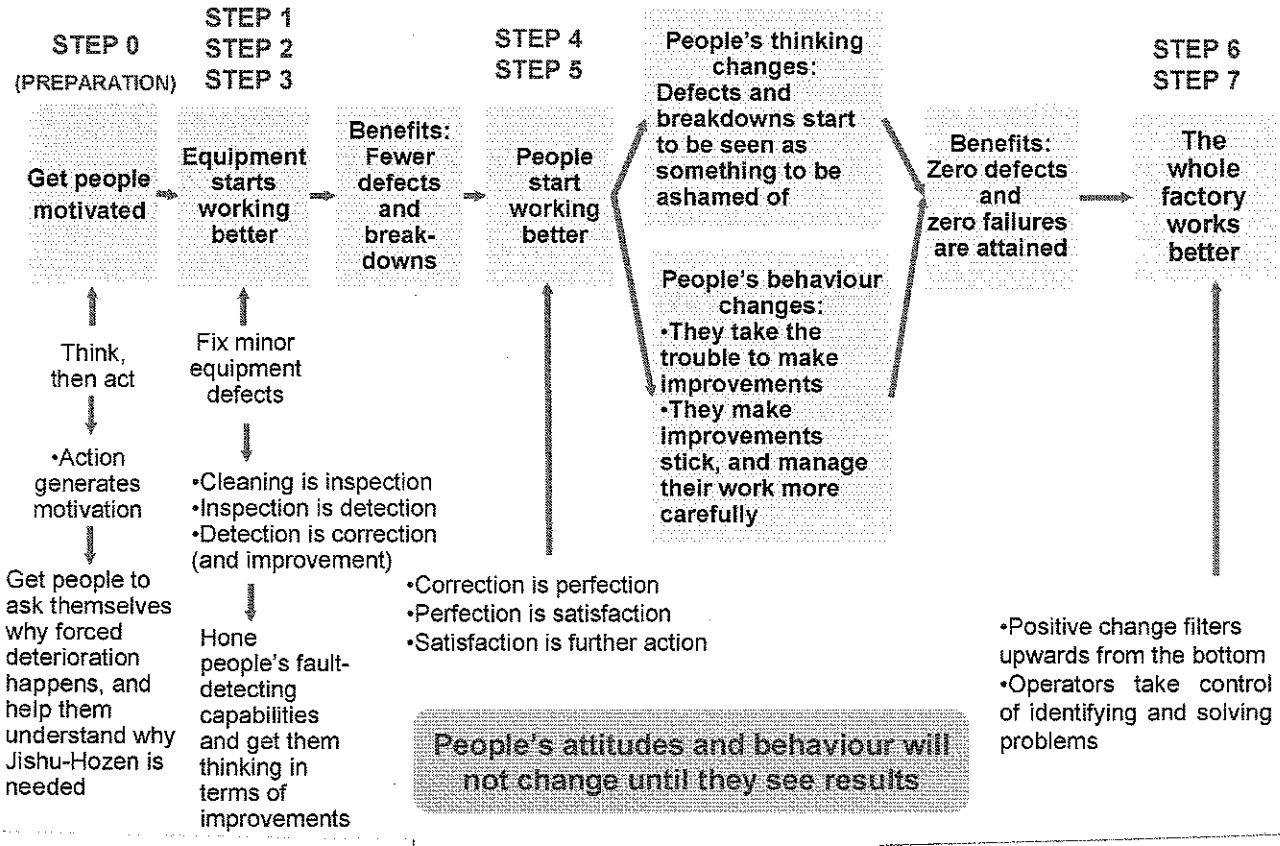
Operators need the ability to

1. Recognise abnormalities when they see them (The ability to identify abnormalities)
2. Respond swiftly and correctly when abnormalities occur (The ability to take corrective action)
3. Set clear criteria defining what is normal and what is not (The ability to set conditions)
4. Keep strictly to the rules governing these conditions (The ability to sustain)

More specifically, each operator needs to acquire the ability to:

1. Identify and correct equipment abnormalities
2. Understand how the equipment works, and identify the causes of any abnormality
3. Understand the relationship between the equipment and the quality of the product, foresee quality problems, and find out what is causing them
4. Carry out repairs
5. Implement appropriate Kobetsu-Kaizen, either independently or in cooperation with other departments

The Steps to Jishu-Hozen and How they Work



The Two Aspects of Maintenance - 'Sustainment' and 'Improvement'

1. 'Sustainment' activities: Preventing and correcting equipment failures.

Measures for 'sustaining'

a. Correct operation
b. Routine maintenance, periodic maintenance, predictive maintenance

2. 'Improvement' activities: Prolonging the working life of the equipment, reducing the time spent on maintenance, and eliminating the need for maintenance.

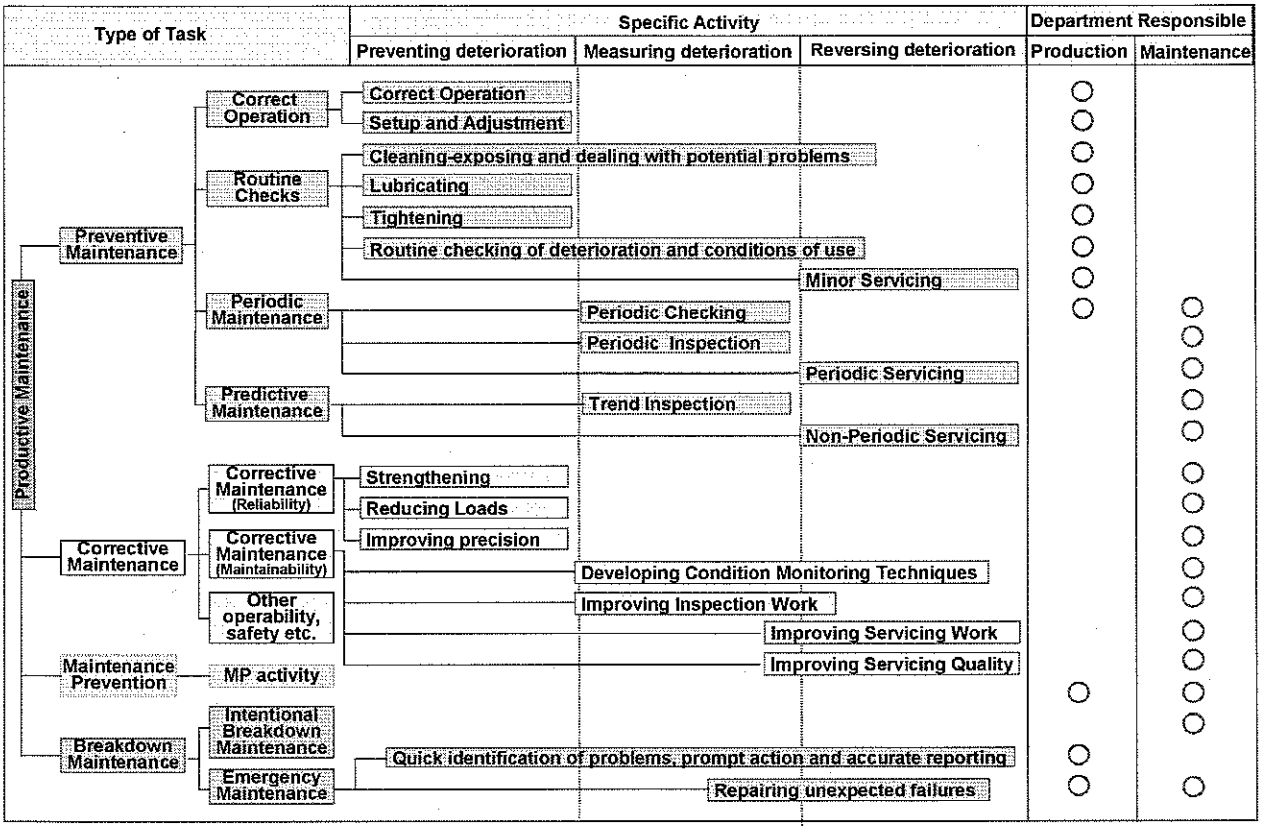
Measures for 'improving'

a. Corrective maintenance: improving equipment reliability and maintainability
b. Maintenance prevention: designing out the need for maintenance

Classifying and Allocating Maintenance Tasks

Type of Task			Specific Activity			Department Responsible	
			Preventing deterioration	Measuring deterioration	Reversing deterioration	Production	Maintenance
Productive Maintenance	Preventive Maintenance	Correct Operation	Correct Operation			○	
			Setup and Adjustment			○	
		Routine Checks	Cleaning-exposing and dealing with potential problems			○	
			Lubricating			○	
			Tightening			○	
			Routine checking of deterioration and conditions of use			○	
					Minor Servicing	○	
		Periodic Maintenance		Periodic Checking		○	○
				Periodic Inspection			○
					Periodic Servicing		○
		Predictive Maintenance		Trend Inspection			○
					Non-Periodic Servicing		○
	Corrective Maintenance	Corrective Maintenance (Reliability)	Strengthening				○
			Reducing Loads				○
			Improving precision				○
		Corrective Maintenance (Maintainability)		Developing Condition Monitoring Techniques			○
		Other operability, safety etc.		Improving Inspection Work			○
					Improving Servicing Work		○
	Maintenance Prevention	MP activity			Improving Servicing Quality		○
	Breakdown Maintenance	Intentional Breakdown Maintenance				○	○
		Emergency Maintenance	Quick identification of problems, prompt action and accurate reporting			○	
					Repairing unexpected failures	○	○

Classifying and Allocating Maintenance Tasks



MIN. 2 HRS. /week

A Typical Jishu-Hozen Programme for Machining

Step	Name	Activities
1	Initial cleaning (cleaning is inspection)	Eliminate dust and dirt from main body of equipment, lubricate and tighten, expose and deal with equipment problems
2	Countermeasures for Contamination sources and hard-to-access areas	Reduce housekeeping time by eliminating or containing sources of dust, dirt or other contamination, and improving places that are hard to clean, lubricate, tighten or check
3	Provisional standards	Formulate provisional standards to enable cleaning, lubricating, tightening and checking to be sustained dependably with minimal time and effort (this will mean establishing time slots for routine and periodic maintenance)
4	General Inspection	Train operators in inspection procedures using inspection manuals, enabling them to expose and correct equipment defects by performing comprehensive equipment inspections
5	Autonomous inspection	Formulate definitive cleaning, lubrication and inspection standards that can be followed efficiently and dependably; draw up autonomous inspection checklists and put them into use
6	Standardisation	Develop comprehensive housekeeping system by devising additional standard for items such the following: •Development of materials around the shop floor •Data recording •Control of moulds, jigs, tools, etc. •Quality assurance data on the process
7	Full self-management	Roll out and implement company policies and objectives, and continually improve the equipment by keeping accurate MTBF and other maintenance records, analysing the data captured, and doing improvements as a routine part of the job

A Typical Jishu-Hozen Programme for Process Industries

Step	Name	Activities
1	Initial cleaning (cleaning is inspection)	• Eliminate dust and dirt from main body of equipment • Identify faults, sources of contamination, hard-to-access areas, sources of quality defects, etc. • Remove unnecessary or obsolete equipment and simplify remaining equipment
2	Countermeasures for Contamination sources and hard-to-access areas	• Reduce time required for all sorts of tasks by eliminating or containing sources of dust, dirt or other contamination, and improving places that are hard to clean, lubricate, tighten or check
3	Provisional standards	• Formulate provisional action standards to enable cleaning, lubricating, tightening and checking to be sustained dependably with minimal time and effort • Improve inspection efficiency by introducing visual controls
4	General equipment inspection	• Train operators in inspection procedures using inspection manuals • Restore individual equipment units to their ideal state through comprehensive inspection and restoration • Make the equipment easier to inspect and introduce comprehensive Visual control
5	Total process inspection	• Improve the reliability of processes by developing process-competent operators thoroughly trained in process performance, operation, adjustment, and corrective action • Integrate provisional cleaning and inspection standards for each unit with periodic inspection and replacement standards for each area or process in order to eliminate duplication and ensure all necessary checks are done
6	Systematisation	• Ensure that Jishu Hozen is reliably performed, and assure Quality-Hozen and safety by making system flow charts and standards clear • Improve changeovers and reduce work-in-progress inventories • Establish self-managed systems for controlling workplace flow, spare parts, tools, work in progress, documentation, etc.
7	Full self-management	• Develop activities in line with company and factory policies and objectives and make improvement a routine part of the job, reducing costs by driving out waste

A Typical Jishu-Hozen Programme for Fabrication and Assembly Industries

Step	Name	Activities
1	Initial cleaning	• Remove all unnecessary items, particularly from work areas • Sort out all jigs, tools and parts, and arrange them efficiently • Eliminate dust and dirt from work areas
2	Countermeasures for Contamination sources and hard-to-access areas	• Eliminate sources of unnecessary items
3	Provisional 5S standards	• Formulate provisional action standards to enable the 5 Ss to be sustained dependably with minimal time and effort • Devise creative ways of making inspection easier and managing visually
4	General inspection	• Use inspection manuals to develop knowledge and skills • Expose and correct slight equipment defects by performing comprehensive inspections • Formulate provisional autonomous checking standards
5	Autonomous inspection	• Raise inspection efficiency by comprehensively revising provisional 5S standards, provisional autonomous checking standards and routine control items • Devise visual controls and implement comprehensive Visual control • Prepare and use autonomous checking checksheets • Prepare and use autonomous checking calendars
6	Standardisation	• Develop multiskilled operators to ensure stable quality and output regardless of who is doing the work • Formulate work standards
7	Full self-management	• Roll out and implement company policies and objectives and make improvement a routine part of the job

The 7 Jishu-Hozen Steps

Stage 1

1. Cleaning is inspection
2. Inspection is detection
3. Detection is correction
3. Operators get into the habit of working through difficulties, and exercising creativity and ingenuity in solving problems

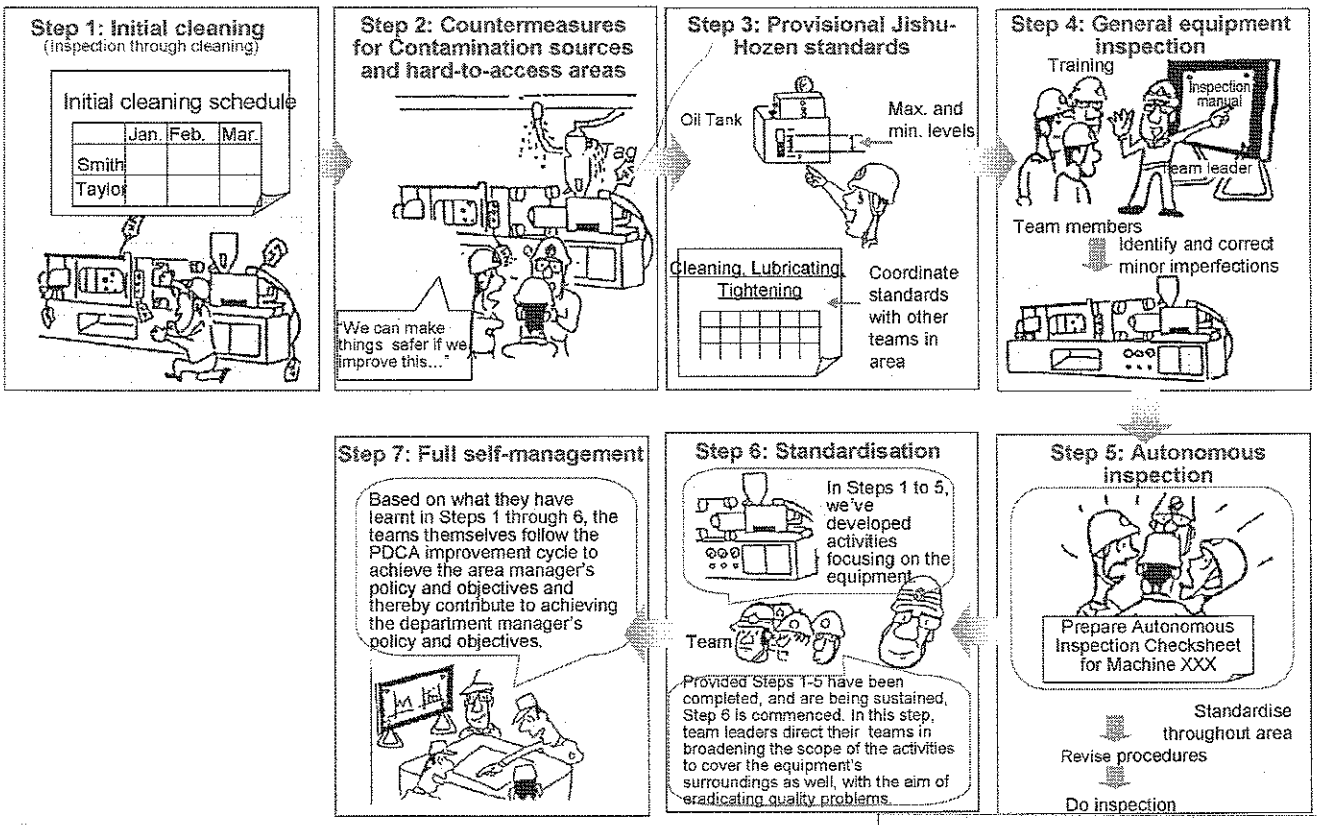
Stage 2

4. Correction is perfection
4. Perfection is satisfaction
5. Operators become truly equipment-competent, capable of performing routine checks using their five senses backed up by logic, and able and willing to make improvements on their own initiative.

Stage 3

6. Improve workplace management techniques, expand the scope of self-management, heighten goal-consciousness, instill awareness of maintenance and other costs, and perfect operators' maintenance skills including the ability to do minor repairs.

Development of Jishu-Hozen (A typical example)



The Management Pilot Model Activities

Management pilot model
Leaders: Top executives, plant managers
Members: All regular employees

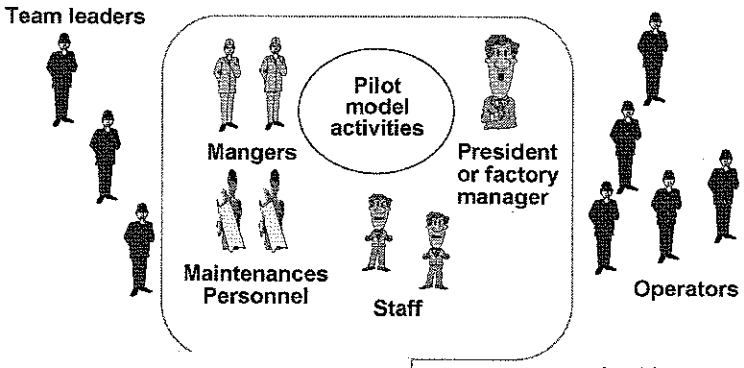
Step 1 → Step 2 → Step 3

General pilot models
Leaders: Team leaders
Members: Team members

Step 1 → Step 2

- Proceed step by step
- Gain hands-on experience
- Coach
- Review and follow up

The managers and supervisors must either manage and maintain the management pilot model on a daily basis themselves or explain to the machine's operators what needs to be done, and have them do it.



Demonstrate results
Show leadership and initiative
Promote TPM prior to kick-off

Step 0: Preparation

- This is an important step, where operators find out for themselves that bad things happen as a result of forced deterioration of equipment. This is how they come to realise why TPM is necessary.
- Note that action comes first, and motivation grows out of the action process. To become motivated, the operators first have to carry out the prescribed actions.
- This preparatory step is designed to make the operators think about the causes of forced deterioration, and understand why they are now embarking on Jishu-Hozen

Preparation (Step 0)

1. Make sure Aims

(1) Make sure operators understand why Jishu-Hozen is necessary

(2) Make sure operators understand why basic equipment conditions need to be sustained

(3) Have operators observe their own equipment

Hold meetings for:

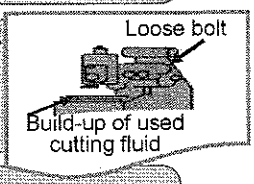
- Team members
- Team leaders
- Managers and supervisors

2. Draw up plans

1) **Safety**
- Draw up a list of injuries and accidents that could happen during initial cleaning (such as electric shocks, injury due to residual air pressure, skin irritation by cleaning agents, foreign objects in the eye, injury by falling objects, and so forth)
- Provide safety training and establish procedures for predicting and averting hazards (unsafe conditions and behaviours)

2) **Forced deterioration and consequent losses**
- Find out what is causing forced deterioration
- Find out what losses are caused by forced deterioration
- Find out what situations result in quality defects, breakdowns and minor stops

3) **Ensure that operators understand their equipment**
- Draw simple diagrams showing how the equipment work
- Make sure everyone understands the mechanisms
- Consider what problems might happen if a mechanism gets dirty or runs out of lubricant, or if any bolts, etc. work loose



4) **Skills needed**
- Cleaning: Techniques for removing dirt efficiently, ways to detect equipment problems
- Lubrication: Purpose, types, method, quantity, interval
- Tightening: Purpose, correct method, correct use of tools

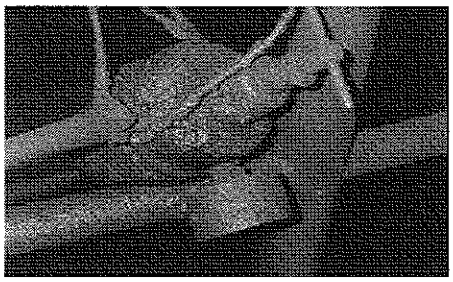
Step 1: Initial Cleaning (Checking through Cleaning)

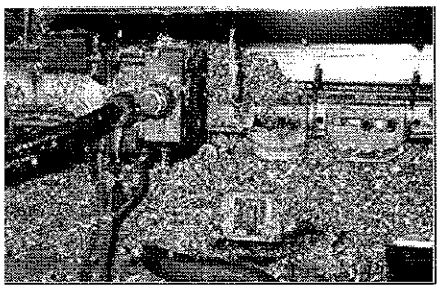
- This is a crucial step, at which the 'cleaning is inspection' concept is put into practice. It is not a matter of just making the equipment look clean on the surface; the process of cleaning exposes abnormalities, such as leaks, loose fastenings, or damaged parts.

- The aim of this step is to get to grips with the equipment, getting our hands dirty and removing every last bit of dust or grime and keeping our eyes open as we do so, because this is by far the best way of discovering problems.

Some Harmful Effects of Inadequate Cleaning

1. Breakdowns	When dirt or debris gets into rotating or sliding parts, pneumatic or hydraulic systems, electrical control systems, sensors, or other components, it can create problems such as wear, blockage, electrical resistance defects and electrical conduction defects, which can in turn cause malfunction, breakdown, loss of precision, etc.
2. Quality defects	Foreign matter in equipment can be directly transferred to products, or can cause the equipment to malfunction, leading to quality defects.
3. Forced deterioration	The presence of dirt makes it more difficult to spot abnormalities such as loose parts, cracks, rattling, or oil leaks, and they may be overlooked.
4. Speed losses	Dirt in equipment increases rotational friction and sliding resistance, lowering production capacity and causing idling and other speed-related problems.





Workflow for Step 1 (Initial Cleaning Inspection) - 1

[AIMS] By completely eradicating dust and dirt from the main body of the equipment and its surroundings, to
* Prevent forced deterioration;
* Detect and rectify latent minor equipment defects through the cleaning process.

Why is initial cleaning necessary?
Compile a list of requirements
Draw up a plan

Preparation
1. Understand the aims of Step 1
2. Understand precisely what tasks are involved
3. Draft a detailed work plan

(Detailed plan) Cleaning map
Combine

Target for number of minor equipment defects to be detected
'Sort and store' standards

Execute cleaning blitz
1 Clean away dust and dirt, inspect equipment, detect and rectify latent defects.
2 Sustain basic standards for cleaning, lubricating and tightening.
3 Detect sources of contamination and hard-to-access areas, and take provisional corrective action.
4 Sort and store unneeded items, tools and spares.

Compile a list of defects detected
Tag defects

Hold meetings to:
•Devise improvement methods
•Assign responsibility for improvements (include general staff as well as operators)
•Explore the reasons behind the defects

(1) Decide which restoration and improvements can be carried out during Step 1

Compile a list of equipment defects
•Micro-defect detection list
Problem status and solution
-where dust and dirt are found
•List of hard-to-clean areas
•List of entry points for foreign matter
•List of superfluous and inessential items

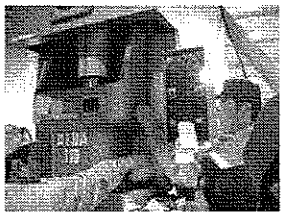
Guidance
(2) Restore and improve
Check results and de-tag
Formulate provisional cleaning standards
Conduct self-review
Receive factory review
Pass Step 1

Some defects have to be left over until the next step

Activity board

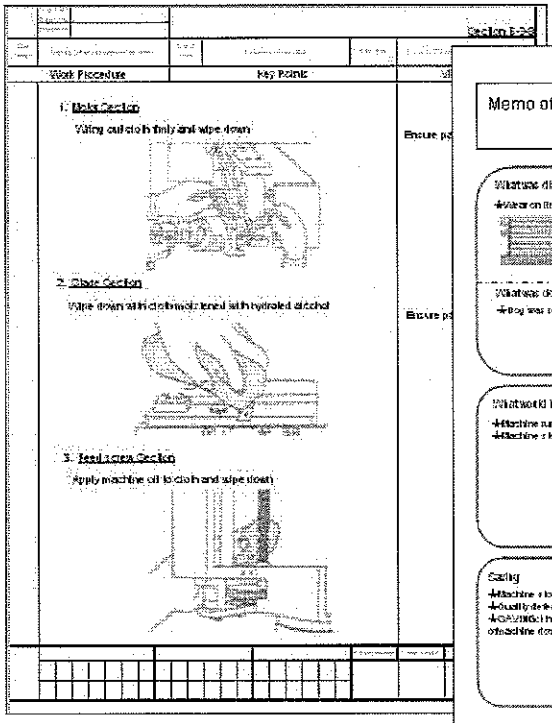
Improvement record
Hold a team meeting
Apply for factory review
Submit activity report
Submit improvement activity status report

A TPM One-Point Lesson

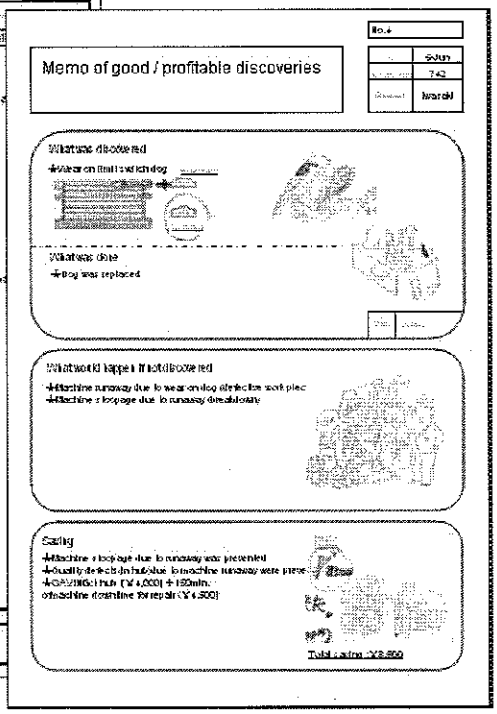


Make & use OPLs to share what learned from Fuguai and questions

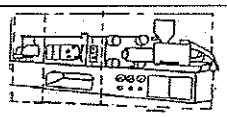
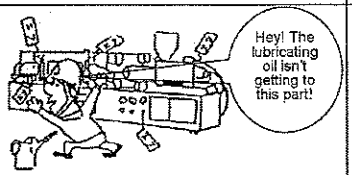
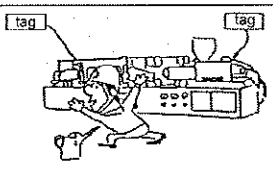
Cleaning Method



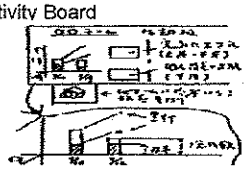
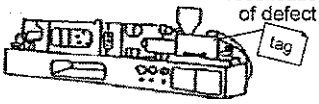
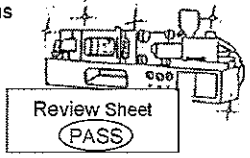
Example of Problem



Step 1 Initial Cleaning (Checking through Cleaning) - 2

Step / Stage	Step 1 Initial Cleaning (Checking through Cleaning)			
	Decide Responsibilities	Create Schedule	Check by Cleaning	Locate and Correct Problems
Objectives	Progressively upgrade skills by making operators responsible for difficult areas one level up from their current level of ability.	Include everyone and get them all working towards the same objective.	Eradicate accumulated grime and identify any degradation of the equipment compared to its optimal state.	Each operator identifies any problems in his or her area. The team leader then reviews what that operator has done, and points out anything that has been missed.
Actions Required	1. The team leader assigns an area of responsibility to each operator (including him/ herself), based on the individual's skill level. 2. To develop the operator's skills, the team leader assigns an area with a level of difficulty one step up from his or her current skill level.	1. The team leader explains the overall plan that he or she has decided with the supervisor. 2. A schedule is established, based on each operator having his/her own area of responsibility. 3. The team draws up an action plan specifying: ·Overall schedule ·Day assigned for task ·Time slot assigned for task The team leader is responsible for coordinating the plan with other departments.	1. The team leader must always give safety instructions before operators start any cleaning, inspection, problem-finding or repair work. 2. To inspect the equipment properly, operators must reach into every corner, opening up covers and flaps they have never seen inside, and cleaning away all the dirt, dust and grime. 3. Before work is started, the team leader should explain the typical problems operators should look out for. 4. Operators should remain vigilant while cleaning and find as many defects as they can.	1. The operators attach a tag to the location of any problem they find during cleaning, and tear off the lower half of the tag if they are able to fix the problem there and then. 2. The team members look at all of the tags together and help each other spot any defects that have been overlooked or parts that have not been properly cleaned. 3. When everyone has looked at a tagged location and agreed that the problem has been rectified, the whole tag is removed. 4. Tags that cannot be resolved straight away are put into an improvement plan.
Completed Scenario	 All operators have been assigned their own area of responsibility.	Month / Jan / Feb / Mar Overall schedule Team leader A B C Worked out by everyone together		
Key Points	1. Decide responsibilities for all operators and achieve consensus on how to proceed. 2. If the whole team looks after one area collectively, then responsibility will be diluted, and the operators will not learn very much. 3. A team activity report must be prepared and filed after each session.	1. The team leader should resolve disputes and keep everyone pulling in the same direction. He or she must deal with problems as they arise, and revise the cleaning plan if necessary.	1. Remember that the point of cleaning is to discover problems by removing layers of built-up grime and dirt. 2. Before starting, the team leader must carefully explain the purpose of the cleaning so that it does not end up as a cosmetic exercise. 3. Everyone should look closely to see how long it takes for the equipment to get dirty again, and where the contamination is coming from.	1. Basically, operators themselves should try to correct the problems they find, because this is how they learn. 2. The original, ideal state of the equipment must be borne in mind when looking for defects. 3. Operators must read the instruction manual and understand it fully. 4. The team leader must develop the team members by reviewing what they have done, and point out any defects they have missed or any parts they have not cleaned properly.

Step 1 Initial Cleaning (Checking through Cleaning) - 3

Stage	Summary	Self-Review	Department Manager's and Factory Manager's Reviews
Objectives	Make details of the activities known to everyone concerned (not just the team members) and handle things systematically.	The team leader improves the skills of all team members.	The review process enables managers at each level to coach the manager next in line under them (line managers coach team leaders, area managers coach line managers, and so on).
Actions Required	1. Review initial plan (make revisions and inform all team members about them). 2. Collate data on equipment defects. 3. Produce team activity report.	1. Each team member takes an Jishu-Hozen Self-Review Sheet and goes to the designated area. 2. The team leader reads out the items to be reviewed, one by one, and the team members check that item. 3. Any problems are then tagged and rectified. 4. The process is repeated until the whole team is satisfied with every area.	1. Each review team member scores the area using an Jishu-Hozen Review Sheet. 2. The reviewers point out specifically what has been done well and what not so well, e.g.: - "All cleaning done properly and equipment in excellent condition." - "There's still quite a bit of dirt. Not really good enough."
Completed Scenario	Example: 'Red Arrows' Team Activity Board 	Clearing up defects Date set for rectification of defect  Clear plan and deadlines for removing all remaining tags	* Problems dealt with effectively * Good plan for dealing with remaining problems 
Key Points	1. The plan should be monitored at least once a week on days-only working, or once per cycle on a shift system, and all changes reported in detail to everyone in the team. 2. State clear deadlines for removing tags on persistent problems. 3. Devise creative ways of carrying out the team activities.	1. Team leaders should give individual guidance to each operator, in order to raise his or her capabilities. 2. When assessing the standard achieved, give most weight to the lowest score achieved for each item reviewed.	1. Be specific when pointing out the good and bad points. Give motivating advice, so that the team is encouraged to do even better next time. Encourage the team leader to provide effective leadership to the whole team. 2. Take the lowest score for each item reviewed as the score for that item.

Step 2: Tackling Contamination Sources and Hard-to-Access Areas

- In Step 2, ways are found to combat sources of dirt, leaks, and so on, and improve accessibility to areas that are hard to clean, lubricate, tighten, or inspect. This is a crucial process that nurtures the seeds of improvement, as operators find ways to improve the situation on their own initiative.

- It allows them to derive real pleasure from the process of improvement and the results attained, and to share a sense of achievement with their supervisors and fellow team members.

Step 2: Tackling Contamination Sources and Hard-to-Access Areas - 1

[AIMS] Eliminate sources of dust, dirt and other contaminants, prevent scattering, and shorten the time needed for cleaning, lubricating and inspecting by improving inaccessible areas;
* Help operators to acquire the equipment-improvement mindset, creating real benefits for the business.

◎Uunderstand the harmful effects of dust, dirt and foreign matter

◎Locate the areas where dust, dirt and foreign matter accumulate
◎Analyse dust, dirt and foreign matter to identify their material, shape and composition

◎Hard-to-access areas are areas which:
• take a long time to clean, lubricate or inspect
• are awkward to clean, lubricate or inspect

Collect hard data
◎ Why is the contamination happening?

◎ Find out exactly where the contamination is coming from:
•Is it coming from the previous process?
•Is it generated by this process?
•Is it generated in the course of machining?
•Is it coming from the equipment?
•Is it coming from the external environment?

Which tasks are affected by the difficulty?
•Cleaning/lubricating/tightening
•Which tools are used?
•Does the difficulty make it impossible to perform the task?
•In what way is the result checked?
•Is the work performed by eye, using the bare hands, etc?

◎ Cultivate improvement-oriented mindset

Plan countermeasures
•Cut off contamination source
•Prevent scattering
•Prevent contaminants getting into or settling on equipment
•Set action schedule and assign responsibilities

◎ Plan countermeasures
•Set time targets
•Decide improvement methods

Display target times for routine cleaning and inspection

Eliminate → Minimise → Localise

Guidance

Restore and improve → Record improvements
Check results → Revise provisional standards drafted in Step 1 and subsequently improved
Revise provisional cleaning standards
Perform cleaning based on provisional cleaning standards → Check that cleaning can be carried out properly in the time allowed by the provisional standards, and remove tags
Conduct self-review → Draw up team activity report and apply for a factory review
Receive factory review

Activity board

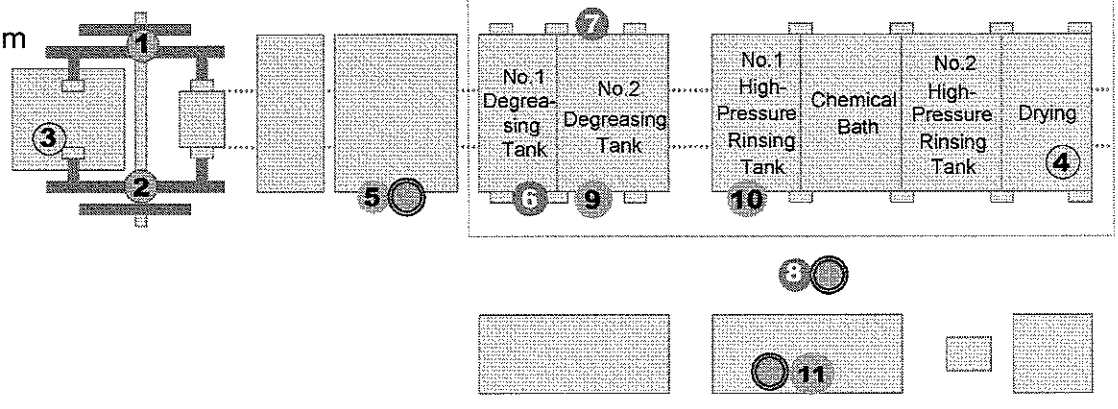
Pass Step 2

Map of Contamination Sources

____Dept., ____ Area, _____ Team

Dirt Oil leak Action complete
Air leak Water leak

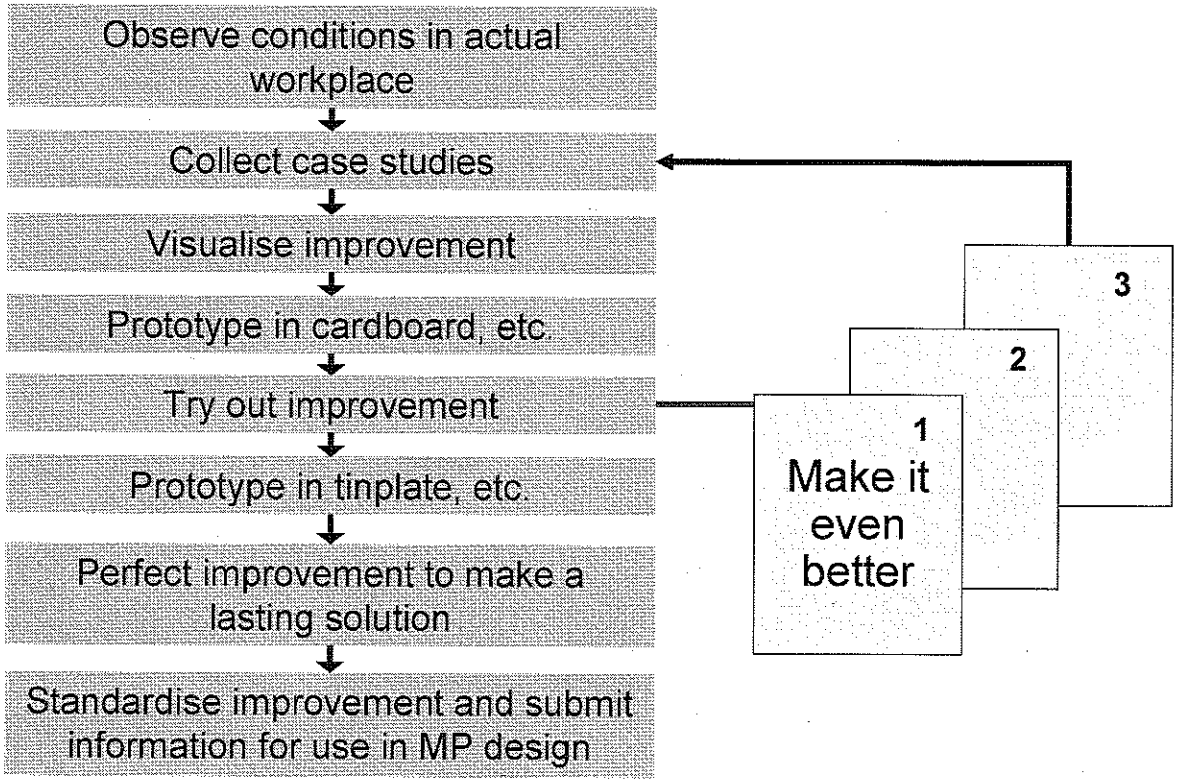
Diagram



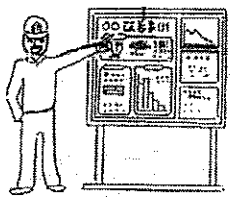
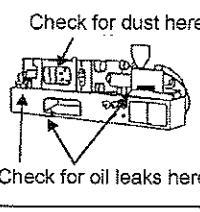
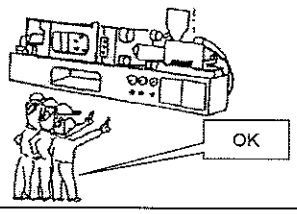
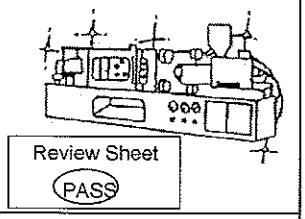
No.	Location	Description
1	Loader	Oil leak from bearing
2	Loader	Oil leak from bearing
3	Lifter	Air leak from air cylinder
4	Dryer	Air leak from air-knife pipe joint
5	Conveyor	Spillage from degreasing tank
6	No.1Degreasing Tank	Soiling caused by fluid leakage

No.	Location	Description
7	No.2 Degreasing Tank	Soiling caused by fluid leakage
8	Aisle	Staining due to water leakage from sink
9	No.2 Degreasing Tank	Leakage of cooling water
10	No.1 High-Pressure Rinsing Tank	Leakage of water from gasket
11	Sink	Leakage of water from pipe joint

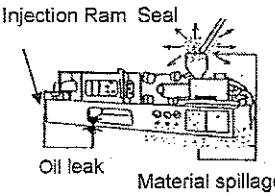
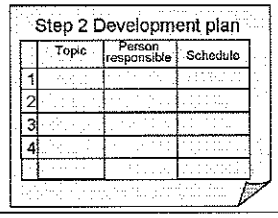
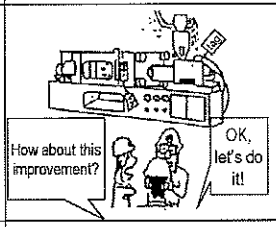
Step 2: Tackling Contamination Sources and Hard-to-Access Areas -2



Step 2: Tackling Contamination Sources and Hard-to-Access Areas -3

Stage	Identify benefits	Set monitoring points for periodic checking	Self-Review	Department Manager's and Factory Manager's Reviews
Objective	Experience the pleasure that improvement brings. Publicise your activities to others to serve as an example.	Determine points to be monitored regularly with a view to creating cleaning, lubrication and inspection standards in Step 3, and decide on monitoring methods.	The team leader improves the skills of all team members.	The review process enables managers at each level to coach the manager next in line under them (line managers coach team leaders, area managers coach line managers, and so on).
Action Required	1.Check that the measures taken really work 2. List any problems that have not yet been rectified, and re-investigate them. 3. Post all the improvements on an activity board, to let everyone know what has been done.	1. Decide which points need to be monitored for cleanliness, lubrication and oil scatter. State clearly who should do the checks, how they should do them, and how they should be recorded. Carry out the checks. 2. Decide which points need to be monitored for accumulation of dirt and dust, and how they should be monitored. Carry out the checks.	1. Each team member takes an Jishu-Hozne Self-Review Sheet and goes to the designated area. 2. The team leader reads out the items to be reviewed, one by one, and the team members check that item. 3. Any problems are then tagged and rectified. 4. The process is repeated until the whole team is satisfied with every area.	1. Each review team member scores the area using an Jishu-Hozne Review Sheet. 2. The reviewers point out specifically what has been done well and what not so well.
Comp-leted Scenario				
Key Points Checks	1. See tangible benefits in terms of quality, equipment reliability, ease of checking and cleaning, and maintainability. 2. Review the plan at least once a week (for automated plant) and once per cycle (on a shift system).	1. Work out a way of measuring the amount of contamination. e.g. for dust: None A B C Place a sheet of paper divided into three sections on the area to be observed, and tear off one section per week to see how much dirt is accumulating.	1. Team leaders should give individual guidance to each operator, in order to raise his or her capabilities. 2. When assessing the standard achieved, give most weight to the lowest score achieved for each item reviewed.	1. Be specific when pointing out the good and bad points. Give motivating advice, so that the team is encouraged to do even better next time. Encourage the team leader to provide effective leadership to the whole team. 2. Take the lowest score for each item reviewed as the score for that item.

Step 2: Tackling Contamination Sources and Hard-to-Access Areas -4

Stage	Check existing contamination sources and find new ones	Reassess schedule	Investigate proposed improvements	Implement improvements
Objective	Get all operators to reassess contamination sources, so that effective countermeasures are taken that really deal with the root causes.	Get all operators to work together towards achieving the targets.	Get operators to learn the basic theory and practice of equipment improvement.	Get the operators themselves to make the equipment easier to maintain.
Action Required	1. Identify all contamination sources, by looking at the location and extent of dust, dirt, oil leaks, product spills, etc., and how they affect the equipment.	1.Reassess and finalise the improvement plan for contamination sources and hard-to-access areas from Step 1. 2. The team leader explains the plan to his or her manager, and gets it approved. 3. The plan is posted on the activity board.	1. First, try to cut off all contamination sources at their root. If there is no way a particular source can be eradicated, localise (contain) the contamination. 2. See if the cleaning times can be shortened, or the intervals between inspections extended.	1. As far as possible, get operators to make improvements themselves, so as to give them a sense of craftsmanship and pride. 2. Set clear deadlines and request assistance for problems that are hard to resolve. 3. Keep to schedule by checking deadlines periodically, until the final deadline is reached.
Completed Scenario				
Key Points Checks	1.Understand how the contamination affects quality, equipment failure, setup time, and maintainability. 2. In particular, devise ways of identifying sources of dirt and dust. (e.g. dirt falling from beams) Primary source: top of beam Secondary source: top of hopper loader	1. The team leader must ensure that everyone stays on board and pulls in the same direction, by resolving individual problems and posting the plan up promptly.	1.Team leaders and supervisors advise team members on how to implement their ideas. 2. Everyone must understand the relevant parts of the equipment (how they are designed and how they work). 3. The team should get help from experts when necessary.	1. Get operators to learn all about materials, and the craft skills needed for working with them. 2. Make sure that any work requests are processed rapidly.

Step 3: Provisional Jishu-Hozen Standards

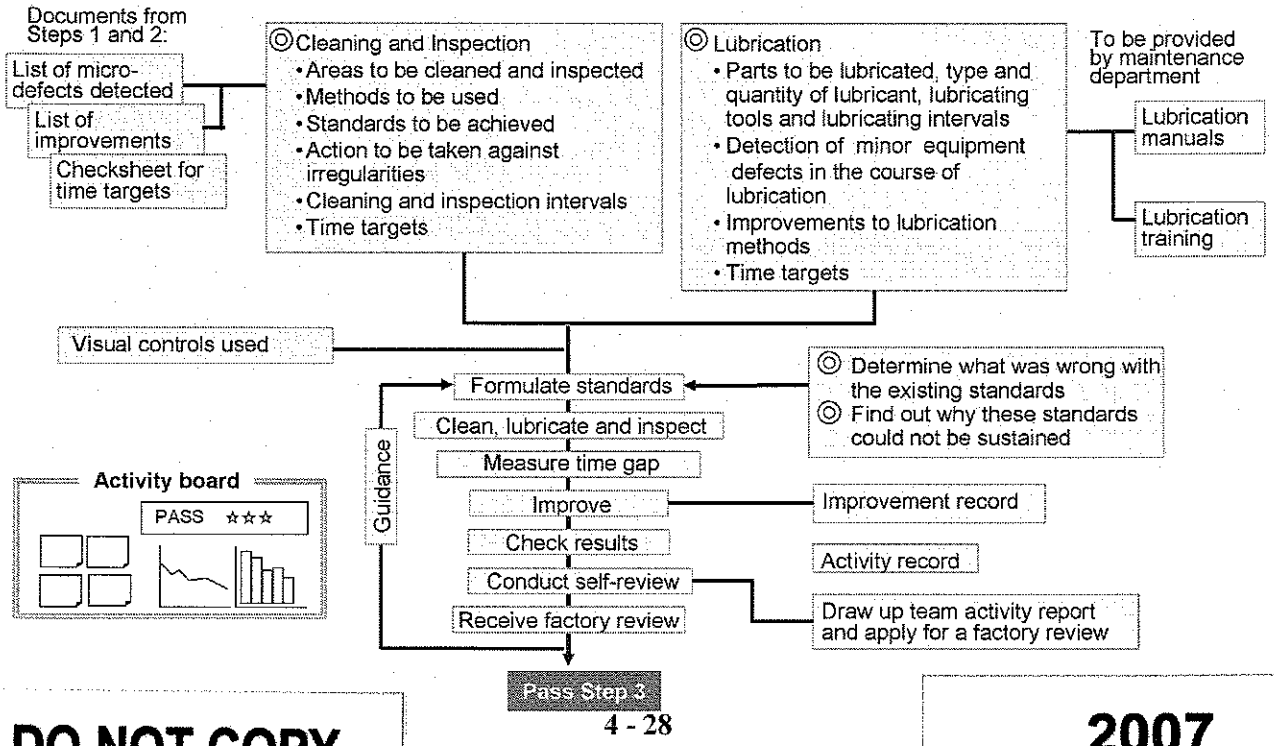
Step 3 is an important step in which operators use the experience they have acquired in Steps 1 and 2 to clarify what the ideal conditions for their equipment should be, and devise standards for the actions necessary to sustain those conditions (standards specifying the 5 Ws and 1 H, i.e. who is to do what, where, when, why and how).

Establish standards that can be followed

- The conditions to be sustained, and the methods to be followed, must be made explicit.
- The reasons why these conditions need to be sustained, and the negative consequences of not sustaining them, must be fully understood.
- The operators concerned must be given the capabilities needed to sustain the conditions.
- The prerequisites (such as sufficient time, etc.) for sustaining the conditions must be made available to the operators.

Step 3: Provisional Jishu-Hozen Standards - 1

[AIMS] * To formulate basic conditions for activities designed to prevent equipment deterioration, and to sustain cleaning, lubricating and tightening;
* To self-formulate action standards enabling these basic conditions to be faithfully upheld with minimal expenditure of time; To promote visual control.



Template for Creating Provisional Jishu-Hozen Standard

(At least one of these forms should be drawn up for each unit of equipment).

To be recorded on operator process chart

'Provisional' added

Circle as appropriate

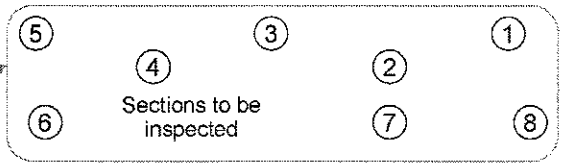
Serial number used within team

TPM	Provisional Jishu-Hozen Standard (for cleaning/lubrication/inspection)	No.
Area/process	Equipment name	Issued: Day: Month: Year:
		Area manager / Section manager / Super-visor / Team leader

The following should be entered regarding areas to be inspected in the course of cleaning:
- Items to be checked by sight
- Items to be checked by touch
- Items to be inspected using cleaning equipment

Diagram

Match with numbers in diagram



Target number of labour-hours to be spent on routine cleaning and lubrication (improvement target)

Include all important sections

Sections to be inspected

Method to be used

Standard or level required

Action to be taken if status is unsatisfactory

Target: mins / machine or month

Only regular lubrication tasks are entered.

	No.	Section	Method	Standard	Action	Interval: Month	Day	Week	Shift	Time (Min.)	Operator
Cleaning	1										
	2										
	3										
	4										
Lubrication	2										
	5										
	6										
	7										
									Total	(Min.)	

Note: Enter number of labour hours (if 2 persons are assigned, enter total)

Routine inspections of quality, safety, etc., must be controlled using separate work standards and checksheets.

Note: Σ (shift, day, week, month): Enter total number of labour-hours in minutes/month and improve until it meets the target time.

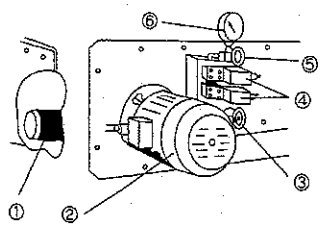
Approved by	Dept. Mgr.			Dept. Mgr.			Revised	△		△	
								△		△	

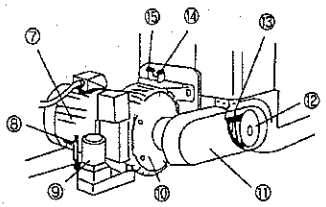
* These are the actions currently sustained by operators (i.e. the ones they actually can sustain, not the ones it is hoped they might sustain!) Put together, they constitute the standard. (Operators' performance improves through practical action.)

* Note: This is the current activity time. Enter the actual figure, and revise it whenever an improvement is m[illegible]

A Typical Provisional Jishu-Hozen Standard

Work Procedure	Provisional Standard for Cleaning, Lubrication and Inspection	Issued	Publish Date:	Area Manager	Supervisor	Team Leader
Area ———	Name of Equipment ——— (Part 1)	/				





No.	Name of part	Function	Replacement
1	Suction strainer	Removes dirt and debris	
2	Hydraulic drive motor	Drives pump	0.75 kW
3	Pressure control valve	Controls pressure	
4	Solenoid	Changes flow direction	
5	Pressure gauge cock	Prevents shocks on pressure gauge due to pulsing	
6	Pressure gauge	Indicates pressure	
7	Main motor	Drives equipment mechanisms	3.7 kW
8	Oil level indicator	Shows level of lubricating oil in gearbox	
9	Pilot motor	Drives planetary gears	
10	Stepless gearbox	Changes drive ratio using stepless system	
11	Belt cover	Protects drive belt	
12	Pulley	Transmits driving force	
13	Drive belt	Transmits driving force	A-49 V-belt
14	Lubricating nipple	Opening for replenishing lubricating oil	
15	Air bleed nipple	Opening for bleeding out air trapped inside motor during oil replenishment	

Cleaning

No.	Cleaning point	Standard required	Method	Tools	Time	Frequency: Daily	Weekly	Monthly	Person responsible
	Hydraulic unit (main body)	Free of dirt	Wipe with cloth	Cloth	4 min		○		Operator
	Main motor (main body)	Free of dirt	Wipe with cloth	Cloth	3 min		○		Operator

Lubrication

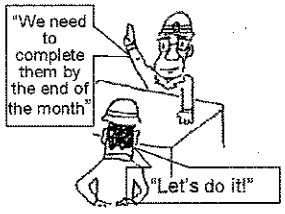
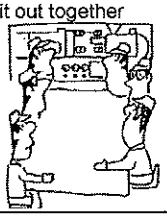
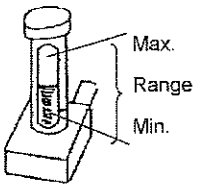
No.	Lubrication point	Standard required	Method	Oil to use	Tools	Time	Frequency: Daily	Weekly	Monthly	Person responsible
1	Level in hydraulic fluid reservoir	Between marks on level gauge	Visual	Multi 32	Oil can	5 min			6-monthly	Operator
8	Oil level in gearbox	Between marks on level gauge	Visual		Oil can	3 min			6-monthly	Operator

Inspection

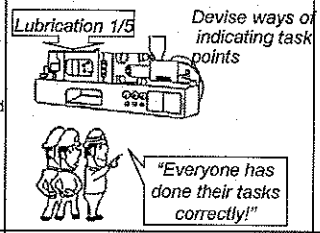
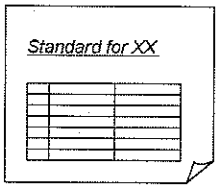
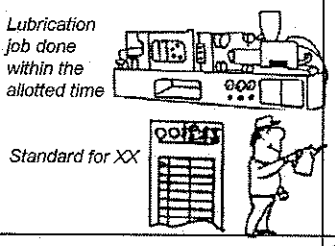
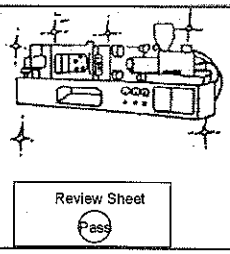
No.	Inspection point	Standard required	Method	Remedial Action	Time	Frequency: Daily	Weekly	Monthly	Person responsible
1	Suction strainer	Free of dirt	Visual	Clean during inspection	5 min			3-monthly	Operator
2	Hydraulic motor	No abnormalities (noise, smell, overheating)	Hearing / Touch / Smell	Stop machine and call technician	30 sec		○		Operator
3	Pressure control valve	Maintains set operating pressure	Visual	Stop machine and call technician	20 sec		○		Operator
4	Solenoid	Grindwheel holder moves back and forth smoothly	Visual / Touch	Stop machine and call technician	30 sec		○		Operator
5	Pressure gauge cock	Diaphragm works properly	Visual / Touch	Replace	5 min			○	Operator
6	Pressure gauge	Within indicated limits	Visual	Adjust at pressure control valve	10 sec		○		Operator
7	Main motor	No abnormalities (noise, smell, overheating)	Hearing / Touch / Smell	Stop machine and call technician	30 sec		○		Operator
9	Pilot motor	No abnormalities (noise, smell, overheating)	Hearing / Touch / Smell	Stop machine and call technician	15 sec		○		Operator
10	Stepless gearbox	No abnormalities (noise, smell, overheating)	Hearing / Touch / Smell	Stop machine and call technician	30 sec		○		Operator
11	Belt cover	Correct rotation direction No contact with pulleys or belt	Visual / Touch	Adjust	15 sec			6-monthly	Operator
12	Pulley / Belt	No cracks, play, or wear	Visual / Touch	Replace	5 min			6-monthly	Operator

Visual Controls are must, increase Precision & Reduce man power cost.

Step 3: Provisional Jishu-Hozen Standards - 2

Stage	Coordinate the approach (time / method)	Establish points to be covered by standards	Create plan and schedule	Promote Visual control
Objective	Agree with supervisors	Decide the points that require cleaning, lubricating or tightening in order to prevent the equipment from deteriorating.	Get all operators to work together towards achieving the targets.	Ensure that conditions can be judged quickly, on the spot.
Actions Required	1. Get advice on deciding which points require cleaning, lubricating or tightening. 2. Discuss the timescale for this step.	1. Get the whole team together to examine the equipment and identify which points require cleaning, lubricating or tightening in order to prevent it from deteriorating. 2. List the identified points in order of importance, stating why each is necessary. 3. Decide which points can be dealt with during the normal working day.	1. The team leader explains the overall plan that he or she has decided with his/her supervisor. 2. A schedule is established, based on each operator having his/her own area of responsibility. 3. The team draws up an action plan specifying: •Overall schedule •Schedule for each location and point •Improvement days	1. Think up ideas for implementing Visual control to enable conditions to be judged quickly and accurately, on the spot. 2. Select the best ideas. 3. Decide who will be responsible for each improvement and when they have to complete it by, and go ahead with the improvements.
Completed Scenario		Work it out together 	(Example : Schedule for oil gauge) Jan / Feb / Mar Overall Schedule David Andy Standard	(Example : Oil gauge) 
Key Points Checks	1. Talk to the supervisor to get his or her advice. 2. Agree deadlines by which improvements have to be completed.	1. The team leader should get advice before deciding on the servicing points.	1. The team leader must ensure that everyone stays on board and pulls in the same direction, by resolving individual problems and posting the plan up promptly.	1. Devise controls that allow operators to judge conditions on the spot, at a glance, by using maximum and minimum marks, colour coding, etc.

Step 3: Provisional Jishu-Hozen Standards - 3

Stage	Implement standards	Formulate standards	Self-Review	Department Manager's and Factory Manager's Reviews
Objective	Make sure that the standards can be applied during normal working hours.	Formulate standards that everyone can adhere to.	The team leader improves the skills of all team members.	The review process enables managers at each level to coach the manager next in line under them (line managers coach team leaders, area managers coach line managers, and so on).
Action Required	1. Decide where to keep all necessary objects. 2. Decide task order. 3. Leader does tasks and confirms that they can be completed within the specified time. 4. Check that all operators can complete their tasks within the specified time. 5. If the tasks cannot all be completed within normal working hours, improve them so that they can.	1. Decide equipment and specific points requiring inspection / cleaning / lubrication. 2. Decide what tools are needed. 3. Decide frequency of tasks. 4. Decide how to do each task. 5. Decide how to clear up afterwards. 6. Decide how much time each task requires.	1. Each team member takes an Jishu-Hozen Self-Review Sheet and goes to the designated area. 2. The team leader reads out the items to be reviewed, one by one, and the team members check that item. 3. Any problems are then tagged and rectified. 4. The process is repeated until the whole team is satisfied with every area.	1. Each review team member scores the area using an Jishu-Hozen Review Sheet. 2. The reviewers point out specifically what has been done well and what not so well.
Completed Scenario				
Key Points Checks	1. Ensure that all operators can carry out their tasks within normal working hours.	1. Written standards must be easy to follow. 2. It must be possible to implement the standards within normal working hours. 3. Use the same format for standards throughout the area (get advice from supervisor).	1. Team leaders should give individual guidance to each operator, in order to raise his or her capabilities. 2. When assessing the standard achieved, give most weight to the lowest score achieved for each item reviewed.	1. Be specific when pointing out the good and bad points. Give motivating advice, so that the team is encouraged to do even better next time. Encourage the team leader to provide effective leadership to the whole team. 2. Take the lowest score for each item reviewed as the score for that item.

Step 4: General Inspection

- In Jishu-Hozen Steps 1 to 3, the emphasis is on eliminating forced deterioration and sustaining basic conditions. Operators search out and eliminate equipment abnormalities, institute countermeasures against contamination sources and hard-to-access areas, and develop provisional cleaning, checking and lubricating standards. Thanks to these activities, they become increasingly able to recognise abnormalities and stop forced deterioration, as well as acquiring an improvement-oriented mindset and learning how to actually make improvements.

- While Steps 1 to 3 focus on detecting abnormalities using the five senses, Step 4 (General Inspection) takes this further. It aims to give operators a thorough understanding of the functions and structure of their equipment, and develop their ability to perform routine maintenance backed up by relevant logic and knowledge.

- When checking equipment, it is very important to pay close attention to minor abnormalities that could lead to breakdowns, quality problems and other chronic losses, identifying them precisely and taking effective action to eliminate them. To be able to do this, operators need to use the process of Step 4 to learn how to measure deterioration and predict when breakdowns and quality defects are likely to happen.

Step 4: General Inspection

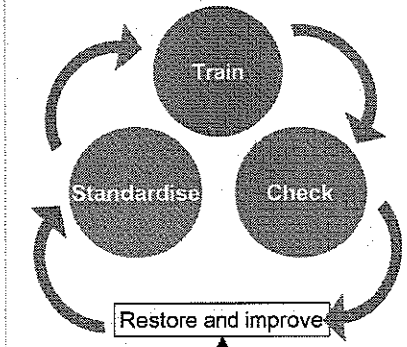
Aims

(1) Understand the equipment's structure, functions, principles and optimal condition.
(2) Acquire the skills needed to check the equipment's main functional components.
(3) Perform a thorough check of all the main functional components, and identify and correct potential problems.

- Cutaway models
- Checklists
- Flowcharts
- System diagrams

Preparation
- Identify required checks
- Prepare training materials
- Formulate a training plan

Implementation
- Appoint instructors
- Train team leaders
- 6 basic categories + 2 additional categories



Implementation

1. Fasteners
2. Lubrication
3. Hydraulics
4. Pneumatics
5. Drives
6. Electrics
7. Safety
8. Process Conditions

Draft an inspection standard for each category

- Create one-point lessons
- Conduct relay teaching
- Produce general inspection manuals
- Check theoretical understanding
- Check practical skills
- Visual control

Conduct a self-review in each category → Team Activity Report; Factory Review Application

Conduct a factory review in each category

Pass Step 4

Visual control
Activity board
- Examine the data for each category
- .....
- .....

Reviewers' comments

Step 4: Sub-Steps

Preparation for training

Select General Inspection categories — Maintenance staff — (Fasteners, lubrication, hydraulics, pneumatics, drives, electrics, safety, and process conditions)

Develop training materials — Maintenance staff — **General Inspection Checksheet**

Formulate training plan — Maintenance staff, Area managers — **General Inspection manuals** (cutaway models, wallcharts, slides, etc.)

Training

Train team leaders — Maintenance staff

Prepare for relay teaching to team members — Team Leaders, Workplace managers

Carry out relay teaching to team members — Team Leaders — (conduct General Inspection of pilot machine)

General Inspection

Perform General Inspection — Team Members — (conduct General Inspection of all machines)

Hold team meeting to list problems and plan countermeasures — Team — **Problem list** (areas of deterioration, hard-to-check places)

Solve problems — Team Members, Assigned maintenance personnel

Standardisation

Draft daily inspection standard — Team Members — **Draft standard** (for each category)

Check inspection skills — Team Leaders — **Skills check chart** (administer tests)

Conduct self-review and apply for factory review — Team Leaders

Conduct factory review — Maintenance staff, Area managers

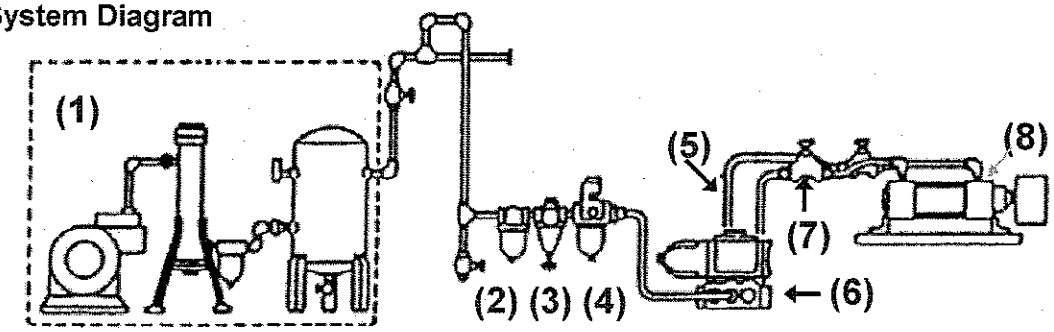
Act on reviewers' comments — Team Members, Assigned maintenance personnel

Move to the next General Inspection category (approx. 2 months / category)

Pneumatic System Flowchart

(1) Compressed air supply → (2) Filter → (3) Pressure control valve → (4) Lubricator → (5) Piping and joints → (6) Directional control valve → (7) Flow control valve → (8) Actuator

System Diagram



Developing General Inspection Points for a Pneumatic System

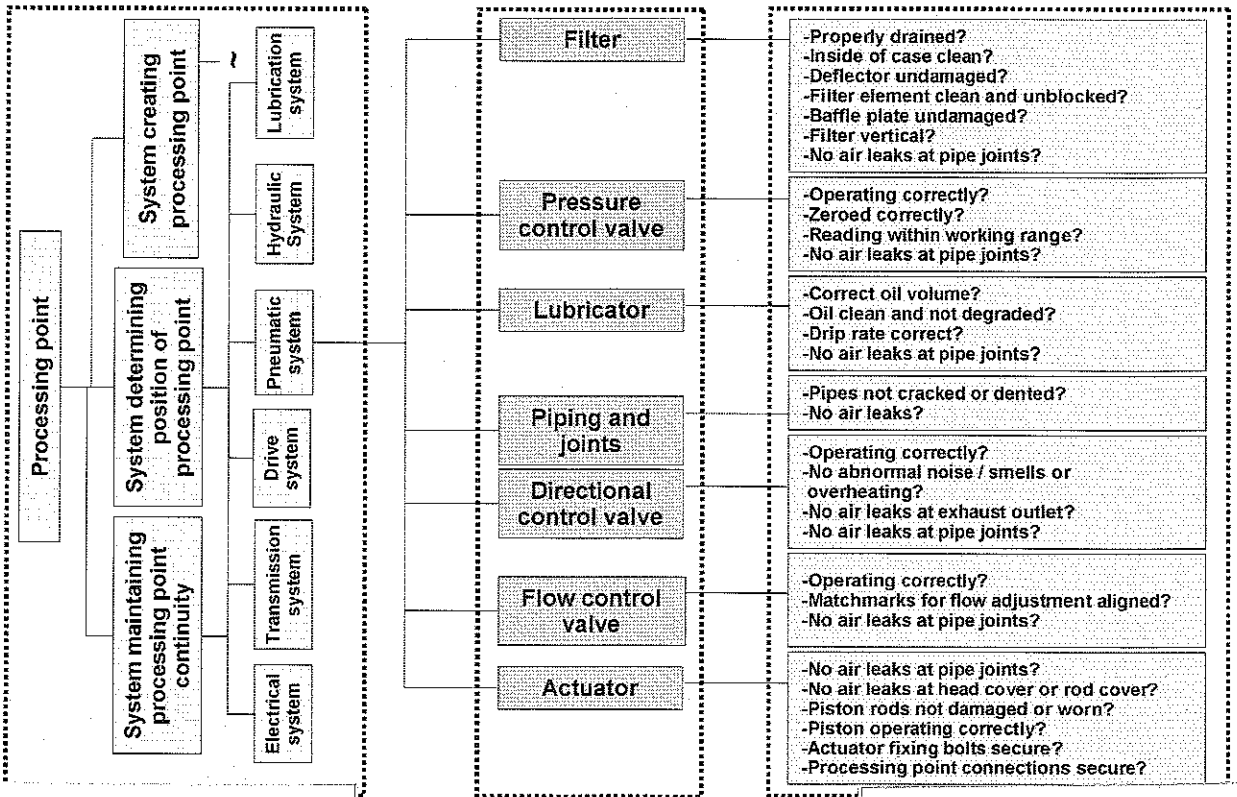
Identify processing points of equipment in question, understand functions and mechanisms, and identify necessary conditions.

Create system flowchart and system diagram, and identify parts to be checked.

Identify checks to be made at each part, and state why checks are necessary.

Create General Inspection Checksheet.

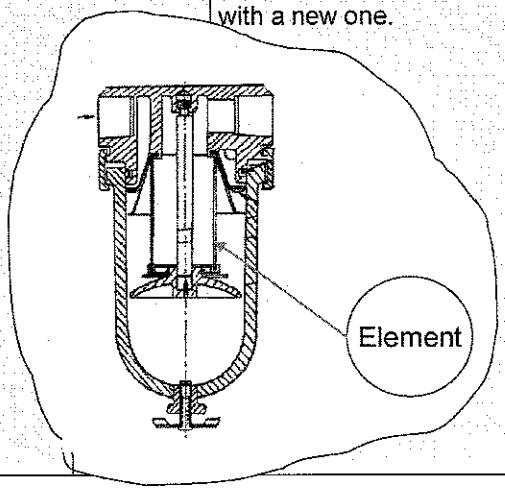
Review and improve checks.



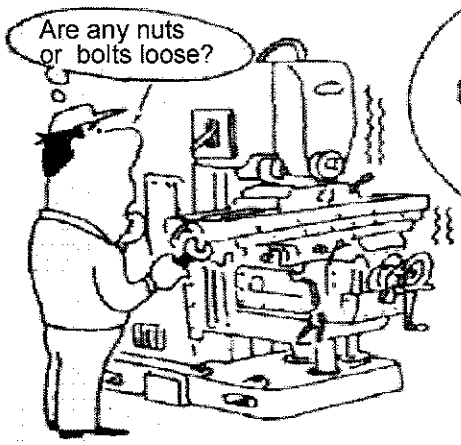
Procedure for Checking Filter Element (Know-why)

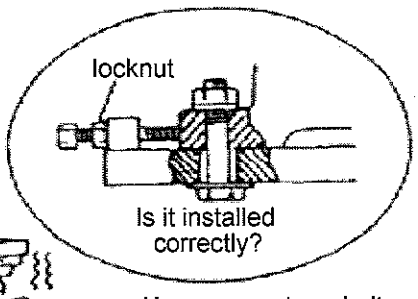
Part	Filter	Check	Filter element

Inspection Method and Required Standard	Action to Take if Part Does Not Meet the Standard	"Know-why" (Why this Check is Necessary)
•Remove filter element, and check that it is not dirty or blocked.	•If it is only lightly soiled, clean the element by blowing compressed air through it from the inside. •If it is blocked, replace it with a new one.	If the element is blocked, this will cause: → Fall in pressure → Uneven operation of actuator → Fluctuation in movement of processing point → Quality defects → Reduced speed → Breakdown → Malfunction of actuator → Breakdown → Ingress of dirt / dust / debris → Abnormal wear of directional control valve → Internal leaking → Uneven operation of actuator (same as above) → Sludge in flow control valve → Drop in flow rate



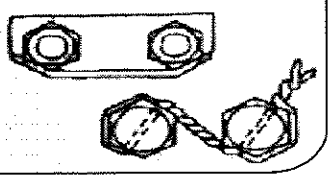
Fasteners



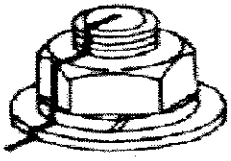


- Have any nuts or bolts worked loose or come off?
- Are flat washers used with all slotted bolt-holes?
- Are all the bolts inserted from below, with the nuts on top?

Skill Training (Example)
locking device

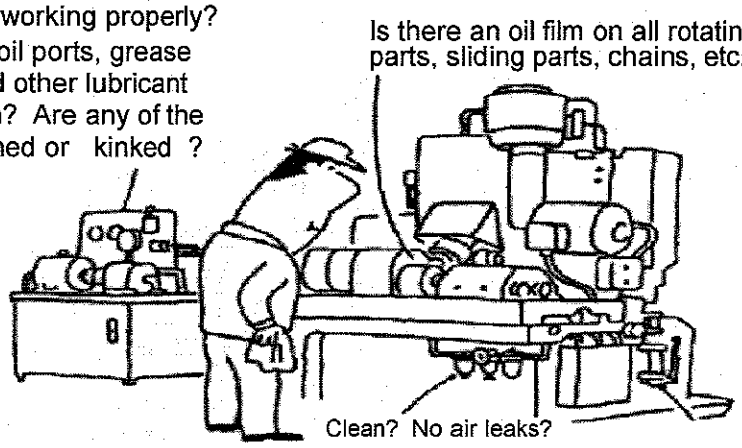


Visual Control (Example)
matchmark

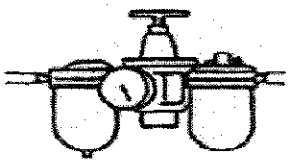


Lubrication

- Is the automatic lubricating equipment working properly?
- Are all the oil ports, grease nipples and other lubricant inlets clean? Are any of the pipes crushed or kinked ?

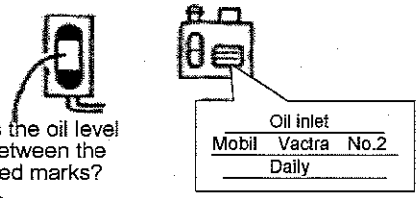


Skill Training (Example)

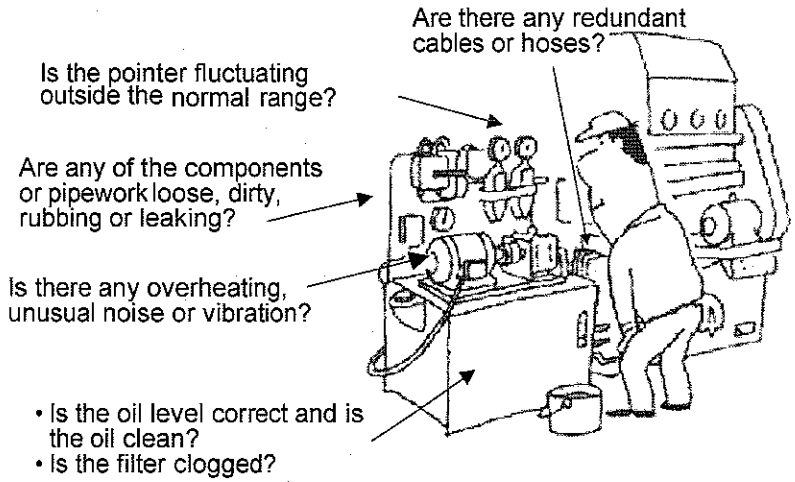


How to check an FRL

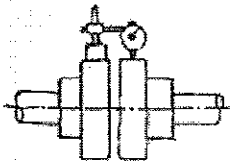
Visual Control (Example)



Hydraulics and Pneumatics

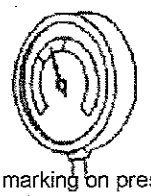


Skill Training (Example)



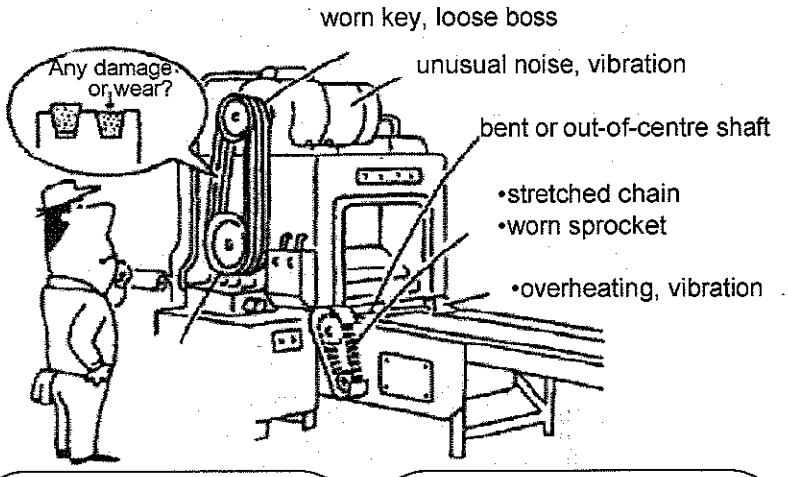
How to centrea coupling

Visual Control (Example)



Range marking on pressure gauge

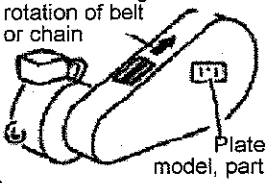
Drives



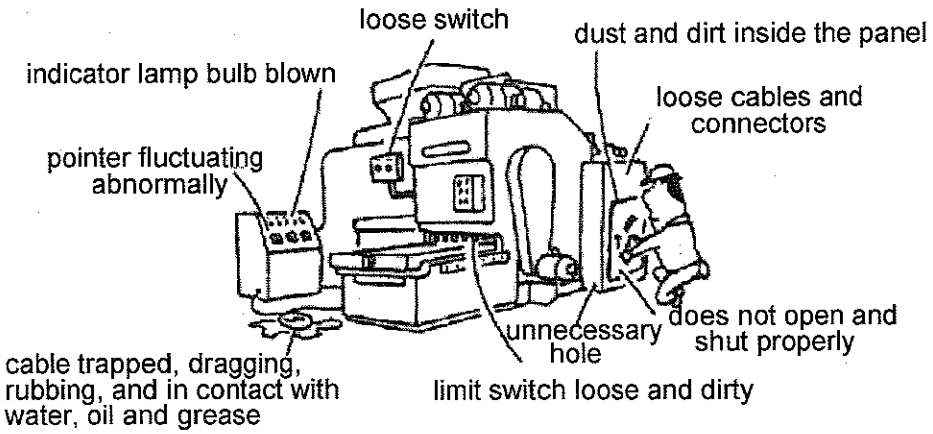
Skill Training (Example)

Visual Control (Example)

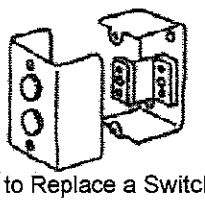
Arrow showing direction of rotation of belt or chain



Electrics



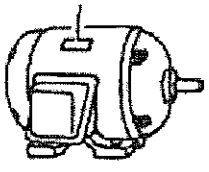
Skill Training (Example)



How to Replace a Switch

Visual Control (Example)

thermosensitivelabel



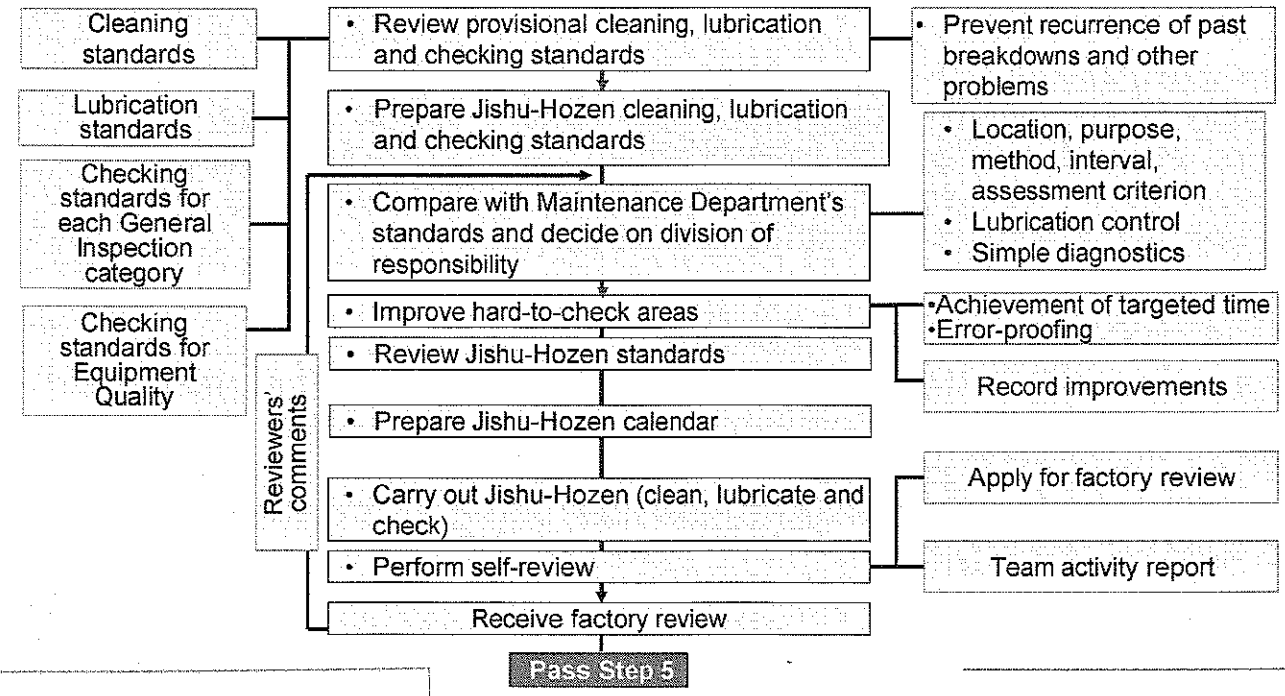
Step 5: Autonomous Inspection

- In the previous four steps, operators have reversed deterioration and restored equipment to its original condition. The aim of Step 5 is to sustain and further raise the levels of reliability, maintainability and quality thus achieved.
- This entails reviewing the provisional standards for cleaning, checking and lubricating developed so far, with the aim of working them up into a definitive set of efficient and comprehensive standards.

Step 5: Autonomous Inspection

Aims

- To review the provisional cleaning, lubrication and checking standards and develop a definitive set of Jishu-Hozen standards.
- To improve the efficiency of the autonomous checking tasks and introduce comprehensive visual control and error-proofing to ensure that the Jishu-Hozen standards are reliably upheld.



Example of Standard for Cleaning, Checking and Lubricating Bending Machine

Machine : No. 7 NC Bender

We have pledged to look after our equipment ourselves. So we are going to clean it, lubricate it and check it as laid out in this standard.

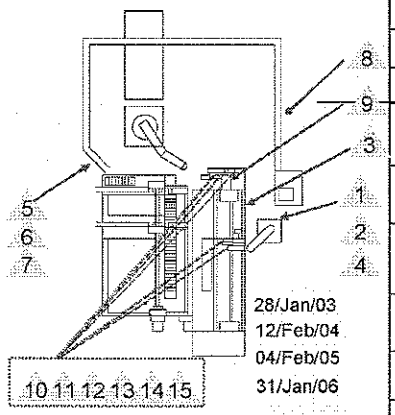
Team: XX Team, No.2 Manufacturing Section

Names of People Responsible for Keeping Machine Clean	OO OO

Serial No.NF－01

Date:

Area Mgr	Super-visor	Team Leader	Standard drafted by

Drawing	No.	Task	Part	Standard	Method	Tool	Time	Interval D	W	M	Time Slot
	1	Check	Main power switch	Beeps when pressed	Press power switch	Indicator on screen	10 s	○			8:30 - daily
	2	〃	Hydraulic pump S/W	Sound of motor turning	Press hydraulics switch	Sound	10 s	○			〃
	3	〃	Main hydraulic pressure	40 kPa	Check with hydraulics on	Visual	5 s	○			〃
	4	〃	Control panel	Check manual switches	Operate switches manually	〃	5 s	○			〃
	5	〃	NC-side air pressure	4 kPa	Check with air on	〃	25 s	○			〃
	6	〃	Supply-side air pressure	5 kPa	〃	〃	5 s	○			〃
	7	〃	FRL	No air leaks	〃	〃	3 s	○			〃
	8	〃	Emergency stop on safety guard	Machine shuts down; indicator lights up	Shuts down 3 seconds after opening guard	〃	15 s	○			〃
	9	〃	Workpiece detector	Check that indicator lamp on amplifier section lights up	Check using dummy bar	〃	10 s	○			〃
	10	〃	Operation of drive section	No abnormal movement	Check during continuous operation	〃	〃	○			When operating
	11	〃	Operation of bending jaws	〃	〃	〃	〃	○			〃
	12	〃	Operation of pressure plate	〃	〃	〃	〃	○			〃
	13	〃	Operation of chuck	〃	〃	〃	〃	○			〃
	14	〃	Operation of contact sensors	〃	〃	〃	〃	○			〃
	15	〃	Vertical movement of carriage	〃	〃	〃	〃	○			〃

○ Clean △Check ▢Lube

Visual control

Visual control is one of the areas where the strength of TPM, particularly its philosophy of prevention (one of its basic tenets) shows it self most dramatically.

On a production floor, visual controls make abnormalities, losses, waste and other unwanted situations instantly visible so that appropriate action can be taken before a real problem develops. Visual control is a collection of techniques and systems that enable preventive management to be practised.

<The Definition of Visual control>

Visual control is defined as a system for ensuring that whatever is being controlled knows when something has gone wrong, by which the abnormality itself attracts the attention of the human operators in the area and makes them take appropriate action to resolve the issue.

Visual indicators and visual controls are different!

Figure 1.1 Example of Visual Indicator

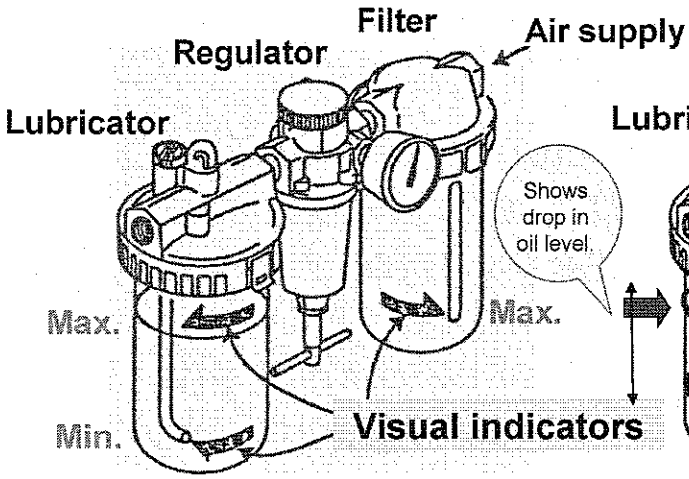
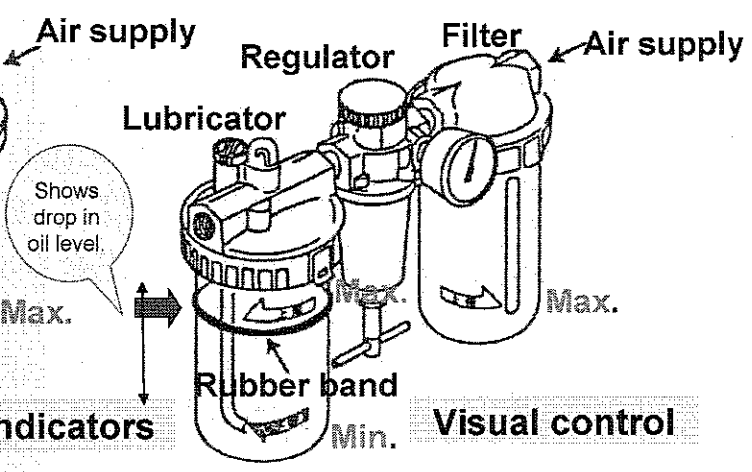


Figure 1.1 Example of Visual Control



1. Visual indicators provide a guide for monitoring the item under observation.
2. Visual controls make abnormalities in the actual function performed by the item under observation visible.

The 3 Big Benefits of Visual control

1. Abnormalities are promptly detected (losses and problems are prevented)
   → Since the abnormality itself attracts attention, it is quickly discovered
2. Misjudgements, misoperation, carelessness and forgetfulness are prevented
   → These can be prevented because whatever is being controlled makes its own judgements
3. Inspection is simplified and made more efficient
   → Because it is a system for making things visible, it eliminates waste and strain, and leads to greater efficiency

Step 6: Standardisation

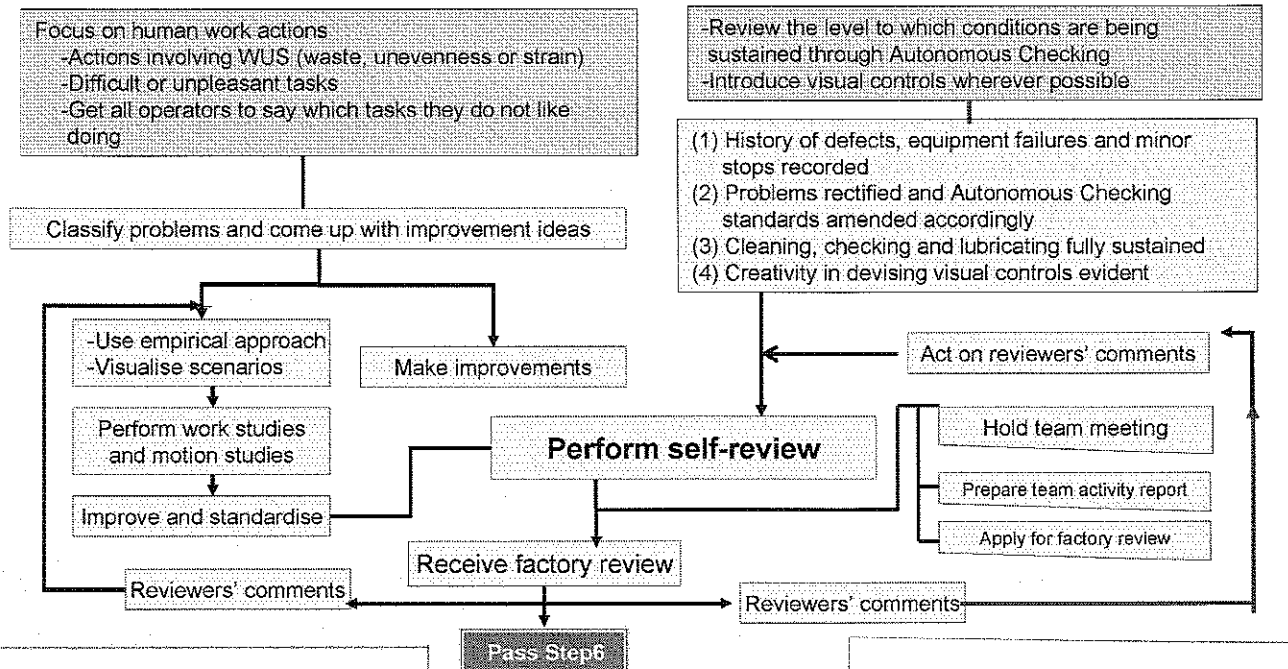
- Up to this stage, the Jishu-Hozen activities have focused on the equipment, and in particular, the basic equipment conditions and the daily checks required to maintain them.
- The aim of Step 6, in addition to consolidating what has been done so far, is to expand the operator's role to cover the equipment's surroundings as well as the equipment itself, continue to drive down the losses closer and closer to zero, and put the finishing touches to the teams' ability to manage their own work.

Step 6: Standardisation

Aims
(1) To review the operators' role, and rationalise and standardise their ancillary work
(2) To improve the level of sustainment achieved through Autonomous Checking, and build a system to maintain this improvement

Identify anything that has not been made optimally efficient and fully standardised in Steps 1 through 5 of Jishu-Hozen programme, and make suitable improvements

-Standards for the movement of materials around the shop floor
-Standard operating procedures
-Basic work standards
-Standards for data recording, etc.
-Standards for managing moulds, tools, jigs, and measuring equipment
-Standards for managing spare parts
-Standards for process quality assurance, etc.



Step 7: Full Self-Management

- The aim of Step 7 is to consolidate all of the activities undertaken in Steps 1 through 6. By this stage, the operators should have gained real confidence about the changes they have made in the equipment and the workplace, and in their own self-development, and understand the positive results that these changes have produced. The aim of Step 7 is to keep on encouraging them to see improvement as an endless process in which they can and must take the initiative. It should be used as an opportunity to reinforce the sense of participation and solidarity that their team activities will have developed, and allow them to go on exercising their creativity and ingenuity and build up even stronger emotional bonds with their colleagues and a solid sense of commitment to their workplace and the work they do there.
- They should no longer rely on external inputs but be totally autonomous and independent, drawing on their own resources to drive their actions, and fully capable of making the required contribution to the company's policy and objectives on their own

Step 7: Full Self-Management

Aims
(1) To consolidate the changes made to equipment and people, and the results achieved, and build a self-managing system in which operators take the initiative, ceaselessly striving to improve.
(2) To have everyone participate actively in a relentless drive towards zero failures, zero defects, and 'management at the source'.

Establish a system of workplace management that will not break down

(1) Clearly establish Jishu-Hozen as an integral part of the production department's responsibilities.
(2) Incorporate items covered by Jishu-Hozen into company policy, establishing zero accidents, zero defects, zero breakdowns and zero minor stops as explicit goals.
(3) Have Jishu-Hozen teams give mini-presentations at regular intervals. Ensure good communication with top management to give impetus to the activities.
(4) Hold regular Jishu-Hozen study sessions (including practical sessions on Kobetsu-Kaizen (Focused Improvement)) to increase operators' abilities to improve their work areas, and build a system that encourages an upward spiral of ongoing development.

Improve operators' abilities to fulfil their production role

(1) Select special, challenging topics related to company policy.
(2) Make it clear why those topics have been chosen, decide how the topics are to be developed, set targets, and put together an action plan.

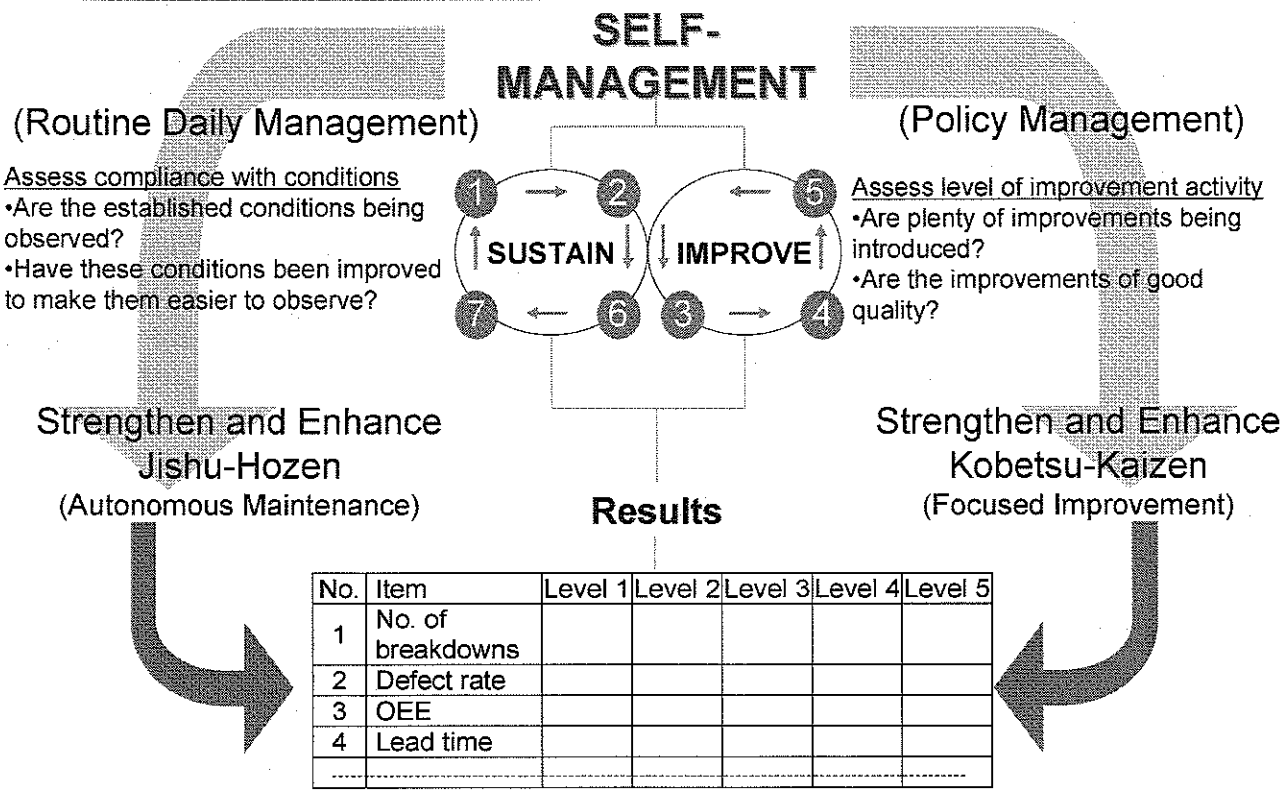
Use analytical methods extensively in carrying out improvements

Arrange events at which teams can present their improvements

Evaluate •Process used for meeting targets
•Number of suggestions relating to MP design

Regularly review work done to achieve business goals set by senior management

Basic Approach to Achieving a Self-Managing Workplace



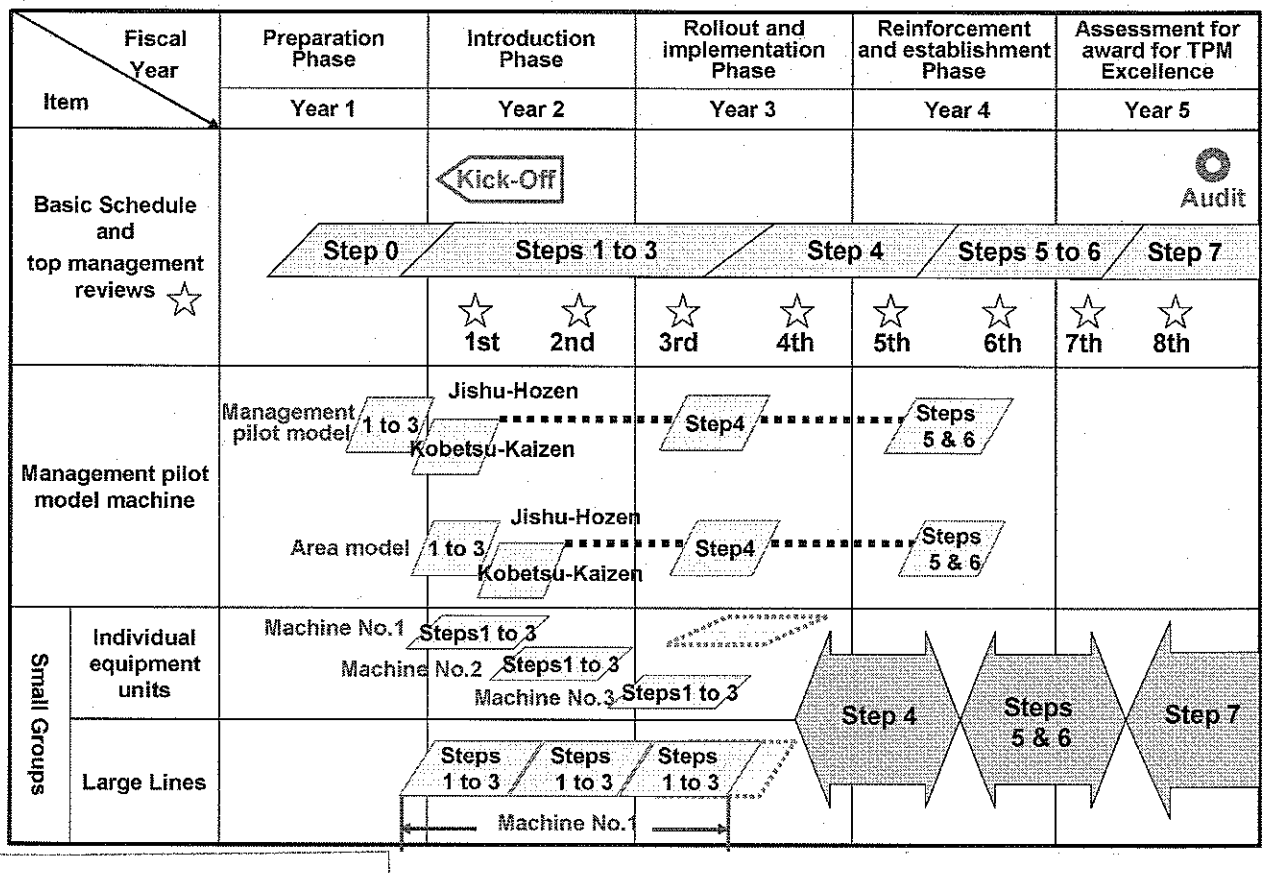
No.	Item	Level 1	Level 2	Level 3	Level 4	Level 5
1	No. of breakdowns					
2	Defect rate					
3	OEE					
4	Lead time					
...						

* What levels have been achieved compared to the companywide optimal levels?

Example of Self-Management Level Assessment

	Item to be reviewed	Points to check
Sustainment	Are the conditions being observed?	1. Have systems been put in place to sustain conditions?
		2. Are the established conditions being observed?
	Have the conditions been made easier to observe?	1. Have the established conditions been improved to make them easier to observe?
		2. Have these improvements been successfully locked down?
		3. Can the sustainment activities be carried out within the time allowed?
Improvement	Are plenty of improvements being implemented?	1. Are the teams working actively and positively towards completing their topics?
		2. Is everybody involved in the improvement activities?
		3. Does the number of completed topics meet the targets?
	Are the improvements of good quality?	1. Are the teams working on topics agreed with management?
		2. Are the improvements receiving high assessment scores?
Overall results	To what level are the site targets being achieved?	1. Has the number of equipment failures been reduced?
		2. Has the number of process defects been reduced?
		3. Has the OEE increased?
		4. Has productivity improved?
		5. Have skill improvement targets been met?
	To what level are the workplace targets being achieved?	1. Are the improvements specific to this workplace well chosen?
		2. What level have these improvements reached?

A Typical Jishu-Hozen Rollout Plan



The 14 Key Points for Successful Jishu-Hozen - 1

Key Points for Rollout

1. Carry out introductory training and ensure interdepartmental collaboration
2. Take a management-led, practical approach
3. Follow a step-by-step rollout programme
4. Use pilot models to show the way
5. Conduct proper reviews at each step

Key Points for Activities

6. Base the activities around small teams (at each organizational level)
7. Let rules be set by those who have to observe them
8. Carry out equipment modifications and other work promptly
9. Use the Kobetsu-Kaizen approach in team activities

Activity Tools (the '3 Crown Jewels')

10. Activity boards
11. Team meetings
12. One-point lessons & relay-teaching

Key Points for HRD

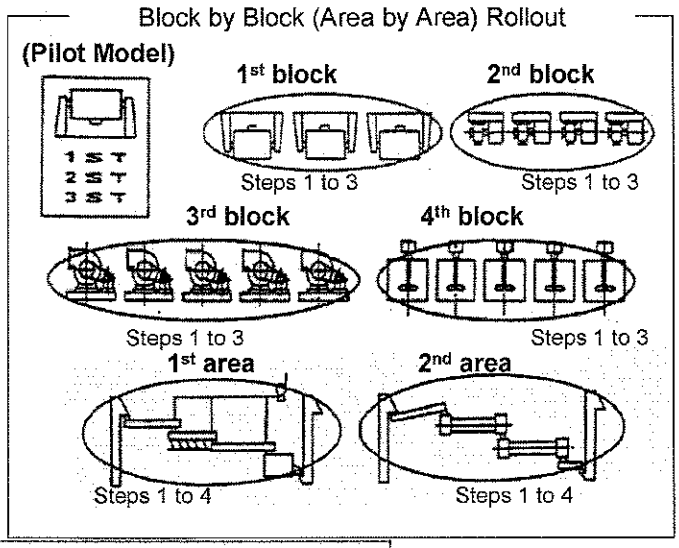
13. Success breeds success
14. Be thorough

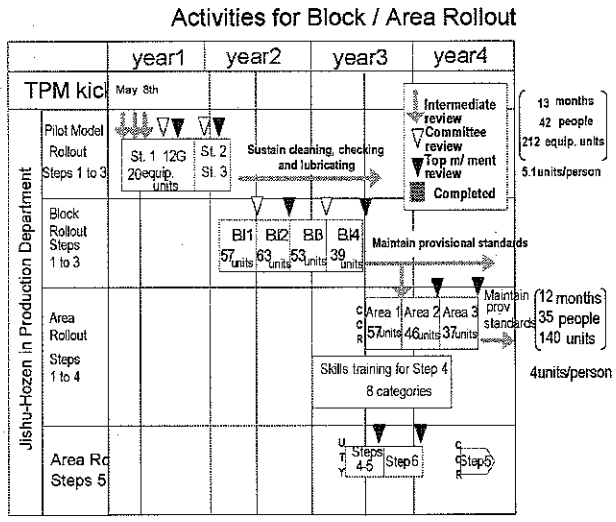
Example of Step-by-Step Rollout of Jishu-Hozen

(Illustration of excessive equipment load on each person)

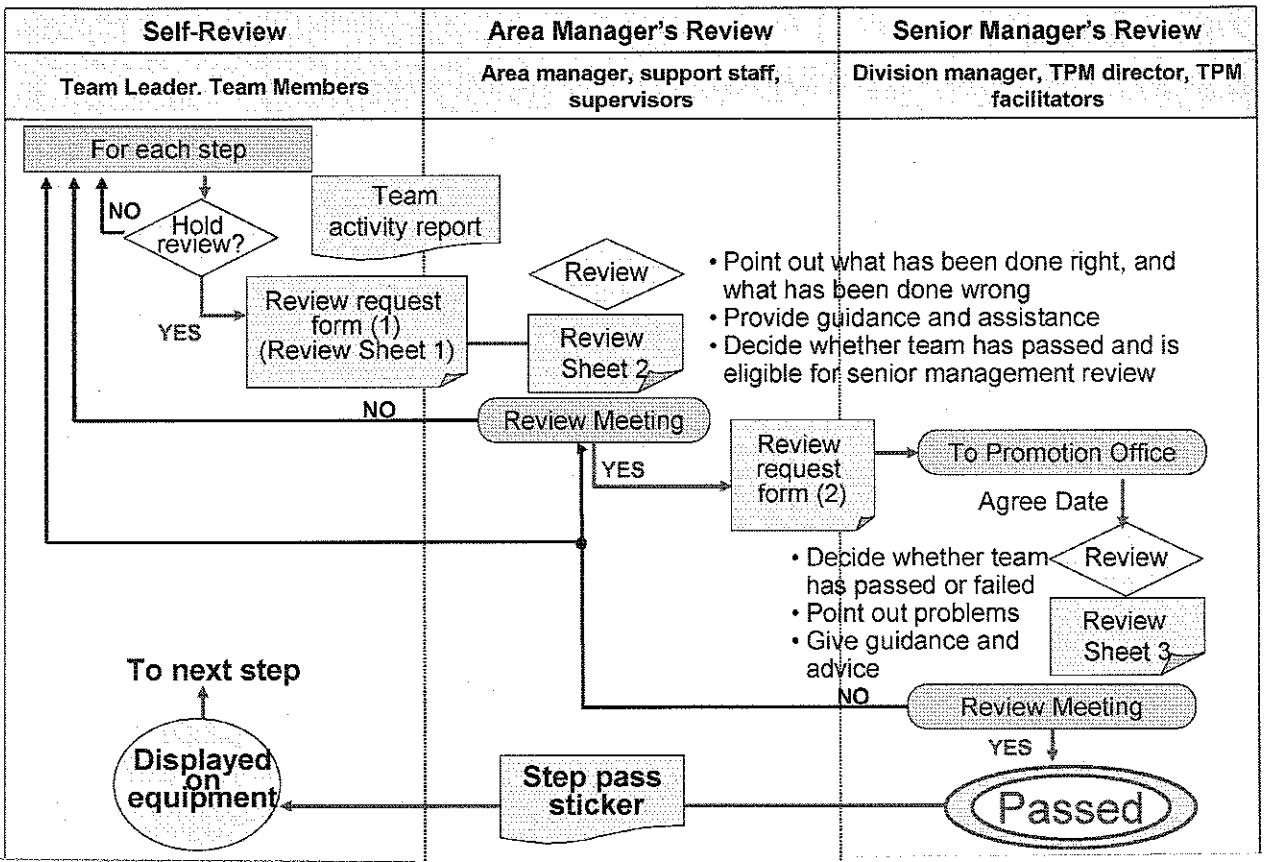
A	B	C	D	E	F	G	H	I	J
K	L	M	N	O	P	Q	R	S	T
U	V	W	X	Y	Z	a	b	c	d

Number of team members	5
Number of equipment units	30
Load per person	6





The Step Review Process



The 14 Key Points for Successful Jishu-Hozen - 2

Key Points for Rollout
1. Carry out introductory training and ensure interdepartmental collaboration
2. Take a management-led, practical approach
3. Follow a step-by-step rollout programme
4. Use pilot models to show the way
5. Conduct proper reviews at each step

Key Points for Activities
6. Base the activities around small teams (at each organizational level)
7. Let rules be set by those who have to observe them
8. Carry out equipment modifications and other work promptly
9. Use the Kobetsu-Kaizen approach in team activities

Activity Tools (the '3 Crown Jewels')
10. Activity boards
11. Team meetings
12. One-point lessons & relay-teaching

Key Points for HRD
13. Success breeds success
14. Be thorough

The 14 Key Points for Successful Jishu-Hozen - 3

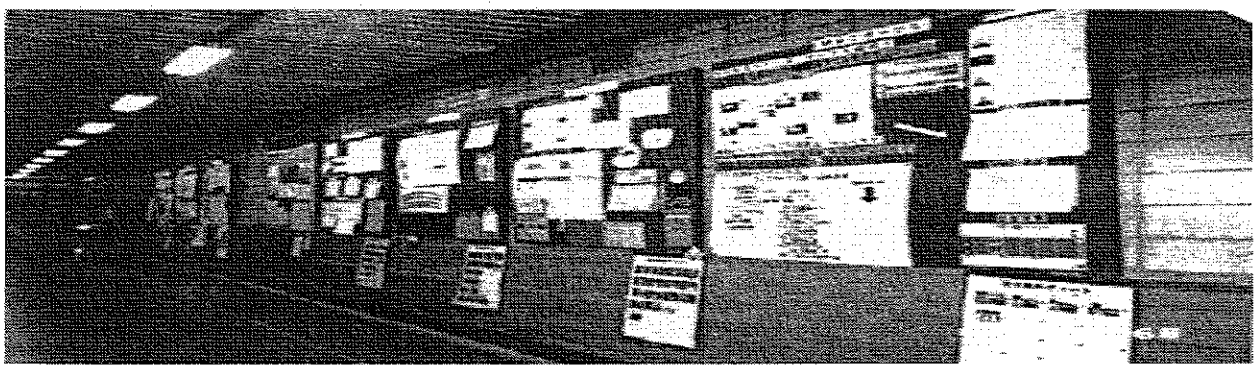
Key Points for Rollout
1. Carry out introductory training and ensure interdepartmental collaboration
2. Take a management-led, practical approach
3. Follow a step-by-step rollout programme
4. Use pilot models to show the way
5. Conduct proper reviews at each step

Key Points for Activities
6. Base the activities around small teams (at each organizational level)
7. Let rules be set by those who have to observe them
8. Carry out equipment modifications and other work promptly
9. Use the Kobetsu-Kaizen approach in team activities

Activity Tools (the '3 Crown Jewels')
10. Activity boards
11. Team meetings
12. One-point lessons & relay-teaching

Key Points for HRD
13. Success breeds success
14. Be thorough

Typical Activity Board



Policies

- Company-wide policies
  Area policies
- Team policies
  (own workplace)
- Team targets
  (own workplace)
- Master Plan
  (Schedule)
- Layout of
  teams work area
  ·Overall
  ·Area now being
  worked on
  ·Team members

Management indicators

- Throughput
- Availability
- Breakdowns
- Changeovers
- OEE
- Performance
- Die failure
- Productivity
- Quality
- Minor Stops

Jishu-Hozen

For area currently being worked on)

- · Ideal scenario
  · Targets
- Schedule
  (3months)
- Activity Timetable
- Tags place
  Tags removed

Kobetsu-Kaizen

No.	Topics
1	*********
2	*******
3	**********

- Topic No.1
- Topic No.2
- Topic No.3

Results, etc.

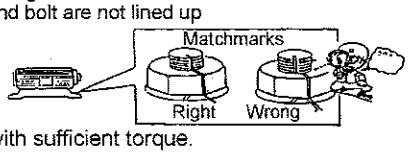
- Training Results
- No. of suggestions
- Near missies

- List of minor equipment defects
- One-point Lessons
- Activity Report
- F-tags

Typical One-Point Lessons

Topic	Checking loose motor fixing bolts

1. How do I tell if the bolts are loose?
   How to spot if there is something wrong...
   If the matchmarks on the nut and bolt are not lined up



2. What makes them come loose?
   They have not been tightened up with sufficient torque.
3. What will happen if the machine is used without correcting this problem?

-The motor will vibrate and cause unevenness in the drive output This will lead to product quality defects

Causes play or vibration -- which results in idling, failure or shutdown in other parts of the drive system

4. What to do if you spot the problem
   (1) Report it to your supervisor
   (2)Tighten up the loose bolt(s)

Circle the Category, Aim and People designated to receive the lesson:	People designated to receive lesson:
(Category) a. Training b. Quality c. Maintenance d. Safety e. 4S f. Other (Aims) a. New-entrant training b. Improvement advice c. Standardisation d. Skill upgrading e. Other	a. New entrant b. Operator new to line c. All operators in area d. Team e. Other ( )

Lesson	Month / Day	/	/	/	/	/	/	/	/	/	/	/
	Name of Instructor											
	No. of Trainees											

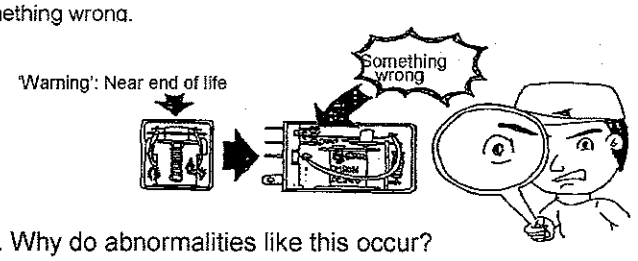
	Created	Date	Approved	Created
	Workplace			
	Team Name			

Typical One-Point Lessons

Topic	Problems with Relays

•If there is any discolouration of the inside of the relay case, or on the common lead, it means that the relay is near the end of its life.

•If the contact points or coil inside the case are discoloured, it means that there is something wrong.



N.B. Why do abnormalities like this occur?

1. Lifespan (the relay has exceeded its rated number of operations)
2. Excessive current

Place a circle around the Category, Aim and the People designated to receive the lesson	People designated to receive lesson
(Category) a. Training b. Quality c. Maintenance d. Safety e. 4S f. Other (Aims) a. OJT b. Improvement c. Standardisation d. Upgrade skills e. Other	a. New staff b. Team c. Other ( )

Lesson	Month / Day	13/6	17/6	18/6	/	/	/	/
	Name of Instructor	Stevens	Stevens	Lee				
	No. of Trainees	5	23	18				

Serial No. (Use[...] units for serial No.)	Created	Date	Approved	Created
	Workplace			
	Team Name			

The 14 Key Points for Successful Jishu-Hozen - 4

Key Points for Rollout

1. Carry out introductory training and ensure interdepartmental collaboration
2. Take a management-led, practical approach
3. Follow a step-by-step rollout programme
4. Use pilot models to show the way
5. Conduct proper reviews at each step

Key Points for Activities

6. Base the activities around small teams (at each organizational level)
7. Let rules be set by those who have to observe them
8. Carry out equipment modifications and other work promptly
9. Use the Kobetsu-Kaizen approach in team activities

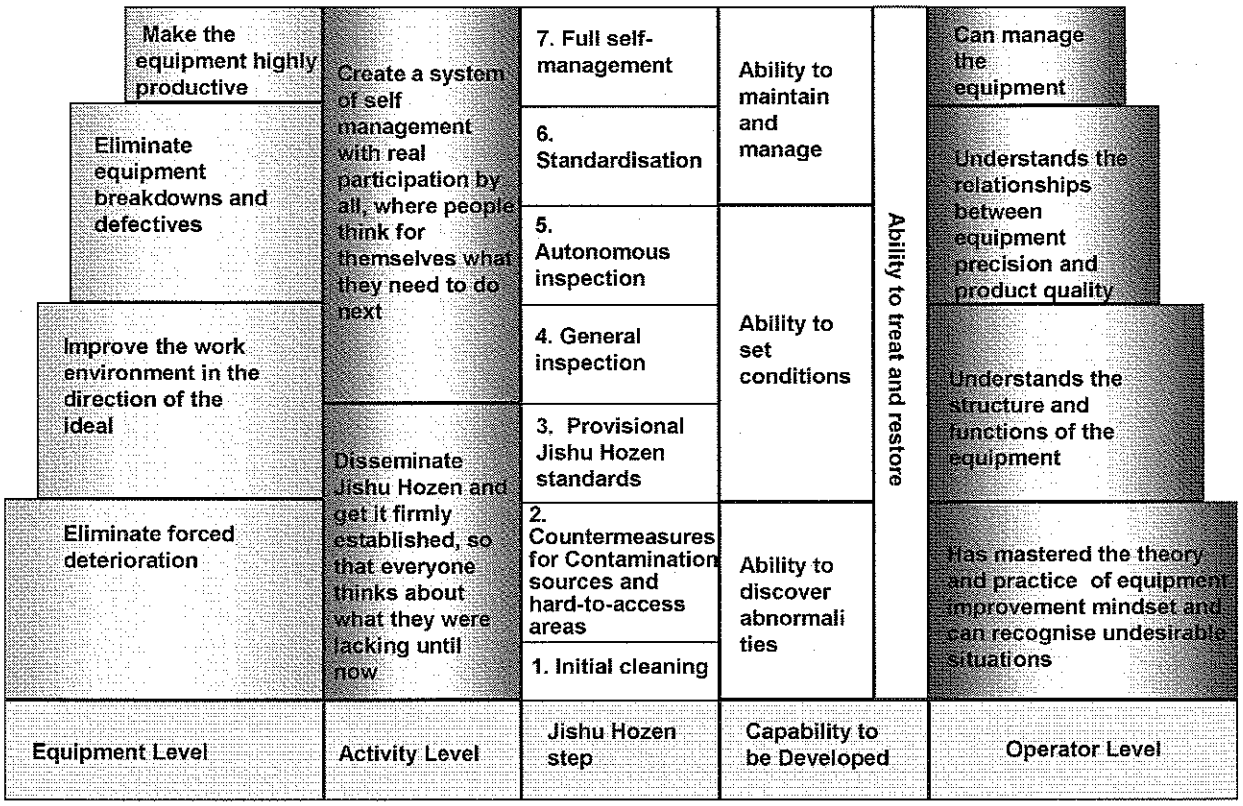
Activity Tools (the '3 Crown Jewels')

10. Activity boards
11. Team meetings
12. One-point lessons & relay-teaching

Key Points for HRD

13. Success breeds success
14. Be thorough

The Interaction of People and Equipment



Jishu-Hozen Review Sheet (Processing Equipment) -1

Jishu-Hozen Review Request

Jishu-Hozen Review Sheet

Step 1: Initial Cleaning(Processing Equipment)

Review type	Self	Area Manager	Senior Manager

Area / Team	
Equip. Unit No.	
Date requested for review	
Actual date / Time of review	
Name of reviewer	

Submission	Area manager	Team leader

Score: pt.	Pass	Fail

Pass levels :Score = total score for 'equipment' (Review Items 1-5) + score for 'people' (Review Item 6)

Self	Area M.	Senior M.
90 or over	85 or over	80 or over

Review Item	Key Points to Review	Poor 1 pt.	Rather poor 2 pt.	Fair 3 pt.	Quite good 4 pt.	Good 5 pt.	Comments
1. Cleanliness of main body of equipment	-Dust, dirt, oil stains and waste all cleaned off, and materials and tools put neatly in order (jigs, chucks, sliding parts, chutes, frames, beds, pipes, wires, etc.)?						
	-Looseness, play, vibration, friction and overheating eliminated (nuts, bolts, jigs, rotating and sliding parts, chutes, etc.)?						
2. Cleanliness of peripheral apparatus -Hydraulic, pneumatic, and water systems -Electrical control systems -Other	-Dust, dirt, oil stains and debris all cleaned off (cylinders, solenoids, FRLs, motors, limit switches, belts, proximity switches, photocells, control panel interiors/exteriors, meters / gauges, etc.)?						
	-Looseness, play, vibration, friction, buzzing and overheating eliminated (motors, solenoids, limit switch mounting plates, relays, wires, nuts, bolts, etc.)?						
3. State of lubrication	-Dust, dirt and oil stains all cleaned off (lubricators, oil pumps, level gauges, filler caps, supply pipes, etc.)?						
	-Oil volumes and drip rates correct, and looseness, play, and vibration eliminated (contamination/degradation of oil itself, pipe joints, valves, gearboxes, oil temperature, etc.)?						
4. Cleanliness of equipment surroundings	-Tools, measuring instruments, and spare parts all organised correctly? -Guards, nameplates, labels, and other signs all displayed correctly? -Unnecessary objects removed, and correct products and parts kept in correct places?						
	-Defective products clearly separated from good ones? -Aisles clear and tidy? -No scattering of dust/dirt from other equipment?						
5. Contamination sources and hard-to-access areas	-Chart drawn up plotting all sources of dirt, dust and oil stains, and areas that are hard to clean? Plan formulated for dealing with these?						
	-Improvements made to guards and cleaning tools? -Checking through cleaning' being implemented? -Cleaning areas clearly allocated?						
6. Way in which TPM is being addressed	-Do all team members have a good understanding of what TPM means, and are they all fully involved in implementing it? Points	10	20	30	40	50	
	Score						

Scoring key	Points		1 point / 10 points	2 points / 20 points	3 points / 30 points	4 points / 40 points	5 points / 50 points
	1-5	Equipment	Hardly implemented at all	Only implemented in obvious places	Implemented in specific locations (e.g. sliding parts, chutes)	Also implemented in more difficult and less obvious places	Full 'checking through cleaning' achieved, and difficult areas starting to be addressed
	6	People	No interest at all	Only maintenance staff and supervisors active	Operators taking part, but doing the easy tasks only	Operators doing nearly all the work	Responsibilities clearly defined, and everything being done properly

Jishu-Hozen Review Sheet (Processing Equipment)-2

Jishu-Hozen Review Request

Jishu-Hozen Review Sheet

Step 2: Contamination Sources and Hard-to-Access Areas(Processing Equipment)

Review type	Self	Area Manager	Senior Manager

Area / Team	
Equip. Unit No.	
Date requested for review	
Actual date / Time of review	
Name of reviewer	

Submission	Area manager	Team leader

Score: pt.	Pass	Fail

Pass levels :Score = total score for Review Items 1- 6

Self	Area M.	Senior M.
90 or over	85 or over	80 or over

Review Item	Key Points to Review	Poor	Rather poor	Fair	Quite good	Good	Comments
		2 pt.	4 pt.	6 pt.	8 pt.	10 pt.	
1. Sustainment of Step 1	- Cleaning levels achieved in Step 1 (Initial Cleaning) being properly sustained?						
2. Countermeasures for main body of equipment	Sources of dirt, dust, oil leaks, air leaks, etc. all plotted on a chart, and action taken to rectify them?						
	- Hard-to-access areas all marked on a chart, and creative improvements implemented to make them more accessible (guarding improved, original cleaning tools devised, everything sorted and reorganised)?						
3. Countermeasures for peripheral devices	Sources of dirt, dust, oil leaks, air leaks, etc. all plotted on a chart, and action taken to rectify them?						
	- Hard-to-access areas all marked on a chart, and creative improvements implemented to make them more accessible (guarding improved, original cleaning tools devised, everything sorted and reorganised)?						
4. Countermeasures for equipment surroundings	Sources of dirt, dust, oil leaks, air leaks, etc. all plotted on a chart, and action taken to rectify them?						
	- Hard-to-access areas all marked on a chart, and creative improvements implemented to make them more accessible (guarding improved, original cleaning tools devised, everything sorted and reorganised)?						
5. Improvement and sustainment	Lubrication points clearly labelled according to lubrication standards, so that anyone can lubricate the machines correctly?						
6. Status of activities	-All team members actively involved?						
	- Plenty of original thought going into the improvements?						

Scoring key	Points		2	4	6	8	10
	1-5	Equipment	Hardly implemented at all	Only implemented in obvious places	Implemented in specific locations	Also implemented in more difficult and less obvious places	Comprehensive lubrication achieved; hardly any outstanding issues
	6	People	No interest at all	Only maintenance staff and supervisors active	Operators taking part, but doing the easy tasks only	Operators doing nearly all the work	Responsibilities clearly defined, and everything being done properly

Jishu-Hozen Review Sheet (Processing Equipment)-3

Jishu-Hozen Review Request

Jishu-Hozen Review Sheet

Step 3: Provisional Jishu-Hozen Standards (Processing Equipment)

Review type	Self	Area Manager	Senior Manager

Area / Team	
Equip. Unit No.	
Date requested for review	
Actual date / Time of review	
Name of reviewer	

Submission	Area manager	Team leader

Score: pt.	Pass	Fail

Pass levels

Self	Area M.	Senior M.
90 or over	85 or over	80 or over

Review Item	Key Points to Review	Poor	Rather poor	Fair	Quite good	Good	Comments
1. Sustainment of Steps 1 and 2	- Cleaning levels achieved in Step 1 (Initial Cleaning) and improvements made in Step 2 (Contamination Sources and Hard-to-Access Areas) being properly sustained?	3 pt.	6 pt.	9 pt.	12 pt.	15pt.	
2. Maintenance of basic equipment conditions (action standards for cleaning, lubricating and tightening)	(Cleaning Standards) - Separate standards created for each equipment unit, area, etc.?	1 pt.	2 pt.	3 pt.	4 pt.	5 pt.	
	- Cleaning areas, locations and work duties properly defined and allocated?						
	- Cleaning methods and tools specified?						
	- Suitable cleaning times and intervals set and observed?						
	- Standards clear enough for anyone to follow?						
	(Lubrication Standards) - Type and quantity of oil, frequency of lubrication, method and responsibilities all clearly specified?						
	- All lubrication points correctly labelled?						
	- Required lubricants always available?						
	- Lubricants stored neatly and systematically (lubricant storage areas clean and tidy)?						
	(Tightening) - Nuts and bolts all correctly tightened?						
	- Any nuts and bolts missing?						
3. Awareness of role in creating standards	- Teams setting their own standards?	2 pt.	4 pt.	6 pt.	8 pt.	10pt.	
	- Standards being observed?						
	- Improvements actively pursued to make checking easier and enhance Visual control?						

Jishu-Hozen Review Sheet (Fastenings)

Jishu-Hozen Review Request

Jishu-Hozen Review Sheet

Step 4-1: General Inspection (Fastenings)

Review type	Self	Area Manager	Senior Manager

Area / Team	
Equip. Unit No.	
Date requested for review	
Actual date / Time of review	
Name of reviewer	

Submission	Area manager	Team leader

Score: pt.	Pass	Fail

Pass levels :Score = total score for Review Items 1- 6

Self	Area M.	Senior M.
90 or over	85 or over	80 or over

Review Item	Key Points to Review	Poor	Rather poor	Fair	Quite good	Good	Comments
		20 pt.	40 pt.	60 pt.	80 pt.	100 pt.	
Sustainment	(Steps 1 to 3 activities properly managed and sustained?) -Action against contamination sources being properly sustained? -Good improvements making hard-to-access areas more accessible? -Cleaning and lubrication standards completed and applied rigorously?						
		1 pt.	2 pt.	3 pt.	4 pt.	5 pt.	
1. Skills Training	-Leaders and team members actively creating OPLs and compiling them into manuals to upgrade their skills?						
	-General Inspection skills mastered by all team members?						
2. General Inspection	-Inspection done correctly, covering all items in category trained?						
	-Minor equipment problems identified reliably during inspection process?						
	-Action taken to deal with these problems?						
3. Safety	-Progress made in identifying and fixing minor equipment problems that compromise safety?						
4. Shop-floor review (Fastenings)	-All nuts and bolts, etc. correctly tightened?						
	-Any nuts or bolts missing or damaged?						
	-Countermeasures against loosening (locknuts, etc.) introduced where necessary?						
	-Flat washers used for oval holes?						
	-Bolts of suitable length used?						
	-Matchmarks inscribed on nuts and bolts susceptible to vibration?						
	-Same kinds of nuts, bolts, washers, etc. used in same kinds of locations?						
	-Spanners and other tools located and arranged for easy use (marked location for each tool)?						
	-Regularly-used fastenings improved for easy installation and removal??						
5. Provisional Autonomous Maintenance standards	-Provisional checking standards completed?						
	-Improvements made to reduce number of checks required?						
	-Improvements done to make checks easier to carry out?						
	-Suitable checking methods and checking intervals adopted?						
	-Ways found to ensure that all checks are done reliably, without any being omitted?						

Jishu-Hozen Review Sheet (Lubrication)

Jishu-Hozen Review Request

Jishu-Hozen Review Sheet

Step 4-2: General Inspection (Lubrication)

Review type	Self	Area Manager	Senior Manager

Area / Team	
Equip. Unit No.	
Date requested for review	
Actual date / Time of review	
Name of reviewer	

Submission	Area manager	Team leader

Score: pt.	Pass	Fail

Pass levels :Score = total score for Review Items 1- 6

Self	Area M.	Senior M.
90 or over	85 or over	80 or over

Review Item	Key Points to Review	Poor	Rather poor	Fair	Quite good	Good	Comments
		20 pt.	40 pt.	60 pt.	80 pt.	100 pt.	
Sustainment	(Steps 1 to 3 activities properly managed and sustained?) -Action against contamination sources being properly sustained? -Good improvements making hard-to-access areas more accessible? -Cleaning and lubrication standards completed and applied rigorously?						
		1 pt.	2 pt.	3 pt.	4 pt.	5 pt.	
1. Skills Training	-Leaders and team members actively creating OPLs and compiling them into manuals to upgrade their skills?						
	-General Inspection skills mastered by all team members?						
2. General Inspection	-Inspection done correctly, covering all items in category trained?						
	-Minor equipment problems identified reliably during inspection process?						
	-Action taken to deal with these problems?						
3. Safety	-Progress made in identifying and fixing minor equipment problems that compromise safety?						
4. Shop-floor review (Lubrication)	-Lubrication points correctly and clearly labelled, with effective systems for ensuring that none is missed out?						
	-Correct lubricant types being used?						
	-Correct amounts of lubricant being used?						
	-Lubricants clean and not degraded?						
	-All lubrication pipes unblocked and undamaged?						
	-Lubricants always available when needed?						
	-Different lubricators, oil cans, etc. used for different types of lubricant?						
	-All grease nipples and lubricators undamaged and free of dust and dirt?						
	-Different lubricant types separated and arranged systematically in lubrication stations? Lids always kept on containers? Stations appropriately located and free from dust and dirt?						
5. Provisional Autonomous Maintenance standards	-Provisional checking standards completed?						
	-Improvements made to reduce number of checks required?						
	-Improvements done to make checks easier to carry out?						
	-Suitable checking methods and checking intervals adopted?						
	-Ways found to ensure that all checks are done reliably, without any being omitted?						

Jishu-Hozen Review Sheet (Drives)

Jishu-Hozen Review Request

Jishu-Hozen Review Sheet

Step 4-3: General Inspection (Drives)

Review type	Self	Area Manager	Senior Manager

Area / Team	
Equip. Unit No.	
Date requested for review	
Actual date / Time of review	
Name of reviewer	

Submission	Area manager	Team leader

Score: pt.	Pass	Fail

Pass levels :Score = total score for Review Items 1- 6

Self	Area M.	Senior M.
90 or over	85 or over	80 or over

Review Item	Key Points to Review	Poor 20 pt.	Rather poor 40 pt.	Fair 60 pt.	Quite good 80 pt.	Good 100 pt.	Comments
Sustainment	(Steps 1 to 3 activities properly managed and sustained?) -Action against contamination sources being properly sustained? -Good improvements making hard-to-access areas more accessible? -Cleaning and lubrication standards completed and applied rigorously?						
		1 pt.	2 pt.	3 pt.	4 pt.	5 pt.	
1. Skills Training	-Leaders and team members actively creating OPLs and compiling them into manuals to upgrade their skills?						
	-General Inspection skills mastered by all team members?						
2. General Inspection	-Inspection done correctly, covering all items in category trained?						
	-Minor equipment problems identified reliably during inspection process?						
	-Action taken to deal with these problems?						
3. Safety	-Progress made in identifying and fixing minor equipment problems that compromise safety?						
4. Shop-floor review (Drives)	-V-belts unworn and in good condition? Pulleys unworn and properly centred?						
	-V-belts correctly tensioned?						
	-Visual controls introduced on V-belt covers to indicate direction of rotation, belt specifications, etc.?						
	-Lubricating oil penetrating fully between pins and bushes on chains?						
	-Chains unstretched and properly centred? Chains free of meshing problems due to worn sprockets?						
	-Bearings free of overheating, vibration or strange noises due to bent or off-centre shafts, loose fixing bolts, under-lubrication, etc.?						
	-Shafts, keys and couplings free of play (loose bolts, etc.)?						
	-Irregular noise in gearboxes, speed reducers , etc.?						
	-Gearboxes, speed reducers, etc. properly lubricated? Any overheating?						
5. Provisional Autonomous Maintenance standards	-Provisional checking standards completed?						
	-Improvements made to reduce number of checks required?						
	-Improvements done to make checks easier to carry out?						
	-Suitable checking methods and checking intervals adopted?						
	-Ways found to ensure that all checks are done reliably, without any being omitted?						

Jishu-Hozen Review Sheet (Hydraulics and Pneumatics)

Jishu-Hozen Review Request

Jishu-Hozen Review Sheet

Step 4-4: General Inspection (Hydraulics and Pneumatics)

Review type	Self	Area Manager	Senior Manager

Area / Team	
Equip. Unit No.	
Date requested for review	
Actual date / Time of review	
Name of reviewer	

Submission	Area manager	Team leader

Score: pt.	Pass	Fail

Pass levels :Score = total score for Review Items 1- 6

Self	Area M.	Senior M.
90 or over	85 or over	80 or over

Review Item	Key Points to Review	Poor 20 pt.	Rather poor 40 pt.	Fair 60 pt.	Quite good 80 pt.	Good 100 pt.	Comments
Sustainment	(Steps 1 to 3 activities properly managed and sustained?) -Action against contamination sources being properly sustained? -Good improvements making hard-to-access areas more accessible? -Cleaning and lubrication standards completed and applied rigorously?						
		1 pt.	2 pt.	3 pt.	4 pt.	5 pt.	
1. Skills Training	-Leaders and team members actively creating OPLs and compiling them into manuals to upgrade their skills?						
	-General Inspection skills mastered by all team members?						
2. General Inspection	-Inspection done correctly, covering all items in category trained?						
	-Minor equipment problems identified reliably during inspection process?						
	-Action taken to deal with these problems?						
3. Safety	-Progress made in identifying and fixing minor equipment problems that compromise safety?						
4. Shop-floor review (Hydraulics and Pneumatics, plus water circulation systems)	-Pipes and units free of leaks and stains?						
	-All units effectively protected against dust?						
	-Motors and pumps free of irregular noise and vibration, and switchover valves, solenoid valves, etc. free of odd noises, strange smells, etc.?						
	-Correct oil volume and oil temperature in hydraulic units?						
	-FRLs being used correctly (correct oil volume, clean filter, etc.)?						
	-Hoses correctly installed, clean, undamaged and free of vibration?						
	-Pipes run above floor level, and properly supported?						
	-Pipes easy to inspect and service?						
	-Pressure gauges all in order (correct readings, easily-read dials)?						
5. Provisional Autonomous Maintenance standards	-Provisional checking standards completed?						
	-Improvements made to reduce number of checks required?						
	-Improvements done to make checks easier to carry out?						
	-Suitable checking methods and checking intervals adopted?						
	-Ways found to ensure that all checks are done reliably, without any being omitted?						

Jishu-Hozen Review Sheet (Electrics)

Jishu-Hozen Review Request

Jishu-Hozen Review Sheet

Step 4-5: General Inspection(Electrics)

Review type	Self	Area Manager	Senior Manager

Area / Team	
Equip. Unit No.	
Date requested for review	
Actual date / Time of review	
Name of reviewer	

Submission	Area manager	Team leader

Score: pt.	Pass	Fail

Pass levels :Score = total score for Review Items 1- 6

Self	Area M.	Senior M.
90 or over	85 or over	80 or over

Review Item	Key Points to Review	Poor	Rather poor	Fair	Quite good	Good	Comments
		20 pt.	40 pt.	60 pt.	80 pt.	100 pt.	
Sustainment	(Steps 1 to 3 activities properly managed and sustained?) -Action against contamination sources being properly sustained? -Good improvements making hard-to-access areas more accessible? -Cleaning and lubrication standards completed and applied rigorously?						
		1 pt.	2 pt.	3 pt.	4 pt.	5 pt.	
1. Skills Training	-Leaders and team members actively creating OPLs and compiling them into manuals to upgrade their skills?						
	-General inspection skills mastered by all team members?						
2. General Inspection	-Inspection done correctly, covering all items in category trained?						
	-Minor equipment problems identified reliably during inspection process?						
	-Action taken to deal with these problems?						
3. Safety	-Progress made in identifying and fixing minor equipment problems that compromise safety?						
4. Shop-floor review (Electrics)	-Distribution panels, control panels and operating panels all clearly marked?						
	-Temperature in distribution panels, control panels and operating panels low enough?						
	-Distribution panels, control panels and operating panels all clean (free of water, oil, dirt, etc.?)						
	-Door seals, filters, etc. on distribution panels, control panels and operating panels all clean and undamaged?						
	-No irregularities in wiring or contacts (overheating, damage, unsafe layout)?						
	-Motors free of overheating, strange noises, vibration?						
	-Sensors securely installed in correct positions, and making proper contact?						
	-Sensors all clean (free of water, oil, dirt, etc.)?						
	-Sensors undamaged, with all lead wires correctly installed? Effectively protected against possible damage?						
5. Provisional Autonomous Maintenance standards	-Provisional checking standards completed?						
	-Improvements made to reduce number of checks required?						
	-Improvements made to make checks easier to carry out?						
	-Suitable checking methods and checking intervals adopted?						
	-Ways found to ensure that all checks are done reliably, without any being omitted?						

Jishu-Hozen Review Sheet (Assembly Shop) - 1

Jishu-Hozen Review Request

Jishu-Hozen Review Sheet

Step 1: Initial Cleaning (Assembly Shop)

Review type	Self	Area Manager	Senior Manager

Area / Team	
Equip. Unit No.	
Date requested for review	
Actual date / Time of review	
Name of reviewer	

Submission	Area manager	Team leader

Score: pt.	Pass	Fail

Pass levels :Score = total score for 'equipment' (Review Items 1-5) + score for 'people' (Review Item 6)

Self	Area M.	Senior M.
90 or over	85 or over	80 or over

Review Item	Key Points to Review		Poor	Rather poor	Fair	Quite good	Good	Comments
			1 pt.	2 pt.	3 pt.	4 pt.	5 pt.	
1. Cleanliness of surrounding area	-Floors free of dirt, oil stains, sawdust, waste material, nuts, bolts, etc.? -All unnecessary objects cleared away?							
	-Cleaning tools, work tools, etc. all stored neatly in designated positions? -Floor marking standards observed?							
2. Cleanliness of peripheral equipment, assembly tools, etc.	-Free of dirt, dust and oil stains? -All parts suitably tightened and free of wear? -Electric cables undamaged?							
	-Equipment and tools kept in good condition and stored in a well-organised manner?							
3. Cleanliness of trolleys, carts, shelving, work benches and other items on which parts are placed	-Trolleys, carts, shelves, work benches, etc. positioned correctly? -Unnecessary objects cleared away?							
	-Trolleys, carts, shelves, work benches, etc. stable and in good condition, posing no safety -risks?							
4. Cleanliness of storage points for assembly components	-Components stored neatly, in parallel and at right-angles (on shelving, pallets, trolleys, etc.)?							
	-Components clearly labelled to show at a glance what each is used for?							
5. Contamination sources and hard-to-access areas	-Systematic feedback of suggestions to improve precision in upstream processes? -Chart drawn up plotting all sources of dirt and dust, and areas that are hard to clean? Plan formulated for dealing with these?							
	-Improved cleaning tools introduced? -Cleaning areas clearly defined and allocated?							
6. Way in which TPM is being addressed	-Do all team members have a good understanding of what TPM means, and are they all fully involved in implementing it?	Points	10 pt.	20pt.	30pt.	40 pt.	50 pt.	
		Score						

Scoring key	Points		1 point / 10 points	2 points / 20 points	3 points / 30 points	4 points / 40 points	5 points / 50 points
	1-5	Equipment	Hardly implemented at all	Only_implemented_in obvious places	Implemented in specific locations	Also implemented in more difficult and less obvious places	Full 'checking through cleaning' achieved, and difficult areas starting to be addressed
	6	People	No interest at all	Only maintenance staff and supervisors active	Operators taking part, but doing the easy tasks only	Operators doing nearly all the work	Responsibilities clearly defined, and everything being done properly

Jishu-Hozen Review Sheet (Assembly Shop) - 2

Jishu-Hozen Review Request

Jishu-Hozen Review Sheet

Step 2: Contamination Sources and Hard-to-Access Areas (Assembly Shop)

Review type	Self	Area Manager	Senior Manager

Area / Team	
Equip. Unit No.	
Date requested for review	
Actual date / Time of review	
Name of reviewer	

Submission	Area manager	Team leader

Score: pt.	Pass	Fail

Pass levels :Score = total score for Review Items 1- 6

Self	Area M.	Senior M.
90 or over	85 or over	80 or over

Review Item	Key Points to Review	Poor 2 pt.	Rather poor 4 pt.	Fair 6 pt.	Quite good 8 pt.	Good 10 pt.	Comments
1. Sustainment of Step 1	-Cleaning levels achieved in Step 1 (Initial Cleaning) being properly sustained?						
2. Measures for achieving appropriate levels of permanent stock	-Measures taken to ensure suitable stock levels are maintained?						
	-Improvements and modifications introduced to make remaining stock levels visible at a glance?						
3. Countermeasures for peripheral equipment and assembly tools	-Sources of dirt, dust, oil leaks, air leaks, etc. all plotted on a chart, and action taken to rectify them?						
	-Improvements and modifications introduced to make remaining stock levels visible at a glance?						
4. Countermeasures for component shelves and assembly storage points	-Chart drawn up plotting all sources of disruption to storage system, and appropriate action taken?						
	-Improvements and modifications introduced to make remaining stock levels visible at a glance?						
5. Improvement and sustainment, and future plans	-Systematic feedback of suggestions to improve precision in upstream processes? Strategies worked out for sustaining conditions in the future?						
6. Status of activities	-All team members actively involved?						
	-Plenty of original thought going into the improvements?						

Scoring key	Points		2 points	4 points	6 points	8 points	10 points
	1-5	Equipment	Hardly implemented at all	Only implemented in obvious places	Implemented in specific locations	Also implemented in more difficult and less obvious places	Comprehensive lubrication achieved; hardly any outstanding issues
	6	People	No interest at all	Only maintenance staff and supervisors active	Operators taking part, but doing the easy tasks only	Operators doing nearly all the work	Responsibilities clearly defined, and everything being done properly

Jishu-Hozen Review Sheet (Assembly Shop) - 3

Jishu-Hozen Review Request

Jishu-Hozen Review Sheet

Step 3: Sustainment Standards (Assembly Shop)

Review type	Self	Area Manager	Senior Manager

Area / Team	
Equip. Unit No.	
Date requested for review	
Actual date / Time of review	
Name of reviewer	

Submission	Area manager	Team leader

Score: pt.	Pass	Fail

Pass levels

Self	Area M.	Senior M.
90 or over	85 or over	80 or over

Review Item	Key Points to Review	Poor	Rather poor	Fair	Quite good	Good	Comments
1. Sustainment of Steps 1 and 2	-Cleaning levels achieved in Step 1 (Initial Cleaning) and improvements made in Step 2 (Contamination Sources and Hard-to-Access Areas) being properly sustained?	3 pt.	6 pt.	9 pt.	12 pt.	15pt.	
2. Efficient system based on work standards, checking standards and workplace management standards	-Precise standards created for managing assembly equipment, tools, and consumables?	2 pt.	4 pt.	6 pt.	8 pt.	10 pt.	
	-Cleaning and inspection standards created for equipment, tools, assembly areas and storage areas? Standards being observed?						
	-Inspection efficiency maximised; system allows problems or defects to be rectified quickly?						
	-Standards for component storage and placement clearly defined, and visual controls used?						
	-Work standards established and observed?						
	-Layout revised and improved to raise efficiency of assembly work?						
	-Assembly work schedule drawn up by team itself, displayed clearly, and properly maintained?						
3. Status of activities	-Activity boards used effectively?	1 pt.	2 pt.	3 pt.	4 pt.	5 pt.	
	-Many improvement suggestions being made, and efficiency drive being actively implemented?						
4. Improvement and sustainment, and future plans	-Improvements being actively pursued? Team discussing how to proceed to next step?						

Application for Jishu-Hozen Review

Application for Autonomous Maintenance Review Step No. (Review No.)	Date :			
	TPM Office	Area Manager	Supervisor	Originator

Team making application	Area / Line/ Team	Team Name	Leader's Name	No. of members	Equipment to be Reviewed

Overall Status of Activities		Status of Activities Relating to Current Step		
	Date last step passed		Work Time	Total time hr.
				Total no. of people
	Preferred date for review of current step		Meeting time	Total no. of meetings
				Total duration hr.
	Number of improvement suggestions			Total no. of participants

Requested focus of review		
	Scope	
	Key points	
	Difficulties overcome	
	Other	

Date/time of review		Reviewer		Conclusion	Date
Duration of review					

Chief Reviewer's Comments		TPM Office's Comments	

Jishu-Hozen Activities Report

Autonomous Maintenance Activities Report	Date :			
	TPM Office	Area Manager	Supervisor	Originator

Step No.	Area / Line / Team	Team Name	Leader's Name	No. of members	Topic

	Date	Category	Details	Participants (note time spent by each person)	Time spent	No. of people	Total Time
-Meetings held							
-Action taken							
-Training received							
-Results achieved							
Meetings = M Action = A Teaching = T Practice = P							

No. of problems identified	No. taken on by team		No. taken on by other departments		Completed in current month	Carried over to next month	Results		No.	No. of People	Total time
								Meetings			
								Action			
								Teaching			
								Practice			

Schedule of Activities for Next Month	

Focused Improvement Progress Check	Identify Situation	Select topics	Set targets	Plan activities	Analyse situation	Stratify, analyse, and track down causes	Take corrective action	Confirm and consolidate	Assess results and benefits	Review
	1	2	3	4	5	6	7	8	9	10

Managers' views and advice (comments from review, etc.):

TPM Minutes of Meeting / Action

TPM Minutes of Meeting / Action	Area Committee Area Subcommittee Team

TPM Office	Area Manager	Supervisor	Team Leader

Date (of Issue)	Area / Line / Team	Team Name	Leader's Name	Recorder

Topic or agenda		Details of Activities	Meeting Date & Time:
Participants			Action Date & Time
Absentees			Teaching Date & Time
			Training Date & Time
			Practice Date & Time
			Total time (hr.) × (people) = person-hrs.

No	Item Description / Action	Deadline	Person Responsible

Next topic or agenda		Next scheduled meeting	Date	Time	Place

Supervisor's comments		Area Manager's comments		TPM Office's comments	

Example of a Team Activity Report

Example of a Team Activity Report						
Team Activity Report	Issued			October 18, 200_ (5th meeting)		
	Team			Twisters		
Topic Getting ready to undergo the Step 2 review	Area			Tool Area 3, Shift 1, Group 5		
	Team Leader	Johnston		Recorder	Jones	
	Activities	Work done	__:__ to __:__ (time) on ____/____ (date)			
Participants: Johnston, Jones, Shaw, Elliott, Hall, Augustine		Meeting	15:50 to 17:00 on October 15			
		Teaching carried out	__:__ to __:__ (time) on ____/____ (date)			
Absentees: None		Total time	(1 hour) × (6 persons) =(6 persons-) hours			

No.	Item	Action	Duration	Person responsible
1	Our Step 2 review will take place on October 22. What do we do between now and then?	(1) Review initial cleaning (day and night shifts) and carry out 15 minutes' vigorous cleaning after each break	From October 8	Everyone
		(2) Draw up a list of priorities for initial cleaning	October 8	Jones
		(3) Record oil leak de-tagging status on activity boards	October 20	Shaw
2	An anti-scatter cover is now installed, but there is still some spillage from the gaps.	(1) Try out Version 8 spot-cover	October 20	Elliott, Hall
3	Re-check the situation	(1) Record using VTR borrowed from Area Manager	October 20	Augustine
Area Manager's comments: Step 3 should be read and understood		Area Office's comments: Hold meetings more often		Supervisor's comments: Keep following the PDCA cycle as you do this

TPM Manual Chapter 5 Keikaku-Hozen
(Planned Maintenance)

JIPM-Solutions Co. Ltd.

Basic Knowledge for Carrying out Keikaku Hozen

<<The Aims of Keikaku Hozen>>

The purpose of Keikaku Hozen is to make the equipment reliable (with zero failures and quality defects) and to do so efficiently, at minimum cost.

1) Activities for increasing availability

Activities for eliminating failures and quality defects and getting the best out of the equipment

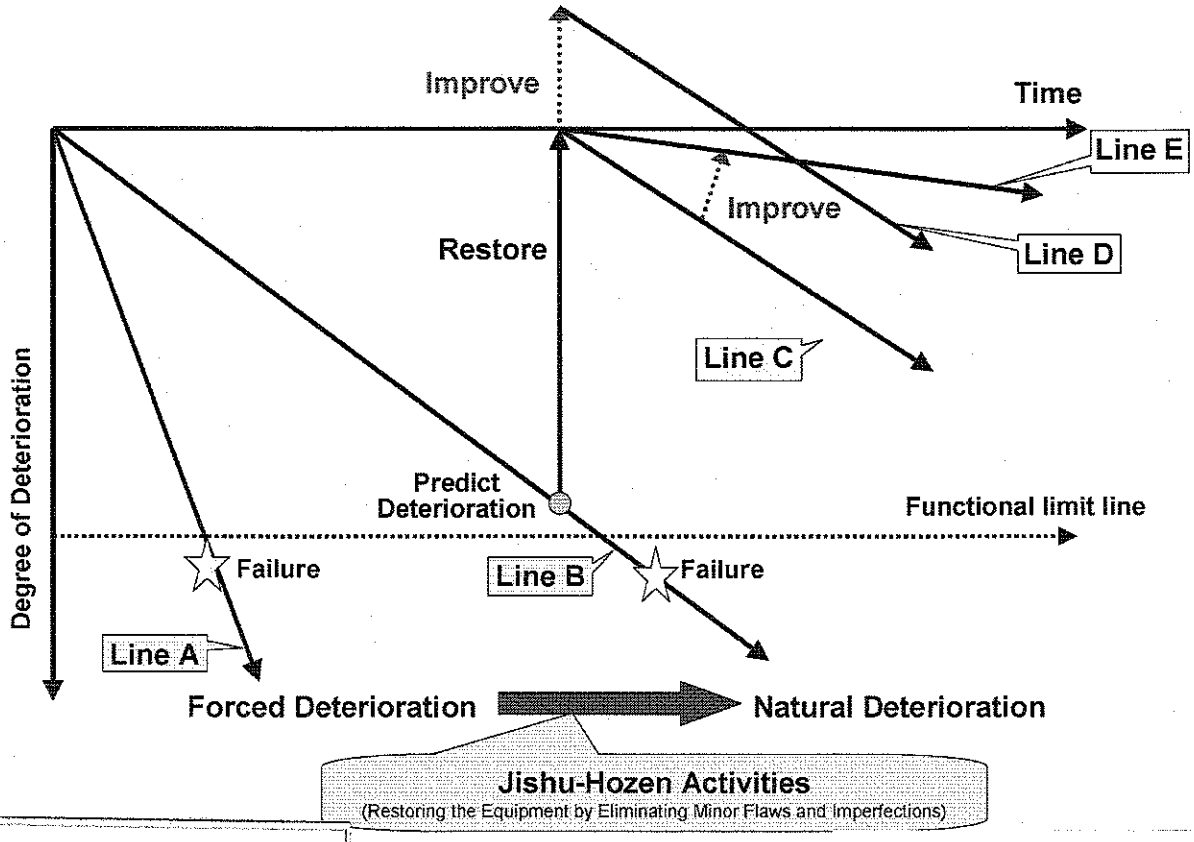
⇨ increase output

2) Activities for doing maintenance efficiently

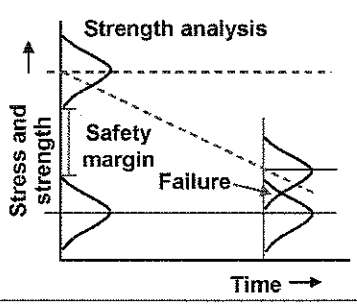
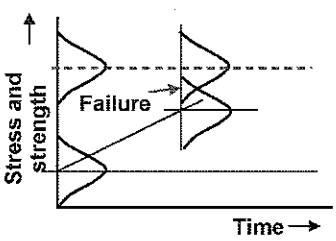
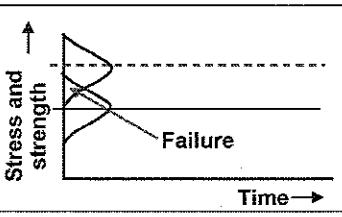
Making maintenance work and equipment management activities more efficient

⇨ reduce input

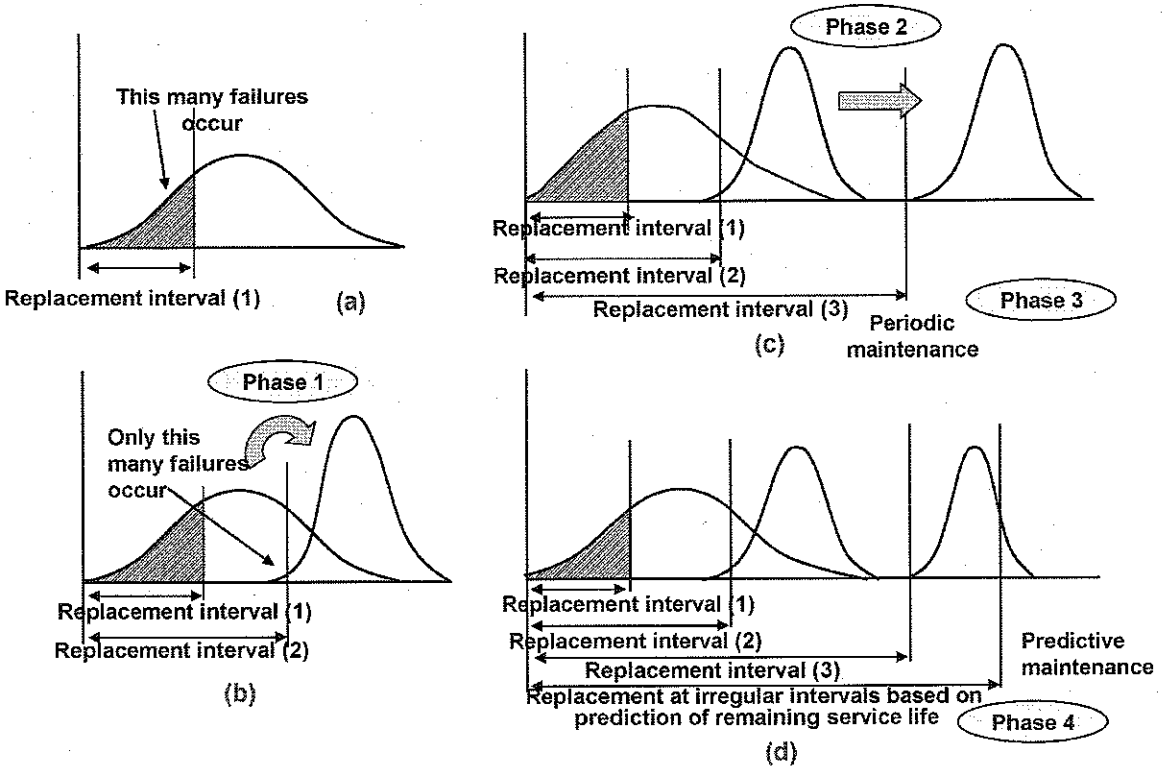
Equipment Deterioration, Failure, and Maintenance Activities



FAILURE, AND ITS RELATIONSHIP WITH STRESS AND STRENGTH

The 3 Main Causes of Failure	Specific Reasons for Failure
1. Uncorrected deterioration 	(1) Deficient basic conditions • Equipment not kept clean, properly-lubricated and tightened • Operators do not do daily maintenance, or only do perfunctorily (2) Leaving deterioration uncorrected • Neglecting to expose natural and forced deterioration and reverse it, i.e. not doing preventive repairs to check and inspect the equipment and restore it to its original state • Not noticing or caring about abnormal stresses on the equipment (3) Not observing correct operating conditions • Failing to observe the conditions of use (current, voltage, rotation speed, linear speed, temperature, etc.) set up in advance whenever a new machine or apparatus is built (4) Lack of skill • Repair errors by maintenance engineers or operating errors by operators (e.g. maintenance engineers who only know how to replace parts, or unqualified operators)
2. Leaving stress unchecked 	
3. Insufficient unchecked 	(5) Inherent design weaknesses • Weaknesses built into the equipment from the start, owing to mistakes or lack of technical expertise at the design, fabrication or installation stages

THE 4 PHASES TO ZERO BREAKDOWNS



THE 4 PHASES TO ZERO BREAKDOWNS

Phase	1	2	3	4
Theme	**Reduce variation in failure interval**	**Extend inherent lifetimes**	**Periodically reverse deterioration**	**Predict Lifetimes**
Main Activities	●Correct neglected deterioration • Fix obvious defects ●Eliminate forced deterioration • Sustain basic conditions • Identify and observe correct operating conditions	●Correct design weaknesses • Improve strength and precision • Select parts suitable for conditions of use • Improve ability to cope with overloading ●Eliminate random failures • Improve operating and maintenance skills • Prevent operating errors • Prevent repair errors ●Reverse visible deterioration	● Periodically reverse deterioration • Estimate remaining life • Establish periodic inspection standards • Establish periodic replacement standards • Improve maintainability ● Use the 5 senses to spot signs of internal deterioration •Identify which kinds of deterioration give warning signs and which do not • What are the warning signs of failure? • How can they be spotted?	●Use equipment diagnostics to predict equipment lifetimes ●Do engineering analysis of catastrophic failures • Analyse fracture surfaces • Analyse materials fatigue • Analyse gear tooth faces, etc. • Extend lifetimes • Periodically restore, based on forecasts of remaining life

Equipment Deterioration, and Maintenance Activities

1. **Activities for turning forced deterioration into natural deterioration**

   This is achieved through Jishu Hozen, in which the operators play the central role. It consists of guarding the equipment from forced deterioration by observing its basic conditions (keeping it clean, properly lubricated and tightened) and conditions of use.

2. **Predictive maintenance and periodic maintenance activities**

   In predictive maintenance, deterioration is reliably predicted and the equipment is carefully restored; in periodic maintenance, the equipment is carefully restored at fixed intervals.

3. **Activities for extending the life of equipment (corrective maintenance)**

   Here, equipment deterioration is slowed down, and the probability of failure is lessened. To extend equipment life, it is made stronger than before, or its deterioration is slowed down, when it is restored.

The 5 Main Causes of Failure, and the 5 Countermeasures

The 5 Main Causes of Failure

1 Not observing basic conditions

Equipment suffers forced deterioration and fails when it is not kept clean, lubricated and tightened.

2 Not observing operating conditions

Equipment suffers forced deterioration and fails when the conditions under which it is designed to be used are not observed.

3 Leaving deterioration unchecked

This happens when deterioration cannot be predicted,

or when equipment is restored, but not properly.

4 Leaving weaknesses uncorrected

Not doing anything about equipment design weaknesses

Not understanding the weaknesses, and/or not being able to do anything about them

5 Human error

Making the equipment break down through operating errors

Making the equipment break down through maintenance and repair errors

The 5 Countermeasures

1 Observe basic conditions

Guard the equipment from forced deterioration by establishing and observing basic conditions (keeping it clean, properly lubricated and tightened)

2 Observe operating conditions

Guard the equipment from forced deterioration by establishing and observing the ideal operating conditions

3 Reverse deterioration

Improve people's ability to predict deterioration

Standardise and train out restoration techniques

4 Correct design weaknesses

Observe the equipment in operation to understand its design weaknesses and take action to correct them

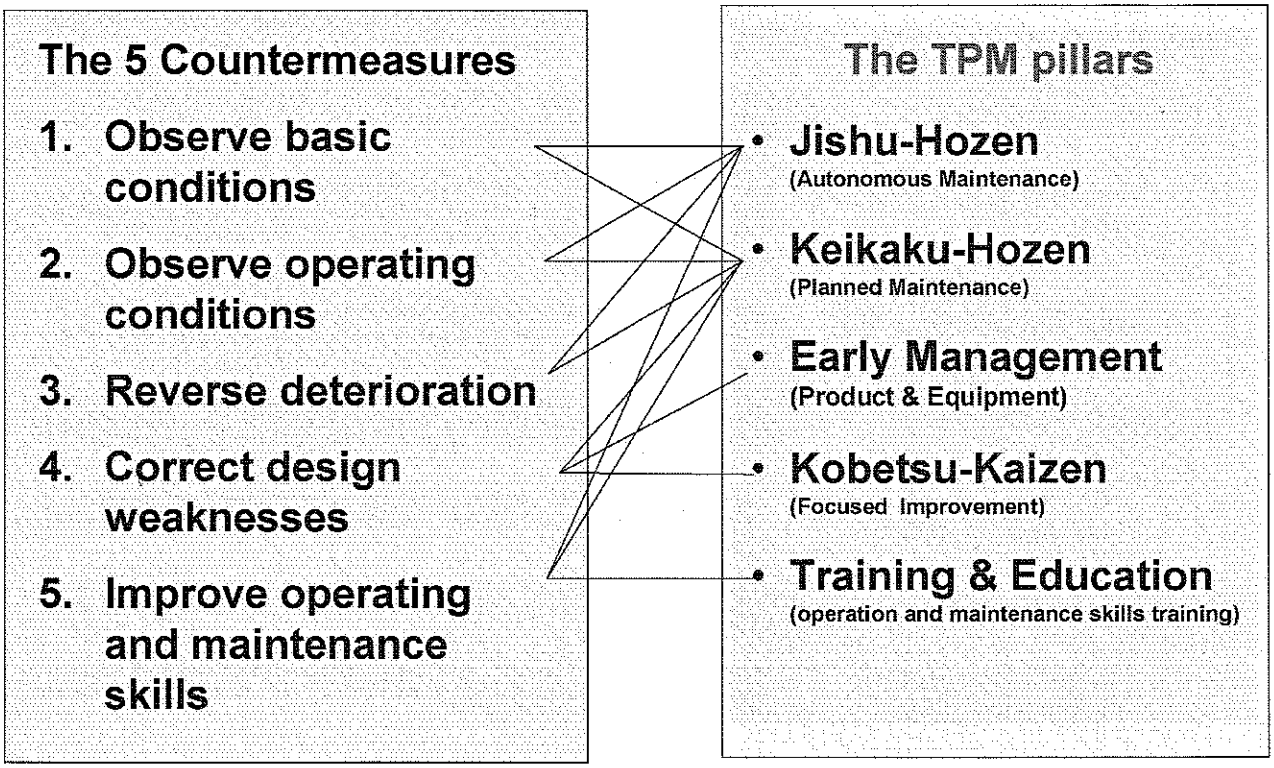
5 Improve operating and maintenance skills

Track down and eliminate the causes of human error

Protect the equipment from error by using error-proof devices and interlocks

Give training in operating and maintenance skills

Zero Failures and the TPM Pillars



Zero Failures and the TPM Pillars

Keikaku Hozen	Maintenance is carried out systematically in accordance with the following approaches
Preventive maintenance (PM)	preventing forced equipment deterioration and failures by checking, inspecting and diagnosing the equipment and restoring it before it breaks down
Periodic maintenance	preventing failures by repairing the equipment and replacing components at suitable intervals (used when the maintenance interval is easily determined and /or periodic replacement is advantageous)
Time-based maintenance (TBM)	preventing forced equipment deterioration and preventing failures by checking, inspecting and diagnosing the equipment and restoring it before it breaks down (this makes maintenance easy, but it can easily turn into overhaul maintenance)
Inspection and repair (IR)	preventing forced equipment deterioration and failures by checking, inspecting and diagnosing the equipment and restoring it before it breaks down
Predictive maintenance	preventing failures by checking and diagnosing the state of deterioration, and restoring the equipment depending on the result (used when the losses due to failure are large and/or when the signs of abnormalities are measurable)
Condition-based maintenance (CBM)	preventing failures by diagnosing the state of equipment deterioration, forecasting its remaining life and restoring the equipment and/or replacing parts when necessary
Breakdown maintenance	repairing the equipment after it has broken down (used when the losses or effects due to failure are small; in practice, it often happens when preventive maintenance is inadequate)
Deliberate breakdown maintenance (BM)	restoring the equipment after it has failed, without inspecting or maintaining it (used when the losses due to failure are small and it would be cheaper to use the equipment until it breaks down)
Corrective maintenance (CM)	devising ways of extending equipment lifetimes, increasing equipment reliability, making repairs and inspection more efficient, and reducing other losses

Zero Failures and the TPM Pillars

Keikaku Hozen — Maintenance is carried out systematically in accordance with the following approaches

- **Preventive maintenance (PM)** — preventing forced equipment deterioration and failures by checking, inspecting and diagnosing the equipment and restoring it before it breaks down
  - **Periodic maintenance** — preventing failures by repairing the equipment and replacing components at suitable intervals (used when the maintenance interval is easily determined and /or periodic replacement is advantageous)
    - **Time-based maintenance (TBM)** — preventing forced equipment deterioration and preventing failures by checking, inspecting and diagnosing the equipment and restoring it before it breaks down (this makes maintenance easy, but it can easily turn into overhaul maintenance)
    - **Inspection and repair (IR)** — preventing forced equipment deterioration and failures by checking, inspecting and diagnosing the equipment and restoring it before it breaks down
  - **Predictive maintenance** — preventing failures by checking and diagnosing the state of deterioration, and restoring the equipment depending on the result (used when the losses due to failure are large and/or when the signs of abnormalities are measurable)
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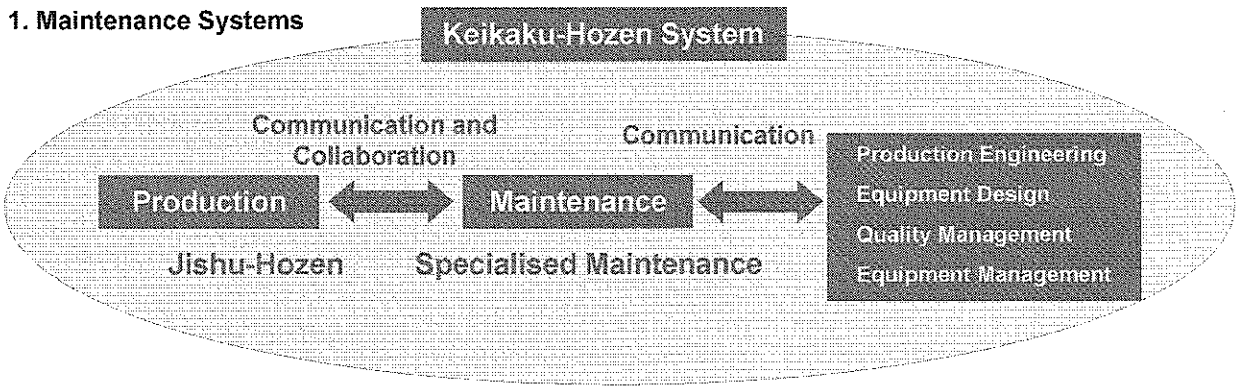
- **Corrective maintenance (CM)** — devising ways of extending equipment lifetimes, increasing equipment reliability, making repairs and inspection more efficient, and reducing other losses

Maintenance Systems and their Operation

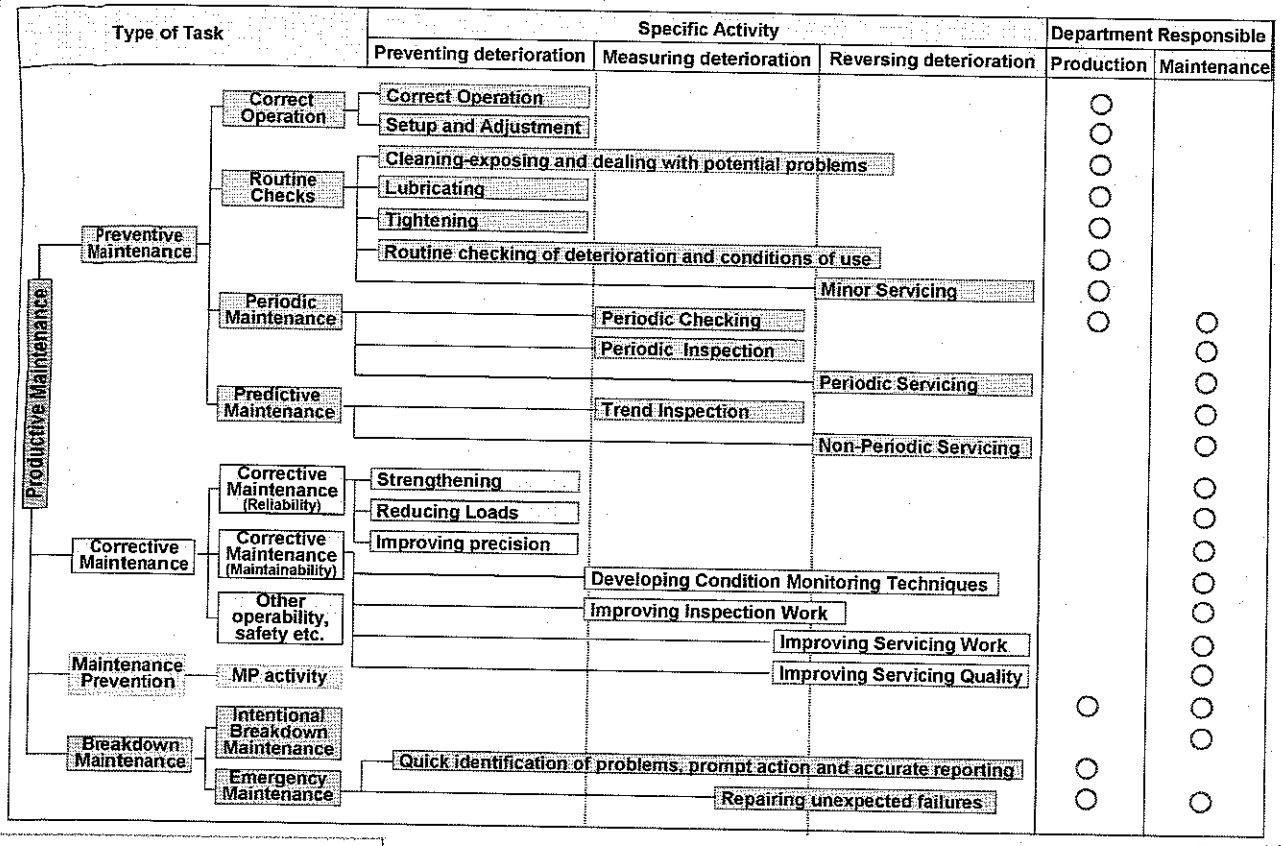
1. Maintenance Systems



2. Pros and Cons of Maintenance Systems

Maintenance System	Pros	Cons
Centralised maintenance system	• Skills and techniques are easily disseminated • It is possible to get to the bottom of problems	• Communicating with the operating department is difficult • The collection of operating data is rough and ready
Decentralised maintenance system	• Communication with the operating department is improved • Maintenance response is faster	• Disseminating skills and techniques is difficult • More people are required, and their rotation is difficult
Combined maintenance system	• Communication with the operating department is good Skills and techniques can be disseminated, and it is possible to get to the bottom of problems	• The system is difficult to manage • Rotation requires ingenuity

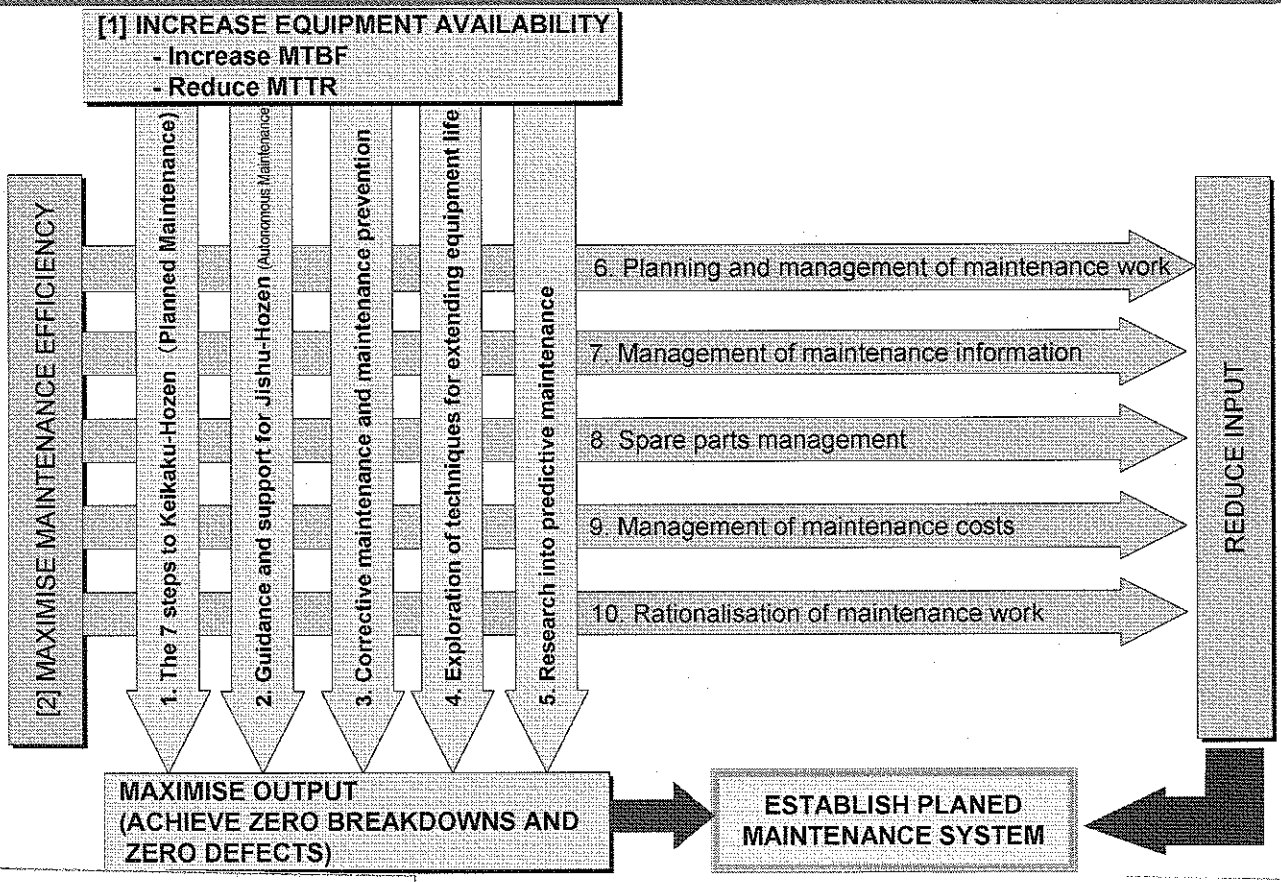
How the Responsibility for Maintenance Should be Allocated (Example)



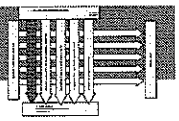
A Typical Keikaku Hozen Programme

8 Pillars of Keikau-Hozen	Objective	Year 1 TPM Introduction	Year 2 Implementation	Year 3 Enhancement	Year 4 Consolidation	Year 5
1. Guidance and support for Jishu-Hozen	- Rapidly resolve any problems with the Jishu-Hozen programme - Help to improve operators' Jishu-Hozen skills	Jishu-Hozen Step 1	Step 2	Step 3	Step 4	Step 5 / Step 6
2. Programme for achieving zero breakdowns	- Reduce total equipment failures in factory to 1/10 or less - Act decisively to prevent the possibility of any problem happening more than once					
3. Establishment of Planned Maintenance system	- Review maintenance management system - Sort equipment by priority,and maintain it systematically and efficiently					
4. Lubrication management	- Eliminate failures due to poor lubrication - Standardise lubricant types and quantities, and reduce storage space					
5. Spare-parts management	- Cut costs of spare-parts retrieval, restocking and management - Minimise variety					
6. Maintenance cost management	- Create system for reducing maintenance costs					
7. Rationalisation of shutdown maintenance, and research into predictive maintenance	- Restore equipment functions and performance, and ensure operation until next scheduled repair - Move from (TBM + BM) to (CBM + TBM) - Shorten shutdown period					
8. Improvement of maintenance technology and skills	- Acquire diagnostic technology and skills for use in predictive maintenance, and ability to use analytical techniques					

Overview of a Keikaku-Hozen Programme

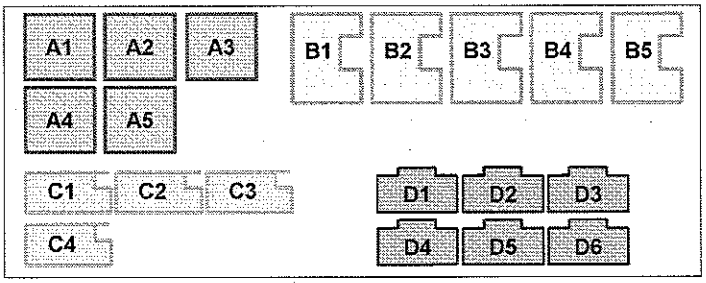


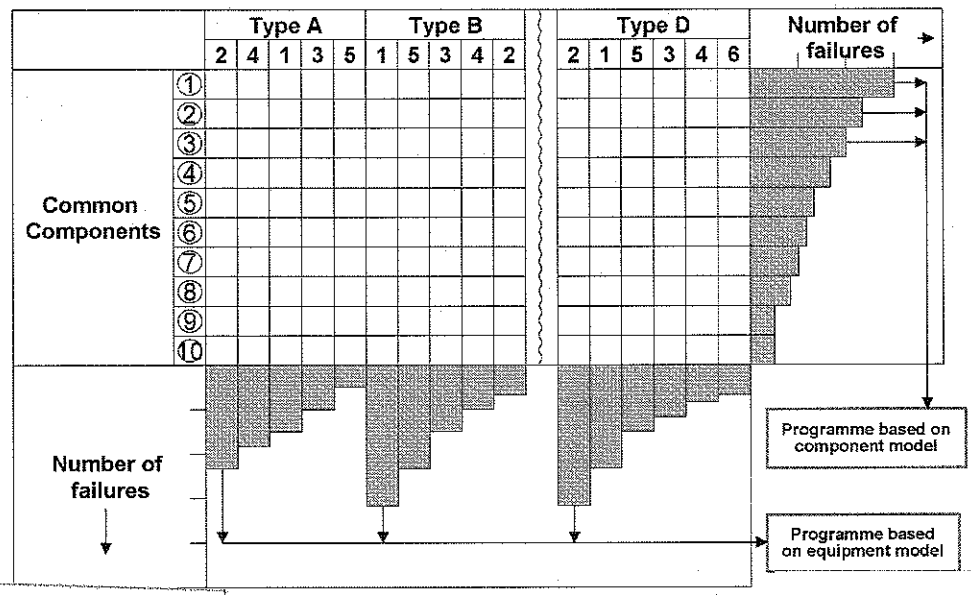
The 7 Steps of Keikaku-Hozen



Step	Keikaku Hozen (equipment model)	Keikaku Hozen (component model)	Jishu-Hozen
1	Analyse difference between basic conditions and current situation	Select key components	Initial cleaning (cleaning is inspection)
2	Correct differences between basic conditions / ideal operating conditions and current situation	Improve current maintenance methods	Countermeasures for contamination sources and hard-to-access areas
3	Establish standards for sustaining basic conditions	Create maintenance standards	Provisional standards
4	Extended working life of equipment and eliminate weaknesses	Extend working life of equipment and eliminate weaknesses	General Inspection
5	Rationalise checking and servicing	Rationalise checking and servicing	Autonomous inspection
6	Perform comprehensive equipment diagnosis	Perform comprehensive equipment diagnosis	Standardisation
7	Maximise use of equipment	Maximise use of equipment	Full self-management

Types of 7-Step Keikaku Hozen programme



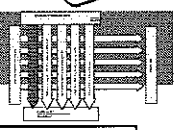


Guidelines for Choosing the Equipment Model or the Component Model

Model type	Number of machines			Forced deterioration			Number of maintenance staff		
	Many	Medium	Few	Severe	Medium	Mild	Many	Medium	Few
Equipment		○	○	○			○	○	
Component	○				○	○	○		○

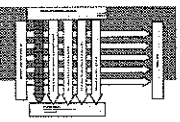
Model type	Maintenance skills			Jishu-Hozen		
	High	Medium	Low	High	Medium	Low
Equipment		○	○	○		
Component	○				○	○

The 7 Steps for the Equipment Model



Phase	Phase 1 Reduce variation in failure interval	Phase 2 Extend inherent lifetimes	Phase 3 Periodically reverse deterioration	Phase 4 Predict Lifetime
Establish Preventive Maintenance system	Step 1 Analyse difference between basic conditions and current situation Step 2 Correct differences between basic conditions / ideal operating conditions and current situation Step 3 Establish standards for sustaining basic conditions			
Implement Corrective Maintenance		Step 4 Extend working life of equipment and eliminate weaknesses		
Implement Predictive Maintenance			Step 5 Rationalise checking and servicing	
Establish Quality Management system	Step 6 Perform comprehensive equipment diagnosis			
Establish Effective Maintenance system	Step 7 Maximise use of equipment			

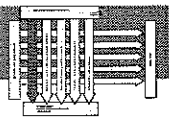
Overview of the 7 Steps for the Equipment Model - 1



Step	Item	Overview
1	Analyse difference between basic conditions and current situation	• Select priority lines and equipment based on situation analysis • Understand equipment's functions, construction and principles • Identify and correct obvious and hidden equipment defects • Analyse failure causes and determine relationships with the 7 Steps
2	Correct differences between basic conditions / ideal operating conditions and current situation	• Implement solutions and improvements based on defect map with aim of preventing recurrence • Doggedly track down causes of failure • Reverse unchecked deterioration and eliminate forced deterioration • Identify locations that must be kept clean and properly lubricated to maintain equipment's functions • Persuade operating department to make functional cleaning an integral part of their operating procedures • Improve operating conditions • Permanently solve random failures
3	Establish standards for sustaining basic conditions	• Formulate standards • Correct omissions and improve unclear points in standards based on preventive maintenance map • Introduce visual controls for equipment (labels, displays, matchmarks, etc.) • Clarify division of responsibilities between maintenance and Jishu Hozen • Prepare and operate maintenance calendars • Prepare standard working procedures • If function-stoppage failures have not greatly reduced, return to Step 1
4	Extended working life of equipment and eliminate weaknesses	• Implement corrective maintenance, mainly for extending lifetimes • Analyse failure maps, PM cards and MTBF records • Doggedly track down and eliminate causes of failure using techniques such as P-M Analysis and FTA* • Organise information on improvements and submit it as MP information • Reduce random failures, review maintenance skills, and deliver training

FTA: Fault Tree Analysis

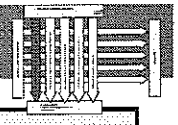
Overview of the 7 Steps for the Equipment Model - 2



Step	Item	Overview
5	Rationalise checking and servicing	• Rigorously implement preventive maintenance and reduce maintenance labour requirement • Select appropriate preventive maintenance regime depending on variation in lifetimes of units and parts • Establish appropriate maintenance intervals based on analysis of deterioration patterns • Investigate evidence of deterioration and devise visual indicators for deterioration measurements • Use simple diagnosis to detect internal deterioration • Do improvements to reduce checking and overhauling times • Review maintenance standards and calendars prepared in Step 3
6	Perform comprehensive equipment diagnosis	• Take up the challenge of reducing function-deterioration failures, and failures whose causes cannot be determined without performing detailed analysis • Basically, implement steps 1-5 with zero quality defects as the theme • Select MQ* Analysis topics • Investigate correlation between equipment conditions and product quality • Investigate quality defect mechanisms through their relationships with equipment operating conditions and deterioration • Analyse relationships between equipment and energy quality • Investigate effect of equipment surroundings (particularly vibration) • Identify conditions under which quality defects are not produced, and improve equipment and maintenance methods to fit those conditions • Formulate maintenance standards for sustaining quality conditions • Identify MQ points for sustaining equipment conditions, and incorporate them in checking and overhauling standards
7	Maximise use of equipment	• Implement predictive maintenance with the aim of using the equipment to the ultimate • Predict overhaul times for priority components (use Weibull probability paper) • Research and utilise equipment diagnostics • Research ways of providing equipment with self-diagnostic functions

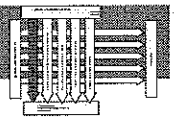
* MQ : Machine Quality

The 7 Steps of Keikaku Hozen for the Component Model



<table>
<tr><th>Phase</th><th>Phase 1:
Reduce variation in failure interval</th><th>Phase 2:
Extend inherent lifetimes</th><th>Phase 3:
Periodically reverse deterioration</th><th>Phase 4:
Predict lifetimes</th></tr>
<tr><td rowspan="3">Install preventive maintenance system</td><td>Step 1:
Select key components</td><td colspan="3" rowspan="3"></td></tr>
<tr><td>Step 2:
Improve current maintenance methods</td></tr>
<tr><td>Step 3:
Create maintenance standards</td></tr>
<tr><td>Do corrective Maintenance</td><td rowspan="2"></td><td>Step 4:
Extend working life of equipment and eliminate weaknesses</td><td colspan="2">Steps1-5
· Can be done without stopping the equipment
· Cycle rapidly, one priority component at a time</td></tr>
<tr><td>Do predictive Maintenance</td><td colspan="2">Step 5
Rationalise checking and servicing</td></tr>
<tr><td>Establish Quality-Hozen Maintenance</td><td colspan="2">Step 6:
Perform comprehensive equipment diagnosis</td><td colspan="2" rowspan="2">Step 6
· Start after parts failures have decreased by 70%
· Amalgamate with equipment model teams at Step 6</td></tr>
<tr><td>Establish Keikaku-Hozen System</td><td colspan="2">Step 7:
Maximise use of equipment</td></tr>
</table>

Overview of the 7 Steps for the Component Model

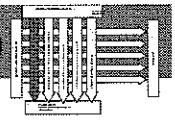


Step	Item	Overview
1	Select key components	Rank components and select priority components from the following two perspectives: 1. From the perspective of increasing MTBF*1 • Prepare MTBF analysis record table • Select equipment that would have a major impact on production if it broke down, and investigate its parts replacement and failure history • Draw up Pareto diagrams for parts replaced by preventive maintenance and parts replaced owing to failure, and calculate the MTBF and MTBM for each component • Analyse the failure pattern for each component 2. From the perspective of reducing MTTR • Select components that are labour-intensive to replace, expensive, require high-level skills, are inefficient to replace, are on the work plan's critical path, extend shutdown times, etc.
2	Improve current maintenance methods	• Improve present maintenance methods • Increase MTBF • Understand failure mechanisms of failed parts • Review methods of detecting deterioration, and develop checking tools • Investigate ways of preventing deterioration • Clarify objectives and content of daily checking, periodic checking and periodic overhauls, and their relationships with failure • Reduce MTTR*2 (MTBM) • Improve methods of detecting failure • Improve maintenance work methods (consider block parts replacement, improvement of jigs and tools, use of lifting equipment, etc.) • Improve ways in which spare parts are held • Improve procedures for tear-down inspection and overhaul

* 1 - MTBF : mean time between failures

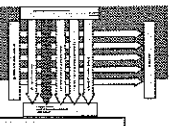
* 2 - MTTR : mean time to repair

Overview of the 7 Steps for the Component Model (2)



Step	Item	Overview
3	Create maintenance standards	• Standardise results obtained in Steps 1 and 2, and establish preventive maintenance technology • Formulate daily checking standards • Formulate periodic checking standards (checking intervals, checking procedures, etc.) • Formulate periodic overhaul standards • Hold study meetings with equipment model teams • Sort out division of maintenance responsibilities with Jishu Hozen
4	Extend working life of equipment and eliminate weaknesses	• Do corrective maintenance (investigate design conditions to extend lifetimes and correct weaknesses; improve operating conditions, etc.) • Analyse failure mechanisms. Probe deeper into failure mechanisms identified in Step 2. • Analyse correlations between operating conditions and component functions (temperature, humidity, energy quality, vibration, shock, noise, dirt, fatigue, etc.) • Secure parts functioning (improve energy quality by changing component configurations and using protective covers, shock absorbers, fixed-voltage power sources, air dryers, etc.)
5	Rationalise checking and servicing	• Decide on optimal times for carrying out maintenance • Reduce labour requirement for preventive maintenance • Prevent random failures and reduce Keikaku Hozen work • Further improve maintenance standards from Step 3 • Develop checking and diagnosis tools • Research equipment diagnostics
6	Perform comprehensive equipment diagnosis	In Steps 6 and 7, extend activities from individual components to entire machines. Steps 6 and 7 are same as for equipment model.
7	Maximise use of equipment	

Guidance and Support for Jishu-Hozen



Basic thinking

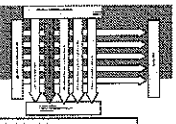
<<Activities>>

The following four steps are implemented in conjunction with the 7 Jishu Hozen steps:

1. **Delivering Maintenance (Planned Maintenance) training to Jishu Hozen team leaders**
2. **Dealing with equipment problems pointed out by Jishu Hozen teams**
3. **Helping Jishu Hozen teams to formulate standards**
4. **Supporting and advising on all kinds of improvements and maintenance-related technology**

Ensure that the Jishu-Hozen programme proceeds smoothly and is successful

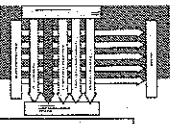
Guidance and Support (1)



Trg. Operator's whose resp.

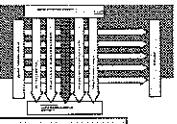
JH Step 1: Initial cleaning	1. Relay training on safety 2. Relay training on key points for establishing basic conditions 3. Help to restore parts where problems have been discovered
JH Step 2: Countermeasures for contamination sources and hard-to-access areas	1. Fulfilling requests for improvement 2. Instructing in fabrication skills 3. Providing and explaining devices, materials and tools for improvement 4. Preparing and providing work areas 5. Checking improvement plans and supporting their implementation
JH Step 3: Provisional Jishu-Hozen standards	1. Supporting and advising on the preparation of standards

Guidance and Support (2)



JH Step 4: General Inspection	1. Maintenance skills training 2. Equipment defect repair and improvement
JH Step 5: Autonomous Inspection	1. Determination of roles and responsibilities 2. Help in preparing standards, etc. 3. Help with Quality Hozen activities 4. Training in simple diagnostic techniques
JH Step 6: Standardisation	1. Supporting and advising on the preparation of standards
JH Step 7: Full Self Management	1. Making maintenance management work more efficient

Corrective Maintenance and Use of MP Information



(1) Corrective Maintenance

<<The aims of corrective maintenance>>

1) To identify and correct equipment weaknesses (failures, quality defects, maintainability, productivity, safety, etc.)
2) To evolve existing equipment in line with technical development

>>> Achieve zero failure and zero quality defects, and improve maintainability and productivity

<<Activities>>

1) Activities for increasing reliability (so as not to permit function-reduction or function-stoppage failures)
   - Does not fail • Does not produce quality defects
   - Has a stable cycle time • Is adjustment-free

2) Activities for increasing maintainability (to facilitate diagnosis and reversal of deterioration)
   - Rapid location of deterioration • Rapid parts replacement and restoration
   - Rapid checking and diagnosis

Maintenance Prevention (MP Design)

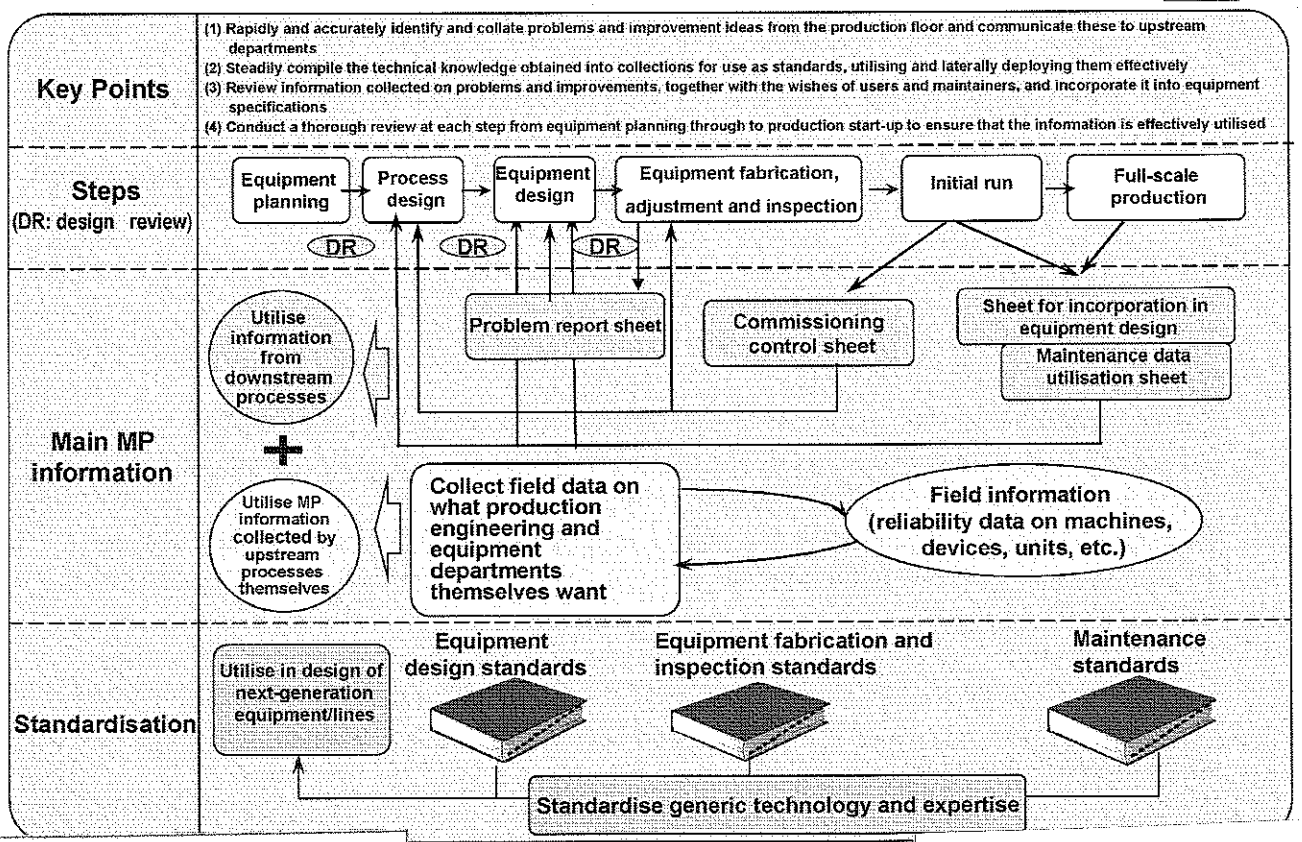
<<What is maintenance prevention?>>

Maintenance prevention is an activity for improving reliability, maintainability, cost effectiveness, operability and safety, and reducing maintenance costs and deterioration losses, by introducing maintenance information and new technologies at the planning and design stages of new equipment - that is, it is an activity for eliminating losses at their source.

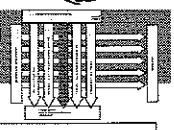
<The importance of using MP information in design>

1. **Fact: Effective use of MP information in design is rare**
2. **Reasons:**
   1. No time is allowed for collecting and utilising MP information
   2. Rules for utilising MP information have been set, but the activity is perfunctory, and the quality and quantity of MP information are inadequate
   3. The department has no experience of using MP information
   4. Investigations are adequate, as they are mainly left up to the equipment manufacturer
   5. The equipment is to be used in a different environment
3. **What happens if a company is incapable of utilising MP information?**
   Huge losses occur in the period from designing the equipment to fabricating it and bringing it into operation
   Losses are even more serious in view of today's ever-shorter product lifetimes
   The size of its losses makes the company uncompetitive

Example of MP Information Utilisation System and Key Points



Record of Modifications Made to Equipment Design, and Action Taken



At stage of (1) Specification concept (2) Basic design (3) Detailed design

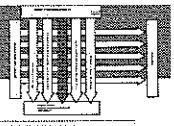
Record of Corrections Made to Equipment Design, and Action Taken					Section receiving equipment		Production Engineering Section					No.
Name of equipment							Person responsible	Supervisor	Manager		Supervisor	Issued

No.	__/__/__ (date)	Information provided (A)	Degree of Seriousness (B)	Problem and action requested	Corrective action	Date action taken:	Action (C)	Cause (D)	Results	Target of amendment (E)	Details of amendment (F)	Action taken by	Remarks
1													
2													
3													
4													

Classification	A: Departments providing information		B: Classification of degree of seriousness		C: Classification of action taken		D: Classification of cause		E: Classification of item amended		F: Classification of nature of amendment			
	1	Fabrication department (in-house)	1	Amendment absolutely necessary	1	Mechanism or Structure changed	1	Defective planning	1	Affected machine only	1	Process capability improved	6	Safety improved
	2	Fabrication department (external)	2	Amendment to be made as far as possible	2	Movement or function changed	2	Defective design	2	Affected machine and next-generation machines	2	Output capacity improved	7	Operability improved
	3	Design department (in-house)	3	Suggestion to be borne in mind	3	Control circuitry changed	3	Defective fabrication	3	Affected machine, similar machines	3	Reliability improved		
	4	Design department (external)			4	Surface or heat-treatment changed	4	Change in specifications		and next-generation machines	4	Maintainability (durability) improved		
	5	Department using equipment			5	Materials or shape changed					5	Economy improved		

Note1: If an item falls into more than one category, mark all the relevant categories.

Points to Note when Utilising MP Information



Problems

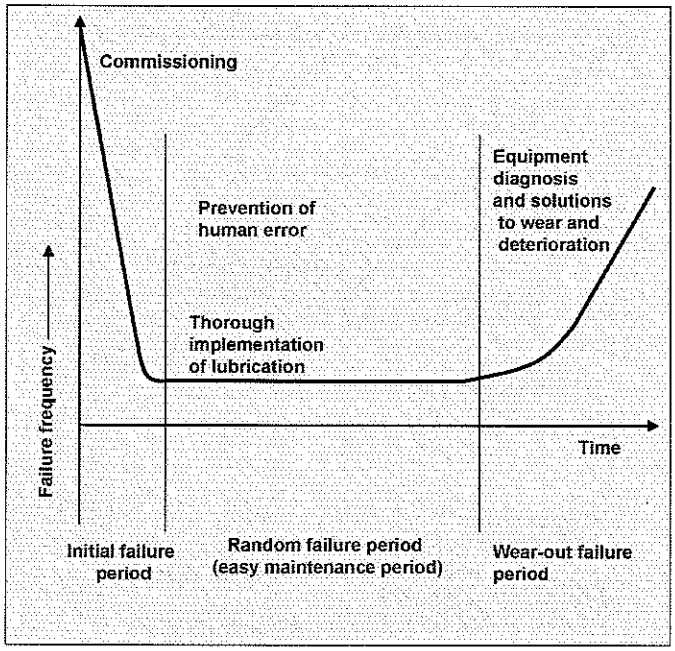
1. Rules exist, but people are often excused from doing the activity on the grounds of being too busy, etc.
2. People go through the motions of carrying out the activities, but they are often superficial

Points to note

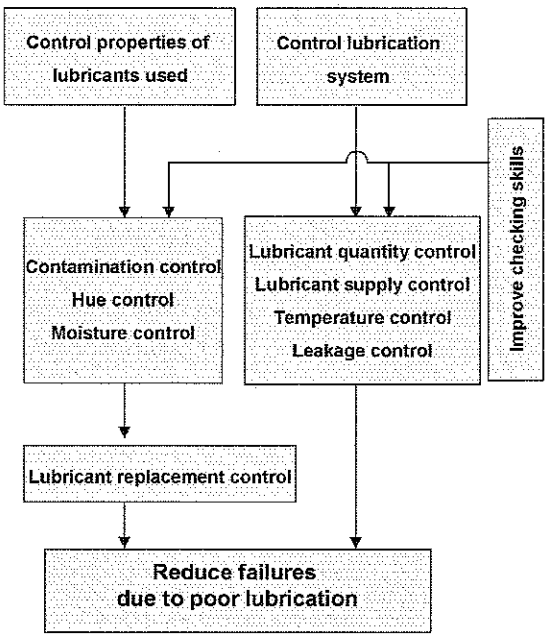
1. Create workflow regulations and systems to ensure that MP information is always utilised when new equipment is planned
2. Create systems and organisations for ensuring that MP information is collected
3. Standardise MP information wherever possible, keeping it simple. (e.g. common equipment specifications, lists of recommended sensors, etc.)
4. Evaluate the use of MP information on each item of equipment (in terms of both quality and quantity) in order to check whether good use is being made of it. If not, the equipment should not be approved.
5. The maintenance and operating departments should keep an eye on the plans for new equipment and start collecting MP information early on in the planning and proposal stage
6. Record MP information not abstractly but with specific structures, shapes, dimensions, etc., so that it can soon be put to use

Researching Technology for Extending Equipment Life

Lubrication technology as a technology for extending equipment life



Lubrication management flow chart



Predictive Maintenance Research

The aims of predictive maintenance

1) To predict failures and quality defects

To predict function-stoppage failures and function-reduction failures by measuring the state of deterioration of the equipment

2) To predict remaining life

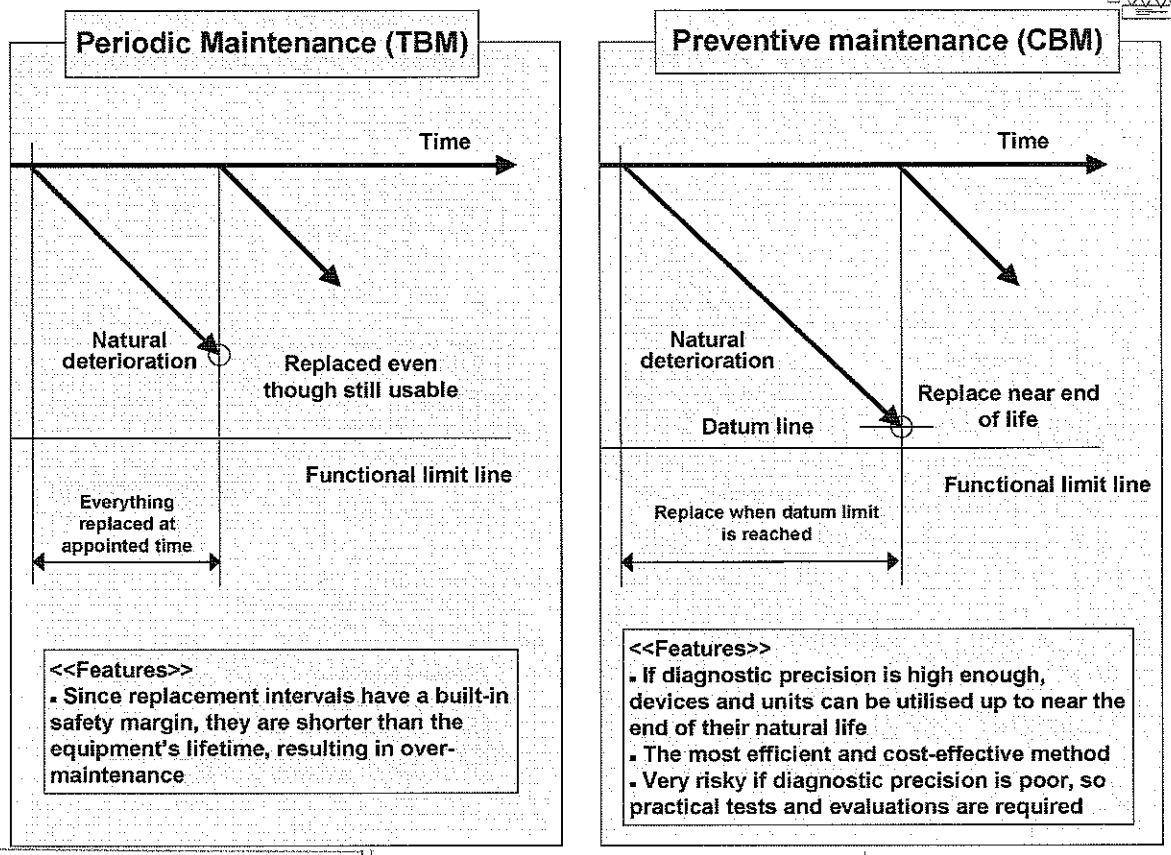
To estimate remaining life by measuring the state of deterioration

Preconditions for predictive maintenance

1) Forced deterioration has been eliminated as a result of advances made in Jishu Hozen and Kobetsu Kaizen, and the equipment is subject only to natural deterioration

2) Sporadic failures have decreased, maintenance personnel are familiar with equipment diagnostic techniques, and facilities are available for using them

Predictive Maintenance and Periodic Maintenance



Equipment Diagnostics

The definition of equipment diagnostics

Equipment diagnostics is a technique for quantitatively identifying the condition of the equipment (the stress on the equipment, and its failures, deterioration, strength, performance, etc.), determining whether abnormalities relating to its reliability, performance, etc. exist, forecasting its future, and deciding on the optimal maintenance action that should be taken.

The two roles of equipment diagnostics

1) It is a technology for measuring and evaluating the extent of deterioration of equipment, machines and components

It is a technology for quantitatively measuring equipment deterioration such as damage and wear when trend control by means of checking has indicated that precision diagnosis is required, and deciding on the optimal maintenance action.

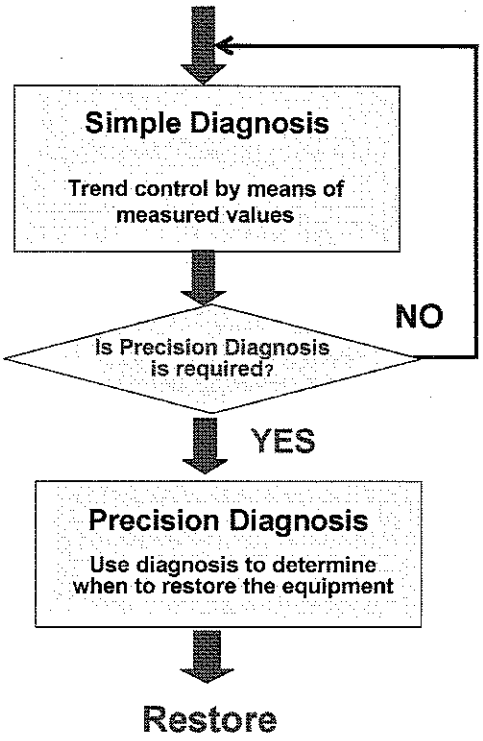
2) It is a technology for estimating the time remaining until equipment, machines and components break down because they have reached the end of their natural life

It is a technology for analysing historical data and experimental data based on results from deterioration diagnostics, estimating the time remaining until a function-stoppage or function-reduction failure will occur, and restoring the equipment by replacing parts or units at the optimal time.

Being able to estimate remaining life accurately enables us to use all parts of the equipment to the maximum extent of their natural life and makes it possible to restore the equipment systematically before it breaks down, resulting in the most cost-effective type of maintenance.

Types of Equipment Diagnostics, and When to Use Them

Equipment diagnostic system



When to use equipment diagnostics

- When a failure would have a big effect on production
- When a failure would stop the equipment for a long time
- When failure losses would be large
- When it is difficult to prevent failure by normal inspection
- When deterioration trends can be measured
- When deterioration and failure are closely correlated

Procedure for Developing Equipment Diagnostics

Step 1

Determine equipment units to be diagnosed

Determine the equipment units or components to be diagnosed by examining records of major failures over the past three years or more, and identifying the parts of the equipment that are liable to fail again.

Step 2

Investigate those units or components and determine their deterioration characteristics

Investigate the deterioration patterns in order to determine the deterioration characteristics. Identify a pattern by examining what is deteriorating and seeing how it changes with time.

Step 3

Select a physical quantity, based on which changes in that deterioration characteristic can be detected quantitatively

Decide what physical quantity to use in order to detect the change. With vibration, for example, this could be displacement, speed or acceleration.

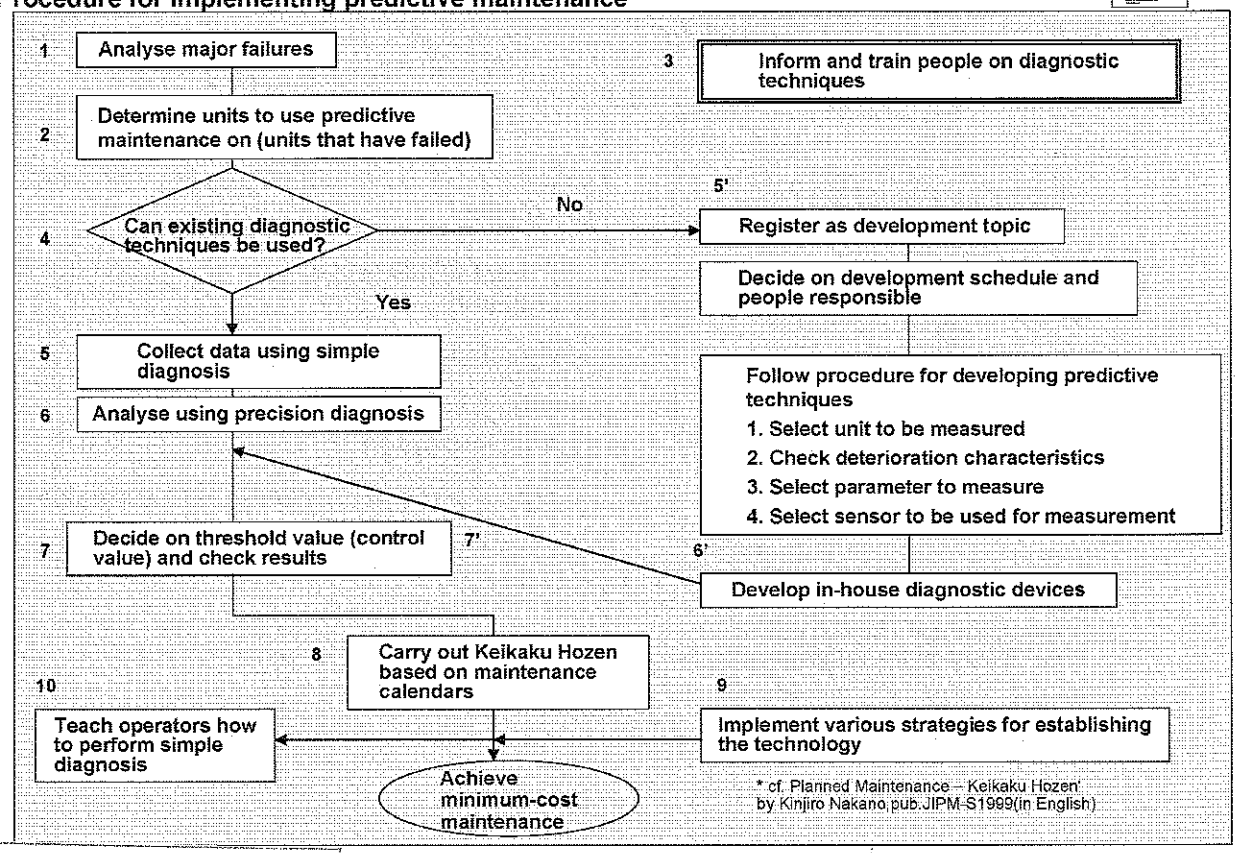
Step 4

Find out whether the technology exists for measuring that change (i.e. deterioration)

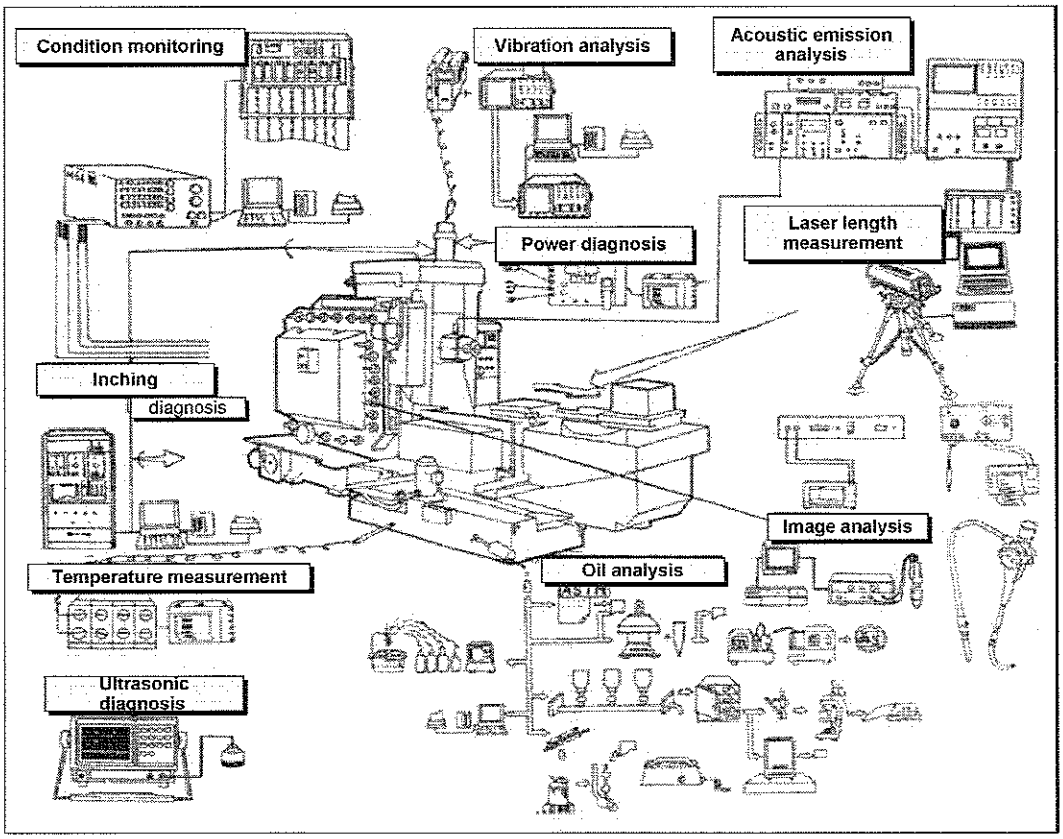
Find out whether devices exist for measuring the signals obtained by sensing the deterioration. Commercially-available devices are usually expensive, so it is preferable to find ways of diagnosing the equipment by combining sensors with devices developed in-house.

Implementing Predictive Maintenance

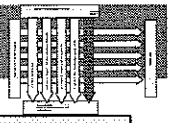
Procedure for implementing predictive maintenance



Some Typical Equipment Diagnostic Techniques

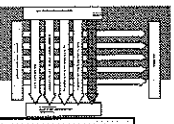


Principal Equipment Diagnostic Techniques



Diagnostic techniques for rotating systems	This area of equipment diagnostics, which is applied to rotating machinery such as pumps, blowers, motors, gearboxes, transmission systems, machine tool shafts and so forth, was developed first and is highly systematised. Vibration analysis and acoustic emission analysis are two of the main techniques employed, and a wide range of sensors and devices is available to suit the purpose of the diagnosis.
Structural diagnostic techniques	Various kinds of non-destructive testing technology, infra-red monitoring and so forth are used for checking structures such as press stands, pipework supports and tanks for cracks and internal flaws. A recent advance is the development of pipework inspection robots for checking the insides of pipes.
Diagnostic techniques for lubrication and wear	The properties of lubricants have a profound influence on the efficiency of, and condition of, machinery and equipment. However, although many companies manage their lubricants well, periodically cleaning or replacing them, very few make use of lubricant analysis as an advanced equipment diagnostic technique. One simple diagnostic technique is to measure changes in lubricant properties such as specific gravity, viscosity, ignition point, hue, total acid, moisture separation and anti-foaming properties. Other techniques such as ferrography and SOAP (spectroscopic oil analysis procedure) can be used to check for equipment abnormalities by measuring the wear particle content of lubricants.
Diagnostic techniques for electrical and control systems	Techniques such as insulation diagnosis for high-voltage devices and gas chromatography techniques for analysing the gas content of transformer oil are well established. Methods of assessing deterioration in control systems by comparing temporal changes in analogue devices with control characteristics also exist. Some digital devices have built-in self-diagnostic functions whereby the characteristics to be monitored are simulated by a microprocessor. However, it is often unclear whether these have been installed for the purpose of predictive maintenance, and their need should be thoroughly assessed before the equipment is purchased.
Diagnostic techniques for machine tools	Diagnostic techniques for machine tools include vibration analysis and acoustic emission analysis for early detection of abnormal deterioration in main spindles, motor active power diagnosis for detecting whether a machining operation such as cutting or grinding is in normal or abnormal condition, laser length measurement for monitoring table control precision, monitoring the thermal distribution within various components to determine its effect on precision, temperature monitoring to detect abnormalities, oil analysis for analysing the properties of lubricants, ultrasonic techniques for detecting internal cracks and other flaws, and condition monitoring systems for monitoring the overall condition of these tools.

Principal Equipment Diagnostic Techniques



Diagnostic techniques for rotating systems	This area of equipment diagnostics, which is applied to rotating machinery such as pumps, blowers, motors, gearboxes, transmission systems, machine tool shafts and so forth, was developed first and is highly systematised. Vibration analysis and acoustic emission analysis are two of the main techniques employed, and a wide range of sensors and devices is available to suit the purpose of the diagnosis.
Structural diagnostic techniques	Various kinds of non-destructive testing technology, infra-red monitoring and so forth are used for checking structures such as press stands, pipework supports and tanks for cracks and internal flaws. A recent advance is the development of pipework inspection robots for checking the insides of pipes.
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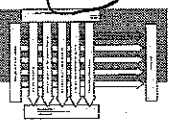
Maintenance Planning and Management



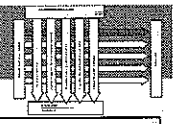
Purpose

Maintenance planning and management forms the core of Keikaku Hozen and is indispensable for carrying out the wide range of maintenance tasks required systematically, efficiently and without omissions

Activities

- Read through the inspection standards, equipment standards and other documents to identify all the maintenance tasks required
- Enter all these tasks on the annual and monthly maintenance calendars
- Distributing the work evenly, draft an annual plan (calendar), monthly plan (calendar) and weekly plan (calendar)
- Monitor the state of implementation in order to check progress against the calendars and ensure that everything goes according to plan
- Establish and operate systems and standards for ensuring that the maintenance work is carried out systematically according to plan

Types of Maintenance Calendar



Long-term Calendar	(1) Formulate long-term concept proposals for equipment renewal and periodic shutdown maintenance and overhauls, and select the most cost-effective plan. (2) To ensure that nothing is left out when drawing up the annual calendar, draft the proposal to cover more than one year's worth of preventive maintenance tasks.
Annual Calendar	(1) Ensure that the annual calendar includes everything that the long-term calendar specifies needs to be done that year (2) Before preparing the annual calendar, ensure that the maintenance budget has been finalised. (3) Make sure that the plan includes work to extend equipment lifetimes and make maintenance checks and overhauls more efficient. (4) In addition to being an action plan for the maintenance work, the annual calendar should clearly show when maintenance supplies are to be ordered and outsourced work arranged, with their lead times, and progress must be controlled at each point. (5) Examine progress over the year, and, if the plan has not been completed, find out why and take action to prevent the same problem from recurring.
Monthly Calendar	(1) When drafting a monthly calendar, check progress during the previous month, and, if it looks as if any tasks will have to be carried over to the present month, make a recovery plan and incorporate it into the present month's plan. (2) When preparing the monthly calendar, consider the work arrangements and what human resources will be required (decide which members of which team will do which task, and when, including whether it will be done on a weekday, at the weekend, etc.), then build this into the site's shift schedule. (3) Arrange the work of each member of the maintenance department as efficiently as possible, spreading the workload out to reduce the need for overtime. (4) Some items on the monthly calendar will need to be reviewed in collaboration with the production control department, operating department or production engineering department, and action taken to adjust the annual plans, arrange for members of the production department to come in on days off, avoid clashes with engineering work planned by the production engineering department, and so forth. (5) Monitor progress over the month, and, if the plan has not been completed, find out why and take action to prevent the same problem from recurring.
Weekly Calendar	(1) Plot the week's maintenance tasks on a weekly calendar, showing what is to be done at what time each day. (2) New maintenance tasks generated for the present month should be added, and the work of each member of the maintenance department should again be arranged as efficiently as possible, spreading the workload out to reduce the need for overtime. (3) Adjust the work plans for weekends and other holidays, making sure the work is balanced and minimising the need for overtime. (4) As well as checking progress daily and taking corrective action, monitor progress over the week, and, if the plan has not been completed, find out why and take action to prevent the same problem from recurring.

Progress Control of Maintenance Plans

Reasons for failing to meet the plan

1) Planned work interrupted by urgent tasks (sudden failures, help urgently required elsewhere, and other problems)

2) Lax planning (inaccurately estimating amount of work required, etc.)

3) Poor execution of work (duplication, rework, wasteful motion)

Key points for progress control

1) Make progress against the monthly calendar visible at a glance

Make it possible to see at a glance which tasks have been completed, so that it is easy to see whether or not the work is proceeding according to plan

2) When the work falls behind plan, act promptly to identify the causes and prevent them from recurring.

As well as acting promptly when the work falls behind plan, it is important to find out why the delay occurred and prevent it from happening again. Steady implementation of strategies to prevent the recurrence of problems will result in less trouble and improve the accuracy of the plans.

Maintenance Information Management

The need for maintenance information management

1) To understand the situation regarding the occurrence of failures, analyse their causes promptly, and prevent them from recurring.

2) To see how the maintenance work is being performed, identify the causes of losses, and reduce those losses

Actions required under maintenance information management

1) Preparing records and standards (e.g. maintenance reports and maintenance action records)

As well as standardising the forms to be used for recording maintenance information (e.g. maintenance reports and maintenance action records), the terms used in them should be clearly defined so that everyone speaks the same language.

Data collection sheets should be designed so that the data can be categorised in different ways.

If possible, the recording of information should be computerised.

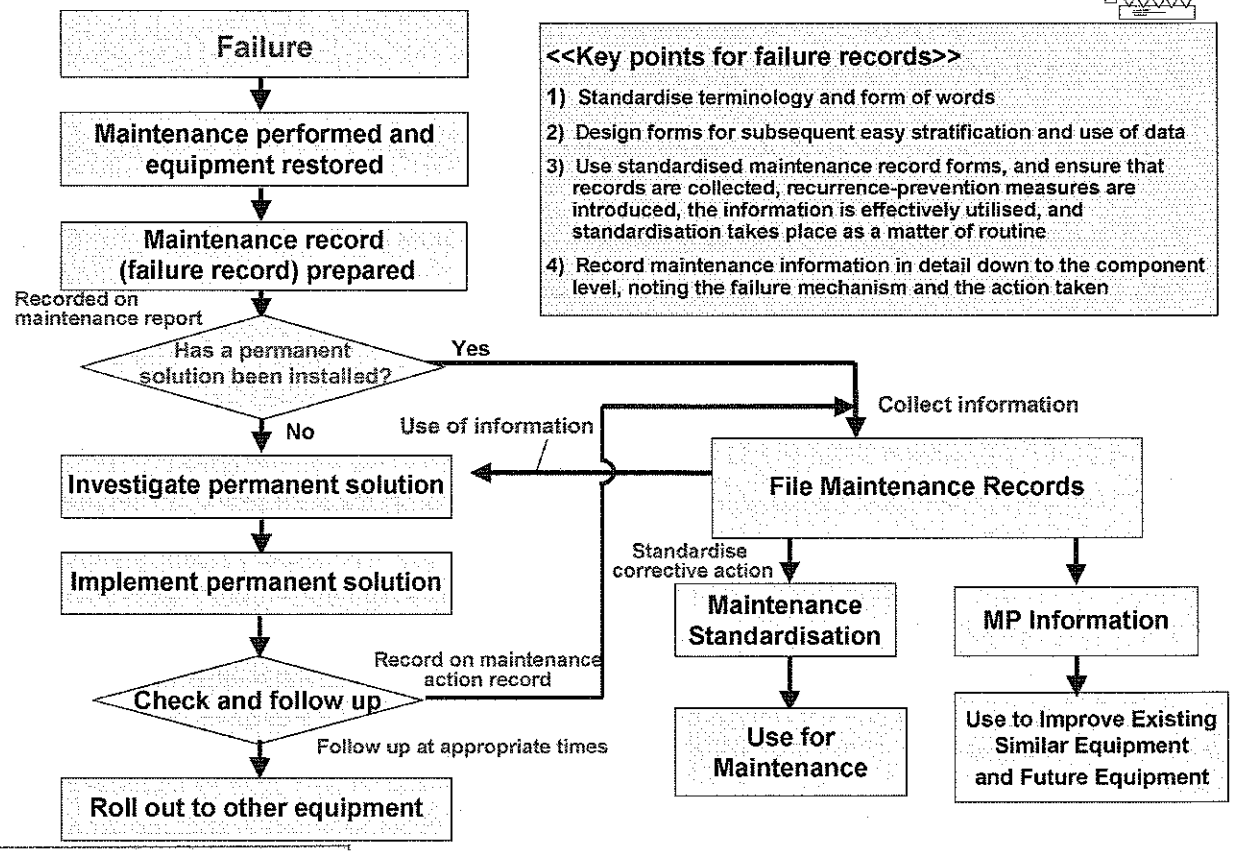
2) Creating systems for collating records, and standardising rules

Systems need to be put in place for the collection of records. This should be computerised if possible so that it can be done rapidly and efficiently.

3) Creating systems and standard rules for analysing records

Systems should be put in place for stratifying and analysing data records. If possible, this should also be computerised to make it rapid and efficient.

Collection and Utilisation of Maintenance Information and Failure Data



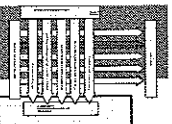
<<Key points for failure records>>

1) Standardise terminology and form of words
2) Design forms for subsequent easy stratification and use of data
3) Use standardised maintenance record forms, and ensure that records are collected, recurrence-prevention measures are introduced, the information is effectively utilised, and standardisation takes place as a matter of routine
4) Record maintenance information in detail down to the component level, noting the failure mechanism and the action taken

Key Points for Failure Records

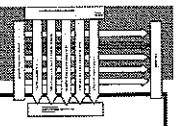
1. Use standard terminology	⇒	Using non-standard terminology makes Pareto analysis impossible
2. Design data entries for easy stratification and analysis	⇒	Before collecting data, decide how it will be used
3. Failure analysis starts from component-level failure-mode records	⇒	Failure analysis cannot be started on the basis of general statements about malfunctions (e.g. 'the motor stopped working')

Table of Data Entry Items for Failure Records (Example)



No.	Entry item	Remarks
1	Department	Code indicating department or section where equipment is in use
2	Process	Process category (cold heading, welding, painting, etc.)
3	Line	Line category (part of process)
4	Stage	Stage category (part of line)
5	Equipment category	Category of equipment
6	Equipment control number	
7	Equipment name	
8	Unit	Functional block category (drive, transmission, control system, welder, etc.)
9	Device	Motor, sequencer, etc.
10	Component	Smallest repair unit, e.g. bearing, seal, circuit board, etc.
11	Problem phenomenon	Equipment problems that first became apparent (workpiece falling off, overloading, mis-actuation, etc.)
12	Failure mode	Failure phenomenon at component level (seized up, worn, broken, etc.)
13	Cause (physical)	Inadequate lubrication, overloading, off-centring, etc.
14	Cause (management)	Design fault, fabrication defect, unsuitable operating condition, mis-operation, incorrect maintenance, unsuitable maintenance plan, etc.
15	Date of occurrence	Year Month Day
16	Time of occurrence	Year Month Day
17	Line downtime	Line downtime affecting production
18	Equipment downtime	Time for which equipment itself was stopped
19	Corrective action	What repair was done (part replaced, adjustment made, etc.)
20	Permanent solution	What was done to prevent recurrence (circuit changed, standard revised, skill training given, etc.)

Maintenance Report



Issue date			Phenomenon/ situation	What happened?			
Group number							
Machine name							
Maintenance category	Periodic	Predictive	Date and time of occurrence	Month Day Hour Minute	Equipment downtime during production time		
	Random/recurring	Corrective	Date and time of restoration	Month Day Hour Minute	Equipment downtime outside production time		
	Date of previous occurrence		Restoration form	Line ( )	Engineering work ( )	Total downtime	
Items investigated	What was checked and confirmed?						
Results of investigation	What was found, where was it found, and in what condition was it in?						
Action taken	What was done to what?						
Presumed causes	Why did it happen? Why was it caused?						Maintenance supervisor

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Unit Code	Shaft	Bearing	Bolt	Key	Shaft joint	Gear	Chain	Belt	Pulley	Cam	Packing	Pipe/ hose	Valve/ pipe joint	Cylinder	Solenoid	Sensor	Motor	Gearbox	Sequencer	Wiring	Pneumatic/ hydraulic device	Internal table mechanism			
	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
Phenomenon code	Worn	Corroded	Strained	Fallen off/ detached	Distorted	Cracked	Broken	Peeled off	Leaking	Blocked	Seized	Abnormal noise	Vibration	Heat	Displaced	Ran dry	Melted	Mis-actuation	Mis-contact	Short-circuit	Detective insulation	Broken wire	Burnt out		
	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
Cause code	Detective lubrication	Detective operation	Detective checking	Detective adjustment (by maintenance)	Detective adjustment (by operation)	Deterioration over time	Precision problem	Overloading	Ingress of foreign matter	Stress concentration	Incorrect selection of equipment	Detective repair	Detective installation	Detective machining	Detective design										

Maintenance Action Report

Phenomenon		Works section manager	Maintenance section manager	installer
Mechanism		MP information		Prepared by
		Required / not required		
Constituent conditions		Sketch		
True cause				

Permanent countermeasure proposal	Proposal A		Proposal B	
	Sketch or drawing number		Sketch or drawing number	
Maintenance regime to be used from now on	Re-investigate	Specific details	When corrective maintenance is to be used	
	Jishu-Hozen		Scheduled design completion date	Person responsible
	Periodic maintenance		Scheduled installation completion date	Person responsible
	Predictive maintenance		Estimated cost	
	Corrective maintenance		Estimated benefit	
	Breakdown maintenance			

Straight-through rate control section	True cause discovered		Permanent solution proposed		Solution implemented		Solution standardised		
	Person responsible	Confirmed by section manager (signature)	Person responsible	Confirmed by section manager (signature)	Person responsible	Confirmed by section manager (signature)	Person responsible	Confirmed by section manager (signature)	File
	Date		Date		Date		Date		

Spare-Parts Management

The aims of spare-parts management

1) Preventing downtime losses due to spare-parts problems when equipment breaks down, and eliminating long stoppages

This is the most basic objective of spare-parts management; if the right spare parts are not available when a machine breaks down, and it takes a long time to acquire them, the machine will be out of commission for a long time. This not only creates extremely large failure losses but can affect customers if it causes delays to delivery schedules, possibly leading to loss of confidence in the company.

2) Reducing inventory costs by keeping stocks at the appropriate level

Efforts should be made to reduce inventory costs and improve supply reliability by reducing the variety of spares kept in stock (standardising on a certain number of manufacturers and types, and using as many common parts as possible), monitoring the numbers of each part kept in stock and systematically replenishing them as they are used, and managing the purchasing of spares so as to minimise lead times.

3) Reducing indirect costs associated with spare-parts purchasing

Correctly understand spare-parts categories, and make use of all available information from various industries to increase purchasing efficiency.

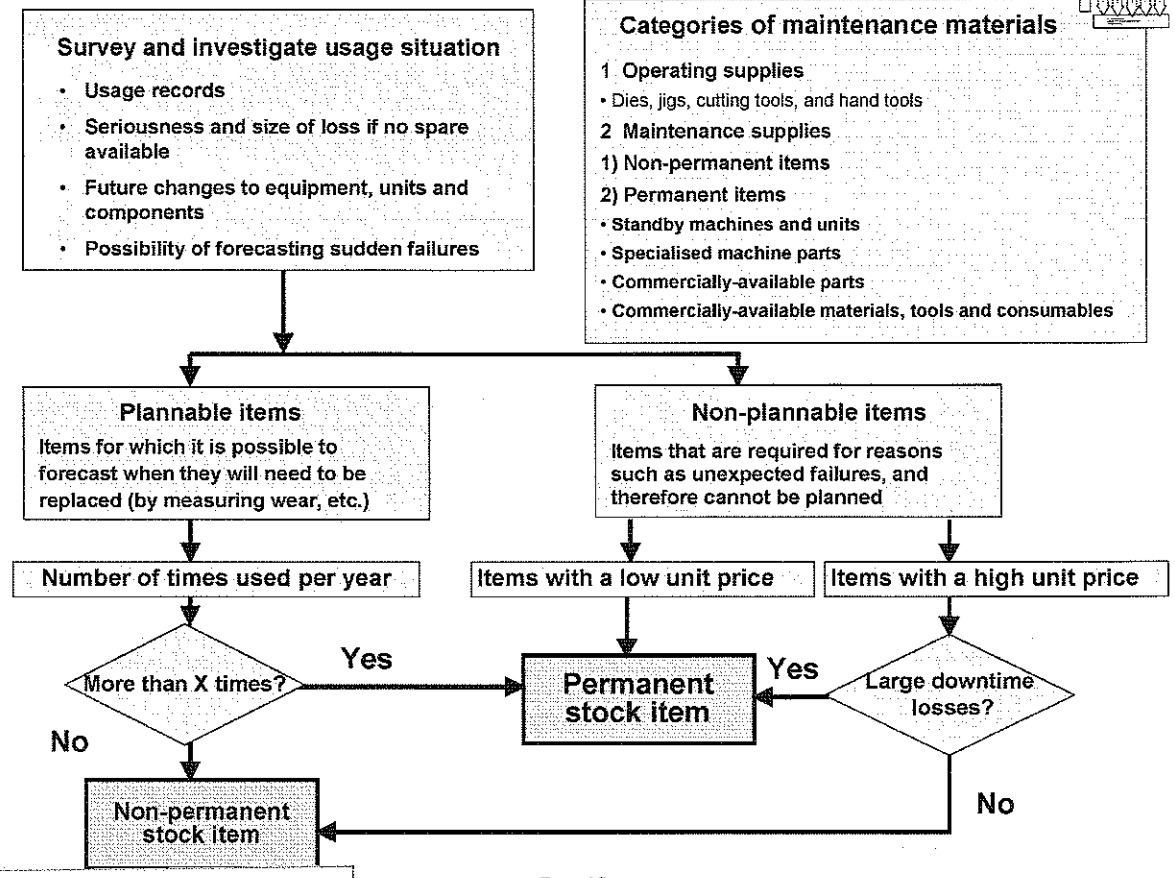
4) Improving the efficiency of preparing for and implementing maintenance work

Ensure that maintenance work can be progressed systematically and without losses by arranging to acquire the necessary spare parts in advance.

5) Pinpoint weaknesses and effect improvements by monitoring consumables

Records of spare parts usage can indicate which parts have a durability problem. This data can be used to see whether the problem is with the spare parts themselves or with the conditions under which they are being used in particular machines. Failures should be reduced and lifetimes extended by analysing the causes of short lifetimes and taking action to make the relevant parts last longer and be more reliable.

Categorising Spare Parts as Permanent or Non-Permanent



Spare-Parts Categories and Ordering Systems

ABC analysis (categorising) of spare parts; and ordering systems

Category	Cumulative proportion	Management Approach	Ordering System
A	~75%	Control most tightly, keeping safety stocks to a minimum (for high-priority items)	• Fixed-period • As used • Planned
B	75% ~ 95%	Control less tightly than category A	• Order-point
C	95% ~ 100%	Control even less tightly	• Order-point

The fixed-period order system and the fixed-quantity order system

Fixed-period order system	A system in which the stock is checked at fixed intervals (on the first day of the month, for example, or on the 1st and 15th) and the appropriate quantity is ordered in accordance with the formula: Order quantity = {quantity used during (procurement lead time + order cycle time)} – {quantity on order but not yet received} – {current quantity in stock} + {quantity of safety stock}
Fixed-quantity order system	A system in which a predetermined standard quantity is ordered when the number of items in stock reaches a set level (the order point). This system requires little time and effort to operate once the order point and the standard order quantity have been decided.

Making Maintenance Work More Efficient

The aims of making maintenance more efficient

1) Establish a Keikaku Hozen system

⇨ Use the time released by improving the maintenance work for preventive maintenance, corrective maintenance and MP activities

• Shift from the fire-fighting type of maintenance to systematic Keikaku Hozen

2) Reduce total maintenance costs

▪ Minimise maintenance costs and losses due to interrupted production by reducing maintenance labour requirements and improving equipment reliability

Maintenance Characteristics, and How to Increase Efficiency

1. Part of the time is spent waiting, and the workload is concentrated in the times when repairs need to be done

- 1-1 Keikaku Hozen is carried out mainly when the equipment is stopped
- 1-2 Emergency repairs sometimes have to be done during production
- 1-3 Attention is focused on the most important lines

2. A lot of the work is irregular

- 2-1 Standardisation makes slow progress
- 2-2 Work improvement is slow
- 2-3 Differences in skill levels have a large impact

3. Similar tasks are seldom repeated, and similar machines are seldom worked on

- 3-1 Equipment investment for improving maintenance tasks is not very beneficial
- 3-2 The key point is to adopt improvements that can be rolled out to similar parts on other machines

→

- Use waiting time effectively
- Create systems for giving and receiving assistance
- Multi-skill (maintenance, Jishu-Hozen)
- Roll out generic industrial-engineering-type improvement techniques
- Improve existing maintenance tools, and develop new ones
- Prevent recurring failures
- Utilise MP information extensively
- Develop people
- Automate diagnosis
- Automate maintenance and control

Examples of Maintenance Work Improvement

Increase proportion of Keikaku Hozen	• Obtain time for Keikaku Hozen by arranging maintenance personnel's schedules effectively • Reduce random failures and breakdown maintenance by preventive maintenance, predictive maintenance and recurrence-prevention activities • Increase the amount of preventive and predictive maintenance work done while the equipment is operating
Reduce time spent on non-maintenance tasks	• Make administrative work more efficient by introducing computerised equipment management, spare-parts management and maintenance work management systems • Ensure that meetings and discussions are conducted efficiently • Analyse work and improve efficiency by eliminating WUS (waste, unevenness and strain)
Reduce time spent on maintenance tasks	• Reduce maintenance time by improving equipment maintainability (including checking and overhauling) • Reduce working time through the use of improved tools and devices • Reduce working time through industrial-engineering-type improvements (motion analysis and motion economy of maintenance tasks, etc.) • Reduce working time by improving changeover between maintenance tasks • Reduce working time by standardising maintenance tasks • Reduce working time by skills development and training
Reduce time spent on preventive maintenance	•Reduce time spent on preventive maintenance by extending equipment lifetimes •Reduce time spent on preventive maintenance by introducing automatic equipment monitoring
Reduce overall maintenance time by utilising MP information extensively	• Introduce innovations to make newly-installed equipment failure-free, trouble-free, and maintainable with little time and effort • Greatly reduce failures, problems and the preventive maintenance requirement through widespread rollout of maintainability improvements and solutions to failures and other problems
Reduce overall maintenance time by improving skills	• Deliver maintenance skills training (including preventive maintenance and breakdown maintenance) and Jishu Hozen skills training (for preventive maintenance) • Develop multi-skilled personnel (maintenance personnel capable of maintaining both mechanical and electrical equipment; operators who can also do maintenance, etc.)
Make the work of the whole factory more efficient by establishing mutual support systems	• Install systems to enable support between maintenance personnel in different units, maintenance personnel and operators, and maintenance personnel and other departments

TPM Manual Chapter 6 Early Management

(Product & Equipment)

JIPM-Solutions Co. Ltd.

Background and Aims of Product and Equipment Development Management

<Background>

- Global competition (cost, quality, speed)
- Fierce cost-reduction competition
- Quality taken for granted (quality problems critical)
- Shorter product lifetimes

<Current Problems>

- Long time between product development and full-scale production
- Large losses from product development to preparing for production
- Large losses due to quality problems
- Ratio between commissioning period and product lifetime is too large

<Aims>

① Develop attractive, factory-friendly products

② Develop equipment that can manufacture high-quality products cheaply

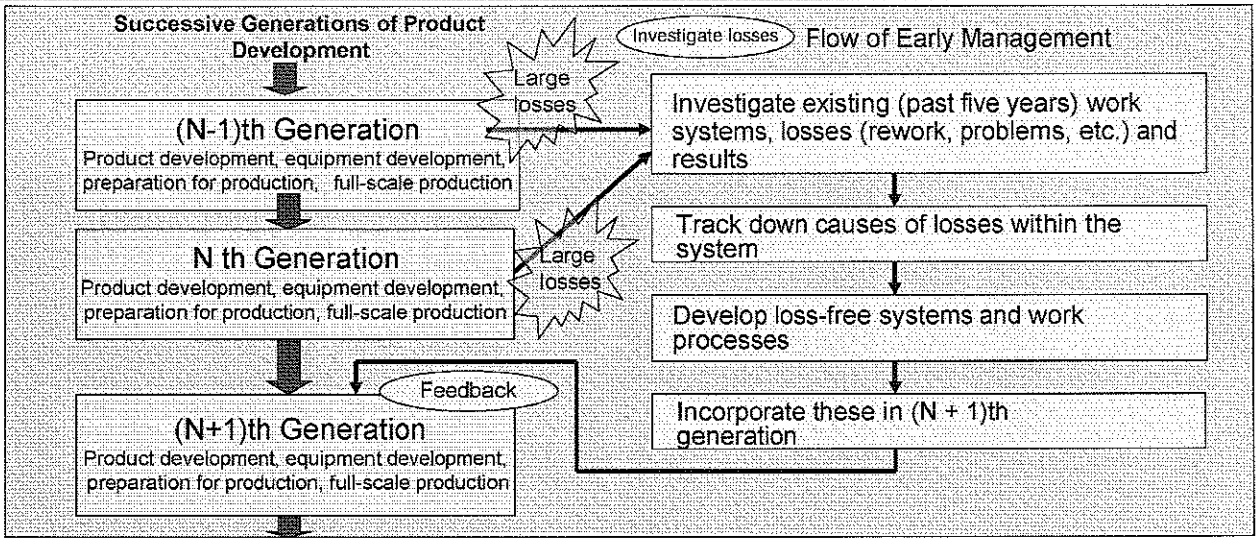
③ Prevent losses (including quality losses)

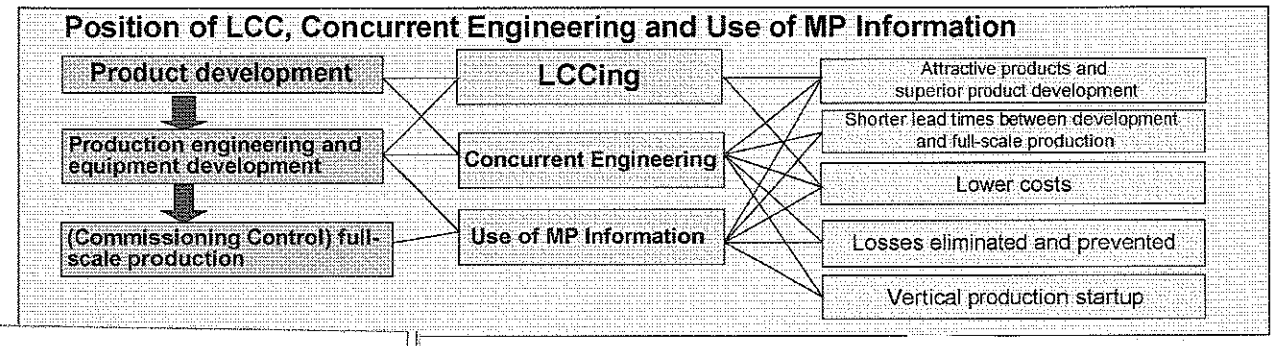
④ Shorten time between development and full-scale production

⑤ Achieve vertical production startup

Build a company that is competitive from product development through to full-scale production

Early Management, LCC, Use of MP Information and Concurrent Engineering





LCC and LCCing

<<What is LCC (life-cycle cost)?>>

Life-cycle cost is defined by the U.S. Office of Management and the Budget as 'The sum of the direct, indirect, recurring, non-recurring, and other related costs of a large-scale system during its period of effectiveness. It is the total of all costs generated or forecast to be generated during the design, development, production, operation, maintenance and support processes.'

<< What is LCCing (life-cycle costing)>>

Life-cycle costing is defined by JIPM's LCC Committee as 'A systematic decision-making technique that incorporates life-cycle cost as a design parameter at the system development stage, performing all possible trade-offs to ensure an economic life-cycle cost for the user's system.'

The Life-Cycle Costing Procedure

Step 1: Clarify the mission of the system being studied

↓

Step 2: List several alternative ways of achieving the mission

↓

Step 3: Identify the elements by which the system can be evaluated and methods for quantifying these

↓

Step 4: Evaluate the alternative proposals

↓

Step 5: Document the analytical process and results

Key Points for Equipment Life-Cycle Costing

Key Point 1

When selecting an equipment system, consider the initial cost and running cost on an equal basis, and investigate the life-cycle cost from the start of the development project.

By doing this, try to minimise the total cost through economic design with a high degree of freedom.

Key Point 2

When designing an equipment system, conduct evaluations using life-cycle cost as a design parameter (devise several different systems and choose the best)

Achieve the planned cost through permitted-cost design,
rather than putting the design first and allowing the cost to turn out as it will.

Key Point 3

Make all possible trade-offs; and, where two elements conflict, compare their relative importance and adopt the proposal that gives the greatest overall economy.

By doing this, try to achieve the best possible system proposal.

Examples of Trade-Offs

1) Between acquisition costs (initial cost) and running costs

Include systems for maintaining the equipment efficiently in order to reduce maintenance costs

Evaluate not just in terms of initial cost but also in terms of maintenance and running costs

2) Between different elements of initial cost (e.g. prototyping cost and fabrication cost)

Reduce fabrication cost through sufficient equipment prototyping
Costs can effectively be reduced by limiting the scope of the development prototyping

3) Between different elements of maintenance cost (e.g. Keikaku-Hozen cost and downtime loss)

Reduce downtime losses by increasing Keikaku-Hozen

Also minimise downtime losses by increasing the efficiency of preventive maintenance and by automating

It is important not to compare trade-offs but to come up with creative concepts leading to proposals with a high degree of overall cost effectiveness.

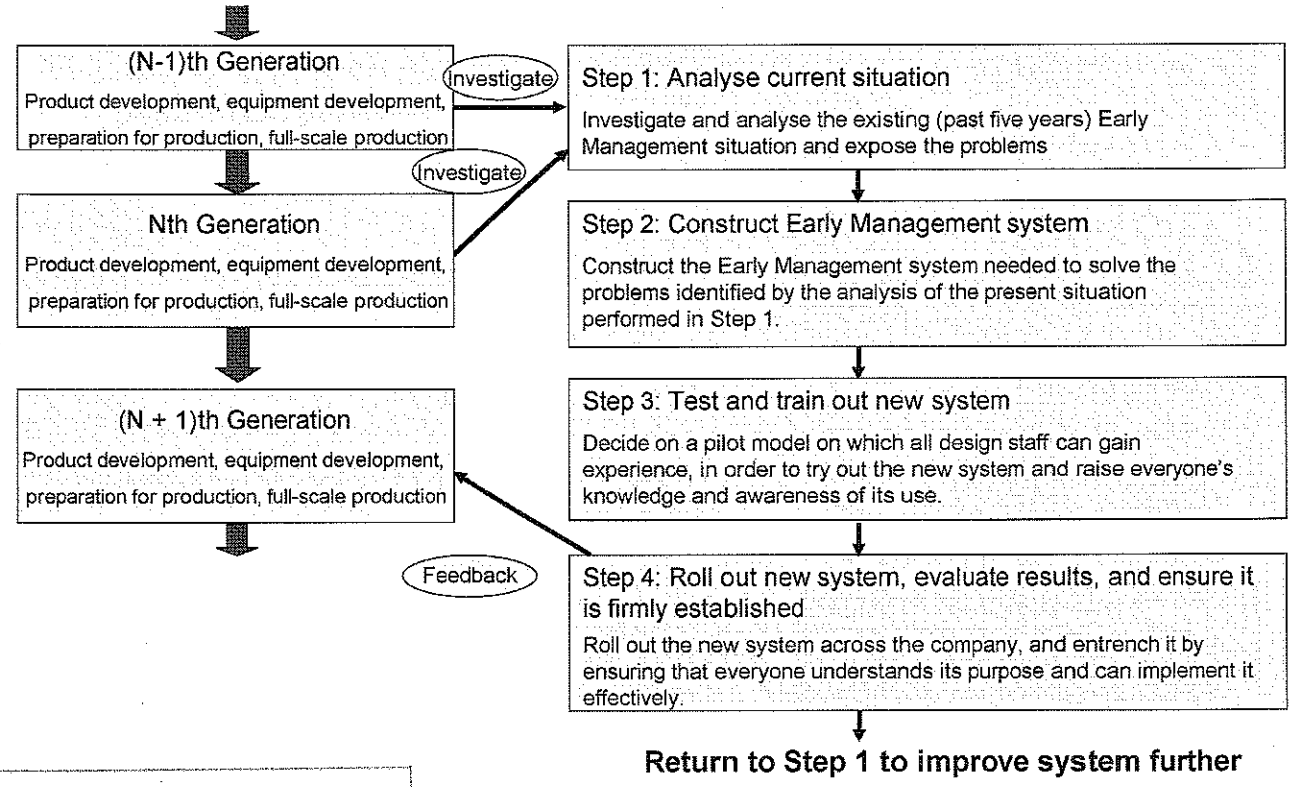
LCC Calculation Method Compared with Conventional Investment Calculation Methods

	Formula	Main criteria
Payback period method	Payback period (years) $= \frac{\text{Initial Cost}}{\text{Annual profit}} = \frac{\text{Initial Cost}}{\text{Sales Revenue} - (\text{Cost}^{*1} - \text{Depreciation})} = \frac{IC}{S-C+D}$	◎The shorter the payback period, the better *1 Total cost not including depreciation
Cost comparison method	$(CC+OC)_A \lessgtr (CC+OC)_B$ CC: Cost of capital / OC: Operating cost	◎The lower the sum of the cost of capital and the operating cost, the better. Note: If the alternative proposal has a different output, the comparison is done using the cost per unit of output.
ROI (return on investment) method	$ROI = \frac{\text{Annual Profit}}{\text{Initial Cost}} = \frac{\text{Sales Revenue} - (\text{Cost} + \text{Interest})}{\text{Initial Cost}} = \frac{P}{IC} = \frac{S-C+Int}{IC} = \frac{P+Int}{IC}$	◎The criterion is the annual profit obtained through this investment expressed as a percentage of the initial cost, so the higher, the better.
LCC method	Cost Effectiveness $= \frac{\text{System Effectiveness}}{\text{Life Cycle Cost}} = \frac{\text{Material or monetary benefit}}{\text{LCC (=IC+OC)}}$ And if the monetary benefit V (value) is used as the numerator, then $= \frac{V}{IC+OC}$	◎Whether the numerator is material or monetary benefit, the larger the better. ◎The denominator is the sum of the initial cost and the operating cost, and the smaller it is, the better. ◎Thus, the larger the value of this ratio, the greater the cost effectiveness.

IC: Initial Cost
OC: Operating Cost
CC: Capital Cost
C: Cost
V: Added Value
Dep: Depletion
P: Profit
Int: Interest
LCC: Life Cycle Cost
S: Sales
ROI: Return on Investment

Implementing Early Management (Product & Equipment)

Successive Generations of Product Development



Implementing Early Management (Steps 1-2)

Step 1: Analyse current situation

1. Clarify current Early Management workflow.
2. Identify problems with current workflow.
3. Find out what is currently being done to 'design out' foreseeable problems at each stage of Early Management process.
4. Find out what problems are currently arising at prototyping, test-run and commissioning stages, and what is being done to deal with them and prevent them recurring.
5. Find out how process is being held up at prototyping, test-run and commissioning stages, and what is being done to deal with it and prevent it recurring.
6. Find out what is currently being done in the way of collecting, storing and using information with a view to designing products and equipment to be user-friendly, factory-friendly, non-defective-generating, maintenance-friendly and highly-reliable, as well as safe and commercially-competitive.

Step 2: Construct Early Management system

1. Think through basic framework of Early Management system and define its scope of application.
2. Define scope of system for collecting, collating and utilising data needed for Early Management.
3. Formulate and refine various standards and forms needed for Early Management.

Implementing Early Management (Steps 3-4)

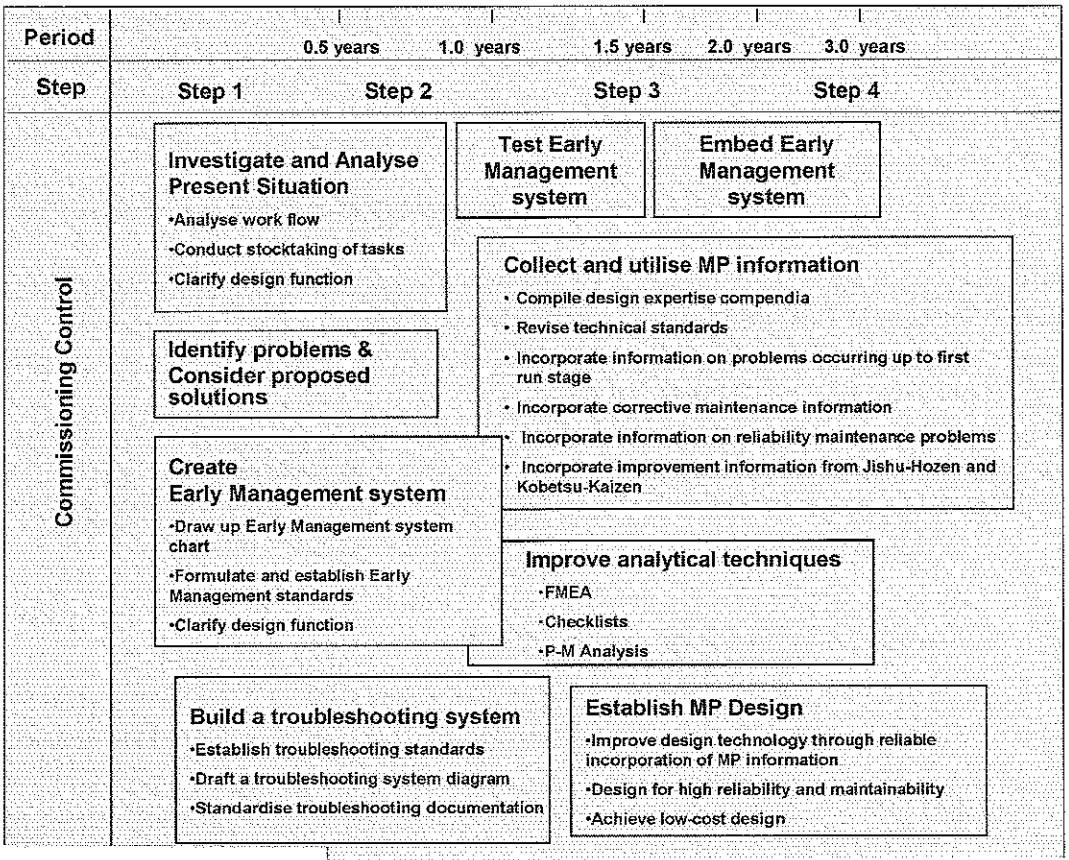
Step 3: Test and train out the new system

1. Implement the new system for each project and work step selected as a pilot model
2. Meanwhile, train everyone in the standard techniques needed to implement the system
3. Through the work steps, evaluate the understanding, techniques, suggestions incorporated into designs, and other aspects of the new system
4. Based on the results of implementing the system, amend and improve the system itself and the associated standards, forms and other documentation
5. Identify results, such as the benefits gained by applying the new system

Step 4: Roll out new system, evaluate the results, and ensure it is firmly established

1. Expand the new system to all projects
2. Enhance the use of information in LCC optimisation and MP design (discussed in detail later) as part of the Early Management system
3. Evaluate results such as the state of deployment of the new system and its effects
4. ※ For each project and work step to which the new system has been applied, collect figures every six months on things such as the number of problems identified, the number of ideas incorporated, the number of projects which have run into trouble, the number of projects behind schedule, and the time required from starting the production line to achieving the production target, then collate this information and present it as results.
5. Return to Step 1 to improve the system further

Rolling out an Early Management Programme (example)



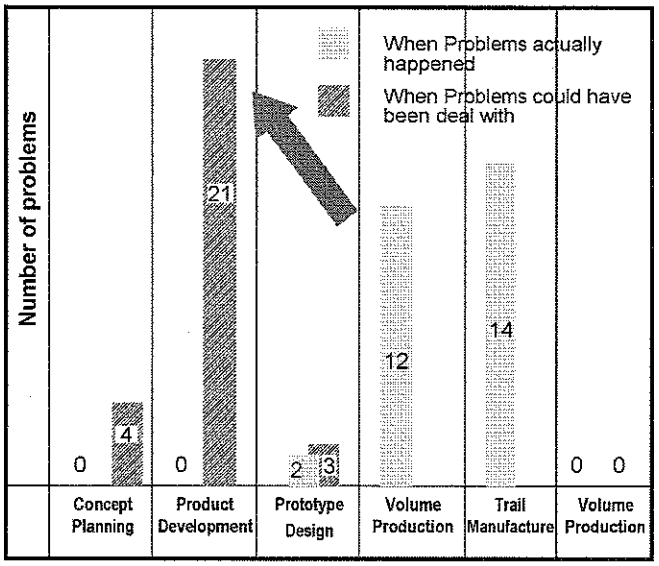
Early Product Management

The need for early product management, and its aim

Need

(1) Large losses in downstream processes (2) Long lead times (3) Slow startup

When and How Often Development Problems occur (example)



Aim

Construct systems for superior product development and forestalling problems at every stage

- Develop attractive products
- Shorten time between development and full-scale production
- Reduce costs
- Eradicate and prevent losses
- Achieve vertical production startup

Methods and Systems for Implementing Early Product Management

A Typical Early Management System

	Flow Diagram of Early Management	What to check	Standards and formats
1. Concept	What customers want to buy / What Company wants to sell → Explore Possibilities ← Fist Design Review → Decide on development	Check basic potential and hurdles concerning market technology and cost	Development Topic Selection Sheet
2. Planning	Decide on Specifications ← Second Design Review → Decide on Conceptual design ← Third Design Review → Give go-ahead for development ← Board of Directors / New-Product Development Meeting	Desktop Review Review basic performance in terms of function and strength and possible manufacturing methods	Conformity Review Check Sheet Concept Proposal Evaluation System
3. Design	Do detailed (assembly) design ← Fourth Design Review → Do detailed (parts) Do process design ← Fifth Design Review	Identify and deal with potential problems	FMEA Sheet -Assembly -Components -Processes
4. Prototyping	Order Prototype → Inspect components → NO / YES → First Prototype → NO / YES → Second Prototype	Check Functions Check Performance	Prototype Order Control Ledger
5. Evaluation	Confirm Performance and Specifications → Evaluate ← Sixth Design Review → NO / YES	Identify and deal with potential problems Implement and check countermeasures aimed at ensuring that defectives cannot be produced or passed on	Conformity Review Report Test Report
6. Volume Production	Register for volume production		Process FMEA

Establishing Systems for Evaluating and Selecting Product Development Projects

No.		No.		1	2	3	4	5	Total	Remarks
1	**Commercial viability: 40 points**	A	Price				ABCD		4	
		B	Competitiveness			C	AB D		3.75	
		C	Size of market				ABCD		4	
		D	Novelty and originality			BCD	A		3.25	
		E	Expectation				C	ABD	4.75	
		F	Life cycle				BCD	A	4.25	
		G	Growth potential				CD	AB	4.5	
		H	Patent potential				CD	AB	4.5	
									33	82.5%
2	**Development capability: 30 points**	A	Technological capability	New technology	Application of general-purpose technology	Further development of proprietary technology ABCD	Spin-off from proprietary technology	Proprietary technology	3	
		B	Human resources			Collaborate with engineers in other fields	Current project team ABCD	Within current department	4	
		C	Process technology			D	ABC		3.75	
		D	Assembly technology			ABCD			3	
		E	Materials technology				ABCD		4	
		F	Parts and materials supply technology				ABCD		4	
		G								
									21.75	72.5%

Establishing Systems for Evaluating and Selecting Product Development Projects

3	**Development schedule: 15 points**	a	Schedule	1.5 years or more	1 year	10 months	6 months ABCD	3 months	4	
		b	Labour-hours		2 full-time equivalents	1.5 full-time equivalents	1 full-time equivalent ACD	Shared with other development projects B	4.25	
		c	Priority rating				AB	CD	4.5	
									12.75	85%
4	**Other: 15 points**	a	Compatibility with company policy and plans	60% or lower	60%	75%	90%	100% ABCD	5	
		b	Extent to which new ideas could be rolled out to other products		BCD	A			2.25	
		c	Degree to which it enhances the company's image			A	BCD		3.75	
									11	73.3%
Overall evaluation	Product potential was rated high, at 82.5%. The development schedule also rated high. Compatibility with company policy was rated at 100%. Based on the above evaluation, the go-ahead was given and a high development priority was assigned. ABCD: Evaluators								78.50	

Factory-Friendly Design at the Product Development and Design Stage

What is a factory-friendly product?

A factory-friendly product is a product that can be made easily, with simple equipment, at low cost, and which creates few problems during production. Such products are essential for cost-competitiveness.

Easy to process (e.g. machining)

- Easy to create a reference surface on
- Easy to clamp
- Easy to position in holder
- Resistant to going out of centre
- Scratch-resistant
- Burr-resistant
- Easily machined
- Easily screened for defectives
- Easily measured
- Easy to remove cutting debris from

Easy to put together: (e.g. parts assembly)

- Relaxed assembly precision requirements
- Large sizes
- Simple shapes
- Few in number
- Few different types
- Few assembly orientations
- Easy assembly methods (no complex positioning, glueing, precision assembly, welding, etc.)

Five Strategies to Achieve Factory-Friendliness

1. Before starting the design of a new product, collect and utilise feedback information on existing products' ease of manufacture

2. Analyse the processes used to make existing products in order to find out what is needed to make the product easy to manufacture, and act on this information

3. Conduct a process analysis on the new product at the concept and design stages, to find out what would make it factory-friendly, and how that could be achieved

4. Design and develop the new product in such a way as to make it unlikely that quality defects would occur, by conducting design reviews to analyse the probability of quality defects occurring

5. Design and develop factory-friendly products by identifying and solving potential volume-production problems beforehand, at the prototyping and testing stage

Building in Product Quality at the Design Stage

Improve product quality by using analytical techniques such as FMEA (failure mode and effects analysis) at the design stage to highlight problems in advance and take action to prevent them.

→

Prevent quality claims
Prevent trouble at the full-scale production stage (in-process defects, etc.)

FMEA (for Components)

Part name		Part No.		Manufacturer		Vehicle type	

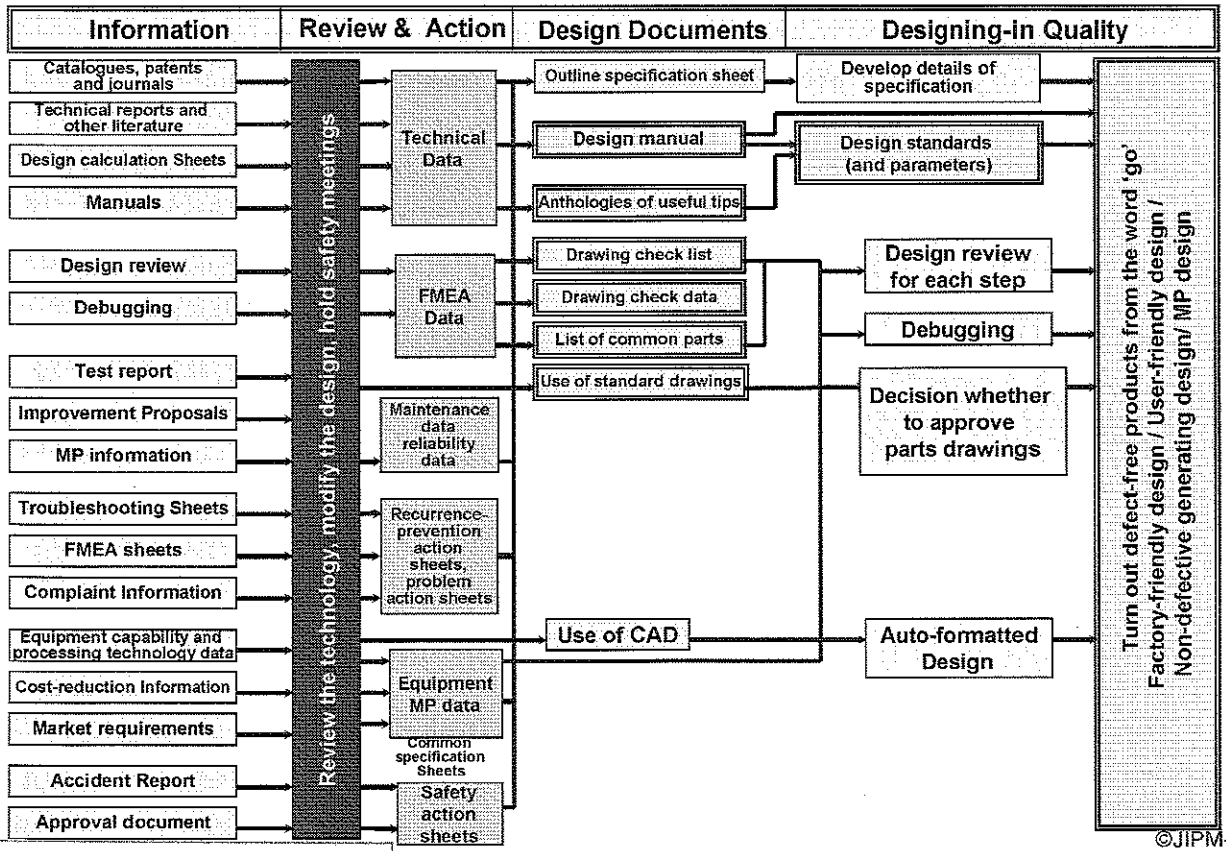
Part name	Function	Defect mode	Effect of defect	Cause of defect	Evaluation score				Measures taken	Evaluation score			
					Likelihood of occurrence	Severity	Detectability	Importance		Seriousness	Frequency	Impact	Detectability

FMEA (for Assembly)

Part name		Part No.		Manufacturer		Vehicle type	

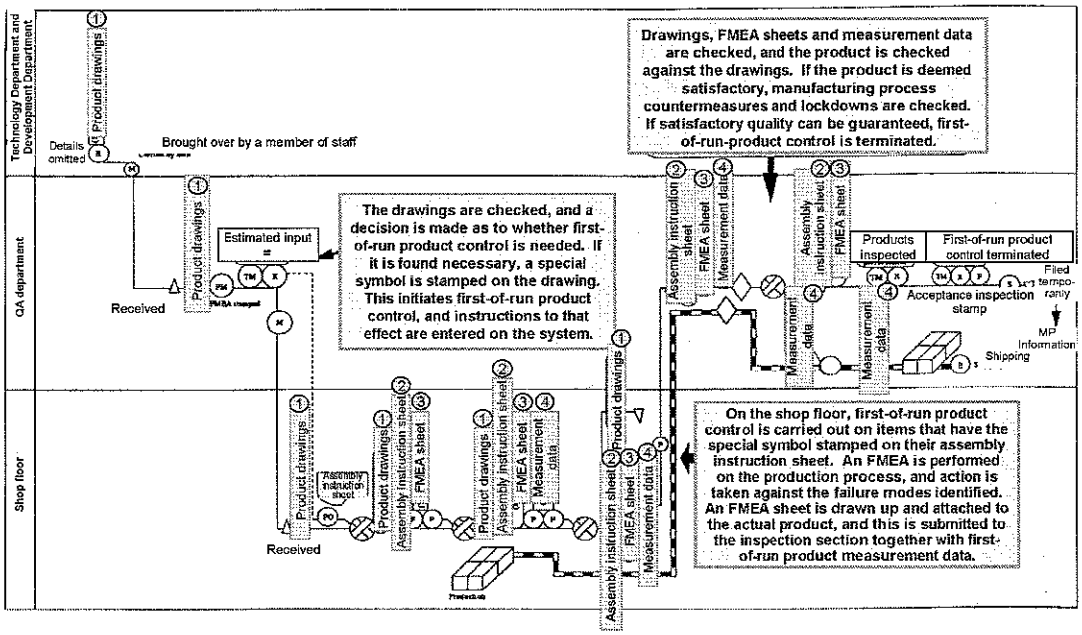
Function	Component	Defect mode	Effect of defect	Cause of defect	Evaluation score				Measures taken	Evaluation score			
					Likelihood of occurrence	Severity	Detectability	Importance		Seriousness	Frequency	Impact	Detectability

Collecting and Utilising Technical Data at the Product Design Stage



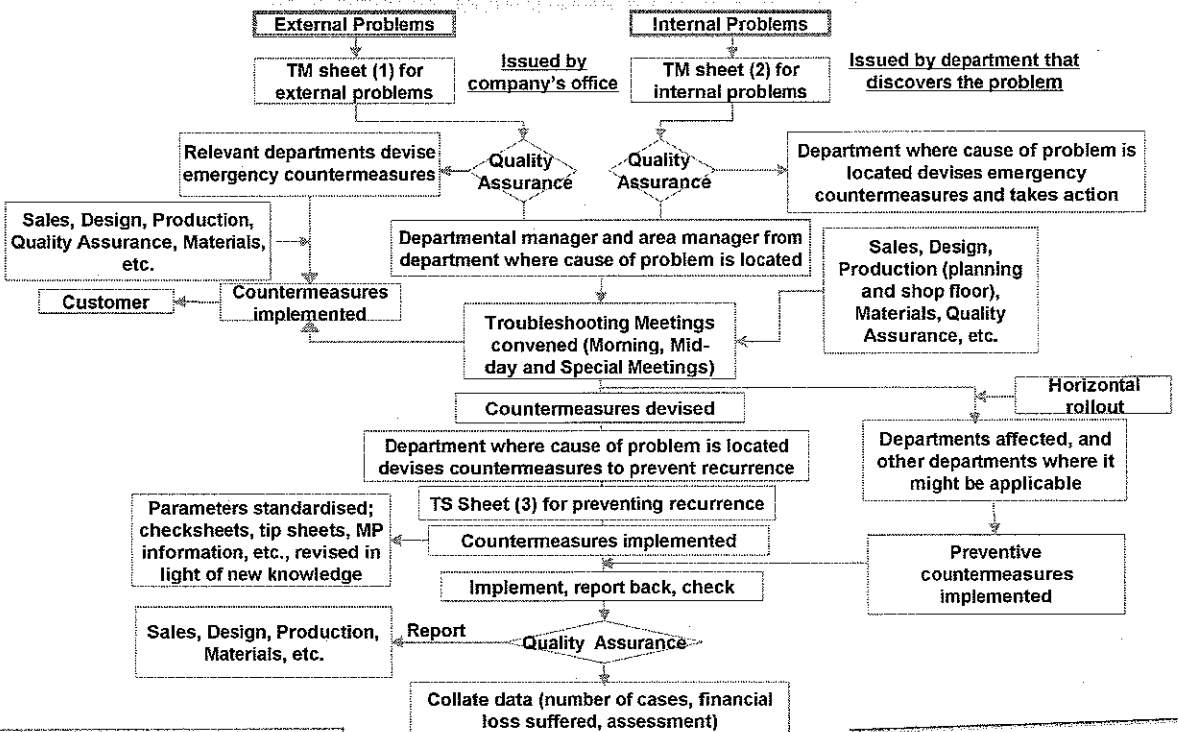
Building in Quality through First-of-Run Product Control

First-of-Run Product Control entails accurately measuring the first products to come off the line during trial production or when starting full-scale production in order to obtain a detailed understanding of the production situation. If any problems are discovered, the 4 Ms (materials, machinery, methods, and mend/women) are examined to see which is causing them, and action is taken to solve them. The first-of-run products are then carefully re-measured, and full production is only started once it has been confirmed that no problems remain.

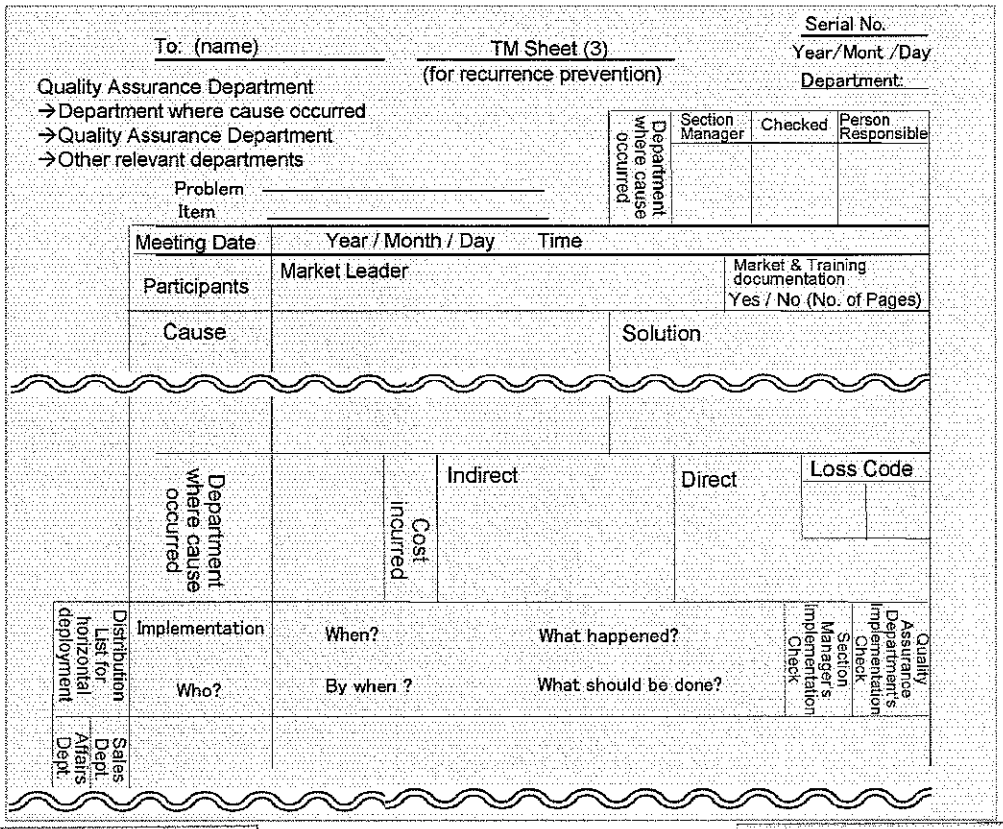


Making use of Information on Problems Arising during Early Product Management

It is important to obtain accurate information about external and internal problems occurring at every stage of the development process from equipment fabrication, assembly and installation through trial production to full-scale production, investigate their causes, give feedback on them to previous processes, and devise solutions to prevent them from recurring.



Example of a Trouble Management Form



Concurrent Engineering

Concurrent engineering, and its aims

Aims

Develop low-cost, easily-manufactured, revolutionary new products with superior performance

Develop highly superior production processes and equipment to allow newly developed products to be manufactured at high quality and minimum cost

Rapidly develop revolutionary new products, production processes and equipment rapidly and bring them to full-scale production

Activities

Coordinate development strategy by sharing information on product development, production engineering and equipment development

From the product development stage on, use the product development proposal as a basis for considering the practical problems foreseen and improvement strategies envisaged at the production engineering and equipment development stages, and move closer and closer to the optimal products, production processes and equipment by repeatedly implementing ideas, suggestions, investigations and improvements.

Because modifications and improvements are introduced simultaneously and in parallel from various production engineering and equipment development perspectives (i.e. from the standpoint of downstream processes) from the product development stage on, changes and rework occurring when bringing the final development proposal (finalised on completion of the development stage) to full-scale production can be drastically reduced, and the lead-time greatly shortened.

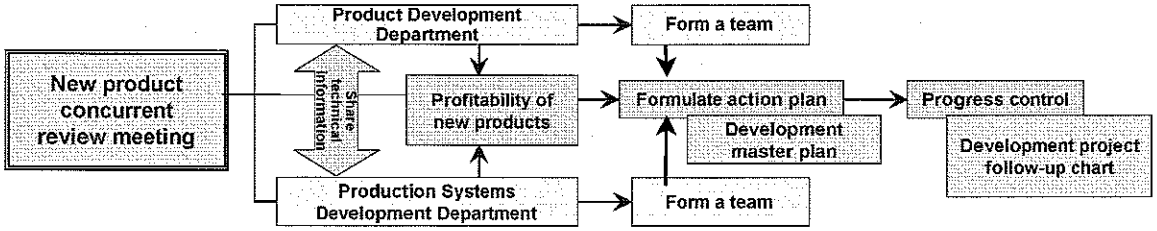
Example of Concurrent Engineering 1

1) Aims of activities

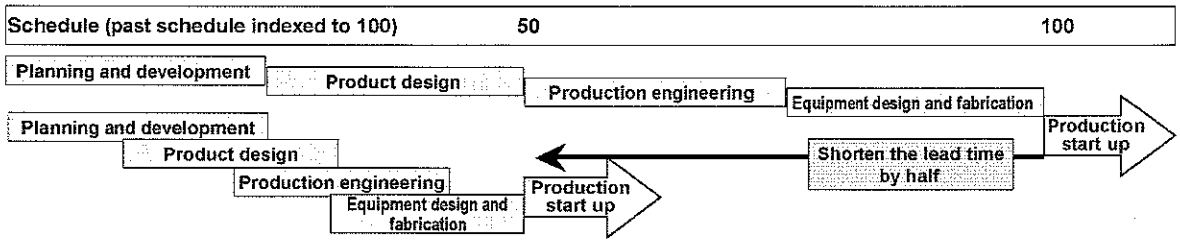
① Develop superior products that can beat the market competition
② Develop processes and equipment by which the product can be manufactured more cheaply and with higher quality than the market competition
③ Reduce development lead times for products, production processes and production equipment

2) Organisation and operation

<< Key operational points >> From the product planning stage on, the Product Development Department and the Production Systems Development Department form teams to share product development information and conduct the work for which each department is responsible in parallel

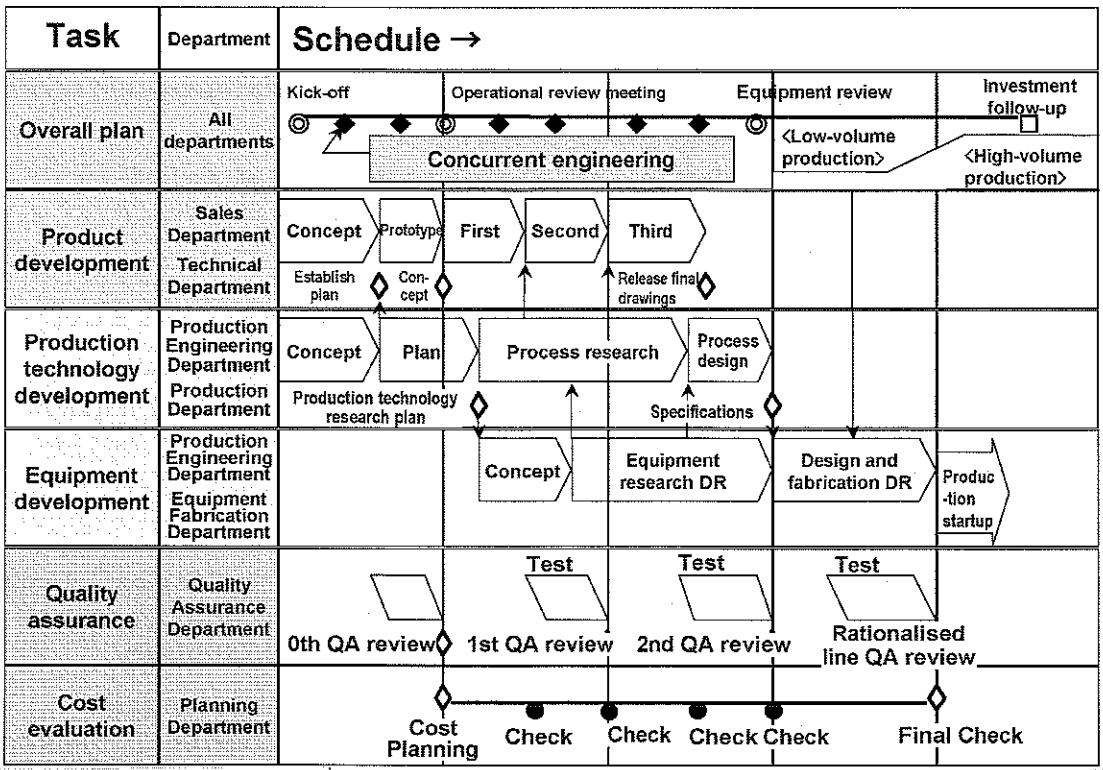


3) Activity schedule



Example of Concurrent Engineering (2)

A typical concurrent engineering development master plan



Early Equipment Management

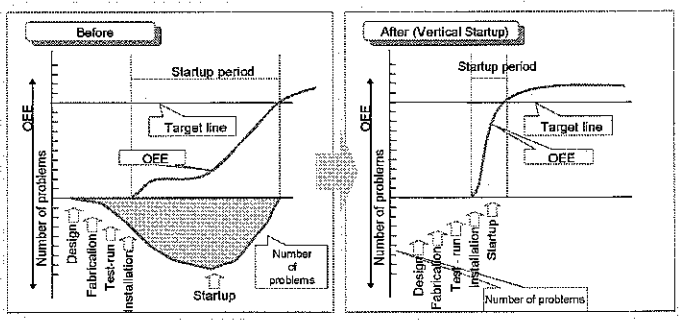
Aims

Aims of Early Equipment Management

1. Develop superior production processes and equipment
Compare functions and costs with those of competitors' equipment at the planning and development stage, perform life-cycle costing, and create superior equipment by incorporating knowledge obtained from existing equipment into the design of the new equipment

2. Eradicate and prevent losses
When introducing new equipment, prevent all kinds of losses from arising at any of the stages from planning, design, fabrication, and installation through to operation

3. Achieve vertical startup
Once a new production line has been installed, it should start operating immediately, with zero quality defects and breakdowns



Key techniques

- LCC
- LCP
- Design reviews at each step
- Use of MP information
- Investigate in advance using various analytical techniques

LCC for Minimising Equipment Cost and LCP for Responding to Change

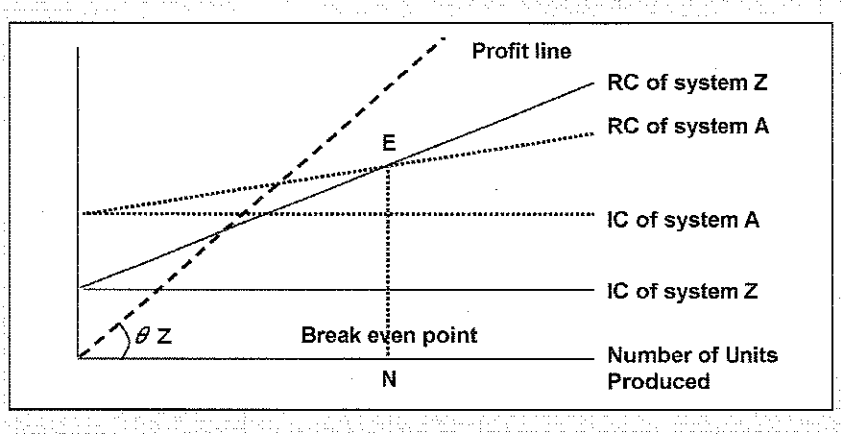
•Minimising equipment cost - LCC

- Minimal-cost design means designing the equipment in such a way that its total cost - that is, the sum of the initial investment in it (its initial cost) and the cost of operating and maintaining it (its running cost) is minimised.
- There is usually a trade-off between initial cost and running cost, and life-cycle costing (LCCing) is used to design the equipment to its optimal total cost

•Designing for flexibility - LCP (life-cycle profit) design

- Fluctuations can occur in production volume, number of product types handled, quality level, product specifications and so on.
- At the design stage, production volume is strictly hypothetical, or is no more than a forecast and is not guaranteed.
- In real life, fluctuations in production volume can reduce profits: if the equipment is over-specified, a cut in production can raise the unit cost of the product, while if it is under-specified, an increase in production can lead to lost opportunities.
- The design philosophy that aims to create equipment able to accommodate fluctuations in indeterminate factors like production volume, is called LCPmax design.

Relationship between total equipment cost and number of units produced, and LCP (Example)



- Point E is the cross over point between system A and system Z
- Point N is the number of units planned to be produced.
- θA and θZ represent the RC per unit of product

Optimal LCP – Proposal that allows the strategy to be changed

Z-to-A strategy: In the initial stages of production, when the sales volume is hard to predict, start with the low-IC system Z. Then, when a hike in production looks on the cards, quickly invest some money and switch to system A

A-to-Z strategy: This makes it possible to switch back quickly from system A to system Z if sales drop.

LCC, LCP and Cost Reduction Strategies

Production Line and Equipment → LCC and LCP analysis → Strategy

Where costs are generated

Initial Cost

1. Design cost	Labour-hours	·Use CAD ·Standardise, reduce variety
2. Materials cost	Price	·Use lower-grade materials ·Reduce weight
3. Purchased parts cost	Price	·Reduce number of parts ·Reduce variety of parts
4. Processing cost	Labour-hours	·Reduce amount of materials that has to be removed ·Standardise, reduce variety
5. Electric power and instrumentation cost	Price	· Standardise, reduce variety · Reduce number of input / output variety
6. Assembly and adjustment cost	Labour-hours	·Simplify ·Standardise, reduce variety

+

Running Cost

1. Energy cost	Cost	·Introduce energy-saving measures ·Reduce size
2. Repair cost	Cost	·Do MP Design ·Incorporate self-diagnostic functions
3. Cost of consumable materials	Cost	·Use lower-cost materials ·Raise yield
4. Cost of consumable Tools and devices	Cost	·Lengthen service life ·Standardise, reduce variety
5. Wasted time	Time	·Do MP design ·Increase flexibility
6. Low yield	Ratio	·Improve process ·Reduce number of defectives

Maintenance Prevention (MP Design)

<<What is maintenance prevention?>>

Maintenance prevention is an activity for improving reliability, maintainability, cost effectiveness, operability and safety, and reducing maintenance costs and deterioration losses, by introducing maintenance information and new technologies at the planning and design stages of new equipment - that is, it is an activity for eliminating losses at their source.

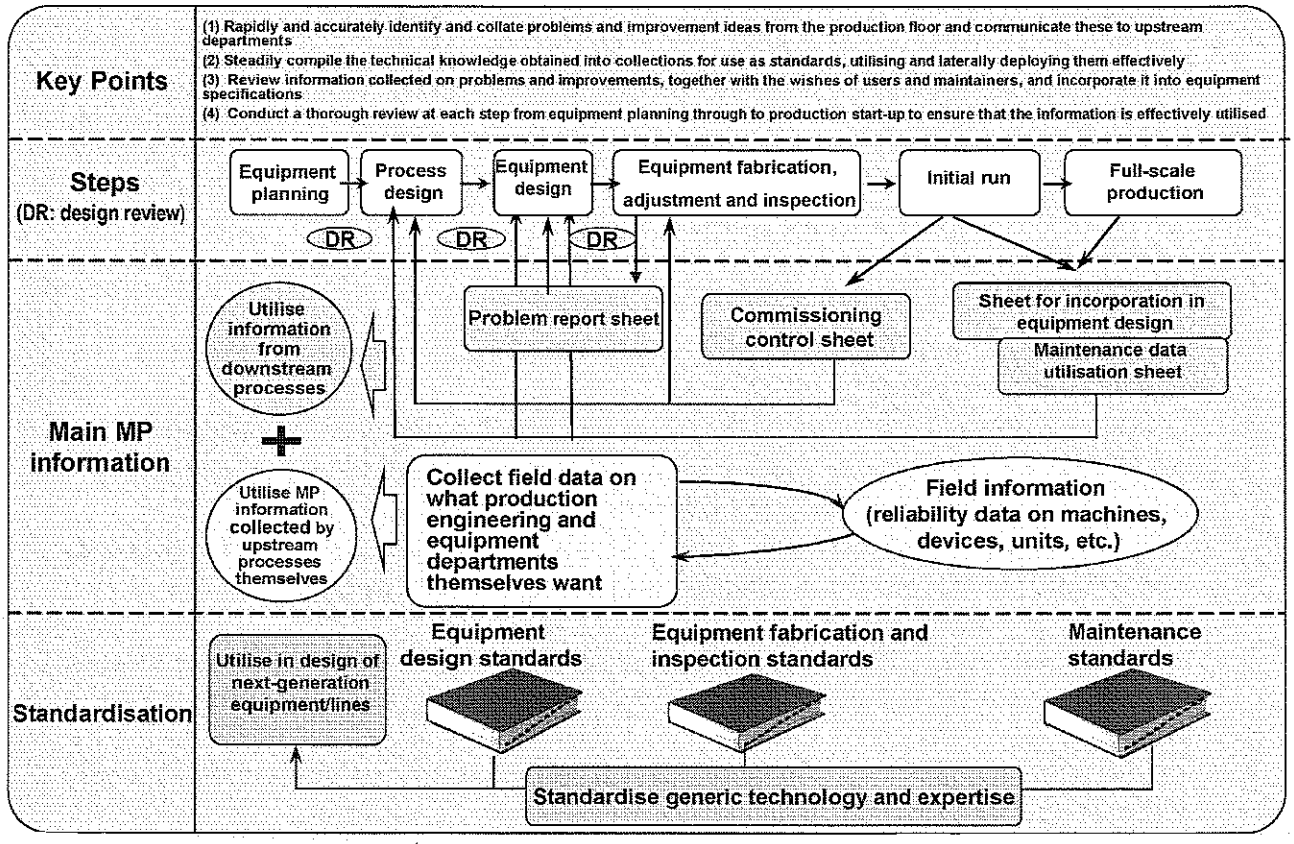
<The importance of using MP information in design>

1. **Fact: Effective use of MP information in design is rare**
2. **Reasons:**
   1. No time is allowed for collecting and utilising MP information
   2. Rules for utilising MP information have been set, but the activity is perfunctory, and the quality and quantity of MP information are inadequate
   3. The department has no experience of using MP information
   4. Investigations are adequate, as they are mainly left up to the equipment manufacturer
   5. The equipment is to be used in a different environment
3. **What happens if a company is incapable of utilising MP information?**
   Huge losses occur in the period from designing the equipment to fabricating it and bringing it into operation
   Losses are even more serious in view of today's ever-shorter product lifetimes
   The size of its losses makes the company uncompetitive

Equipment Prerequisites and Their Definitions

Prerequisite	Definition	Description in concrete terms
Reliability	The ability of the equipment to operate without malfunctioning or breaking down	• Infrequent failures • Infrequent minor stops • Infrequent defectives • Infrequent need for adjustment • Stable machine cycle time • Static and dynamic precision can be measured easily
Maintainability	The ease with which deterioration can be measured and reversed	• Failures can be located quickly • Parts can be replaced easily and restored functions checked quickly • Deterioration can be located quickly • Lubrication and oil changes can be performed easily • Equipment can be overhauled easily
Autonomous maintainability	The ability of the equipment to be cleaned, lubricated, checked and otherwise maintained easily and quickly by the operators	• Cleaning, lubrication and inspection can be carried out easily • Cutting debris can be cleared easily • Contamination is contained near source • It is easy to check whether lubricants are reaching the parts where they are needed • Quality can be maintained easily (precision and other parameters can be measured easily)
Operability	The ability of the equipment to be operated correctly, swiftly and reliably during normal running, changeovers and so forth.	• Changeovers and adjustments can be performed easily • Cutting tools and grindstones can be replaced easily, and the associated adjustments can be made easily • Controls can be manipulated easily (owing to user-friendliness of position, layout, number, shape, colour, etc.) • Equipment can be transported and installed easily
Resource economy	The ability of the equipment to make efficient use of the resources it requires for its operation (energy, cutting tools, grindstones, lubricants and so forth)	• Consumption (per unit of product produced) of materials and energy is low • A high proportion of resources can be recycled
Safety	The ability of the equipment to operate without harming anyone or anything	• Low requirement for irregular tasks needed to deal with failures, minor stops, defectives and the like • Little exposure of rotating or moving parts • Few protruding or catching parts • Easy for operators to remove themselves from danger • Zero emission of dangerous materials or harmful substances, and minimal scattering of debris
Flexibility	The ability of the equipment to be modified quickly and easily, to accommodate changes in the product	• Plenty of leeway for switching from products currently processed to products that may be produced in the future • Low cost of improvements made to increase equipment's flexibility • Short time required for improvements made to increase equipment's flexibility

Example of MP Information Utilisation System and Key Points



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6 - 31 (same as slide 5-26)

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Record of Corrections Made to the Equipment Design, and Action Taken

At stage of (1) Specification concept (2) Basic design (3) Detailed design

Record of Corrections Made to Equipment Design, and Action Taken		Section receiving equipment		Production Engineering Section					No.
				Person responsible	Supervisor	Manager		Supervisor	Issued
Name of equipment									

No.	__/__/__ (date)	Information provided (A)	Degree of Seriousness (B)	Problem and action requested	Corrective action	Date action taken:	Action (C)	Cause (D)	Results	Target of amendment (E)	Details of amendment (F)	Action taken by	Remarks
1													
2													
3													
4													

Classification

A: Departments providing information		B: Classification of degree of seriousness		C: Classification of action taken		D: Classification of cause		E: Classification of item amended		F: Classification of nature of amendment			
1	Fabrication department (in-house)	1	Amendment absolutely necessary	1	Mechanism or Structure changed	1	Defective planning	1	Affected machine only	1	Process capability improved	6	Safety improved
2	Fabrication department (external)	2	Amendment to be made as far as possible	2	Movement or function changed	2	Defective design	2	Affected machine and next-generation machines	2	Output capacity improved	7	Operability improved
3	Design department (in-house)	3	Suggestion to be borne in mind	3	Control circuitry changed	3	Defective fabrication	3	Affected machine, similar machines	3	Reliability improved		
4	Design department (external)			4	Surface or heat-treatment changed	4	Change in specifications		and next-generation machines	4	Maintainability (durability) improved		
5	Department using equipment			5	Materials or shape changed					5	Economy improved		

Note1: If an item falls into more than one category, mark all the relevant categories.

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6 – 32 (same as slide 5-27,6-41)

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Points to Note when Utilising MP Information

Problems

Rules exist, but people are often excused from doing the activity on the grounds of being too busy, etc.

People go through the motions of carrying out the activities, but they are often superficial

Use of MP Information is almost always insufficient

Points to note

1. Create workflow regulations and systems to ensure that MP information is always utilised when new equipment is planned
2. Create systems and organisations for ensuring that MP information is collected
3. Standardise MP information wherever possible, keeping it simple. (e.g. common equipment specifications, lists of recommended sensors, etc.)
4. Evaluate the use of MP information on each item of equipment (in terms of both quality and quantity) in order to check whether good use is being made of it. If not, the equipment should not be approved.
5. The maintenance and operating departments should keep an eye on the plans for new equipment and start collecting MP information early on in the planning and proposal stage
6. Record MP information not abstractly but with specific structures, shapes, dimensions, etc., so that it can soon be put to use

A Typical Equipment Management System

Step	Other relevant departments / Manufacturing Department / Production Engineering Department	Checkpoints	Stands and forms
Step 1 Planning	Policy → Formulate equipment plan → Review equipment plan → 1st DR	-Commissioning control required or not? -Purpose and necessity -Cost benefit -Priority ranking -Development period -Persons responsible	1. Annual Equipment Planning Application Form 2. Equipment Planning Review Form 3. Equipment Specification Setting Sheet 4. Equipment Planning Checksheet
Step 2 Action Planning	Approve Plan → Equipment budget plan → Purchase request → Approved	-Budget and Schedule -Preventative measures for foreseeable problems -Running cost -Production capacity -Reliability -Flexibility -Operability -Initial cost -Maintainability -Safety -Procurement lead times	5. Equipment Planning and Budgeting Table 6. Process QA Matrix 7. 4-M Analysis Table 8. FMEA Sheet (for process) 9. Record of Changes Needed in Equipment Design, and Action Taken 10. Equipment Design Fabrication Specification
Step 3 Design	Formulate equipment specifications → 2nd DR → Estimate → Request for order placement → Basic design → 3rd DR → Detailed design → 4th DR → Fabrication drawings / Approved fabrication drawings	Equipment FMEA -Capacity -Reliability -Flexibility -Operability -Maintainability -Safety -Economy	11. Common Equipment Specifications 12. FMEA Sheet (for equipment) 13. Basic Design Checksheet 9. Record of Changes Needed in Equipment Design, and Action Taken
		-Shape of parts, machining tolerances, materials, surface roughness, heat-treatment, -Selection of commercially-available parts	14. Detailed Design Checksheet 9. Record of Changes Needed in Equipment Design, and Action Taken
		-Interim check -Schedule, main parts (precision of fitting and processing)	15. Witnessed Inspection Checksheet (Interim)
		-Production capacity, process capability -Functionality and performance (operation, maintenance, safety, reliability) Correction schedule, amendments to drawings	15. Witnessed Inspection Checksheet (final)
Step 4 Fabrication	Estimate → Request for order replacement → Fabrication	-Layout and installation -Plumbing and wiring	16. Equipment Installation Check Sheet
Step 5 Witnessed test-run	Witnessed test-run	-Production capacity, process capability -Record of action taken regarding problems -Initiation and termination of commissioning control -Operating log -Defect rate (or good-product rate) -Failures and minor stops -Safety -Handling guidance -Performance, availability	17. Commissioning Control Notice 18. Commissioning Control Table 19. Record of Action Taken Regarding Problems
Step 6 Installation	Installation → Test-run adjustment		
Step 7 Commissioning	Initiate commissioning control → Prepare for volume production → Start volume production → Terminate commissioning control → Hand over	-Guidance on operation and Jishu-Hozen	20. Operating Manual 21. Periodic Inspection Standards 22. Jishu-Hozen Standards 23. Work Standards

MP Meeting

Step 1: Planning

This step is an important one, in which the equipment investment plan is formulated, based on the business plan. The budget framework approach leads to insufficiently thorough consideration of the requirements. Always select the best proposal in terms of the LCC cost performance.

Key Points at the Planning Stage

1. Start working on the equipment's overall concept from an early stage of the product's planning or improvement, i.e. from the concept planning stage.

2. Clearly identify the purpose and need for the equipment as well as its profitability (LCC) and the conditions that it must embody.

3. Formulate several alternative proposals and estimate the investment benefits for each

4. Painstakingly examine the main items listed below in order to select the best proposal, and improve it by conducting thorough technical investigations of similar equipment inside and outside the company

A Typical Investment Proposal Comparison Table

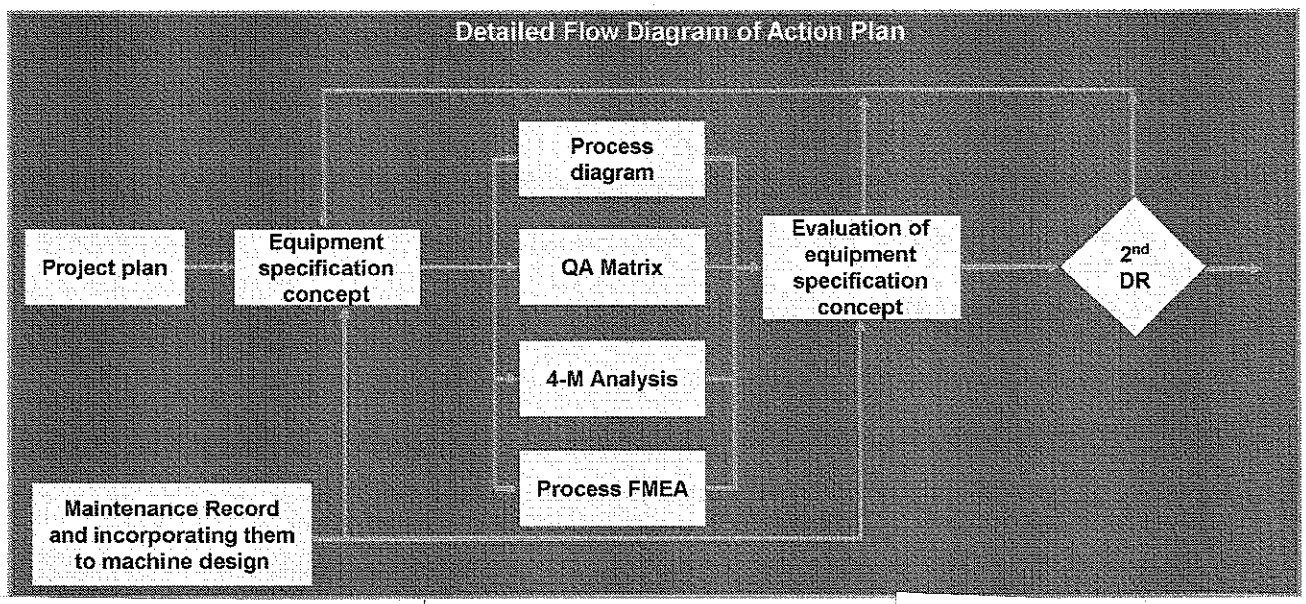
	Production Engineering			Environmental Safety		Drafting		
Investment Proposal Comparison Table for the Fiscal Year	Manager	Supervisor	Person responsible	Manager	Supervisor	Manager	Supervisor	Person responsible
	Lee	McDonald	Nixon	Hudson	Parker	Matsui	White	Smith

Proposal name	Production Equipment for Product X	Equipment prerequisites	Purpose of Investment	Factory priority rating:
Purpose and necessity of investment 1. To put a new product (Product X) on the market, establish a proprietary technology, and expand our operations		1. Production capacity: Y tons/month 2. Quality: In accordance with Quality Standards 3. Cost: Product gross margin: Z% 4. Location: North side of Building No.3, currently blocks 313 to 315 5. Workforce: Same number as at present 6. Legal constraints: None in particular	I. Development II. Expansion III. Reduce variable costs IV. Reduce fixed costs V. Unavoidable investment	2/48

Proposals for consideration	Investment benefit (before-and-after comparison)	Recommended proposal	Alternative proposal A	Alternative proposal B
		(Proposed) integrated production system Produce material A and Product X in-house. Two production lines are needed, one for material A and one for product X. The investment needed is large, but since everything is done in-house, it will be easy to keep quality consistent. Another advantage is that the equipment can also be used to produce other products made from material A.	(Proposed) buying-in of materials Buy in material A from outside (company M or company N), to produce product X. Only one production line is needed, so the capital investment is lower.	(Proposed) buying-in of material A and pre-blended powder Buy in material A and pre-blended powder, and produce product X using a single production line. This proposal requires no blending equipment, thus minimising the investment cost, but it has the largest variable costs. Note that our blending technology will be used, but it will be contracted out.
	Estimated cost based on outline design	Fixed assets: 210,000 Expenses: 2,000	Fixed assets: 180,000 Expenses: 2,000	Fixed assets: 150,000 Expenses: 2,000
	Lead time until end of commissioning	10 months	10 months	10 months
	Degree of technical difficulty	Moderate (should be checked by testing)	Moderate	Moderate
Investment profit	Return	60%	31%	36.5%
	Payback period	1.6 years	2.4 years	2.3 years

Step 2: Action Planning

In this step, the equipment design and fabrication specifications are finalised, based on the investment proposal comparison table drawn up at the planning stage. At the same time as formulating the equipment concept for the equipment shown to have the highest cost performance in the investment proposal comparison table, a process diagram, QA matrix, 4M analysis chart, process FMEA chart and records of the use of MP information in the equipment's design and action taken to solve problems with similar equipment should be prepared, as shown in the above diagram. It is important to ensure that MP information is utilised in the design of the new equipment by conducting rigorous checks and evaluations.



Process QA Matrix

Process QA Matrix

Item name

Item number

Supplier

Operator	Supervisor	Manager

Failure mode: % completed; Component

Probable cause: Location on equipment; Phenomenon

Process name

Process

◎ Strongly implicated ○ Implicated △ Possibly implicated

Location	Quality characteristic	Defect mode	Standard	1	2	3	4	5	6	7	8	9

4M Analysis

4-M Analysis Table

Page	Item name		Operator	Supervisor	Manager
	Item number				
	Date completed				

Process function	Potential causes / Workflow			Defect mode										People	Equipment	Methods	Materials
				1	2	3	4							Forgetting; overlooking; making mistakes; misunderstanding; being insufficiently thorough	Initial imprecision; wear, breakdowns	Production methods; handling methods; process conditions	Product; supplementary materials; working environment
	Step	Task description	Automated?														
	1																
	2																
	3																
	4																
	5																
	6																

Process FMEA

FMEA Sheet (Process)		Equipment name		Higher-priority product	Higher-priority process	Com-pleted	--/--/---- (date)
Purpose		Product name and number		Lower-priority product	Lower-priority process	Opera-tor	

		5	4	3	2	1
A	Frequency of incidence	Occurs chronically (in every lot)	Occurs sporadically (about once a month)	Occurs occasionally (about once every 3 months)	Hardly ever occurs, but remains possible	Not possible
B	Seriousness	Critical defect (affecting final strength, operation, watertightness, durability)	Serious defect (affecting strength, dimensions and durability characteristics other than those to do with safety)	Cannot be fitted on vehicle (wrong, misassembled or defective)	Cosmetic defect (scratch, position of colour protector, etc.)	No effect
C	Detectability	Not detectable from external appearance	Detectable using five senses	Can be detected by measurement	Can be detected during fitting	Can be detected before fitting

Process name	Process function	Failure mode	Effect of failure	Cause of failure	Action required when score is 25 or over A × B × C = degree of risk								Corrective action	Improvement schedule	Job title of person responsible	Signed off
					Be-fore	Af-ter	Be-fore	Af-ter	Be-fore	Af-ter	Be-fore	Af-ter				

Record of Corrections Made to the Equipment Design, and Action Taken

At stage of (1) Specification concept (2) Basic design (3) Detailed design

Record of Corrections Made to Equipment Design, and Action Taken		Section receiving equipment		Production Engineering Section: Person responsible	Supervisor	Manager		Supervisor	No. / Issued
Name of equipment									

No.	/ / (date)	Information provided (A)	Degree of Seriousness (B)	Problem and action requested	Corrective action	Date action taken:	Action (C)	Cause (D)	Results	Target of amendment (E)	Details of amendment (F)	Action taken by	Remarks
1													
2													
3													
4													

Classification

A: Departments providing information		B: Classification of degree of seriousness		C: Classification of action taken		D: Classification of cause		E: Classification of item amended		F: Classification of nature of amendment			
1	Fabrication department (in-house)	1	Amendment absolutely necessary	1	Mechanism or Structure changed	1	Defective planning	1	Affected machine only	1	Process capability improved	6	Safety improved
2	Fabrication department (external)	2	Amendment to be made as far as possible	2	Movement or function changed	2	Defective design	2	Affected machine and next-generation machines	2	Output capacity improved	7	Operability improved
3	Design department (in-house)	3	Suggestion to be borne in mind	3	Control circuitry changed	3	Defective fabrication	3	Affected machine, similar machines	3	Reliability improved		
4	Design department (external)			4	Surface or heat-treatment changed	4	Change in specifications		and next-generation machines	4	Maintainability (durability) improved		
5	Department using equipment			5	Materials or shape changed					5	Economy improved		

Note1: If an item falls into more than one category, mark all the relevant categories.

Equipment Specification Concept Evaluation Table

Equipment Specification Objective Setting / Concept Evaluation Table

			Production Engineering Section		Receiving department	
			Person responsible	Leader	Section Manager	Person responsible	Department Manager
Equipment name		At concept Planning stage					
Receiving department		At Equipment Planning stage					
Prepared by	At concept planning stage	Date: Year Month Day					
	At equipment planning stage	Date: Year Month Day					

Category	Item	Description	At concept planning stage: Target	At equipment planning stage: Planning forecasts	Evaluation
	Production capacity	Cycle time, production volume			
		Utilisation rate	(%)	(%)	
	Reliability	Quality (good-product rate)	(%)	(%)	
		Durability	(Year)	(Year)	

Overall evaluation	
Evaluation	A: Above target B: Equal to target C: Below target (when the overall evaluation is C, proposal must be redone)

Step 3: Design

In this step, the equipment is designed on the basis of equipment design and fabrication specifications and common equipment specifications prepared at the action planning stage.

As well as doing the cost design and ensuring that nothing appertaining to quality has been omitted, it is important to use design reviews or other procedures beforehand to verify that an equipment FMEA study has been performed, MP information has been utilised, and the equipment design standards are being properly adhered to, and take appropriate action if any problems are found.

Key Points at the Design Stage

1. Perform an FMEA study to determine what effects there would be on the equipment system's operation, safety and product quality if the system or any of its subsystems failed. Identify any problems, and incorporate their solutions into the equipment's design.

2. Prevent any omissions from the equipment's concept design conditions and design drawings relating to its reliability, functionality, maintainability, safety, cost-effectiveness, flexibility, etc.

3. Prevent any omissions in the utilisation of MP information by using design standards, technical handbooks, and common equipment specifications in conjunction with MP information tables and records of corrective action, and increase the precision of MP design by using common equipment specifications to eliminate differences among individual designers.

Commissioning Control

What is commissioning control?

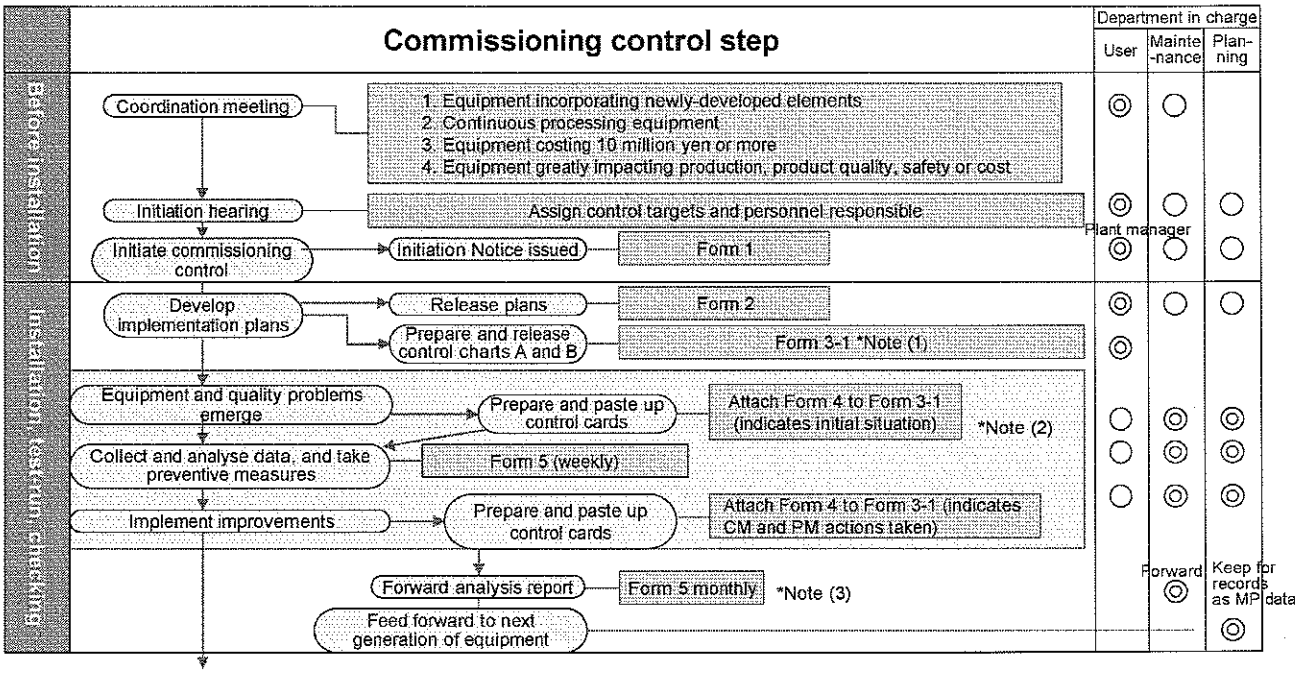
1. Commissioning control is performed after the equipment has been installed and test runs have been performed, while actually manufacturing the products.

2. Production engineering, maintenance, operation and the equipment's designers and fabricators (the manufacturers) form teams to take immediate action to identify and solve the causes of any problems discovered.

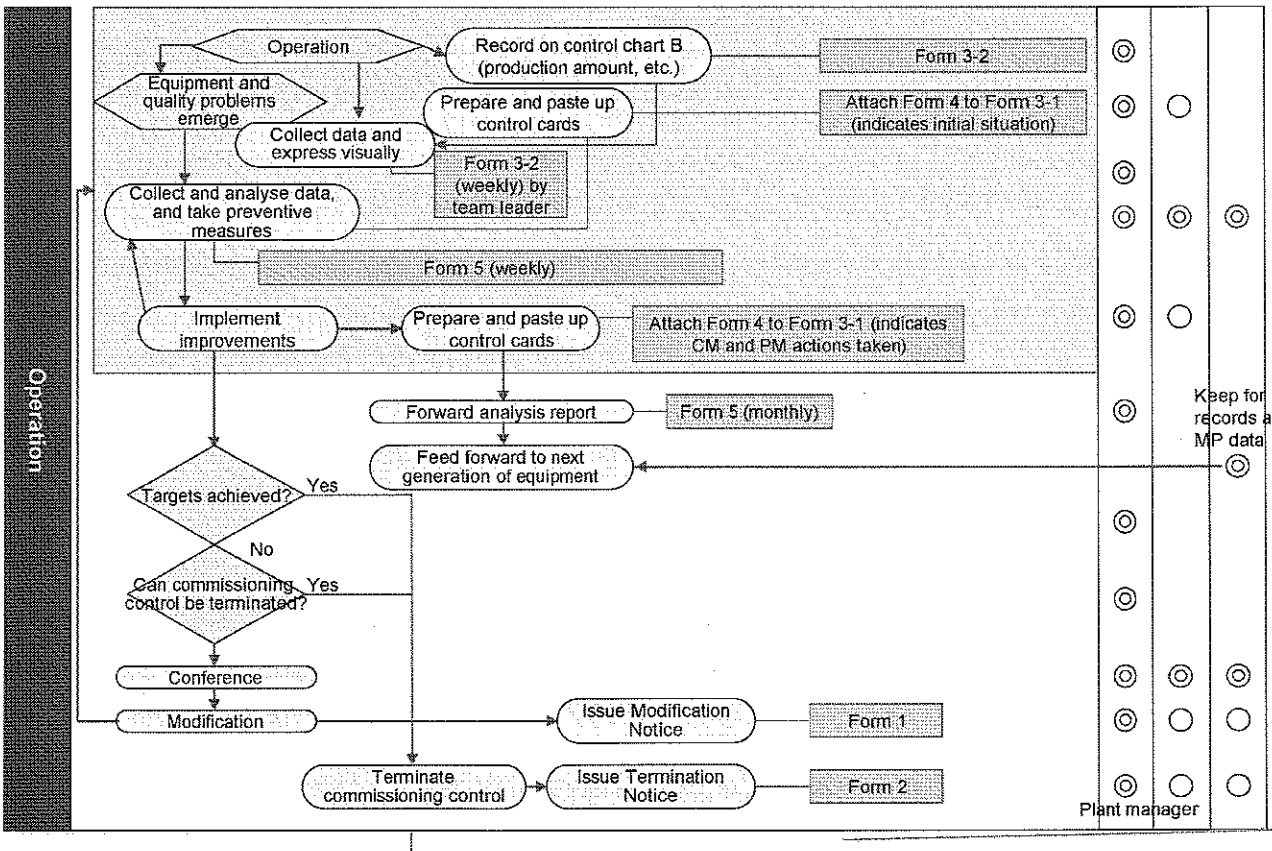
3. Monitor in order to see whether there are any problems (mainly to do with quality, process capability and materials feed and transportation at transfer points between processes) or failure to achieve targets for operating rate, quality, etc.

4. Identify the causes of any problems or failure to meet the targets, take action to eliminate those causes, and try to achieve the targets as quickly as possible (within at most one month).

Flow Diagram for Commissioning Control



Flow Diagram for Commissioning Control



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Flow Diagram for Commissioning Control

*Note (1)
Form 3-1: Commissioning Control Chart A

Commissioning Control Chart A	Equipment name
Name of section of equipment	

Form 3-2: Commissioning Control Chart B

Targets and Results	Production qty.	Stoppage frequency
	Product defect rate	

*Note (2)
Form 4: 'Control cards' for commissioning control

Date			BM, PM, CM		
Labour	Person X min	Down-time	Min	Reason for stoppage	Equipment quality
Phenomenon and cause					
Action and preventive measures					

*Note (3)
Form 5: Commissioning Control Analysis Report

Commissioning Control Analysis

Name of equipment section	Maintenance record		

A Typical Commissioning Control Initiation and Termination Notice

To:
Production Section Area Manager->Supervisor
Maintenance Department
Appropriate personnel in Production Engineering Department

	Initiation	Plant manager	Area manager	Supervisor	Person responsible
	Termination				

Initiation/Termination Notice for Commissioning Control of Mechanical Equipment

Commissioning control of the equipment shown below has been (initiated/terminated)

Equipment name: Automatic grinder for external finishing of pump plungers (Equipment No.: CG280)
Location: Plunger Finishing Line, No.2 Machining Unit, No.2 Production Section, Injection Pump Building
Persons responsible for control: Production: Plunger Production Group, No.2 Machining Unit, No.2 Production Section
Maintenance: Maintenance Team, Tooling and Equipment Group, Pump Engineering Section
Production Engineering: Tooling and Equipment Group, Pump Engineering Section

Details	Initiation	Termination
	Date	Date
Reason	1. New, high-cost equipment Purchase price = 10 million yen 2. Automatic grinder. Many problems experienced with existing No.1 machine.	Commissioning control terminated on achieving stable operation. 1. Work drive defective-work drive mechanism improved-OK 2. Automatic conveyor operation defective-feed screw backlash eliminated-OK 3. Outfeed forward movement defective- addition of interlock with fixed-distance retraction-OK

	Targets	Results
Production capacity	24,000 units/200h	24,000 units/200h
(a) Net processing time per unit	20 sec	20 sec
(b) Operating rate	75%	76%
(c) Loading rate	90%	168%
2. Stoppage frequency	0.2%	0.2%
3. Stoppage severity	0.3%	0.05%
4. Defect rate	1.0%	0.06%

Route (Termination)
Production Engineering Section → Original ——— Production Engineering Section → Original
→ Copies to all related departments → Copies to all related departments

(from Giichi Takahashi: Productive Maintenance Promotion Manual (Tokyo: Japan Institute of Plant Maintenance, 1975)

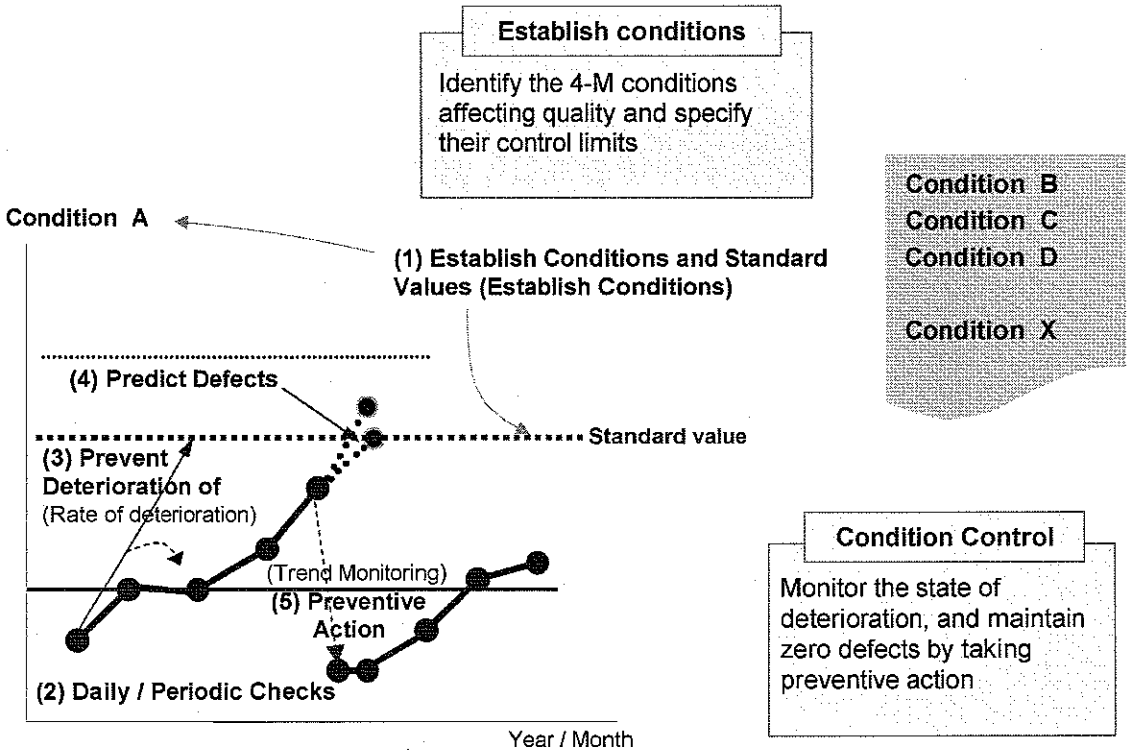
TPM Manual Chapter 7 Quality-Hozen
(Quality Maintenance)

JIPM-Solutions Co. Ltd.

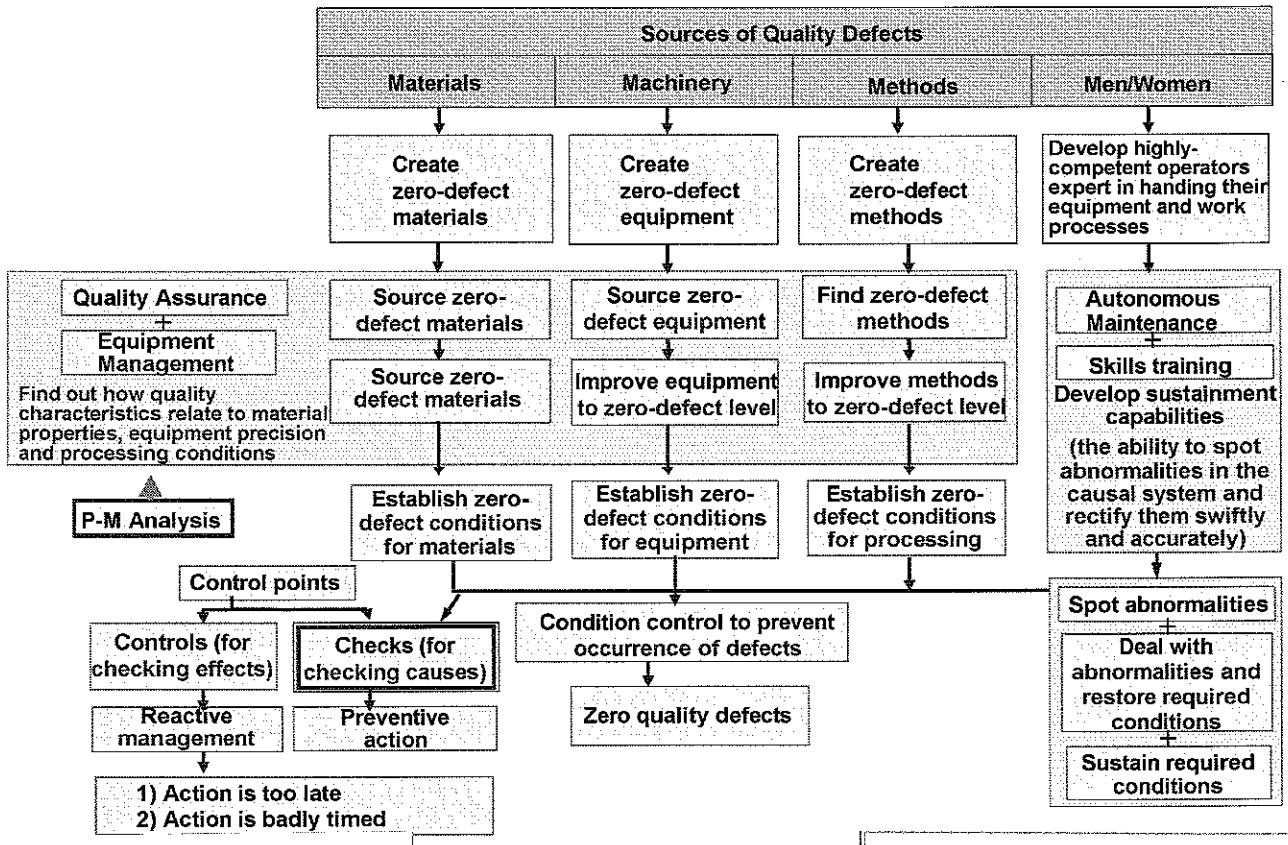
The Definition of Quality-Hozen (Quality Maintenance)

Definition	Action
Establish zero-defect conditions in order to create equipment and processes that do not produce any quality defects	Establish Conditions
Check and measure those conditions periodically	Daily Checks / Periodic Checks
Prevent quality defects by maintaining those conditions within a standard range of values	Preventive Quality-Hozen
Predict the possibility of quality defects by monitoring trends in the measured values	Trend Monitoring / Predictive Maintenance
Take preventive action	Preventive Action

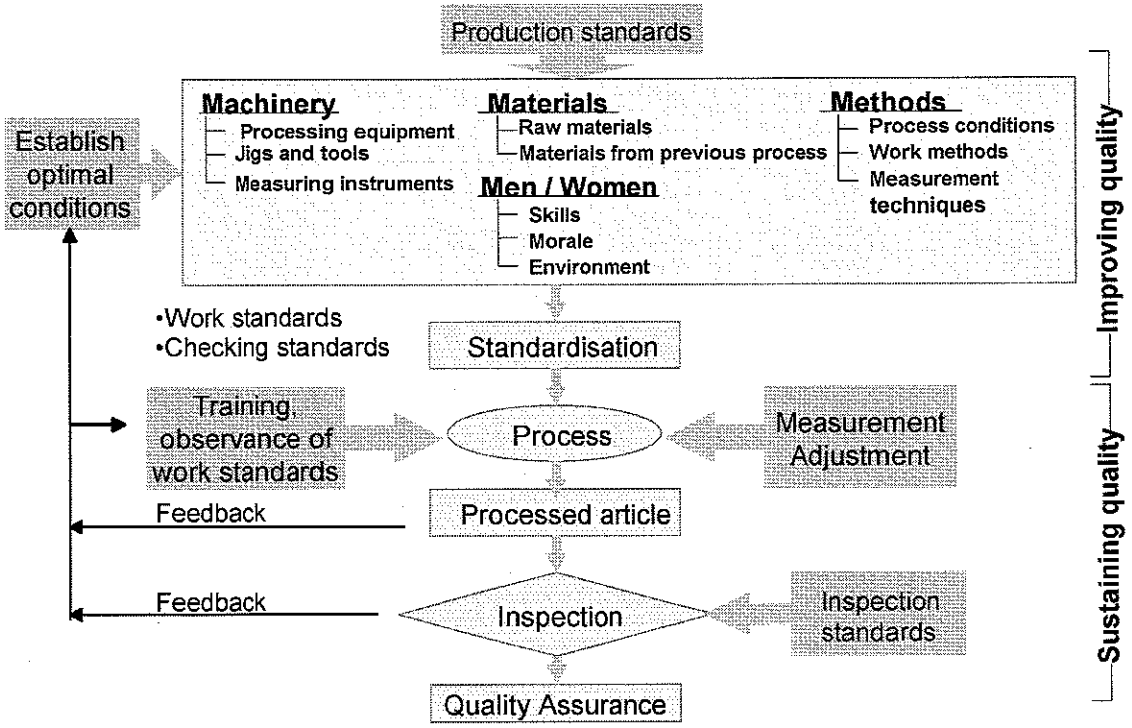
An illustration of The Definition of Quality-Hozen



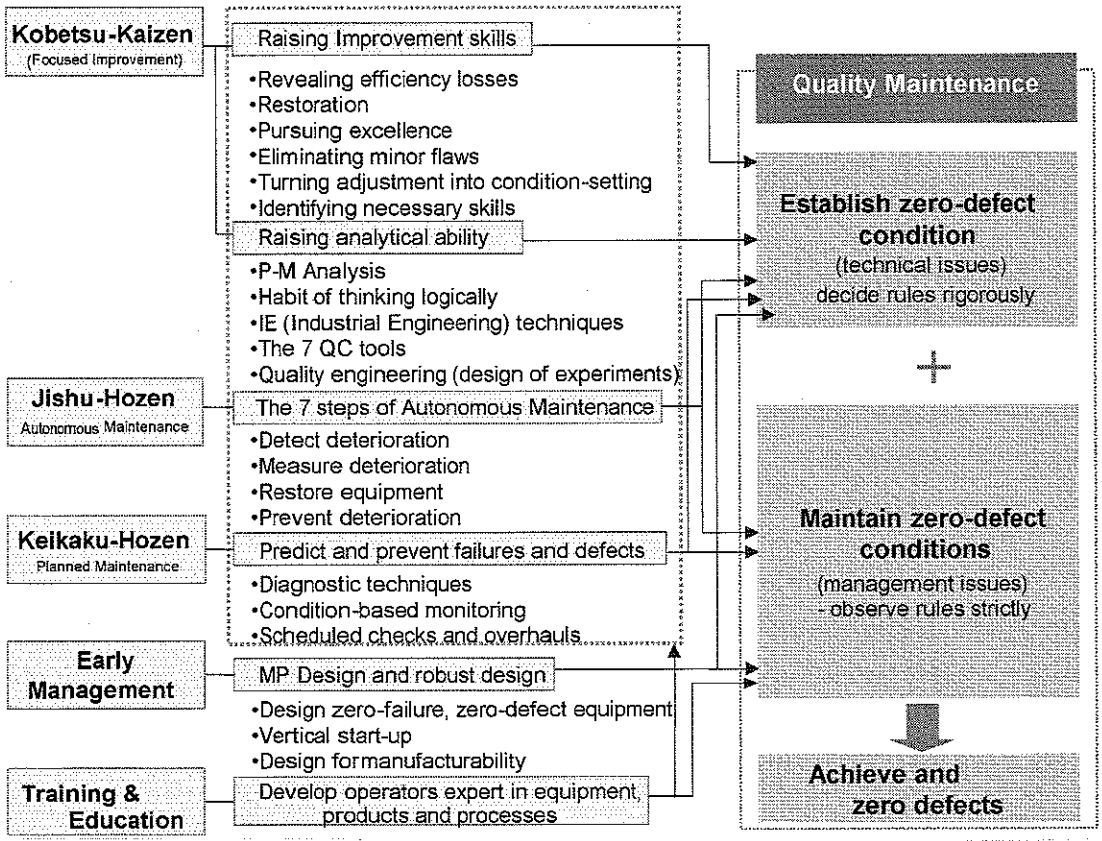
The Basic Approach to Quality-Hozen



The 4 Ms – The Determinants of Quality



Quality-Hozen and the other TPM pillars



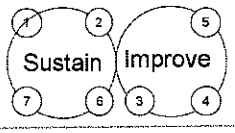
The Evolution of Quality-Hozen

1. QM at Fujikoshi	
1	Check quality standards and quality characteristics
2	Check quality defect phenomena
3	Determine equipment to be managed
4	Identify equipment functions and structure, processing conditions and setup procedures
5	Investigate state of equipment and restore
6	Do P-M Analysis
7	Establish defect causes
8	Optimise settings, processing conditions and setup procedures
9	Expose flaws
10	Restore or improve
11	Check results
12	Establish conditions that allow good product to be achieved
13	Consolidate checking methods
14	Determine standard values
15	Create Quality-Hozen Matrix
16	Incorporate into checking standards
17	Monitor trends and confirm results

2. QM Procedure from TPM Instructor Course (this manual)		
1	Verify the existing situation	• Confirm quality standards and characteristics values • Create flow diagram of individual processes for building in quality • Investigate defect situation and phenomena, and stratify
2	Investigate the processes where defects occur	• Draw up QA matrix
3	Investigate and analyse 3M conditions	• Investigate 3M conditions in each process • Identify deficiencies through on-site investigation
4	Plan action to correct deficiencies	• Create Deficiencies Chart and identify countermeasures • Verify state of equipment, and restore / improve it
5	Analyse situations where the conditions for building in quality are unclear	• Analyse situations where the conditions for building in quality are unclear • Experiment to find optimal conditions • Evaluate
6	Eliminate flaws in 3M conditions	• Expose flaws in 3M conditions • Carry out improvements • Evaluate results
7	Finalise 3M conditions	• Establish 3M conditions that allow good •product to be achieved
8	Consolidate checking methods	• Find ways to consolidate and fix the checking methods, and •carry out improvements
9	Determine standard values for checks	• Determine standard values for checks • Create QM matrix • Increase reliability of checks, simplify them, and reduce number of people involved
10	Revise standards and monitor trends	• Revise materials standards, checking standards and work standards • Identify Q components so that standards •are kept • Monitor trends and confirm results

3. QM at Nissan	
1	Identify Existing Situation
2	Eliminate Deficiencies
3	Analyse Causes of Chronic Defects
4	Eradicate Causes of Chronic Defects
5	Establish Zero-Defect Conditions
6	Maintain Zero-Defect Conditions
7	Improve Zero-Defect Conditions

4. The Figure-of-Eight Method		
1	Identify Existing Situation	• Investigate quality situation • Identify rules and procedures • Assess compliance
2	Restore	• Restore to current optimal state • heck results
3	Analyse Causes	• Analyse causes • Revise the ideal conditions (standard values)
4	Eradicate Causes	• Thoroughly investigate all causes • Restore and improve • Check results
5	Establish Conditions	• Revise QM matrix • Revise standards
6	Improve Conditions	• Consolidate checks • Revise check intervals • Improve checking methods
7	Maintain Conditions	• Carry out checks based on check standards • Monitor trends



The Evolution of Quality-Hozen

The History of Quality-Hozen

1984: Fujikoshi wins TPM Award; a particular highlight is its development of QM

1986: JIPM publishes Fujikoshi no TPM ('TPM at Fujikoshi')

1991: Nissan Motor Corp.'s Tochigi Plant wins Special TPM Award

1993: TPM Instructor Course manual is revised

1993: JIPM publishes Nissan Jidosha no TPM ('TPM at Nissan Motor Corp.')

1997: JIPM publishes Hinshitsu Hozen Hachi no Ji Tenkaiho ('The Figure-of-Eight Method for Quality-Hozen ')

2003: TPM Instructor Course manual is again revised and updated

2003: JIPM publishes Ryohin 100% no Hinshitsu Hozen ('Quality-Hozen for Perfect Product')

The award of the TPM Prize to Fujikoshi and the publication of 'TPM at Fujikoshi' were the events that triggered the development of Quality-Hozen . The methodology has become firmly established and is continually being enhanced through the efforts of the JIPM to inform industry about it, and the research and practical application carried out by individual companies.

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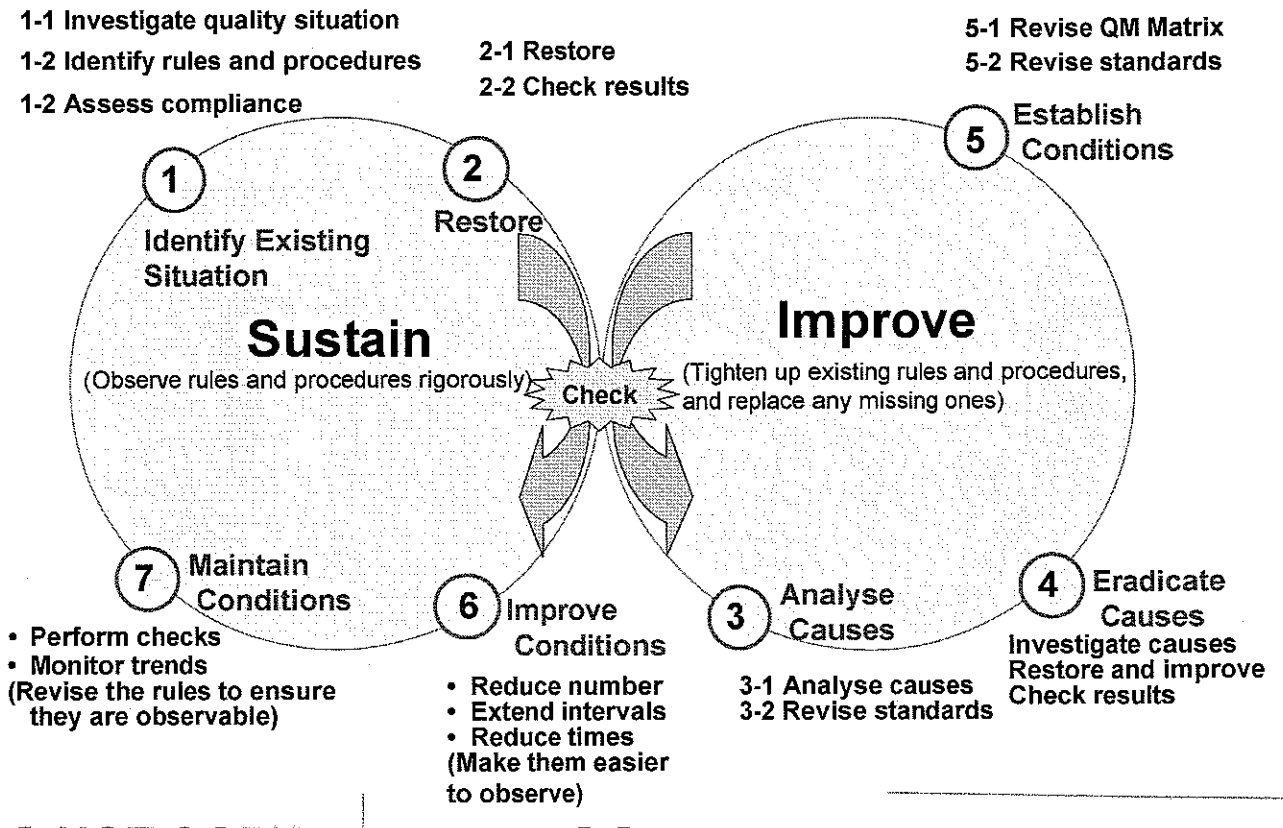
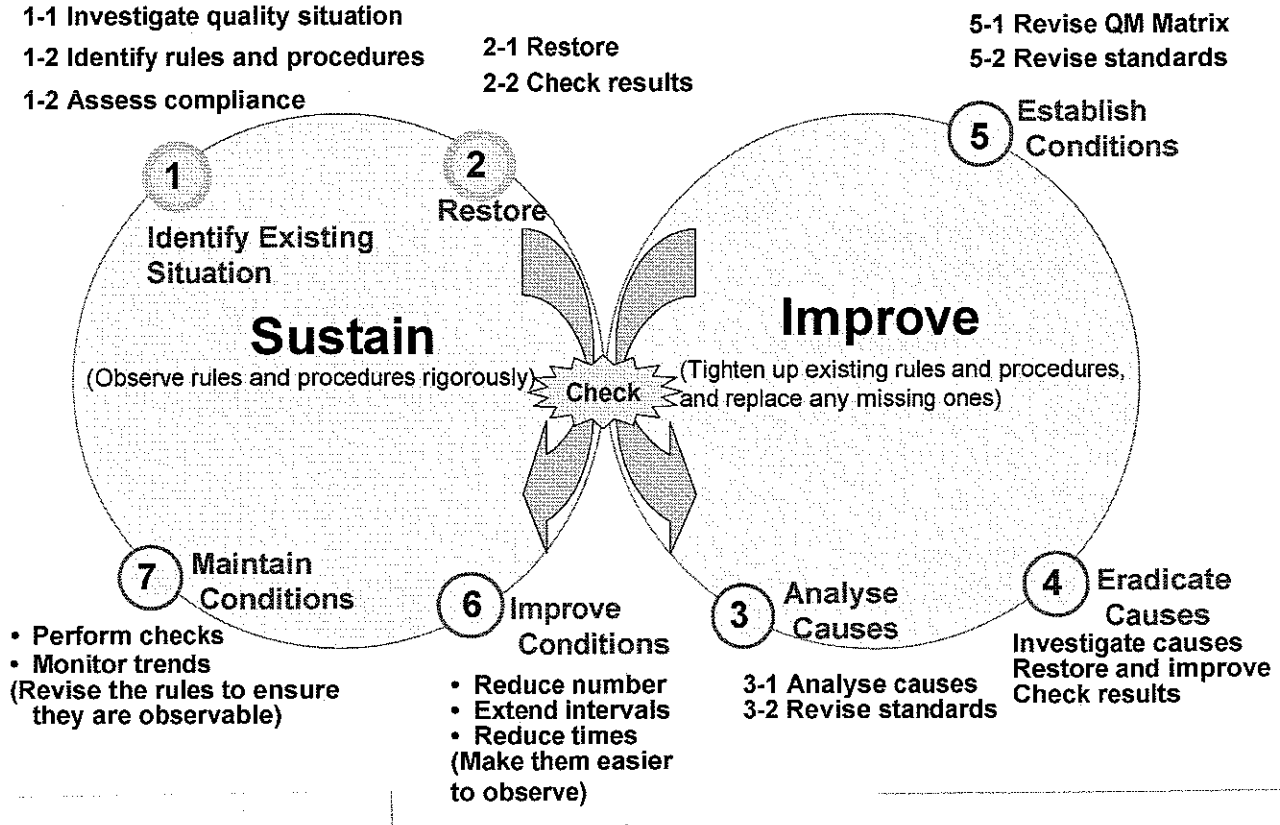
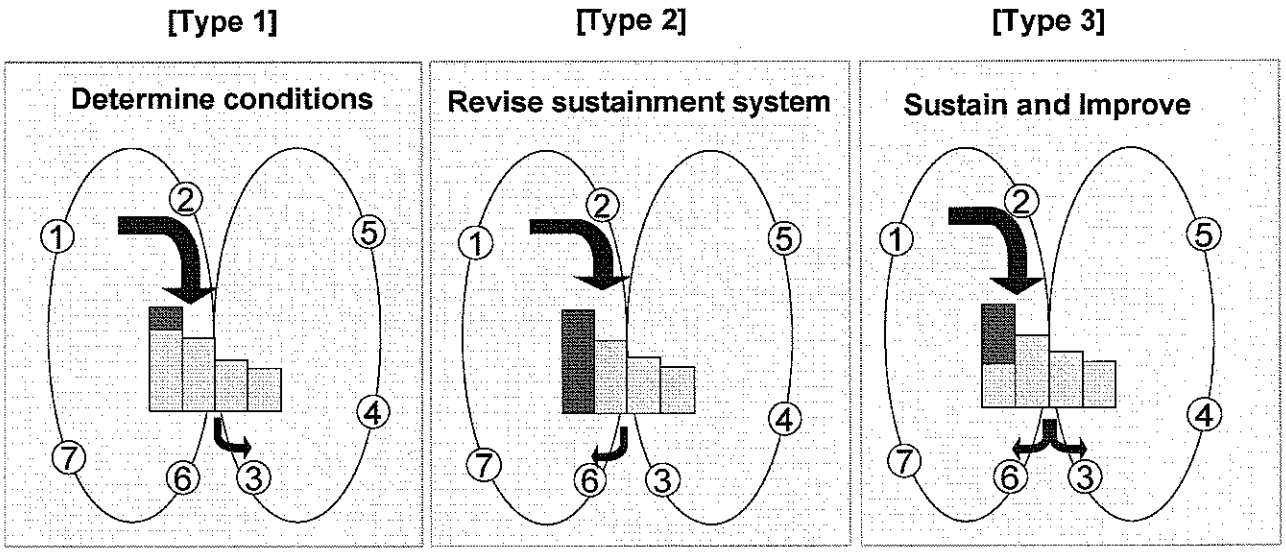
Overview of the Figure-of-Eight Method for Quality-Hozen



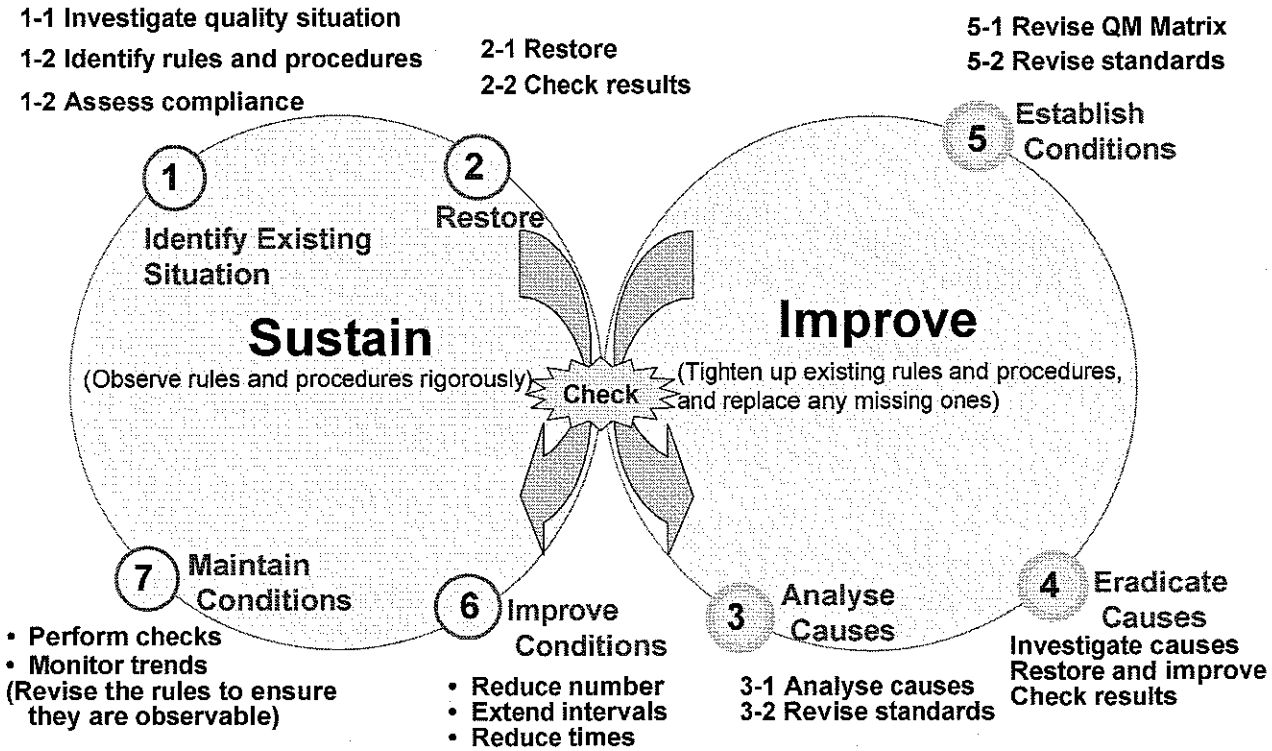
Overview of the Figure-of-Eight Method for Quality-Hozen (Step1,2)



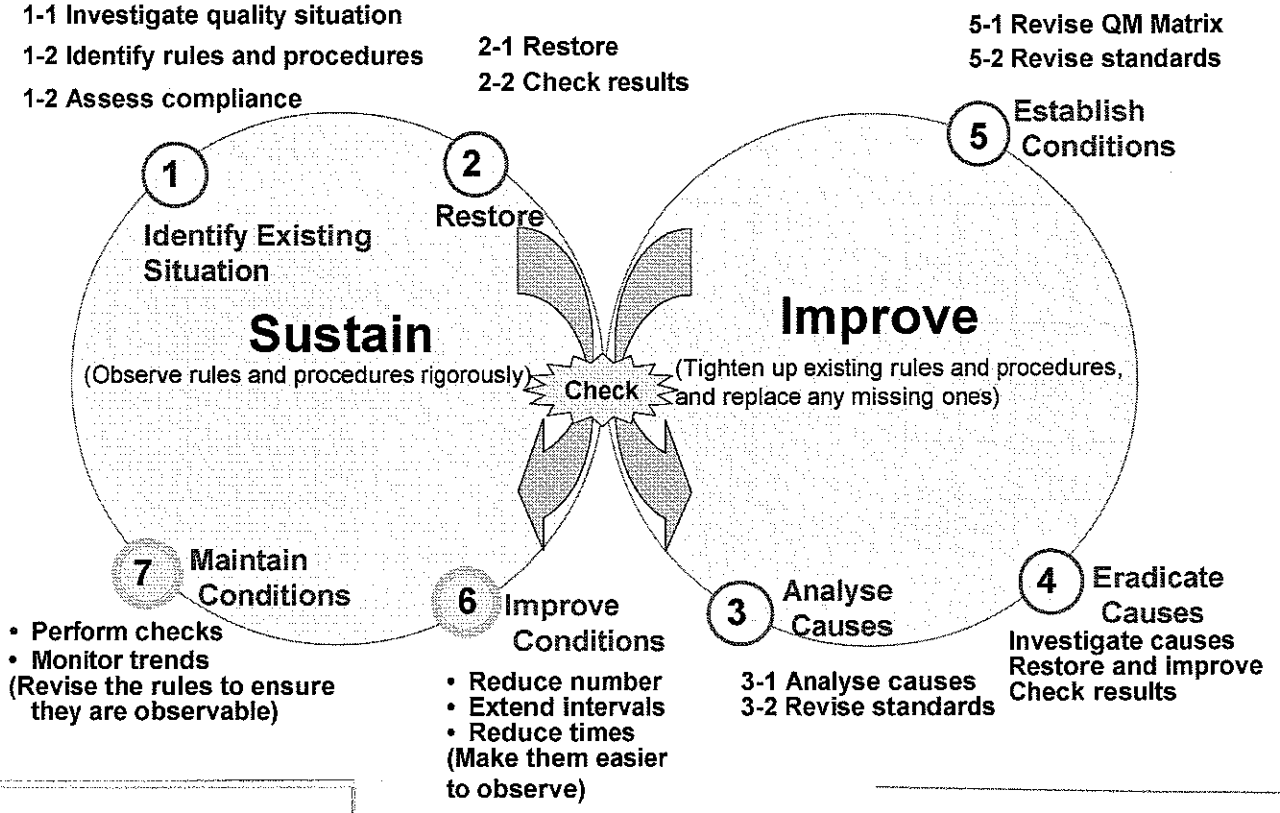
Actions Taken After Checking Results



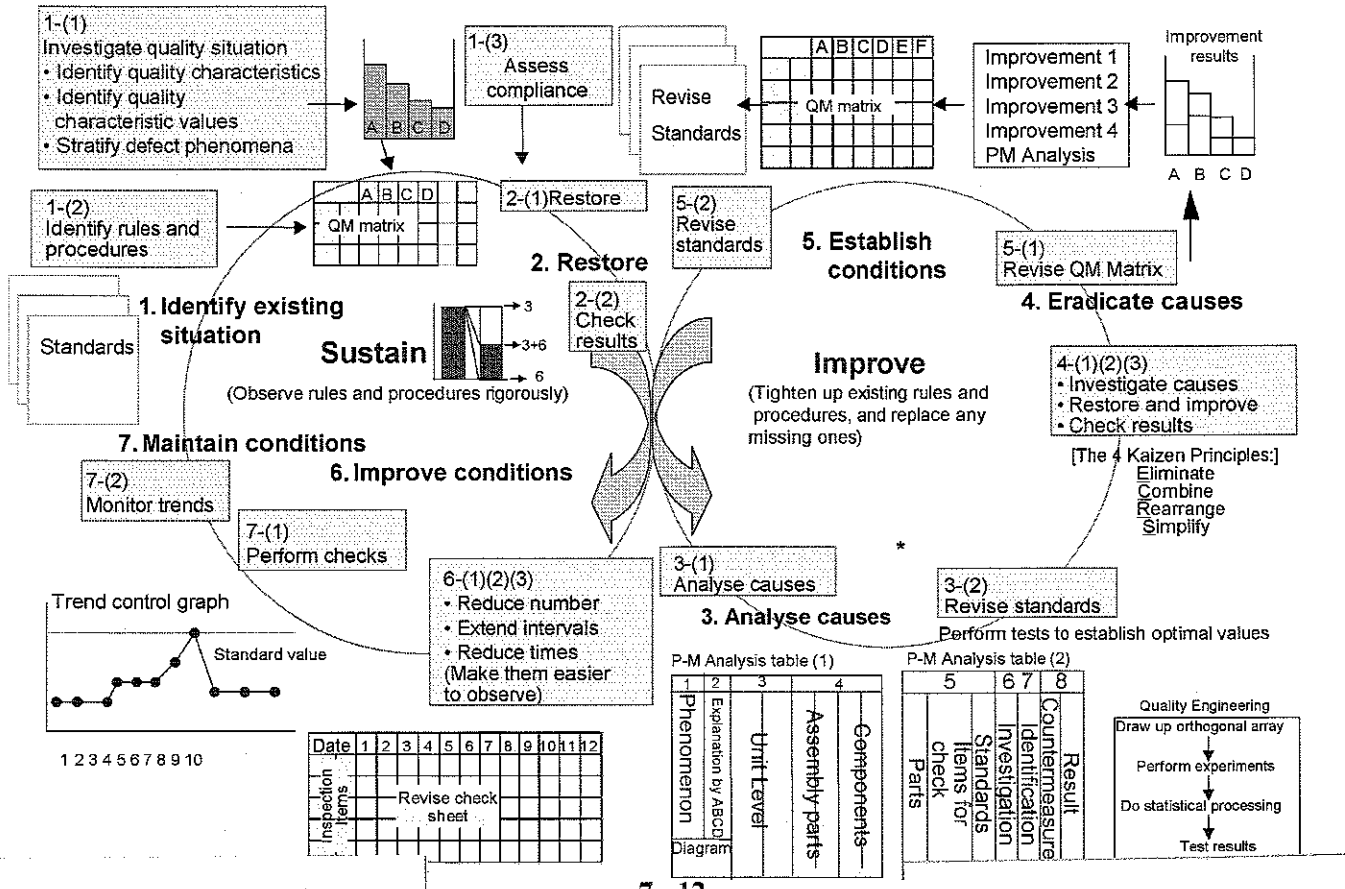
Overview of the Figure-of-Eight Method for Quality-Hozen (Step3,4,5)



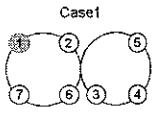
Overview of the Figure-of-Eight Method for Quality-Hozen (Step6,7)



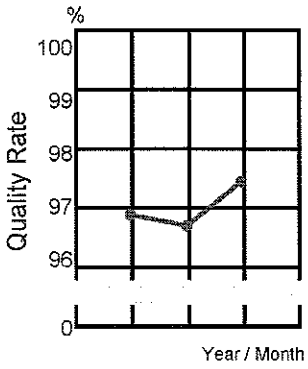
The figure of Eight Method for Quality-Hozen



Results of Investigating Quality Situation

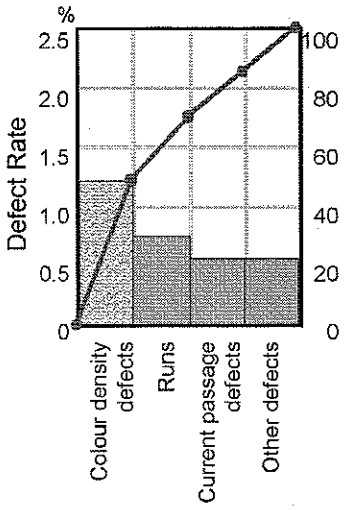


(1) Quality Rate



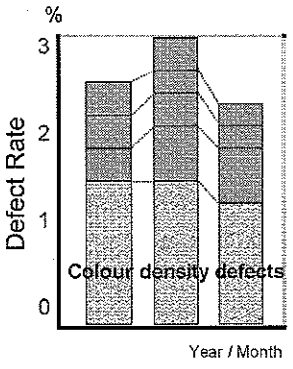
[Monitoring overall quality rate]

(2) Pareto diagram



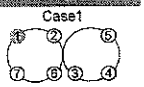
[Stratifying defect rates]

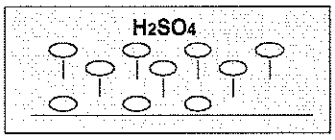
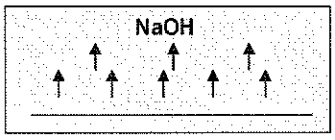
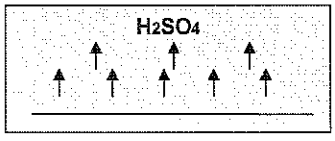
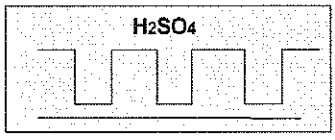
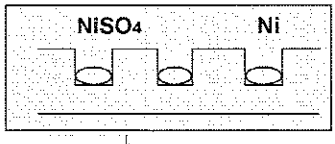
(3) Stratified bar chart



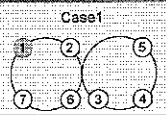
[Monitoring individual defect rates]

Function of Surface Treatment Process



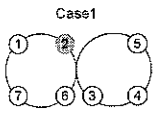
Process		Process Function	Principal conditions
Racking			
Degreasing		Remove oil and grease from Al-Mg-Si alloy	• Sulphuric acid concentration • Temperature • Immersion time
Etching		Dissolve surface of aluminium (to eliminate grease and scratches)	• Caustic soda concentration • Temperature • Immersion time
Neutralisation		Remove smut (Mg, Si)	• Sulphuric acid concentration • Immersion time
Electrolysis		Form alumite	• Sulphuric acid concentration • Temperature • Electrolysis
Electrolytic pigmentation		Deposit nickel (pigment)	• Quantity of nickel metal salts deposited • Temperature • Immersion time

QM Matrix for Surface Treatment Process

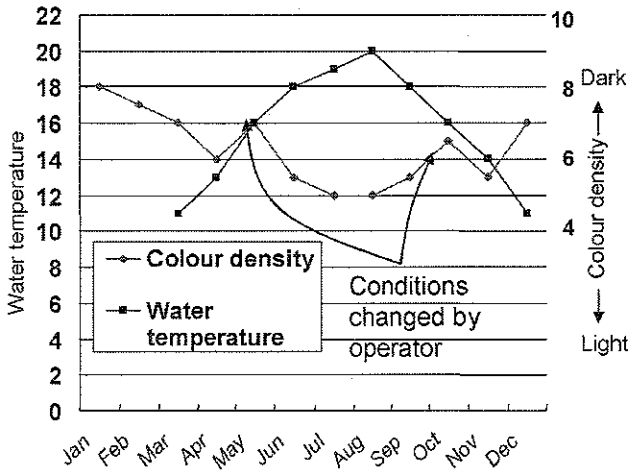


Process	Control Item		Standard value	Interval	Person responsible	Quality Characteristics			Compliance
						Runs	Colour hue	Colour density	
No.9 Wash (Water)	Water temperature		XX ± 2°C					O	X
	pH		3.8 – 4.2	1/shift	Manufacturing			O	△
	Circulation rate		20% open	Daily	Maintenance				-
	Water supply rate		X m³/h	Weekly	Technical			O	O
	Immersion time		X' XX"	Monthly				O	△
No. 13 Pigmentation Process	$NiSO_4$ concentration		XX±10 g/l	Annually				O	O
	Liquid temperature		XX±1°C	±				O	O
	pH		4.7 – 5.3					O	O
	Al concentration		XX ppm max.					O	O
	Circulation rate		100% open						-
	Process conditions	Current density	XX A/m³				O	O	O
		P process	XX second				O	O	△
		Switchover	XX second				O	O	O
		C process	XX second				O	O	△
No. 14 Pigmentation Process	$NiSO_4$ concentration		XX g/l max.			O	O		-
	Circulation rate		Open : 50%						-
	Surface height		461 mm			O			-
	Water supply rate		X m³/h					O	O

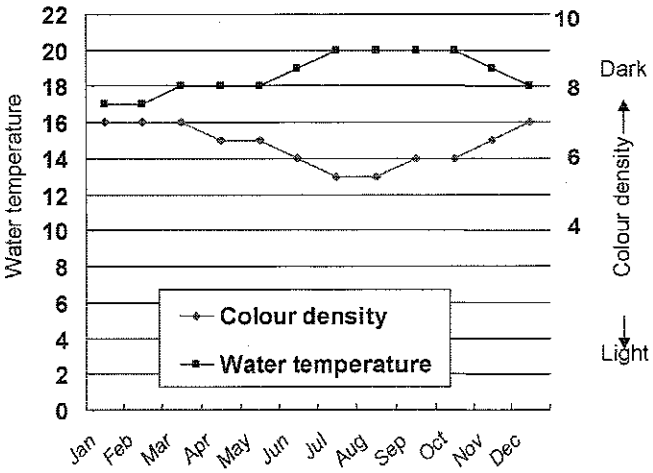
Change in Water Temperature and Colour Density Variation



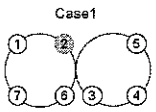
Before Improvement



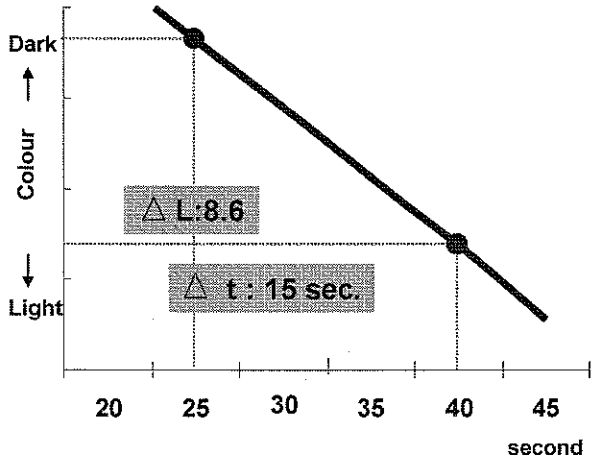
After Improvement



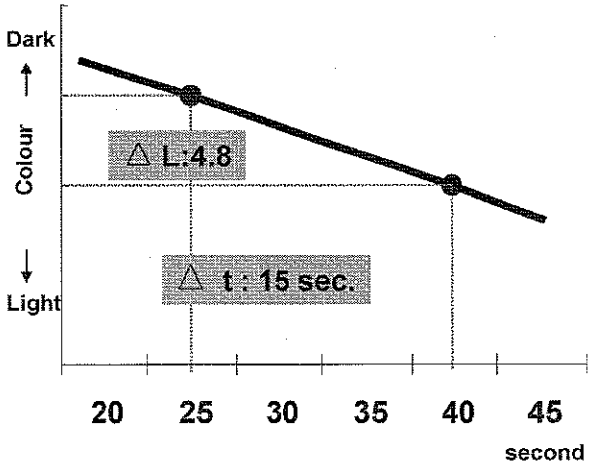
Change to More Tolerant Conditions



Before Improvement
(current density XX A/m²)

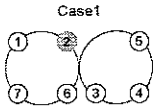


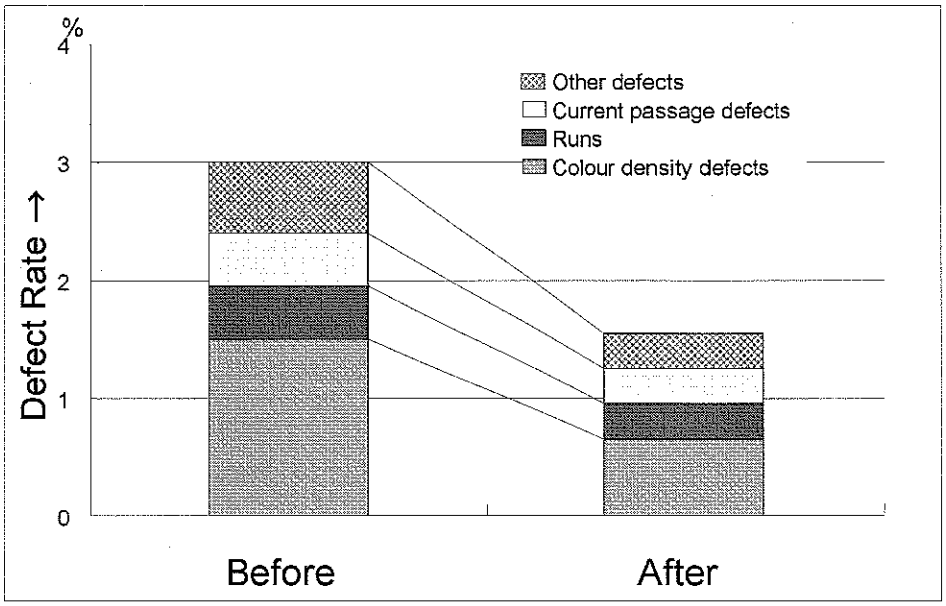
After Improvement
(current density YY A/m²)



Improvement Results

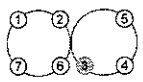
Trend in Defect Rates





Colour Density Control Mechanism

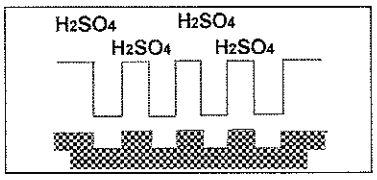
Case1



Electrolysis

Alumite Layer

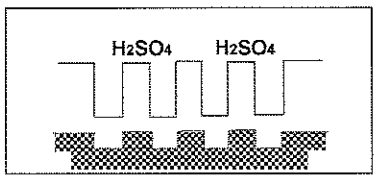
Barrier Layer



When anodic oxidation is carried out in a 10% sulphuric acid electrolyte, the film properties change and become irregular, and the colour of the aluminium substrate itself changes, as a result of heat generation and voltage in the vicinity of the barrier layer

Post-Electrolysis Wash

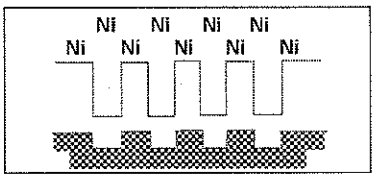
(4-stage)



Dissolved Al becomes hydrated, forming an $Al(OH)_4$ gel, if the water pH is too high or the immersion time too long (i.e.the alumite turns into boehmite)

Pigmentation

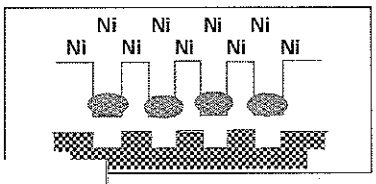
(Pre-treatment)



Passing current through the pigment layer enlarges the barrier layer and improves the pigmentation coverage

Pigmentation

(Full current passage)

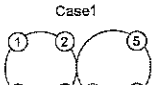


Ni is deposited and the colour density is changed by controlling the time for which current is passed, in accordance with Faraday's Law:

amount of Ni deposited = current (A) x time (s)

P-M analysis Table

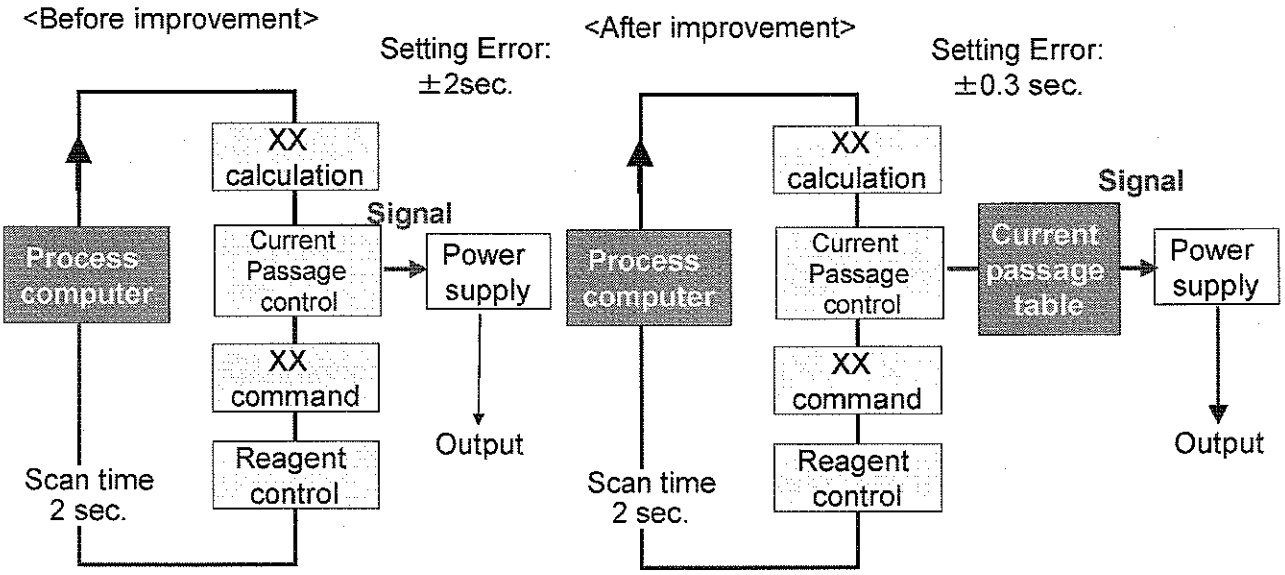
Case1



Phenomenon	Physical Analysis	Contributing Conditions	4-M Correlations (Primary)	4-M Correlations (Secondary)	Investigation results
Sometimes the colour is darker or lighter than standard	The amount (C) of nickel oxide (B) deposited in the porous anodic oxidation film (A) varies (D)	1. The activity of the porous anodic oxidation film varies during pigmentation.	1-1 Post-electrolysis wash conditions are unsuitable.	1-1-1 pH variation	X→ O
				1-1-2 Liquid temperature variation	X→ O
				1-1-3 Immersion time variation	△
				1-1-4 Variation in quality of liquid in tank	X→ O
Anodic oxidation film Level of deposition of metal salts Dark Standard Light		2. Variation in flow of current into material	2-1 Inappropriate control of current	2-1-1 Variation in P treatment time	X
				2-1-2 Variation in P treatment time	X
			2-2 There are defects in the current path	2-2-1 Soiling of clamping jig	O
				2-2-2 Soiling of electrical connector to beam	O
				2-2-3 Looseness of V-groove attachment bolt	O
				2-2-4 Corrosion of beam bracket	O
				2-2-5 Soiling of electrical connector to pigmentation layer	O
				2-2-6 Anode condition	O
			2-3 The electrical conductivity of the Al sections varies	2-3-1 Difference in material	O
				2-3-2 Variation in heat-treatment condition	X

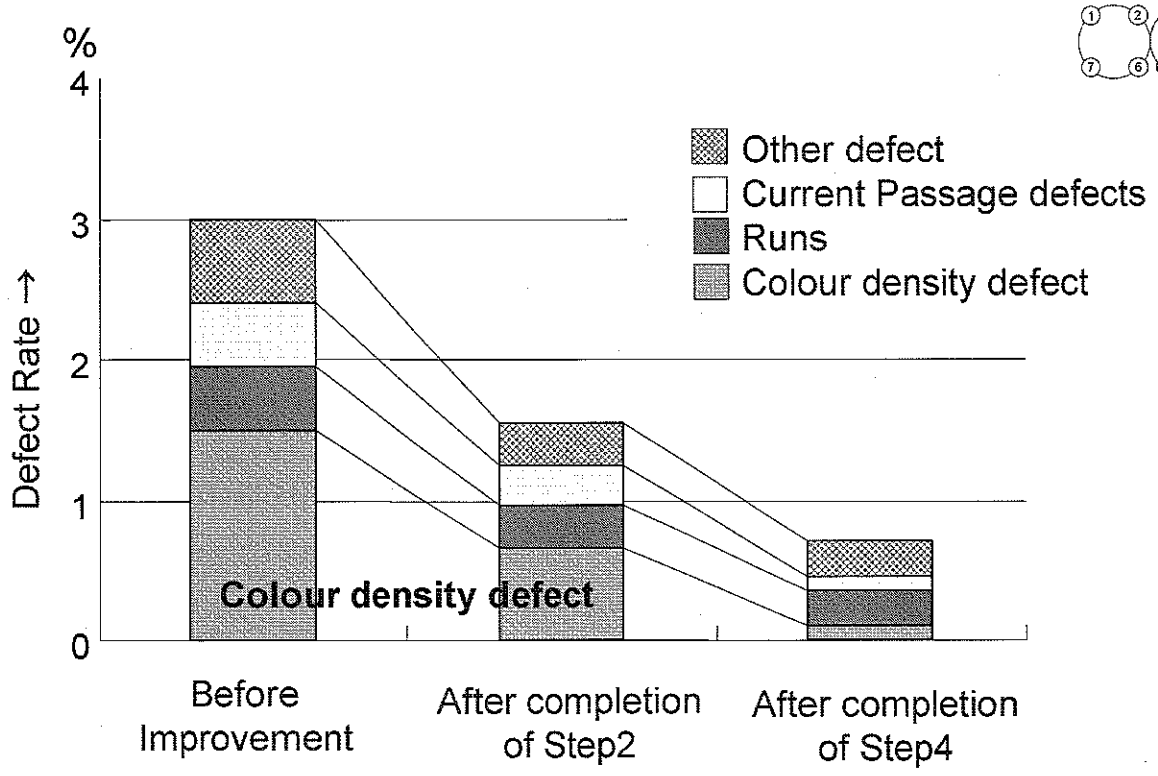
Increase in Precision of Current Passage Control

Case1



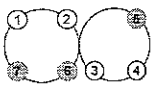
Trend in Defect Rates

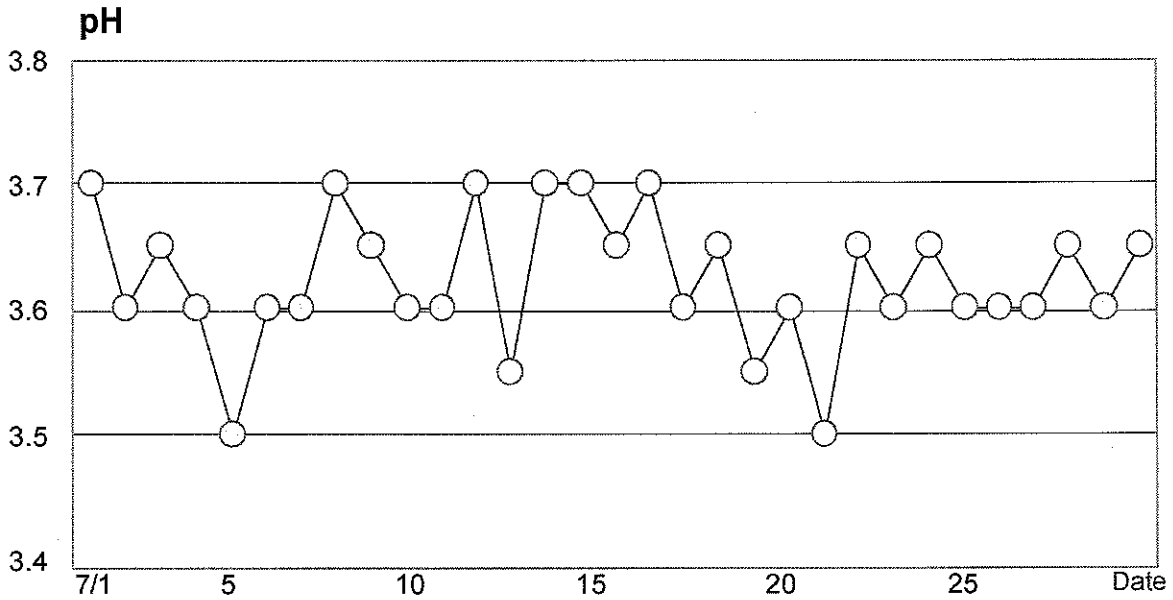
Case1



Trend Monitoring at No. 10 Water Washing Bath

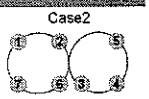
Case1





Standards for Evaluating Level of Control of Rules and Procedures

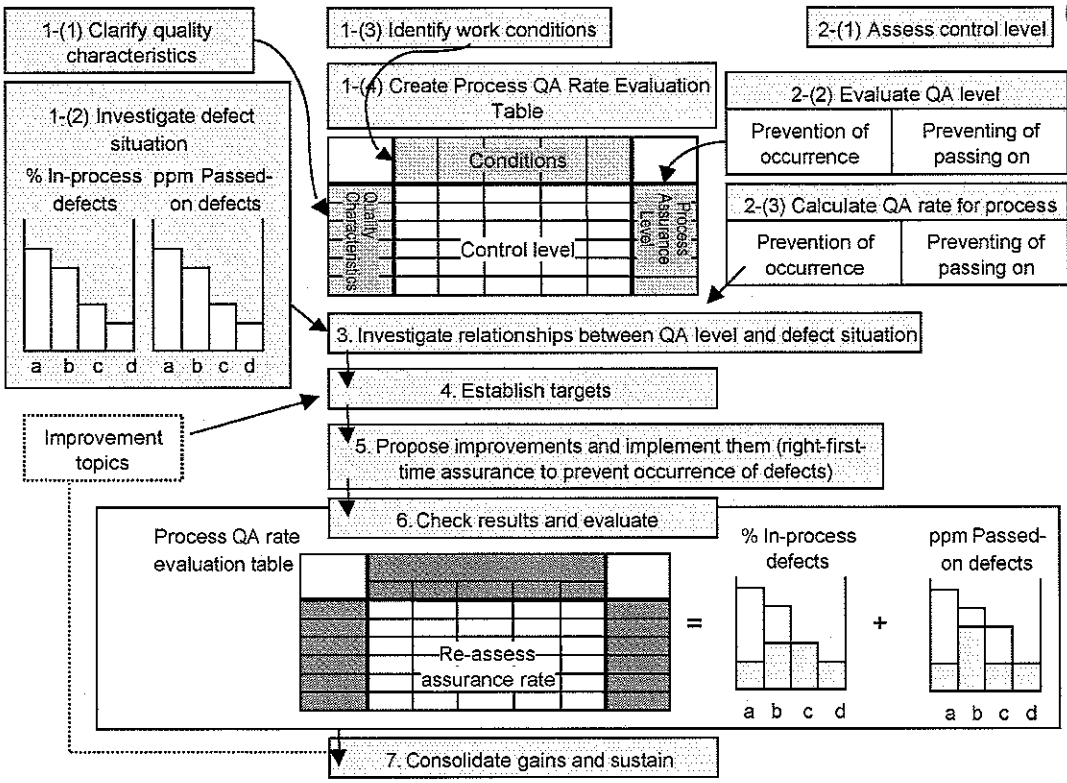
Case2



Control Level	Description of Control Level		Preventing defects from occurring	Preventing defects from being passed on
A	Cannot create defects	Error-proofing of causes	-The equipment controls the good-product conditions, and if the conditions are not satisfied, then the equipment will not operate	-Defects do not occur -Zero possibility of passing on defects
B	Cannot pass on defects	Error-proofing of results	-Individual defects are identified as and when they occur	-There is a system for preventing defective product from being passed on. Defective product halted by equipment and process.
C	Does not create or pass on defects	Operator checks	-Operators control the good-product conditions. If the conditions are not met, then they make adjustments. -There is a possibility of a series of defects occurring	-To prevent defective product from being passed on, operators check the quality and halt any defective products. -High chance of passing on defects
D	Out of control	No control method established	-Defects cannot be prevented	-If a defect occurs, it is always passed on

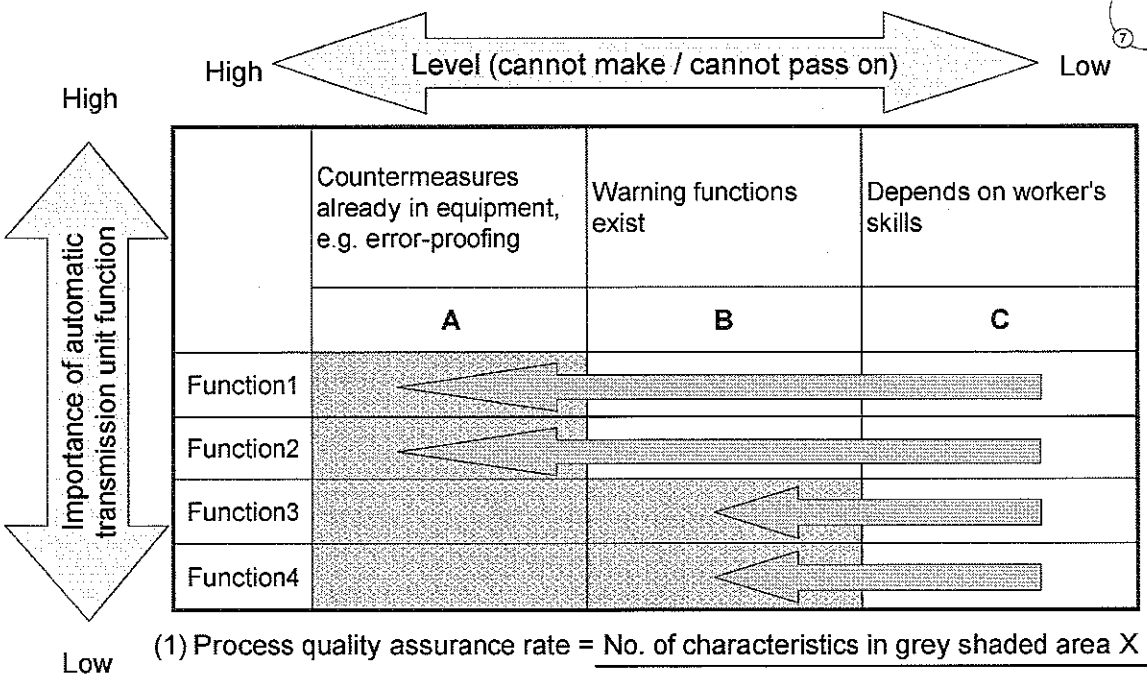
Procedure for Developing Quality-Hozen in Manual Work Processes

Case2



Quality Assurance Rate in an Assembly Process

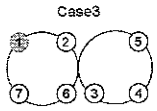
Case3

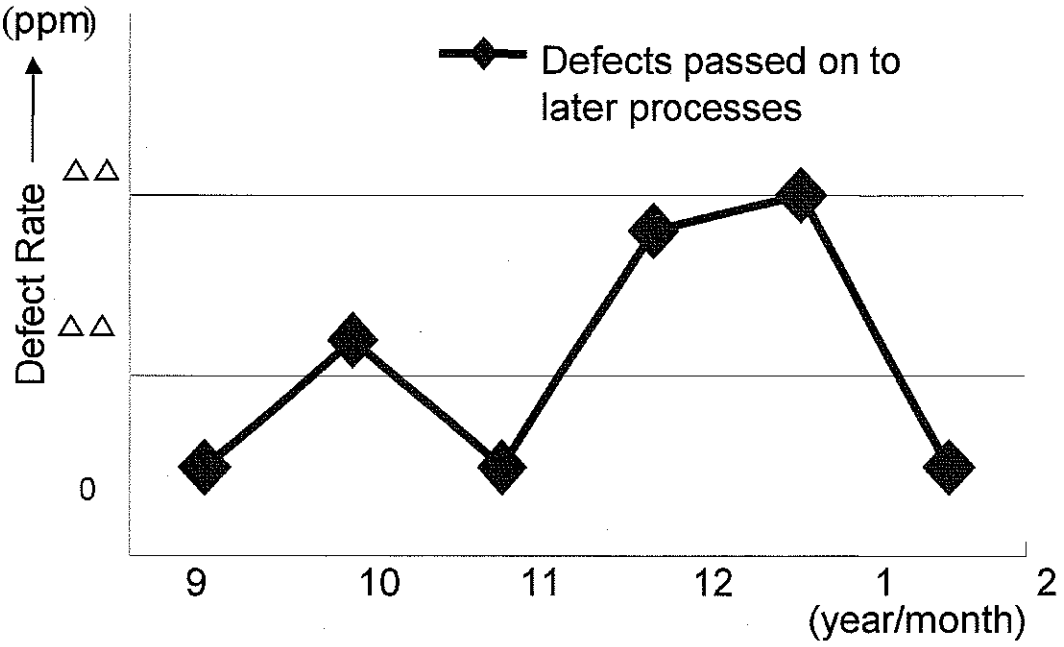


(1) Process quality assurance rate = $\frac{\text{No. of characteristics in grey shaded area X 100}}{\text{Total no. of characteristics}}$

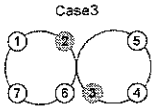
(2) The symbol ⟸ indicates the thrust of activities for improving the process QA rate

Trend in Rate of Assembly Defects





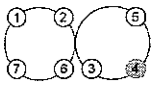
QA Matrix (Process QA Rate Evaluation Table)

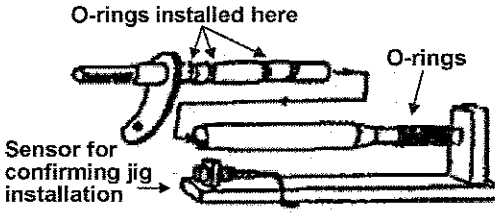
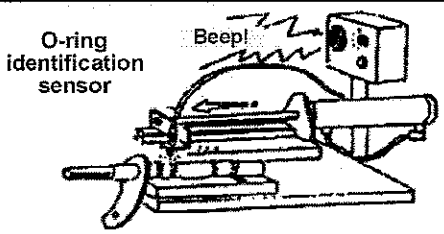
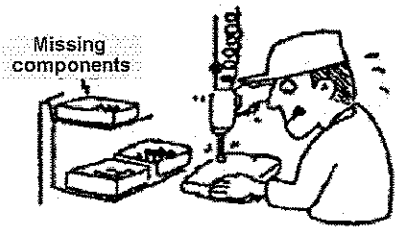
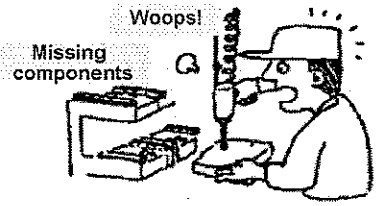


	Name of Process		Actual /Envisaged Deficiencies	Importance	FMEA	Actual Deficiency	Assurance (Check) Process 1 Press Fitting	2 Support Assembly	5 SP Assembly	6 Shaft Assembly	7 Parking Assembly	20 Performance test	Overall Verdict	Remarks
1	Press Fitting	Knock pins	Part missing Insertion Defect	C	O		A						A	Error Proofed
		Lever pins	Part missing Insertion Defect	A	O		A					B	A	Error Proofed
		One-way valve	Assembled	B			B					B	A	Test Pattern Changed
2	Support Assembly		Fastening Defect	A	O			A					A	Error Proofed
5	Spring Assembly		Fastening Defect	B	O								C	Needs Action
6	Shaft Assembly		O-ring Missing	B									C	Needs Action
			Pin Missing	B									B	
7	Parking Assembly		E-ring Missing	A	O								B	Needs Action
			Ring Insertion	A	O								B	Needs Action
			Ball Missing	A		O							A	Error Proofed

Improving Operator-Dependent Assurance Modes 1

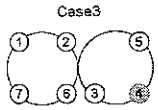
Case3

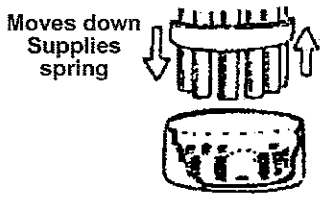
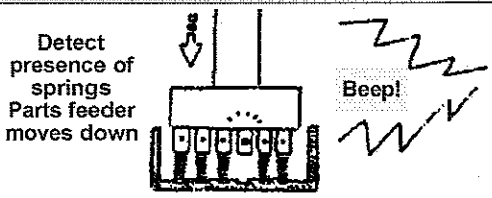
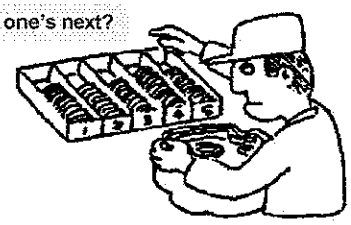
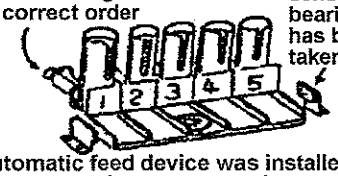


Item	Before Improvement	After Improvement
Error-proofing introduced to detect missing O-ring	 O-rings are installed in the three grooves on the shaft. It was envisaged that one or more of the O-rings might be omitted when doing this task.	 An error-proofing device was installed, consisting of a detector used after installation to check that all the O-rings are in place.
Error-proofing introduced to prevent missing components in control valve assembly	 11 different components are used in assembling the control valve; the operator occasionally missed a component and had to redo the task..	 An error-proofing device was installed, using sensors fitted to the component box and assembly tools. If one of the components or tools has not been used, then the hydraulic tool for fastening the last bolt is prevented from operating.

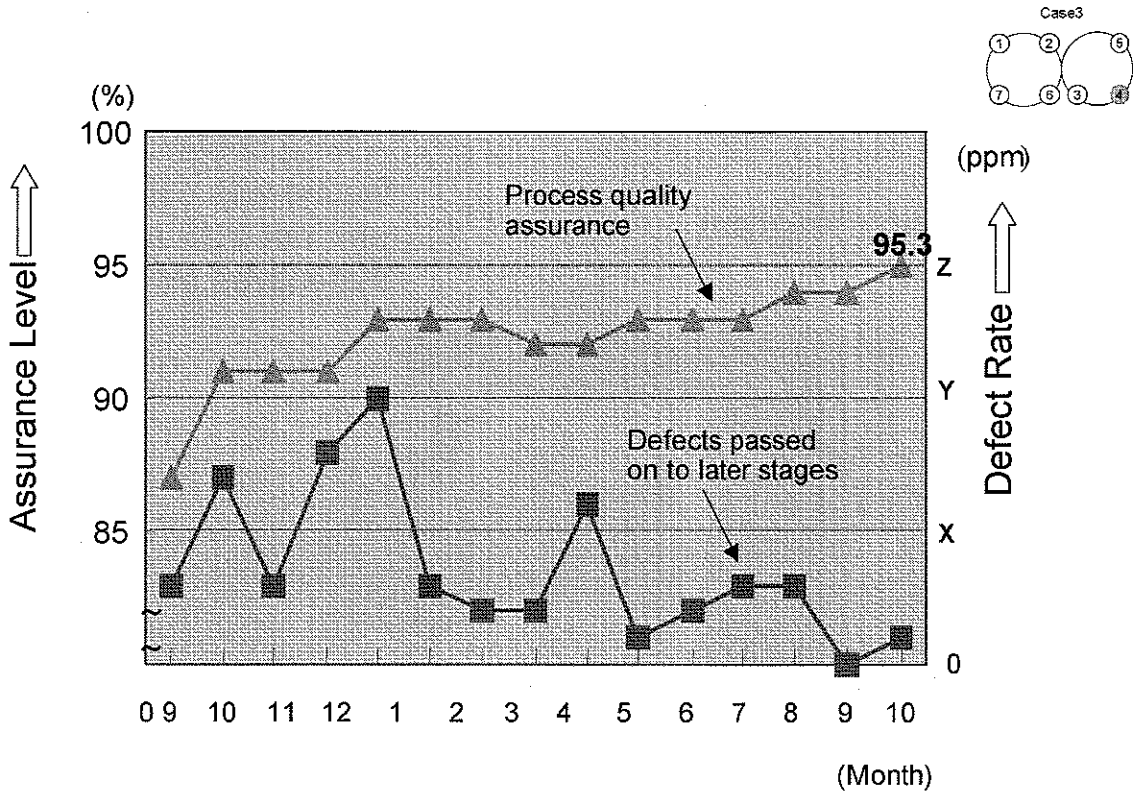
Improving Operator-Dependent Assurance Modes 2

Case3



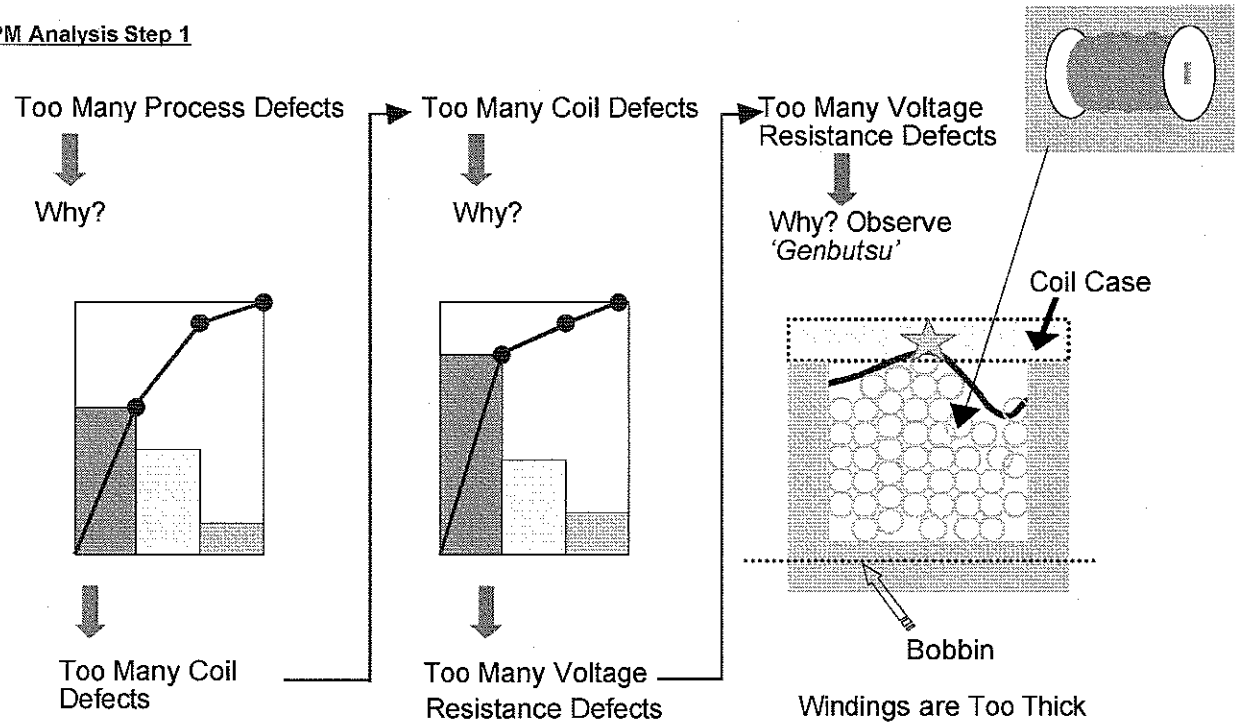
Item	Before Improvement	After Improvement
Error-proofing introduced to prevent missing springs	 In the automatic assembly device used in the packing process, 12 springs are supplied by a parts feeder. At the next station, components are installed on top of these springs. The team were concerned that springs might be omitted.	 Error-proofing using contact sensors was introduced, to check that all the springs were in place after the supply step. If a spring is missing, an alarm sounds and the machine is halted.
Error-proofing introduced to prevent omission of bearing races	 It was imagined that, when fitting the bearing races, some might be left out, or the wrong ones used.	 An automatic feed device was installed to supply the bearing races, one by one, in the correct order. Each time one is taken out, a photocell detects it, and the device delivers the next one to be fitted. This system prevents bearing races from being missed out, or the wrong ones being used.

Confirmation of Results



Using Pareto-diagram Stratification to Observe the *Genbutsu*

PM Analysis Step 1



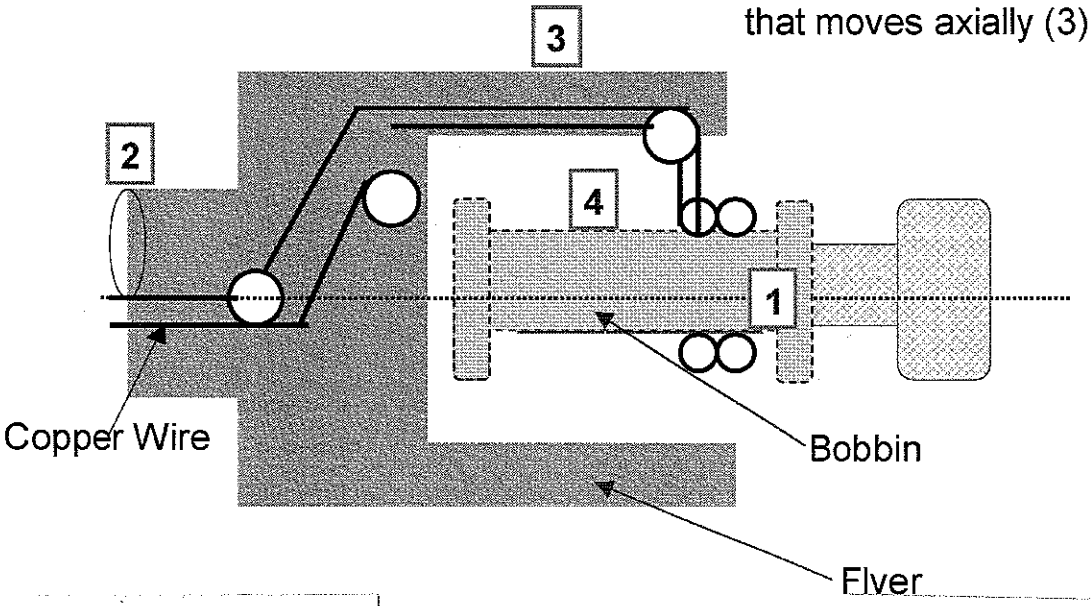
Understanding the Contact point and the Principles of Processing

PM Analysis Step 2

[Principles and Parameters]

A fixed bobbin (1) is wound with copper wire (4) paid out from a rotating flyer (2) that moves axially (3).

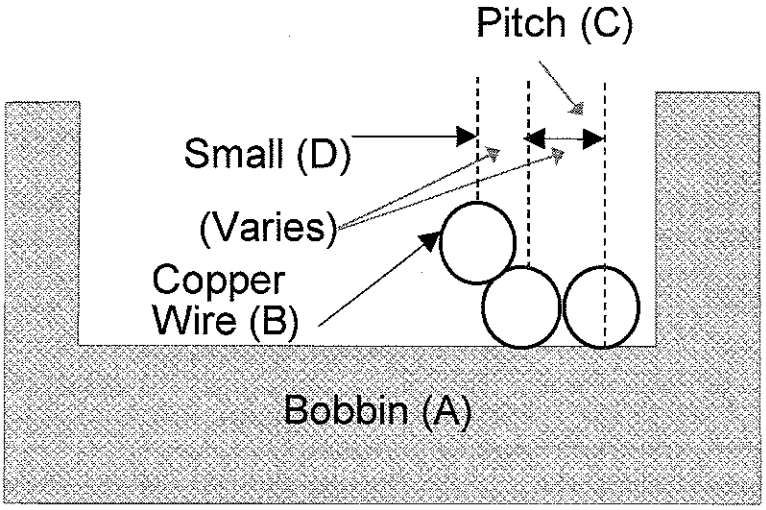
Contact Diagram



Physical Analysis Using ABCD Description

PM Analysis Step 2

◆ Draw Diagram To Aid Thinking Process

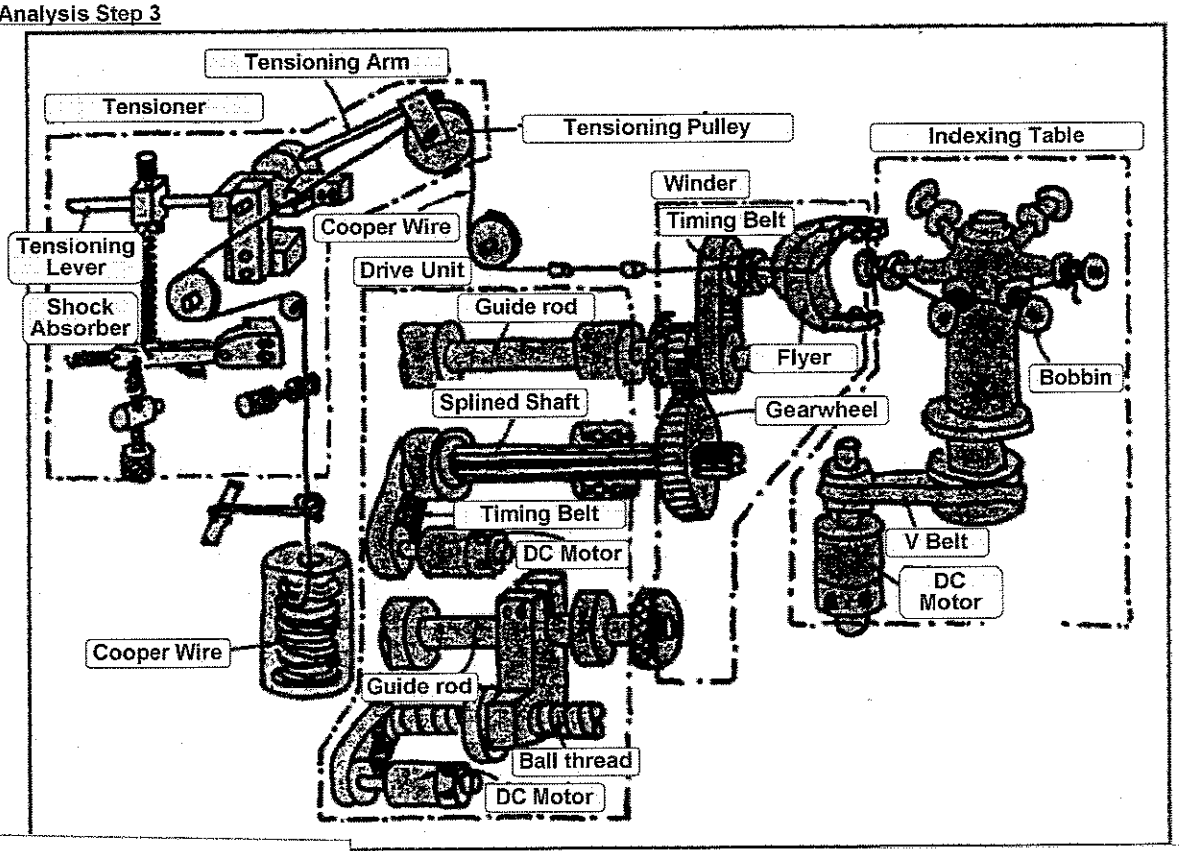


◆ Describe in ABCD Format

- A fixed bobbin (A)
- Is wound with copper wire (B)
- Paid out from a rotating flyer and pitch (C)
- Is too small (D) (varies)

Simple Mechanism Diagram (Compact Turntable Winder)

PM Analysis Step 3



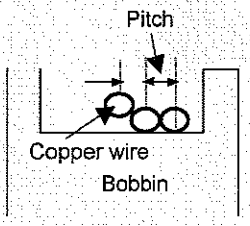
Unit Function Investigation Table

PM Analysis Step 3

Functional Unit	Functions		Affects Physical Quantity?	Contributing conditions
	Necessary	Desirable		
Tensioner	Supply copper wire	Maintain constant tension	Yes	Tension varies
Winder	Rotate flyer	Rotate at constant speed	Yes	Rotation speed varies
Drive unit	Move flyer axially	Move at constant speed	Yes	Speed varies
Indexing table	Supply bobbins	Supply to fixed point	Yes	Bobbin moves
Number of contributing conditions = total number of functional units +2				Poor materials
				Unsatisfactory method

P-M Analysis Table

PM Analysis Step 4

Phenomenon	Physical Analysis	Contributing Conditions	4-M Correlations (Primary)	4-M Correlations (Secondary)
The coil windings are too thick	The Pitch[C] of a copper wire[B] wound about a bobbin[A] shows variation [D]	1.The required tension varies	1-1. Tension setting varies	1-1-1. Playing spring fixing block
				1-1-2. Block fixing bolts loose
				1-1-3. Springs worn out
				1-1-4. Play in shock-absorber plate
				1-1-5. Shock-absorber spring worn out
				1-1-6. Shock-absorber spring adjustment bolts loose
				1-1-7. Play in tension lever fixing
				1-1-8. Play in tension arm fixing
 The Pitch[C] of a copper wire[B] wound about a bobbin[A] shows variation[D]			1-2. Set tension cannot be maintained	1-2-1. Wire not wound correctly onto supply wheel
				1-2-2. tension rubbers worn
				1-2-3. Rubber tension adjusting bolts loose
		2.The lateral speed varies	2-1. Variation in rotational speed of motor	.....
				.....
			2-2. Variation in rotational speed of ball screw	2-2-1. Timing belt loose worn
				2-2-2. Timing pulley worn
				2-2-3. Pulley loose
			2-3. Variation in speed of movement of flyer	2-3-1. Ball screw worn
				2-3-2. Block fixing bolts loose
				2-3-3. Guide bar bolts loose
				2-3-4. Sliding bearings worn or loose

(remainder omitted)

Investigation Results and Deficiencies Identified

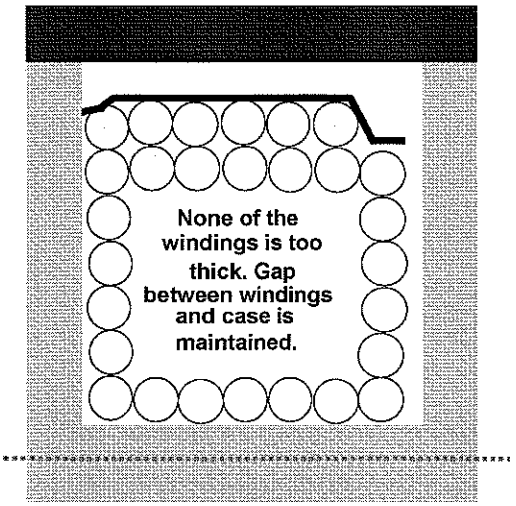
PM Analysis Step 5,6,7,8

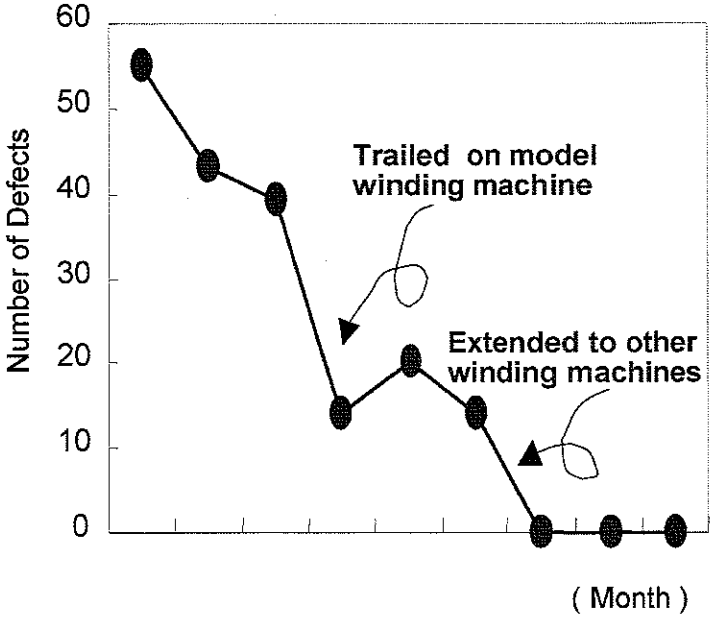
Location of Check	Item to be Checked	Measurement Method	Tolerances	Measured value	Corrective Action	Result
Tensioner	Variation in tension	Tensometer	510–580 g	120–580 g	1. Redesign tensioner device 2. Redesign all rollers 3. Clean all guide holes	Kept within tolerances
Winder	Variation in rotational speed	Tachometer	± 2%	± 0	OK	
Drive unit	Variation in speed of movement	Dial gauge	Variation in return point ± 0.05mm	0–0.32 mm	1. Adjust slack in timing belt 2. Halt operation for 0.5 sec. at return point	Within 0.03 mm

(remainder omitted)

Condition of Windings and Trend in Voltage Resistance Defects After Improvement

PM Analysis - result





The Development of Quality-Hozen (a 10-step procedure)

		Step		Contents	Comments
Improve Quality	Investigate and Analyse	Prepare	1 Verify existing situation	(1) Confirm quality standards and characteristics	· Specify the quality characteristics to be maintained
				(2) Create flow diagram of individual processes that determine product quality	· Identify equipment systems' mechanisms, functions, processing principles, sequences, etc.
				(3) Investigate defect situation and phenomena, and stratify	· Understand circumstances in which a quality defect occurs in processing · Stratify defect phenomena · Identify individual processes giving rise to defect phenomena
				(4) Set targets and make action plan	
			2 Investigate processes where defects occur	On this basis, draw up a QA matrix * Investigate individual processes where defect modes occur	· Find relationships between individual processes and defect modes
			3 Investigate and analyse 3-M conditions	(1) Investigate 3-M conditions in each process (2) Identify lapses in these conditions through on-site investigation	· Investigate 3-M conditions, using drawings, standards, manuals, etc. · Work out what the 3-M conditions should be, on the basis of processing principles, equipment mechanisms/functions, etc. · Do on-site investigation to establish 3-M conditions and highlight failures to maintain them

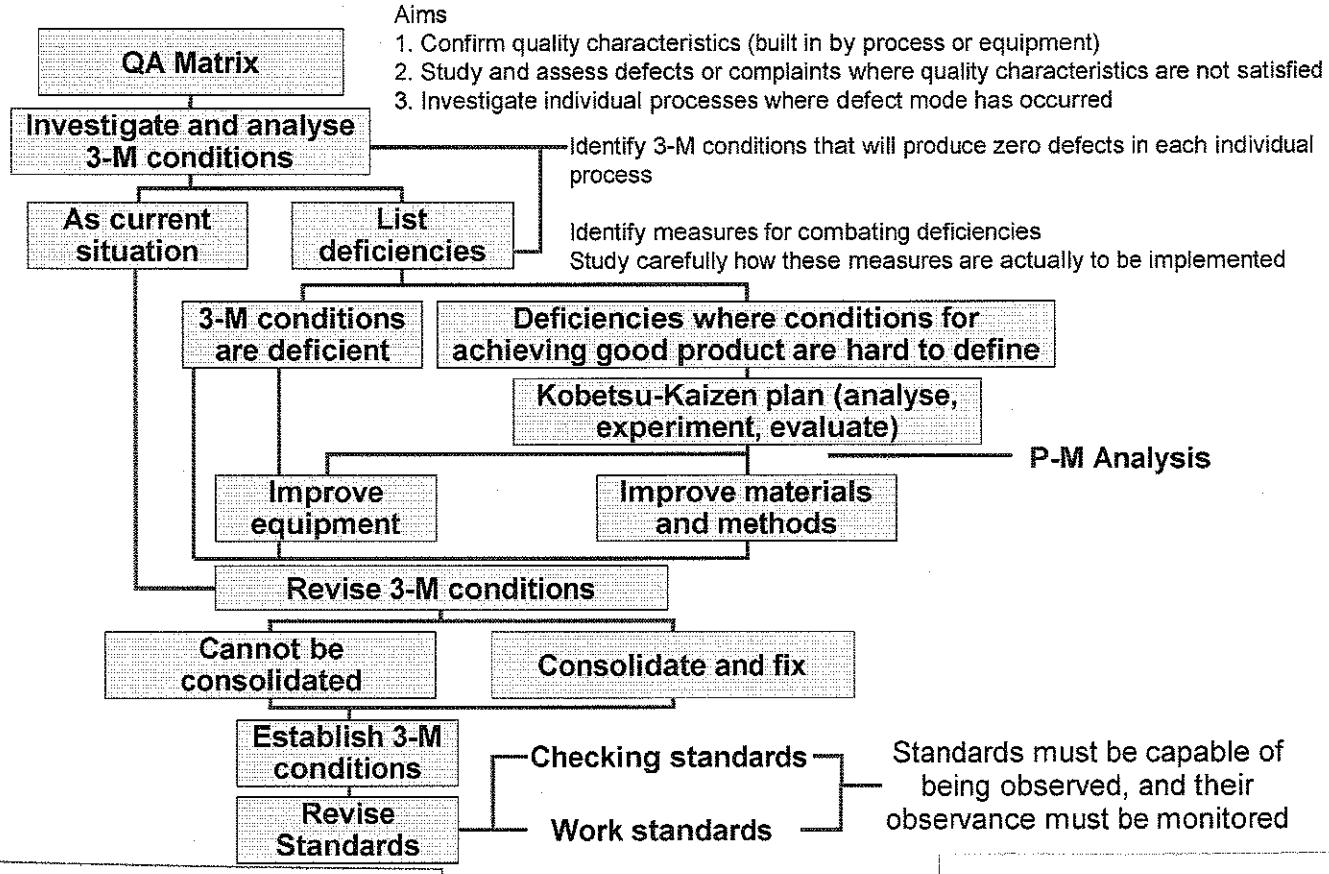
The Development of Quality-Hozen (a 10-step procedure)

Plan improvements	4	Plan action to correct deficiencies	(1) Create Deficiencies Chart and identify countermeasures (2) Verify state of equipment, and restore/improve it	· Verify sustainment through Jishu-Hozen activities; investigate process conditions and setup methods; restore to fix deficiencies · Improve equipment that does not meet equipment conditions
	5	Analyse situations where conditions for achieving good product are unclear	(1) Analyse situations where the conditions for building in quality are unclear Experiment to find optimum situation (2) Evaluate	· Return to principles and parameters of processing, and identify all relationships between quality characteristics and processing conditions / equipment precision · If there are several problematic characteristics in the same equipment, then work out which part of the equipment affects which quality characteristic · Use P-M Analysis, FMEA, design of experiments, etc. to pinpoint the relationships between defect causes and the 3 Ms; establish 3-M conditions for building in quality · Set provisional tolerances (standards) for equipment precision and processing conditions, so that the quality characteristics stay in the standard range
Implement improvements	6	Eliminate flaws in 3-M conditions	(1) Expose flaws in 3-M conditions (2) Improve (3) Evaluate results	· Check/investigate 3 Ms according to 3-M conditions from analysis results · Identify deficiencies, restore original state and improve · If all checkpoints are within provisional tolerances, check that quality characteristics meet standard values
	7	Finalise 3-M conditions	Establish conditions for the 3 Ms which allow good product to be achieved	

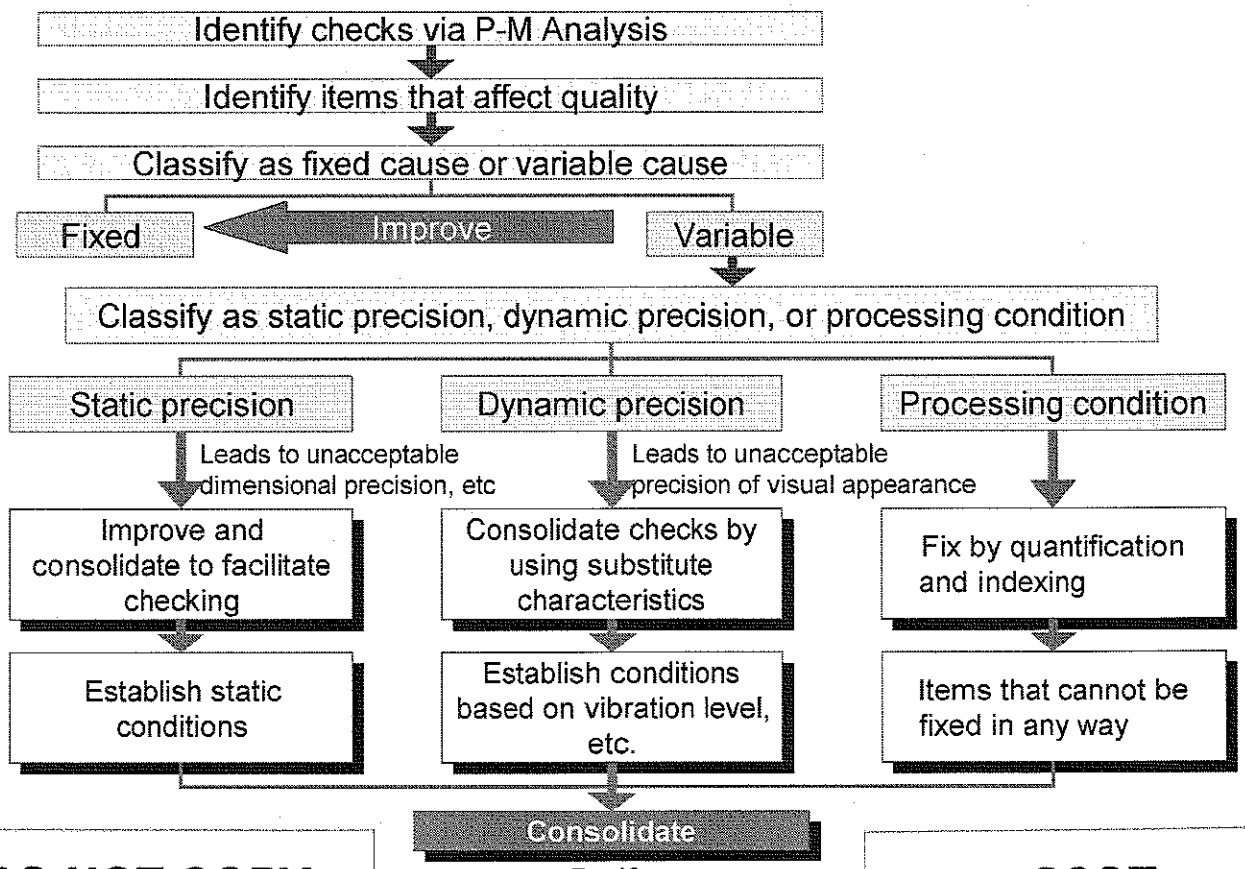
The Development of Quality-Hozen (a 10-step procedure)

Sustain Quality	Standardise	8	Consolidate checking methods	Find ways to consolidate and fix the checking methods, and carry out improvements	· Classify the checkpoints into static precision, dynamic precision and processing conditions; try to consolidate checks · At the same time, do improvements to make checks quicker and easier
		9	Determine standard values for checks	(1) Determine standard values for checks (2) Create QM matrix (3) Increase reliability of checks, simplify and reduce number of people involved	· Using methods such as vibration measurement, establish substitute characteristics for controlling the equipment precision tolerances (standard values) required to keep quality characteristics within standards · Assign all checks apart from those needing special measuring equipment, or strip-down checks requiring skill/time, to the Operations Department · Find and implement ways of increasing checking reliability, simplifying checks, and reducing number of personnel required
		10	Revise standards and monitor trends	(1) Revise materials standards, checking standards and work standards (2) Display Q component tables so that standards are adhered to (3) Monitor trends and confirm results	· Managers must educate operators about the reasons why these checks are necessary, on the basis of the equipment mechanisms, structures and functions, and the processing principles · Operators should add their own notes to checking manuals · By monitoring trends, take preventive action before values exceed the standard ranges · If any other quality problem arises, unrelated to the specified standard values, revise the standard values, items to be checked, and checking methods

Carrying Out Quality-Hozen

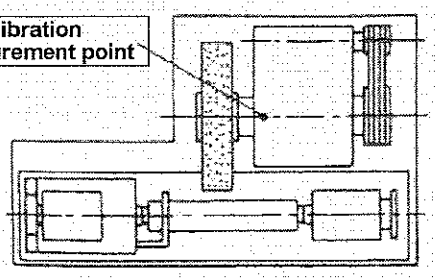


Basic Approach to Consolidating Checks



Examples of Consolidating Checks by Vibration Monitoring

Plan view of cylindrical grinder

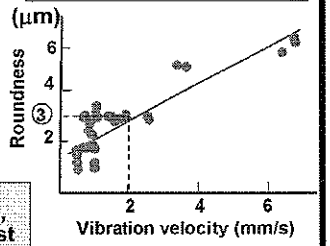


Investigate vibration levels and roundness in similar models.

Correlation exists between vibration level and roundness. Correlation coefficient was 0.87, so looked for regression line

From regression line, vibration velocity must be kept to 2 mm/s or less to keep roundness within 3 μm of standard.

Correlation between roundness and vibration velocity



Max. vibration set to 2 mm/s

Why do some machines vibrate a lot and some only a little?

Machines that vibrate a lot have a large gap between bearing and shaft

When bearing was adjusted, vibration velocity reduced, and roundness improved

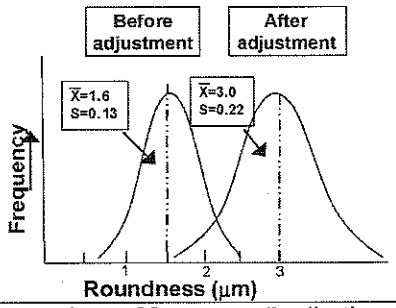
Bearings of heavily-vibrating machines were adjusted to bring vibration velocity below 2 mm/s

Measure vibration once a fortnight, and monitor trends Adjust bearing if vibration starts to approach 2 mm/s

Relation between Roundness and Vibration after adjustment

		Roundness	Vibration
Before Adjustment	μm 80 - 100	5.0 μm 	12.1 mm/s
After Adjustment	μm 20 - 30	2.7 μm 	1.8 mm/s

* Gap between bearing and shaft



Comparison of frequency distribution of roundness before and after adjustment

Example of Check Consolidation in Chemical Plant

	Check	Possibility of Consolidation	Consolidation
Materials	1 PVC slurry density 30% max. 2 PVC slurry temp. 70% max. 3 Feed water concentration	1 PVC slurry determined in previous step; no direct relationship with contaminants in the feed stage, so no need for check here 2 Feed water standards adhered to	No checks required
Equipment	1 P11 –1, 2, 3, 4-D stuffing box Must not overheat 2 P11 –1, 2, 3, 4-D stuffing box Water injection 2l/min. at least 3 Water injection pump: min. pressure 5kg/cm2	1 P11 –1, 2, 3, 4-D stuffing box converted to self-flushing (does not require water injection). No overheating occurs, but priming is needed at start up and shutdown. 2 Check required	1 Consolidate checks so that water volumes injected at pump start up and shutdown are checked as part of standard operating procedures. 2 Check at start up and shutdown.
Methods (People)	1 Stuffing box overheating check Once / shift 2 Stuffing box water flowrate check 3 Pump discharge pressure check 2 kg/cm2 minimum 4 Pump current check Once / shift 5 Water injection pump discharge pressure check 5 kg/cm2 minimum	1 Water injection required at startup and shutdown, as in Equipment category. 2 Confirmation required at shutdown Confirmation of normal operation required 3 Check required	1 Same as Equipment category, so check to confirm water volume of 2l/min. at pump startup and shutdown 2 Check once per shift 3 Check once per shift
	11 Checks	⇨	5 Checks

Example of Quality Check Matrix Example (1)

Part	Item to be measured	Standard value	Measurement interval	Quality characteristics		
				Roundness	Cylindricality	Surface damage
A Grindstone spindle	Vibration	Y mm/s or less	Once / month	○		
B Work spindle	Vibration	Y mm/s or less	Once / month	○		
D Table	Parallelism	A μm or less	Once / month		○	
E Aux. guide	Wear	B mm or less	At setup		○	○
F Aux. guide	Wear	C mm or less	At setup		○	○

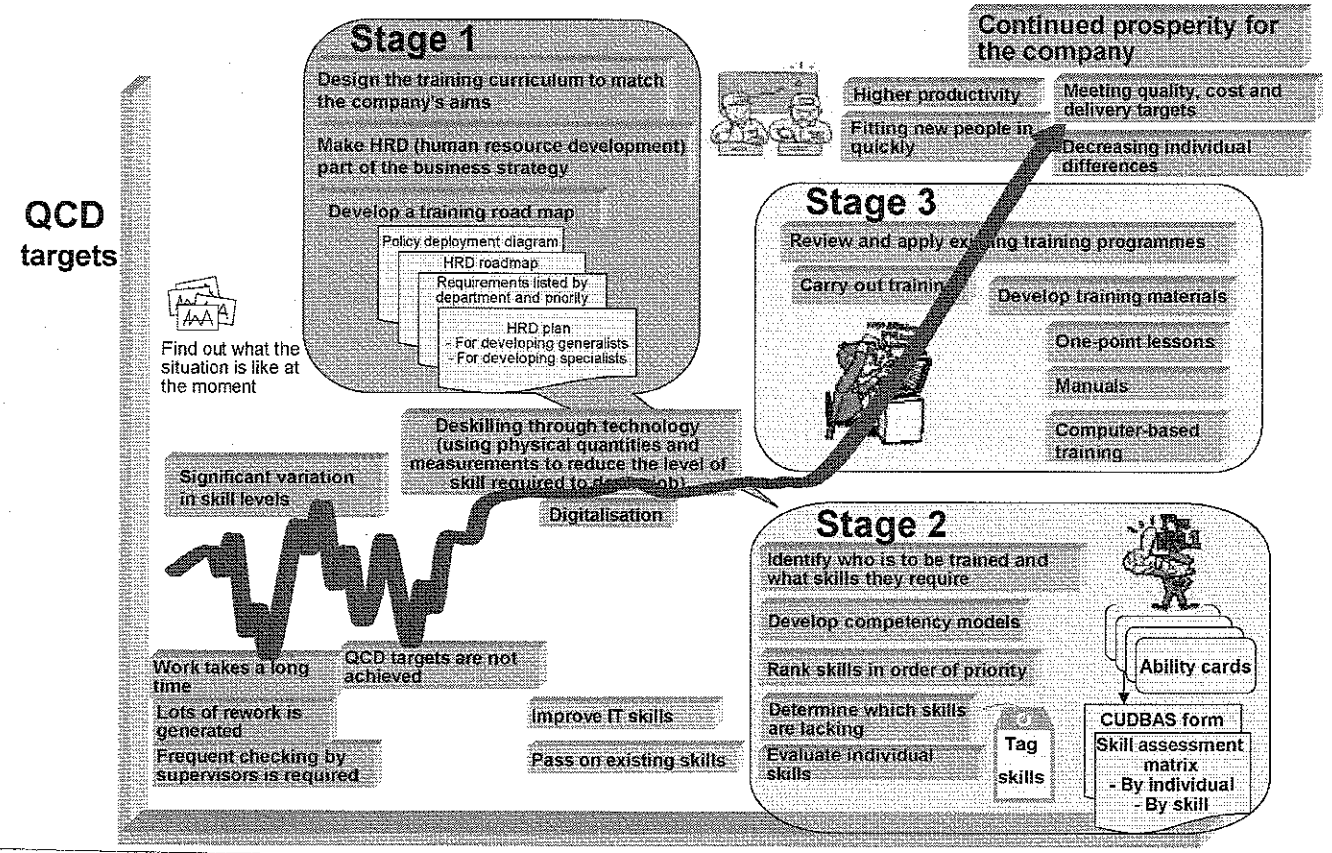
Example of Quality Check Matrix Example(2)

Part		Extrusion Machine			Die			Forming die				
		RT temp.	Barrel	Screw	Temp.	Outer dia.	Clearance	Top die	Bottom die	Clearance	Cooling water	
Check Point		Temp.	Wear	Wear	Temp.	Wear	Thickness difference	Vacuum nozzle dia.	Vacuum nozzle dia.	Thickness difference	Flow rate	Temp.
Standard value		185°C ± 3°C	Dia. ±0.3mm	Dia. ±0.3mm	220°C ±3°C	0.02mm max.	1.13 mm ±0.03	1.0–0.2 max.	1.0–0.2 max.	1.55 ±0.03		15°C ±2°C
Frequency		Once / day	Once / 6 mth.	At setup	Once / day	At setup	At setup	At setup	At setup	At setup	Once / cycle	Once / cycle
Quality Characteristics	Bumpiness	O	O	O				O			O	O
	Lustre				O	O						
	Shrinking						O			O		
	Warping	O			O			O	O		O	

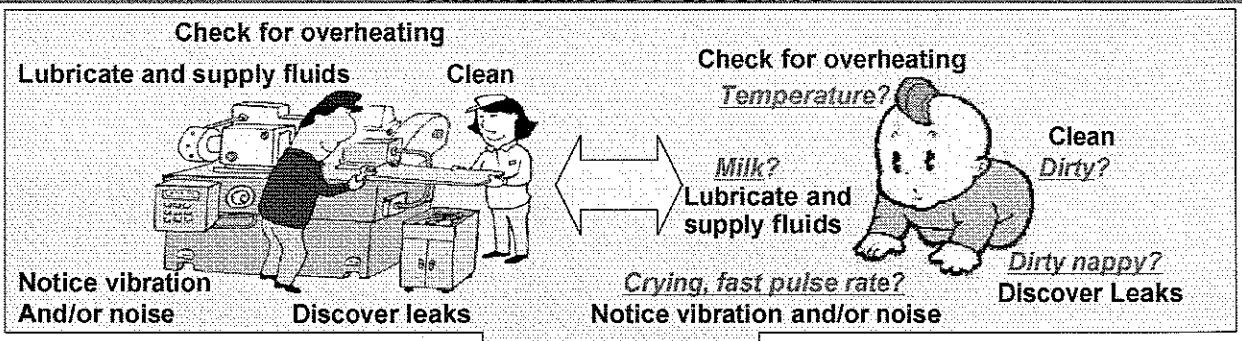
TPM Manual
Chapter 8
Training & Education

JIPM-Solutions Co. Ltd.

The Need to Pass on Skills



The Need to Increase the Knowledge and Skills of Operators and Maintenance Personnel



Food、Exercise
Bathing, Sleeping

Treat
mild illnesses

Health checks
Vaccination

Hospitalisation (operation)
Overnight check-up
Treatment of serious illness

Daily discoveries, routine checks, cleaning, lubrication, parts replacement, simple repairs

Operator: Mother

Periodic checks, tear-down inspection, shutdown overhaul, breakdown repair, modification

Maintenance personnel: Doctor, hospital

All this requires knowledge and skill

User-friendly equipment
Maintenance-friendly equipment
Reliable equipment

Design and Production Engineering Department: Father

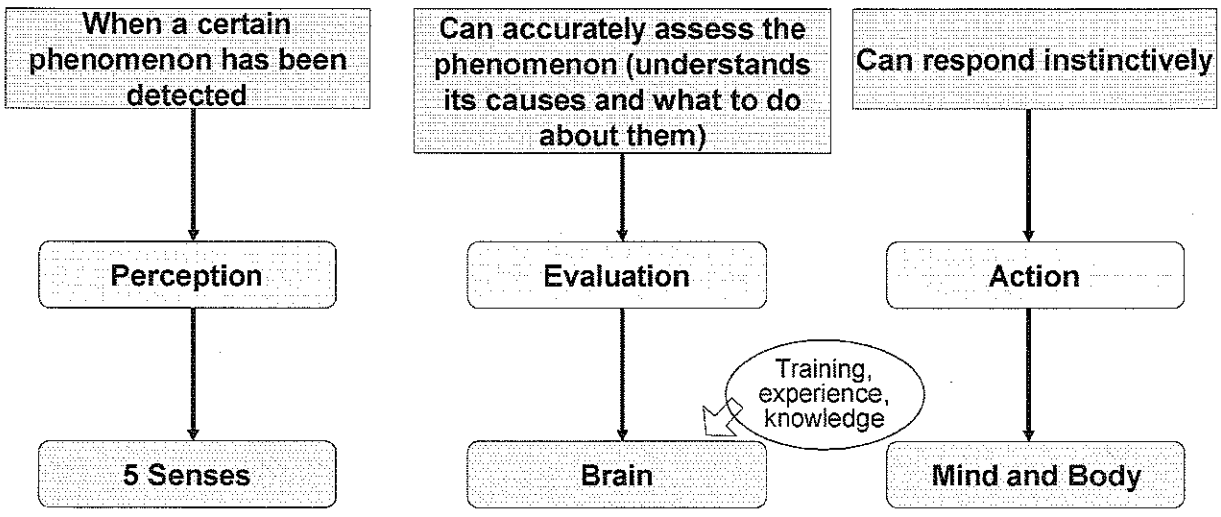
The Ability Most Needed in Operators

- Detecting problems with the equipment and carrying out continuous improvement
- Understanding the structure and functins of their machinery, and discovering the root causes of abnormalities.
- Understanding the relationship between machinery and quality, and foreseeing and detecting quality problems.
- Carrying out repairs
- Doing Kobetsu-Kaizen on suitable topics, either independently or with other departments

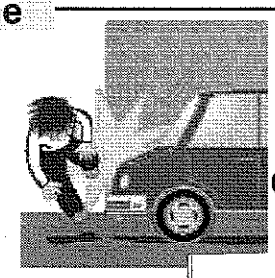
The Abilities Most Needed in Maintenance Staff

- Instruct operators in daily maintenance and the correct handling of machinery.
- Know when something is not right with the equipment.
- Investigate the root causes of problems and solve them correctly by the most appropriate methods.
- Increase the reliability of machines and components, make them last longer, and minimise the rate of occurrence of breakdowns and other such problems (i.e. extend the MTBF, or mean time between failures).
- Increase equipment maintainability (e.g. by making it possible to replace complete units instead of individual parts) in order to minimise the time spent on repairs (i.e. reduce the MTTR, or mean time to repair).
- Acquire and apply diagnostic techniques and develop standardised ways of using them.
- Optimise all of these activities and maximise their cost benefits.

What is Skill?



A function of time



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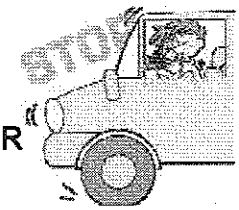


The 5 Steps to Mastery

Skill Level 1 - Does not even know the theory (has not been taught): Insufficient knowledge

Skill Level 2 - Knows the theory

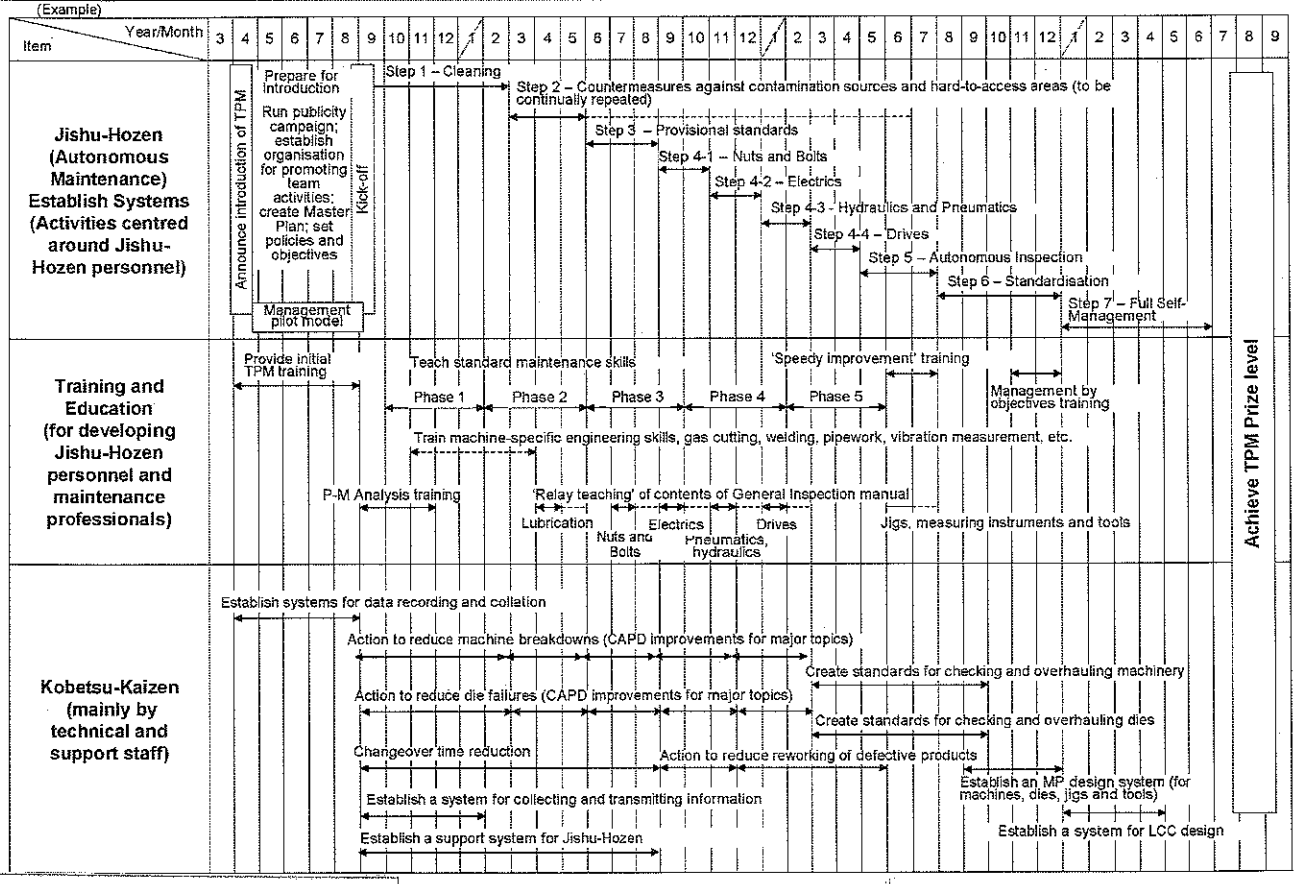
Skill Level 3 - Can perform the task after a fashion

Insufficient Training

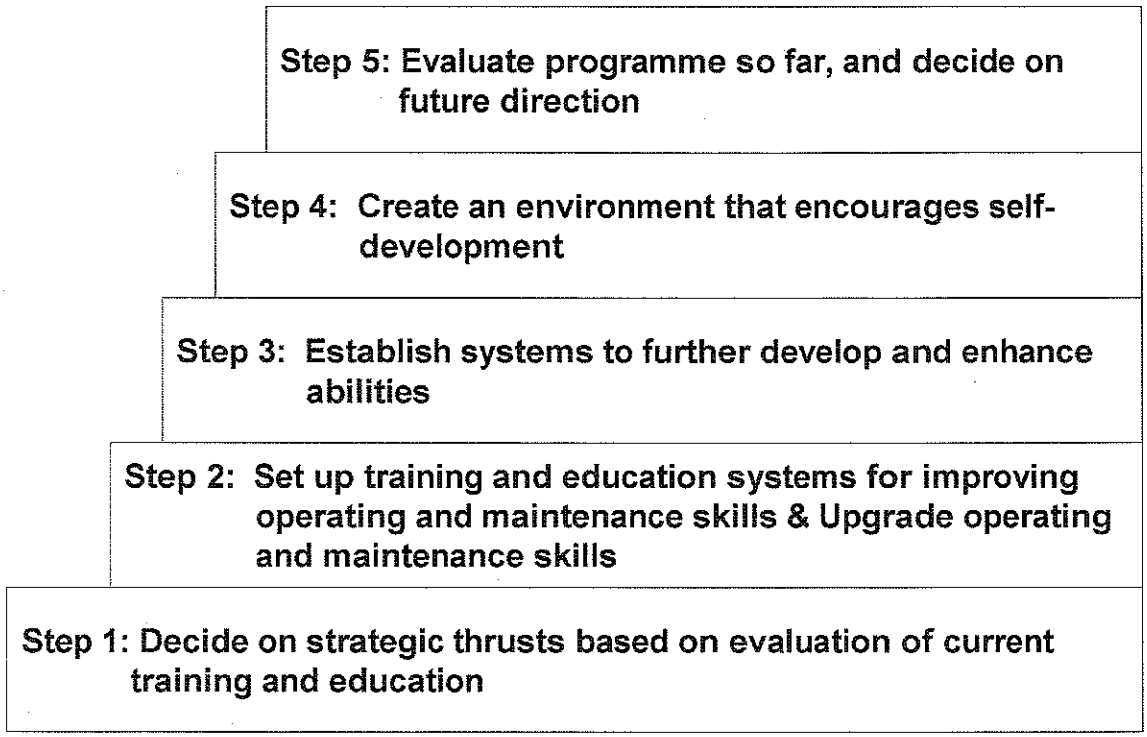
Skill Level 4 - Can perform the task confidently

Skill Level 5 - Can teach the task to others (has mastered)

Proposed TPM Rollout Schedule – 1



Proposed TPM Rollout Schedule - 2



An Example of a Training and Education Programme's Basic Policy, Goals and Strategic Thrusts

Basic Policy

'The basic policy for training and education in our factory is that improving everyone's individual abilities helps to improve the company's business results, as well as giving people a sense of pride and achievement in their work and daily lives. We will use on-the-job training and self-development, in conjunction with off-the-job training, to actively raise our levels of expert skills.'

Goals

1 Use the TPM programme to develop people who are highly competent at handling their equipment and performing administrative tasks.
2 Develop people capable of responding to the needs of the workplace over the long term.

Strategic Thrusts

To achieve these goals, we will review our existing training and implement the following strategic thrusts:

1 Develop people who understand their equipment extremely well
- Enable maintenance staff to acquire even greater skills and analytical strengths.
- Establish maintenance training curricula, and teach operators to know their equipment intimately.
- Develop specialised skills by sending people on courses run by outside organisations such as the JIPM.

2 Develop people who can perform their administrative duties extremely well
- Roll out the Jishu-Hozen steps and give training in automated office systems.

3 Establish skill upgrade programmes
Identify essential core skills in order to systematically develop people with a high level of competence in handling their equipment and performing administrative tasks.

CUDBAS 1

A Method of Curriculum Developing Based on Ability Structure

--- Prepare (Introduce Participants and Explain Rules) ---

Assemble five or six people who know the person whose job skills are being evaluated. They should be related to this person in various different ways (e.g. colleague, supervisor, trainer, manager, etc.).

Note:

1 All the members of the evaluating team have equal authority in the evaluation process.

2 No individual must be criticised or personally attacked.

3 All team members should work together to create a definitive list of skills.

4 People should be as flexible as possible in exchanging ideas and try to keep the quality of the discussion high.

--- First Meeting ---

Spend about ten minutes choosing which experienced worker to evaluate and discussing what he or she does. Making notes on a whiteboard can help people to visualise what they are talking about.

1 Define specifically what part of the person's job is to be evaluated.

2 Discuss the size of his workplace, the content of his job, and the position he holds.

CUDBAS 2

--- Individual Brainstorming (using cards) ---

Each team member then thinks about the following questions and fills in the answers on his or her cards. Then distribute 30 cards to each person. These cards are called 'ability cards'.

1 What must the experienced worker be able to do? ('Can .....')

2 What must the experienced worker know? ('Knows.....')

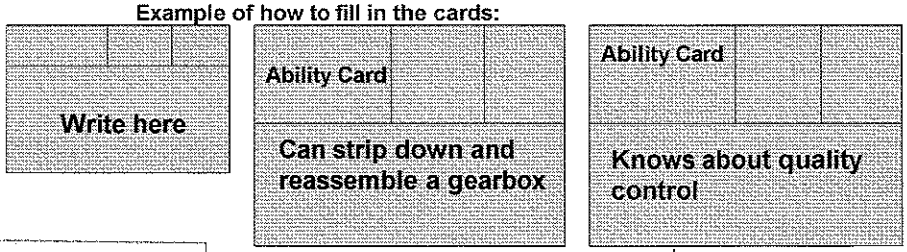
What attitudes (not personal character traits) must the experienced worker have? ('A/An.....attitude')

The participants should fill in the cards rapidly, without worrying about whether they are duplicating what another member of the team has written, because experience shows that under 10% of the contents of the cards will be duplicated. They should express themselves as clearly as possible and should aim to complete about 30 cards, so the whole exercise will take about 30 minutes if they work at the rate of one card per minute.

(The more cards they complete, the more difficult it will become to think of new things to write, but considering the following points will help to generate fresh ideas):

What skills are required: 1. In different situations? 2. At different times (morning, noon, evening, night?) 3. During different seasons (spring, summer, autumn, winter)? 4. On different occasions (busy, quiet, special events)? 5. During emergencies? 6. When dealing with different kinds of people?

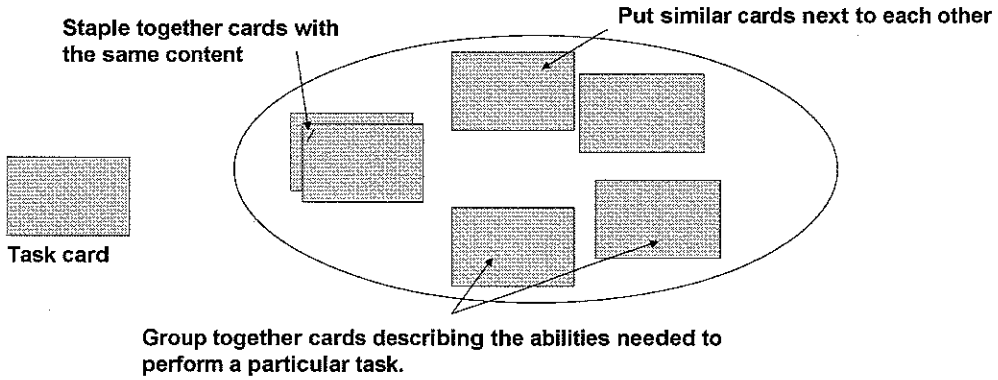
Example of how to fill in the cards:



CUDBAS 3

--- Sort the Cards ---

One participant starts placing his cards on the table while reading them aloud, putting any identical or similar cards in the same pile. Meanwhile, the other participants spread their cards on the table and add them to the appropriate piles. This continues until all the cards have been sorted (if a card is not quite the same as the others in a pile but is not so different as to merit a pile of its own, place it next to the pile). Check the cards in each pile from time to time, and place the one that describes the ability most accurately on top. If none of the cards really describes the ability accurately, write out a fresh one. Then check the top cards, and if they are satisfactory, staple the cards in each pile together. Next group the cards into 'tasks'. Each person's job will normally consist of 5-10 of these tasks. This will be possible if you visualise what the tasks are from the information on the cards, without being led astray by any preconceived notions. Then describe each task on a sticky note based on the descriptions on the cards in each group. These sticky notes are called 'task cards'.

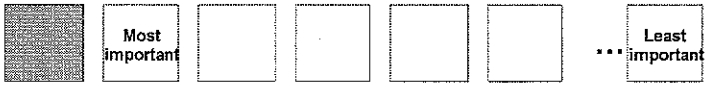


CUDBAS 4

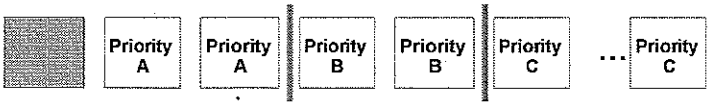
--- Prioritise the 'ability' cards ---

Place the ability cards for each task side by side, next to the task card on the far left.

Look at the ability cards again and rearrange them in order of importance from left to right (i.e. with the most important one on the far left and the least important on the far right).



Next, assign a priority ranking (A, B or C) to the ability cards. The best way of doing this is to place a pencil between one group and the next, as shown in the diagram.



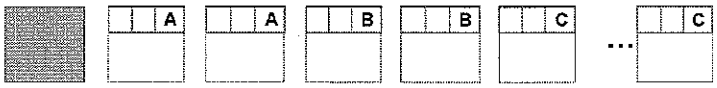
Use the following guidelines to decide on the priorities:

A: Extremely important and specialised. The worker must understand exactly what is required and be able to exercise the ability at the highest level.

B: Everyday ability of normal importance. The worker must have a good grasp of what is required and be able to exercise the ability reasonably well.

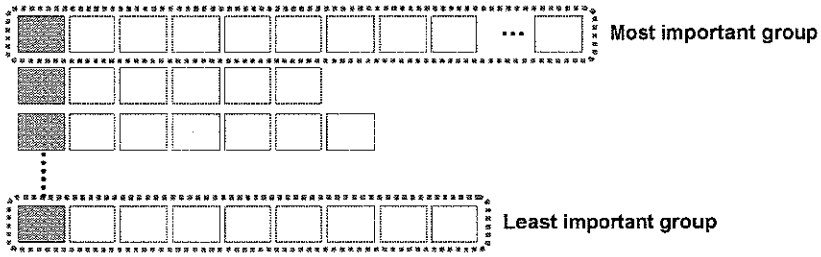
C: Not particularly important. The worker only needs to know more or less what is required and can acquire the ability through experience.

Note the priority (A, B or C) in the blank space provided for this purpose at the top right of each ability card.

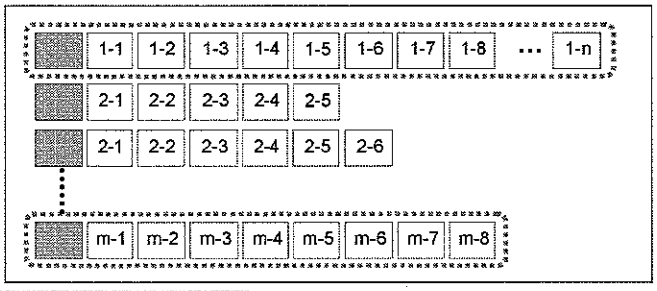


--- Prioritise the 'task' cards ---

The groups of cards, which are now laid out side by side, should next be arranged vertically. Compare the groups, and lay them out in order of importance from top to bottom (i.e. with the most important group at the top and the least important at the bottom)



When everyone has agreed that the cards have been laid out correctly, note the priority (A, B or C) in the blank space provided for this purpose at the top right of each task card. Finally, write the serial number in the space provided at the top centre of each ability card as shown in the following diagram:



CUDBAS: Carat of Essential Abilities and Qualities

Task	Ability 1	Ability 2	Ability 3	Ability 4	Ability 5	Ability 6	Ability 7	Ability 8
Finishing	1-1 A	1-2 A	1-3 A	1-4 A	1-5 A	1-6 A	1-7 A	1-8 A
	Can measure dimensions of fits (shrink fits and expansion fits) of machine parts	Knows how to assess whether parts are acceptable or not	Can select and use the appropriate jigs and measuring devices	Can measure dimensions with gauges and can set them to whatever the part is going to be used for	Can determine the correct sequence for dismantling and reassembling equipment by looking at the drawings	Knows about bearings and can fit and remove them correctly	Can strip down and reassemble rollers	Can dismantle and reassemble pumps
	1-11 A	1-12 A	1-13 A	1-14 A	1-15 A	1-16 A	1-17 B	1-18 B
	Can grind valves	Can strip down and reassemble gearboxes	Can service compressors	Can decide what action to take when something is wrong with the equipment	Knows the correct procedure for installing machinery	Can follow the correct procedure for servicing turbines	Can service heat exchangers	Can dismantle and reassemble pneumatic and hydraulic cylinders
	1-21 C	1-22 C	1-23 C					
	Can always work safely	Has a good knowledge of safety	Observes working regulations					
Controlling Quality	2-1 A	2-2 B	2-3 B	2-4 B				
	Feels responsible for the quality of his/her work	Knows about quality control	Can predict and anticipate quality problems	Can understand the assigned work targets				
Setting up Work Plans	3-1 A	3-2 A	3-3 A	3-4 A	3-5 A	3-6 B		
	Can carry out process control	Takes on the challenge of cost reduction and work improvement	Can improve the efficiency and reduce the costs of certain tasks	Can allocate personnel appropriately	Can make the necessary arrangements for jobs to be carried out			
	3-11 A							
	Can arrange for the necessary spare parts to be available							
Getting Work Done	4-1 A	4-2 A	4-3 A	4-4 B	4-5 B			
	Can get a team to work together	Can quickly think of ways to get things done	Gets people to understand what needs to be done					
Leading a Team	5-1 A	5-2						
	Is a good role model for his/her team							

Example of Skill Assessment

How to Assess Skills

Improve maintenance efficiency by identifying the levels of understanding and skill required by maintenance personnel, performing assessments, drawing up individual training plans, and systematically implementing these plans to raise each person's abilities.
Method of Assessment
Identify the required understanding and skills, and assess individuals
Assessment categories: Main categories: 10 Sub-categories: 29 Sub-sub-categories: 658 (knowledge 493, skill 165)
Assessment standard: Grade 2 Maintenance Practitioner level

Skill Assessment
● Skill Level 1 Does not even know the theory
△ Skill Level 2 Knows the theory
□ Skill Level 3 Can perform the task after a fashion
○ Skill Level 4 Can perform the task confidently
◎ Skill Level 5 Can teach the task to others

Job Category	Basic				Skill				Assembly					Hydraulics and Pneumatics						Drawings	Cleaning	Peripheral Equipment		Other			Consumable Parts		Safety	Score (max: 29)	
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	Understanding	Skill
Item Assessee's name	Understanding and handling of tools	Understanding and handling of nuts and bolts	Understanding and handling of keys	Understanding about and knowing how to secure bosses on shafts	Understanding and skill at marking out	Understanding and skill at filing	Understanding and skill at grinding	Understanding and skill at welding	Understanding and handling of cams, ratchets, and levers	Understanding and handling of racks, pinions and gears	Understanding and handling of clutches and brakes	Understanding, assembling and adjusting special-purpose machines	Ability to assess and deal with sudden breakdowns	Understanding and handling of speed control, flow control and non-return valves	Understanding and handling of filter, regulator, lubricator sets	Understanding and handling of solenoid valves	Understanding and handling of cylinders	Understanding and handling of hydraulic and pneumatic pipework and joints	Understanding of pneumatic circuit diagrams	Understanding of drawings	Understanding of lubrication	Understanding and handling of peripheral equipment	Understanding and handling of measuring instruments	Understanding and handling of motors and gearboxes	Understanding and handling of drive pumps and hydraulic pumps	Understanding and handling of parts feeders and table feeders	Understanding and handling of bearings	Understanding and handling of O-rings and packing	Safety awareness and understanding		
Kana	○	○	□	□	○	□	□	□	○	○	△	□	○	○	○	○	○	○	○	○	△	●	○	△	□	□	□	△	○	24	19
Nagata	○	○	□	△	○	□	□	□	○	△	△	△	△	○	○	○	○	○	○	○	△	○	△	△	△	□	□	△	○	19	25
Yamamoto	○	○	□	△	○	△	△	△	○	△	△	△	△	△	△	△	△	△	△	○	△	●	○	△	●	●	□	△	○	9	24
Iwatsuki	○	○	△	□	○	□	□	□	○	○	△	△	○	○	○	○	○	○	○	○	□	●	○	□	□	□	□	△	○	24	19
Miyazaki	○	○	□	△	○	□	□	□	○	○	□	△	△	○	○	○	○	○	○	○	△	●	△	△	●	□	□	△	○	20	20
Yoshikawa	○	○	□	△	○	●	●	○	□	□	○	△	△	△	○	○	○	△	△	○	△	●	△	△	●	●	●	●	○	13	19
Saito	△	△	△	●	△	●	●	△	●	△	△	●	△	●	●	●	●	●	●	□	●	●	●	●	●	●	●	●	○	2	9
Kato	○	○	□	□	○	●	●	○	△	□	△	●	△	△	△	△	△	●	●	○	△	●	△	●	●	●	●	△	○	9	16
Kurono	○	○	△	△	○	○	○	△	□	□	○	△	△	△	△	△	△	△	△	○	□	○	○	△	△	●	○	△	○	14	26

Example of Skill Assessment

Category and content	Understanding or Skill	No.	Sub-category / Sub-sub-category
		2	Sub-category: Understanding and handling of nuts and bolts
		No.	Sub-sub-category
Systems	Understanding	1	Knows the differences between ISO and JIS standards
	Understanding	2	Knows the various types of nuts and bolts
	Understanding	3	Knows the different uses for the various types of nuts and bolts
	Understanding	4	Knows what size, pitch and lead mean
	Understanding	5	Understands the standards and uses of fine screw threads
	Understanding	6	Knows the various types and uses of pipe thread, trapezoid thread and square thread
	Skill	19	Can correctly tighten the different sizes and types of bolts
	Skill	20	Can make and use slotted nuts to prevent loosening
	Skill	21	Can correctly fit wire stoppers
	Skill	22	Can take steps to prevent nuts and bolts from seizing up

Category and content	Understanding or Skill	No.	Sub-category / Sub-sub-category
		16	Sub-category: Understanding and handling of solenoid valves
		No.	Sub-sub-category
Systems	Understanding	1	Knows the symbols for solenoid valves on pneumatic circuit diagrams
	Understanding	2	Understands the workings and details of solenoid valves
	Understanding	3	Knows about different spool types and their uses
	Understanding	4	Knows about different poppet types and their uses
	Understanding	5	Knows what a single solenoid should be used for
	Understanding	6	Knows what a double solenoid should be used for
Applications	Skill	21	Can deal with spool misalignment and O-ring damage in a spool-type solenoid valve
	Skill	22	Knows how to remove solenoid valves without letting dust or debris get in
	Skill	23	Knows how to remove oil from solenoid valves' exhaust ports
	Skill	24	Knows how to reduce the exhaust noise made by solenoid valves

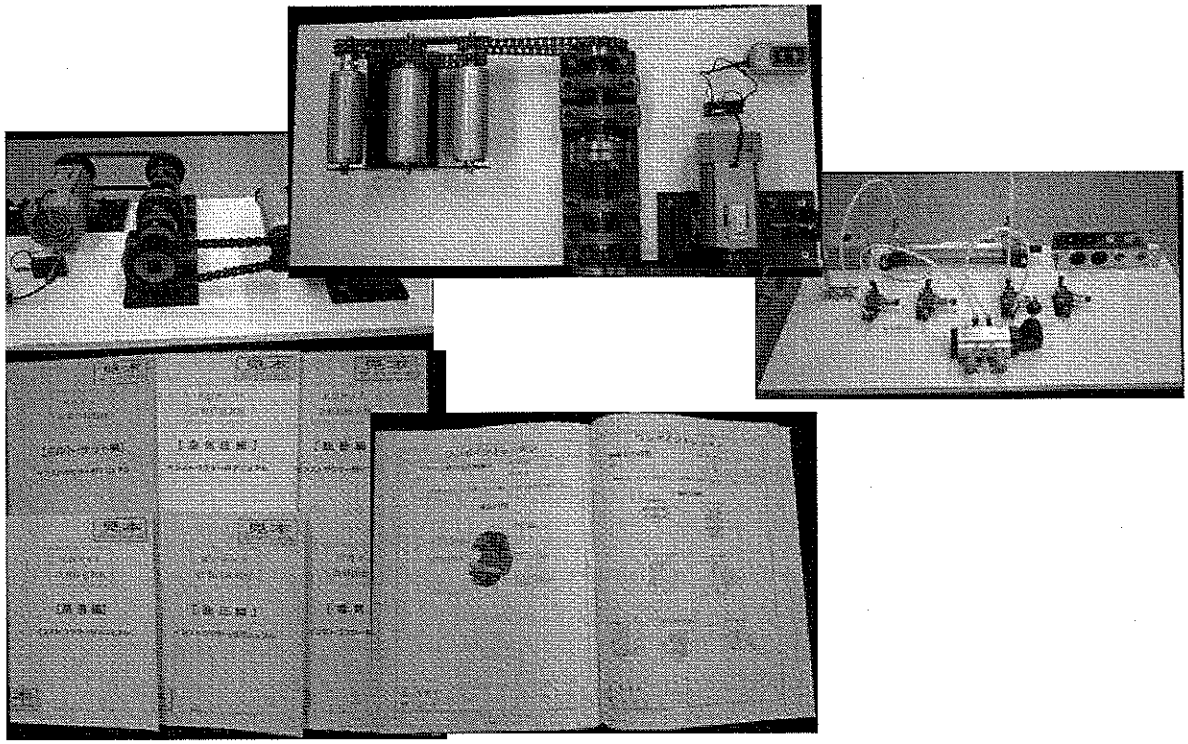
Basic Machine Maintenance Course Curriculum

Module	Content (3 Days per Module)	Objectives
Module 1	**Aims** Acquire practical and theoretical knowledge of the correct way to tighten and lock nuts and bolts	
	* Opening Ceremony. * Module 1 orientation. * Self-evaluation test / model answers / explanation. * Marking, drilling and tapping steel plate. * Principles and correct torques for tightening bolts. * Using a torque wrench to tighten nuts and bolts correctly. * Theory and practice of locking nuts and bolts. * Theory and practice of Heliserts / tapping / strength testing. * Understanding and using standard symbols for metals. * Review of Module 1 / questions and answers / comprehension test.	Understand the relationship between tightening mechanisms, tightening force and torque for tightening nuts and bolts. Mark out, drill and tap 16 holes in steel plate for bolts of 5 different sizes. Learn how to tighten bolts correctly by using a torque wrench to tighten the bolts with the appropriate torque for their size and strength. Compare the results obtained by the usual 'tightening by feel' approach with those obtained by the correct method. Learn the correct use of tools and tapping techniques for softer materials by tapping a piece of bakelite, inserting a Helisert, and performing a strength test.
Module 2	**Aims** Acquire basic practical and theoretical knowledge of keys, anti-friction bearings, and fitting techniques	
	* Module 2 orientation. * Questions and answers about Module 1, and review of comprehension test. * Theory of fitting and dimensional tolerances. * Theory, correct handling and use of measuring tools. * Filing a surface flat (including filing techniques and use of surface plates and marking compound). * Key fitting (theory and practice, using tapered keys). * Assessment of quality of fit by measuring key extraction torque. * Shrink fitting (theory and practice, using anti-friction bearings). * Basic theory and correct handling of anti-friction bearings. * Review of Module 2 / questions and answers / comprehension test.	Understand the different types, standards and characteristics of keys. Learn how to use a file correctly, and practise by fitting keys (assess quality of fit by measuring torque required to extract key). Shrink-fit six typical anti-friction bearings to shafts (measure dimensions of shafts and bearings, check expansion and interference, and calculate required heating temperatures). Understand the fitting of bearings to shafts and the life-expectancy of the parts, and how to select the correct fit for the size and nature of the load. Learn how to calculate the tolerances for fitting bearings onto shafts and into housings.

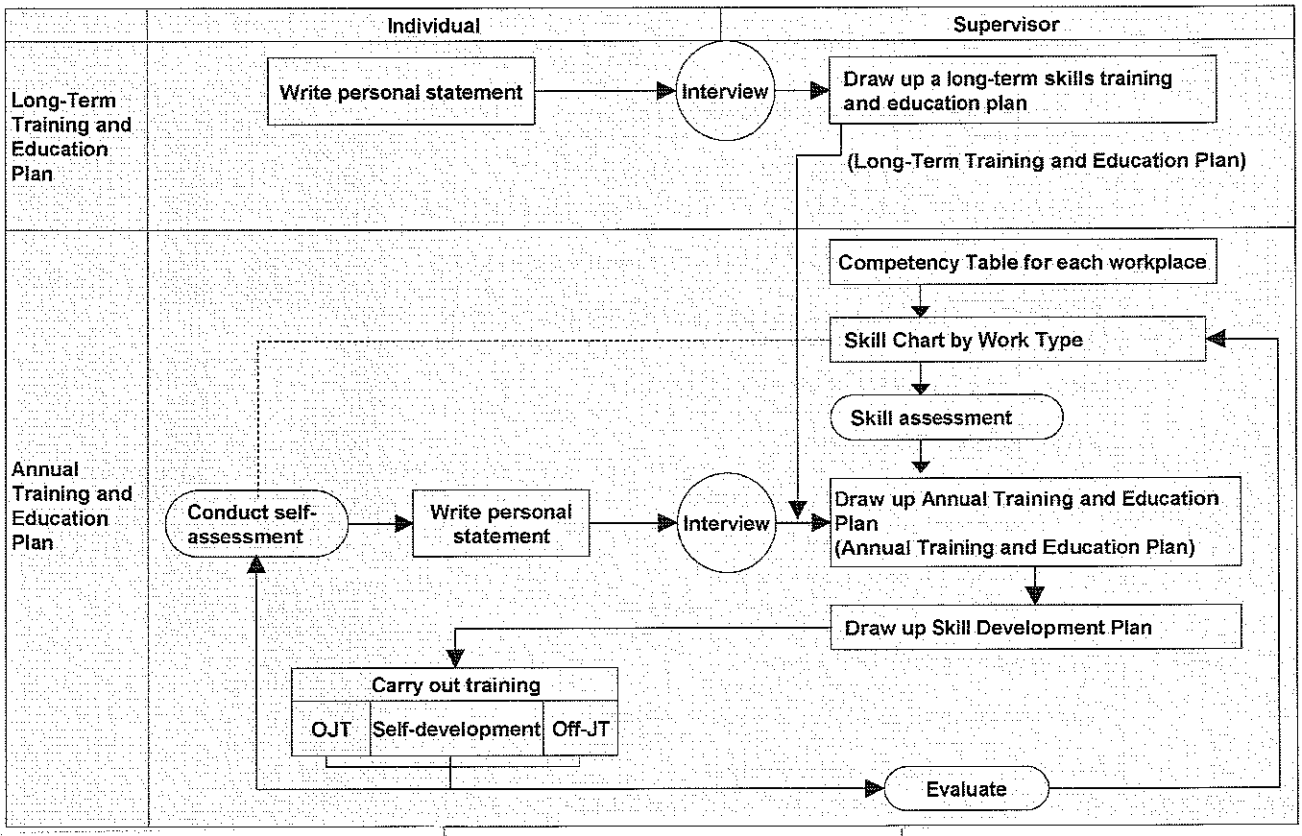
Basic Machine Maintenance Course Curriculum

Module	Content (3 Days per Module)	Objectives
Module 3	**Aims** Acquire practical and theoretical knowledge of failures and failure mechanisms in transmission systems, and how these relate to their assembly and lubrication conditions, using working simulation boards of anti-friction bearings, gears, V-belts, chains, etc.	
	* Module 3 orientation. * Questions and answers about Module 2, and review of comprehension test. * Assembling anti-friction bearings, and setting and measuring their initial internal clearances. * Theory and practice of installing, aligning and tensioning V-belts and chains. * Installing, measuring backlash and adjusting tooth contact of gears * Lecture by manufacturer on basic theory and practice of machine diagnosis. * Use of simple diagnostic devices to measure and assess vibration levels. * Measuring temperature, vibration and other characteristics of gears and anti-friction bearings during continuous running on a transmission simulation board. * Review of Module 3 / questions and answers / comprehension test.	Using a transmission simulation board, learn the knack of fitting and aligning anti-friction bearings, gears, V-pulleys, belts and chains on shafts; assembling anti-friction bearings and setting their internal clearance; tensioning chains and belts; adjusting gear backlash and tooth contact; etc. Learn the differences between the correct and incorrect handling of mechanical parts like these, and how these differences relate to the failure modes and mechanisms the parts exhibit (do this not just theoretically, but by actually measuring temperature, noise, vibration and other parameters after assembly).
Module 4	**Aims** Acquire practical and theoretical knowledge of hydraulics, pneumatics and seals. Understand the functions and structures of key hydraulic and pneumatic devices by making cutaway models.	
	* Module 4 orientation. * Questions and answers about Module 3, and review of comprehension test. * Principles and characteristics of pneumatic and hydraulic systems. * Applications, designs and functions of key hydraulic and pneumatic devices. * Construction of cutaway models and presentation to class. * Assembly and leak-testing of high-pressure piping. * Review of Module 4 / questions and answers / final test. * Closing ceremony and presentation of completion certificate, course memento and commemorative photograph.	Understand the design and function of key pneumatic and hydraulic devices. Understand the relationship between these devices and their standard symbols by examining basic circuit diagrams. Learn about the applications, standards and correct handling of O-rings, gaskets and other seals by constructing simple circuits using high-pressure tubing and parts. Raise awareness of the importance of preventing leaks by performing leak tests on these circuits using pressurised water. Construct cutaway models of devices (cut apart, file, reassemble and adjust, disassemble, paint, and reassemble again) and explain them, to gain a better understanding of their functions, designs and operating principles.

Upgrade Operating and Maintenance Skills



Example of Training and Education System



Competency Table

Department	Factory - Production Section - Finishing	Type of Work	Assembly

*Any changes to the contents of this table must be registered with the Training Department

	Skill	Details	
1	Understanding drawings	Can check dimensions, position and orientation of parts	
2	Understanding drawings	Can distinguish the parts and materials to be used in an assembly	
3	Measuring dimensions	Can measure parts using scales, calipers and micrometers	
4	Lubrication	Understands lubricant types and standards and can lubricate in accordance with standards	

Skill Chart by Job Type

Factory - Production	Section - Finishing	Type of Work	Assembly

Knowledge, Technical Abilities, Qualification		Name	Yamaguchi				Fukuda			
		Marks attained					Marks attained			
Knowledge	Can look at an assembly drawing and understand the parts		1	2	3	4	1	2	3	4
	Can look at an assembly drawing and understand where the parts have to be fitted		1	2	3	4	1	2	3	4
	Can look at an assembly drawing and understand the orientations of the parts		1	2	3	4	1	2	3	4
	Can look at an assembly drawing and understand what jigs and tools are required to assemble the parts		1	2	3	4	1	2	3	4
	Knows the codes for the company's products		1	2	3	4	1	2	3	
	Understands the 6 Big Losses		1	2	3	4	1	2	3	
	Understands the daily production figures		1	2	3	4	1	2	3	
Skills			1	2	3	4	1	2		
	Can measure correctly to 0.05 mm with calipers		1	2	3	4	1			
	Can set the zero point on calipers		1	2	3	4	1			
	Can measure correctly to 0.01 mm with a micrometer		1	2	3	4				
	Can set the zero point on a micrometer		1	2	3					

Annual Ability Development and Training Plan

B. Skill Training Plan (Annual) - Example

	Main Subject	Subject	Level	How	Targets	By when	Progress Check
Year X	Basic skill at shop floor	Knowledge handling flammable materials	4 3 2 (1) 0	Comprehensive courses to obtain the certificate	4 (3) 2 1 0	End of August	*Good Progress
		Basic Maintenance sills	4 3 2 (1) 0	Attend maintenance training class (Knowledge)	4 (3) 2 1 0	End of December	*Plan to test & follow-up the knowledge obtained
	dd/mm/yy	Knowledge about Quality	4 3 (2) 1 0	Attend QC Training Class Teach Genba-Genbutsu	(4) 3 2 1 0	End of April	*Needs more strict attitude to quality *Needs "Re-do"
			4 3 2 1 0		4 3 2 1 0		
Year X	dd/mm/yy		4 3 2 1 0		4 3 2 1 0		
Skill Level	0. Do not know the theory 1. Knows the theory but cannot perform by oneself 2. Knows the theory and can perform 3. Can perform confidently						

Skill Training Plan

Skill Training Plan for Operators

Section	Finishing	Dept.	Production	Category	Assembly Work

	Subject	Name:		Nakajima		Smith			
		Trainer	Method	Date		Date		Date	
Knowledge									
Technique/Skill									

Subjects, Main Topics and Sub-Topics of Written Examination

Subjects and Main Topics of Practical Examination

Subject	Main Topic
1. Identifying Losses and Taking Action	1. Defining and Classifying Losses, Calculating OEE 2. Loss-Cost Tree 3. The Zero-Breakdown Philosophy 4. Calculating maintenance indicators 5. Evaluating cost-benefit
2. Training, Safety and Environment	1. One-Point Lessons 2. Safety Awareness Training 3. The 5 Ss 4. Safety, Health and Environment
3. Analytical Tools and Kaizen Know-How, and Tools for Supporting Jishu-Hozen	1. The 7 QC Tools 2. The QC Story 3. Why-Why Analysis 4. P-M Analysis 5. Industrial Engineering 6. Activity Boards 7. Use and Control of Hand Tools for Improvement
4. Detecting, Correcting and Sustaining	1. Sustaining Basic Conditions (Clean, Lubricated, Tight) 2. Jishu-Hozen Standards 3. Visual Control 4. Identifying Minor Equipment Defects
5. Maintenance Basics (Knowledge of Functions, Structures and Procedures Needed for Carrying Out Checking, Simple Repairs and Improvements)	1. Fasteners 2. Lubrication 3. Pneumatics 4. Hydraulics 5. Drives 6. Electrics 7. Measuring Instruments

Subjects, Main Topics and Sub-Topics of Written Examination

Subjects, Main Topics and Sub-Topics of Written Examination

Key:
N/A – not applicable
Overview – outline knowledge (true/false)
General – general knowledge (4-choice)
Detail – detailed knowledge (fill in the blanks)

Subject	Main Topic	No.	Sub-Topic	Grade 2	Grade 1
1. General Jishu-Hozen	A. The Basics of Jishu-Hozen	1	What is Jishu-Hozen?	General	Detail
		2	The Production and Maintenance Departments' Responsibilities		
		3	The Steps to Jishu-Hozen		
		4	Setting Objectives		
		5	The Keys to a Successful Rollout		
		6	Keeping Records of Activities		
		7	Time Required for Activities		
		8	Guidance on Working Safely		
		9	Team Activities		
	B. Tools for Supporting Jishu-Hozen	1	Tagging	General	Detail
		2	Activity Boards		
		3	One-Point Lessons		
		4	Team Meetings		
		5	Visual Control		
		6	Fixed-Point Photography		
2. Identifying Losses and Improving Efficiency	A. Basic TPM knowledge	1	Basic TPM Knowledge	Overview	General
	B. Overall Equipment Effectiveness	1	Overall Equipment ness		Detail
		2	Availability		
		3	Performance Rate		
		4	Quality Rate		
	C. Identifying Losses	1	The 8 Big Equipment Losses	Overview	Detail
		2	The 5 Big People-Related Losses		
		3	The 3 Big Resource Consumption Losses		
		4	Chronic Losses		
		5	Minor Equipment Defects		
		6	Restoration		
		7	The Zero Breakdown Philosophy		

Subjects, Main Topics and Sub-Topics of Written Examination

Subject	Main Topic	No.	Sub-Topic	Grade 2	Grade 1
3. Equipment Managment	A. Essential Equipment Management Terms	1	BM (Breakdown Maintenance)	Overview	General
		2	PM (Preventive Maintenance)		
		3	TBM (Time-Based Maintenance)		
		4	CBM (Condition-Based Maintenance)		
		5	PdM (Predictive Maintenance)	N/A	
		6	CM (Corrective Maintenance)		
		7	MP (Maintenance Prevention)		
	B. Essential Maintenance Terms	1	Forced and Natural Deterioration	Overview	Detail
		2	MP (Maintenance Prevention) Information		
		3	MTBF (Mean Time Between Failures)		
		4	MTTR (Mean Time To Repair)		
		5	Failure Mode		
		6	Failure Severity		General
		7	Failure Frequency		
		8	Bath-Tub Curve		
		9	LCC (Life-Cycle Costing)		
		10	Maintainability and Reliability		
		11	Failure Analysis		
		12	Failure Mechanism		
	C. What to Do when Equipment Fails	1	What to Do when Equipment Fails	Overview	Detail

Subjects, Main Topics and Sub-Topics of Written Examination

Subject	Main Topic	No.	Sub-Topic	Grade 2	Grade 1
4. Production Basics BASICS	A. Quality	1	Data Basics	General	Detail
		2	Cause-And-Effect Diagrams		
		3	Pareto Diagrams		
		4	Graphs And Charts		
		5	Checksheets		
		6	Histograms		
		7	Scatter Diagrams		
		8	Control Charts		
		9	Normal Distribution	Overview	
		10	Sampling Inspection		
		11	Work Standards		
		12	Sensory Testing		
		13	QC Process Charts		
		14	Standard Deviation		
		15	Process Capability	N/A	General
		16	ISO, JIS and other Standards		
	B. Cost	1	Cost Management	Overview	General
		2	Materials Costs		
		3	Conversion Costs		
		4	Overheads		
		5	Variable Costs		
		6	Fixed Costs		
		7	Labour Costs		
	C. Workplace Morale	1	The 5Ss	General	Detail
		2	Teamwork		
		3	Leadership	Overview	
	D. The Production Process	1	JIT (Just-In-Time)	N/A	General
		2	Lead Time		
		3	Inventory		
		4	Progress Control		
		5	Inventory Turnover Rate		
		6	Production Regimes		
		7	Production Scheduling		
		8	Progress Control		
		9	Work Control		
	E. Labour Management	1	Labour Management Basics	N/A	General
		2	Labour Legislation		

Subjects, Main Topics and Sub-Topics of Written Examination

Subject	Main Topic	No.	Sub-Topic	Grade 2	Grade 1
5. Training, Safety and Environment	A. Training and Development	1	Self-Development	General	General
		2	Skill Evaluation	Overview	
		3	Relay Teaching		
		4	On-the-Job Training		
		5	Off-the-Job Training		
	B. Health and Safety	1	Safety at Work	General	General
		2	Using Machine Tools Safely		
		3	Using Ancillary Equipment Safely		
		4	Using Conveying Equipment Safely		
		5	Using Electrical Equipment Safely		
		6	Handling Chemicals Safely		
		7	Safety Programmes and Emergency Action		
	C. Health and Safety Legislation	1	Health and Safety Legislation	Overview	General
	D. General Safety Terminology	1	Safety Awareness Training	General	General
		2	The Heinrich Principle		
		3	Near-Misses		
		4	Failsafing		
		5	Error-Proofing		
		6	Hand/Voice Confirmation Signals		
		7	Safety Patrols		
		8	Accident Frequency Rate		
		9	Accident Severity Rate		
	E. Environmental Awareness	1	Air Pollution	Overview	General
		2	Water Pollution		
		3	Noise Pollution		
		4	Vibration Pollution		
		5	Odour Pollution		
		6	Soil pollution		
		7	Waste Sorting and Disposal		
		8	The 3Rs (Reduce, Reuse, Recycle)		
		9	ISO 14000		
		10	Environmental Legislation		

Subjects, Main Topics and Sub-Topics of Written Examination

Subject	Main Topic	No.	Sub-Topic	Grade 2	Grade 1
6. Analytical Tools and Kaizen Know-how	A. Analysis and Improvement Techniques	1	Improvement Basics	General	Detail
		2	Why-Why Analysis		
		3	The QC Story		
		4	P-M Analysis	Overview	
		5	FTA (Fault Tree Analysis)		
		6	FMEA (Failure Mode and Effects Analysis)		
		7	IE (Industrial Engineering)		
	B. Tools and Materials	1	Boring Machines		General
		2	Milling Machines		
		3	Lathes		
		4	Grinders		
		5	Portable Power Tools		
		6	Shearing Machines		
		7	Hand Tools and Materials		
	C. Industrial Standards	1	Drawing Methods: * Projections and sectioning * Line types * Simplified representation of screws, gears, etc. * Dimensioning * Surface roughness and finish symbols * Processing method symbols * Welding symbols * Representation of flatness, rectangularity, etc.	N/A	Detail
		2	Symbols for Metals		
		3	Pneumatic and Hydraulic Symbols		
		4	Electrical Symbols		
		5	Terminology, Types and Classes of Systems of Fits		

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Subjects, Main Topics and Sub-Topics of Written Examination

Subject	Main Topic	No.	Sub-Topic	Grade 2	Grade 1
7. Detecting, Correcting and Sustaining	A. Initial Cleaning	1	The Purpose of Cleaning	General	Detail
		2	Preventing Forced Deterioration		
		3	Finding Hidden Defects		
		4	Restoring and Improving		
		5	Sustaining Basic Conditions (Cleanliness, Lubrication, Tightness)		
		6	Identifying Problems, Contamination Sources and Inaccessible Areas		
		7	Measuring the Benefits of Initial Cleaning	Overview	
	B. Tackling Contamination Sources and Hard-to-Access Areas	1	Tackling Contamination Sources	General	Detail
		2	Tackling Hard-to-Clean, Hard-to-Lubricate and Hard-to-Check Areas		
		3	Local, Minimized Covers		
		4	Quantifying Contamination Sources		
		5	Quantifying Hard-to-Access Areas		
		6	Measuring the Benefits of Countermeasures Against Contamination Sources and Hard-to-Access Areas	Overview	
	C. Formulating Provisional Jishu-Hozen Standards	1	Locations, Methods and Assessment Criteria for Cleaning and Checking	General	Detail
		2	Cleaning and Checking Intervals		
		3	Setting Cleaning and Checking Target Times		
		4	Lubrication Locations, Types, Quantities, Tools and Intervals		
		5	Finding and Solving Lubrication Problems		
		6	Drafting Provisional Jishu-Hozen Standards and Measuring the Benefits	Overview	

Subjects, Main Topics and Sub-Topics of Written Examination

Subject	Main Topic	No.	Sub-Topic	Grade 2	Grade 1
8. Maintenance Basics (Knowledge of Functions, Structures and Procedures Needed for Carrying Out Checking, Simple Repairs and Improvements)	A. Basic Checking	1	Purpose of Checking	General	Detail
		2	Checking Times		
		3	Detecting and Rectifying Abnormalities		
		4	Manuals	Overview	
		5	Checksheets		
		6	Units		
		7	Skill Checks		
		8	5-Senses Checking		
	B. Fasteners	1	Fasteners in General	General	Detail
		2	Functions of Threaded Fasteners		
		3	Types of Threaded Fasteners		
		4	Deterioration of Threaded Fasteners		
		5	Standard Tightening Torques		
		6	Tightening		
		7	Locking Techniques		
		8	Matchmarks		
		9	Measuring Instruments and Techniques		
	C. Lubrication	1	The Function of Lubrication	General	Detail
		2	Lubricant Types		
		3	Deterioration of Lubricants	Overview	
		4	Inspection of Lubricating Apparatus		
		5	Lubrication Conditions		
		6	Leaking Pipework		
		7	Coolant		
		8	Measuring Instruments and Techniques		
	D. Pneumatics	1	Features of Pneumatic Systems	General	Detail
		2	Types of Pneumatic Device		
		3	Deterioration of Pneumatic Devices	Overview	
		4	Checking of Pneumatic Devices		
		5	Maintenance of Pneumatic Devices		
		6	Air Leaks		
		7	Pneumatic Circuits		
		8	Measuring Instruments and Techniques		

Subjects, Main Topics and Sub-Topics of Written Examination

Subject	Main Topic	No.	Sub-Topic	Grade 2	Grade 1
8. Maintenance Basics (Knowledge of Functions, Structures and Procedures Needed for Carrying Out Checking, Simple Repairs and Improvements)	E. Hydraulics	1	Features of Hydraulic Systems	Overview	Detail
		2	Types of Hydraulic Device		
		3	Deterioration of Hydraulic Devices		
		4	Checking of Hydraulic Devices		
		5	Maintenance of Hydraulic Devices		
		6	Hydraulic Fluid Leaks		
		7	Hydraulic Circuits		
		8	Measuring Instruments and Techniques		
	F. Drives	1	Features of Drive Systems	General	Detail
		2	Types of Drive and Transmission		
		3	Deterioration of Drives and Transmissions		
		4	Checking of Drives and Transmissions		
		5	Maintenance of Drives and Transmissions		
		6	Measuring Instruments and Techniques		
	G. Electrics	1	Function of Electricity	General	Detail
		2	Types of Electrical Device		
		3	Deterioration of Electrical Devices	Overview	
		4	Deterioration of Sensors		
		5	Maintenance of Electrical Devices		
		6	Maintenance of Sensors		
		7	Measuring Instruments and Techniques		
	H. Process Conditions	1	Controlling Process Conditions	General	Detail
	I. Autonomous Checking	1	Identifying and Improving Hard-to-Check Areas	General	Detail
		2	Converting Provisional Standards into Definitive Standards	Overview	
		3	Preparing an Jishu-Hozen Calendar		
		4	Measuring the Benefits of Autonomous Checking		
		5	Reviewing Division of Responsibility between Operating and Maintenance Departments	N/A	General

Example from Engine Production Dept. at M Co.

The requirements for operations engineers, specialist engineers and managers were identified, and training is being carried out systematically in line with the following plan.

Basic development requirements

Developing self-managing operations engineers

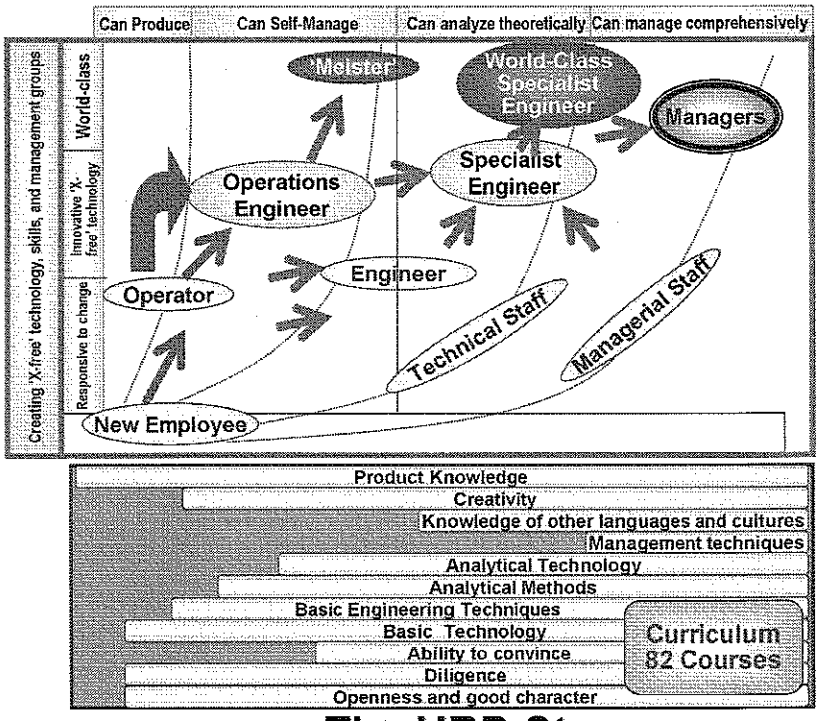
1. Can produce to QCD requirements
2. Can control and maintain equipment and quality
3. Can make creative, intelligent improvements

Developing specialist engineers capable of developing 'X-free' technologies

1. Can understand the physical mechanisms of what is happening (on the spot, with the actual objects involved) and can utilise problem-solving techniques ly
2. Can eliminate engineering bottlenecks by discovering 'X-free' technologies

Developing managers capable of rapid, accurate leadership

1. Can articulate a vision and make it happen
2. Can predict technological shifts and direct their teams appropriately



The HRD Steps

Training and Education KPIs

One way of judging the ness of a company's training and education programme is by the number of external qualifications its employees have acquired. Some other possible methods are given in the table

Training and Education KPIs
■ Total number of people holding National Vocational Qualifications or other external qualifications
■ Number of people holding qualifications, as a percentage of number of people planned to obtain qualifications (qualification attainment rate)
■ Number of graduates of internal training courses (%)
■ Number of graduates of external training courses
■ Number of people with maintenance skills qualifications
■ Number of people with other skills qualifications
■ Number of one-point lessons prepared
■ Number of one-point lessons taught
■ Total training hours
■ Number of subjects taught
■ Number of operating procedures written
■ Number of QC process charts prepared

TPM Manual
Chapter 9
Office TPM
(TPM in Administrative and Support Dept.)

JIPM-Solutions Co. Ltd.

A TPM System for Administrative and Support Departments

Definition of Administrative and Support Departments

◆ **Administrative and support departments' means all departments apart from those directly involved in production.**

(Example)

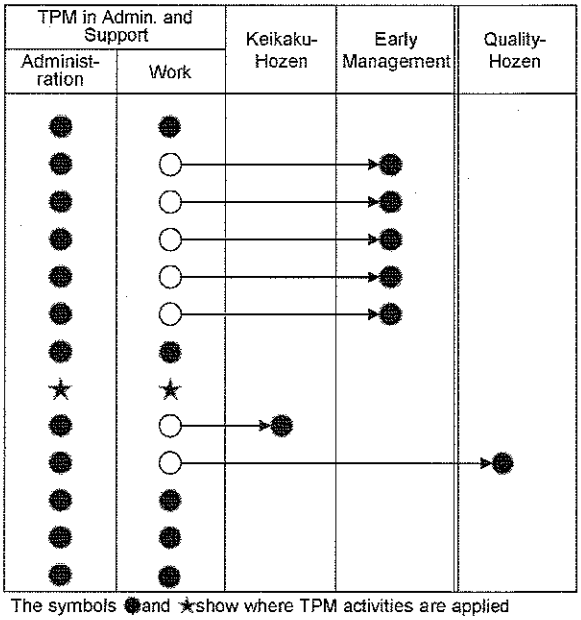
Business Process

Administrative and support:
1. Marketing and Market Research
2. Research and Development
3. Planning (Product / Equipment)
4. Design (Product / Equipment)
5. Prototyping and Testing
6. Pre-Production (Production Engineering)
7. Purchasing (Strategy and Procurement)

8. Production and ★Production Control

Administrative:
9. Maintenance
10. Inspection and Quality Assurance
11. Distribution
12. Sales and Service

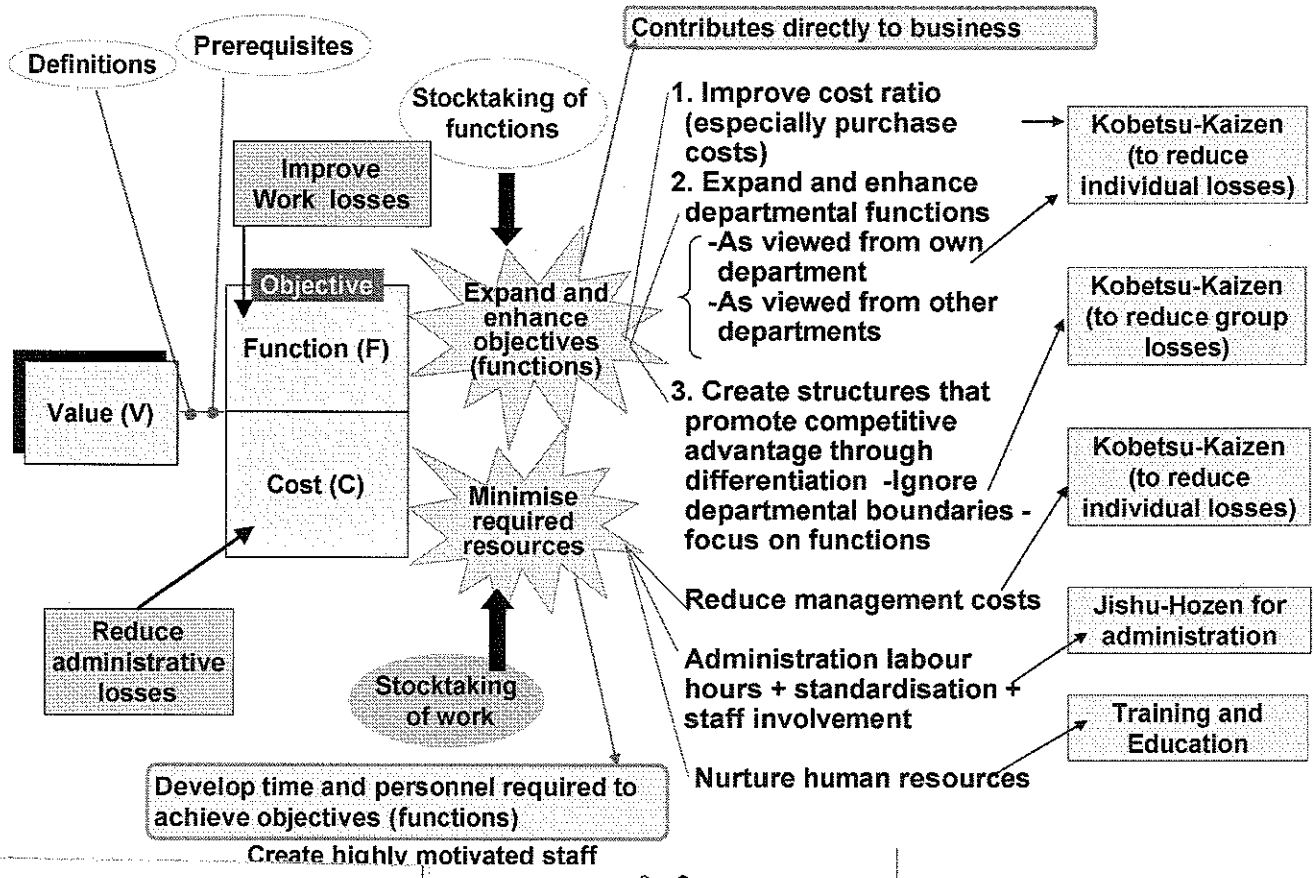
13. Personnel and Finance



The symbols ● and ★ show where TPM activities are applied

*** Office TPM means TPM undertaken by non-production staff. In the chart above, the symbols ● and ○ indicate the processes where these activities are implemented. Activities are applied either to administrative functions or to core work functions. However, Keikaku-Hozen, Early Management and Quality-Hozen are core work functions themselves, and activities related to these are therefore excluded from the TPM system for administrative and support departments.**

System of Office TPM (based on Value Engineering)



Setting up TPM Pillars in Administrative and Support Departments

Value Engineering - 3 main pillars (6 activities)

1. Jishu-Hozen → (Autonomous Maintenance)

(1) Create basic system and culture
- -Environment (hardware): stress-free office environment
- -Functions (software): standardised administrative tasks, with zero defects and zero losses

2. Kobetsu-Kaizen → (Focused Improvement)

(2) Improve cost ratio
- -Eradicate any imbalances in ratio of costs to sales revenue, [e.g.] ratio of material costs to sales revenue
- -Achieve costs that give competitive edge in the market, [e.g.] target costs

(3) Expand and enhance departmental functions
- -Contribute to the bottom line by restructuring administrative system and functions in your own department, as part of the overall business strategy,
- [e.g.] * Production control that achieves zero over-production
  * Procurement system that achieves zero over-buying
  * Purchasing merely for procurement → Strategic purchasing
  * Passive marketing→ Proactive marketing
  * Bean-counting → Intelligent accounting

(4) Create structures that promote competitive advantage through differentiation
- -Construct new and innovative interdepartmental work processes to achieve the speed of response essential for differentiating the company from other firms,
- [e.g.] * Production and marketing systems for eliminating missed opportunities
  * Forecasting systems for predicting uncertain demand and taking appropriate decisions
  * Business management systems for maximising cash flow

(5) Reduce management costs (departmental operating costs)
- -Correct any imbalances in the ratio of operating costs (staff costs) to sales revenue by, for example, outsourcing or restructuring

3. Training & Education→

(6) Nurture human resources
- -Give training in basic skills and multiple competencies
- -Develop fields of expertise and specialisation, and create 'office professionals'

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The Difference between Administration and Core Work

'Administration'

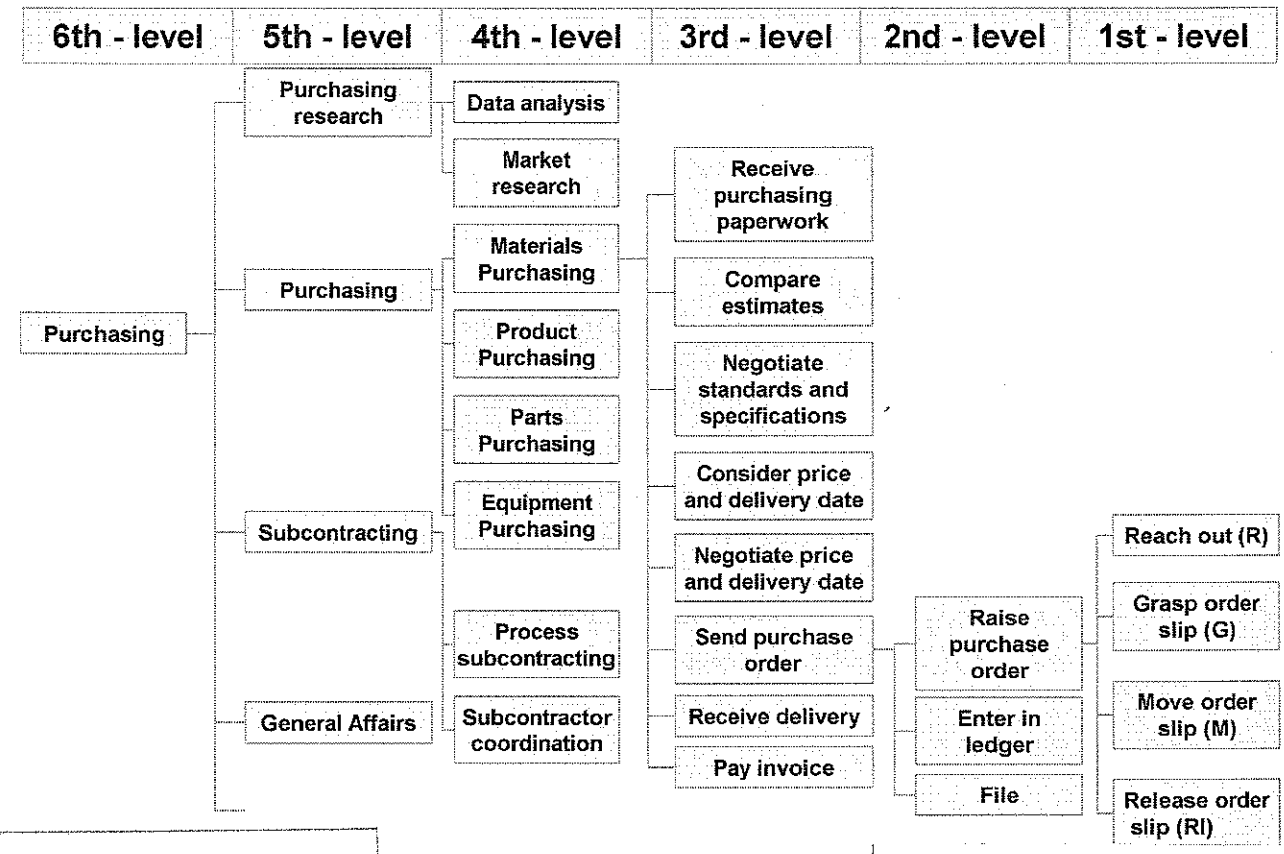
- means job inputs – information processing functions, such as reading, writing and calculating
- is expected to generate efficient inputs
- relates to third-level or fourth-level work units (WU)

'Core Work'

- means job outputs – business functions

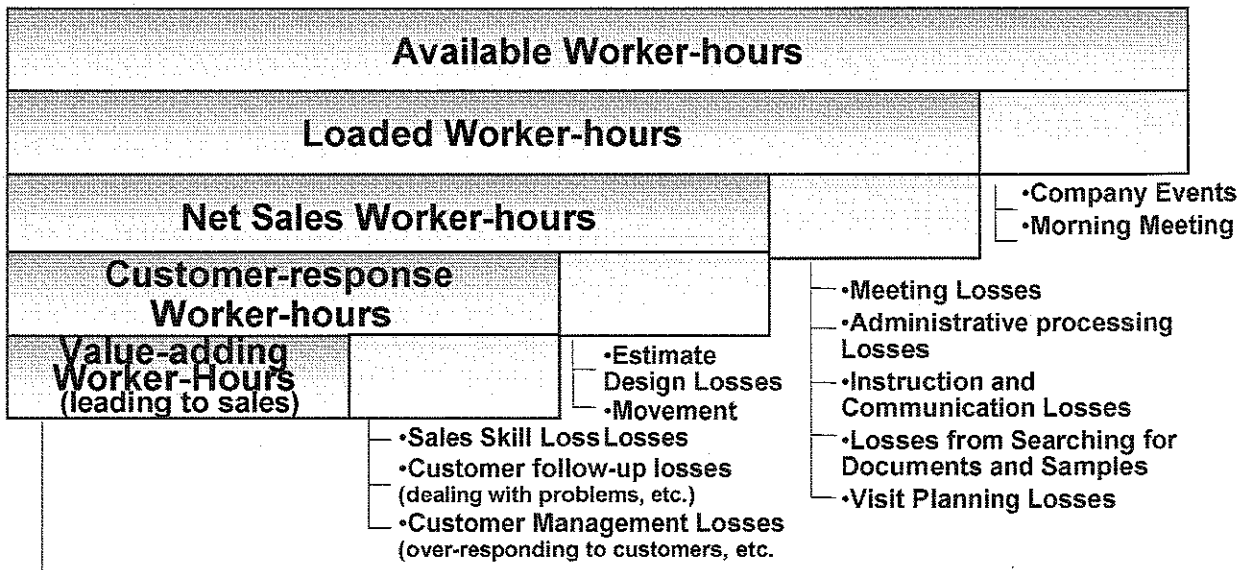
  (e.g. achieving target purchasing costs, and always purchasing exactly what is needed)
- is expected to generate profitable out puts
- relates to fifth-level or sixth-level work units (WU)

Typical Structure of Work Units



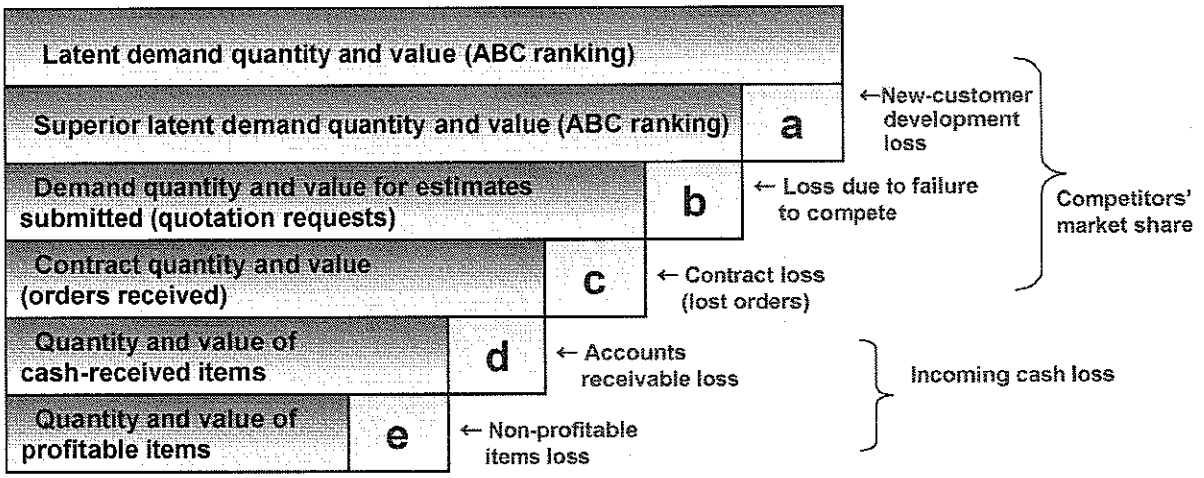
Administrative Loss Example: How Administrative Losses in Sales Activities Can Be Structured

Own Department's sales-activity loss structure



Remarks: There are other type of losses influencing other departments. Losses influencing Production Planning, Inventory, New Product Design and etc. result in big cash losses.

Core-Work Loss Example: How Core-Work Losses in Sales Activities Can Be Structured



Corresponds to utilisation loss

- ◆ Demand promotion loss → No request for quotation even after four sales calls
- ◆ Loss due to failure to compete → Quotation requested but no quotation or samples submitted; company did not compete for order
- ◆ Contract Loss → Quotation, samples, etc. were submitted, but no contract was obtained Reasons for contract losses include high selling price, insufficiently attractive product, failure to develop essential technologies, and lack of communication
  - New-customer loss (romantic rejection)
  - Repeater loss (unfaithfulness)
  - Loss of long-established customer (divorce)
- ◆ Accounts receivable loss → Quantity and value of products resulting in bad debts or payments unrecoverable by specified date
- ◆ Non-profitable item loss → Quantity and value of products sold at a loss or whose actual cost is less than the estimated cost

What Is Administrative Jishu-Hozen?

Establish basic conditions for administrative tasks currently performed within the department, and create standards for these tasks after eradicating all losses and irregularities through restoration and improvement.

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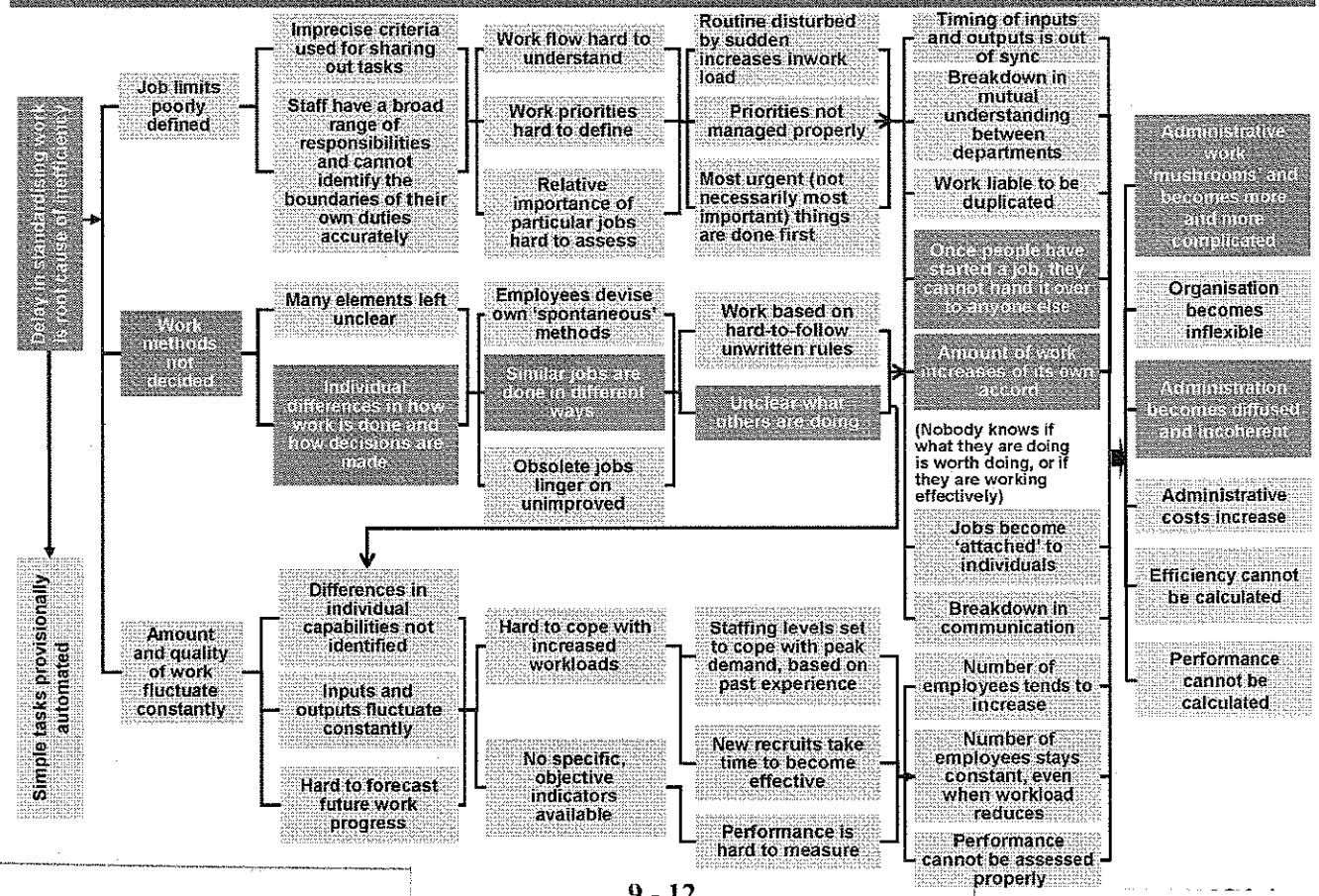
Programme for Rolling Out Administrative Jishu Hozen

Category	Step	Name		Activities	Objectives
Administrative Environment (physical surroundings)	1	Check and overhaul environment	Initial cleaning	•Remove unnecessary objects and sort out and organise furniture and fittings •Clean away all dust and dirt •Expose and correct defects by checking through cleaning (lighting, colour scheme, etc.)	•Demonstrate importance of 5 Ss •Train staff to recognise defects when they see them •Create bright and pleasant office environment by clearing away sources of worker fatigue
			Identify problems and implement countermeasures	•Identify and eliminate irregularities and losses relating to equipment, furniture, fittings, and operating methods •Identify and assess results of improvements •Establish filing systems and fix locations for them	•Pursue optimal conditions •Instil awareness of problems and how to spot them •Help staff learn ways to approach and effect improvements •Establish methods and procedures for measuring and calculating results
			Deal with sources of loss/waste and hard-to-access areas	•Take action to remedy sources of dirt, dust, and unnecessary items •Make areas more accessible for cleaning, etc. •Introduce visual controls •Compile history of improvement and confirm benefits	•Prevent office from slipping back into old ways, by making everything easy to see and action easy to take •Let staff appreciate the pleasure that can be gained from making improvements (get them to invent and make their own gadgets)
			Prepare standards and manuals	•Formulate action standards that allow cleaning, checking, sorting and organising activities to be sustained	•Staff aim to inculcate best practice by determining their own standards and rules
Administrative Functions (intangible aspects)	2	Perform administrative stocktaking		•Learn techniques for analysing administrative work •Quantify actual situation relating to administrative work in department (in terms of labour-hours) •Pick out 'worst' administrative tasks, set improvement targets and draft improvement plan	•Gain overall awareness of work system (work units) and volume of work •Identify characteristics of administrative work load •Identify how 'personalised' administrative tasks have become •Establish how to decide what the 'worst' tasks are •Determine priority for resolving tasks •Propose individual improvement plan for each employee
	3	Identify problems and implement countermeasures		•Confirm objectives and functions of administrative work •Use job analysis, administrative work flow analysis, Makigami Analysis, etc. to highlight (tag) weak spots •Expose administrative losses •Do improvement and confirm benefits	•Make employees aware of gaps between current and optimal situation and view them as obstacles that must be removed if the business objectives are to be achieved. •Help staff learn ways of thinking about and promoting improvement •Eradicate all administrative losses
	4	Deal with sources of problems		•Identify administrative problems arising in work that spans organisations or departments •Expose losses and take action •Pinpoint causes and set targets •Check results and take action to ensure they are sustained	•Optimise administration at business process level •Build system that prevents improvements from being reversed and results from being undermined •Build capacity to make improvements that traverse the whole organisation
	5	Prepare standards and manuals		•Establish administrative standards and regulations based on improvements, and set down in manuals •Assess how these standards, regulations and manuals work in practice	•Establish administrative standards and regulations, and create manuals for administrative practice •Aim to move beyond standardisation, towards inculcating best practice •Progress systematically towards multi-skilling
Physical Surroundings and Intangible Aspects	6	Perform comprehensive inspection		•Revise monitoring systems •Carry out comprehensive inspection with reference to administrative standards and administrative environment standards, and rectify deficiencies	•Create and apply systematic methods for monitoring administration •Ensure regulations and standards do not become fossilised or obsolete
	7	Fully self-manage		•Practice full self-management based on policies and objectives deployed from above, and cement it in place •Itemise individual skills and work towards multi-skilling and specialisation	•Combine Kobetsu-Kaizen and Jishu-Hozen activities to get the most out of individuals and teams •Ensure that auditing becomes standard practice

Characteristics and Potential Problems of Administrative Work



How Jishu-Hozen differs from Kobetsu-Kaizen in Administrative and Support Departments

Category	Method	Objectives	Means	Results
Administrative Kobetsu-Kaizen (Focused Improvement)	• Activities based on analysis of current situation (improvement through analysing status quo and deciding priorities)	• The objective of the activities are achieved by reaching the targets set for the improvement	• Analytical techniques	• Better administrative productivity • Increased efficiency and effectiveness
Administrative Jishu-Hozen (Autonomous Maintenance)	• Activates based on pursuing 'optimal conditions' (improvement to identify and rectify defects through cleaning and checking	• Eradicate every single defect and loss, and standardise administrative tasks	• Step-by-step procedure	• Workforce with excellent administrative skills • Better administrative productivity • Increase efficiency and effectiveness • Streamlined workplaces

◆Kobetsu-Kaizen: Helps to achieve administrative efficiency targets
◆Jishu-Hozen: Aims to crate workforce of excellent administrators, through standardisation of administrative tasks.

The 'Hard' Side of Office TPM

Focus of Activities

(1) Furniture and fittings:	Desks, chairs, lockers, shelves, office tools, etc.
(2) Office equipment:	Computers, photocopiers, fax machines, etc.
(3) Utilities:	Lighting, decoration, ventilation, air-conditioning, PA systems, etc.
(4) Layouts:	Fixed locations for each item, clearly indicated; passageways, time/space conditions (ergonomics), etc.
(5) Filing systems:	Filing for work in progress, document storage, archiving, etc.

* Ideally, filing should be tackled along with other hardware issues in Step 1

If activities like these, aimed at improving the 'hard', or tangible, side of things, engender the right organisation and culture, in which people are able to spot abnormalities or problems and deal with them promptly and effectively, then this will also give a great impetus to activities on the 'soft', or intangible, side, aimed at resolving work-related problems and achieving skill-related goals. This means that no corners can be cut – the activities should be implemented thoroughly and precisely, down to the last detail.

Metabolising the accepted wisdom creates the energy for evolution!

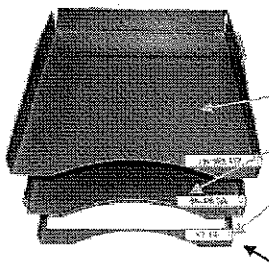
It takes more than conventional restorative activity to turn the company around!

Towards a paperless office: Useful hints

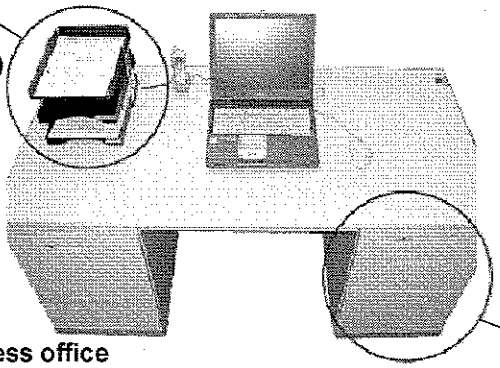
- All documents are kept in a file, tray or binder.

Tray System (Example)

- In : Post and circulars that have just come in
- Out: Finished jobs ready to be sent on / submitted.
- Pending: Jobs you cannot deal with immediately. Items you cannot file away because you are awaiting a reply, etc.



Tray system
(documents stored by day)



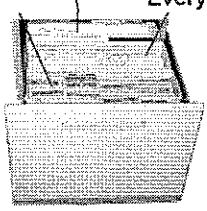
◆ Filing cabinet for reference (documents stored by month) and Filing cabinet for storage (documents stored by year)

- The current use cabinet will contain:

Ready reference data

Documents required for meetings

Everyday



Filing cabinet for current use (week units)

- Example of paperless office

My Documents			
My Documents	Name	Size	Type
	01	Current	File Folder
	02	Reference	File Folder
	03	Store	File Folder

01 Current			
01Current	Name	Size	Type
	Project_Smith & Co.		
	Info_Smith & Co.		

The 'Soft' Side of Office TPM

Here, we standardise administrative tasks from which administrative losses have been eliminated, restoring administrative functions, improving their quality and thereby increasing administrative reliability, as well as developing highly competent administrators

Focus of Activities

1. Overhaul Filing System

[Carry out in administrative environment (physical surroundings) step]

Ensure that documents, books, manuals, plans, drawings, computer files, catalogues, etc. are all sorted out, arranged properly, and effectively filed or archived. Establish a confidential file access system

2. Standardise Administration

Itemise departmental tasks, pick out the 'worst' ones, and improve them. Advance from standardisation of administrative tasks to 'professionalisation', where all staff automatically adopt good practice as a matter of routine. Balance workloads and develop multi-skilled office staff.

Example of Core work losses: Core Work Loss Structure in Sales

Administrative losses

- Losses in regular ordering
- Losses in special ordering
- Losses in chasing up deliveries
- Losses in replacing provisional tickets
- Losses in checking inventories
- Losses from conferences and meetings

The 7 Big Administrative Losses

- **Value losses**
  Tasks and procedures that are unused, little used or obsolete
- **Processing losses**
  Duplication, mistakes, rework, adjustment
- **Accuracy losses**
  Accuracy, reliability, degree of detail
- **Timing losses**
  Time required, timing
- **Idling losses**
  Waiting, travelling, searching
- **Communication losses**
  Transmission level, collaboration level, response level
- **Cost losses**
  Processing costs, use of money

Tips for tackling the administrative functions (the intangible aspect)

Step 2 Do Administrative Stocktaking

1. Sketch out administrative structure (tree diagram of work units)
2. Study manpower (labour-hours) required for third-level and fourth-level work units
3. Create bar graph of required labour-hours based on manpower study
4. Establish activity targets and identify 'worst' administration tasks
   'Worst 10'?
5. Draw up activities plan (master plan and action schedule)

Step 3 Identify Problems and Implement Countermeasures

-Use administration flow analysis and/or Makigami Analysis for the 'worst' tasks picked out in Step 2
-Tag any problems or doubts, then work to remove all the tags
  * Does not match objectives
  * Takes time and effort
  * Depends on individual know-how

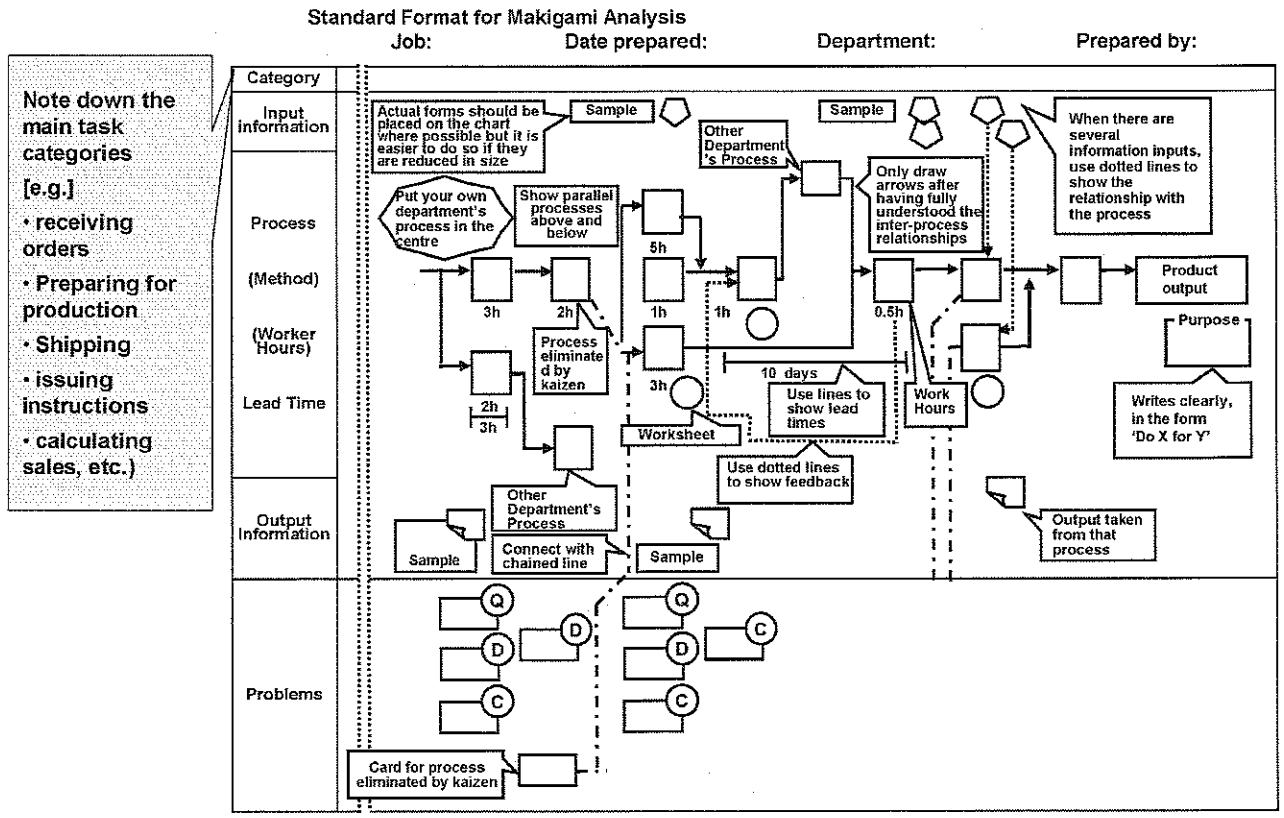
Step 4 Deal with the Sources of Problems

-Identify any factors that may undermine or reverse the improvements made in the 'worst' tasks (e.g. organisational or inter-departmental rules badly defined, or ignored). Take appropriate action.

Step 5 Prepare Standards and Manuals

-Create manuals for improved administrative tasks (standardise), and seek to inculcate best practice → multi-skilling
↓
Instil tasks as routine jobs that workers always do in the correct way

Standard Format for Makigami Analysis



What are Administrative Kobetsu-Kaizens (Focused Improvements)?

Administrative Kobetsu-Kaizen: Activities that make a direct contribution to the business by improving cost ratios and restructuring the work functions and work processes in administrative and support departments. In other words, activities aimed at building the ability to respond flexibly to market changes, and creating a structure that differentiates the company from its rivals and gives it a competitive advantage.

◆ Aim to restructure work functions and work systems
- IMPROVEMENT
- INNOVATION
- CREATION

◆ There are two types of Kobetsu-Kaizen

Kobetsu-Kaizen within department (Intra-Departmental)
⇩
<Eliminate individual losses>
[Strategy for Survival]
- Improve work functions and cost ratios within department (Pursue ideal conditions for internal work functions)
- Requires departmental perspective.
- Establish improvement topics directed at 5th-level work units

Kobetsu-Kaizen spanning departments (Inter-departmental)
⇩
<Eliminate system losses>
(Strategy for Winning)
- Rebuild interdepartmental work systems and structures (Work towards structure that promotes differentiation and competitive advantage)
- Requires company / factory perspective
- Establish improvement topics directed at 6th-level work units

The 4 Activity Topic Phases

Phase 4: Building a Structure for Differentiation and Competitive Advantage

Phase 3: Topics to do with addressing future issues

Phase 2: Topics to do with solving management system problems

Phase 1: Topics to do with solving production system problems

Topics to do with solving departmental (workplace) problems

Pursuing the ideal state of business functions — Kobetsu-Kaizen

Pursuing the ideal state of departmental functions — Jishu-Hozen

Examples of support for production

Production management
- Provide stable production plans and instructions with minimal sudden fluctuations and changeovers
- Speed up and automate production information processing (from planning to results)
- Increase accuracy of inventory control data and supply it in real time
- Prepare personnel deployment plans incorporating cost control functions

Sales and Purchasing
- Make production requests with few sudden changes or rush orders
- Secure accurate, timely information on orders received
- Prevent stockouts of purchased parts and materials

Administration and Control
- Reduce and eliminate data and documentation requirements
- Simplify and speed up procedures
- Provide rapid feedback of daily results data

SHE (Safety, Health and Environment)
- Institute hygienic control of shared facilities and areas
- Provide safe, clean, comfortable workplaces, and enhance disaster management systems
- Provide medical facilities

Implementing Administrative Kobetsu-Kaizens 1

1. **Improving cost ratios:**
   Through improvements aimed at eliminating losses, each expense element in the total cost will become smaller in ratio to the sales revenue. This reduction in costs helps to give better business results.

2. **Expanding and enhancing departmental functions:**
   Restructure the departmental work functions in line with future business strategy. Take the viewpoints of other departments into account when considering the optimal conditions for the work functions in your own department.

3. **Building a structure for differentiation and competitive advantage:**
   Construct innovative work processes that negate departmental boundaries, based on the quick-response strategy essential for differentiating the company form its competitors.

4. **Reducing managements costs:**
   Apply restructuring, outsourcing, etc. to eliminate losses due to imbalance in fixed costs (staff costs, departmental operating costs, etc.) versus sales revenue.

Implementing Administrative Kobetsu-Kaizens 2

$V = \frac{F}{C}$

- (1) Improve cost ratio ← Approach 1
- (2) Enhance and expand departmental functions ← Approach 2
  (Enhance and expand intra-departmental work functions)
- (3) Build structure for differentiation and advantage ← Approach 3
  (Innovation in inter-departmental work functions)
- (4) Reduce management costs ← Approach 4
- (Reduce administrative labour-hours and standardise administrative tasks ← ← Administrative Jishu-Hozen approach

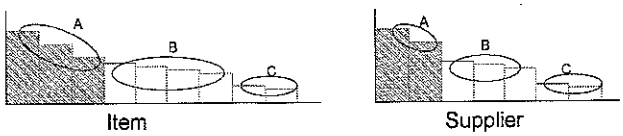
•In many cases, a combined approach is adopted for reducing both administrative labour-hours and management costs.

•V: Value, F:Function, C:Cost

Example of Approach: How to improve cost ratios

Step 1 | **Survey items, prices and quantities**

1. Confirm business requirements : Check business strategy, business goals and deadlines specified in mid-term business plans
2. Study purchasing (payment) records: * Analyse items, prices and quantities * Study amounts paid to each supplier or dealer
3. Clarify where improvements are to be targeted:
   * Apply ABC ranking to items
   * Apply ABC ranking to suppliers



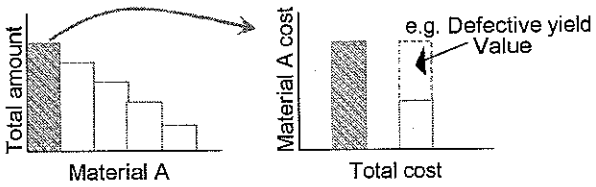
Item Supplier

Step 2 | **Establish business goals**

1. Establish secondary business goals: Break down the business goals on the basis of the ABC rankings from Step 1.
   (Example) Materials Costs -Cost of material a -Cost of material b -Cost of part c
   Distribution Costs -Delivery Costs -Transport Costs -Packaging/Shipping Costs

Step 3 | **Perform cost analysis and functional analysis**

1. Analyse 'value' and 'no value' elements of cost:
   Dissect costs to see what they are being spent on.



* How to identify 'no value' elements.
  1. Define 'no value' elements and find them
  2. Define 'value' elements and find them

Step 4 | **Select and register items for improvement**

1. Identify all the factors that make up the 'no value' elements (i.e. losses) discovered through the cost analysis and function analysis performed in the previous step, and register them as items for improvement.
   (Example) Distribution Costs → Delivery Costs, Transportation Costs; Delivery Costs → Delivery Losses → Delivery of urgent orders, Delivery of replacement articles, Inefficient loading, High contacted delivery costs
2. Identify all the factors that make up the 'value' elements (i.e. required functions), and register them as items for improvement.
   (Example) Metal castings → Make from sheet metal → Make from plastic
   Reduce number of components
3. Make a list of items for price reduction, from the ABC ranking of payments to suppliers created in Step 1.
4. Where necessary, carry out analysis to elucidate loss mechanisms, and select items to be combated as sources of loss.

Example of Approach: How to improve cost ratios (continued)

Step 5 | **Devise improvements**

1. Come up with improvement ideas for each item. To start with, identify where an improvement can be made (e.g. ask, "Couldn't we eliminate/reduce/change that?"), and then develop these thoughts into concrete improvement proposals.

2. Come up with improvement ideas by benchmarking other companies and items
   (Example) * Look at best practice in other companies (particularly the way they make things)
   * Disassemble and compare similar products made by other companies
   * Compare prices with other companies' prices and lowest industry prices

3. Create improvement schedule (with clearly visible 'milestones')

Step 6 | **Implement improvements and evaluate**

1. Implement improvements in your own department, other departments, suppliers, etc.
   Rigorously control the progress of improvements by means of intermediate targets and deadlines.
2. Compare the results with the objectives. If they fall short,
   repeat Steps 4 and 5.
3. Identify the proportion of improvement accounted for by cost reduction and by price reduction
   (is the improvement due almost entirely to price reduction, for example?)

Step 7 | **Consolidate gains and introduce MP**

1. Standardise:
   Create rules for sustaining the one-off results that have been achieved through improvement.
2. 'Professionalise':
   Make sure the standardised rules take root in everyone's daily work.
3. Move to Maintenance Prevention (MP):
   Ensure that the same improvements do not have to be repeated, by implementing complete and thorough systems for preventing losses and avoiding unnecessary functions in upstream work processes, (during design and development, when raising orders, etc.)

A Typical Programme for Enhancing and Expanding Departmental Functions (example of Approach 2)

Stage	Title of Activity	Contents	Key Points
1	Clarify what to work on	Evaluate work from the viewpoint of its expected results and contribution to business performance	1) Analyse current situation • Do complete breakdown of work units to gain overall understanding of work system and work volumes • Identify characteristics of work through workload analysis • Clarify all departmental costs 2) Study work requirements • Assess functional value of work • Introduce trade-offs and determine which tasks are necessary and which are not 3) Decide what to work on • List all unnecessary tasks, and take action to eliminate them • Determine priority order for improvement of necessary tasks
2	Identify problems and recognise structural relationships	Identify any disparities between the optimal and current situation as problems, and gain a structural view of the relationships involved	1) Apply function deployment analysis to work tasks, in order to identify problems 2) Use From-To Analysis to identify structural relationships of problems
3	Set improvement topics and priorities	Determine order of priority for improvements, based on different categories of topic	Individual topics are categorised according to their basic type, i.e. cultural/organisational-type improvements (for solving specific problems), or upgrading-type improvements (for addressing general issues), which tend to produce results at different speeds. An order of priority is then determined on the basis of these categories.
4	Establish basic improvement concepts	Set basic improvement directions, by highlighting the requirements and constraints in system design, relationships with other systems, etc.	1) Draw up structured programme for development of topics 2) Establish procedures for development of topics 3) Establish requirements / conditions for topics
5	Implement improvements	Monitor progress against topic implementation schedule, measure improvement results, and consolidate gains	1) Monitor progress of improvement activities 2) Measure improvement results 3) Follow up to ensure gains are locked into place

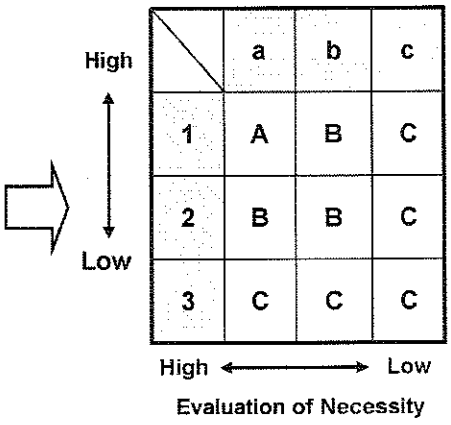
Step 1: Pursuing Value in Core Work (Evaluating the Need)

Contribution to factory results (helping to make the production system more efficient)

- Connection ..... Degree of relevance of task to business results
- Effect ..... Degree of influence of task on business results

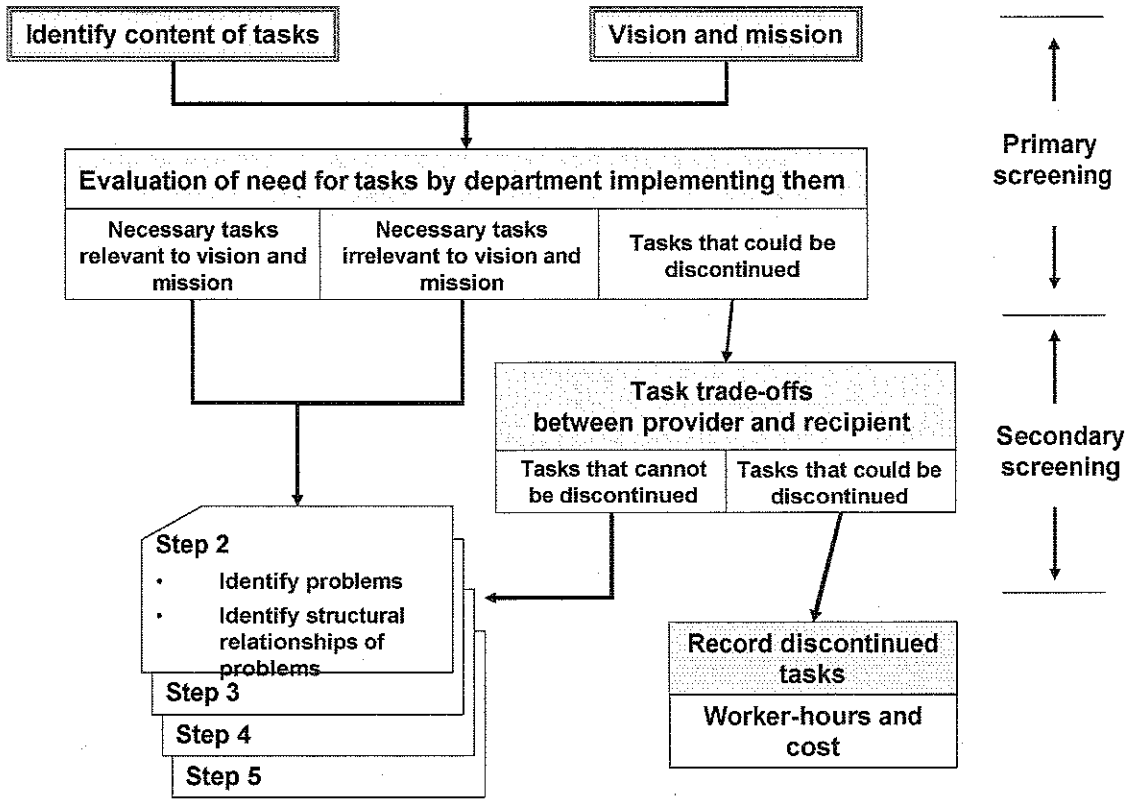
Functional value evaluation approach ..... 'Valuable work' is work that exerts a major influence on the production system (ask what would happen if the task were discontinued)

Connection with Business Results	Rank	Item evaluated
Connection	1	Necessary for company's competitiveness and corporate citizenship Essential part of business activities Should be discontinued, but cannot do so yet
	2	Probably necessary Cause for concern if discontinued Inconvenient if discontinued
	3	No problem if discontinued Irrelevant Could discontinue if instructed to do so
Effect	a	Has an immediate impact Has a gradual impact
	b	Probably has an impact Has a long-term impact
	c	Irrelevant Is convenient, but has no impact



A: Indispensable (corporate business function would stop)
B: Necessary (between A and C) (departmental function would stop)
C: Unnecessary (individual's function would stop)

The Task Trade-Off Approach

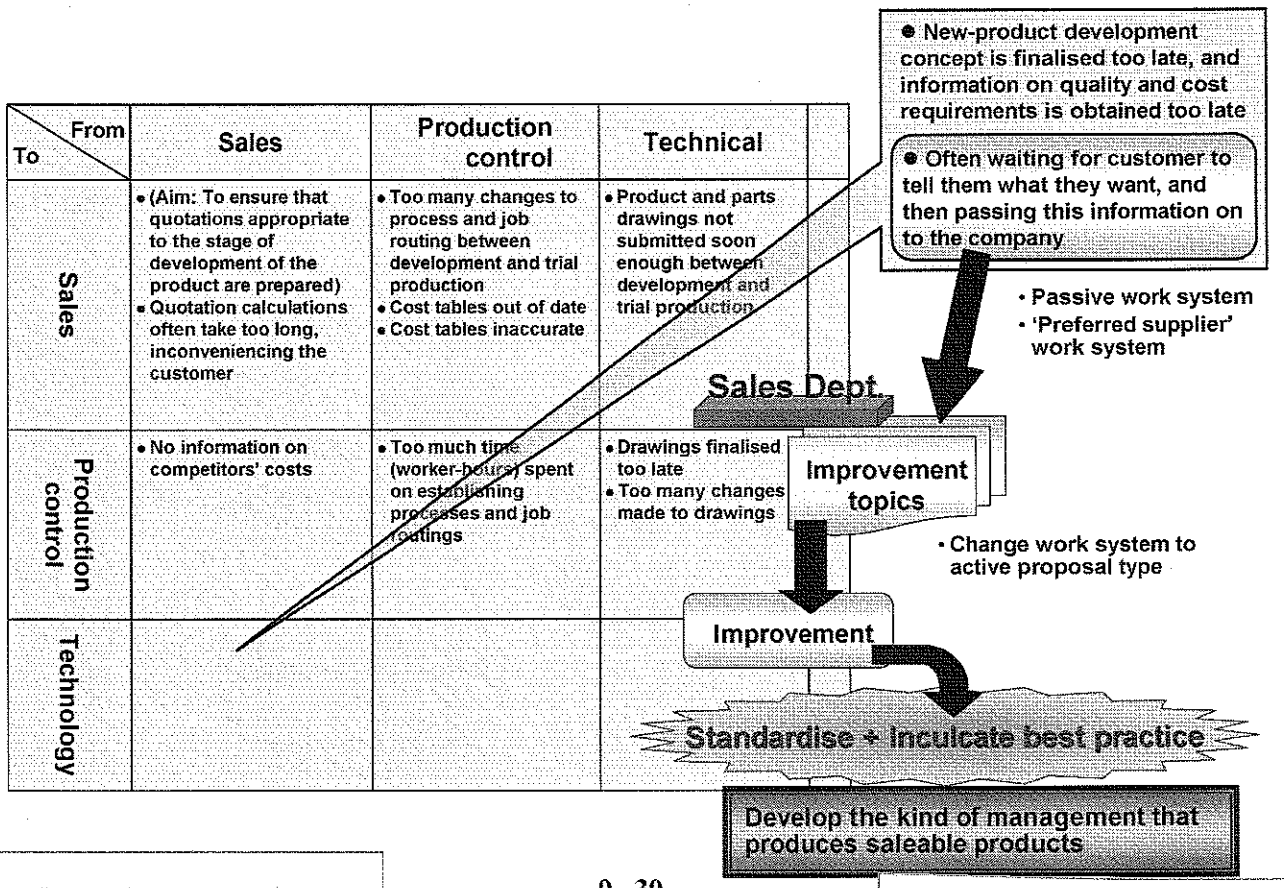


Step 2: Function Deployment Analysis Table

No	Present Work				Problems as seen from function deployment viewpoint (gap between aim and present status)
	Primary Function	Secondary Function	Aim (Mission)	Present Level	
1	Support for quality problems	1-1 Troubleshooting and follow-up 1-2 Support for quality check systems 1-3 Support for establishing quality systems 1-4 Support for establishing inspection systems	Greatly reduce current quality and delivery problems	1. Although the inspection system is weak, there is little guidance and follow-up 2. Instruction and guidance for first-of-run products tends to be insufficiently thorough, so there is too much troubleshooting 3. Problems are tackled enthusiastically, but response is too late	1. More inspection staff must be appointed and clearer guidance given 2. A first-of-run control system must be established 3. Quality check sheets should be prepared and trained out, and their use should be periodically checked 4. Introductory Quality-Hozen training is required
2	Guidance on design changes	2-1 Establishment of processes 2-2 Establishment of layouts 2-3 Establishment of working methods 2-4 Establishment of inspection methods	Increase subcontractors' sense of independence and let them work autonomously in both technical and managerial areas	1. Design changes and other responses are slow, creating large production losses 2. Design changes are not done properly, and there are many careless errors	1. Training and Education is required for design and drafting staff 2. Training on processes, job routing and work control is required

Step 2: Using From-To Analysis to Speed Up Non-Work in Preparing Quotations

To \ From	Sales	Production control	Technical
Sales	• (Aim: To ensure that quotations appropriate to the stage of development of the product are prepared) • Quotation calculations often take too long, inconveniencing the customer	• Too many changes to process and job routing between development and trial production • Cost tables out of date • Cost tables inaccurate	• Product and parts drawings not submitted soon enough between development and trial production
Production control	• No information on competitors' costs	• Too much time (worker-hours) spent on establishing processes and job routings	• Drawings finalised too late • Too many changes made to drawings
Technology			



Step 3: A Typical Work Function Improvement Topic Table

Affiliate Work	Vision	Mission or 4th-Level Work Unit	Current Problem	Improvement Topic	Priority	Type of Topic
(Purchasing and sub-contracting)	1. Actively promote cost reduction	1. Find ways to reduce costs by reviewing annual plan (cost item, target, etc.) 2. Create system for making cost-reduction plans and assessing results • Create systems that allow costs to be calculated more quickly, easily and accurately • Make the process of deciding on prices more rational by identifying where there is room for cost reductions 3. Review VA and VE proposal system and use it quantitatively (make deciding on prices conditional on proposing and adopting VA/VE)	◆ It is difficult to achieve cost reductions because negotiations for discounts are not backed up by good arguments	□Set clear cost targets and adhere to them	4	• (Own) Other Manufacturers' production engineering and control
			◆ Although the evaluation system has been reviewed, there are differences in the VA and VE proposals from customer to customer	□Reinforce use of evaluation system	4	• (Own) Other Manufacturers
	2. Create systems that allow costs to be calculated more quickly, easily and accurately	1. Draw up cost tables • Make pricing decisions more efficiently 2. Install a cost table maintenance system (for revisions and abolitions) 3. Standardise the development of cost calculation standard methods	◆ Because the cost calculation standards are not transparent, they cannot determine pricing autonomously	□Prepare a cost table for each item (specifying unit resource requirements), and make its use routine	9	• (Own) Other Production control • Production engineering • Planning • Sales • Development
(Order and delivery control (subcontracting)	1. Prevent disturbances to production lines by creating control systems enabling response to changes in delivery dates due to sudden production increases, etc. at commissioning stage	1. Create and utilise systems for thoroughly assessing targeted manufacturers' capabilities (production capacity and control capacity, i.e. process characteristics)	◆ Because the long-term capability has not been identified, problems occur when it is time for production	□Unify or establish capability identification standards (for targeted manufacturers)	1	• Manufacturers' Development • Production engineering • Sales • IT Production control • Autonomy
(Purchasing and sub-contracting)		1. Review the ordering system, and carry out improvements	◆ Since the number required has not been determined, changes ...	□Create a system for identifying required numbers to be used	2	• Manufacturers • IT (Own)

Administrative Jishu-Hozen Audit Sheet
Step 1: Check and overhaul environment

Example

Administrative Jishu-Hozen Audit Sheet
Step 1: Check and overhaul environment

Audit type	Self	Area Management	Senior Management

Team Name	
Reg. No.	
Date / Time of audit	
Auditors	

Score:	Pass / Fail
Self-audit	90 or above
Area Managers' audit	85 or above
Senior Managers' audit	80 or above

Item Audited	Key Points	Poor←Normal→Good 2 pt.	4 pt.	8 pt.	10 pt.	Comments
1. Preparation (10 points)	* Do employees recognise need for activities, understand objectives, and view them as their own concern? * Are the activity areas (e.g. offices, meeting rooms, training rooms, etc.) and the focus of the activities clearly defined? * Are common approaches and common definitions of terms being used?					
2. Removing unnecessary objects and cleaning away dirt and dust (10 points)	* Have unnecessary objects been removed from the activity area, and have non-urgent items been stored outside the workplace? * Is there any dust, dirt, rust, damage, etc. in the activity area, or on furniture and fittings (desks, chairs, shelving units, lockers, etc.)? * Is there any dust, dirt, rust, damage, etc. on the office equipment (computers, fax machines, copiers, air conditioning, sound equipment, etc.)? * Have rules been set for periodic cleaning and disposal of unnecessary objects, and have they been consolidated into a workable system?					
3. Dealing with fuguai and hard-to-access areas (20 points)	* Do staff understand how 'fuguai' (irregularities or imperfections) are defined? * Have fuguai in the activity area and furniture, fittings, equipment, etc. been identified and dealt with?					
	* Do staff understand how 'hard-to-access areas' are defined? * Have hard-to-access areas been identified and made more accessible, shortening the time required for the activities?					
4. Dealing with sources of problems (10 points)	* Do staff understand how 'sources of problems' are defined? * Have sources of problems been specified clearly as a focus of the activities, and have their causes been analysed? * Have comprehensive countermeasures been painstakingly implemented, so that the expected standards are achieved?					
5. Sorting out and organising filing systems, improving layouts, and fixing locations for furniture and fittings (20 points)	* Does the filing system allow staff to generate and store information without wasting time? * Does the office layout help to improve administrative efficiency and eliminate personnel losses? * Have furniture and fittings been located to the required standards?					
	* Has anything requiring visual control been identified and improved to the required standards?					
6. Building a stress-free office environment (20 points)	* Do staff fully understand the definition of a 'stress-free office environment'? * Have all deficiencies (where current situation deviates from optimal) been thoroughly weeded out and efforts made to rectify them?					
	* Do the results meet the required standards?					
7. Sustaining improvements and keeping staff motivated (10 points)	* Have rules been created for keeping the activity area clean and organised, and are they being kept? * Have provisional standards been created for maintaining the required levels of cleanliness and efficiency in the office environment, filing system, furniture, fittings and equipment? Are these standards being applied? * Are staff learning from improvement case studies relating to other offices?					

Administrative Jishu-Hozen Audit Sheet
Step 2: Perform administrative stocktaking

Administrative Jishu-Hozen Audit Sheet
Step 2: Perform administrative stocktaking

Audit type	Self	Area Management	Senior Management

Team Name	
Reg. No.	
Date / Time of audit	
Auditors	

Score:	Pass / Fail
Self-audit	90 or above
Area Managers' audit	85 or above
Senior Managers' audit	80 or above

Item Audited	Key Points	Poor←Normal→Good 2 pt.	4 pt.	8 pt.	10 pt.	Comments
1. Sustainment of Step 1 (10 points)	* Are initial cleanliness levels being maintained? * Are fixed locations, signs, etc. being preserved? * Are filing control standards (work-in-progress, file, archive) for creating and storing files being observed? * Are the measures for areas of office equipment that are hard to clean or check being maintained (and further improved)? * Have the countermeasures against sources of dirt, dust, unnecessary objects, equipment errors, etc. been effectively locked in place? * Have standards and manuals been established for the administrative environment, and are they being applied?					
2. Understanding of departmental functions (30 points)	* Have the basic tasks been clearly specified for the whole range of departmental functions? * Have the relationships between functions been clarified? * Is there a good match between the functions and the actual work being carried out? * Are work responsibilities clearly defined, and is there a good awareness of the current situation and any problems? * Have all the functional issues been properly sorted out?					
3. Awareness of work volume (30 points)	* Has the work survey been extended right through to the section work level (third-level work units)? * Does the work survey provide an accurate picture of the actual conditions? * Are consistent methods used for work volume estimates (frequency, number, time)? * Are the deficiencies in the current situation, compared with the business mission, appreciable at the unit work level (4th-level work units), and have these deficiencies been organised as improvement topics?					
4. Analysis of workload (30 points)	* Is there a proper understanding of the workload and its characteristics? (1) Operation analysis (2) Peak workload estimates (workload by group, individual and schedule) * Is there a clear awareness of the issues relating to the work in question, based on the department's vision and mission?					

Administrative Jishu-Hozen Audit Sheet
Step 3: Identify problems and implement countermeasures

Administrative Jishu-Hozen Audit Sheet
Step 3: Identify problems and implement countermeasures

Audit type	Self	Area Management	Senior Management

Team Name	
Reg. No.	
Date / Time of audit	
Auditors	

Score:	Pass / Fail
Self-audit	90 or above
Area Managers' audit	85 or above
Senior Managers' audit	80 or above

Item Audited	Key Points	Poor←Normal→Good 2 pt.	4 pt.	8 pt.	10 pt.	Comments
1. Sustaining previous steps (20 points)	* Has the team kept up its eradication of unnecessary objects, dirt and dust, and maintained a well-organised filing system? * Is it preserving a stress-free office environment, and keeping fixtures in their assigned locations?					
	* Have the comments made in Step 2 been fully taken on board?					
2. Selecting activity topics and establishing targets (10 points)	* Have suitable activity topics been selected based on the results of the administrative stocktaking? * For each activity topic, have targets been established that take account of the work objectives and functions, and the business mission? * Is there a clear schedule for future activities relating to these topics?					
3. Exposing problems and losses (20 points)	* Are staff fully aware of the work functions and objectives, and the work mission? * Has a chart of the work processes and administrative work flow been created, so that the required labour-hours, time, etc. can be identified?					
	* Have deficiencies and losses been recognised, and has each and every problem or query within the work flow been tagged?					
4. Proposing and focusing on areas for improvement (10 points)	* Have employees learned how to identify areas for improvement, through 'one-point lessons', etc? * Are the areas for improvement properly related to the problems and losses that have been exposed? * Have the areas for improvement been narrowed down suitably into the points that staff must tackle through Jishu-Hozen?					
5. Proposing and implementing improvement ideas (20 points)	* Have concrete improvements been proposed for the areas for improvement to be addressed through Jishu-Hozen? * Have the implementation schedule, deadlines, and responsibilities for the proposed improvements been clearly specified, and are all staff involved in the implementation?					
	* Have the improvements been carried out properly, and have the identified problems and losses been rooted out satisfactorily? * Have the staff learned from examples of improvements made in other workplaces?					
6. Measuring results and consolidating gains (20 points)	* Are there clear calculation standards for measuring results? * Do the results match the targets, or required levels? * Have the administrative tasks been standardised after being improved?					
	* Is there a precise schedule for multi-skilling staff in the administrative tasks, once they have been standardised? * Is steady progress being made towards multi-skilling in administrative work, and are staff coming up with their own schemes for rotating everyday duties?					

Administrative Jishu-Hozen Audit Sheet
Step 4: Deal with sources of problems

Administrative Jishu-Hozen Audit Sheet
Step 4: Deal with sources of problems

Audit type	Self	Area Management	Senior Management

Team Name	
Reg. No.	
Date / Time of audit	
Auditors	

Score:	Pass / Fail
Self-audit	90 or above
Area Managers' audit	85 or above
Senior Managers' audit	80 or above

Item Audited	Key Points	Poor←Normal→Good 2 pt.	4 pt.	8 pt.	10 pt.	Comments
1. Sustaining previous steps (10 points)	* Are the fixed locations and signs for the furniture and fittings being observed correctly? * Are all records, analysis results, etc. being stored in an orderly fashion? * Are results indicators and management indicators strictly monitored?					
2. Identifying and sorting out inter-organisational and inter-departmental problems and deficiencies (20 points)	* Have the work processes been broken down? * Have any problems or deficiencies arising from work spanning different organisations or departments been sorted out effectively? * Have problem sources and hard-to-access areas been identified (tagged), based on a proper understanding of the improvements made in Step 3?					
3. Exposing losses and establishing targets (20 points)	* Have the losses relating to problems and deficiencies been sorted out and properly understood? * Are the targets consistent with the department's mission?					
4. Pinpointing causes and proposing countermeasures (20 points)	* Is the improvement process logical and efficient? * Are activities being developed on the basis of a good understanding of improvement principles and rules? * Has action been taken against the sources of problems? * Has action been taken against hard-to-access areas? * Are there any particular highlights in the improvements made (breadth, depth, detail of investigation, scale of results, benefits, etc.)?					
5. Checking results and consolidating gains (20 points)	* Have the results been properly grasped? * Are there clear standards and methods for measuring results? * Is there proper follow-up to make sure improvements are locked in place once they have been made? (including reviews of standards and rules)?					
6. Status of activities (10 points)	* Are all the relevant people taking part, regardless of job demarcations? * Are activity boards being used effectively? * Have the numbers of tags placed and removed, and the number of improvement suggestions, reached their respective targets?					

Administrative Jishu-Hozen Audit Sheet
Step 5: Prepare standards and manuals

Administrative Jishu-Hozen Audit Sheet
Step 5: Prepare standards and manuals

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Team Name	
Reg. No.	
Date / Time of audit	
Auditors	

Score:	Pass / Fail
Self-audit	90 or above
Area Managers' audit	85 or above
Senior Managers' audit	80 or above

Item Audited	Key Points	Poor←Normal→Good 2 pt.	4 pt.	8 pt.	10 pt.	Comments
1. Preparation (10 points)	* Do the staff appreciate the need for the activities, understand the objectives, and see them as their own concern? * Are all the (provisional) standards used in the work processes filed in an orderly way? * Is there a detailed action plan?					
2. Work standards documents (20 points)	* Are the work standards consistent with the division of work duties? * Are the work standards consistent with the company's rules and regulations?					
	* Have all the required standards been prepared, and are they revised as necessary, without any holdups? * Are all employees observing the work standards properly?					
3. Work procedure documents (10 points)	* Do all procedures relate clearly to the work standards and contain more specific information? * Are they understandable enough for anyone to use?					
4. Standardisation (10 points)	* Have the provisional standards created in Steps 3 and 4 been developed properly into definitive standards? * Are the standards easy to understand and comply with?					
5. Office automation (10 points)	* Has the right environment for automation been created, with administrative work being processed on a daily basis? * Is there a constant drive to automate tasks, with the aim of reducing staff requirements? * Is there an active and positive approach to operating computer equipment, using databases, etc?					
6. Identification of topics relating to office automation (10 points)	* Has WUS (waste, unevenness and strain) been identified and eliminated from tasks to be automated? * Is there any waste, such as delays during transfer of information? * Are there any time lags in the flow of objects and information?					
7. Staff flexibility (10 points)	* Have each individual's job skills been assessed? * Has each worker been told which work functions he or she must improve, and have they taken up the challenge? * Does each workplace have at least three people who are capable of doing any particular job?					
8. Sustaining improvements and keeping staff motivated (20 points)	* Are satisfactory levels of cleanliness and tidiness being maintained in the office? * Is every care being taken to meet customers' needs?					
	* Is everyone coming up with at least five suggested improvements per month? * Are the activity boards being updated constantly, to keep them alive and dynamic?					

Administrative Jishu-Hozen Audit Sheet
Step 6: Perform comprehensive inspection

Administrative Jishu-Hozen Audit Sheet
Step 6: Perform comprehensive inspection

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Auditors	

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Item Audited	Key Points	Poor←Normal→Good 2 pt.	4 pt.	8 pt.	10 pt.	Comments
1. Preparation (10 points)	* Do the staff appreciate the need for the activities, understand the objectives, and see them as their own concern? * Has information been gathered on all operator errors and difficulties in administrative work, and has appropriate action been taken? * Does each person in charge have his or her own detailed action plan?					
2. Review of administrative environment (10 points)	* Can the work be done in line with the standards? * Can the standards and specifications be easily understood by anyone? * Is work being done in accordance with the standards? * Have office manuals been prepared, and are they being kept in order?					
3. Review of administrative functions (10 points)	* Can the work be done in line with the standards? * Can the standards, specifications and flow charts be easily understood by anyone? * Is work being done in accordance with the regulations? * Have office manuals been prepared, and are they being kept in order?					
4. Management of documents and data (10 points)	* Are there precise standards for managing documents and data? * Are the authorised staff maintaining documents and data properly, and are the latest versions available?					
5. Internal quality monitoring (10 points)	* Have a written plan and procedure been established for internal monitoring, and are they being maintained? * Are monitored results being recorded, and are measures taken to correct any deficiencies that arise?					
6. Identification of concerns, and countermeasures (10 points)	* Have all outstanding issues been arranged systematically? * Has someone been delegated to address each concern, propose an improvement plan, and see that it is implemented?					
7. Information sharing (10 points)	* Is the right information transmitted to the locations where it is needed? * Is the information transmitted quickly enough? * Is the transmitted information of high quality?					
8. Multi-skilling (10 points)	* Are there proper written procedures for the training required to ensure that each person can process a number of different jobs? * Is suitable training being given and properly recorded? * Are employees able to take on an increasing number of tasks for someone else, and is the standard of their work improving?					
9. Visual control (10 points)	* Are each person's monthly and daily work duties clearly visible to everyone in the office? * Is it easy to comprehend the work flow and tell how far each job has progressed?					
10. Sustaining improvements and keeping staff motivated (10 points)	* Are satisfactory levels of cleanliness and tidiness being maintained in the office, with a place for everything and everything in its place? * Is every care being taken to meet customers' needs? * Is everyone coming up with at least seven suggested improvements per month? * Are the activity boards in constant use?					

Administrative Jishu-Hozen Audit Sheet
Step 7: Fully self-manage

Administrative Jishu-Hozen Audit Sheet
Step 7: Fully self-manage

Audit type	Self	Area Management	Senior Management

Team Name	
Reg. No.	
Date / Time of audit	
Auditors	

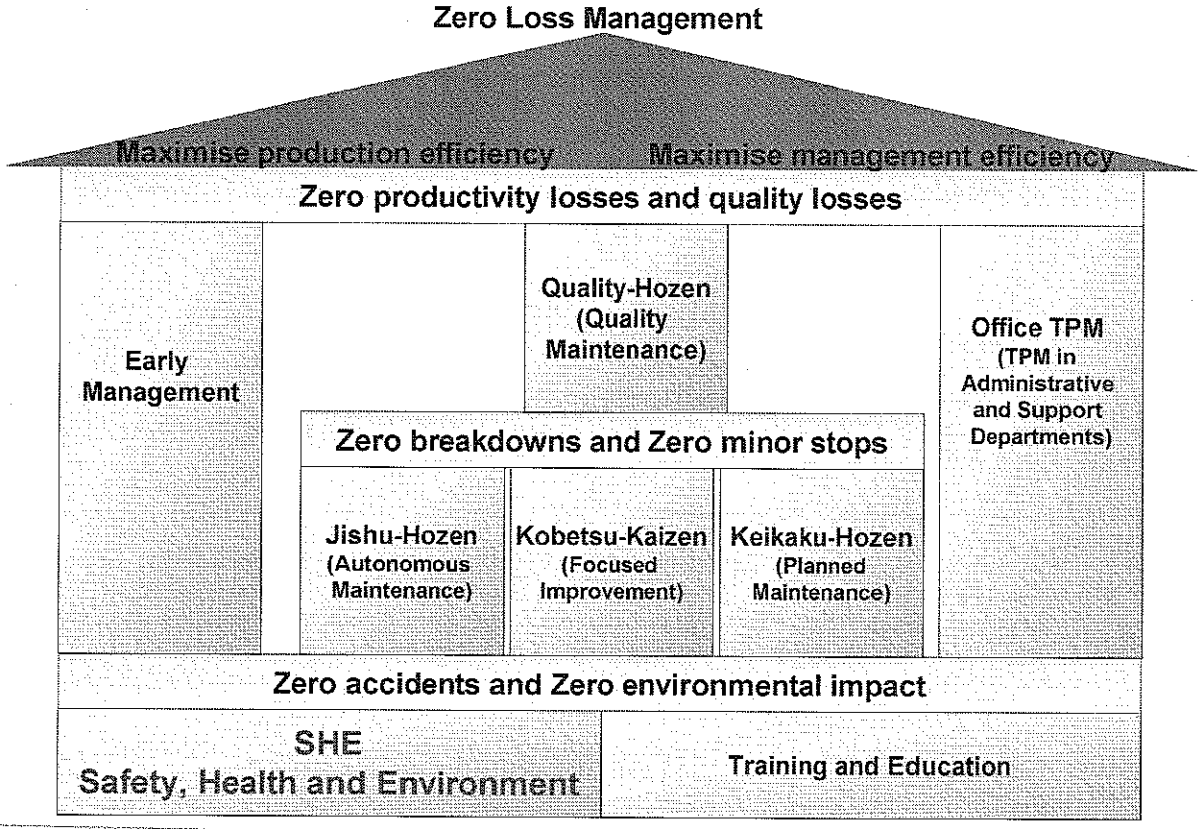
Score:	Pass / Fail
Self-audit	90 or above
Area Managers' audit	85 or above
Senior Managers' audit	80 or above

Item Audited		Key Points	Poor←Normal→Good 2 pt.	4 pt.	8 pt.	10 pt.	Comments
1. Sustaining previous steps (20 points)		* Has the team kept up its eradication of unnecessary objects, dirt and dust, and maintained a well-organised filing system and stress-free office environment?					
		* Have they sustained the results gained by the improvements made up to and including Step 6? * Have the comments made in the previous steps been fully taken on board?					
2. Understanding higher-level management policies and awareness of own role (10 points)		* Do employees understand higher-level policies properly? * Have the activity themes been divided into different categories, and have concrete topics been derived from these? * Do staff fully appreciate the role that they have to play in relation to the derived topics?					
3. Setting up special campaigns and targets (20 points)		* Have the staff carried out a thorough stocktake of the specific topics that they themselves have to tackle? * Have the specific topics been examined properly to assess their order of priority and establish special campaigns?					
		* When it comes to setting campaign topics and targets, is there sufficient consultation and fine tuning involving staff and management? Is the office making a sufficient contribution to meeting management targets?					
4. Development of special campaign activities	Analysis of status quo (10 points)	* Are there clearly defined activity steps and procedures for each campaign topic? Has an activity schedule been drawn up and put into action? * Are all the right tools being used skilfully to analyse the current situation?					
	Exposure of problems and proposal of improvements (10 points)	* Have the loss structures, problems and deficiencies been properly analysed and highlighted? * In a design-based approach, are the primary and secondary designs actually illustrated? * Are areas for improvement being narrowed down, and improvement proposals made correctly and precisely?					
	Implementation of improvements (20 points)	* Have the highlighted losses and problems been overcome satisfactorily?					
		* Have employees learned improvement techniques from other workplaces, reports on other companies, literature and other sources?					
5. Measurement of results and consolidation of gains (10 points)		* Are precise calculation standards used for measuring results? * Have the targets and required levels been reached? * Is progress being made on standardisation and instilling routine good practice after improvements have been achieved? * Is there steady progress towards multi-skilling?					
6. Work audits (10 points)		* Does the department have an internal system for doing periodic work audits? * Does the department always act on comments made during these internal audits? * Is the department working steadily towards achieving zero faults in the internal audits?					

TPM Manual
Chapter 10
SHE
(Safety, Health & Environment)

JIPM-Solutions Co. Ltd.

The Importance of Safety, Health and Environment



How Safety Relates to the other TPM Pillars

(1) Jishu-Hozen
Step 1 of Jishu-Hozen is Initial Cleaning. Safety problems, (unsafe situations, unsafe behaviours, and other hazards) are identified during this step along with the other problems usually addressed in Jishu-Hozen. The problems are then tackled through restoration and improvement during Step 2, and provisional standards are established in Step 3 to sustain the situation. Effective action must be taken during these steps to clear up any nagging concerns that operators may have relating to the possibility of behavioural accidents, fire, explosion, or other undesirable incidents. From Step 4 onwards, activities are pitched at progressively higher levels, with the aim of creating worker-friendly, accident-free workplaces. However, this cannot be achieved through Jishu-Hozen alone, and must be developed in conjunction with the other TPM pillars.

(2) Keikaku-Hozen (also applies to Kobetu-Kaizen aimed at reducing equipment failures)
The key objective of Keikaku-Hozen is to eliminate unexpected breakdowns. This improves safety, because equipment problems often lead to accidents, which are often due to operators' lack of experience in dealing with abnormalities or carrying out non-routine tasks. Working towards zero breakdowns, minor stops and other equipment-related problems lessens the chance of accidents happening. However, maintenance itself necessitates a great deal of non-routine work, so painstaking efforts must be made to identify unsafe situations or unsafe behaviours and nip every possible accident in the bud.

(3) Early Management (Product & Equipment)
This pillar aims to create user-friendly, hazard-free equipment that can be operated with confidence. Fail-safe mechanisms and error-proofing systems should be incorporated into machinery and plant from the early design stages, and ways found to simplify operating and maintenance tasks to avoid the need for strenuous physical effort. The purpose of Early Management is to work towards achieving robust, trouble-free equipment and comfortable work environments, from the development phase onward.

How Safety Relates to the other TPM Pillars

(4) Quality-Hozen (also applies to Kobetsu-Kaizen aimed at reducing quality defects)
Quality-Hozen aims to sustain zero-defect conditions (conditions guaranteeing defect-free product) in every production process. Any lapse in managing these conditions creates the possibility not only of quality defects but also of accidents or other mishaps. Rigorous establishment and sustainment of processing conditions is particularly crucial when hazardous materials are being handled. If a quality defect occurs, non-routine work will be required to deal with the problem, increasing the risk of an accident, which is why Quality-Hozen is important not only for guaranteeing product quality but also for improving safety.

(5) Training and Education
In Training and Education within TPM, skills (the ability to do the job) are divided into five levels, ranging from level 0 (no knowledge at all) to level 4 (capable of teaching others), and the capabilities of individual operators are upgraded level by level. Accidents can happen if operators do not know how to handle tools correctly, for example, so this pillar of TPM helps to eliminate unsafe behaviour by improving people's operating and maintenance skills.

(6) Office TPM
Safety is also important in administrative and support departments. **Development departments, for example, operate equipment such as pilot plants and test rigs in their laboratories to test new products and manufacturing processes, so they must manage safety effectively in order to prevent any accidents from occurring when using this equipment.** Support departments may be responsible for packaging and transporting the final products, so they must also identify and resolve any unsafe situations or behaviours occurring in their workplaces through the step-by-step development of an Jishu-Hozen programme as described in (1) above.

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Key Safety Policies

- Safety is the foundation of all business operations
- Safety and higher productivity go hand in hand
- Safety improvements lead to more efficient production
- Safety improves communication
- Safety prevents equipment-related losses

Extract from the Industrial Safety and Health Law

Chapter I (General Provisions)
(Purpose)
Article 1

The purpose of this Law is to secure, in conjunction with the Labour Standards Law (Law No. 49 of 1947), the safety and health of workers in workplaces, as well as to facilitate the establishment of comfortable working environments, by promoting comprehensive and systematic countermeasures concerning the prevention of industrial accidents, such as taking measures for the establishment of standards for hazard prevention, the clarification of responsibility and the promotion of voluntary activities with a view to preventing industrial accidents.

(General Safety and Health Manager)
Article 10

(1) matters pertaining to measures for the prevention of the hazards or health impairment of workers;
(2) matters pertaining to the provision of education on the safety and health of workers;
(3) matters pertaining to the medical examination, the maintenance and the promotion of the health of workers;
(4) matters pertaining to the investigation of the causes of industrial accidents and measures for preventing the recurrence of such accidents.

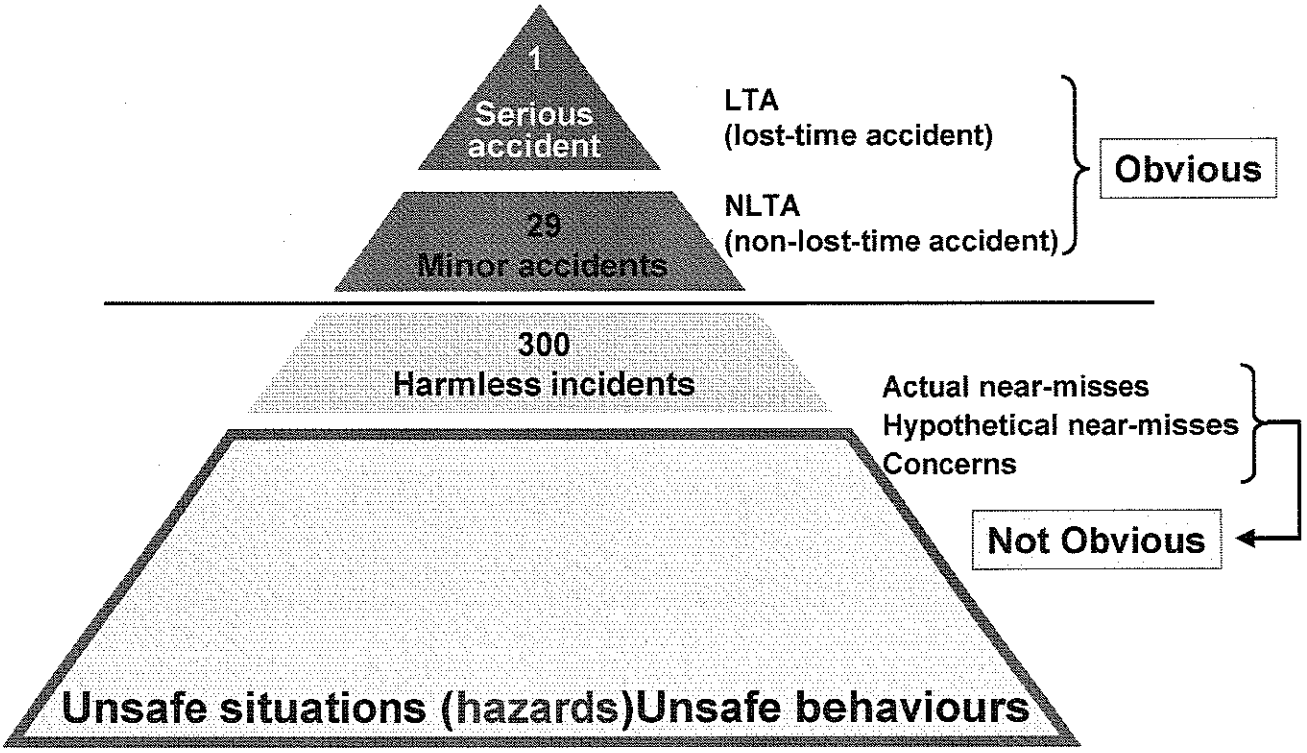
(Safety Committee)
Article 17

(1) Basic strategies for preventing hazards to workers;
(2) Causes of industrial accidents and strategies to prevent them recurring;
(3) Other important matters pertaining to the prevention of hazards to workers.

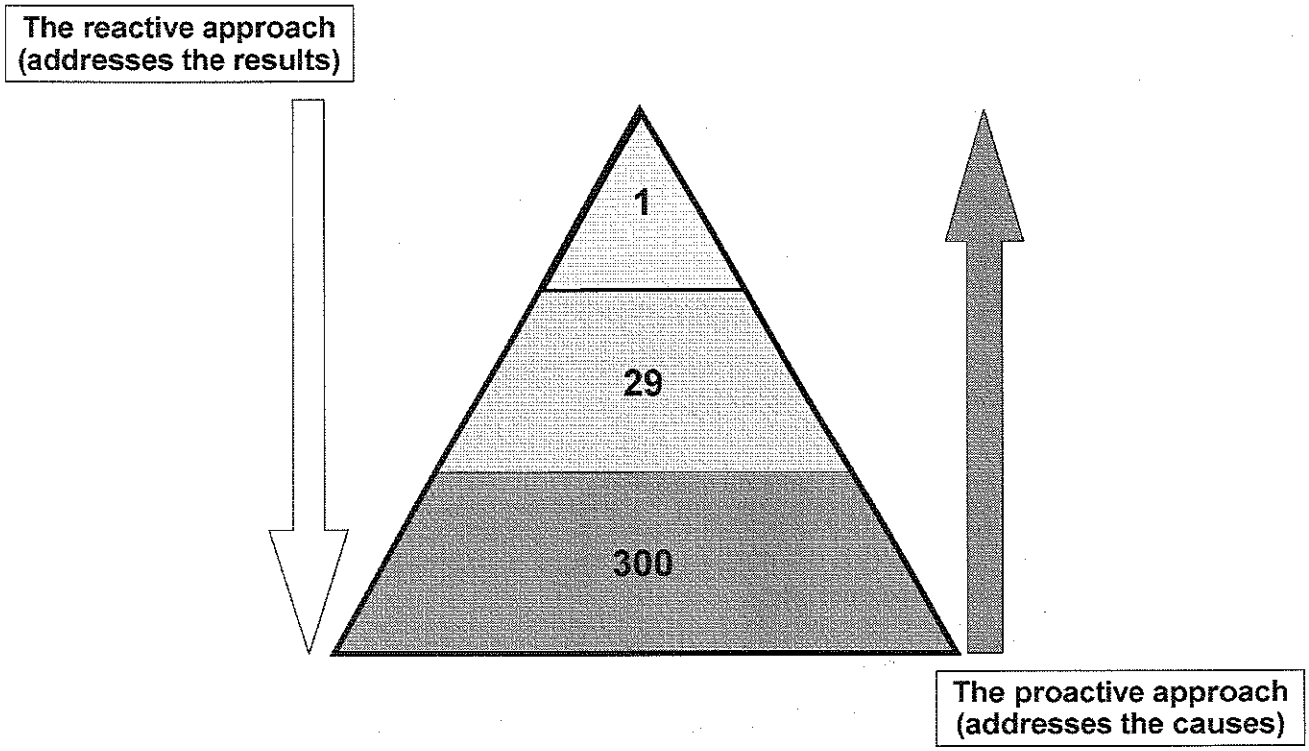
Chapter IV (Measures for Preventing the Hazards to or Health Impairment of Workers)
(Measures to Be Taken by Employers, etc.)
Article 20

The employer shall take necessary measures for preventing the following hazards:
(1) hazards due to machines, instruments and other equipment
(2) hazards due to substances of an explosive nature, substances of a combustible nature and substances of an inflammable nature; and
(3) hazards due to electricity, heat and other energy.

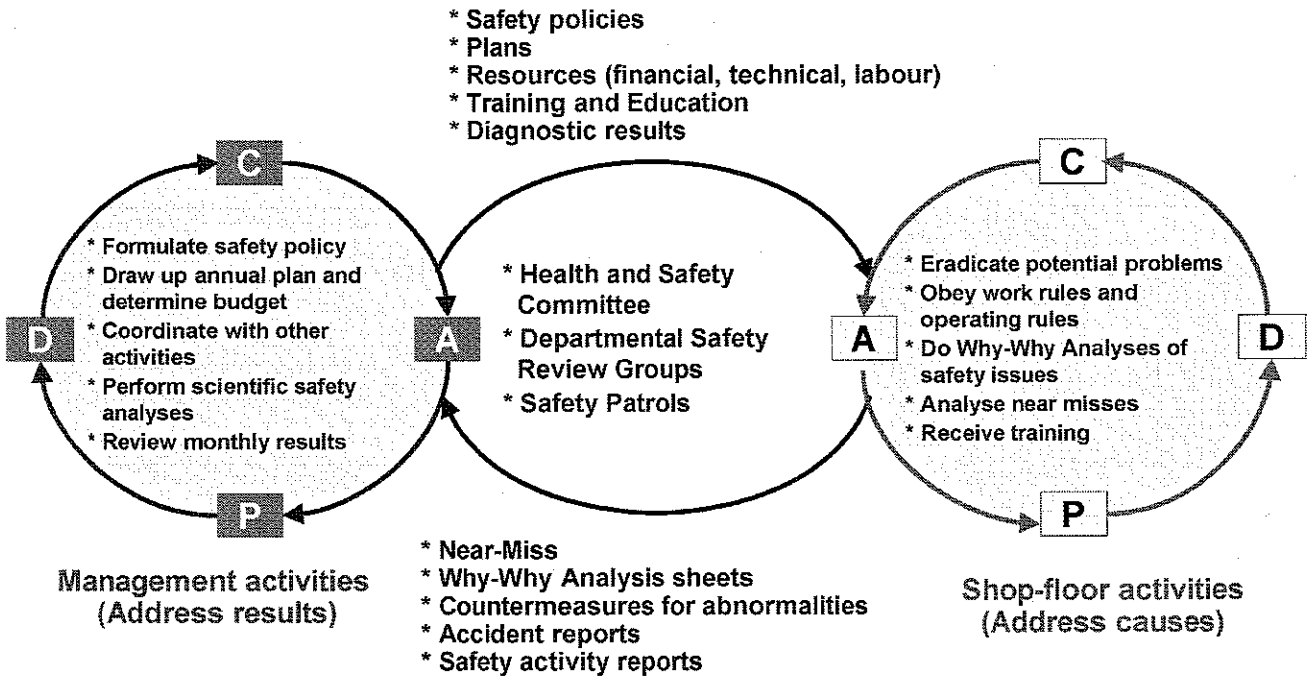
The Heinrich principle



The proactive approach



The Safety Chain



Step-by-step programme for eradicating behavioural accidents

Remove Hazards

- Step 1: Analyse Current Situation
- Step 2: Perform General Inspection for hazards
- Step 3: Create hazard chart
- Step 4: Eliminate hazards
- Step 5: Establish zero-accident conditions

Maintain Safety

- Step 6: Create inspection standards, and conduct training
- Step 7: Perform safety reviews

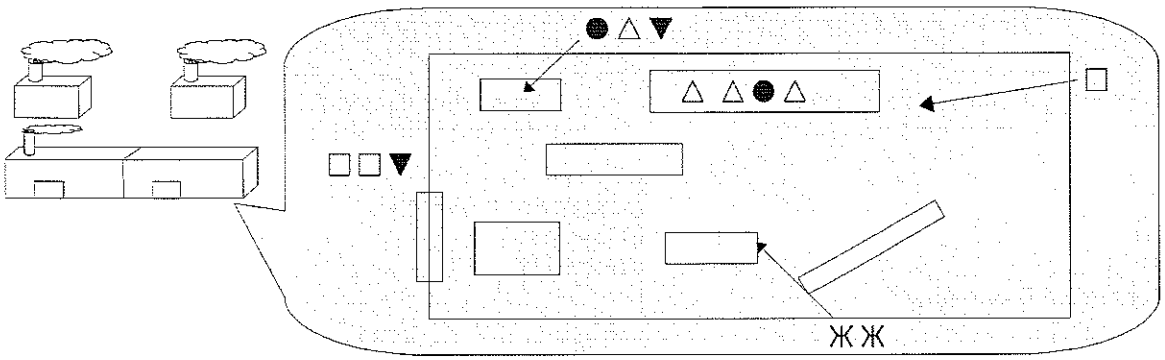
A Step-by-Step Programme for Eradicating Behaviour-Related Accidents

		Step		Action	Remarks
Dealing with hazards at source	Prepare	1	Analyse Current Situation	1. Review basic safety policy 2. Review safety standards 3. Identify accident modes 4. Examine and stratify accident statistics 5. Create safety matrices 6. Identify worst tasks 7. Analyse worst tasks	* Include accident modes specific to your own company. * Analyse correlations between tasks and accident modes. * Incorporate opinions of shop-floor personnel (use interviews, questionnaires, etc.). * Identify hazardous operations by examining what actually happens in the workplace (use videos).
	Investigate and analyse	2	Perform General Inspection of hazards	1. Establish ideal safety conditions for each task 2. Create level assessment table for safety conditions 3. Identify hazards based on analysis of current situation, and organise on General Inspection chart	* Determine ideal 3M1E conditions (Materials, Machines, Methods and Environment), based on statutory and company regulations, past experience, and existing know-how. * Inspect actual 3M1E conditions, based on drawings, standards, work instructions, etc.
	Identify and rectify hazards	3	Create hazard chart	1. Create chart of hazards and consider possible improvements 2. Deal with any hazards that can be handled straight away 3. Analyse hazards where conditions required for creating intrinsic safety are not yet known 4. Create improvement plan 5. Use FMEA analysis to assess proposed improvements 6. Evaluate level of ideal conditions achieved by improvement plan	* Employ techniques for identifying true causes (Why-Why Analysis, P-M Analysis, FMECA, FTA, etc.) * Use FMEA analysis to prioritise proposed improvements. * Reassess improvement plan if ideal conditions have not yet been achieved.
		4	Eliminate hazards	1. Corroborate improvement plans technically and economically 2. Implement improvements 3. Reassess improvement results	* Make active use of error-proofing to ensure that measures against misoperation are locked into place. * Reassess work-related hazard levels by actual observations on the shop floor.
		5	Establish zero-accident conditions	1. Confirm 3M1E conditions for achieving zero accidents 2. Create one-point lesson sheets for teaching safety	* Set observable standards.
Safety Maintenance	Standardise	6	Create inspection standards, and conduct training	1. Establish standard inspection values and create safety inspection matrices 2. Highlight components for safety inspection 3. Implement training 4. Roll out improvements to other relevant areas	* Create safety inspection matrices by incorporating safety checkpoints into existing equipment checksheets. * Implement improvements designed to make safety checks easier to perform. * Managers must do Steps 1 to 5 themselves, and reach a high enough level to be able to teach others. * Mangers must train team members fully and thoroughly, explaining why the safety checks are necessary, so that work can be carried out under safe conditions. This requires a good understanding of the equipment, how it is constructed, how it works, and the mechanisms involved.
	Sustain and improve safety	7	Perform safety reviews	1. Incorporate findings into preliminary safety assessment standards 2. Review and revise safety standards 3. Implement top-management safety reviews and assessments	* Carry out preliminary safety assessments on new equipment. * Raise standard of safety activities in an upward spiral.

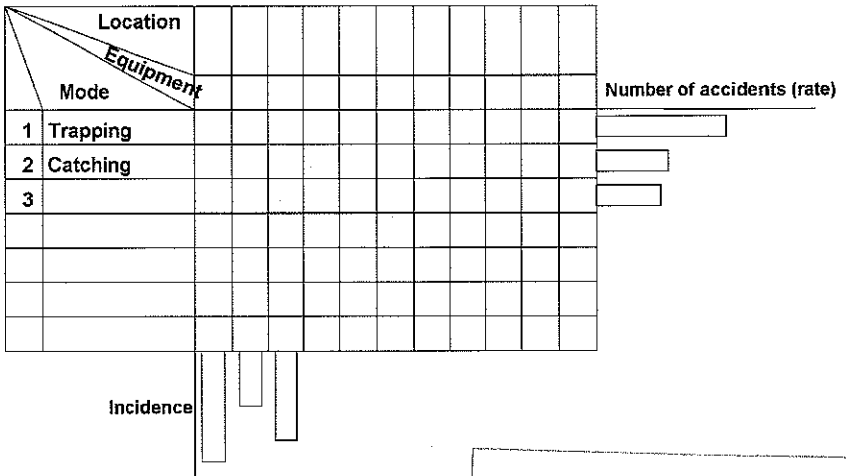
Typical Accident Category

Falling down	Falling down from a tree, building scaffold, platform, ladder, stairway, slope, etc.
Falling over	Falling over on a more or less horizontal surface (by tripping, slipping, etc.)
Colliding	Bumping into a stationary or moving object, (except when falling down or falling over), bumping against or jumping down against a suspended load, part of a machine, etc.
Being struck (1)	Being hit by a falling or flying object.
Being struck (2)	Being hit or buried as a result of the collapse of accumulated materials (including ash, for example), scaffolding or other structures.
Being struck (3)	Being hit by an object other than one that is falling, flying or collapsing.
Trapping / Catching	Having something crushed, twisted, etc., by being trapped between two objects or caught up in an object.
Cut/abrasion	Being cut or scraped by an object.
Spiking	Having a foot injured by treading on a nail, shard of metal, etc.
Drowning	
Contact with hot or cold object	Touching a very hot or cold object.
Harmful exposure	Being exposed to a harmful environment, e.g. irradiation, harmful light rays, poisonous material, oxygen-deficient atmosphere, high/low pressure, etc.
Electric shock	Receiving an electric shock by touching a live conductor or being subjected to an electrical discharge.
Explosion	Explosion consisting of a rapid expansion accompanied by an explosive sound, as a result of the sudden generation or release of pressure.
Rupture	Rupturing of a tank or other such device as a result of excessive physical pressure.
Fire	
Traffic accident (road)	Traffic accident in a situation where road traffic laws apply.
Traffic accident (other)	Traffic accident involving a ship, airplane, freight train, passenger train, etc.
Reaction against movement, or strained movement	
Other, unclassifiable incidents	

Record the locations of past accidents and near misses on a map of the workplace



Trapping / Catching	△
Falls (all types)	▼
Bruises / Cuts	□
Burns	●
Electric shock	✳



Tagging/Detagging Procedure

Decide where to focus	Select equipment, area, accident type, etc.
Prepare one-point lessons	Verify what 'unsafe' actually means.
Make maps and boards	Decide how to sort out and display information on hazards.
Affix tags	Affix safety tags to all points considered unsafe.
Sort out tags	Arrange the tags on a map and/or board.
Hold tag review meeting	Get everyone to check the tags and decide what immediate action should be taken. If operators can deal with a problem themselves, they should do so.
Decide how to deal with outstanding tags	Create a list of tags that still need to be dealt with, decide how to do so, and ask relevant departments to deal with any problems that cannot be handled by operators themselves.
Deal with outstanding tags	Deal with remaining hazards and remove relevant tags.

Concepts for crating a Hospitable Work Environment

Positive factors	
Hospitable environment	Work that does not build up fatigue
Bright Calm Soothing Colourful Clean, tidy and well-organised	Easy to understand Unpressured Not tiring
Noisy Hot and humid Dusty Containing harmful gases and vapours Hazardous Frequent breakdowns and minor stops	Uncomfortable working posture Heavy objects Time pressure Extensive movement
Harmful environment	Strenuous work
Negative factors	
Work towards a hospitable environment by eradicating the negative factors	

Illumination Measurement

Date :
No.

Column	Location	Work category	Local illumination (lux)	Overall illumination
1	Offices	Design, Accounts	300 - 400	
		General	150 - 300	
		Conference room	100 - 150	
2	Factory	Ultra-high-precision	1000 - 5000	400
		High-precision (near machinery, and measuring equipment)	300 - 1000	300
		Standard (near machinery)	100 - 300	-
		General area (stock room)	50 - 100	-

Items of Illumination Measurement

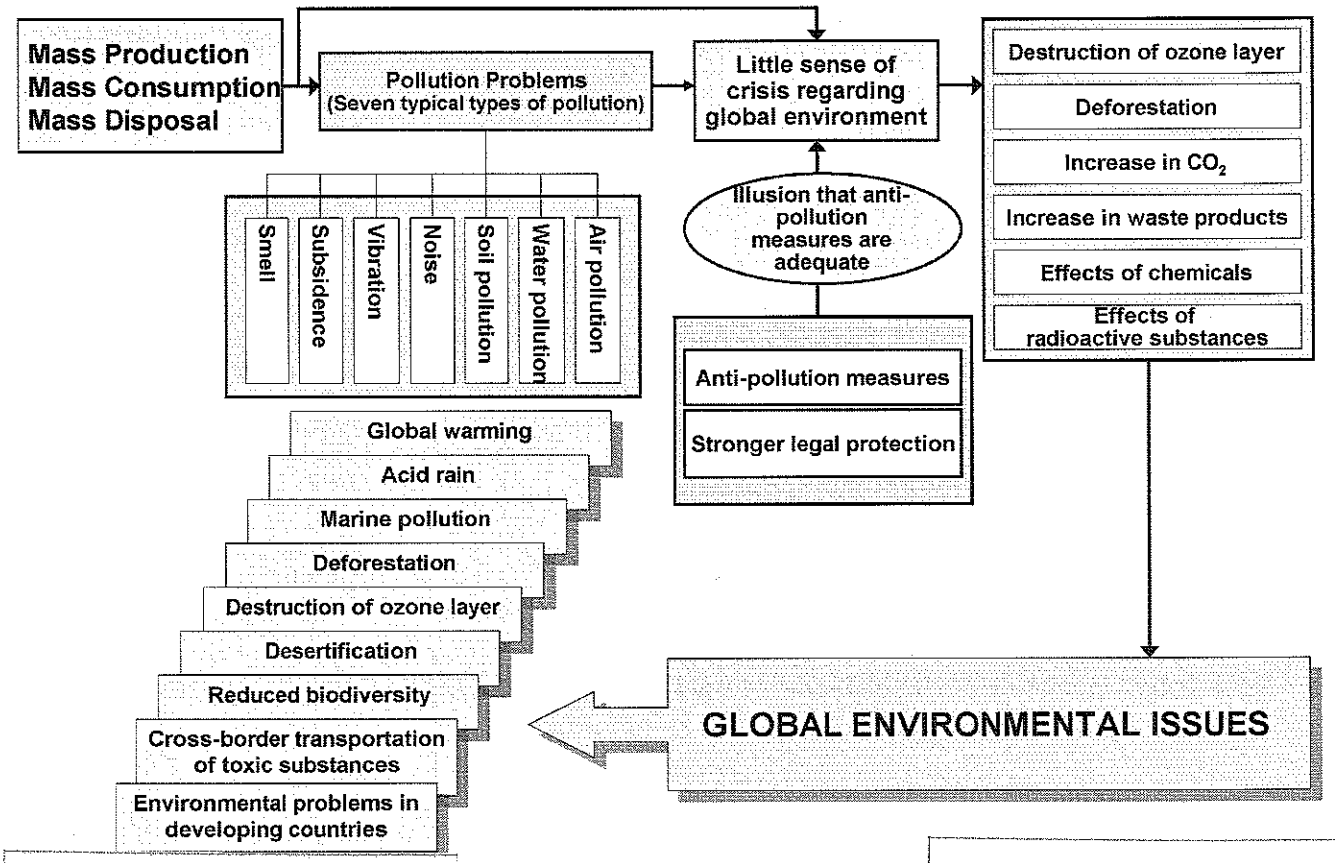
	Measurements			
	Temperature	Humidity	Light level	Noise level
Measuring equipment	Standard hygrometer		Photocell-type light meter	JIS standard C1502 noise meter
Measurement point	Specific points in work area		Standard work positions	
Measurement method	Two-day average of readings taken at a maximum height of 50 cm above floor level.		Stable reading obtained after leaving photoreceiver in measurement position for approximately one minute.	Equivalent noise level after measuring for 10 minutes at a position between 120 cm and 150 cm above floor level.
Measurement time	Around 3 pm. in summer, and around 10 am. in winter (note)		After sunset	Measure during normal working hours
Measurement records	Keep for three years *			

Results-based and Cause-based Indicators and Formulas

Health and Safety	Formula	Remarks
Results-based indicators		
Accident frequency	(No. of fatal and non-fatal injuries / working hours) x 1,000,000	Accident rate (per 1,000,000 working hours)
Accident severity	(No. of working days lost / working hours) x 1,000	Rate of lost days (per 1,000 working hours)
No. of lost-time accidents	Actual figure	
No. of non-lost-time accidents	Actual figure	
Accident-free days / working hours	Actual figure	
No. / rate of people testing positive on medical tests	Actual figure	
Cause-based indicators		
No. of actual near-misses	Actual figure	
(serious / minor)	Actual figure	
No. of hypothetical near-misses (no. of concerns)	Actual figure	
Rate (no.) of troubleshooting jobs	Actual figure	'Troubleshooting' includes minor interventions ('touches')
Work hazard rating	Actual figure	
No. of points raised by safety audit	Actual figure	
No. of MP points incorporated in new designs	Actual figure	

Environment and Pollution		
Standard of working environment	Measure at same point each time	Noise, lighting, dust, strenuous, work, etc.
Reduction in industrial waste	Actual figure	
Reduction in chemical waste	Actual figure	CO_2, NOx, SOx, COD, etc.
No. of external complaints and discharges	Actual figure	

Reflections on the Consumer Society (from local pollution to the global environmental issue)



Tackling Environmental Issues within TPM

TPM Pillar	How Environmental Issues Are Addressed within a TPM Programme
Kobetsu-Kaizen (Focused Improvement)	* Improvements to eliminate losses (e.g. equipment failure / setup and adjustment / minor stops / speed losses / defects / startup and shutdown / energy use / materials and resources)
	* Reduction / replacement of harmful substances
	* Measures for dealing with waste products
	* Compliance with legal requirements, plus self-imposed standards
Jishu-Hozen (Autonomous Maintenance)	* Tagging and detagging of environmental contamination sources
	* Correct setup and operation
	* Routine inspection of equipment and processes
	* Improvements and suggestions
Keikaku-Hozen (Planned Maintenance)	* Elimination of equipment failures
	* Application of maintenance techniques (periodic maintenance / corrective maintenance / predictive maintenance), plus technologies relating to repair and recycling / anti-wear / anti-erosion / anti-corrosion / noise prevention / lubrication / thermal insulation / leak prevention / surface treatment / anti-vibration, etc.
	* Compliance with statutory requirements
	* Management of utility-related facilities (waste water treatment / boilers / outdoor or underground tanks / incinerators / hazardous substances / equipment producing or utilising high-pressure gas, etc.)
Early Management (Product & Equipment)	* Study and application of life-cycle assessment
	* Study and application of environmentally-friendly products
	* Development of environmentally-friendly processes
	* Reduction of trial manufacture and test runs
	* Elimination of fabrication losses in moulds and jigs

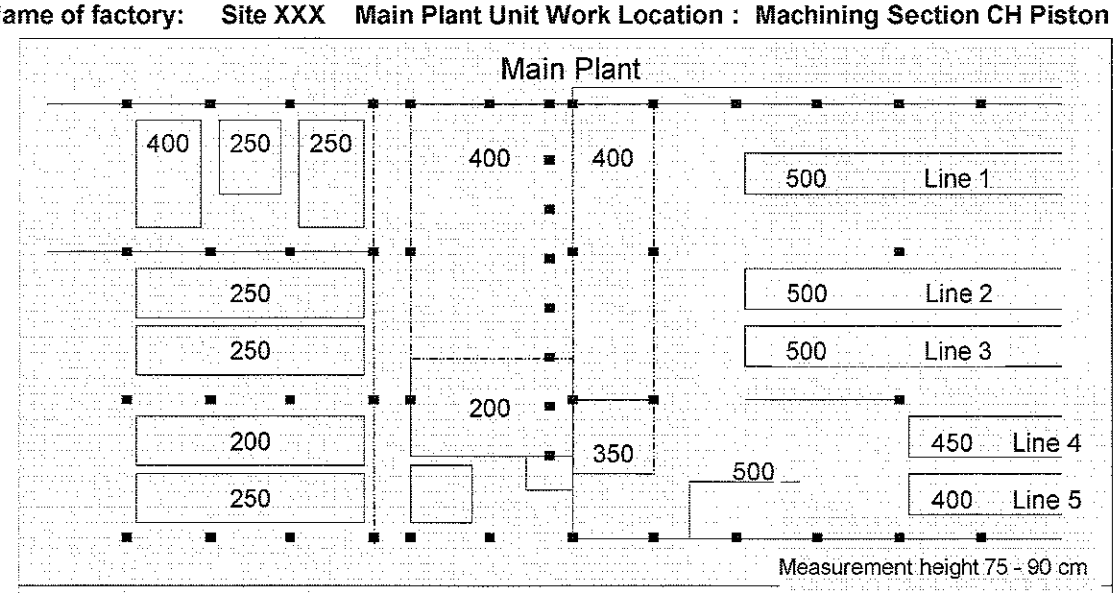
Tackling Environmental Issues within TPM

TPM Pillar	How Environmental Issues Are Addressed within a TPM Programme
Quality-Hozen (Quality Maintenance)	* Zero quality defects (establishment of 'perfect-product' conditions)
Training and Education	* Awareness training in environmental matters
	* System assuring capabilities always available for specific tasks
	* Emergency response training
	* Information and training for external contractors
Office TPM (TPM in Administrative and Support Dept.)	* Compliance with statutory requirements
	* Establishment of documentation system and management of documents
	* Tagging and detagging of environmental contamination sources
	* Appropriate processing of waste products and reduction of discharges
	* Improvements and suggestions
	* Tasks carried out according to established procedure
	* Promotion of 'green' purchasing
	* Improved interfaces for internal and external communication of information
	* Agreements with external contractors
SHE (Safety, Health and Environment)	* Establishment of environmental management system (in cooperation with TPM Office)
	* Environmental improvements on site

Illumination Measurement Results

For each unit work location, indicate the boundaries, the main pieces of equipment, sources, measurement points, etc.

Name of factory: Site XXX Main Plant Unit Work Location : Machining Section CH Piston Line



Illumination measurement results for each line in main plant (unit: lux)

Measurement conditions

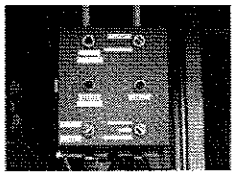
1. **Date and time measurement taken : __ . __ . __ __ : __**
2. **Metering equipment used : _____ . _____**
3. **Weather conditions : Daytime / Evening Clear / Dark cloud / Normal cloud**
4. **Measurements taken by : _____ , Section**

: Report created on: (date)

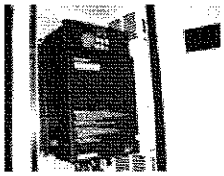
Energy-Saving Examples

Example	Electricity saved (figures in brackets show equivalent amount of crude oil)
Timer operation of air compressors	241,000 kwh (63.9 kl)
Inverter control of air conditioner motors	146,880 kwh (38.9 kl)
Reduction in cooling tower operating time	5,927 kwh (1.6 kl)

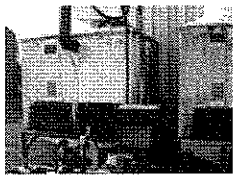
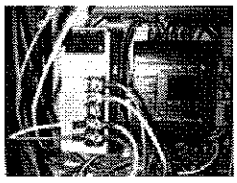
Timer operation of air compressors

Inverter control of air conditioner motors

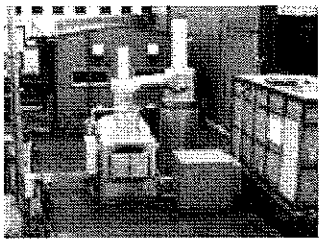
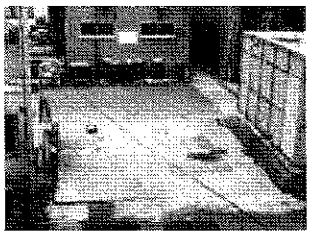



Reduction in cooling tower operating time

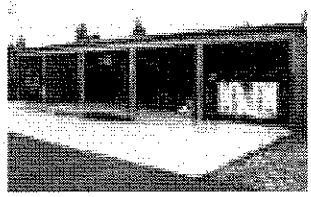



Zero Factory Waste Campaign

Factory incinerator removed

Waste segregated and sent to selected recyclers



Type of Waste	Disposal Method	Recycling Method	
		Raw Material	Raw Material
Food and drink waste	Incinerate in municipal incinerator		
Wood scraps	Pulverize and use for papermaking	○	○
Paper	Raw material for recycling	○	
Metal scraps	Melt and re-use	○	
Food and drink containers	Melt and re-use	○	○
Glass and china	Send to landfill		
Sludge	Incinerate	○	○
Plastic scraps	Send to landfill or use as roadbed material	○	○
Oil	Incinerate or re-use	○	○
Acid effluent	Chemically recycle	○	
Alakaline effluent	Incinerate or neutralise and recycle	○	○
Batteries and fluorescent tubes	Dismantle and recycle	○	
PCs	Dismantle and recycle	○	

TPM Manual Chapter 11 Getting Ready for TPM

JIPM-Solutions Co. Ltd.

TPM Preparation and Kick-Off :Step 1 - 5

Phase	Step	Key Point
Preparation	1. Top Management declares its commitment to introducing TPM.	Announce to Board of Directors and Heads of Department. Announce at in-house TPM seminars.
	2. A publicity campaign is mounted, and TPM orientation sessions are held.	Senior managers attend grade-specific residential courses or the JIPM's TPM course for executives. Others attend video training, team-leader courses, or briefing sessions.
	3. The site's basic TPM policy and targets are set.	Clearly set out business objectives, TPM programme objectives and policies. Survey losses to establish baselines and find out what improvements are needed.
	4. A TPM promotion organisation is established, and management-led pilot models are commenced.	Set up Steering Committee, Pillar Sub-Committees and TPM Office. Begin management pilot models.
	5. The TPM Master Plan is prepared.	Formulate 3-year Master Plan. Develop annual and quarterly action plans and monthly schedules.
Kick-Off	6. The TPM programme is officially kicked off.	Top management publicly reaffirms its commitment to TPM in front of invited outside parties such as customers and suppliers.

Step 1: Top Management declares its commitment to introducing TPM

Phase	Step	Key Point
Preparation	1. Top Management declares its commitment to introducing TPM.	Announce to Board of Directors and Heads of Department. Announce at in-house TPM seminars.
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Kick-Off	6. The TPM programme is officially kicked off.	Top management publicly reaffirms its commitment to TPM in front of invited outside parties such as customers and suppliers.

Step 2: A publicity campaign is mounted, and TPM orientation sessions are held..

Phase	Step	Key Point
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Steps 3-5

Phase	Step	Key Point
Preparation	1. Top Management declares its commitment to introducing TPM.	Announce to Board of Directors and Heads of Department. Announce at in-house TPM seminars.
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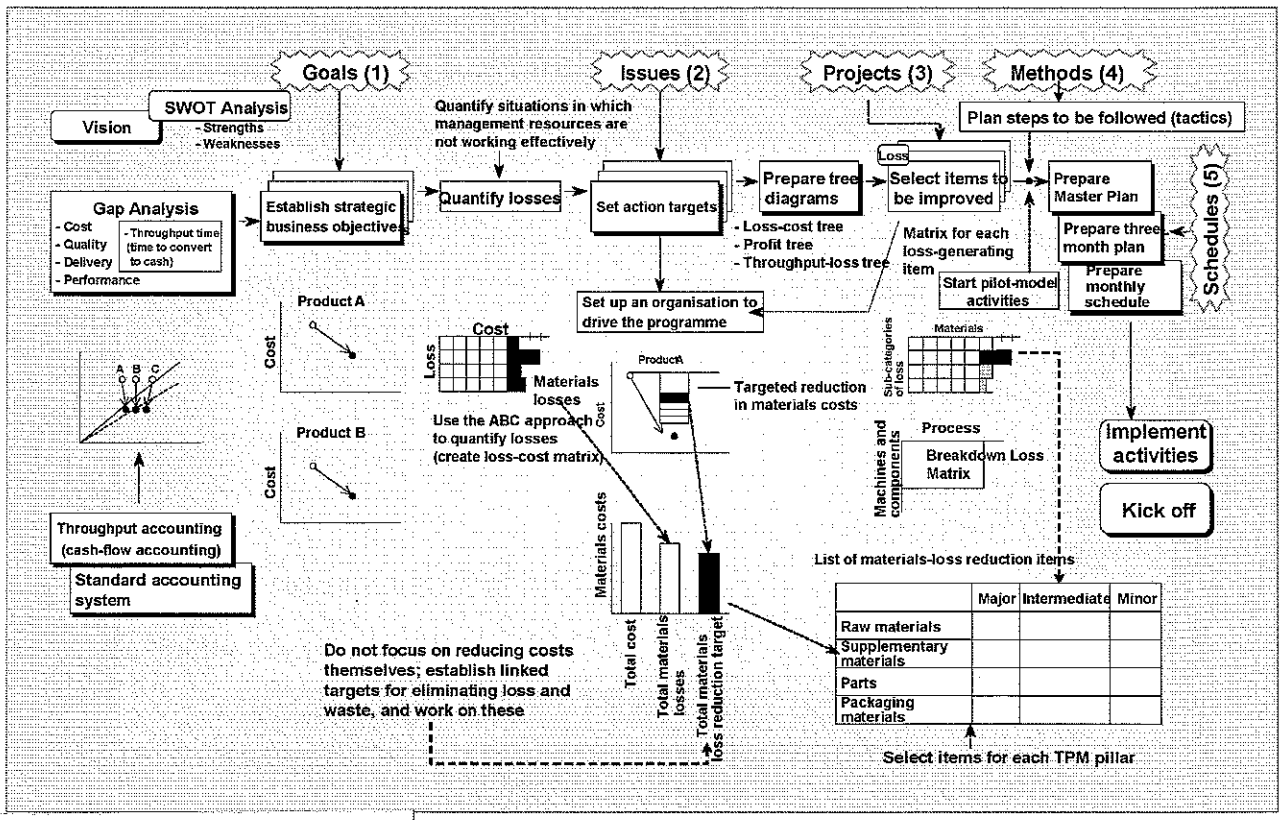
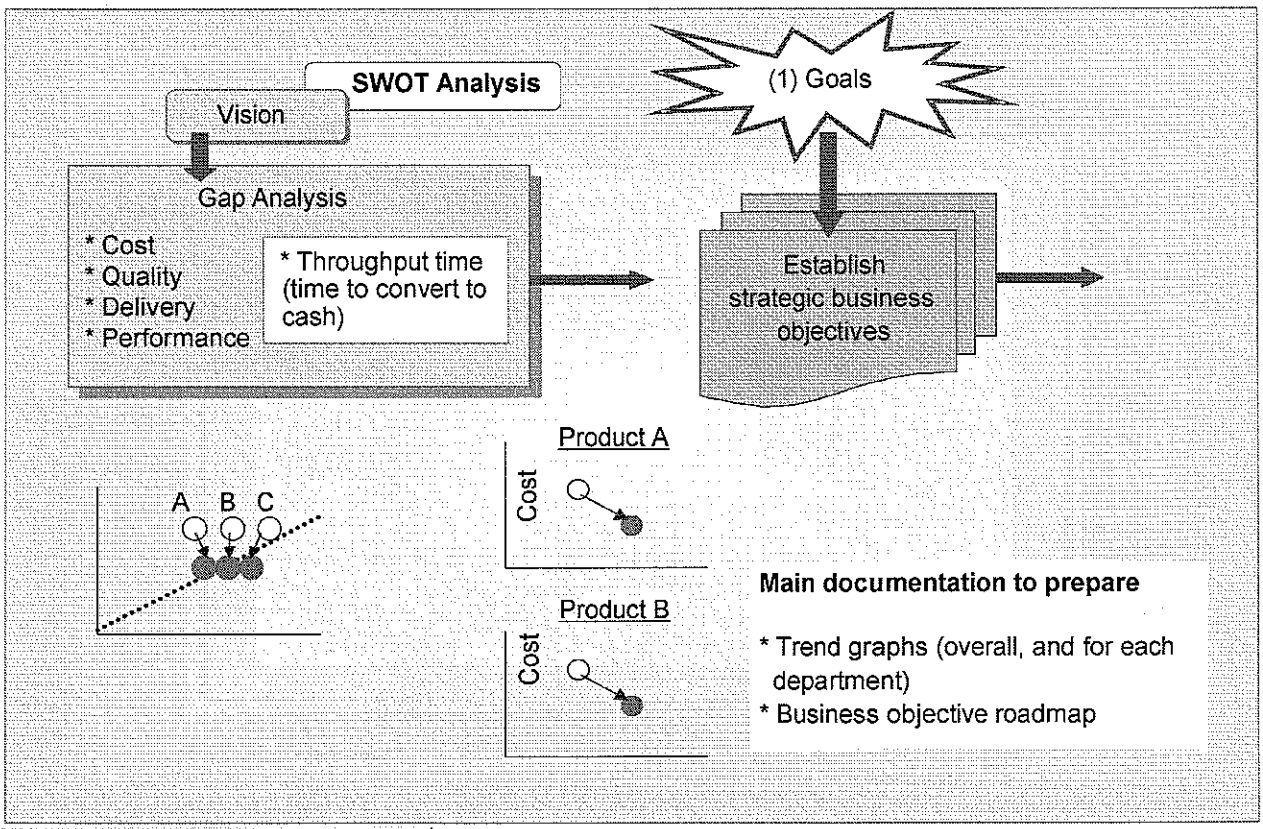
An Overview of TPM Pre-Engineered Planning



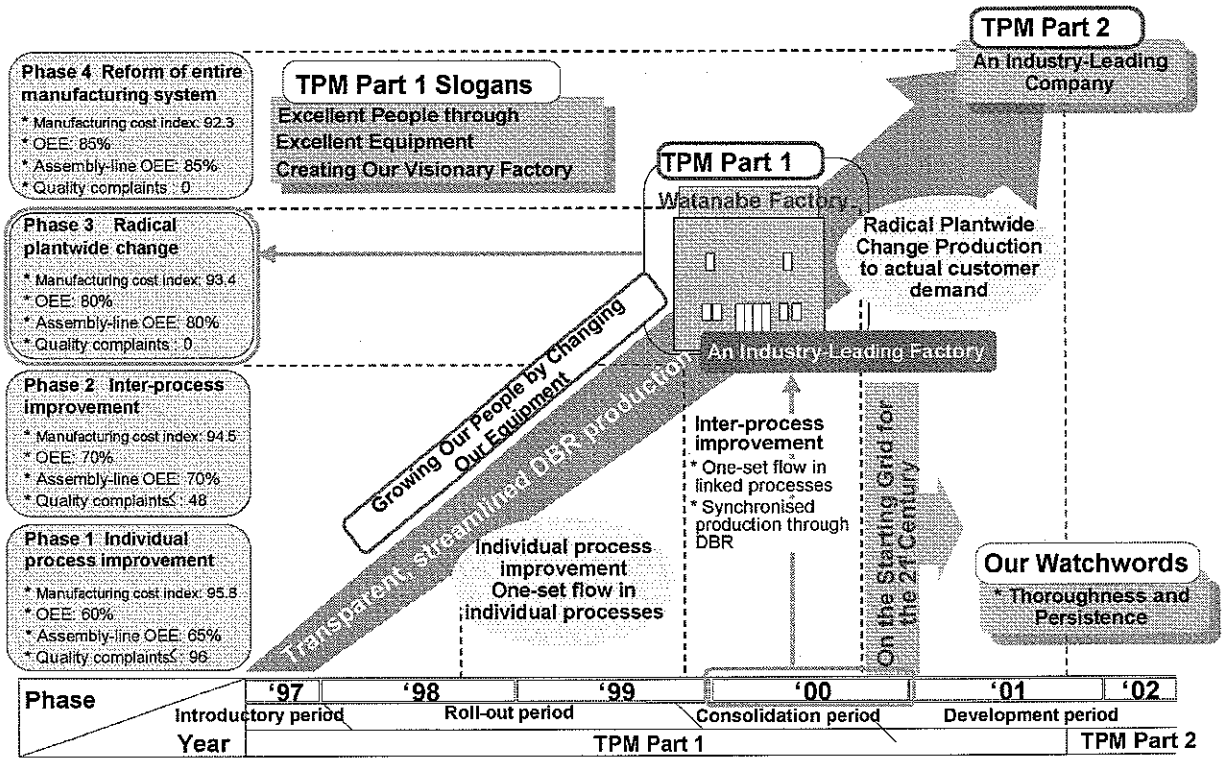
The 5 Key Planning Terms, and Associated Actions

The 5 Key Planning Terms	Principal Actions
(1) Goals	• Create a vision • Establish the business objectives
(2) Issues	• Identify the losses • Set action targets
(3) Projects	• Set up a promotion organisation • Select improvement projects
(4) Methods	• Plan the improvement programme's steps • Organise improvement teams • Implement management pilot models
(5) Schedules	• Prepare a TPM Master plan • Prepare annual and quarterly action plans • Prepare a monthly action schedule

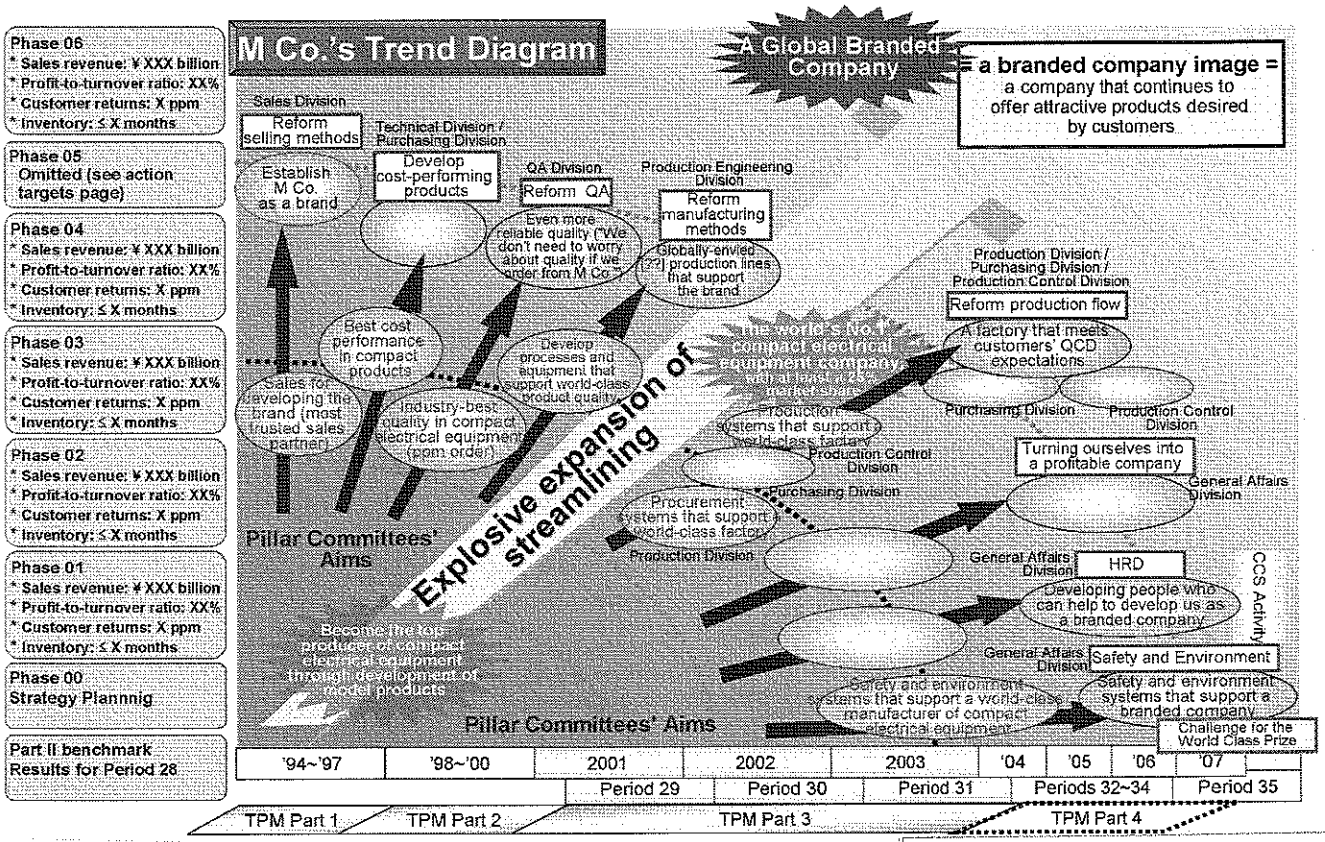
Planning Zone 1 (Goals)



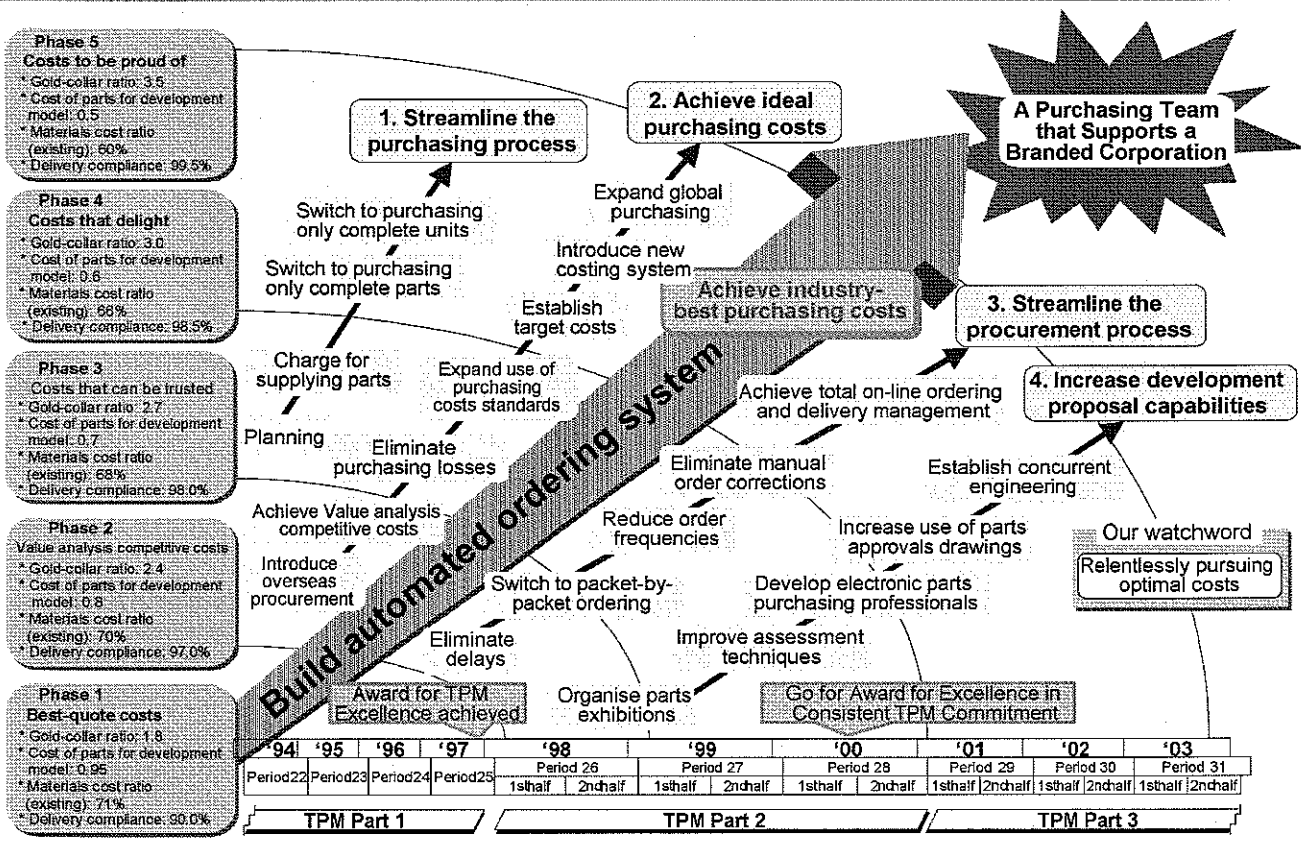
An Example of a Trend Diagram (for a Whole Factory)



An Example of a Trend Diagram (Aiming for TPM Part 3)



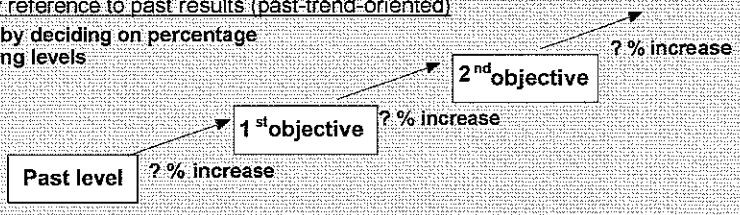
An Example of a Trend Diagram (for a Purchasing Department)



Two Approaches to Establishing Business Objectives

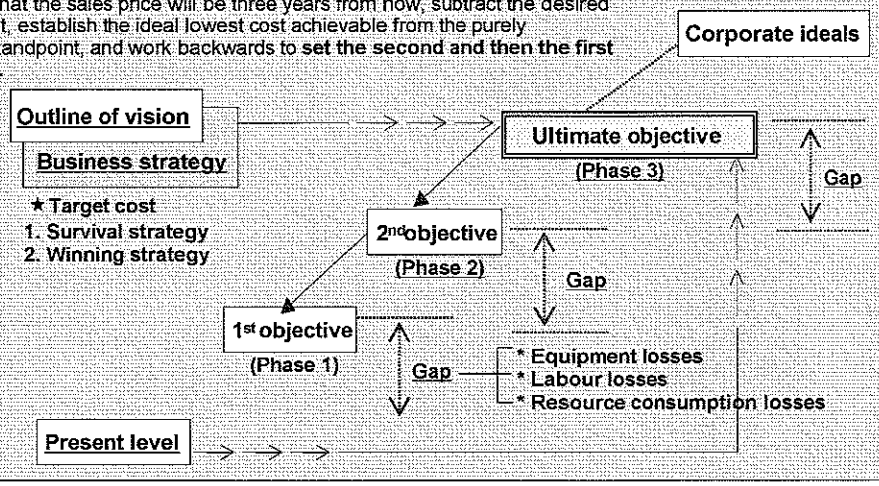
◆ Establish business objectives by reference to past results (past-trend-oriented)

Establish business objectives by deciding on percentage improvements to past or existing levels



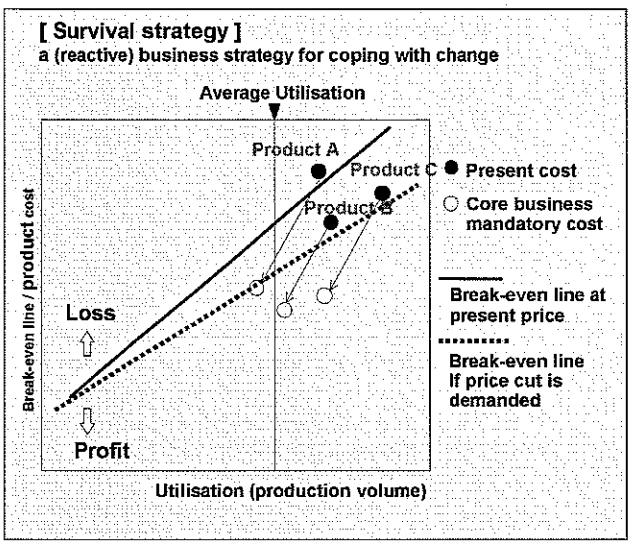
◆ Establish business objectives by reference to future vision (future-oriented)

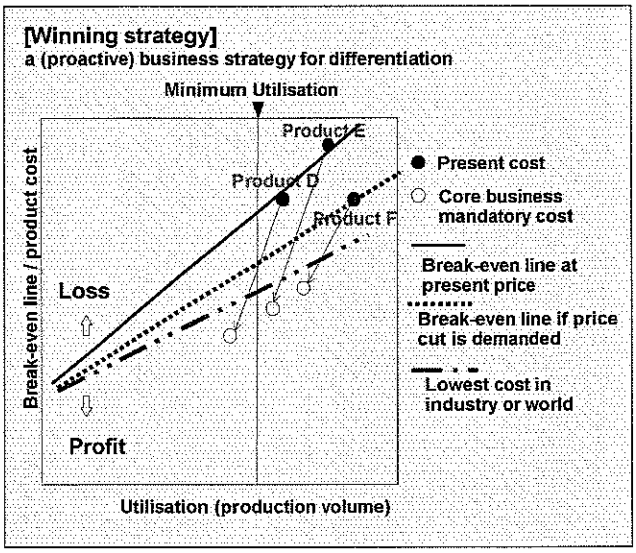
Estimate what the sales price will be three years from now, subtract the desired profit from it, establish the ideal lowest cost achievable from the purely technical standpoint, and work backwards to **set the second and then the first objectives.**



Survival Strategy and Winning Strategy (Cost)

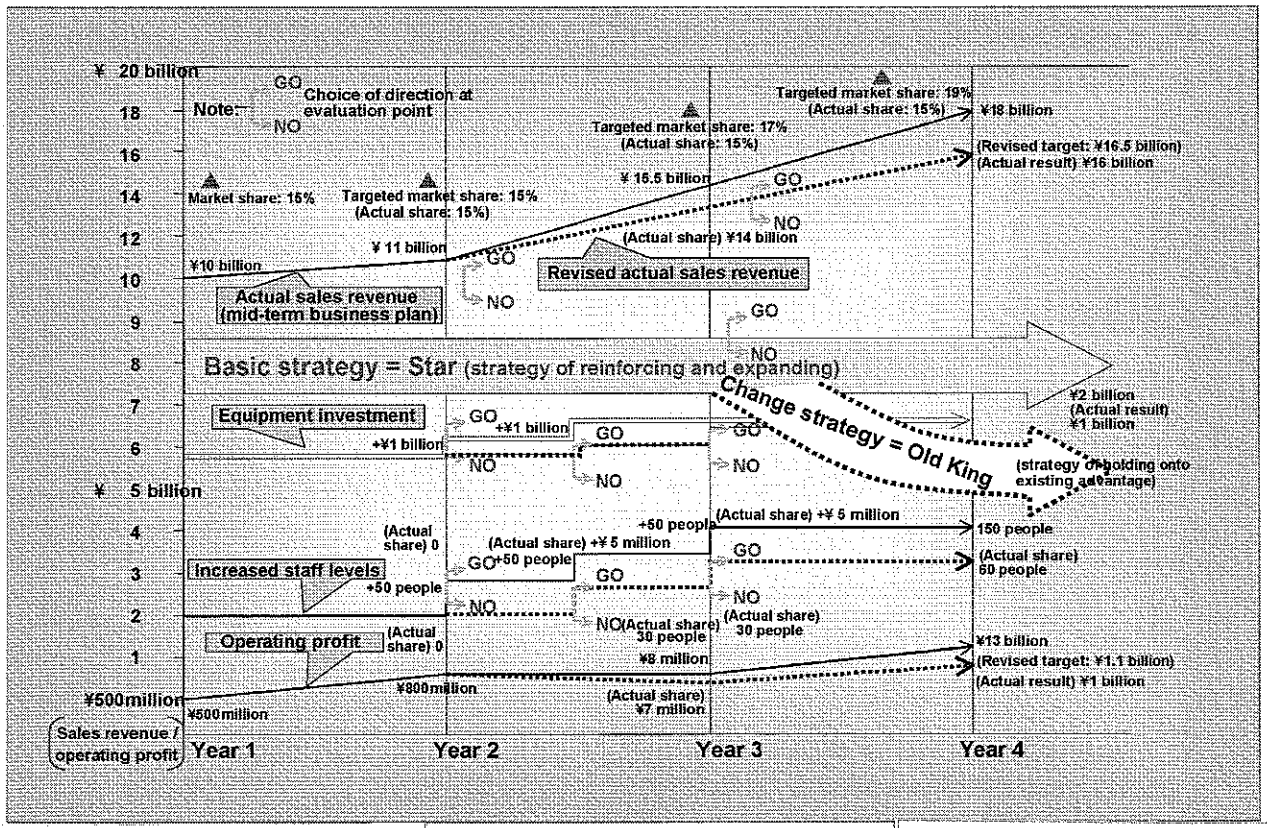
◆The product costs in these charts include not just production costs but everything else as well (direct materials costs, logistics costs, indirect costs, depreciation costs, etc.)



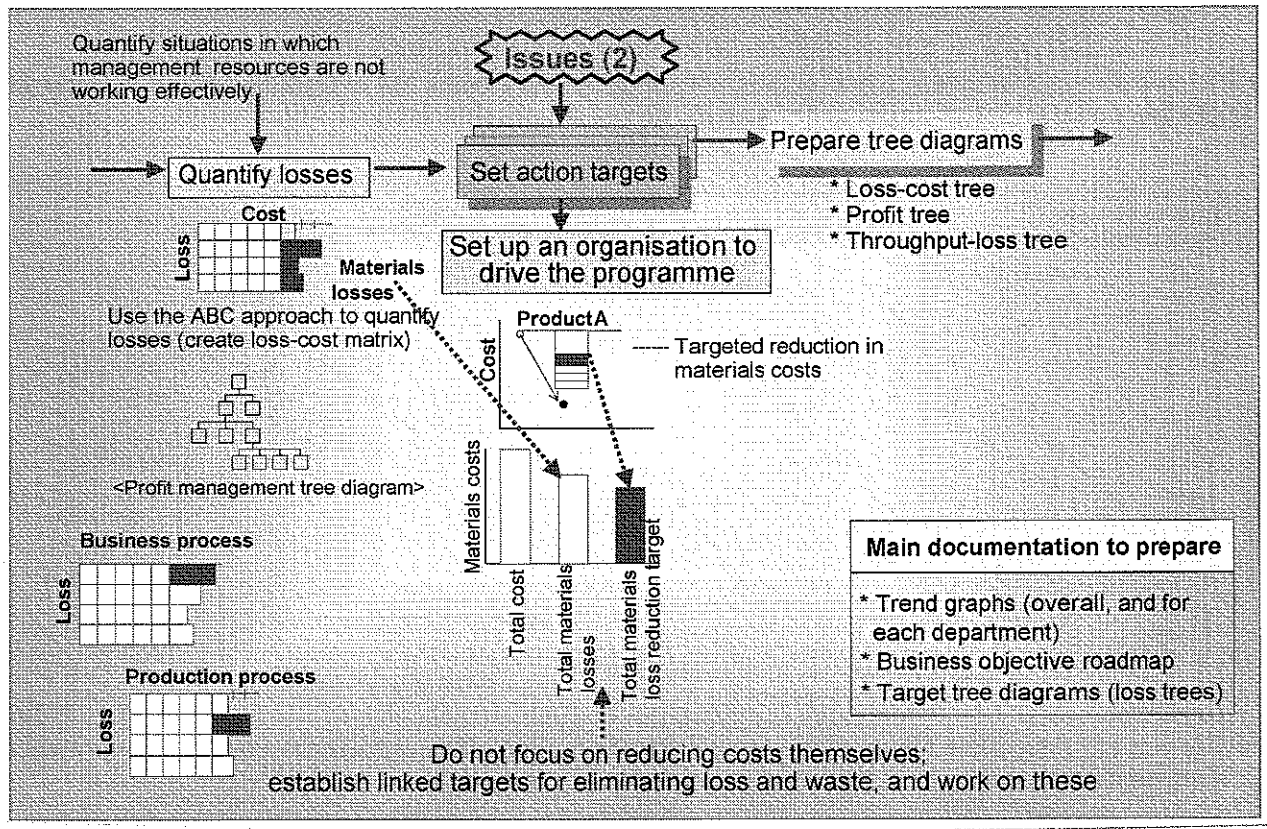


★The vertical axes of the above charts should also be thought of as representing quality, performance and delivery (speed)

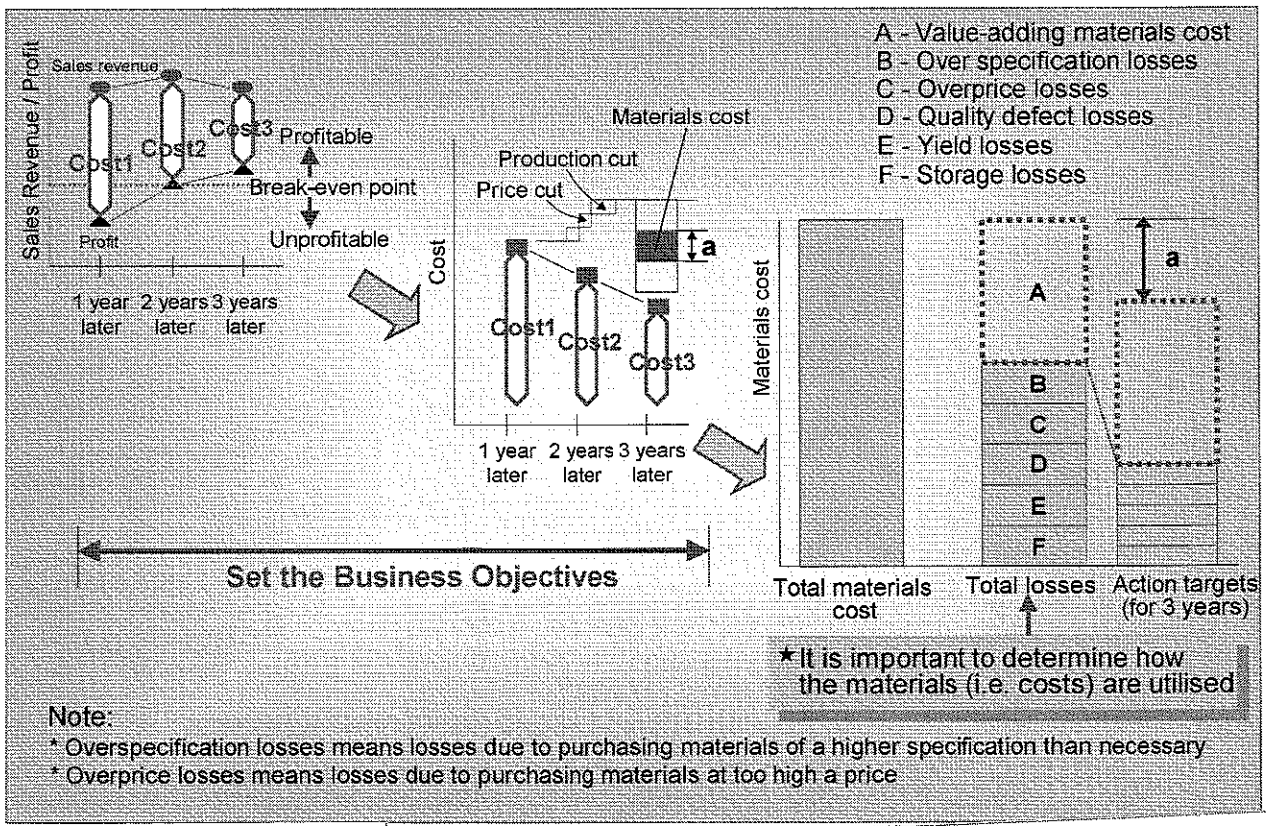
Example of a Business Objective Roadmap



Planning Zone 2 (Issues)



Developing Business Objectives into Action Targets (Example)



Note:
* Overspecification losses means losses due to purchasing materials of a higher specification than necessary
* Overprice losses means losses due to purchasing materials at too high a price

The Basic Approach to Identifying Losses

Step 1 Organise a loss-survey working group

- ◆ At least four people are required (one each for equipment, labour, unit-consumption and management losses)

Step 2 Draw up a profit tree diagram and loss-cost matrix

Step 3 Define the losses and set standards for calculating the costs (effect on operating profit)

- ◆ Example: breakdown loss
  - Definition: the time for which the equipment is stopped for repairs or replacement of parts
  - Cost: (repair downtime x number of people x hourly rate) + cost of parts
- ★ When calculating the cost of losses related to equipment or labour efficiency, note that whether a loss can be converted directly into a cost or not depends on:
  1. Whether demand exceeds capacity or vice versa
  2. Whether the loss is in a bottleneck process or not

Step 4 Verify the model

Step 5 Standardise and develop tools

- ◆ Standardise: loss definition, cost calculation formula, cost evaluation rate, etc.
- ◆ Develop tools: data collection system (log, runtime indicator, on-line system, etc.)
  : data recording system (control charts, target tree diagrams, etc.)

Step 6 Train out by relay teaching to each level (definitions, formulae, use of tools)

Step 7 Measure all the losses and associated costs (effect on operating profit)

- ◆ Enter the total loss and total cost on the loss-cost matrix (complete the matrix)
- ◆ If the demand changes, always re-investigate the losses

Step 8 Set the baseline (for total loss and total cost) and decide on the order of priority for improvement

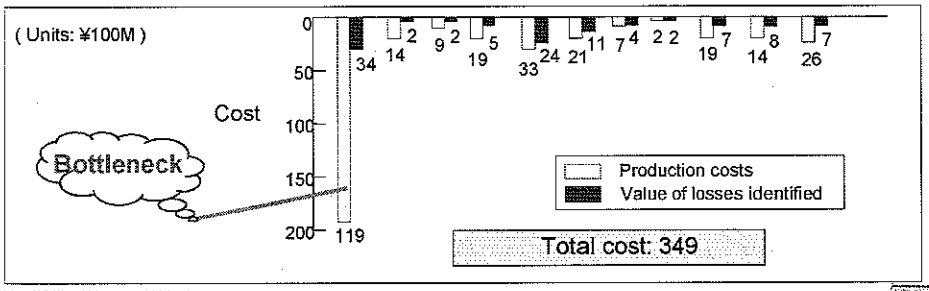
- ◆ Set a baseline for each department, area, line and machine
- ◆ The order of priority for improvement should follow the order of the cost of the losses (the order of the constraints)

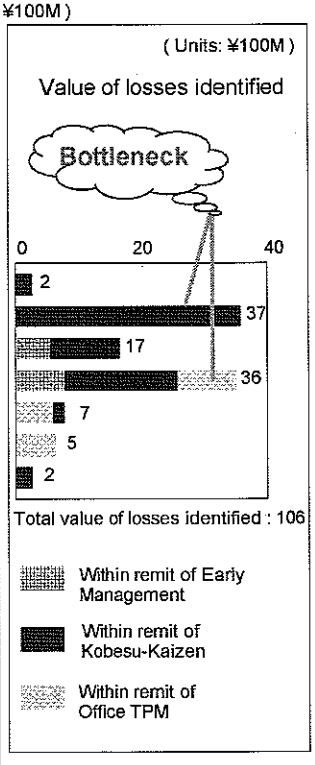
Set loss-reduction targets, draw up a target tree diagram, establish the steps to follow, prepare a plan, and carry out the improvements

A Typical Loss-Cost Matrix (A Loss Structure for an Entire Factory)

(Units: ¥100M)

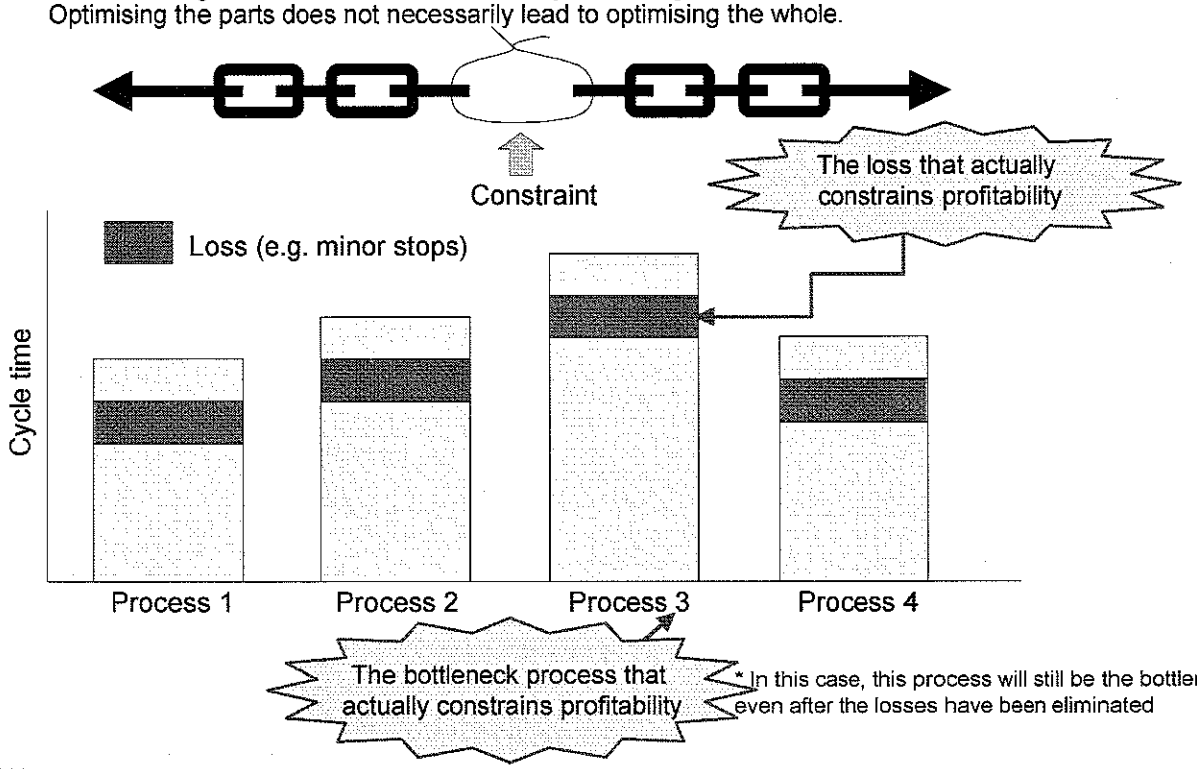
Losses \ Costs	Variable costs				Fixed costs								
	Raw materials costs	Packaging costs	Miscellaneous costs	Utilities costs	Labour costs	Depreciation	Maintenance costs	Miscellaneous costs	Support Departments: Direct	Support Departments: Administrative	Direct sales costs	Other costs borne by company	Total
Production costs	199	14	9	19	33	21	7	2	19	14	26	-15	349
Early-management losses												2.0	2
OEE losses	1.5	0.1			12.6	7.8	2.6	0.9	5.8	5.8			37
Direct labour losses			1.2		11.1	1.9	1.0	0.1	1.3				17
Raw materials losses	29.0	0.9	0.3	5.1				0.8					36
Storage and distribution losses												6.6	7
Purchasing losses	3.7	1.2	0.6										5
Administrative losses										2.0			2
Total value of losses	34	2	2	5	24	10	4	2	7	8	7	2	106



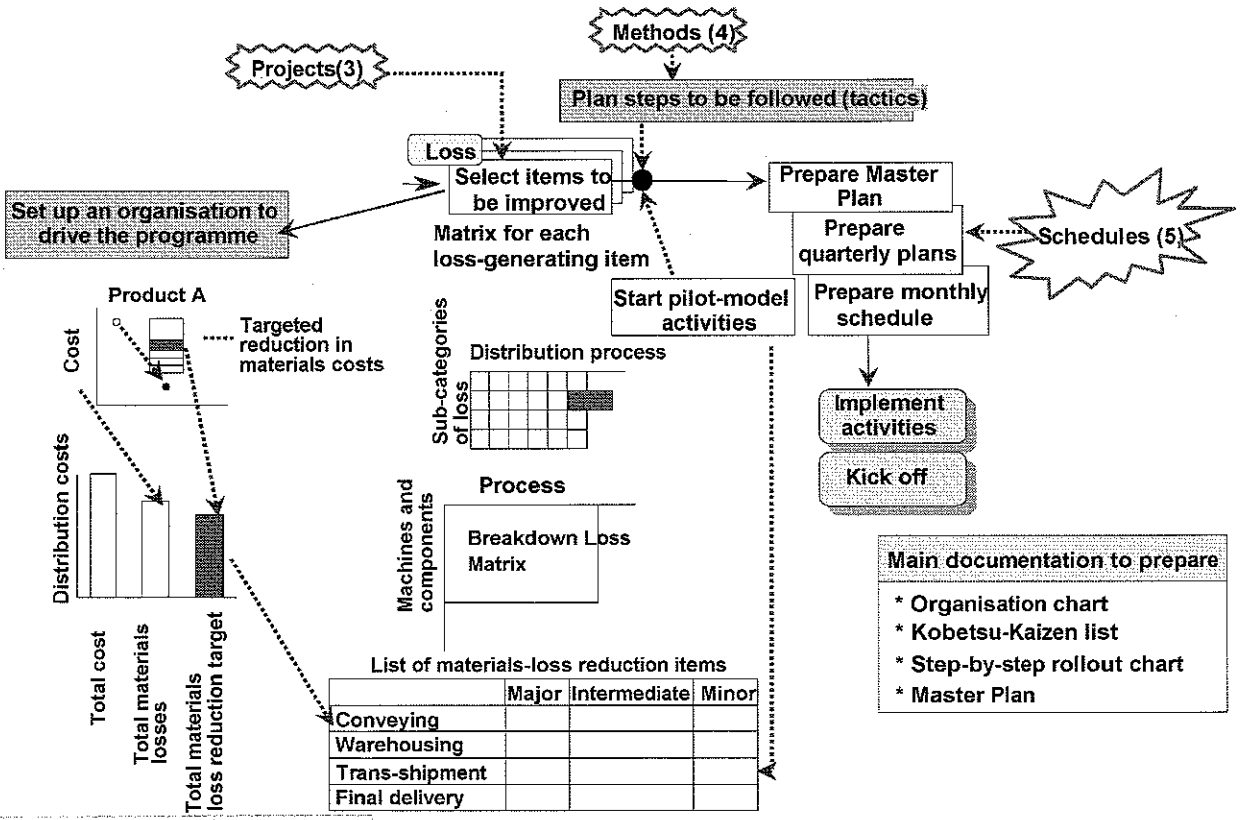


Individual Process Losses on an Automated Machining Line

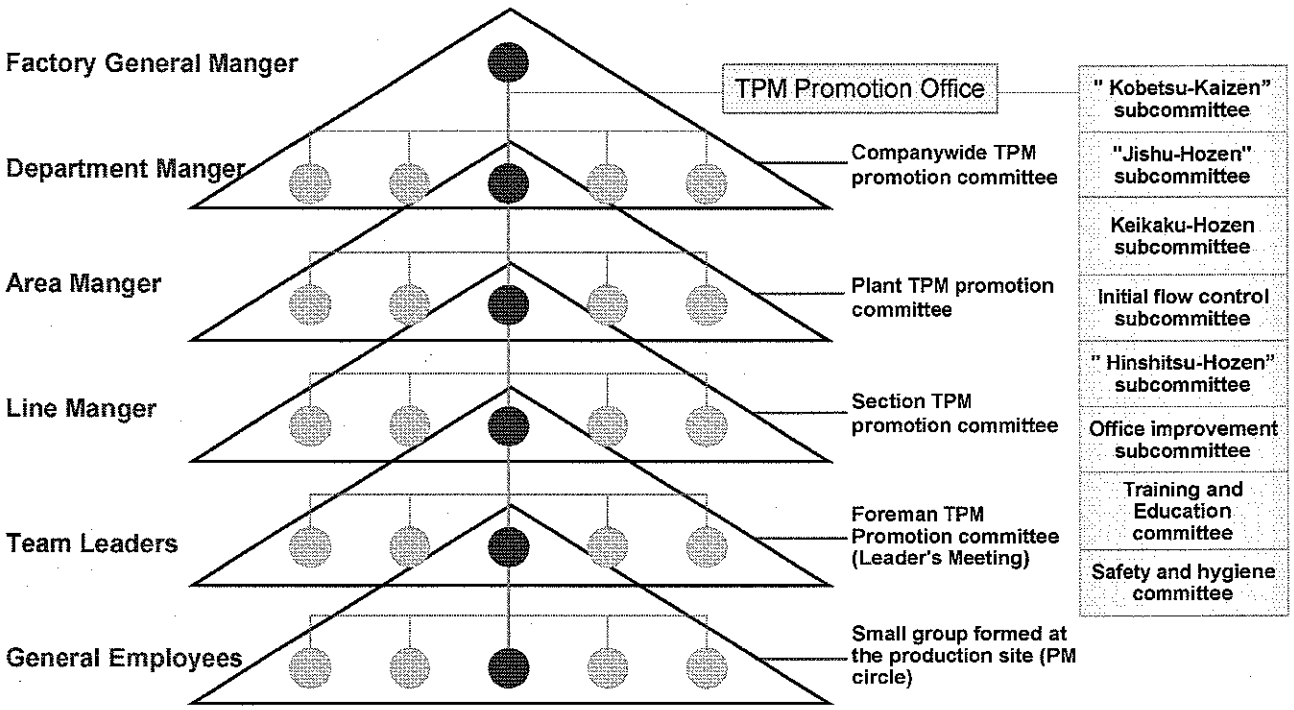
In a ' throughput 'world, the effectiveness of a system is determined by the strength of the chain, and the strength of the chain is determined by the strength of its weakest link.
Optimising the parts does not necessarily lead to optimising the whole.



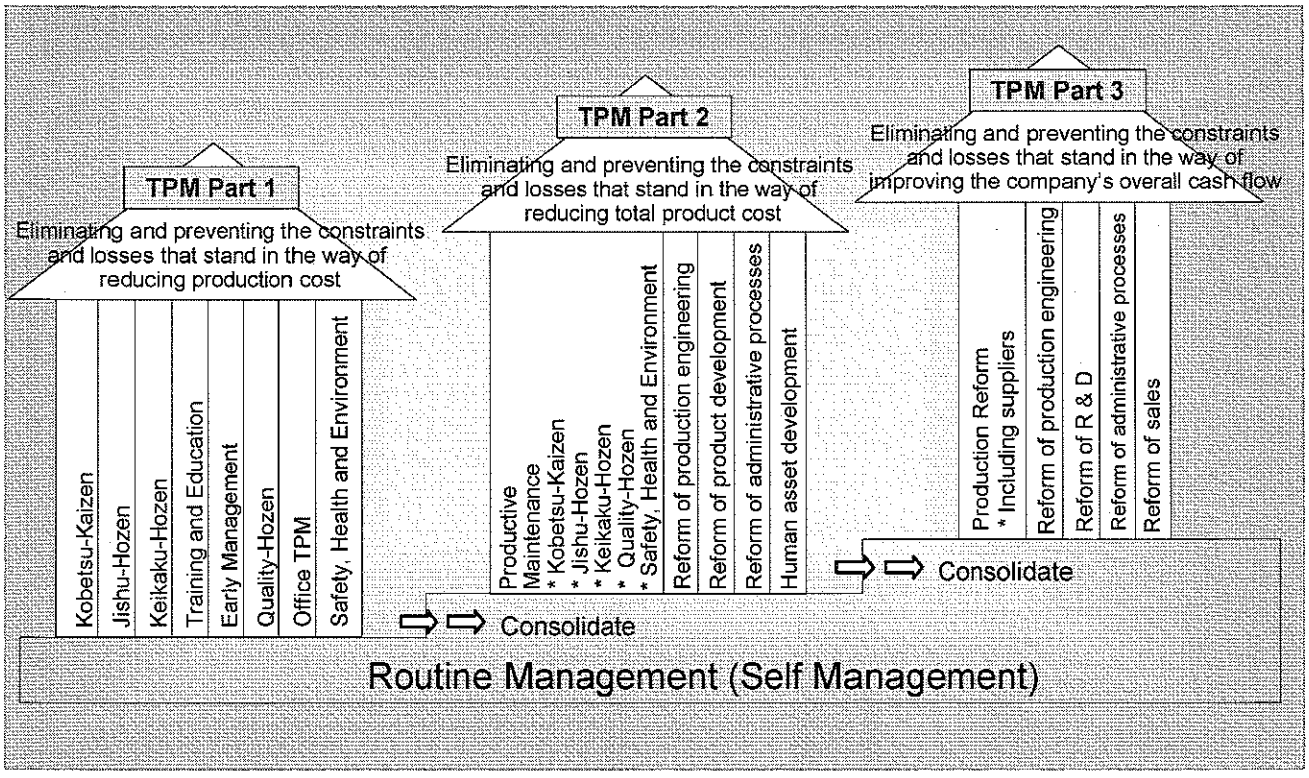
Planning Zone 3 (Projects)



A TPM Promotion Mechanism



Example of TPM Pillar Structure



Organisational Responsibilities for Losses and Costs

			Cost: Variable Costs: Raw Materials and Fuel	Power	Other Variable Costs	Fixed Costs: Administration	Equipment	Labour	Other Fixed Costs	Distribution	Miscellaneous	Work Unit: Production Department: No.1 Production Unit	No.2 Production Unit	No.3 Production Unit	No.4 Production Unit	Supplier (Watanabe Chemical)	Cutting Research	Utilities	General Affairs	Technical	Safety and Environment	TPM Office	Committee: Pillar Subcommittee: Kobetsu-Kaizen	Jishu-Hozen	Effective Maintenance	Training and Education	Development Efficiency	Quality-Hozen	Indirect Efficiency	Safety and Environment
Equipment	1	Quality loss	◎		○							◎	◎	◎	◎	◎	○	◎		○	○		○	○				◎		
	2	Performance loss	◎	○	○	○	○	○	○			◎	◎	◎	◎	◎	○	◎		◎			◎	○						
	3	Stoppage loss	◎		○	○	○	○	○			◎	◎	◎	◎	◎		◎		◎			◎	○	○					
	4	Shutdown loss			○			◎	○			◎	◎	◎	◎	◎		◎					Kobetsu-Kaizen programme from Sect 12							
Labour	5	Human efficiency loss						◎				◎	◎	◎	◎	◎		◎	◎	○		○	◎	○					○	
Unit Consumption	6	Unit-consumption loss	◎	○					○			◎	◎	◎	◎	◎	○	◎		○			◎	○				○		
	19	Resource loss	○	◎	○							◎	◎	◎	◎	◎		◎		○			◎	○						
Management	7	Maintenance loss					◎													◎					◎					
	8	Purchasing loss	◎		○	○	○					◎	◎	◎	◎	◎		◎	◎	◎			○		○				◎	
	9	Distribution loss				○				◎		○	○	○	○	○			◎				○						◎	
	10	Storage loss				◎	○			○		◎	◎	◎	◎	◎		◎	◎	◎			○		○				◎	
	11	Outsourcing loss			○	◎		○	○			◎	◎	◎	◎	◎			◎	◎			○						◎	
	13	Delivery loss										◎	◎	◎	◎	◎			◎				○						◎	
	14	Quality-control loss	○					○	◎			◎	◎	◎	◎	◎					○							◎		
	17	Administrative loss						◎				◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎							◎	
	18	Safety and environment loss			○	○	◎		○			◎	◎	◎	◎	◎		◎		○	○		◎	○						○
Development	15	New-product development efficiency loss	○				○	○				◎	◎	◎	○	○	◎			○							◎			
	16	Equipment investment loss					◎					○	○	○	○	○		○		◎							◎			
Opportunity	12	Missed-opportunity loss		○			○	○				◎	◎	◎	◎	◎	○			○			◎							
Other		Other losses																					◎							

◎ Closely related
○ Related

◎ Responsible Unit
○ Relevant or supporting Unit

◎ Responsible Subcommittee
○ Relevant Subcommittee

Organisational Roles and Responsibilities (Example 1/2)

Title	Composition	Aims	Responsibilities	Meeting Frequency
Company TPM Steering Committee	Chair: President Members: Directors, Factory General Managers, TPM Managers	* Systematically drive the company's TPM programme	1. Set basic company policy and targets 2. Form companywide project teams 3. Monitor progress and provide advice and guidance 4. Approve action plans 5. Decide how to deal with problems	1/month
Factory TPM Steering Committee	Chair: Factory General Manager Members: Department Managers, TPM Manager or TPM Office Staff	* Systematically drive the factory's TPM programme	1. Set basic factory policy and targets 2. Formulate factory TPM Master Plan 3. Form factorywide project teams 4. Monitor progress and provide advice and guidance 5. Decide how to deal with problems	1/month
Department TPM Meetings (Leaders' Meetings)	Leader: Production Department Manager Members: Area Managers, Supervisors, Maintenance Staff	* Systematically drive Autonomous Maintenance and Kobetsu-Kaizen	1. Formulate Jishu-Hozen and Kobetsu-Kaizen implementation plans and monitor progress 2. Define problems and coach teams 3. Form Kobetsu-Kaizen project teams	1/month
Area TPM Meetings (Leaders' Meetings)	Leader: Area Manager Members: Supervisors	* Systematically drive Jishu-Hozen and Kobetsu-Kaizen	1. Formulate Jishu-Hozen and Kobesu-Kaizen implementation plans, and monitor progress 2. Define problems and coach teams	1/month
Kobetsu-Kaizen Subcommittee	Chair: Production Engineering Department Manager Members: Production Engineering Staff	* Create efficient lines by eliminating the 16 Big Losses	1. Advise on how to carry out Kobetsu-Kaizen 2. Advise on how to replicate improvements in other areas 3. Facilitate standardisation and information exchange	1/month
Jishu-Hozen Subcommittee	Chair: Factory General Manager Members: Factory Production Managers, Area Managers	* Develop equipment-competent operators	1. Find out about, and advise on, implementing the Jishu-Hozen steps 2. Coordinate management pilot models 3. Facilitate standardisation and information exchange	1/month

Organisational Roles and Responsibilities (Example 2/2)

Title	Composition	Aims	Responsibilities	Meeting Frequency
Keikaku-Hozen Subcommittee	Chair: Maintenance Manager Members: Maintenance supervisors	* Go for zero breakdowns * Improve maintenance efficiency	1. Study step-by-step development of Kaikaku-Hozen programme 2. Advise on how to carry out Keikaku-Hozen 3. Advise on how to replicate improvements in other areas 4. Facilitate standardisation and information exchange	1/month
Early Management Subcommittee	Chair: Technical Development Manager Members: Research and Development managers and supervisors, Production Engineering Staff	* Develop system for right-first-time vertical startup	1. Study examples of Early Management 2. Review the existing system 3. Standardise	1/month
Quality-Hozen Subcommittee	Chair: Quality Manager Members: Quality Assurance staff, Production Engineering staff, Production supervisors	* Establish zero-defect lines	1. Investigate available techniques 2. Advise on how to implement Quality-Hozen 3. Advise on methods of replicating improvements in other areas 4. Facilitate standardisation and information exchange	1/month
Administrative Improvement Subcommittee	Chair: Administrative and Support Department Manager Members: Administrative and Support department staff	* Create workplaces with high levels of administrative efficiency	1. Find out how to develop a step-by-step programme 2. Advise on how to carry out administrative Kobetsu-Kaizens 3. Advise on how to replicate improvements in other areas 4. Facilitate standardisation and information exchange	1/month
Training and Education Subcommittee	Chair: Personnel Manager Members: Staff from each area	* Improve maintenance skills * Improve management skills / Improve technical skills	1. Draw up a Training and plan 2. Monitor progress and consider problems	1/month
TPM Promotion Office	Chair: TPM Manager Members: Chairpersons of Subcommittees, TPM Office staff	* Manage the TPM programme efficiently	1. Draw up TPM promotion plans 2. Propose facilities for keeping TPM programme energised 3. Consider, coordinate and advise on problems encountered by Pillar Subcommittees	Whenever necessary

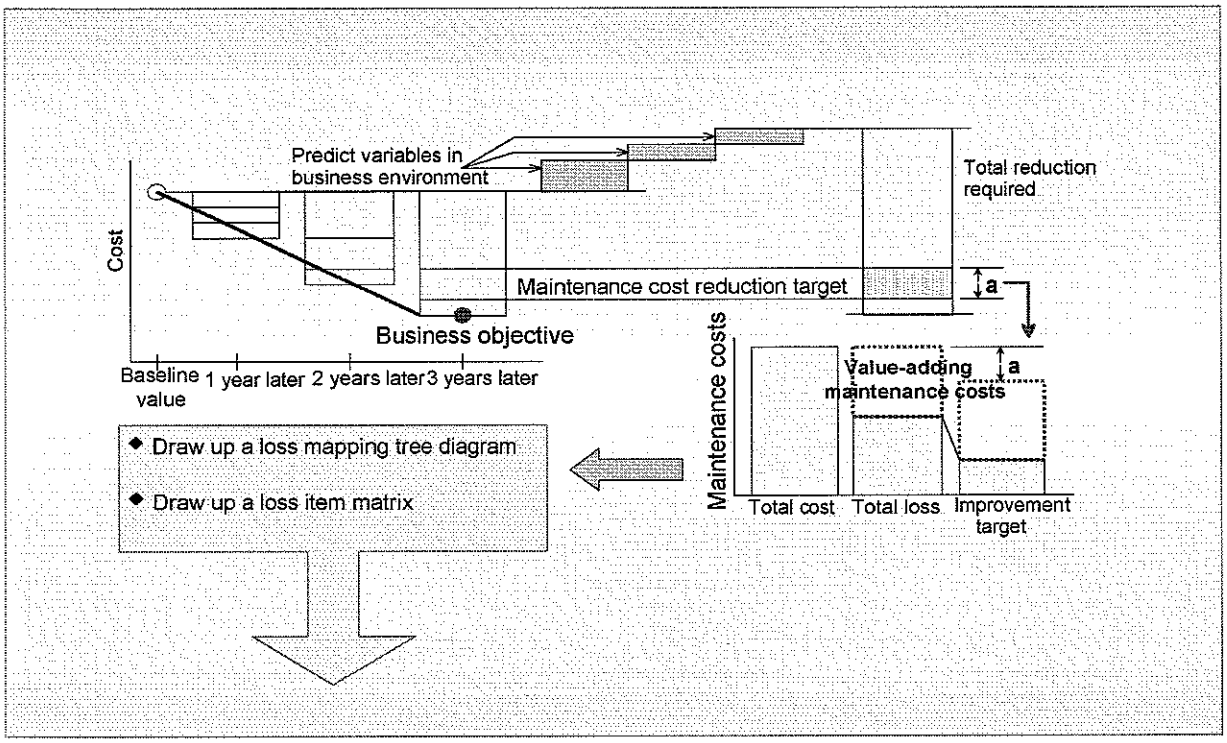
Improvement Project Selection and Registration (Example)

Improvement Project	Assembly Line A (Main Line) Breakdown Reduction	Pillar	Effective Maintenances
Type of Target	Breakdown Recurrence Prevention	Target Value	0 Breakdowns

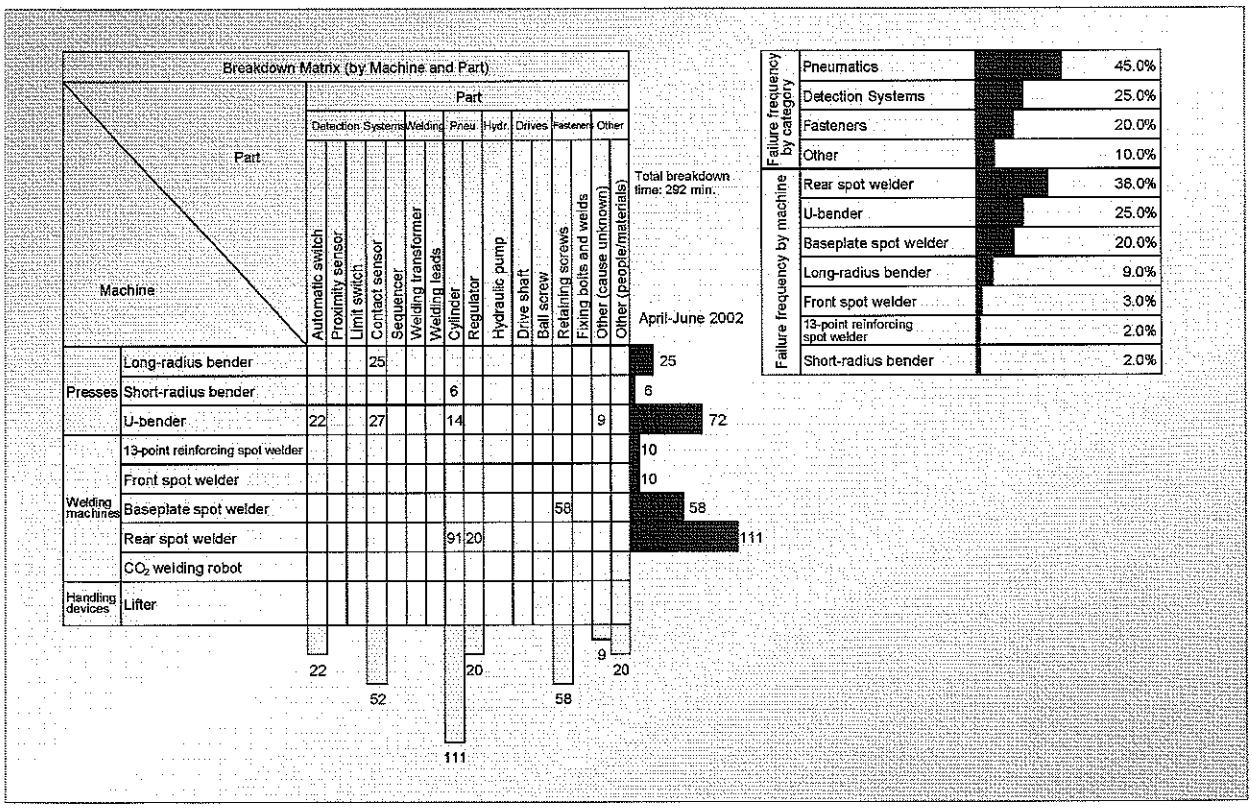
◎ — Ahead of schedule △ — Somewhat behind schedule
○ — On schedule ▲ — Very behind schedule

Category	No.	Topic (work item)	Reason for stoppage	Down time (min)	Time scale (months)	Pillar Responsible	Project Leader		1	2	3	4	5	6	7	8	9	10	11	12	Progress	Remarks
Control	1	Eliminate malfunction of U-bender datum-line cylinder	Sequence input 310 from FXD die came on	19	3.5	Keikaku-Hozen	Smith	Plan														
								Actual														
Control	2	Eliminate malfunction of lifter valve for U-bender FXD die	'On' signal was applied to both sides of solenoid valve during operation	28	3.5	Keikaku-Hozen	Smith	Plan														
								Actual														
Control	3	Eliminate mis-initiation of U-bender replacement head	On initiation, replacement head failed to return to start point	5	3.5	Keikaku-Hozen	Hillman	Plan														
								Actual														
Control	4	Eliminate front and rear spot-welder pressurising defect	Thyristor timer (CPU board, thermal) malfunctioned	175	5	Keikaku-Hozen	Lewis	Plan														
								Actual														
Hydraulics	5	Eliminate leakage from U-bender hydraulic system	Hydraulic fluid leaked from pressure gauge	6	3.5	Jishu-Hozen Keikaku-Hozen	Baker Hillman	Plan														
								Actual														
Drives	6	Improve bearings in U-bender out-take rollers	Needle bearings became deformed	9	4	Keikaku-Hozen	Lewis	Plan														
								Actual														
Drives	7	Eliminate malfunction of U-bender depth end bearings	Bearings sagged as a result of mis-installation of tool	114	3	Jishu-Hozen Keikaku-Hozen	Baker Jones	Plan														
								Actual														
Hydraulics	8	Prevent puncturing of short-radius bender hydraulic pipework	Vibration of hose caused pinholes to form in weld	23	3	Jishu-Hozen	Smith	Plan														
								Actual														
Drives	9	Improve bearings in U-bender infeed rollers	Needle bearings became deformed	9	4	Keikaku-Hozen	Lewis	Plan														
								Actual														
Welding	10	Improve method of fixing 13-point spot welder cooling hose	Cooling hose became detached from bracket	11	4	Jishu-Hozen Keikaku-Hozen	Jones Smith	Plan														
								Actual														
Pneumatics	11	Eliminate malfunction of short-radius bender front stopper	Front stopper became jammed	9	4	Keikaku-Hozen	Hillman	Plan														
								Actual														
Electrics	12	Improve motor brake circuit on short-radius bender	Magnetic contacts used for brake fused together	83	5	Keikaku-Hozen	Smith	Plan														
								Actual														
Drives	13	Improve conveyor-shaft bracket on long-radius bender	Shaft fixing bracket broke	9	6	Jishu-Hozen Keikaku-Hozen	Baker Hillman	Plan														
								Actual														
Drives	14	Improve U-bender servo-motor connecting pins	Product depth dimension went out of spec because connecting pin broke	10	3	Keikaku-Hozen	Hillman	Plan														
								Actual														
Wiring	15	Prevent severing of lead to discharge pusher sensor on baseplate spot welder	Cable was tugged by cylinder until it broke	53	3	Keikaku-Hozen	Smith	Plan														
								Actual														

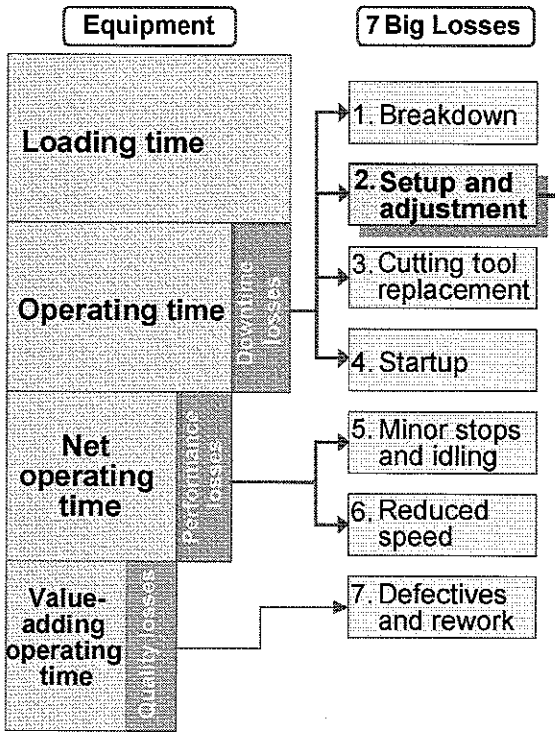
A Typical Approach to Selecting Improvement Projects



A Loss Matrix for a Particular Production Line



A Step-by-Step Programme for Eliminating Setup and Adjustment Losses



The Setup and Adjustment Loss Reduction Programme

Step 1: Find out what is happening at present

Step 2: Set improvement targets

Step 3: Eliminate waste

Step 4: Separate external tasks from internal ones, and standardise the external ones

Step 5: Make internal tasks more efficient

Step 6: Eliminate the need for adjustment, ensure right-first-time startup and check results

Step 7: Standardise, and sustain improvements

Example of Steps to Zero Setup & Adjustment Loss

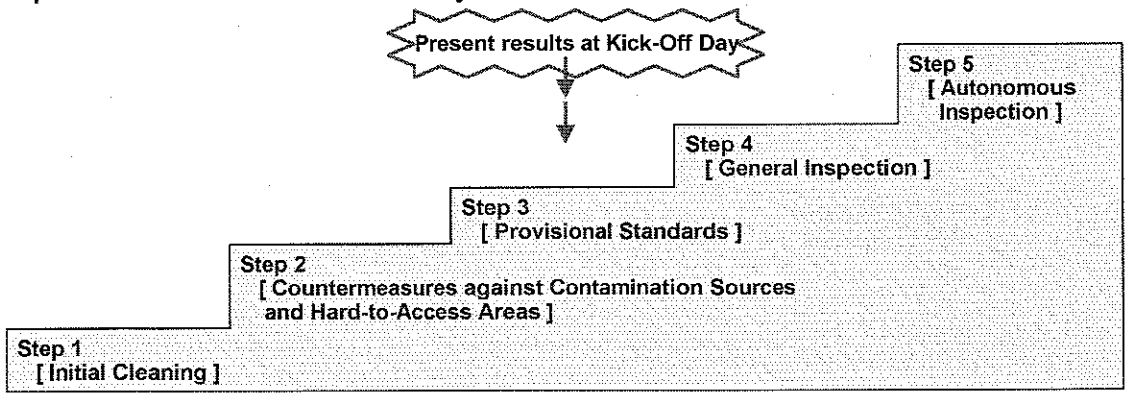
Step 1: Find out what is happening at present	
* Analyse the changeover documentation * Study the features of the equipment * Analyse the changeover operation itself	• Determine the mechanism, system, characteristics, pattern and scope of the changeover. • Ascertain the relationship with auxiliary equipment, and find out the mechanism, shape and precision of the dies, jigs and other parts used. • Identify the setup and adjustment methods and procedures followed (the purpose of each task, the section of the equipment involved, what is done, the parts used, the tools and equipment used, the checks carried out, the time required for each task, and the usefulness of each task).
Step 2: Set improvement targets:	
* Set targets that take into account * Equipment constraints * Equipment improvements	
Step 3: Eliminate waste	
* Eliminate wasteful actions and unnecessary objects * Study preparations required	Ensure that: • No time is wasted looking for things unnecessarily; • No unnecessary movements are made; • Nothing is used unnecessarily; • No tools are surplus to requirements (in type or quantity); • Space is used and objects are stored in a rational and economical way; • Tools and parts are kept in defined locations; • Work procedures create no wasted time or effort.
Step 4: Separate external tasks from internal ones, and standardise the external ones	
* Identify internal tasks (tasks that can only be done when the machine is stopped) * Identify external tasks (tasks that can be carried out while the machine is still working) * Establish standard procedures for external tasks	• Check, pre-heat and pre-install dies, jigs and other parts. • Use gauge blocks for setting up. • Specify the methods, timings, parts and tools to be used, and train operators thoroughly.

Example of Steps to Zero Setup & Adjustment Loss

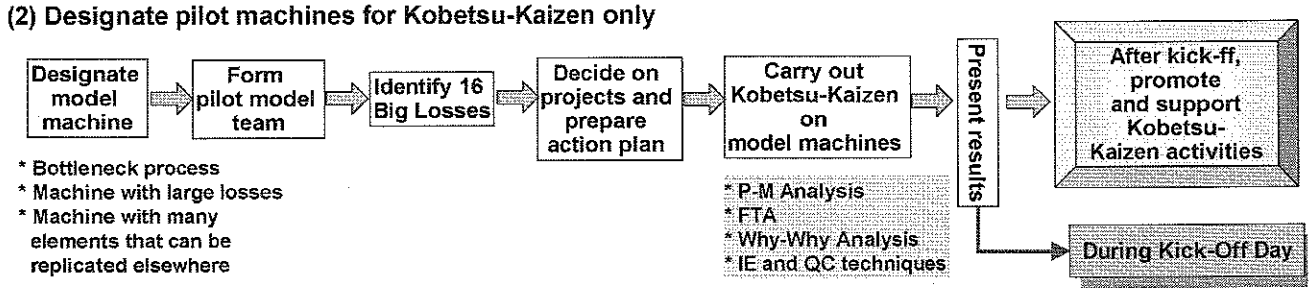
Step 5: Make internal tasks more efficient	
* Establish standard procedures for internal tasks * Stabilise internal-task times * Reduce the time required for internal tasks	• Raise time-target attainment rates, and reduce time variation and quality problems. • Increase startup stability, and list problems (mechanical, human and method-related). • List necessary improvements. • Improve the way operators work (standardise methods, and review task allocation, task usefulness, simplification, making assembly easier, combining tasks, integrating tasks, eliminating tasks, carrying out tasks in parallel, assignment of personnel). • Examine dies, jigs and other parts (review tightening methods, number of tightening tools used, mechanisms and shapes, use of intermediate jigs, standardisation, interchangeability, weight, etc.). • Turn variables into constants (e.g. use fixed positioning, dimension-setting, reducing tasks to a single action, attaching and removing workpieces in a single motion, bolt-free assembly, and automatic clamping).
Step 6: Eliminate the need for adjustment, ensure right-first-time startup, and check results	
* Analyse adjustment effectiveness and eliminate unnecessary work * Make it possible for defect-free products to be produced from the word 'go'	• Study the purpose of each adjustment, and find out what is involved and why the adjustment is necessary in the first place. • Identify principles of adjustments, and look into the possibility of eliminating them. • Implement improvements (accommodate unavoidable adjustments). • Eliminate test-processing.
Step 7: Standardise, and sustain improvements	
* Standardise changeover procedures and drill the actions involved	• Draw up changeover standards. • Drill the actions involved (work to the clock, or to music, etc.).

Types of Pilot Model Activity

(1) Designate pilot machines for Jishu Hozen only



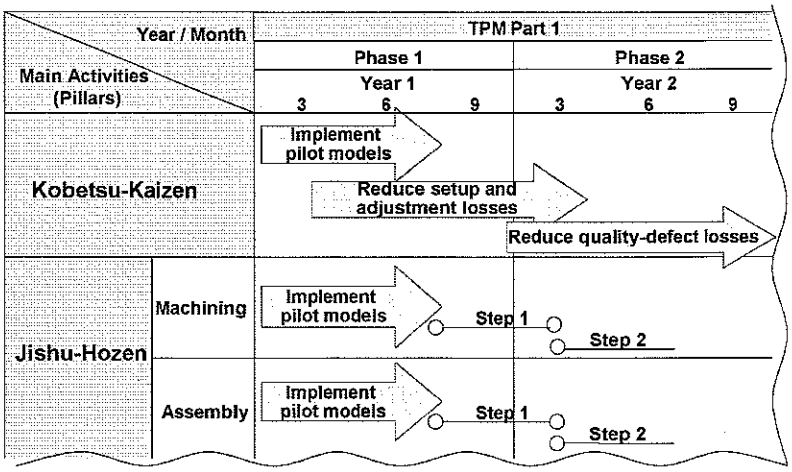
(2) Designate pilot machines for Kobetsu-Kaizen only



The Structure of a Master Plan

The five main elements of the Master Plan

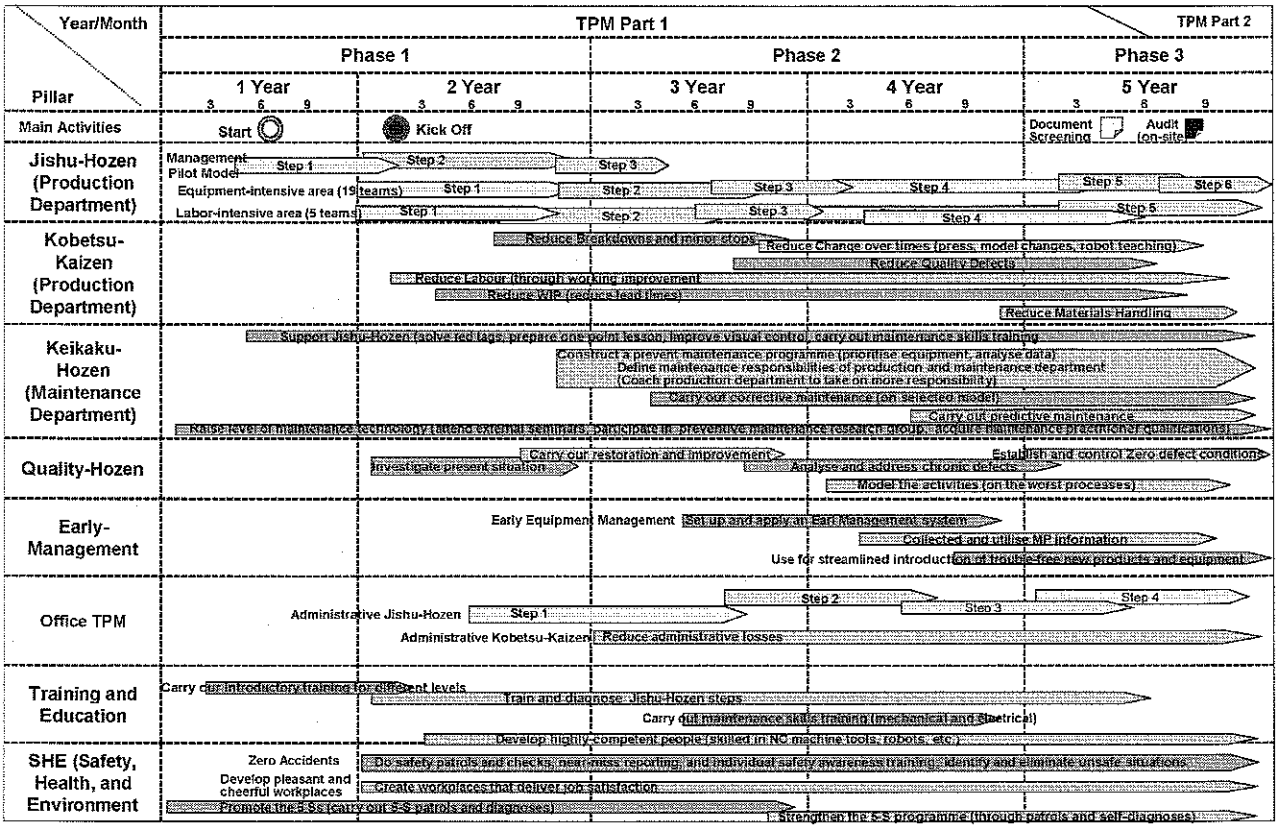
1. Main activities (pillars)
2. Phases
3. Improvement items or topics
   * Especially for Kobetsu-Kaizen Activities
4. Steps
5. Detailed timescales
   * if any of the timescale lines on the plan are too long, this indicates insufficient tactical planning



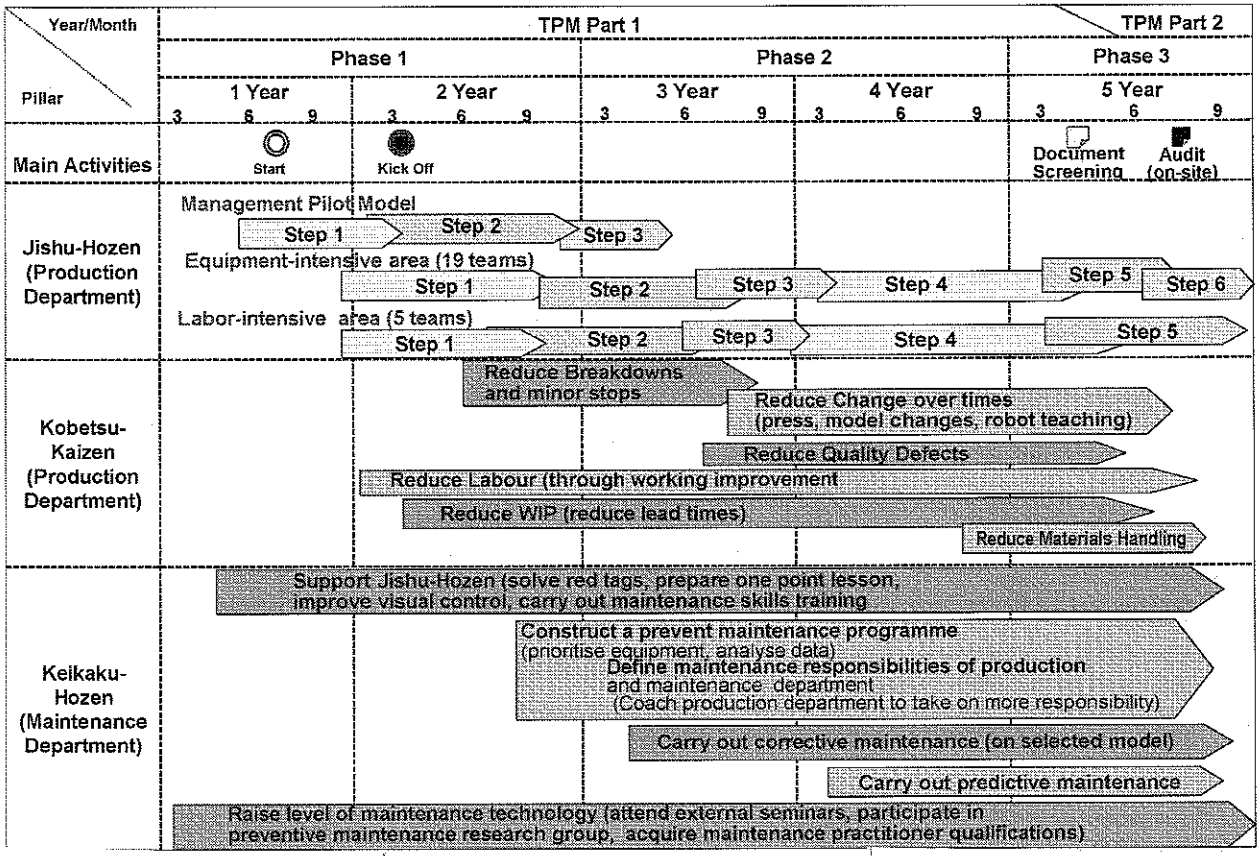
Notes

* Address the highest-priority profit hindrances, or the items most important to senior management, in the first year.
* After drawing up the Master Plan, compile everything planned so far into a single TPM Promotion Plan document and use it for policy deployment.
* Review the Master Plan annually. When conducting this review, look mainly at how thoroughly the programme has been carried out, rather than whether or not it is on schedule.

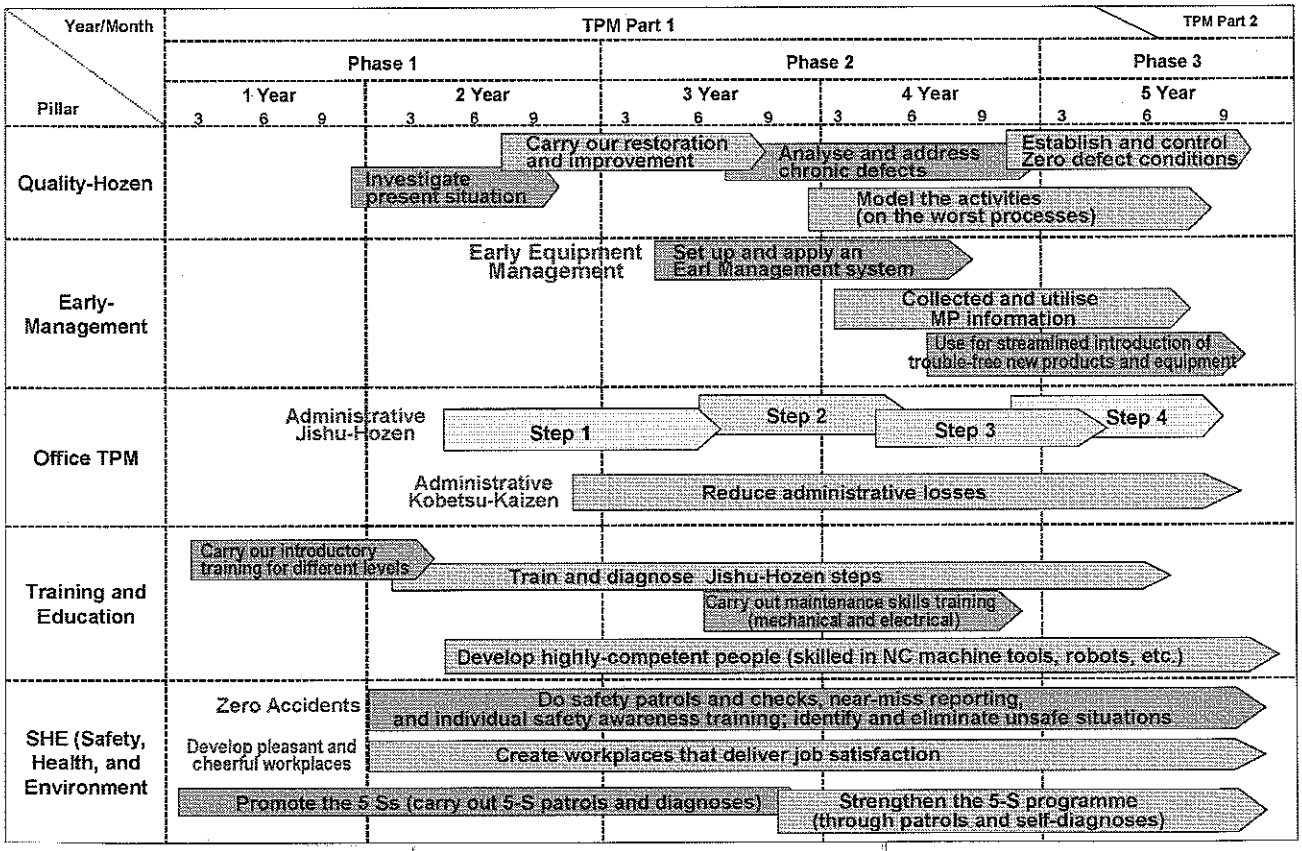
Master Plan (Example)



Master Plan (Example)



Master Plan (Example)



TPM Manual
Chapter 12
Completing and Upgrading the TPM Programme (Part 1, 2, 3,)

JIPM-Solutions Co. Ltd.

The Basic Thinking behind the New Concepts of TPM

< The Key Things Manufacturing Must Now Do >

1. Cope with uncertainty in markets and demand, not certainty.
2. Optimise business processes globally, not locally.
3. Evaluate business results objectively, not subjectively.

↓

This requires a TPM programme that meets the needs of the times

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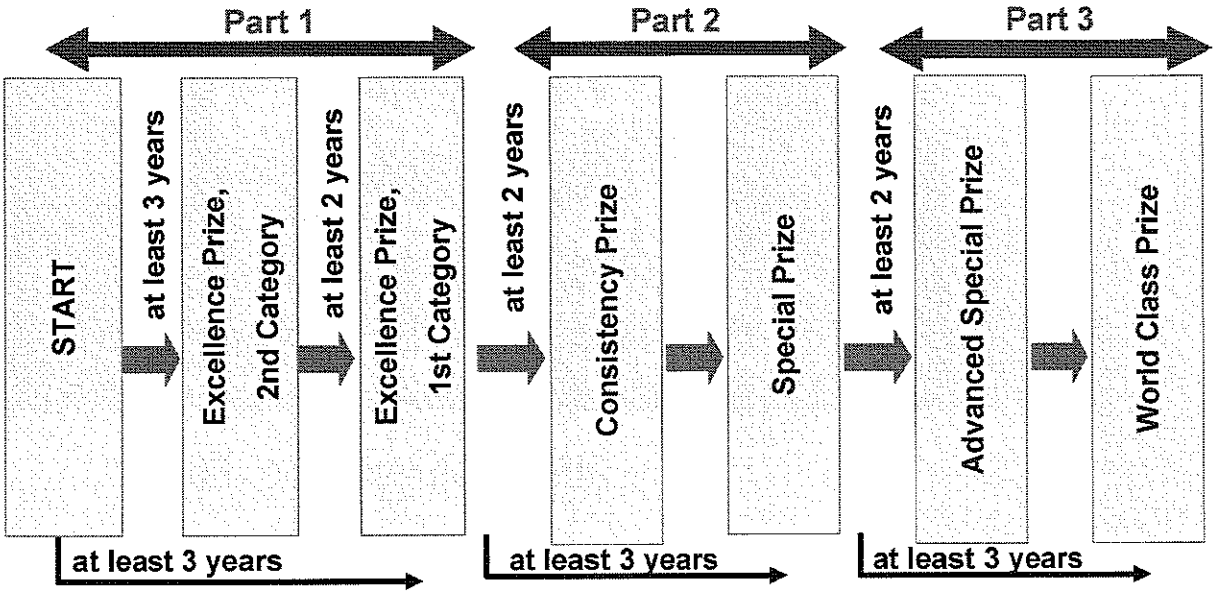
Which is why the new TPM concepts were developed

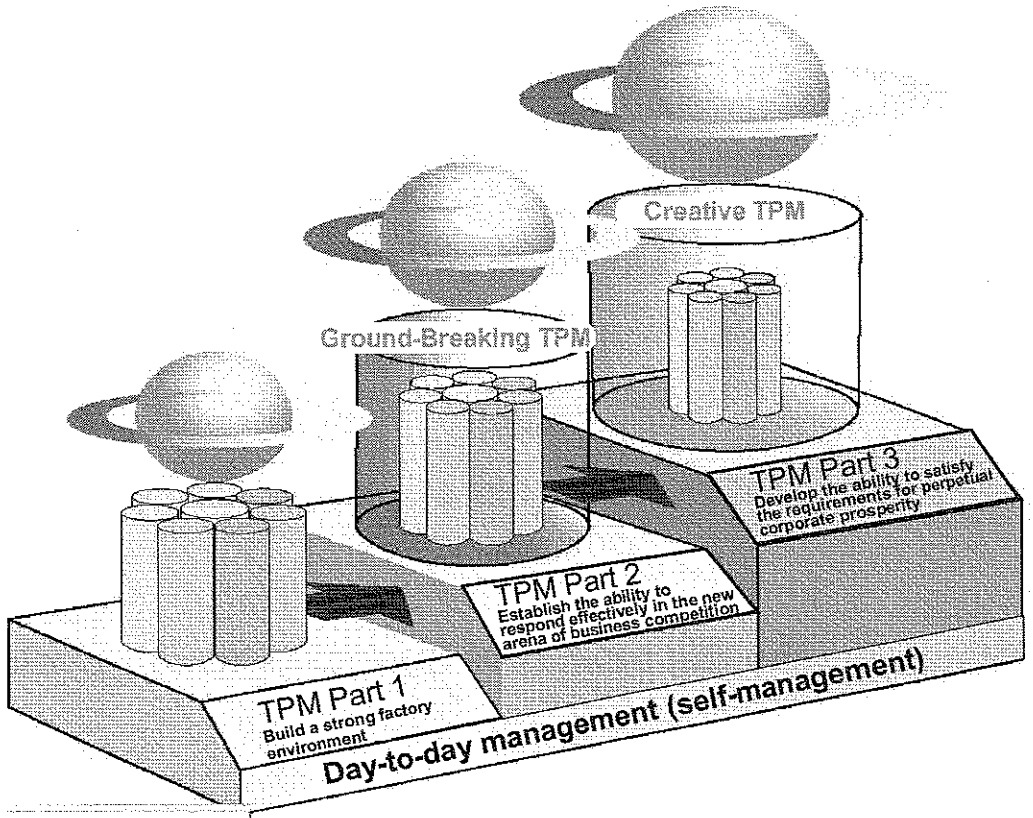
The Relationship between the TPM Parts and the TPM Awards

To begin with, the relationship between the three TPM Parts and the various TPM awards was clarified:



Notes: 1. Sites are defined as First or Second category in the same way as before
2. Second-category sites can attempt First-category awards directly if they wish
3. An Award for Excellence in Consistent TPM Commitment (Consistency Prize) is not an end in itself, but a milestone on the way to the next higher award

A Conceptual View of The TPM Parts



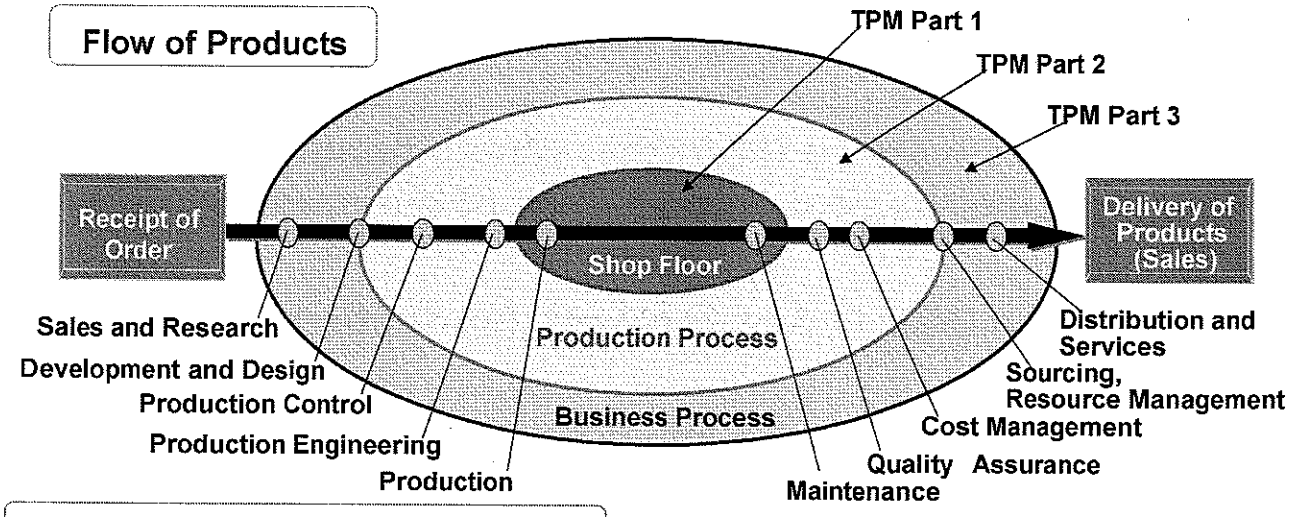
The 4 Key Points of TPM Part 1

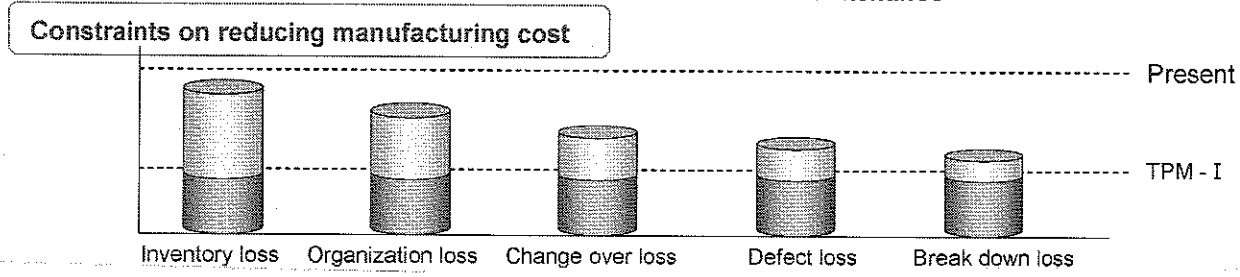
The target -- reduce production cost

1. Equip the production floor with the basic capabilities it needs to make a positive contribution to business results.
2. Strengthen the production floor's QCD performance.
3. Improve the company's ability to manage the development of new products and equipment.
4. Create safe, pleasant working environments.

The Scope of TPM Part 1

A programme for generating profits by eliminating and preventing the constraints and losses that stand in the way of reducing production cost.

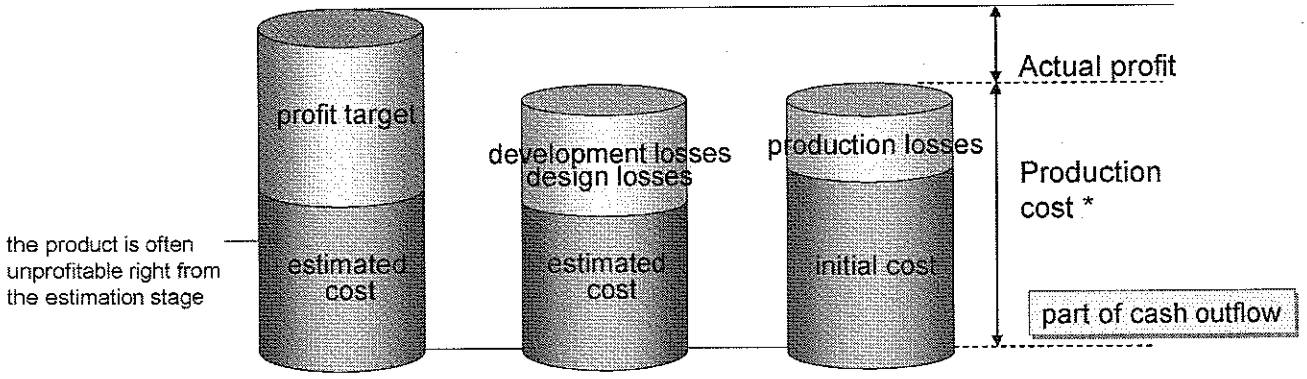




The Challenges of TPM Part 1

A programme for generating profits by eliminating and preventing the constraints and losses that stand in the way of reducing production cost.

production cost = raw materials cost + processing cost + spoilage cost + jig and die depreciation cost (i.e. production cost forms part of the company's cash outflow)



* Production cost = raw materials cost + processing cost + spoilage cost + jig and die depreciation cost

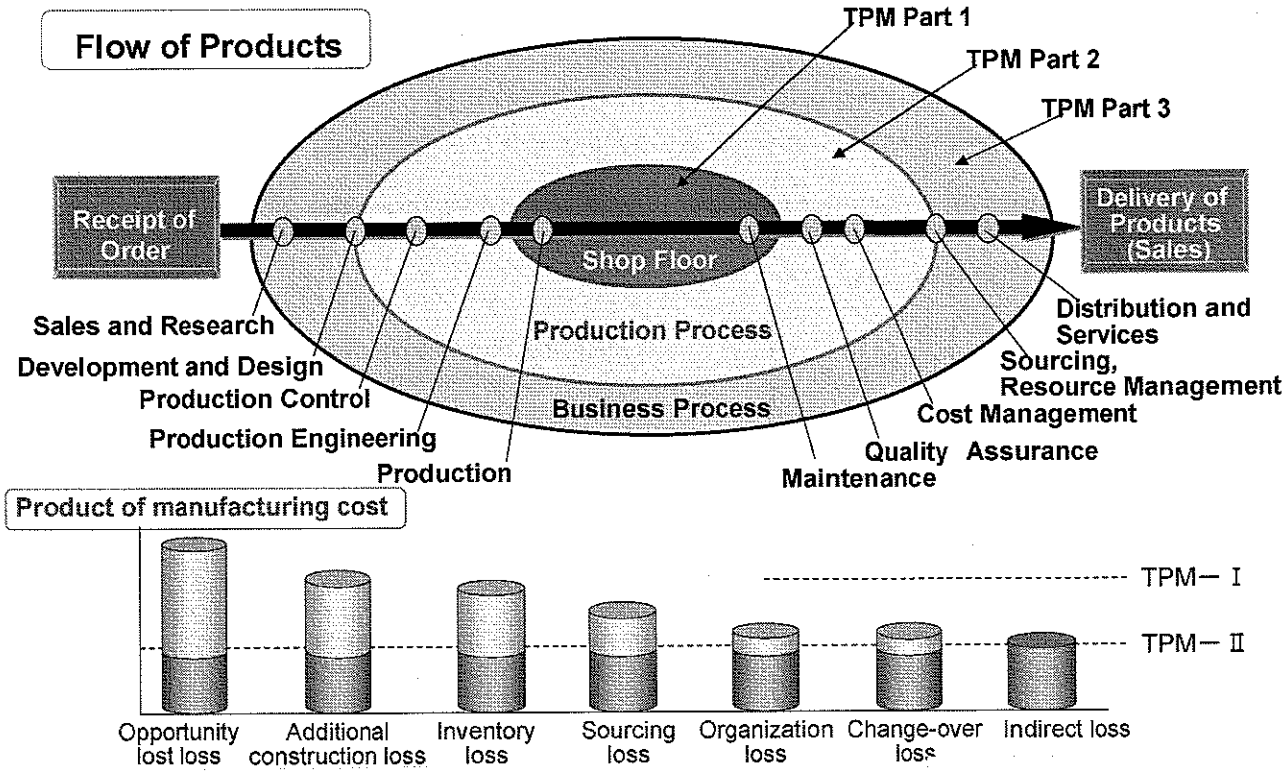
The 4 Key Points of TPM Part 2

The target -- reduce total product cost

1. Establish systems for further strengthening and enhancing the basic capabilities of the production floor.
2. Establish QCD in development, production and marketing.
3. Carry out Kobetsu-Kaizen (Focused Improvement) designed to increase added value.
4. Implement environmental conservation programmes.

The Scope of TPM Part 2

A programme for generating profits by eliminating and preventing the constraints and losses that stand in the way of reducing production cost.



TPM Part 2 requirements (1)

Part 1 (production cost) — shop floor

Part 2 (total product cost) — manufacturing process

【 Production department 】

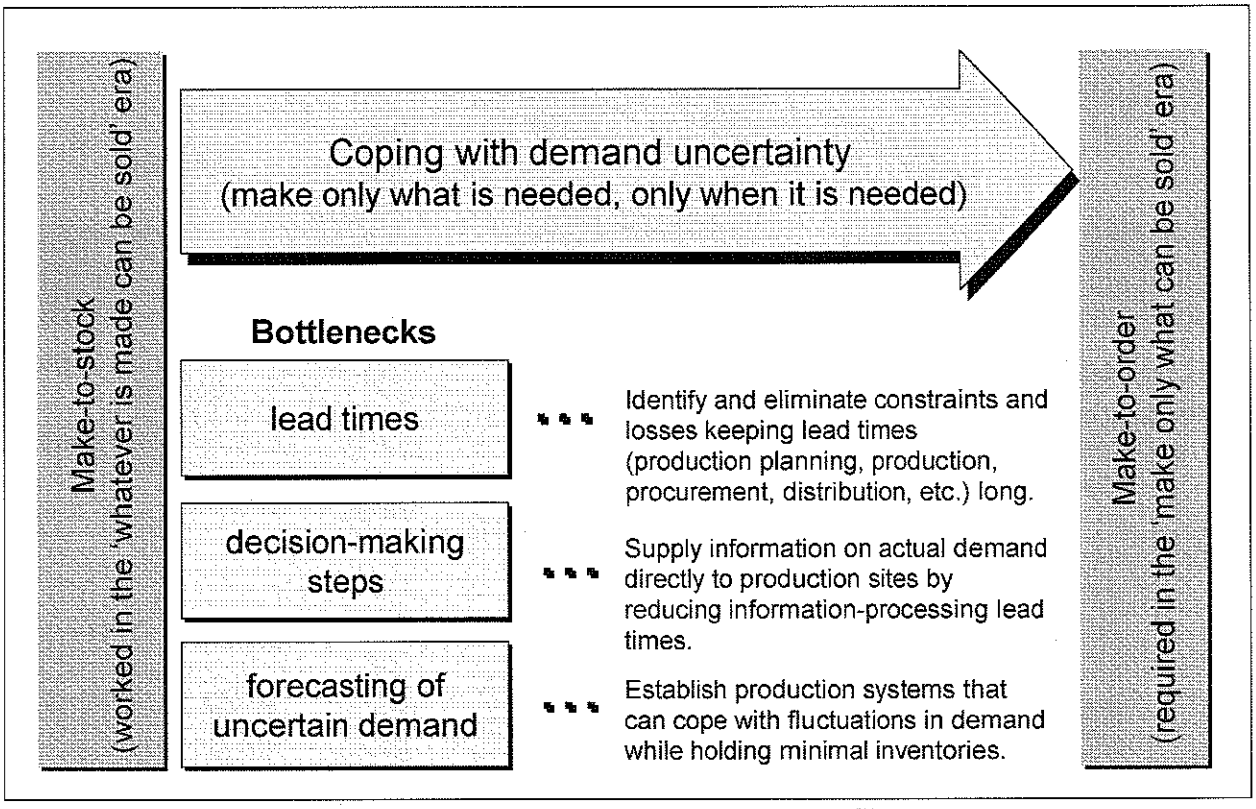
Equipment operating losses
Work organisation losses
Resource utilisation losses

In Part 2, we continue the work we started in Part 1 while strengthening the links between relevant departments from the perspective of the manufacturing process in order to optimise this entire process.

Collaboration with Production
- Sales, e.g. lost opportunities, finished-product inventory losses
- Design and Development, e.g. losses due to failure to achieve new-product target costs
- Purchasing, e.g. losses due to over-buying or failure to achieve purchasing target costs

Optimisation of entire manufacturing process

TPM Part 2 Requirements (2)



The Challenges of TPM Part 2

A programme for generating profits by eliminating and preventing the constraints and losses that stand in the way of reducing total product cost.

Total Product Cost = Production Cost + Energy Cost + Distribution Cost + Development Cost + Sales Cost + General Administrative Expenses, etc.

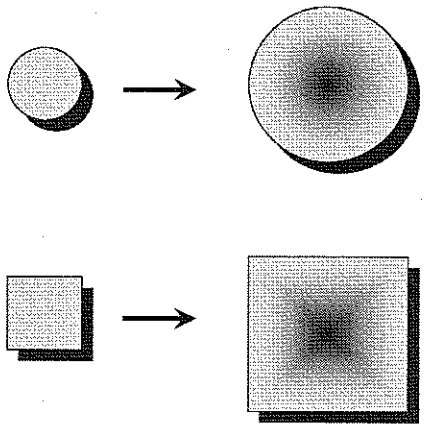
i.e. Total Product Cost = Total Cash Flow

A strategy for achieving differentiation in the industry by means of a ground-breaking TPM programme

Ground-Breaking TPM

What is meant by
'Ground-Breaking TPM'?

Vision



Key Words

- Head and shoulders above the crowds
- Jaw-dropping
- Different by orders of magnitude
- Totally outstanding

【Key Point】

Continue working in similar areas, but increase added value content far above that of competitors

From Productivity of Production to Productivity of Business

Productivity of production

$$\frac{\text{amount produced}}{\text{amount input}} \times 100$$

Productivity of business

$$\frac{\text{amount sold}}{\text{amount input}} \times 100$$

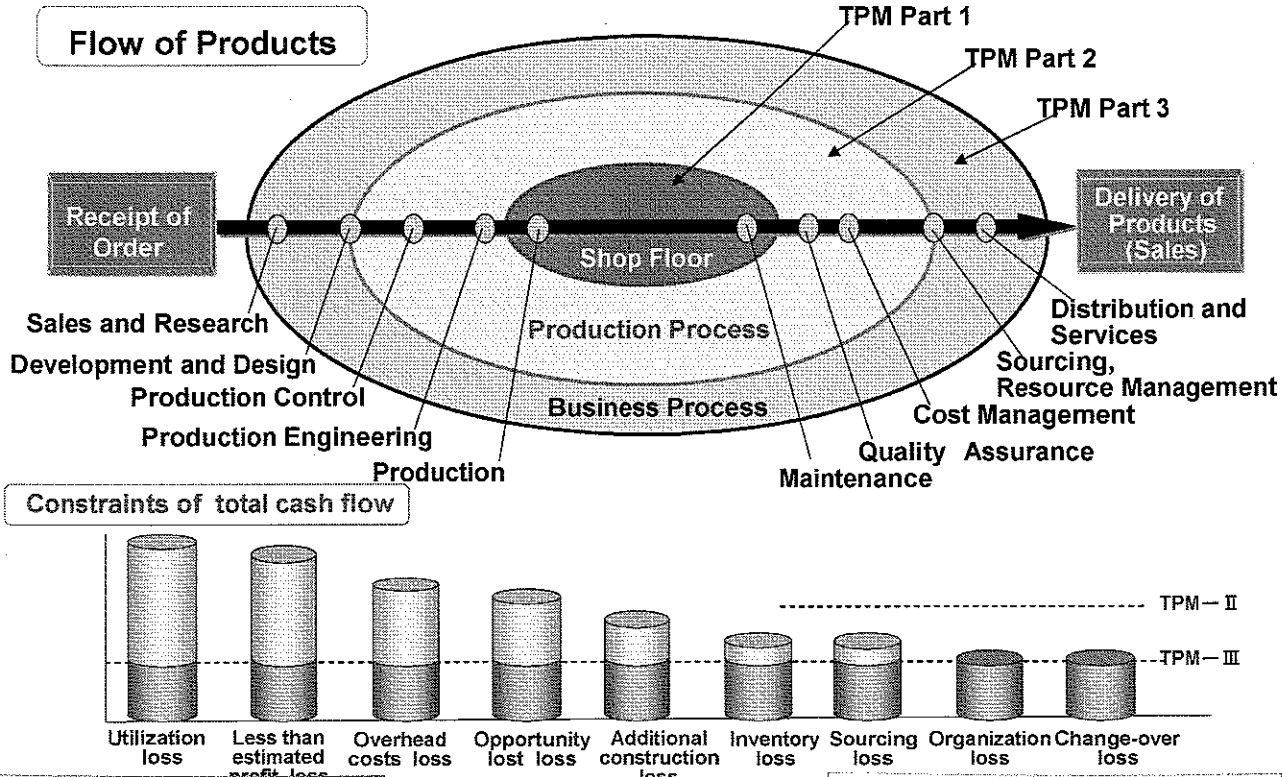
The 4 Key Points of TPM Part 3

The target -- improve cash flow

1. Sustain the basic capabilities of the production floor.
2. Establish QCD in R&D and in prototyping and pre-production.
3. Strengthen and enhance activities for creating overall added value.
4. Conduct environmental and resource conservation programmes.

The Scope of TPM Part 3

TPM Part 3 - A programme for generating profits by eliminating and preventing the constraints and losses that stand in the way of improving the company's overall cash flow.



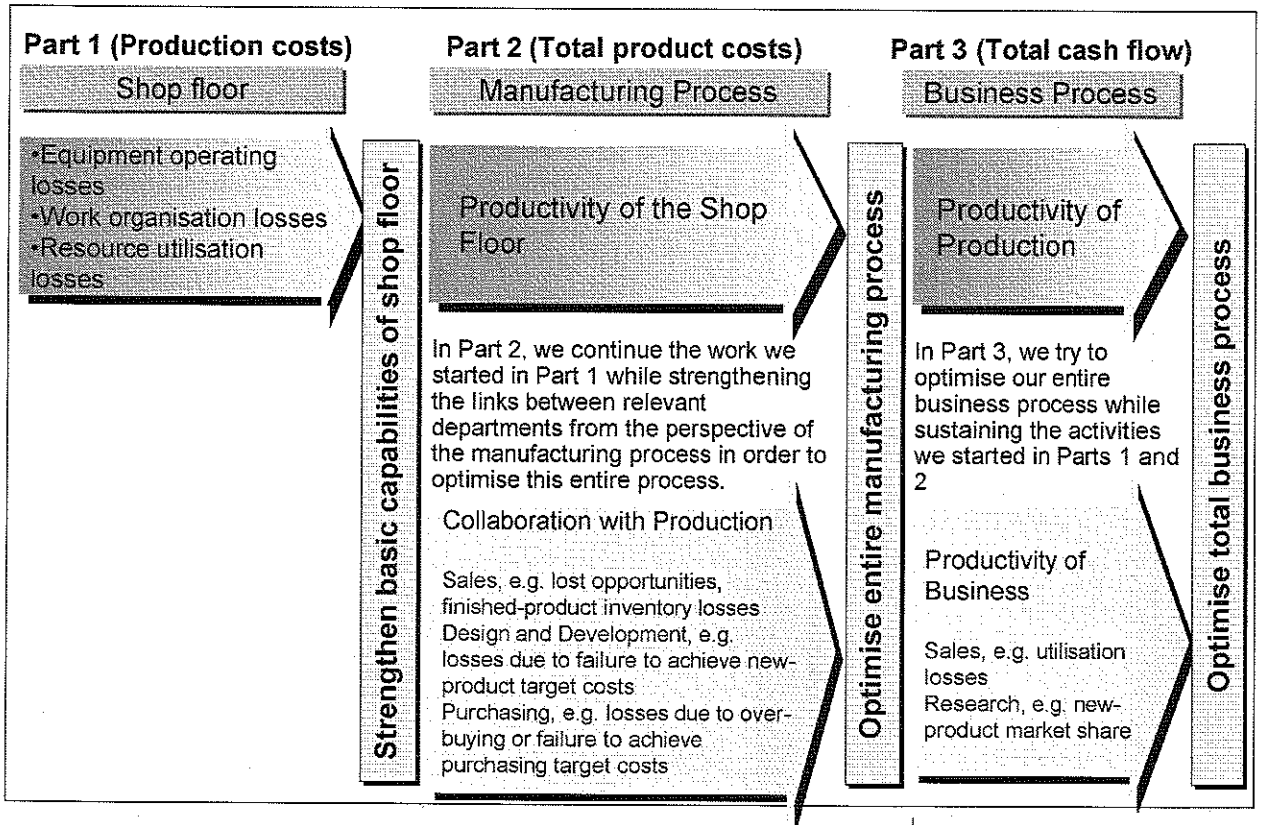
The Challenges of TPM Part 3

Generate profits by eliminating and preventing the constraints and losses that stand in the way of improving the company's overall cash flow.

In TPM Parts 1 and 2, our efforts are focused on becoming as profitable as possible at a given level of sales (i.e. at a given level of utilisation) But all products have a natural life-cycle, and their sales inevitably decline. In TPM Part 3, we develop innovative new products that will boost our sales and utilisation rates, doing so rapidly and at the right time. Our aim is to generate profits by expanding existing sales and creating new ones. By doing this, we put in place the conditions that will allow our companies to continue to prosper.

Move from reform of the production process to reform of the business process

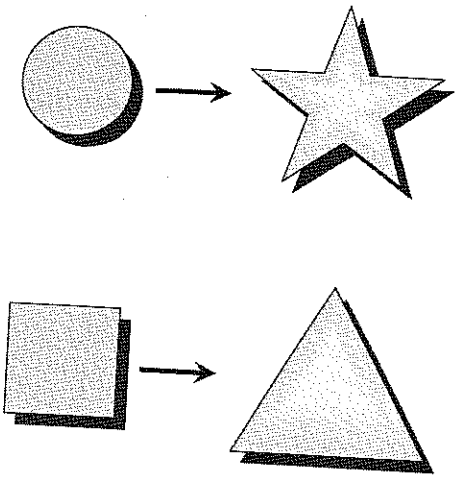
Requirements for Part 3



What is 'Creative TPM'?

What is meant by 'Creative TPM'?

Vision



Key Words

- Unique
- Never before known
- Brimming with novelty

Key Point

Broaden the range of added values (as opposed to increasing existing added value) by creating new value content not seen elsewhere.

TPM Policies and Goals (Ground-Breaking and Creative TPM Programmes)

Category		Part 1	Part 2	Part 3
TPM Policies and Goals	Key Concepts	(1) Establish the basic capabilities required for making a positive contribution to business results. - Reduce production costs (2) Strengthen the factory's internal environment by improving its people and its equipment. (3) Implement the 8 TPM Pillars in a structured, systematic way. (4) Assess the progress and rate of improvement of the activities. (5) Bolster the production floor's QCD performance. (6) Construct effective systems for managing the development of new products and equipment. (7) Create safe, pleasant working environments. (8) Develop a new corporate culture and ethos with a high level of kaizen motivation. (9) Involve the whole workforce in kaizen programmes targeting zero losses. (10) Install systems for using TPM indicators to evaluate business performance.	(1) Implement systems for strengthening and enhancing basic capabilities - Reduce total product costs (2) Improve the ability to respond effectively in the new arena of business competition. (3) Require higher levels of persistence and effort. - Continue to reinforce and enhance the 8 TPM Pillars (4) Develop programmes for increasing existing added value and creating new added value. (5) Establish QCD in development, production and marketing. * Seek to optimise the entire supply chain from development through to marketing (6) Develop new, improved products and production systems. (7) Promote environmental protection programmes. - Aim for zero emissions, overall optimisation and information disclosure (8) Promote TPM activities that directly impact the bottom line. - Assess the effect of TPM programmes on business results (9) Implement ground-breaking TPM programmes. (10) Introduce additional indicators unique to Part 2.	(1) Make continuing to strengthen and sustain basic capabilities a way of life. - Maximise the efficient utilisation of resources - Achieve world-class production floors, in terms of people, materials, equipment and systems (2) Develop the ability to satisfy the requirements for perpetual corporate prosperity. (3) Require even higher levels of persistence and effort. - Make the constant reinforcement and enhancement of the 8 TPM Pillars a way of life (4) Strengthen activities to create added value for the company as a whole (5) Establish QCD in R&D and in prototyping and pre-production. - Achieve overall optimisation (6) Carry out kaizen programmes designed to achieve industry world-beating results in all indicators. (7) Promote advanced resource conservation programmes. (8) Continue to generate profits through the TPM programme. - Achieve indicators that make the company world number one in its industry - Assess the level of management by means of ROA (return on assets) (9) Implement creative TPM programmes. (10) Introduce additional indicators unique to Part 3.

TPM Policies and Goals (Ground-Breaking and Creative TPM Programmes)

Category		Part 1	Part 2	Part 3
TPM Policies and Goals	Expectations	(1) TPM programmes are clearly linked to company policies. (2) TPM policies and objectives are cascaded down to individual departments and every employee is familiar with them. (3) There is a clear master plan for progressing the 8 TPM Pillars, and it is being executed in a structured, systematic way. (4) Progress towards the attainment of TPM policies and objectives is expressed in an easily-understood way. (5) TPM policies and objectives are captured in PQCDSM format, using benchmarking. (6) TPM is progressed through a system of overlapping small groups, with a TPM Steering Committee and specialist sub-committees in place. (7) TPM progress is managed through departmental and area meetings. (8) The specialist sub-committees are functioning effectively. (9) The increase in the basic capabilities of the production floor is leading to better business results. (10) Front-line teams are active, and are helping to create and sustain safe, pleasant working environments.	(1) The relationships between the Part 2 activities and the company's policies and objectives are clear and well known to every employee. (2) The 8 TPM Pillars have become a way of life from development through to production, and this has boosted the company's competitiveness. (3) More sophisticated activities are being carried out within the 8 TPM pillars and are helping to achieve the required business results. (4) Distinctive, ground-breaking TPM programmes tailored to the company's needs are being implemented. (5) Innovative programmes designed to expand existing added value or create new added value are being carried out. (6) Measures to increase employee satisfaction have been taken and are making progress. (7) The company has a clear business policy and is taking action to expand its markets, utilising systems for predicting market and customer trends. (8) Action is being taken to build an internal environment that can cope flexibly with changes in demand. (9) Kaizens are being actively tackled, based on an analysis of business risk. (10) The company takes account of its social responsibilities (to the environment, local communities, etc.) in its activities and has a good reputation in this context	(1) The relationships between the company's Part 3 activities and its policies and objectives are clear and well known to every employee. (2) Innovative activities to create added value for the company as a whole have become strongly embedded and are participated in by the entire workforce. (3) The deployment of the 8 TPM Pillars is still a way of life, and they include significant creative content. (4) Distinctive, creative TPM programmes tailored to the company's needs are being implemented. (5) TPM programmes involving suppliers have become established practice and are helping to create a management environment that can respond flexibly to change. (6) TPM initiatives take full account of future market and customer trends. (7) The conditions required for the company to prosper have been identified, and there are clear indicators of the company's progress towards becoming the world number one in its industry. (8) Initiatives designed to make a social contribution are being conducted, and the company's management has achieved a significant degree of transparency. (9) Global harmonisation is a business priority, and the management environment is oriented towards this. (10) The company is implementing more advanced programmes that take even greater account of its social responsibilities (to the environment, local communities, etc.).

TPM Policies and Goals (Ground-Breaking and Creative TPM Programmes)

Category		Part 1	Part 2	Part 3
Ground-Breaking and Creative TPM Programmes	Key Concepts	(1) Build a strong factory environment. (2) Assess the progress and rate of improvement of the activities. - Implement the 8 TPM Pillars in a structured, systematic way - Lay the groundwork and pursue local optimisation (3) Establish the basic capabilities required for making a positive contribution to business results. (4) Reduce production costs. (5) Involve the whole workforce in kaizen activities. (6) Construct an effective system for managing development. (7) Create safe, pleasant working environments. (8) Bolster the production floor's QCD performance. (9) Use TPM indicators to evaluate business performance. (10) Begin to develop a new corporate culture and ethos.	(1) Establish the ability to respond effectively in the new arena of business competition. (2) Require higher levels of persistence and effort. - Continue to reinforce and enhance basic capabilities and the 8 TPM Pillars - Optimise locally and pursue overall optimisation (3) Assess the contribution of TPM activities to business results. (4) Reduce total product costs. (5) Develop programmes for increasing existing added value and creating new added value. (6) Develop new, improved products and production systems (7) Promote environmental protection programmes. (8) Establish QCD in development, production and marketing. (9) Introduce additional indicators unique to Part 2. (10) Implement ground-breaking TPM programmes.	(1) Develop the ability to satisfy the requirements for perpetual corporate prosperity. (2) Require higher levels of persistence and effort. - Make the constant reinforcement and enhancement of basic capabilities and the 8 TPM Pillars a way of life - Achieve overall optimisation (3) Assess the level of management itself. (4) Maximise the efficiency of resource utilisation. (5) Embed programmes to create added value for the company as a whole. (6) Carry out development programmes aimed at making the company world number one in its industry. (7) Conduct resource conservation programmes designed to protect the global environment. (8) Establish QCD in R&D and in prototyping and pre-production. (9) Introduce additional indicators unique to Part 3. (10) Implement creative TPM programmes.
	Expectations		(1) The company's competitiveness vis-à-vis its competitors in the same industry has been strengthened. (2) Each of the TPM Pillars is more advanced and includes innovative content. (3) Improvement programmes that increase existing added value and create new added value are being rolled out. (4) Distinctive, ground-breaking TPM programmes tailored to the company's needs are being implemented. (5) The entire TPM programme is of a higher standard and is helping the company to achieve its business targets.	(1) The conditions required for the company to prosper have been identified, and are being strengthened. (2) The 8 TPM Pillars are still a way of life and include significant creative content. (3) Improvement programmes that involve head-office functions and increase added value have been strengthened and have become established practice. (4) Distinctive, creative TPM programmes tailored to the company's needs are being implemented. (5) TPM activities have become established practice and are helping to create a management environment that can respond flexibly to change

TPM Benefits

Category		Part 1	Part 2	Part 3
TPM Benefits	Key Concepts	(1) Reduce production costs (2) Strengthen the factory's internal environment. (3) Develop the basic capabilities of the shop floor. (4) Bolster the shop floor's QCD performance. (5) Improve the company's ability to manage the development of new products and equipment. (6) Create safe, pleasant working environments. (7) Use TPM indicators to evaluate business performance. (8) Increase employees' desire to improve. (9) Begin to develop a new corporate culture.	(1) Reduce total product costs. (2) Develop programmes for enhancing added value. (3) Establish the ability to respond effectively in competitive business environments. (4) Continue to strengthen and enhance basic capabilities. (5) Establish QCD in products, production and marketing. (6) Develop improved products and production systems. (7) Strengthen environmental protection programmes. (8) Boost the company's competitiveness through ground-breaking TPM programmes.	(1) Maximise the efficiency of resource utilisation. (2) Achieve industry world-class levels in performance indicators. (3) Develop the ability to satisfy the requirements for perpetual corporate prosperity. (4) Make strengthening and enhancing basic capabilities a way of life. (5) Establish QCD in R&D and in prototyping and pre-production. (6) Strengthen activities to create added value for the company as a whole. (7) Strengthen and enhance resource conservation programmes. (8) By implementing creative TPM programmes, develop the conditions required for the company to prosper.
	Expectations	(1) OEEs are on target and productivity is improving. (2) Significant results have been achieved in reducing equipment breakdowns, in-process quality defects, customer complaints, etc. (3) Production lead times have decreased, and stocks of finished goods and work-in-process are far lower than before TPM was introduced. (4) Systems for ensuring zero lost-time accidents and environmental complaints are in place and are producing the desired results. (5) Production costs are being decreased. (6) Vertical startup of new products and equipment is being achieved. (7) The cost-benefits of TPM are being	(1) Indicators unique to Part 2 have been set, and results are being achieved. (2) Results are continuing to be achieved in the indicators set at Part 1. (3) The results of kaizen initiatives are leading to lower product costs and helping to boost profits. (4) Progress is being made with lowering break-even points. (5) Management ratios such as profitability and capital turnover rate are improving. (6) Wasteful investment is avoided through risk assessment based on well-designed market surveys. (7) The company's products are highly regarded by its customers, and its market share is rising.	(1) Good results are being achieved in indicators unique to Part 3, and some of these are the best in the world for the industry. (2) Good results are continuing to be achieved in the TPM indicators set at Parts 1 and 2. (3) When looking at the industry in the global context, some of the things the company is doing could become best practice. (4) New markets and customers are being actively developed. (5) The efficiency of resources invested has been maximised through improvement initiatives targeting all management resources. (6) Solid results have been obtained for QCD indicators in administrative and support departments.

TPM Benefits

Category		Part 1	Part 2	Part 3
TPM Benefits	Expectations	(8) Employees' attitudes and abilities are changing, and working environments have become more pleasant. (9) Results that contribute to the company's bottom line have been achieved. (10) Outstanding issues have been clearly identified, and concrete action plans for dealing with them have been formulated.	(8) Targets for reducing losses in sales operations have been met, enabling sales revenue and profit targets to be met also. (9) Environmental protection programmes are being actively pursued, and targets for waste disposal and energy conservation have been met. (10) Development lead times have been cut, and targets for the proportion of sales revenues accounted for by new products have been met.	(7) Noteworthy results have been achieved in the development of new technologies, which enjoy a reputation second to none in the industry. (8) There are some examples of newly-developed products that have created new markets and are recognised as having made outstanding contributions to the company's profits. (9) The company is accepted by the public as a model of environmental best practice. (10) The company has succeeded in new business ventures based on forecasting and analysing products and markets.

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Kobetsu-Kaizen (Focused Improvement)

Category		Part 1	Part 2	Part 3
Kobetsu-Kaizen	Key Concepts	(1) Identify and eliminate constraints and losses impeding the reduction of production costs. (2) Eliminate losses from equipment and production systems. (3) Conduct kaizen programmes participated in by all employees. (4) Strengthen the company's kaizen capability (the ability to observe, analyse and take effective action). (5) Establish the habit of looking at situations from the viewpoint of principles and parameters. (6) Accumulate examples of the achievement of zero or minimal losses. (7) Achieve some examples of industry-best kaizens. (8) Strengthen QCD in the workplace.	(1) Painstakingly eliminate constraints and losses impeding the reduction of total product costs. (2) Implement programmes to identify and reduce total losses (process losses and functional losses). (3) Reduce development losses through innovative technical kaizens. (4) Strengthen the company's ability to develop new technologies and manufacturing processes. (5) Develop new measurement techniques. (6) Apply engineering economics as a matter of routine. (7) Establish QCD in development, production and marketing. (8) Do kaizens of the type that create new added value.	(1) Painstakingly eliminate constraints and losses impeding the company's overall cash flow. (2) Develop techniques for predicting and preventing losses. (3) Implement kaizen programmes for recycling resources. (4) Establish activities based on benchmarking. (5) Acquire business model patents. (6) Utilise IT effectively. (7) Integrate TPM into the company's business vision. (8) Establish QCD in R&D and in prototyping and pre-production. (9) Enhance improvement programmes that involve head-office functions and increase added value.
	Expectations	(1) Losses holding back production efficiency have been clearly identified, and progress is being made towards eliminating them. (2) Loss-cost trees, loss maps, etc. have been drawn up and are being used to direct the kaizen programmes. (3) Losses that are one's own responsibility are clearly distinguished from those that are the responsibility of others. (4) Each improvement project's contribution to the relevant target attainment indicator is clearly identified. (5) Kaizen programmes are proceeding vigorously. (6) Systems for preventing problem recurrence are in place, and reliable recurrence-prevention measures are taken.	(1) Clear processes for identifying and prioritising losses that hold back management efficiency have become firmly established. (2) Product cost losses have been clearly identified within each department, and programmes for eliminating these are being implemented vigorously. (3) Loss reduction programmes are linked to financial indicators. (4) Many non-value-adding processes have been eliminated. (5) In kaizens, engineering economics is being used to perform accurate cost-benefit analyses. (6) There are no recurring losses, and there are many examples of zero-breakdown, zero-defect lines.	(1) Loss identification and elimination has reached an advanced level, from development through to recovery and recycling. (2) The company's overall cash flow losses have been clearly identified, and programmes to reduce them are proceeding vigorously. (3) Systems are in place for ceaselessly increasing the company's kaizen capabilities, and are producing significant results. (4) Systems are in place for increasing the company's ability to detect losses, so that they can be prevented in advance. (5) Plans for addressing future predicted losses are in hand, and there are some examples of advance loss prevention. (6) The company has developed some of its own improvement and analysis techniques.

Kobetsu-Kaizen (Focused Improvement)

Category		Part 1	Part 2	Part 3
Kobetsu-Kaizen	Expectations	(7) Kobetsu-Kaizens are reliably replicated to other areas, utilising the QC Story. (8) Many zero-loss results have been achieved. (9) P-M Analysis and other kaizen tools are being used effectively, and the habit of looking at things from the principles and parameters standpoint has become firmly established. (10) Some kaizens have received recognition in the form of awards from external bodies.	(7) Many kaizens have resulted in the registration of patents and utility models. (8) Tools appropriate to the particular losses being addressed are used effectively and to a high standard. (9) Many new measurement tools and methods have been developed in order to effect and sustain improvements. (10) There are some examples of the development of industry-first technologies and manufacturing processes.	(7) Kaizen abilities unmatchable by competitors in the same industry have been developed. (8) Losses are reliably detected and kept at low levels through the use of IT. (9) There are some competency models. (10) There are many examples of the development of new technologies, manufacturing processes and materials.

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Jishu-Hozen (Autonomous Maintenance)

Category		Part 1	Part 2	Part 3
Jishu-Hozen	Key Concepts	(1) Build a strong factory environment. (2) Equip the production floor with sufficient basic capabilities to enable it to make a positive contribution to business results. (3) Bolster the production floor's QCD performance. (4) Create safe, pleasant working environments (5) Raise employees' enthusiasm for doing kaizens and begin to develop a new corporate culture and ethos. (6) Establish basic conditions and make progress in changing people's attitudes. (7) Set definitive standards for the main workplace tasks and embed and sustain these.	(1) Establish the ability to respond effectively in the new arena of business competition. (2) Establish and operate systems for strengthening and enhancing basic capabilities. (3) Establish QCD in all departments. (4) Install and embed environmental protection systems. (5) Achieve persistency of effort and develop innovative programmes. (6) Install and operate systems for sustaining basic conditions. (7) Establish daily management as a way of life, and construct and operate self-management systems.	(1) Develop the ability to satisfy the requirements for perpetual corporate prosperity. (2) Make continuing to reinforce and sustain basic capabilities a way of life. (3) Establish QCD across the company, in all functional departments. (4) Develop and extend resource conservation programmes. (5) Help to sustain and improve the level of management through persistent efforts and creative programmes. (6) Establish an internal environment that can respond flexibly to change. (7) Embed and upgrade self-management systems.
	Expectations	(1) Definitive standards have been set for the main workplace tasks, and the level at which these are sustained is rising. (2) The detection and correction of minor abnormalities (tagging and detagging) associated with the main workplace tasks has become a way of life. (3) Operators are competent in basic Jishu-Hozen skills. (4) Progress has been made with small kaizens (countermeasures against sources of contamination and hard-to-access areas; visual controls, etc.), making the workplace easier to work in. (5) Systems for managing the principal workplace tasks have been installed and have become firmly established. (6) Activity boards showing target attainment and future plans have been set up and are being used.	(1) The standard of daily management has risen; self-management systems have been established and are operating effectively. (2) Tagging and detagging has been extended to work in general, including safety and environment, and has become standard practice. (3) Operators have taken over some of the tasks previously performed by the maintenance department, and Jishu-Hozen rate targets have been achieved. (4) Small kaizens have become a way of life, and workplaces are being made more and more pleasant, safe and easy to work in. (5) Management systems that enable people to take responsibility for looking after their own workplaces have been installed and have become embedded in the culture.	(1) Self-management systems have become established and their level is steadily rising. (2) The detection and correction of minor abnormalities in all of the company's and its departments' work has become routine practice, and its level is rising. (3) Jishu-Hozen rates are being sustained, and the ability to respond flexibly to change has been increased through the use of basic diagnostic techniques, etc. (4) Small kaizens have become a way of life, and workplaces are now always pleasant, safe and easy to work in. (5) Highly cooperative management systems that cut through interdepartmental barriers have been established and are being sustained. (6) Activity boards have been upgraded to show the deployment of company policy at a glance, making the future of the workplace visible; challenging targets are set and met

Jishu-Hozen (Autonomous Maintenance)

Category		Part 1	Part 2	Part 3
Jishu-Hozen	Expectations	(7) Systems are in place for raising the skills of all workers (skill evaluation charts, one-point lessons, maintenance skills training, etc.) (8) An improvement suggestion scheme has become established. (9) Systems are in place for assessing the 5 Ss; these have become embedded in the workplace culture and their level is being improved. (10) All employees are engaged in improving their workplaces with a sense of accomplishment.	(6) Activity boards are used as a matter of course, and clearly show each workplace's policies and progress towards targets. (7) All employees' upskilling targets have been met. (8) The improvement suggestion scheme is active, and suggested improvements are of a high standard. (9) The 5S level of the working environment, work in general, information management, etc. is high. (10) All employees are engaged in improvements designed to make the workplace better able to cope with change.	(7) Higher skill level targets have been set for all employees, and these targets have been met and sustained. (8) Improvement suggestion programmes are directly linked to business results. (9) The level of 5 Ss is solidly upheld in all departments and for all tasks. (10) All employees are engaged in workplace improvements designed to achieve the future vision.

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Keikaku-Hozen (Effective Maintenance)

Category		Part 1	Part 2	Part 3
Keikaku-Hozen	Key Concepts	(1) Escape from the emergency (breakdown) maintenance culture and aim for zero breakdowns. (2) Establish a proper preventive maintenance system. (3) Understand the importance of operators helping to maintain their equipment. (4) Improve the basic capabilities of the production floor. (5) Start sorting out which maintenance tasks will fall under Jishu-Hozen (lay the groundwork). (6) Strengthen the factory environment and make the equipment more robust. (7) Establish a basic system of maintenance activities. (8) Promote and embed maintenance cost reduction programmes. (9) Involve the maintenance department in the management of equipment development (managing MP data, taking part in design reviews, etc.)	(1) Build a maintenance system that can achieve and sustain zero defects. (2) Shift the production maintenance perspective from time-based to condition-based. (3) Create a new maintenance system in which both the operating department and the maintenance department participate. (4) Set up and operate systems for further reinforcing and enhancing basic capabilities. (5) Strive to achieve the best possible maintenance system at the lowest possible cost (using reliability-centred maintenance analysis, etc.) (6) Introduce equipment diagnostics. (7) Investigate maintenance assessment systems. (8) Begin to reform the maintenance department's work.	(1) Build an industry-standard maintenance system. (2) Implement condition-based maintenance, including some continuous monitoring. (3) Make continuing to enhance and sustain basic capabilities a way of life. (4) Establish comprehensive new maintenance systems. (5) Implement and embed systems for optimal maintenance. (6) Minimise maintenance costs. (7) Deploy resource conservation programmes. (8) Build and embed maintenance assessment systems. (9) Revolutionise the maintenance department's work by focusing on the sources of problems.
	Expectations	(1) An effective system of support for Jishu-Hozen has been established and is being operated. (The production environment is being strengthened.) (2) Sporadic breakdowns have greatly reduced as a result of painstakingly analysing breakdowns, implementing corrective maintenance, etc. (Zero breakdown programmes are being implemented.) (3) Maintenance standards have been formulated, and preventive maintenance is being implemented based on maintenance calendars. (Maintenance planning and management systems are in place.)	(1) Some of the maintenance department's work has been transferred to the operating department. (2) The relationship between equipment and product quality is understood, and equipment is being maintained in such a way as to produce zero quality defects. (3) The maintenance system has been optimised through the use of reliability-centred maintenance, etc., and cost-Keikaku-Hozne schedules are being implemented using information technology. (4) Computer-based information management is being used for preventive maintenance and new-equipment development.	(1) A maintenance system that unites the operating and maintenance departments has been achieved. (2) An optimal maintenance system that sustains zero quality defects and breakdowns has become firmly established. (3) All the information on production, quality, equipment, maintenance, etc. has been integrated into a single computerised information network. (4) Identification of deterioration parameters and patterns has enabled a wide range of equipment monitoring to be performed. (5) The company has developed its own original diagnostic techniques and has established rules for diagnosing deterioration.

Keikaku-Hozen (Effective Maintenance)

Category		Part 1	Part 2	Part 3
Keikaku-Hozen	Expectations	(4) Maintenance records are faithfully kept, an information management system is in place, and information is being used in the development of new equipment. (Maintenance information management systems have been set up) (5) The purchase and control of spares for Keikaku-Hozen is being properly managed. (Proper spare-parts management is being practised.) (6) Condition-based monitoring has been introduced, and operators are doing some of the diagnoses. (Predictive maintenance systems are being used.) (7) Lubricating oils, hydraulic fluids, etc. are being efficiently managed through the use of oil stands, etc. on the production floor. (Proper lubrication management is being practised.) (8) Almost all maintenance personnel have achieved a recognised maintenance qualification. (Good maintenance skills training is being carried out.) (9) The amount of preventive and predictive maintenance, fabrication of peripheral equipment, and restoration and repair work done in-house is increasing. (The job content is being changed.) (10) The proportion of costs accounted for by maintenance has been reduced. (Maintenance cost reduction is being pursued.)	(5) Spare parts are being minimised through corrective maintenance and unification. (6) The transition from time-based maintenance to condition-based maintenance is being actively progressed through in-house developments. (7) Lubricant consumption has been minimised through an active programme of use reduction as part of the company's resource conservation effort. (8) Some people have become equipment diagnostic experts, and an appropriate training system is in place. (9) The work of the maintenance department is being steadily reformed, and it is becoming increasingly involved in developing new equipment and peripherals. (10) Maintenance optimisation initiatives are helping to reduce total product costs.	(6) There is a well-established training system for continuously passing on and acquiring high-level skills. (7) The work of the maintenance department has been transformed, and systems are in place for sustaining the new situation. (8) The disruptive effects of maintenance work on every aspect of the business have been minimised.

Quality-Hozen (Quality Maintenance)

Category		Part 1	Part 2	Part 3
Quality-Hozen	Key Concepts	(1) Reduce production costs. (2) Strengthen the factory environment. Develop the capabilities of people and equipment (3) Strengthen the basic capabilities of the production floor. Build quality into the product via the process (4) Bolster the production floor's QCD performance. (5) Implement the 8 TPM Pillars in a systematic, structured way. (6) Build an effective development management system. (7) Understand the relationships between product quality characteristics and the principles and parameters of processing plus the 4M conditions.	(1) Painstakingly eliminate constraints impeding the reduction of total product costs. (2) Reinforce and embed the ability to respond effectively in competitive business environments. (3) Establish systems for strengthening and enhancing basic capabilities. (4) Establish QCD in development, production and marketing. (5) Implement programmes designed to increase existing added value and create new added value. (6) Raise standards by continuing to reinforce the 8 TPM Pillars. (7) Establish customer-focused quality management systems and raise the level of customer satisfaction. (8) Implement ground-breaking TPM programmes Establish Quality-Hozen systems (for quality in its narrow sense) tailored to the company's own internal environment	(1) Eliminate losses and constraints that impede the maximisation of resource utilisation efficiency. (2) Develop the ability to satisfy the requirements for perpetual corporate prosperity. (3) Make the sustainment of basic capabilities a way of life. (4) Establish QCD in R&D and in prototyping and pre-production. (5) Carry out development programmes designed to make the company number one in its industry. (6) Continue to strengthen the 8 TPM Pillars, and make this a way of life. (7) Implement creative TPM programmes. Establish Quality-Hozen systems (for quality in its broad sense) tailored to the company's own internal environment
	Expectations	(1) Arrangements are in place for establishing a Quality-Hozen system (the Figure-of-Eight Method, etc.) (2) Progress has been made with Kobetsu-Kaizens designed to prevent quality defects from being generated or passed on, and there are many zero-defect examples. (3) There is a strong culture of following the rules. (4) The ability to analyse causes is improving, based on an understanding of principles and parameters.	(1) A system for maintaining quality in its narrow sense has been established; a start has been made on setting up systems for maintaining quality in its broad sense, and trials are being conducted. (2) The level of improvements and error-proofing for preventing quality defects from being generated or passed on has risen, and this is leading to better results. (3) A culture of following the rules has become entrenched.	(1) Systems for maintaining quality in its broad sense (from development through to volume production) have been firmly established. (2) The developmental and technical capability for creating attractive qualities has been generated, and the production department has developed the ability to sustain these qualities. (3) The standard to which rules are followed has risen even further. (4) The production and development departments share a common understanding of the rules and standards that must be observed.

Quality-Hozen (Quality Maintenance)

Category		Part 1	Part 2	Part 3
Quality-Hozen	Expectations	(5) The ability to prevent quality defects from recurring or being repeatedly passed on is improving. (6) The need to control conditions is understood, and trend control is being implemented. (7) A quality assurance system is in place, and process capability indices have been measured. (8) There is a strong system of cooperation between the production department and other relevant departments concerning quality. (9) Quality defects are decreasing steadily. (10) The quality assurance system has been strengthened, and in some months there are zero complaints from next processes.	(4) The custom of thinking in terms of principles and parameters, and the use of techniques for establishing optimal conditions, have become established. (5) Measures taken to prevent the recurrence of problems have become more advanced, and systems have been set up for preventing problems from occurring in the first place. (6) Predictive diagnostic techniques needed for controlling conditions in order to sustain zero defects are being developed. (7) Quality assurance and follow-up systems have been established, and customer satisfaction has increased. (8) Systems for cooperating with other departments on quality have been strengthened, helping to reduce quality costs. (9) Some months go by with zero (or ppm level) in-process quality defects. (10) Vertical startup is achieved in the full-scale production of new products.	(5) Initiatives for preventing quality defects in advance are operating from the development stage for new products and new equipment. (6) Techniques for predicting quality defects are rolled out concurrently with the rest of the development process. (7) Quality assurance systems are established and sustained as part of the management of the development of new products. (8) Quality-Hozen systems involving suppliers and affiliates have been set up, and the level of customer complaints is among the lowest in the industry. (9) Whole months with zero in-process defects are achieved as a matter of course. (10) New products start up without problems in a very short time, and contribute to increased sales revenues soon after their launch.

Early Management (Products & Equipment)

Category		Part 1	Part 2	Part 3
Early Management	Key Concepts	(1) Identify and eliminate constraints impeding the reduction of production costs. (2) Painstakingly eliminate QCD constraints. (3) Utilise maintenance prevention data effectively, enhance preliminary planning for new products and equipment, and achieve vertical startup. (4) Build and operate a basic system for managing development and pre-production for new products and equipment. (5) Reduce the labour and lead times required for developing new products and equipment. (6) Practise concurrent engineering.	(1) Identify and painstakingly eliminate constraints impeding the reduction of total product costs. (2) Develop new, improved products. (3) Develop new, improved production systems. (4) Implement ground-breaking TPM programmes Build an innovative development management system suited to the company's own internal environment (5) Minimise development lead times through the comprehensive use of information technology, including maintenance prevention data. (6) Strengthen the ability to respond effectively in the new arena of business competition. (7) Implement concurrent engineering programmes participated in by all departments. (Raise the level of concurrent engineering dramatically)	(1) Eliminate constraints impeding cash flow. (2) Establish and operate systems for developing innovative new products. (3) Build innovative new production systems. (4) Implement creative TPM programmes Build a creative development management system suited to the company's own internal environment (5) Painstakingly eliminate hidden QCD losses in R&D and in prototyping and preproduction. (6) Develop the ability to satisfy the requirements for perpetual corporate prosperity. (7) Conduct development programmes designed to achieve world-class standards.
	Expectations	(1) There is a system for managing the development of new products and equipment, and some examples of its application. (2) Development management losses have been identified, and progress is being made in reducing them. (3) Design for manufacture has been introduced, and standards for evaluating ease of manufacture have been set. (4) The life-cycle costing and life-cycle planning philosophies have been incorporated into the design process (engineering economics is being deployed).	(1) A system is in place for ensuring that new products are good from the start, and the development period has been shortened. (2) An information network linking sales, development, design, prototyping and production has been set up. (3) A system for evaluating design robustness and ease of manufacture has been established. (4) Design takes account of environmental impact, and environmental protection costs are factored into life-cycle cost calculations.	(1) The company's development management system is the best in the industry and is making a significant contribution to it. (2) A companywide integrated information network is functioning effectively, and the time taken from market launch to profit contribution is short. (3) Development is progressed concurrently, from product development through equipment development to marketing development. (4) Production systems designed for resource recycling have been constructed, and many new products designed for recycling have been developed.

Early Management (Products & Equipment)

Category		Part 1	Part 2	Part 3
Early Management	Expectations	(5) The use of computer systems in the design task is well advanced, and the efficiency of design work has risen. (6) There are some examples of vertical startup in new product and new equipment development, and concurrent engineering is also being introduced. (7) There are some examples of the application of associated techniques such as failure mode and effects analysis and fault tree analysis. (8) There are some examples of the development of new technology and new manufacturing processes leading to the development of new products and equipment. (9) There is an information feedback system in place for maintenance-friendly design. (10) Some new-product and new-equipment development projects have involved affiliates and suppliers	(5) The low-cost automation philosophy has been incorporated into new-product development. (6) Systematic concurrent engineering activities are being routinely carried out. (7) Vertical startup of new equipment and products has become firmly established. (8) New technology and manufacturing processes are being actively developed as needed for the development of new equipment and products. (9) Statistical tools and simulation techniques are being actively utilised at the development stage, and progress is being made towards achieving prototype-free development. (10) A development system that involves suppliers and affiliates has been installed and is being operated effectively.	(5) The development right-first-time rate is higher than other companies in the industry, at every stage from development through prototyping to full-scale production. (6) All activities are performed concurrently, from planning through development and prototyping to full-scale production. (7) The proportion of sales accounted for by improved and innovative new products, and their contribution to company profits, are higher than at industry competitors. (8) The company leads the industry in pioneering new technologies that lead to the development of new equipment and new products. (9) Prototype-free development has become firmly established as a result of the use of quality engineering and simulation techniques at the development stage. (10) Suppliers and affiliates are integrated into the development management system.

Office TPM (TPM in administrative and support dept.)

Category		Part 1	Part 2	Part 3
Administration and Support Departments	Key Concepts	(1) Create working environments that are easy and pleasant to work in. (2) Standardise routine work and make it more efficient. (3) Reduce administrative losses. (4) Painstakingly eliminate loss costs. (5) Multiskill in administrative departments. (6) Ensure workplaces have the basic capability to contribute to business results. (7) Strengthen support for related departments. (8) Begin to develop a new culture and ethos with a strong desire to continually improve.	(1) Build new systems for routine work. (2) Build new minimal-loss warehousing and distribution systems. (3) Put systems in place for supporting programmes to expand added value. (4) Create systems that can cope with changes in the volume of work. (5) Reduce total product costs - Eliminate all losses holding back the reduction of costs - Enhance and expand work functions (6) Strengthen and enhance basic capabilities. (7) Establish the ability to respond effectively in competitive business environments. (8) Implement ground-breaking TPM programmes.	(1) Build and sustain an integrated sales/production/warehousing/distribution system. (2) Maximise the efficiency of resource utilisation. - Eliminate and prevent losses impeding cash flow by building a work structure that differentiates the company and gives it a competitive advantage (3) Strengthen programmes designed to create added value for the company as a whole. - Strengthen and enhance systems for responding to changes in the business environment (4) Conduct resource conservation programmes. (5) Make the sustainment and enhancement of basic capabilities a way of life. (6) Develop the ability to satisfy the requirements for perpetual corporate prosperity. (7) Conduct creative TPM programmes.
	Expectations	(1) Working environments that are easy and pleasant to work in have been achieved. (2) The principal routine tasks have been standardised, and there is a full programme of efficiency-improvement activities. (3) Progress is being made with reducing the administrative headcount and compressing task times, and administrative fixed costs have been lowered. (4) Information is transmitted rapidly and accurately, and the necessary information can be obtained quickly.	(1) Business management systems that link together all relevant departments including the sales department have been constructed. (2) The causes of management losses have been identified, and progress has been made with improving the systems designed to prevent these. (3) Fixed costs are being converted into variable costs through the effective use of outsourcing. (4) Support systems that help to optimise the overall manufacturing process are in place (systems for self-management are being constructed).	(1) Systems for preventing management losses in advance have been established, and systems for supporting related departments have been strengthened. (2) Work evaluation systems have attained a high level of perfection, and are supporting strategic decision-making. (3) Industry-leading integrated systems for managing business resources (people, materials, money and information) have been constructed. (4) Information lead times have been cut in all areas, and the new lead times are being sustained.

Office TPM (TPM in administrative and support dept.)

Category		Part 1	Part 2	Part 3
Administration and Support Departments	Expectations	(5) Improvements to reduce management losses in other departments are being implemented, and good results have been achieved. (6) Systems are in place for processing management information promptly. (7) Information technology is used to computerise much of the work, and network systems covering the principal tasks have been constructed. (8) Every department is trying to reduce administration-related costs and has made good progress. (9) Multiskilling is taking place, and the administrative labour load is being levelled. (10) Training schemes have been developed to pass on the skills required to maintain administrative systems.	(5) Production control systems that allow operation with minimal finished goods inventories and work-in-process have been established. (6) The speed and accuracy of decision-making is improving as a result of better administration. (7) Integrated production information management systems linking the company with its suppliers and affiliates have been constructed. (8) The proportion of total costs that administrative and indirect departments are responsible for have been reduced a stage further. (9) Systems for transferring administrative skills are functioning effectively, and these skills are being sustained and improved. (10) The ability to develop systems useful for work improvement has been acquired.	(5) Management systems have been established for sustaining the optimisation of overall business processes. (6) The ability to respond to change has been strengthened even further, from both the organisational and skills aspects. (7) The operation of integrated systems has strengthened relationships with suppliers and affiliates. (8) ROA-related costs have been further reduced. (9) Specialised personnel assessment systems are in place, and the people covered by it have acquired the necessary skills and abilities and are sustaining these. (10) Self-management systems have been established in all departments, and proficiency levels continue to rise.

Training and Education

Category		Part 1	Part 2	Part 3
Training and Education	Key Concepts	(1) Improve ability to select topics and solve problems. (2) Develop employees who are highly knowledgeable about their equipment, tasks and duties. (3) Set up and operate a system for delivering the training needed for the various steps of the Jishu-Hozen programme, and ensure that it produces the required results. (4) Do likewise for training in office automation for work improvement. (5) Strengthen the factory environment. Improve and reform people's capabilities (6) Identify the skills needed and assess their levels. (7) Develop the basic shop-floor capabilities needed to contribute to business results.	(1) Improve people's analytical and development abilities, based on understanding principles and parameters. (2) Develop highly competent operators with good maintenance skills. (3) Operate a programme for upgrading technical abilities that takes account of industry trends and technical advances. (4) Set up systems for recognising sustained effort. (5) Establish the ability to respond effectively in competitive business environments. (6) Establish systems for strengthening and enhancing basic capabilities.	(1) Set up Training and Education systems that can cope with change. (2) Strengthen the ability to adapt to changes such as personnel reassignments, introduction of new products, recruitment of new staff, etc. (3) Operate a programme for upgrading technical ability aimed at achieving and maintaining number one position in the industry. (4) Foster the ability to develop new maintenance techniques, new products and new information technologies. (5) Involve suppliers and affiliates. (6) Develop the ability to satisfy the requirements for perpetual corporate prosperity. (7) Make continuing to enhance and sustain basic capabilities a way of life.
	Expectations	(1) The skills and knowledge required for each trade and level have been identified. (2) Systems have been established for training new entrants in addition to training existing employees in each trade and at each level. (3) Training programmes based on the training system have been formulated and are being implemented. (4) Maintenance skills training is functioning effectively. (5) Relay teaching based on the on-the-job training method is functioning effectively. (6) There are many qualified personnel who possess specialised and Jishu-Hozen qualifications in addition to the basic legally-required qualifications and are making active use of these skills.	(1) The skill level of ordinary employees is rising, enabling them to address complex issues as well as simpler problems. (2) Skills transfer programmes are enhancing training benefits. (3) Training programmes adapted to corporate reform are in place, and the ability to cope with change is rising in the context of skills also. (4) The company has developed its own original training systems, programmes and tools for transferring skills. (5) Training for technical staff and maintenance engineers based on improving technical abilities is also of a high standard. (6) Many people have obtained specialised and Jishu-Hozen qualifications and are applying their skills actively to their work.	(1) Clear visions for the type of person required for each trade and at each level have been formulated, and such people are being systematically developed. (2) A Training and Education system for achieving and sustaining world-class systems for managing people, equipment, materials and methods has been established and is being effectively operated. (3) Training and Education systems involving suppliers and affiliates have been set up and are delivering concrete results. (4) The skills of ordinary employees, support staff and engineers are at world-class levels. (5) Workplaces robust enough to be unaffected by changes such as personnel reassignments, introduction of new products, recruitment of new staff, etc. have been established.

Training and Education

Category		Part 1	Part 2	Part 3
Training and Education	Expectations	(7) People make active efforts to gather information by attending external training courses. (8) Training in office automation for work improvement is being given, based on a system designed for this purpose. (9) Clear long-term human resource development targets have been set, and training programmes have been set up to achieve those targets. (10) The benefits of Training and Education have been identified.	(7) Many presentations are made at outside conferences, and a wide range of case studies and technical reports are published. (8) Programmes for raising analytical abilities are producing concrete results. (9) In-house instructors have been trained and are playing an active role in Training and Education. (10) Clear standards for assessing training levels have been set and are helping to keep the activities on the boil.	(6) Sufficient multiskilling has taken place and many people have obtained recognised qualifications. (7) Case studies and technical reports surpassing those of industry competitors have been published. (8) Employees routinely learn from each other by means of regular conferences and other events involving suppliers and affiliates. (9) Suppliers and affiliates are being coached in TPM and have developed some prize-winning examples. (10) A culture in which every employee strives for self-development has been established.

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SHE (Safety, Health and Environment)

Category		Part 1	Part 2	Part 3
Safety, Health and Environment	Key Concepts	(1) Create safe, pleasant workplaces. (2) Comply with all pollution-prevention legislation. (3) Comply with all occupational health and safety legislation. (4) Comply with all local authority ordinances. (5) Improve working environments. (6) Increase employee satisfaction. (7) Strengthen the factory environment. - Improve the basic capabilities of the shop floor (8) Begin to develop a new corporate culture and ethos.	(1) Deploy safety risk analysis. (2) Cut waste and promote the 3 Rs (reduce, reuse, recycle). - Minimise the amount of factory waste disposed of (3) Construct environmental and labour management systems. (4) Implement environmental conservation programmes. - Tackle environmental pollution at its source (5) Actively reduce the use of harmful chemicals. (6) Raise the level of 'social satisfaction'. (7) Strengthen and enhance basic capabilities. (8) Establish the ability to respond effectively in comp	(1) Implement resource conservation programmes. (2) Make activities based on the 3 Rs (reduce, reuse, recycle) a way of life. (3) Create a recycling-oriented factory. (4) Construct recovery systems that treat environmental investment as a cost (practise environmental accounting). (5) Prepare for and implement information disclosure. (6) Raise the level of 'global satisfaction'. (7) Implement creative TPM programmes. (8) Develop the ability to satisfy the requirements for perpetual corporate prosperity.
	Expectations	(1) All occupational health and safety legislation is fully complied with. (2) Working environments meet all legal standards (for noise, vibration, dust, lighting, etc.). (3) Effective action has been taken to eliminate the sources of past incidents, and initiatives such as near-miss reporting, safety awareness training, etc. are being routinely conducted. (4) All employees are thoroughly conversant with the safety rules. (5) Tasks that need monitoring for safety reasons have been identified and are being improved. (6) Thorough safety assessments are performed whenever new equipment or processes are introduced.	(1) Occupational safety assessment systems (safety management systems) have been established and are being operated. (2) Improvements to working environments are being made on a scientific basis rather than on a purely legalistic one. (3) Systematic safety and environmental education and training is being carried out. (4) Tasks that affect the environment or pose the risk of incidents have been identified, and all employees perform them with awareness. (5) An environmental impact assessment is carried out whenever new technology, new equipment or new materials are introduced.	(1) The benefits of preventing incidents and improving the environment have been clearly identified from the business perspective. (2) Occupational health and safety and environmental initiatives and results are a model for the industry. (3) The people-machine interface is taken into account when installing new equipment and processes. (4) The generation of industrial waste has been suppressed even further, and even more outstanding results have been achieved in reducing the quantities disposed of. (5) Systems that treat environmental investment as a cost and attempt to recover it are in place.

SHE (Safety, Health and Environment)

Category		Part 1	Part 2	Part 3
Safety, Health and Environment	Expectations	(7) Initiatives to improve employees' mental health are being actively pursued. (8) Clear emergency response procedures are in place for incidents that could affect the surrounding locality. (9) All national environmental legislation and local-authority ordinances are being complied with. (10) Kaizen programmes are helping to reduce energy and resource consumption.	(6) The company has clear policies that view the global environment from the perspectives of resource conservation and pollution prevention. (7) Environmental management systems have been established and zero-emission initiatives are being progressed. (8) The quantity of harmful chemicals handled has been reduced, and all chemicals are appropriately controlled. (9) Industrial waste and emissions are being kept at low levels by improving yields, reducing unit energy consumption and designing products for ease of manufacture. (10) Significant results have been achieved in reducing the amount of waste disposed of.	(6) Environmental initiatives have been extended to other organisations with which the company does business. (7) The company has developed its own technology for reducing energy and resource consumption. (8) Recycling-oriented production systems have been constructed. (9) The factory is steadily being reformed with the aim of changing it into a resource-recycling type of production facility. (10) Programmes for improving safety and the environment are of a high standard and are helping to sustain the internal environment and produce good results.

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