



How to Improve Workstation and Process Design to Minimise Waste

Value Chain Competitiveness (VCC)

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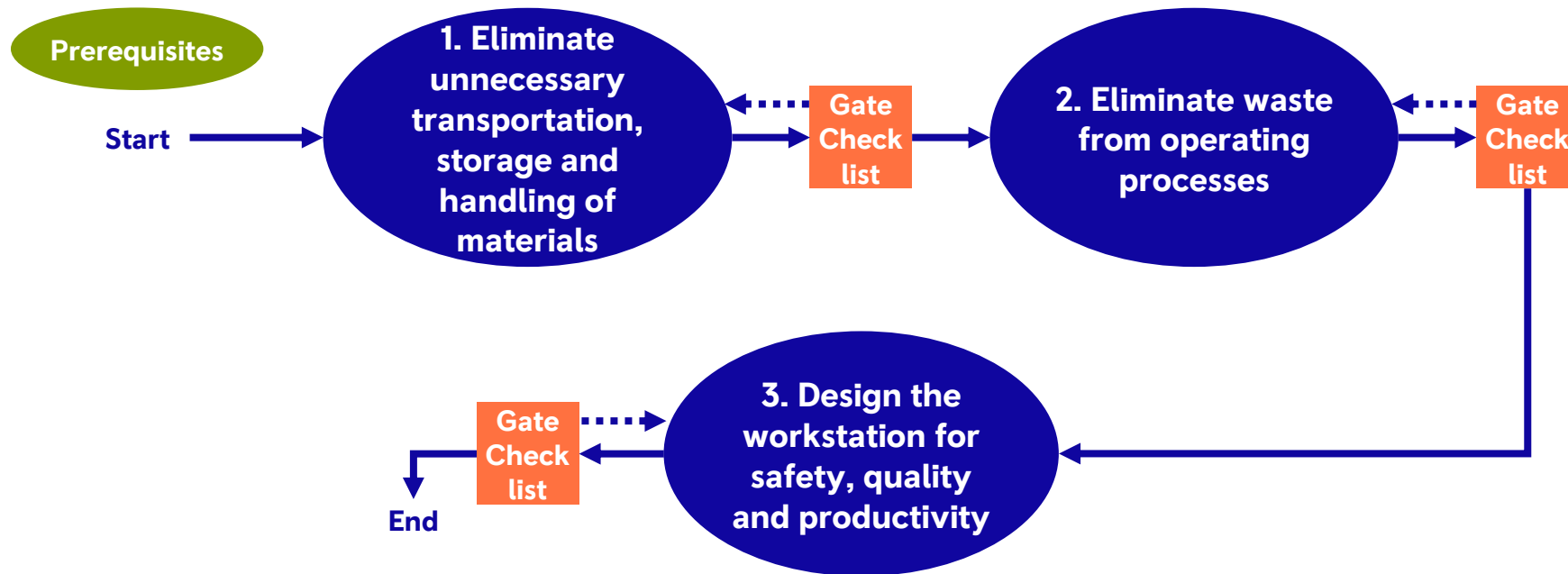


How to Improve Workstation and Process Design to Minimise Waste



Scope

Objectives & Principles





Scope



This 'How To' will enable you to:

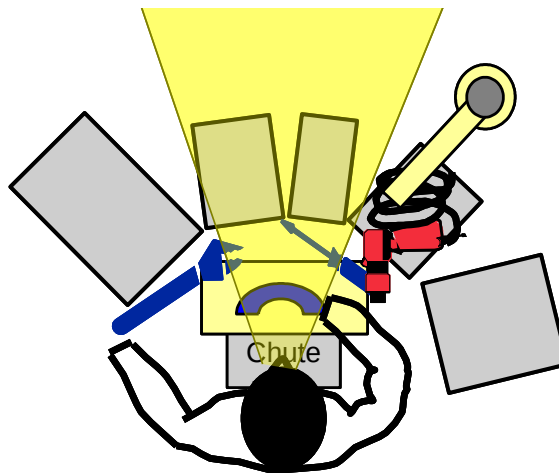
- Use appropriate analysis tools to identify waste
- Apply guidelines to eliminate waste from operating processes
- Apply guidelines to design the workstation for safety, quality and productivity

Objective and Principles



Process Objective: To Improve Workstation and Process Design to Increase Safety, Quality and Productivity Performance

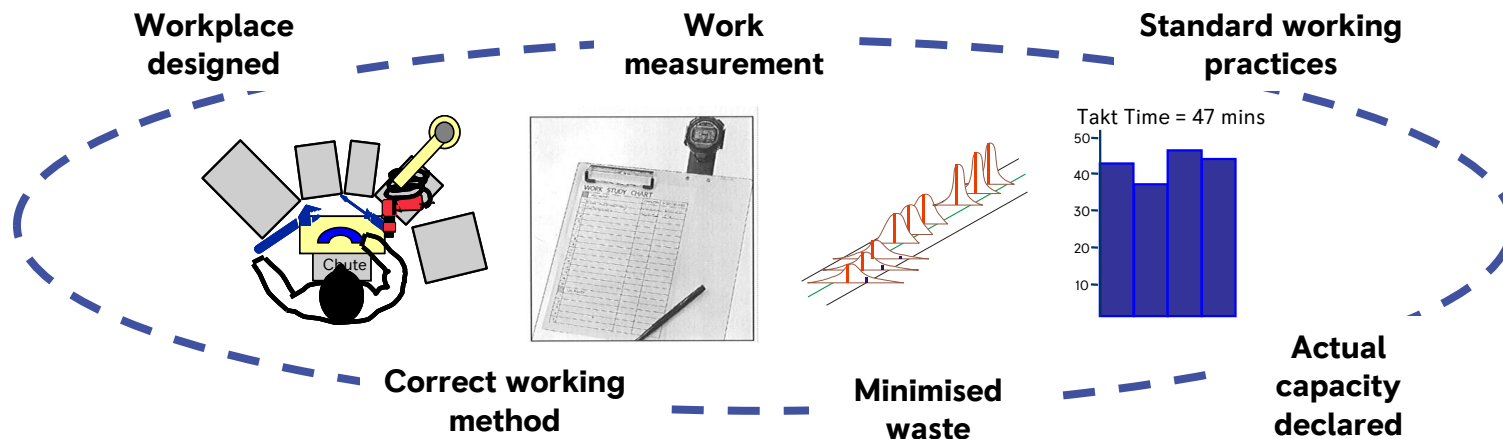
The design of an optimal workplace and processes to provide a safe and comfortable operating environment, minimising waste of effort and movement and ensuring repeatable, high quality and productive operations



Objective and Principles



1. Appropriate analysis to establish details of current or proposed operating process
2. Eliminate, combine or simplify wasteful activities wherever possible
3. Maximise ability to reconfigure



4. Make the work environment safe, comfortable, and efficient
5. Apply error prevention methods to eliminate possible causes of defects
6. Incorporate visual management to immediately expose non-conformance



Prerequisites



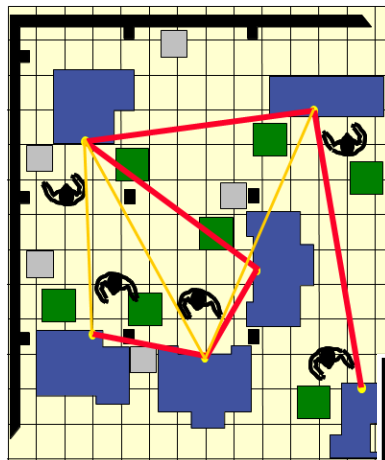
Some knowledge of:

- Lean Manufacturing principles
- Factory Design and Layout
- Error Prevention
- Material Storage
- Performance Management

1. Eliminate unnecessary transportation, storage and handling of materials

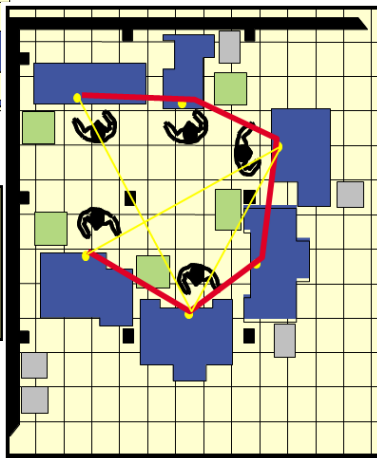


Develop detailed analysis of material process flow



Record and examine the current material movements

Develop improved work area layout



- A 'string / spaghetti diagram' is a good way to engage teams in re-organising the work area
- Use different colour pens to trace the route of material through the cell – eg. thicker lines for higher volumes of the products
- Use the 'string diagram' alongside process analysis to get a full understanding of current state
- Use the current state issues and opportunities as the basis for improvement
- Develop the layout on a scale drawing to improve product flow (& minimise people movement)
- Re-position machines and equipment and measure possible solutions
- Assess with operators to identify any concerns before finalising proposals



1. Eliminate unnecessary transportation, storage and handling of materials

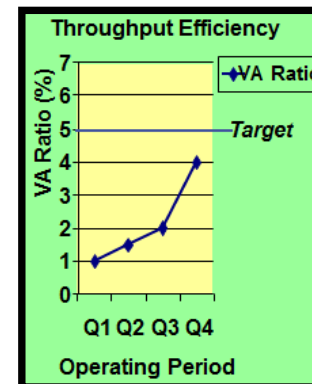


Develop detailed analysis of material process flow

Use 'product' process analysis to analyse the production method with a view to simply (eliminate, combine, or shorten steps) and remove waste

- Use process charting to record measurements for all the steps in the material flow
- Simple visual indicator of value-adding (VA) and non-value-adding - use as a baseline and tracker of improvement
- Can any steps be eliminated or re-sequenced (reduce operations, transport and storage)
- Can any of the steps be combined / done simultaneously with another one?
- Orientation / error prevention of part whilst transporting

FLOW PROCESS CHART					Man / Material / Equipment Type		
Chart No. 7 Sheet No. 2 of 2					CONTINUATION		
METHOD:					Subject Charted: Ward 7 dinner service		
PRESENT / PROPOSED					Activity		
DESCRIPTION	QTY. (plates)	DIST. (m)	TIME (min)	SYMBOL	REMARKS		
Serves from 3 dishes to plate	-	-	.25	● → D ■ ▽	Use trolley to 'move and serve' -		
Carries plate to bed 16 & return	1	6	.23	● →	2 bed each time		
Serves	-	-	.25	● →			
Carries plate to bed 17 and return	1	7.3	.25	● →			
Service complete, return to kitchen	-	16	.50	● →			
Total distance and time		192	10.7	17 20			





1. Eliminate unnecessary transportation, storage and handling of materials



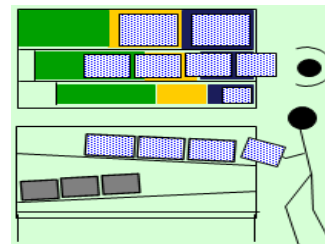
Determine optimal mechanisms of material supply

Develop supply systems using the four principles of stock control:

1. **Replenishment control** - 'How long is required for replenishment? So, what quantity should trigger this?'
2. **Amount control** - 'How frequently is it practical to replenish, and therefore how many pieces, and what space, must be provided for?'
3. **Location control** - 'Where is the optimal location for the part in respect to its size and weight, and the frequency and sequence of use?'
4. **Sequence control** - 'What must be done to maintain 'first in first out', orientation and error prevention?'

For example:

- Material characteristics such as weight and size, along with replenishment frequency, will determine the presentation mechanism
- Deliver and maintain material in the correct orientation and at the operating height wherever possible
- Colour-coded locations for moves between work stations to define minimum and maximum quantity of individual parts or containers
- Use reusable containers where ever possible to avoid unwrapping and disposal of packaging materials





Gate checklist 1: Eliminate unnecessary transportation, storage & handling of materials

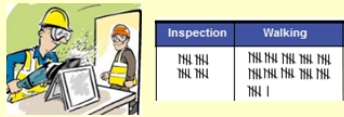
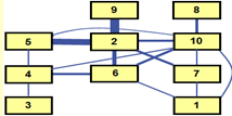
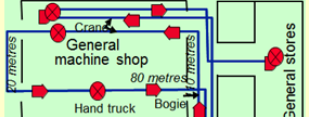
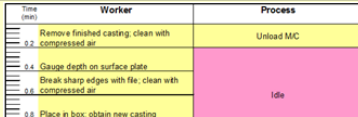
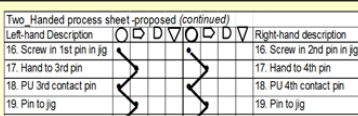


- ☒ Material process analysis completed and value added improvement determined
- ☒ Material presentation mechanism determined according to characteristics such as weight and size
- ☒ Optimal mechanisms of material supply determined with consideration of replenishment control, amount control, location control and sequence control

2. Eliminate waste from operating processes



Select appropriate technique and analyse work method

RECORDING TECHNIQUE	APPLICATION AREA
Activity Sampling 	For analysis of methods of work of both people and equipment, to indicate the relative proportions of value-added and non value-added time.
Travel Chart 	For analysis of complex movements of people, equipment or materials between locations. To rearrange locations / work methods to minimise distances (and difficulties) of movement.
Flow Process Charts 	For detailed analysis of work methods of people and equipment, both at the workstation and when moving around the work area.
Multiple Activity Chart 	For analysis of the activities of more than one subject (person or material) recorded against a common time scale showing their interrelationship.
Two Handed Process Charts 	Primarily for fine detail analysis of light assembly work methods to optimise the use of both hands (short-cycle, repetitive work).
Video 	A visual record typically used to analyse infrequent, non-repetitive work tasks of people and equipment e.g. machine / process changeovers.

Further detail of each is on the following pages

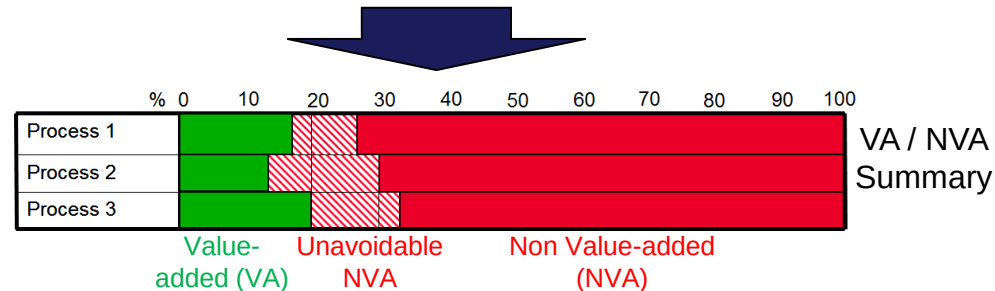
Select appropriate technique & analyse work method – Activity Sampling

Activity Sampling		<table border="1"> <thead> <tr> <th>Inspection</th> <th>Walking</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> </tr> <tr> <td></td> <td> </td> </tr> </tbody> </table>	Inspection	Walking							For analysis of methods of work of both people and equipment, to indicate the relative proportions of value-added and non value-added time.
Inspection	Walking										

- Activity sampling should be carried out over a period with enough frequency that the observations reflect the reality, eg. 10 cycles or a few hours of normal operation
 - Recording the observations (eg. tally) allows for a total % by activity type to be calculated
 - Visually summarising the results shows the VA% and NVA% 'opportunity' for improvement
 - VA: Assembly, machining etc.
 - NVA: Walking, transport, waiting etc.
 - Unavoidable NVA: Inspection etc.
- | Operation | Assembly | Inspection | Walking | Transport | Waiting | Comments |
|-----------|----------|------------|---------|-----------|---------|--|
| 01 | | | | | | Excessive movement distances due to layout. Unbalanced work cause some waiting |
| Total | 36 | 20 | 56 | 78 | 10 | |
| % | 18% | 10% | 28% | 39% | 5% | |
- | Process | VA (%) | Unavoidable NVA (%) | NVA (%) |
|-----------|--------|---------------------|---------|
| Process 1 | 18% | 10% | 72% |
| Process 2 | 12% | 18% | 70% |
| Process 3 | 28% | 10% | 62% |

Operation	Assembly	Inspection	Walking	Transport	Waiting	Comments
01	798 798 798 798 798 798 798 I	798 798 798 798	798 798 798 798 798 798 798 798 798 798 798 I	798 798 798 798 798 798 798 798 798 798 798 798 798 798 798 IIII	798 798	Excessive movement distances due to layout. Unbalanced work cause some waiting
Total	36	20	56	78	10	
%	18%	10%	28%	39%	5%	

Activity tally chart

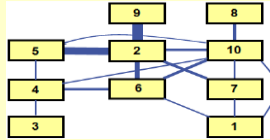


2. Eliminate waste from operating processes



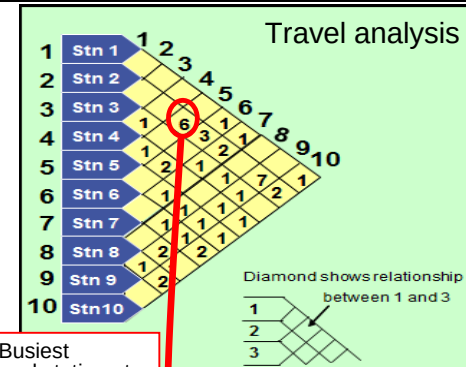
Select appropriate technique & analyse work method – Travel Chart

Travel Chart



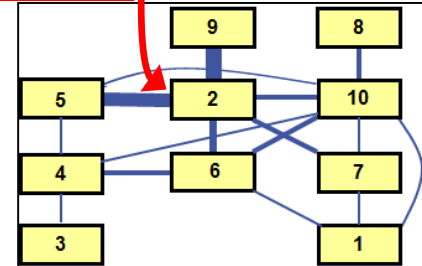
For analysis of complex movements of people, equipment or materials between locations. To rearrange locations / work methods to minimise distances (and difficulties) of movement.

- Use travel analysis to record quantitative data about the movements of people, materials or equipment between locations over a period of time
 - A quicker, more manageable alternative to a string diagram
 - Particularly useful for analysis of complex movement patterns
- A travel chart can then be built using the locations connected by lines, whose thickness are proportional to the number of movements observed
- This analysis allows for the rearrangement of locations / pattern of work to minimise distances (and difficulties) of most frequent journeys
 - Build out from the centre
 - Highest frequency first, with reference to other significant frequencies



Busiest workstation at the centre

Travel chart

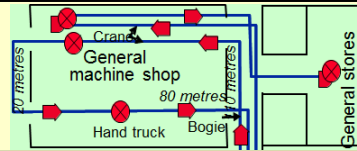


2. Eliminate waste from operating processes



Select appropriate technique & analyse work method – Flow Process Charts

Flow Process Charts



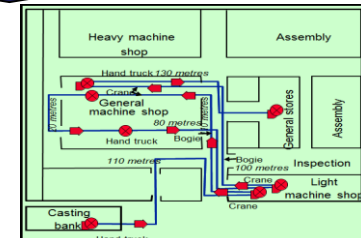
For detailed analysis of work methods of people and equipment, both at the workstation and when moving around the work area.

- Use process flow analysis for detailed assessment of operator (or equipment)
 - Typically with 'average' proficiency to give representative results
- Measurements must be made first hand using the standard symbols for each of the sequential steps observed
- Recorded in a Process Flow Chart or on a Area Layout Chart or a combination
- Examine each step to identify improvement possibilities
 - ELIMINATE - unnecessary parts of work
 - COMBINE - wherever possible
 - REARRANGE - the sequence
 - SIMPLIFY - the operation

Symbol	Meaning	Comment
	Operation value-added	Changing product fit, form or function – eg. assembling, machining, processing
	Operation non value-added	Additional NVA process activity – eg. paint masking, rework, decanting parts, re-packaging
	Inspection	Verification of quality or quantity – eg. visual and dimensional verification, counting, weighing
	Delay	Operator / equipment waiting – eg. person waiting for cycle end, machine waiting
	Storage / hold	Materials being held or stored – eg. in-process materials and stored materials
	Transport / movement	Movements of the person / equipment – eg. person walking, forklift or truck movements
	Decision	Consideration point for next course of action – eg. quality sentencing, administrative decision

FLOW PROCESS CHART					Men / Material / Equipment Type
Chart No. 7 Sheet No. 2 of 2					CONTINUATION
METHOD:					Subject Charted: Ward 7 dinner service
PRESENT / PROPOSED					Activity
DESCRIPTION	QTY. (cases)	DIST. (m)	TIME (min)	SYMBOL	
Serves from 3 dishes to plate	-	-	.25		Ua
Carries plate to bed 16 & return	1	6	.23		2 b
Serves	-	-	.25		
Carries plate to bed 17 and return	1	7.3	.25		
Service complete, return to kitchen	-	16	.50		
Total distance and time		192	10.7	17	20

Flow Process Chart



Area Layout Chart



2. Eliminate waste from operating processes



Select appropriate technique & analyse work method – Multiple Activity Chart

Multiple Activity Chart	<table> <tr> <th>Time (min)</th><th>Worker</th><th>Process</th></tr> <tr> <td>0.2</td><td>Remove finished casting; clean with compressed air</td><td>Unload M/C</td></tr> <tr> <td>0.4</td><td>Gauge depth on surface plate</td><td rowspan="3">Idle</td></tr> <tr> <td>0.6</td><td>Break sharp edges with file; clean with compressed air</td></tr> <tr> <td>0.8</td><td>Place in box; obtain new casting</td></tr> </table>	Time (min)	Worker	Process	0.2	Remove finished casting; clean with compressed air	Unload M/C	0.4	Gauge depth on surface plate	Idle	0.6	Break sharp edges with file; clean with compressed air	0.8	Place in box; obtain new casting	For analysis of the activities of more than one subject (person or material) recorded against a common time scale showing their interrelationship.
Time (min)	Worker	Process													
0.2	Remove finished casting; clean with compressed air	Unload M/C													
0.4	Gauge depth on surface plate	Idle													
0.6	Break sharp edges with file; clean with compressed air														
0.8	Place in box; obtain new casting														

- Shows times for all manual and mechanical work tasks, when resources can progress independently, and when they are mutually involved
- Activity blocks for workers and the processes being operated are plotted on a time-scale, with a separate column for each resource
 - Colour coding highlights categories of work
- Examine for improvement opportunities, eg.
 - Introduce other work tasks (productivity)
 - Reduce waste through effective layout
- Alternative work scenarios can be plotted for future planning

Multiple Activity Chart					
Chart No.	Sheet No.	Summary			
Product			Present	Proposed	Saving
		Cycle time (min.)			
Drawing No.	Operator	2.0	1.08	0.92	
	Machine	2.0	1.08	0.92	
Process	Working				
	Operator	1.2	1.0	0.2	
Machines	Machine	1.0	1.0	0	
	Speed Feed				
	Idle				
	Operator	0.8	0.08	0.72	
Operative(s)	Machine	1.0	0.08	0.92	
	Utilization				
Charted By	Gain				
	Operator	60%	92.6%	32.6%	
	Machine	50%	92.6%	42.6%	
Time (min)	Worker	Process	Time (min)		
		Idle			
0.2	Remove finished casting; Clean fixture; locate new casting in fixture and start machine cycle	Unload / Load M/C			0.2
0.4	Break edge of machined casting with file; clean with compressed air	Finish mill second side			0.4
0.6					0.6
0.8	Gauge depth on surface plate. Place casting in box; pick-up new casting place on machine load station				0.8
1	Idle				1
1.2					1.2

Multiple Activity Chart

2. Eliminate waste from operating processes

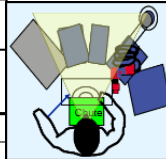


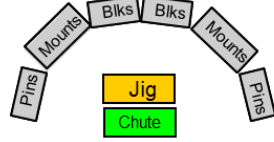
Select appropriate technique & analyse work method – Two-Handed Process Charts

Two-Handed Process Charts	Two-Handed process sheet-proposed (continued)													
	Left-hand Description					○	▷	▷	▷	○	▷	▷	Right-hand description	
	16. Screw in 1st pin in jig												16. Screw in 2nd pin in jig	
	17. Hand to 3rd pin												17. Hand to 4th pin	
	18. PU 3rd contact pin												18. PU 4th contact pin	
	19. Pin to jig												19. Pin to jig	
Primarily for fine detail analysis of light assembly work methods to optimise the use of both hands (short-cycle, repetitive work).														
					Symbol		Meaning		Comment					

- Analysis of work methods at the elemental (micro-motion) level involving two-handed short-cycle work
- Having understood the workstation layout and work cycle, each of the operator movements are categorised and recorded
- Examine each step to identify improvement possibilities
 - ELIMINATE - eg. use jig to hold, not idle hand
 - COMBINE - eg. left & right hands work simultaneously
 - REARRANGE - layout to avoid hands interference
 - SIMPLIFY - eg. Fixture eases operator fatigue and wrist strain
- Apply principles of motion economy

Symbol	Meaning	Comment
	Operation	Used for activities of grasp, position, use, release, inspect of tool, component or material
	Delay	Used to denote time during which the hand or limb being charted is idle
	Hold	For the two-handed process, hold is re-designated in respect to work, tool or material
	Transport	Used to represent movement of the hand (or limb) to, or from, the work, or a tool, or material



Two-handed process sheet - proposed														
Chart No. 2 Sheet No.1 of 1					Workstation layout									
Drawing and Part.														
Operation: Plug mount assembly														
Location: General shop														
Operator: D.G.														
Charted by: A.B. Date: 6/11/xx														
Left-hand description					○	▷	D	▽	○	▷	D	▽	Right-hand description	
1. Hand to 1 st Term. Blk.													1. Hand to 2 nd Term. Blk.	
2. PU 1 st Term. Blk.													2. PU 2 nd Term. Blk.	
3. Move Blk. to jig													3. Move Blk. To jig	
4. Place Blk. In jig													4. Place Blk. In jig	
5. Hand to 3 rd Term. Blk.													5. Hand to 4 th Term. Blk.	
6. PU 3 rd Term. Blk.													6. PU 4 th Term. Blk.	

Two-Handed Process Chart



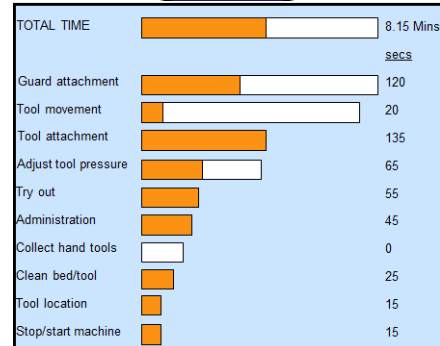
2. Eliminate waste from operating processes



Select appropriate technique & analyse work method – Video

Video		A visual record typically used to analyse infrequent, non-repetitive work tasks of people and equipment e.g. machine / process changeovers.
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- Video offers the opportunity to replay and analyse a process and work tasks
- It is useful for analysing and optimising operator and equipment interactions
 - Improving the work method, ergonomics and equipment
- Use the recorded process timings to confirm the current standard or to continuously improve, eg. set-up time reduction
 - Identifying the categories and amount of time
 - Where opportunities exist for waste reduction and streamlining
- Video is also a great technique for training purposes



Eg. Video Analysis Summary



2. Eliminate waste from operating processes



Apply principles of motion economy to optimise the method

Principles concerning the economy of movements are typically grouped under the following 3 headings:

- a) Effective use of the human body
- b) Arrangement of the workplace
- c) Design of tools and equipment

- a) Effective use of the human body is based on smooth, rhythmical, movement
- Motions of the arms should be simultaneous, symmetrical and in opposite directions
 - Reduce the classification of hand and body motions to the lowest at which it is possible to do the work satisfactorily
 - Use continuous curved movements in preference to straight-line motions involving sudden and sharp changes of direction
 - Free swinging movements are faster, easier and more accurate than restricted or controlled movements
 - Arrange the work to permit easy and natural rhythm wherever possible
 - Maintain common focal point for tools etc. to reduce head movements and eye strain



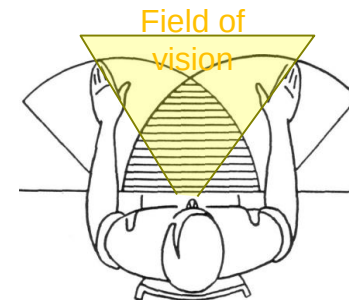
2. Eliminate waste from operating processes



Apply principles of motion economy to optimise the method

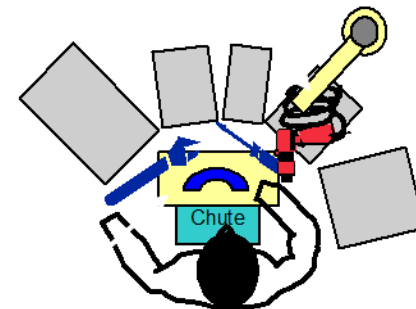
b) Arrangement of the workplace to suit the work task

- Use fixed positions (tooling & parts) to encourage rhythm & avoid searching - allows good habits to form easily
- Gravity feed of materials as close as possible to points of use
- All tools, materials, and controls located within the working area
- Items placed in the primary field of vision in best sequence of motion
- Use ejector systems, or gravity drop deliveries to enable minimum movement to pass on parts to next operator



c) Design of tools and equipment to support optimal working

- Colour code workplace to contrast with the work to avoid eye fatigue
- Position tools for immediate use (minimise turning, lifting etc.)
- Use combination tools where possible - less conflict for space and easier to locate. Use powered tooling where possible.
- Use tool trolleys and utility belts for working beyond the immediate workstations
- Appropriate benches and chairs of type and height for good posture and to avoid interrupted motions – with adequate lighting for task





Gate checklist 2: Eliminate waste from operating processes



- ☒ Appropriate technique(s) selected to give required depth of analysis
- ☒ Work analysed to understand the extent of non value-added activity
- ☒ Principles of motion economy applied to eliminate combine, reduce and simplify activities



3. Design the workstation for safety, quality and productivity



Determine safety and ergonomic considerations

Effective safety management is essential to reduce accidents

Employer responsibilities

- Avoid - The need for hazardous manual handling and excessive motions, as far as reasonably practicable
- Assess - The risk of injury from hazardous manual handling and excessive motions that cannot be avoided; and
- Reduce - The risk of injury from hazardous manual handling and excessive motions as far as reasonably practicable

Employee responsibilities

- Follow - Appropriate Standardised Working procedure
- Use - Safety equipment provided
- Cooperate - On Health and Safety matters
- Apply - The responsibilities of the Employer to their own operations
- Ensure - Activities do not endanger others



3. Design the workstation for safety, quality and productivity



Determine safety and ergonomic considerations

Assess the task to reduce risks and take resulting action, eg.

- Improve workplace layout, reduce the amount of twisting and stooping, avoid lifting from floor level or above shoulder height, cut carrying distances, avoid repetitive handling, vary the work to allow muscles rest

Lifting and material movement considerations

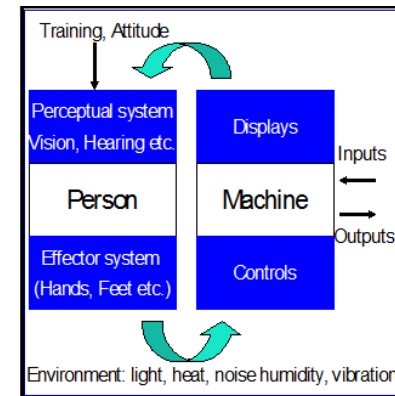
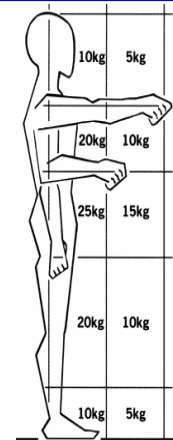
- Stop and think, position the feet, adopt a good posture get a firm grip, keep close to the load, don't jerk, move the feet, put down then adjust

Design of a safe, effective workplace should consider ergonomic factors

- Ergonomics is the scientific study of the relationship between man and the working environment including Anthropometric factors (physical factors and sizes), Neurological factors (functioning of the brain and nervous system), and Environmental factors

Design the workstation to suit the majority of operators

- Standing and sitting, hands, wrists and arms should be kept as neutral as possible in their orientation, parts presentation and use of fixtures or tooling





3. Design the workstation for safety, quality and productivity



Determine safety and ergonomic considerations

Effective workstation design must take full account of all environmental factors

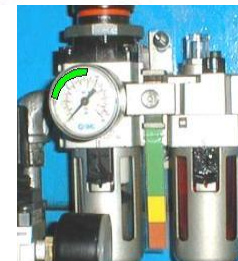
- Create a quiet comfortable environment for optimal working conditions, - avoid unnecessary intrusion by any pollutants: Noise, Heat, Humidity, Smells, Radiation, Gases

Dials and gauges should highlight acceptable (and unacceptable) conditions instantly

- Easier to check information output from the equipment

Lighting at the workstation should be designed to suit the task

- Good lighting is essential for work to be done well and in comfort, use light position and moderate matt colours to focus attention to the area of priority, avoid glare, plan for the maintenance and cleaning of lighting



Consult the appropriate guidelines

Visual task	Lux	Lumens / sq.ft.
Rough work e.g. sawing	200	18.6
Medium work e.g. sheet metal,	400	37.2
Fine work e.g. precision machining	900	83.7
Inspection	2,000	186



3. Design the workstation for safety, quality and productivity



Incorporate mechanical & error-proofing mechanisms

The application of 'low cost automation' is based on the following general principles

- Pneumatic and hydraulic powered actuators to provide dynamic force to support physical task
- Clamping component in fixture
- Pneumatic / hydraulic actuators to replace simple manual actions
- Kick-out devices for ejection of component from fixture
- Pneumatic and hydraulic fluidic devices for a variety of logic control elements
- Part proximity sensing for error prevention



Gate checklist 3: Design the workstation for safety, quality and productivity



- ☒ Appropriate risk assessment completed to support the development of safe working practices
- ☒ Ergonomic considerations deployed in the physical design of workstations
- ☒ Work stations designed for quick and accurate communication of information
- ☒ Work stations designed with full regard to environmental conditions
- ☒ Appropriate mechanical and error-proofing mechanisms employed