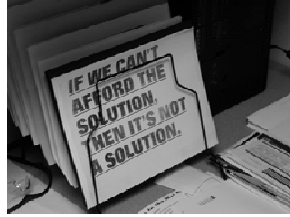


## Cost Reduction Practices

### Workplace Organization and Visual Control



#### WASTE IDENTIFICATION / ELIMINATION TOOLS & TECHNIQUES

<b>Value Stream Mapping</b>	Visual representation of material and information flow in production.
<b>Visual Inspection or Observation</b>	See it. Fix it. Find value - everything else is waste.
<b>5S</b>	Sort, Set in Order, Shine, Standardize, Sustain - an effort to implement visual control of processes.
<b>Jidoka or Autonomation</b>	Automation with a human touch.
<b>Kanban or Pull-Systems</b>	Visible cards, records, signs, or signals used to control the flow of materials in production.
<b>Poka-yoke</b>	Mistake proofing processes to eliminate defects and unsafe operations.
<b>Single Minute Exchange of Dies (SMED) or Quick Changeover</b>	Setup reduction, reduction of change-over times, reduction of change-over steps.
<b>Standardized Operations</b>	Elimination of process variation.

## Waste Reduction: Visual Control

- “Visual control means making it possible for everyone to see whether the situation is right or wrong and wherein lies the waste”  
(Hirano & Black, 1987, p. 174).
- Many techniques exist for identifying non-value-added manufacturing practices: 5S, Kanban and Value-Stream Mapping (VSM). All rely on visual communication.

## Waste Reduction: Visual Control

- VC Communicates information such as:
  - 1. Where items are needed
  - 2. How many items are needed
  - 3. Standard procedures for doing something
  - 4. Status of work process
  - 5. Information about work flow activities
  - 6. Identify standards – indicate whether something is normal or abnormal

(PPDT: "5S", 1996)

## Visual Control: 5S

- 5S/6S is the start of process improvement
- “The 5S system is designed to create a visual workplace – that is, a work environment that is self-explaining, self-ordering, and self-improving. In a visual workplace, the out-of-standard situation is immediately obvious and employees can easily correct it”  
(Dennis, 2002, p. 28).
- “The 5S’s are the start in identifying problems and wastes”  
(Hirano & Black, 1987, p. 28).
- Identifying non-value-added practices can be viewed as an activity.

## 5S

- Seiri, Seiton, Seiso, Seiketsu, and Shitsuke (Hirano & Black, 1988). 5S is described as proper arrangement, orderliness, cleanliness, cleanup, and discipline.
- Japanese terms are often referred to as Housekeeping (Feld, 2000).
- According to Majima (1992), when implemented properly, the 5S’s reveal other opportunities for improvement.
- 5S is viewed as one of the most inexpensive lean techniques – reveals problems

## 5S

- Seiri = Sifting or Sorting out what is necessary and discarding what is not (Feld, 2000; Hirano & Black, 1988).
- Seiton = Orderliness, or assigning locations for everything (Hirano & Black, 1988).
- Seiso = Cleanliness or making the workplace as clean as possible (Hirano & Black, 1988).
- Seiketsu = Standardizing operations (Feld, 2000) or keeping the work area clean and organized (Hirano & Black, 1988).
- Shitsuke = Concerned with Sustaining orderliness and cleanliness or making them habit (Feld, 2000; Hirano & Black, 1988).

## Waste Reduction: 5S

- 5S includes sorting out what is not needed, setting necessary items in an orderly manner, shine – cleaning the area, standardize – making guidelines for keeping the area clean and organized, and sustain – educating and communicating the standards (Davis, 2002; WOT, 1997).
- “An uncluttered, well-organized, and understandable workplace is an essential foundation for lean, low-inventory production, total quality management, total productive maintenance, or any other advanced change initiative or improvement approach” (Productivity Press Development Team (PPT) 1997, p. V).



## 1S: Sort

- Theme for Sort = “When in doubt, move it out” (PPT: “The 5S System”, 1997, p. 22)
- “...Sort means that you remove all items from the workplace that are not needed for current production (or clerical) operations” (PPT: “5S”, 1996, p. 30)
- Problems targeted:
  1. Crowded work areas difficult to work in
  2. Storage areas for unneeded items that block communication
  3. Time wasted searching for needed items
  4. Unneeded inventory or machines that needed maintaining
  5. Unneeded items that hide process problems
  6. Unneeded items that prevent flow (PPT: “5S”, 1996)
  7. Safety problems/hazards (PPT: “The 5S System”, 1997)

## 1S: Sort

- Questions Asked:
  - Is the item needed?
  - Is the item needed in this quantity?
  - Is the item needed in this location?
- Items are red-tagged for various treatments:
  - Disposal
  - Sell (tools, machinery, parts, material, scrap, recycle)
  - Return (to owner, supplier, customer)
  - Lend out or rent (to other companies)
  - Distribute (to other parts of company in need)
  - Give away (to employees, companies, institutions)

## 2S: Set in Order

- Companies need to understand that physical system design affects performance (output)
- Welder
  - Looking for tool/essential at station = average 3 minutes
  - Frequency for looking for looking = 10 times/8 hour shift
  - Work time = 1880 hrs/year (47 weeks)
  - Rate looking for tools/essentials
  - Pay rate = \$27/hr
  - Cost of looking for tools/essentials =
- If have 8 welders doing this =
- (management is worse) – this can be analogous to the business processes found in the office

## 2S: Set in Order (system design)

- Themes for Set in Order = “A place for everything, and everything in its place” (PPT: “The 5S System”, 1997, p. 32)
- Determine arrangement, accessibility, and order of use (sequence) – “Look for areas where flow is restricted (for example, where work is process is delayed; where people, materials, and machines get in each other’s way; or where movement isn’t smooth)” (PPT: “The 5S System”, 1997, p. 33)
- Obvious organization is a theme (KISS-Keep it simple stupid) – 30 second rule to find an item/tool
- “...you arrange needed items so that they are easy to use and label them so that anyone can find them and put them away. The key word in this definition is “anyone”” (PPT: “5S”, 1996, p. 40)
- Ergonomics requirements observed

## 2S: Set in Order (system design)

- Wastes targeted:
  - Motion waste (walking, bending, reaching)
  - Waste of human energy/searching waste/returning waste (e.g. "it is not unusual for a three-hour changeover routine to include 30 minutes of searching" (PPDT: '55', 1996, p. 47)
  - Waste of excess inventory
  - Waste of defective products/obsolete parts
  - Waste of unsafe conditions – e.g. trip hazards, slippery surfaces

(PPDT: '55', 1996)

## 2S: Ergonomics

AKA human engineering

- Ergo = work, Nomics = management
- "The study of human abilities and characteristics which affect the design of equipment, systems, and jobs" (Clark, 1984, p.2)
- Deals with social, physical, and mental requirements for the design of work, accommodates human limitations (DeGarmo, Black & Kohser, 2003)
- Goals:
  - Maximize quality/efficiency of work
  - Maximize human values (safety, comfort, satisfaction)
  - Minimize fatigue and stress

(Kajapalan & Schmidt, 2001)

## 2S: Ergonomics

- Key Factors in Ergonomics: Employee size, area of reach, area layout, blood circulation, vision, lighting, adjustable work aids
- Questions:
  - Are machines/working surfaces designed for common height?
  - Are operations designed to minimize lifting?
  - Are transfer devices designed for ease of sliding parts on/off?
  - Are there signals to inform, interrupt, or monitor the process?

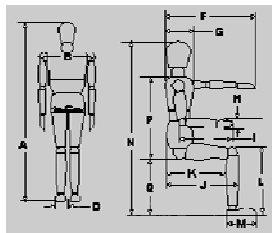
## 2S: Ergonomics

- Machine design considerations:
  - Uniform loading heights
  - Location of walkaway switches
  - Minimum reach (bending) into a machine
  - Eliminating machine obstructions in an aisle
  - Providing access to machine from the back
  - Position of load/unload decoupler (when part requires two-hand load)
  - Part weight, size, shape, burrs, finish, etc.

(DeGarmo, Black & Kohser, 2003, p. 1116)

## Employee Size

- Sit, Stand, Sit-Stand
  - Sit-stand – most desirable, allows individuals to shift posture and reduce stress, strains, fatigue
- Height & width
  - More room for larger people
- Strength
- Chair/work area adjustments



(www.strategosinc.com)

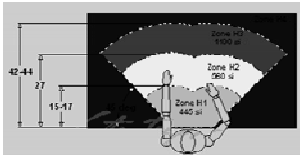
## Employee Size Dimensions

ID	DESCRIPTION	MALE				FEMALE			
		MIN	50	MEAN	MAX	MIN	50	MEAN	MAX
1	Height	69.4	70.8	72.4	74.0	65.3	66.8	68.4	69.9
2	Shoulder Breadth	47.2	48.8	50.4	52.0	43.7	45.3	46.9	48.5
3	Elbow Breadth	40.6	42.2	43.8	45.4	37.1	38.7	40.3	41.9
4	Wrist Breadth	34.0	35.6	37.2	38.8	30.5	32.1	33.7	35.3
5	Hand Length	18.8	19.4	20.0	20.6	17.2	17.8	18.4	19.0
6	Foot Length	25.4	26.0	26.6	27.2	22.9	23.5	24.1	24.7
7	Heel Height	9.1	9.7	10.3	10.9	8.5	9.1	9.7	10.3
8	Sitting Height	45.7	47.3	48.9	50.5	42.2	43.8	45.4	47.0
9	Sitting Depth	38.1	39.7	41.3	42.9	34.6	36.2	37.8	39.4
10	Sitting Backrest Height	21.3	22.9	24.5	26.1	17.8	19.4	21.0	22.6
11	Sitting Backrest Width	15.2	16.8	18.4	20.0	11.7	13.3	14.9	16.5
12	Sitting Backrest Depth	11.7	13.3	14.9	16.5	8.2	9.8	11.4	13.0
13	Sitting Backrest Angle	105	105	105	105	105	105	105	105
14	Sitting Backrest Tilt	15	15	15	15	15	15	15	15
15	Sitting Backrest Flexion	15	15	15	15	15	15	15	15
16	Sitting Backrest Extension	15	15	15	15	15	15	15	15
17	Sitting Backrest Rotation	15	15	15	15	15	15	15	15
18	Sitting Backrest Lateral Flexion	15	15	15	15	15	15	15	15
19	Sitting Backrest Lateral Extension	15	15	15	15	15	15	15	15
20	Sitting Backrest Lateral Rotation	15	15	15	15	15	15	15	15

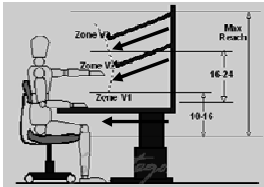
Source: H&D, 1981  
 \*Normal Sitting Height is about 2" Less Than Erect Height  
 Design to "Save the Neckline, Control" 90° of "Down" the Backline  
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## Reach



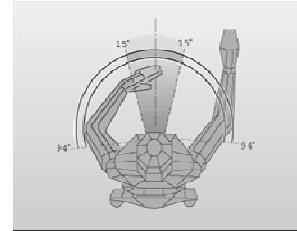
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- Maximum Zone- rarely used components
- Optimum Zone- less frequently used components
- Both Hands Zone- frequently used components

## Vision

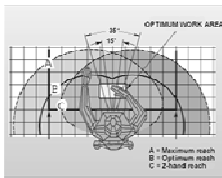
- Frequently used components should be place within 15 degrees from the centerline of the employees face (Wojcikiewicz, 2003).



(www.sme.org)

## Container Layout

- Frequently used containers (within optimum work, within 15 degree vision area)
- Less frequently used containers (within optimum, within 35 degrees of peripheral vision)
- Hardly used containers (place in maximum reach, no further than 94 degrees of peripheral vision)



(www.sme.org)

## Blood Circulation, Lighting, & Work Aid Adjustments

- Blood circulation - work surface should not be higher than the heart (causes fatigue)
- Lighting - proper lighting reduces errors, increases productivity, reduces eyes strain (constant re-focusing) (Wojcikiewicz, 2003)
- Work Aid Adjustments - Adjustable chairs, armrests, footrests, swinging stools make employees more comfortable. Use of jigs, fixtures, vises to help hold work

## Musculoskeletal Disorders

- Disorders of muscles, nerves, tendons, joints, cartilage, and spinal disks that are not caused by car accidents, slips, trips, or falls (Monroe, 2006)

Disorders	Occupational risk factors	Symptoms
Tendonitis/synovitis	Repetitive wrist motions Repetitive shoulder motions Sustained hyper extension of arms Prolonged load on shoulder	Pain, weakness, swelling, burning sensation or dull ache over affected area.
Epicondylitis (elbow tendonitis)	Repeated or forceful rotation of the forearm and bending of the wrist at the same time	Same symptoms as tendonitis
Carpal tunnel syndrome	Repetitive wrist motions	Pain, numbness, tingling, burning sensations, wasting of muscles at base of thumb, dry palm
DeQuervain's disease	Repetitive hand twisting and forceful gripping	Pain at the base of thumb
Theortic outlet syndrome	Prolonged shoulder flexion Extending arms above shoulder height Carrying loads on the shoulder	Pain, numbness, swelling of the hands
Tension neck syndrome	Prolonged restricted posture	Pain

## Other Ergonomic Factors



(archives.fandmag.com)

- Bending more than 20 degrees
- Raising an arm more than 45 degrees
- Bending the neck more than 30 degrees (Heston, 2006)

## Other Ergonomic Factors

- Vibration

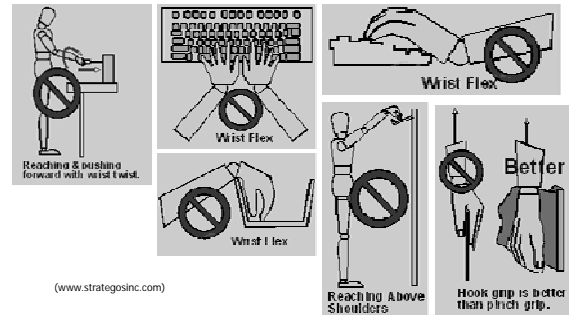


(archives.fandmmag.com)

- Pinch Points



## Other Ergonomic Factors



## 2S: Set in Order

- Principles for (human) Motion Elimination:
  1. Start and end each motion with both hands moving at once.
  2. Both arms should move symmetrically and in opposite directions.
  3. Keep trunk motions to a minimum
  4. Use gravity instead of muscle
  5. Avoid zigzagging motions and sudden changes in direction
  6. Move with a steady rhythm.
  7. Maintain Comfortable posture with comfortable motions.
  8. Use feet to operate on and off switches for machines.
  9. Keep materials and tools close and in front.
  10. Arrange materials and tools in the order of their use.
  11. Use inexpensive methods for feeding in and sending out materials.
  12. Keep operators at a proper height for the work to be done.
  13. Make materials and parts easy to pick up.
  14. Make handles and grips in efficient, easy to use shapes and positions.

(PPDT: "5S", 1996, p. 52-53)

## 2S: Set in Order

- Process:
  1. Analyze current state (scan, map, photograph)
  2. Target improvement areas (storage, large items->small items, access to tools/parts, and problems with flow)
  3. Determine where to place items (everything will have a place, make easy to see, keep items off of floor)
  4. Make item locations obvious (use lines, labels, signboards)

(PPDT: "The 5S System", 1997)

## 2S: Set in Order

- So, in 2S, improvements are made to:
  1. Access and retrieval of parts/tools (spring assists, lifts, tilt mechanisms – for flow)
  2. Layout of areas (for flow)
    - Location of processes, machinery, other equipment
    - Work & safety zones (outlines, color coding)
    - Tooling (outlines, color coding)

## 2S: Set in Order

- In 2S, improvements are made to:
3. Communication of information (for flow)
    - Labels, signals, and instructions for the work area, symbols/arrows for direction, colors for FIFO lane buffers
    - Signboards, providing directions, location of areas, inventory quantities, status, etc.
  4. Safety

## 2S – Set in Order (Flow)

- Utilize arrow diagrams, spaghetti diagrams, operational analysis tables or process flow diagrams to determine arrangement
- Process Flow Diagram Example

## 3S - Shine

- Theme for Shine = “Look good and be able to spot problems”
- Action -> (Result)
  - Clean everything inside/out (leads to more satisfying workplace, reduced hazards and a safer workplace)
  - Inspect equipment while cleaning (locate potential equipment malfunctions or breakdowns, prevent breakdowns)
  - Prevent dirt/contamination from occurring (leads to consistent product quality/customer satisfaction)

(PPDT: “The 5S System”, 1997)

## 3S - Shine

- Benefits:
  - Fewer equipment breakdowns (deterioration will be obvious) → more reliable system
  - Better product quality → increased customer satisfaction
  - Better place to work → more effective in work
  - Safer place to work, fewer hazards → more effective in work

(PPDT: “The 5S System”, 1997)

## 4S: Standardization

- Making standards: “Standardization means creating a consistent way that tasks and procedures are carried out. When we think “standardization,” we should think “anyone.” Machinery standardization means anyone can operate the machinery. Operation standardization means anyone can perform the operation”
- 1) Achieve standards (through 3S)
- 2) Make standards permanent (4S) – paint areas to protect and visualize cleanliness, put in permanent signboards, use color coding

(PPDT: “5S”, 1996, p. 47)

## 4S: Standardization

- Sort, Set in Order, and Shine become habitual
  - 1. Integrate 3S into normal work responsibilities - Assign responsibilities/guidelines for maintaining 3S
  - 2. Make any standard guidelines visible
  - 3. Check on the maintenance of 3S

## 4S: Standardization

- Themes for Standardization = “Maintaining” & “Preventative”
- Maintaining:
  - Maintaining only the items needed are there
  - Maintaining there is a place for everything, and everything is in its place (visually easy to locate/use/replace)
  - Maintaining cleanliness and inspection of equipment

(PPDT: “The 5S System”, 1997)

## 4S: Standardization

- Preventative:
  - Put in preventative measures to preserve 3S (automatically happen – do not wait – items do not accumulate – do not get filthy)
  - Put in tools/mechanisms/devices to *design-out* (reduce/eliminate) operations
  - (e.g. “make it difficult to put things in the wrong place” and “make it impossible to put things in the wrong place”) (PPDT: 5S, 1996, p. 92)

## 4S: Standardization

- Preventative:
  - Prevent items from having to be put back (replaced)
    - Suspended tools that automatically return to proper storage
    - Gauges/devices/measuring instruments fixed in place where needed
  - Tool Unification – combining functions of separate tools into one (*design*)
  - Tool Substitution – *design* change to eliminate one tool
  - Method Substitution – *design* techniques to eliminate tools altogether

## 5S: Sustain

- The themes for Sustain is “Communicating” and “Discipline”
- Establish a 5S board, newsletter, spread information about 5S
- 5S part of daily work
- 5S supported by management/leadership
- Total employee involvement – Train every employee about 5S, purpose and standards

(PPDT: “The 5S System”, 1997)

## 5S: Sustain

- Conditions that promote sustain:
  - 1. Awareness – by everyone
  - 2. Time – to schedule/perform 5S implementation
  - 3. Structure – for when and how 5S activities are implemented
  - 4. Support – from management/leadership and resources to carry out initiatives
  - 5. Rewards/Recognition – for everyone involved
  - 6. Satisfaction/Excitement – achieved when everyone is involved

(PPDT: “The 5S System”, 1997)

## 5S: Sustain

- Tools/Techniques for Sustain:
  - 1. Slogans/Posters
  - 2. Before/After photos of areas
  - 3. Newsletters, reports
  - 4. Suggestion boxes
  - 5. Pocket/training manuals
  - 6. Tours of other areas (for understanding – modeling)
  - 7. Assigning time slots (e.g. specific month) for seminars, training, retraining, promoting improvement programs

(PPDT: “The 5S System”, 1997)

## Notes on 5S

- Only through standardizing and sustaining will 5S/6S work
- Normal checks at normal intervals is recommended
- Making checks routine in ones work is recommended
- Internal audit checks by personnel from different areas is one method to sustain
- 3S will yield some improvements, but transitioning people to different areas with differing standards can lead to variance
- Most companies practice 3S – some do not understand how standardizing work areas can lead to variation reductions
- Without sustain, 5S practices will revert back to initial practices

## Notes on 5S

- Examples used were manufacturing examples – this knowledge transfers to other fields
- Standardize is different from Work Standards
- How do you think the principles of 5S apply to other fields?
  - Healthcare?
  - Restaurant/Food management?
  - Large scale residential construction companies?
  - Finance?
  - Business processes/office?
  - Retail?
  - ....

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