LEAN TECHNIQUES

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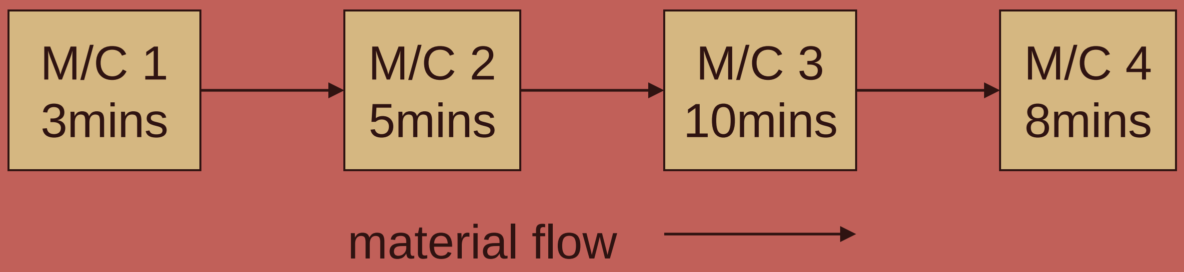
Introduction

- In 1913 Henry Ford revolutionized manufacturing industry by introducing the concept of an assembly line (flow production)

- Flow production – high volume and low variety

Flow Production



- Consider the following questions:

1. How long will it take to produce 50 components?
   500 minutes
2. What is the limited factors?
   Station 3
3. What effects does this have on the subsequence work station?
   Idle
4. How can this problem be resolved?
   Balance the line

Flow Production

- The flow of products along the manufacturing line require a balanced amount of time at each station (line balancing)

- The design of a good product layout for flow (line) manufacture should consider the following points:

  1. What is the customer demand? (takt time)
  2. Is the capacity adequate?
  3. Is the sequence of task feasible?
  4. Is the access to the work area?
  5. Is there space for the required facilities (machines etc.)
  6. Is the line efficient?

Level Production

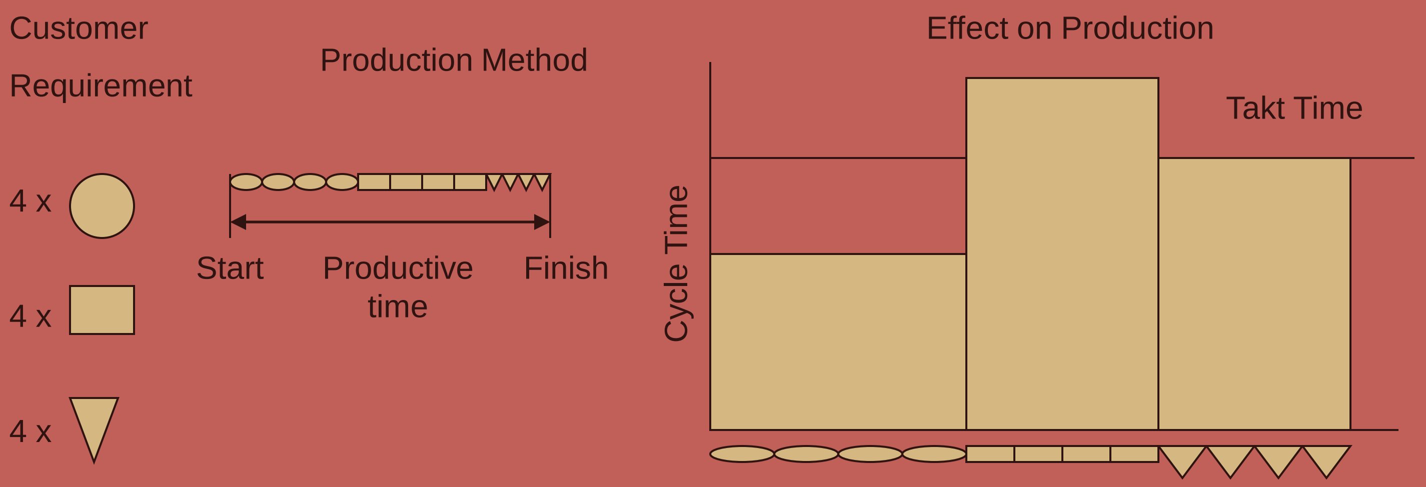
- Leveled production is a means of distributing both the quantity and variety of parts across a production period
- Avoids over and under utilisation in the work place

Level Production

- Encourage small quantities of all parts to be produced on a regular basis
- It avoid over and under utilisation of the work place but eliminating large batches of products with high or low work content

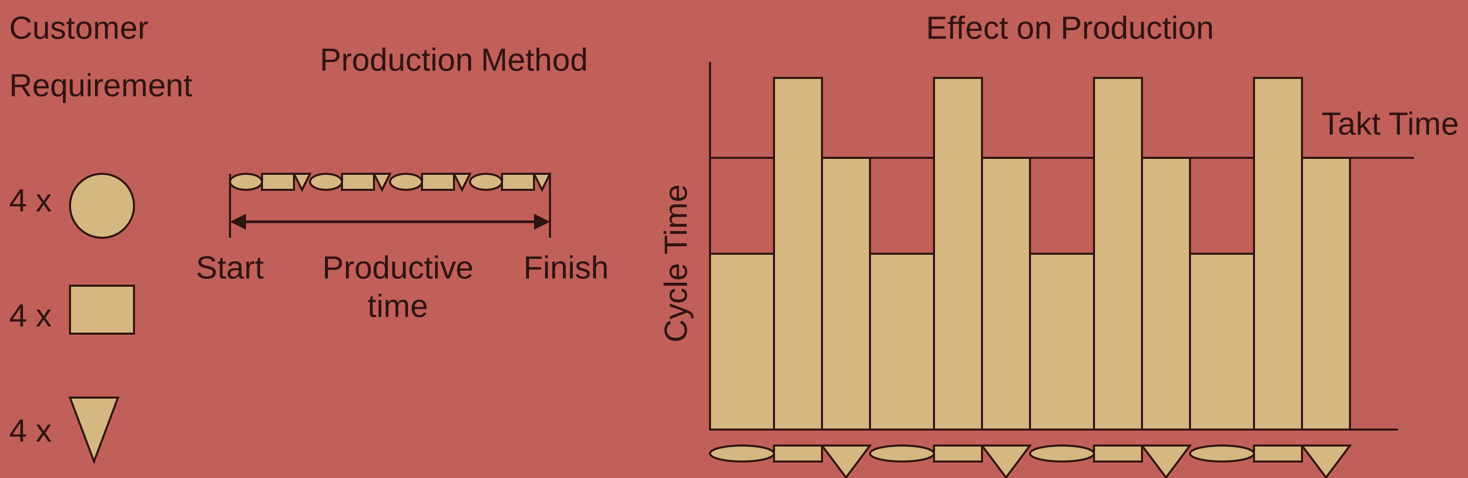
Level Production

- Non leveled production



Creates: Under-utilisation and overburden

Level Production



Benefits: Avoids overburden, ensure consistence delivery

Standard Operations

- The basis of a lean system
- They instruct an activity so that it can be completed consistently complete respect to quality and time
- Example: work combination chart
- Consists of three aspect,

  - takt time

  - standardised work elements

  - standard in process stock

Takt Time

- Takt time is the heartbeat of the manufacturing process
- It is the frequency at which one part should be produced to match the customer requirement
- Matching the customer demand rate prevent feast and famine of stocks

Takt Time

- To eliminate the waste of over production, the customer demand should set the rate of the line
- This commonly expressed as the Takt Time

Takt Time = Time Available/Customer Demand

- Where available time = working time – regular non-direct time (eg. meetings, breaks, cleaning etc.)

Takt Time

- Example:

  i. 7.5 hours available in a working shift and a customer requirement for 300 products

  Takt Time = (7.5 x 60 x 60)/300
  = 90 sec/product

  ii. If the customer requires 100 units a day

  Takt Time = (7.5 x 60 x 60)/100
  = 270 sec/unit

Takt Time

- Customer demand for product RX139 = 300 units/day
- Takt Time = (7.5 x 60 x 60)/300

  = 90 sec/product
- Number of workers

  = total process time/takt time

  = 180/90 = 2 peoples
- That means: each workstation – 2 operators

Takt time

- If production incraesed to 450 units/day
- Takt Time = (7.5 x 60 x 60)/450

  = 60 sec/product
- Number of workers

  = total process time/takt time

  = 180/60 = 3 peoples
- That means: each workstation – 3 operators

Capacity

- The Takt Time for a production line has been calculated as 1 product every 90 sec
- The work elements for the process are given below:

Wes 1	45sec
Wes 2	40sec
Wes 3	30sec
Wes 4	50sec
Wes 5	175sec
Wes 6	88sec

Capacity

- These work element can be split into stations with 90 seconds or under of work content
- Example:

  Station 1 - Wes 1 & 2

  Station 2 – Wes 3 & 4

  However Wes 5 gives us a problem as it requires a time of 175 seconds

  This station (Station 3) must have a capacity of 2

  Takt time = 175/2 = 87.5 seconds

  Station 4 – Wes 6

Sequence

- In order to start certain manufacturing work elements a previous work element must have been complete, ie a precedence task required
- Example:

  The assembly of wheels to a vehicle can only take place after chassis has been assembled

Access

- A the product moves down the assembly line, operators will complete their specific work elements inside the allocated station
- The length of the station will depend on the speed of the track and the takt time
- In this case, each station probably require more than one operator or split work element into several operator

Facility Space

- When design the layout for the flow line, consideration must be given to the machine equipment and other facilities required.
- With limited space available at line side for each station adequate floor space must be available before the assembly work element can be allocated to the station

Efficiency

- Efficiency – to meet all the mentioned condition
- Too much idle time at each station will imply a less efficient design

Efficiency (%) = (Productive Time/Available Time) x 100%

Efficiency

- Example:
  4 operators are allocated to station 1
  Takt time = 4 mins

  Productive time for each operator is 3.5, 4, 3, 3.25 mins respectively

  Efficiency = (13.75/16)x100% = 86%

  Line Balancing Loss = 100% - 86% = 14%

Example

- Grassgro Ltd. is a manufacturing company that produces lawn speed spreaders. It wishes to set up a dedicated assembly line to produce 2400 products a week. Process engineers have identified the required assembly tasks and times

Work Element	Description	Time (sec)	Predecessor
A	Bolt leg to hopper	40	-
B	Insert impeller shaft	50	A
C	Attach axle	30	B
D	Attach agitator	25	B
E	Attach drive wheel	6	B
F	Attach free wheel	40	C
G	Mount lower post	15	F
H	Attach controls	20	D,E
I	Mount nameplate	18	G,H

Example

- Note: Assume a 5 days per week and 8 productive hours per day
- Calculate:

1. Takt time to meet the required output

Takt Time = Time Available/No Products

= (5 x 8 x 60 x 60)/2400

= 60 sec/unit

1 product required every 60 seconds

Example

2. The minimum number of station to achieve the takt time

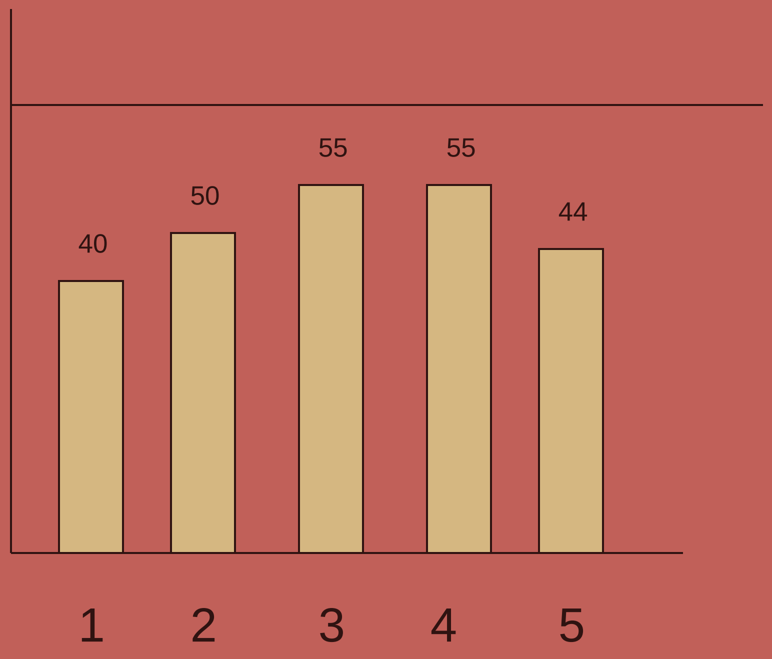
Minimum number of station = Process Time/Takt Time
= 244/60
= 4.1
= 5 stations

3. Design the assembly line to produce the required output

W/S 1	Task A (40 sec)	Total time = 40 sec
W/S 2	Task B (50 sec)	Total time = 50 sec
W/S 3	Task C,D (30 +25 sec)	Total time = 55 sec
W/S 4	Task F,G (40+15 sec)	Total time = 55 sec
W/S 5	Task E,H,I (6+20+18 sec)	Total time = 44 sec

Example

4. Draw Yamazumi Board



Takt Time = 60 sec

Example

5. The utilization/efficiency and line balancing loss

Efficiency = (244/55x5) x 100%

= 88.7%

LBL = [(275 – 244)/275] x 100%

= 11.3%

Class Exercise

- A manufacturing company wishes to set up an assembly line to produce 30000 units over a 2 years period. Engineers suggest an assembly line comprising nine tasks as given in table below

Task	Time (min)	Predecessor
A	4	-
B	3	A
C	4	B
D	2	B
E	6	B
F	5	C,D
G	3	F
H	2	E,F
I	2	G,H

Class Exercise

- Assuming 7.5 productive hours per day and 22 productive days per month

Application of Lean Techniques to Flow line Design

- Having complete the initial design of the flow line layout with respect to allocating tasks to stations to accommodate:

  - takt time

  - precedence diagram

  - accessibility of the work area

  - availability of space for equipment

5S Housekeeping

- A place for everything and everything in it's place!
- 5 S eliminates waste in the working environment
- A Japanese plan for a well organised work place, which eliminates the waste of looking and searching for equipment
- Housekeeping Rating Form (5S1) (5S2)

5 S

- Seiri – Sort, determine necessary equipment & materials
- Seiton – Straighten, remove unnecessary items
- Seiso – Sweep, clean & routine maintenance
- Seiketsu – Standardise, make a standard & stick to it, use regular audits
- Shitsuke – self disciplin, make 5 S part of the everyday life

5 S

- Benefit of 5 S

  - Pride and personal ownership of the work place

  - Highly visible factory

  - Clear indication of commitment to change

  - Good foundation for improvements

  - A better working environment

5 S

- Poor house keeping
  - Welding candles mixed with materials
  - Unidentified materials
  - Dust on welding jig
  - Floor & workbenches dirty, no regular cleaning
  - Parts on floor
  - No proper access
  - No defined place
  - Mixing of parts
  - Inadequate scrap bins

SMED

- **S**ingle **M**inute **E**xchange of **D**ie
- Aims to reduce set up times to single minutes
- To enable high frequency of changeovers
- Grand Prix pit stops are a good example

SMED

- Why reduce set up times?

  TO:

  - Reduce batch size, in order to

  - Reduce lead times, in order to

  - Reduce inventory

SMED

- SMED enables the changeover of machine tools to be reduced dramatically, with the aim for the total time to be less than 10 minutes, hence the name single minute
- External elements

  - Task which can be carried out at any time
- Internal elements

  - Task which can only take place when the machine is stopped

SMED

- The changeover is the organised so that,

  - All external activities are completed while the machine is running (eg. collect tools and dies etc)

  - All internal activities are completed as fast as possible, with improved tooling, organisation and design

- With changeover reduced to a minimum, the need for high batch quantities is eliminated

SMED – 5 Steps

- List elements of the existing changeover procedure
- Separate internal and external elements
- Where possible convert the internal elements to external elements
- Make a remaining internal elements as quick as possible
- Remain alert for continuous improvement

Yamazumi Boards (Pillar Diagrams)

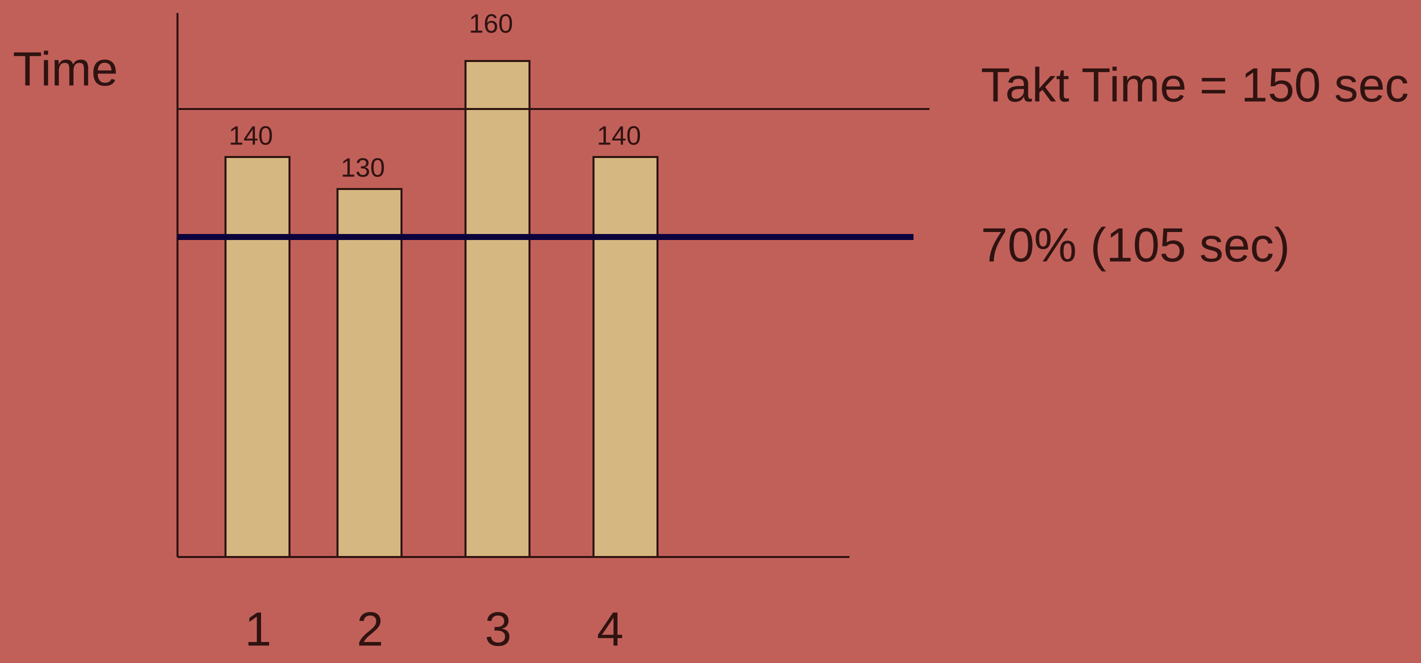
- Japanese word – stacks of wood
- A visual tool to aid the balance of the work assignments allocated to the operators at each station on the line
- Takt time – set by the customer requirement
- All tasks in a station must be completed within this time

Yamazumi Boards

- Displays Takt Time
- Identifies work elements
- Highlights Value Added and Non Value Added work
- Visually shows work balance
- 70% line warns of incomplete within takt time
- Highlights additional work to takt time

Yamazumi Boards

- 70% warns line



Poka Yoke

- A method of fool proofing tasks so that mistakes cannot be made
- Aims to identify and/or stop error at source eg,

  - cannot start

  - cannot release

  - cannot pass

Andon

- Empowers operators to stop line – if they consider quality to be at fault
- A light or noise is used to signal for assistance
- If the problem cannot be dealt with immediately, then the line is stopped as no more quality faults should be made

Andon

- All attention is then focused on resolving the issue
- Hit squads may be used to resolve the problem
- Buffers are sometimes used to avoid complete factory stops every time there is an andon call

Kanban

- Two bins system
- A material control system which only calls for material when it is required
- It does not allow inventories to build up at line side or in part finished goods

Kanban Pull System

Difference Between Push and Pull System

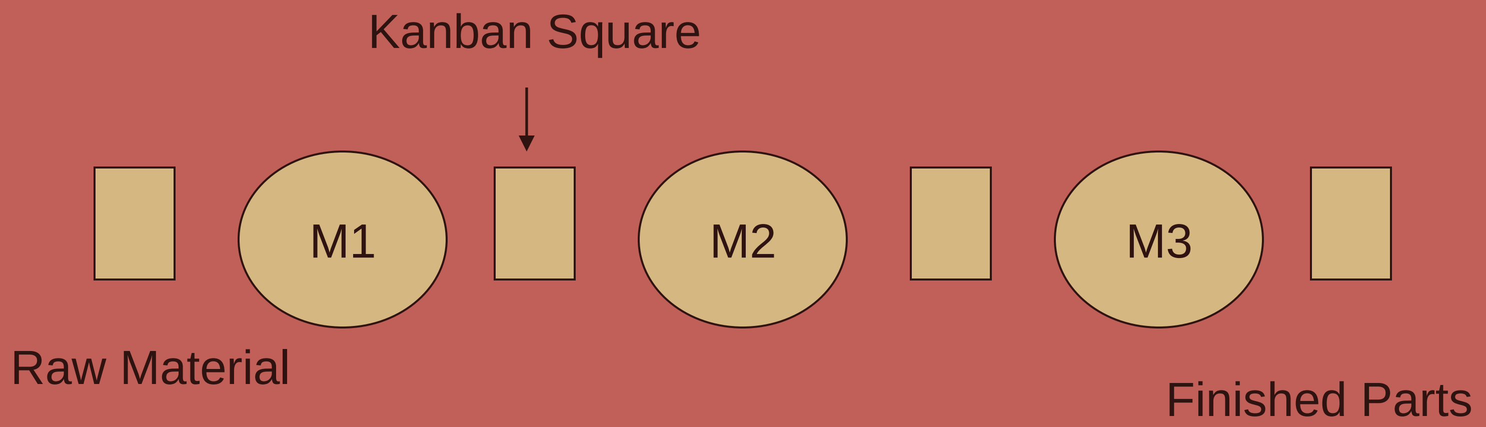
i. **Push**

- Signal to work is given by planning source
- Output is generally moved to the next station immediately

ii. **Pull**

- Signal to work is generated by the customer of the completed work
- Output waits at the station until demanded by the downstream operation

Kanban Pull System



Lean Layout

- Good visibility
- Minimum transport
- Encourage good management of the manufacturing system

Requirements for Lean Layout

- Standardised work
- Kanban of materials lineside
- Ability to recognised and eliminate waste
- Aim for single piece flow

Performance Measures

- Reflect the aims of the company
- Typical example: Overall Equipment Effectiveness (OEE)

Why Use Performance Measure?

To develop and deploy a common set of organisational measures so that they:

- **Change** the focus of the organisation's behaviour towards the important issues
- **Support** the vision and principles of lean manufacturing
- **Drive** continuous improvement

Characteristics of Successful Performance Measures

- Local
- Visible
- Current
- Owned
- Understood
- Audited

Setting Target

Targets need to be challenging and SMART

- Specific
- Measurable
- Agreed
- Realistic
- Timed

Ford Production Measurable

MACRO

- First time through
- Dock to Dock
- Overall Equipment Effectiveness
- Build to Schedule

MICRO

- Labour productivity
- Manufacturing Cycle Time
- Floor area
- Distance traveled
- Down time
- Change over
- Work in process
- Value added ratio

Performance Monitors

- Worked Examples
- First Time Through (FTT)
- Dock to Dock (DTD)
- Overall Equipment Effectiveness (OEE)
- Build to Schedule (BTS)

Visual Management

- Visual management should enable the understanding of the current status of the production facilities within a minute
- Examples: machine availability, production target, buffers etc.

Visual Management

- Visual display to management and workers that all elements that make quality, cost & delivery are in control
- Building participation through shared information

Visual Management Objectives

- To encourage employee involvement and participation
- To quickly identify normal and abnormal condition
- To have real information in real time
- To move manufacturing management from a high level of people to a jointly shared activity

Why Visual Management

- What would it be like to play a game of cricket where nobody knew the score?
- How much fun would it be?
- When would you stop playing?
- How would you know who had scored what?
- How many would change sport?
- Why should manufacturing be ant different?

The Visual Factory

- A place for everything and everything in it’s place
- 5S discipline highlights the unusual
- Visual monitors communicate status to all
- Problem identified quickly
- Promotes teamwork

In Touch with Reality

Manpower

- How is worker moral?
- How do we know people skill level?
- How do we know if we have operator safety problems

Machines

- How do we know…….

…….the machine is producing good products?

…….if the machine has stopped?

…….if the machine has been set up correctly?

…….the machine has been correctly maintained?

In Touch with Reality

Materials

- How do we know…….

…….we are processing the correct material?
…….if material is flowing smoothly?
…….if we have are producing inventory?
…….if we are going to have a stock problem?

Methods/Measurement

- How do we know…….

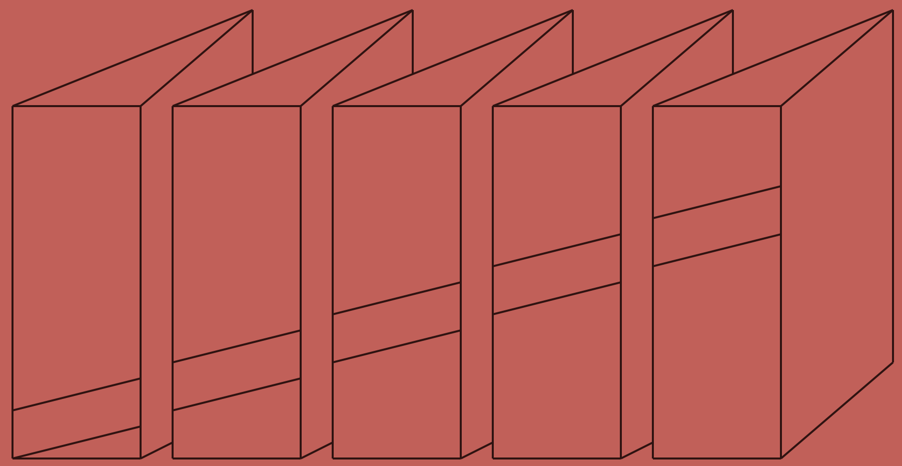
…….that operators, maintenance, etc are doing the job correctly?
…….if the gauges, tools etc have been correctly stored?
…….if the gauges, tools etc have been correctly calibrated?

Visual Management Examples

- 5S Housekeeping
- Signboards
- Signal Lamps
- Stock Control and Location Strategy
- Production Management Boards
- Operator Skill Matrix
- Operator Instructions

Visual Factory

- The stripe makes it easy to put files in the right order



Visual Management Conclusions

- Simple communication
- Easily understandable
- Continuously updated
- Accessible to EVERYBODY

Cellular Manufacturing

Guidelines for Physical Cell Layout

- Position resources to give common flow
- Minimise backtracking between operations
- Avoid movement between cells
- Keep operators inside cell and in full view of others
- Aim for high reliability in all machines and equipment
- Minimise operator and part travel distance
- Make any cell waste visible
- Provides for easy maintenance and housekeeping
- Place cell function above appearance

Lean Conclusions

- High level of waste can be eliminated
- Does not usually mean process technology improvement
- Requires a vision
- Requires commitment at all levels
- Requires participation at all levels
- Lean Manufacturing is a ‘Journey’