SkillPower

Lean Practices

Welcome to this Slide Show

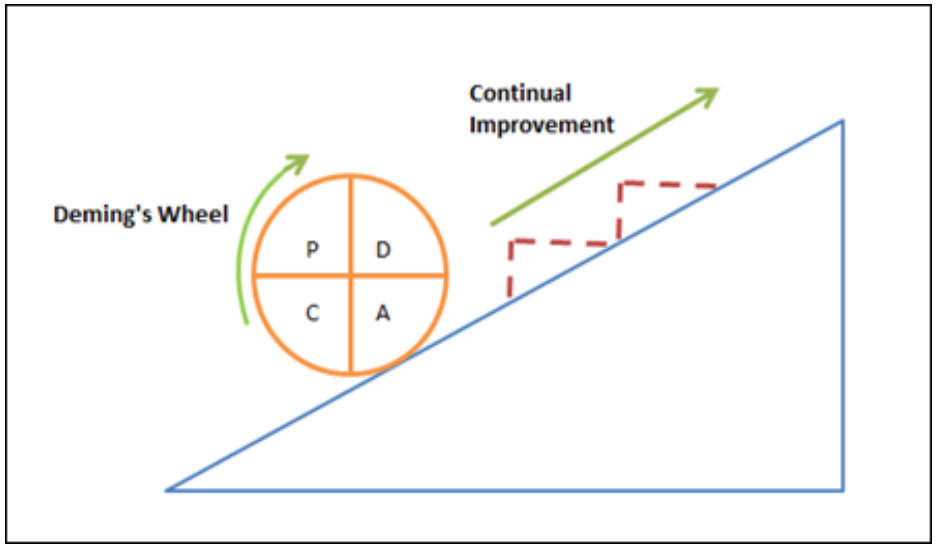
Course Overview

Purpose: To familiarise you with the Lean philosophy and tools and techniques required for Lean process improvements.

Day One	**Day Two**
Lean basics, the elimination of waste, and value stream improvement concepts.	Practise the application of tools for creating and refining Lean processes.

By eliminating waste and creating uninterrupted work flows, companies are able to eliminate costly scrap and rework. Lean is primarily about seeing waste and removing it.

PDCA Lego
Ice-Breaker



- Your job is to build the tallest free-standing tower possible given the customer's requirements.
- It is anticipated that the Lean PDCA "plan–do–check–act" technique will be repeatedly applied during your tower construction to continuously improve your design, particularly since a Lego tower can readily be rebuilt in true Lean fashion towards perfection as defined by the customer.

Lesson 1: Understanding Lean

What Lean Is, Lean Terms, The Value Stream, Lean's Benefits, Principles and Origins, and How Lean Differs From Six Sigma.

What is Lean?

- Lean is a continuous improvement strategy to maximise customer value and minimise, if not eliminate, all forms of waste.
- Lean aims to deliver only what the customer needs, only when it is required, and at the best possible price.
- To realise this aim, Lean perfects production activities needed to produce a product or to deliver a service.

Leanspeak

Every discipline has its language, particularly Lean. See Workbook glossary. Here are some key terms:

- **Value Stream:** All the tasks completed to produce a product or provide a service.
- **Non-Value Added:** Activities that add no real value to the product or service, making the activity a form of waste.
- **Value-Added:** Activities or actions that add real value to the product or service.
- **Internal Customer:** Receiver of the product or service *inside* the organisation.
- **External Customer:** Receiver of the product or service *outside* the organisation.

Traditional vs Lean Production

Traditional Production

- Push scheduling
- Functional layout
- Specialised labour
- Just-in-case inventory
- Large batch sizes
- Adversary relationships with suppliers
- Large / few deliveries
- One-time improvements
- Periodic sampling
- Planning and control
- Low empowerment
- Many suppliers / infrequent deliveries (eg, monthly)

Lean Production

- Pull scheduling
- Production flow layout
- Versatile labour
- Just-in-time deliveries
- Small batch sizes
- Partnering / collaboration relationship
- Many / small deliveries
- Continuous improvements
- Continuous sampling
- Doing and learning
- High empowerment
- Few suppliers / frequent deliveries (eg, daily)

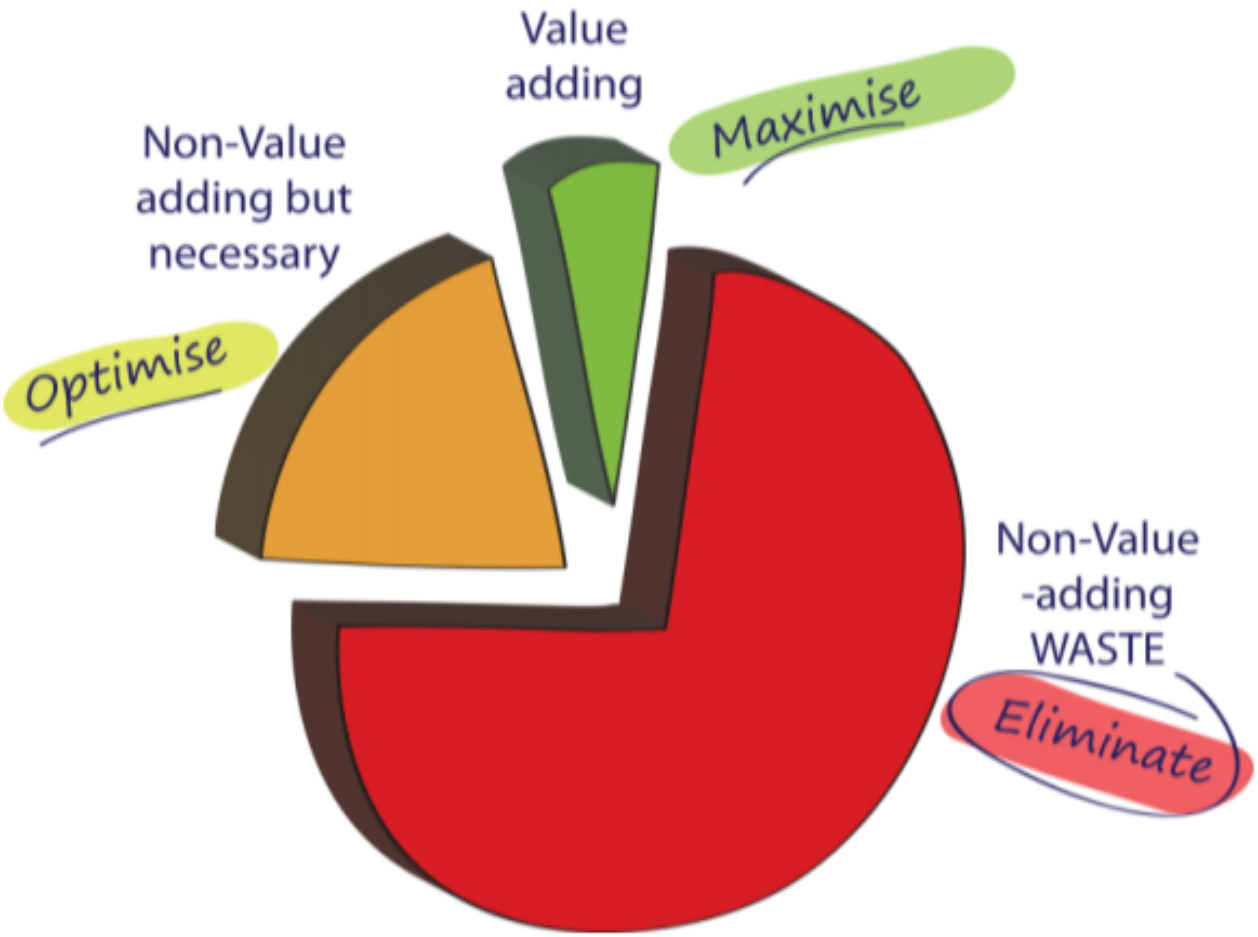
Lean Value Stream

For example: An airline passenger arrival passport check takes say **30 seconds** per person and a security scan takes say a further **30 seconds per person**. The value-add time is **60 seconds**. However, due to queuing the total process time for each passenger might average some **20 minutes** – 95% wasted time.

An important Lean tool is **Value Stream Mapping** used to capture the "current state" or "as-is" process (including both the value-added and non-value added activities) in order to then identify and reduce or eliminate those non-value adding activities that sometimes represent up to 95% of a process.

Making value flow at the customer's pull.

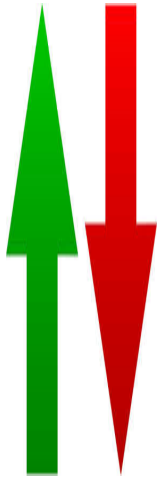
Value vs Waste



Lean Benefits

Improvements in:

- Customer Satisfaction
- Supplier Relations
- Employee Safety
- Productivity
- Process Capacity
- Responsiveness
- Product Quality
- Net Profit



Reductions in:

- Defects and Rework
- Breakdowns
- Lead Times
- Overtime
- Cost
- Inventory
- Clutter
- Waste

Do Lean at home too by continuously looking for better ways of doing things.

5 Lean Principles

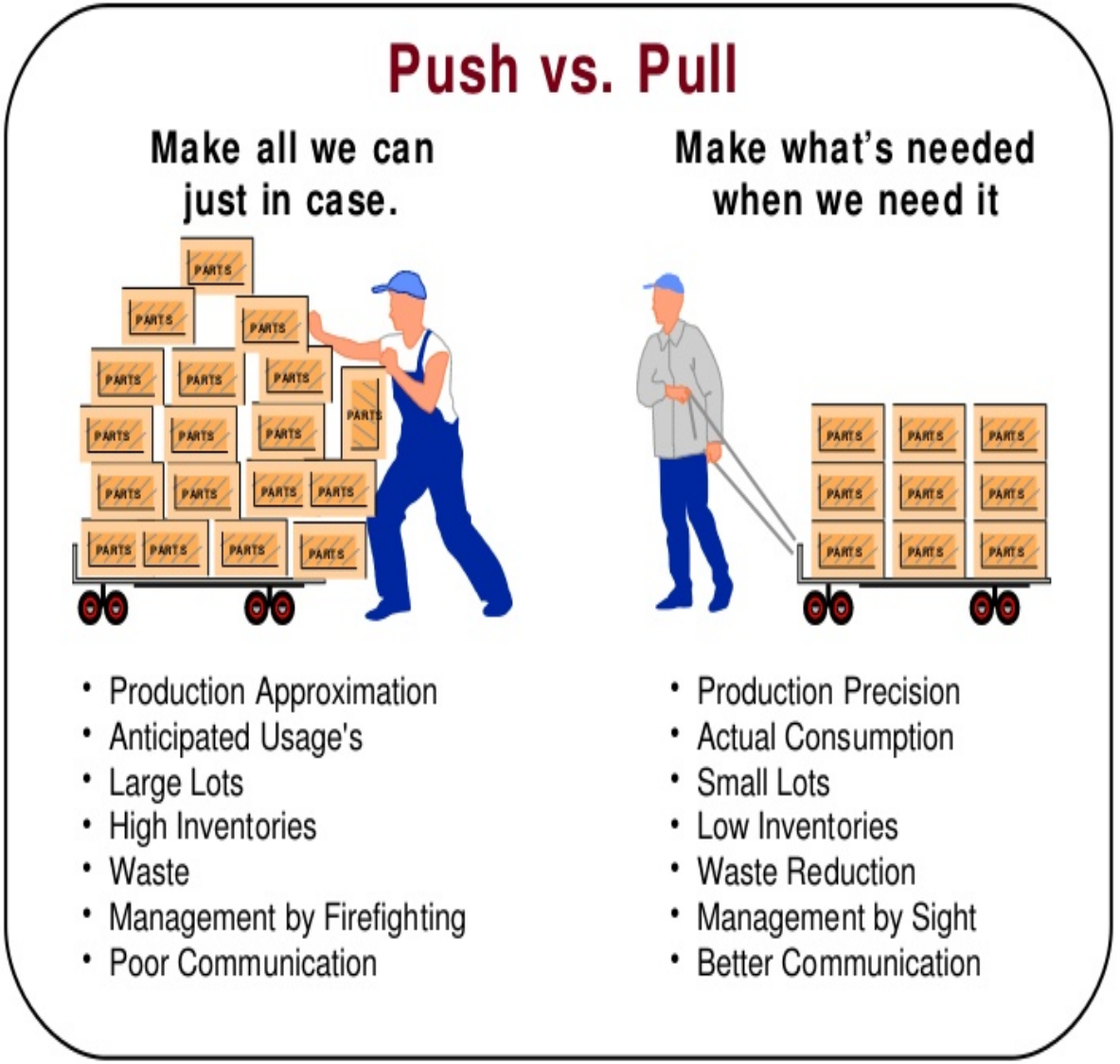
1. *Value* – as defined by the end customer.
2. *Value Stream* – understand the Value Streams that deliver the value and focus on removing the waste.
3. *Flow* – develop processes that ensures the smooth flow of information and material, with no bottlenecks.
4. *Pull* – develop a flexible and responsive business process which works only when the customer wants it.
5. *Seek perfection* – while we improved today, we must be better tomorrow. Continuously strive for process and product perfection.

To these principles we might also add:

- Respect and engage employees. Foster a culture of trust and empowerment.
- Remove functional silos.
- Practice just-in-time deliveries with minimal inventory, rather than just-in-case.

Pull vs Push

A fast food restaurant like McDonald's runs on a pull system by assembling the product only when ordered, while most retail businesses operate on a push system with finished products already produced in anticipation.



Typical Employee Feedback about Lean

- *"Previously I thought Lean was big on hype but short on results."*
- *"I'm now pointing fingers less and looking more closely at our processes."*
- *"I'm checking for root causes instead of workarounds."*
- *"I thought we were productive until we started studying the process and then I saw how much opportunity for improvement we had."*

Difference Between Lean and Six Sigma

There is an ongoing debate over whether Lean or Six Sigma is the better system for improving business processes. In fact, they are complimentary methodologies, which is why *Lean Six Sigma (LSS)* has evolved.

- **Lean** is a Toyota philosophy of eliminating waste (non-essential and non-value adding activities) to streamline production and improve product quality.

- **Six Sigma** was developed Motorola to reduce product defect rates through statistical analysis, where a process only produces 3.4 product defects per million opportunities.

Six Sigma

Sigma is a value from 1 to 6 that signifies the maximum number of defects per million:

- 1 Sigma = 690,000 defects/million = 31% accurate
- 2 Sigma = 308,537 defects/million = 69.1463% accurate
- 3 Sigma = 66,807 defects/million = 93.3193% accurate
- 4 Sigma = 6,210 defects/million = 99.3790% accurate
- 5 Sigma = 233 defects/million = 99.9767% accurate
- 6 Sigma = 3.4 defects/million = 99.999997% accurate

Example: For every 300,000 letters delivered with 99% delivery rate = 3,000 wrong deliveries, whereas Six Sigma = 1 wrong delivery only.

Lesson 2: The Toyota Production System

The Toyota Production System (TPS) House, Just-in-Time, and Inventory analysis.

TPS Five Steps

TPS (renamed "Lean" in the US) is a mindset and management system that embraces continuous improvement and revolves around 5 steps:

1. **Define Value** of your product and make it according to customer needs.
2. **Identify Value Stream** of your product. Follow the product and identify unnecessary actions.
3. **Study the Flow** your product. Eliminate All Waste.
4. **Produce** Just In Time for demand.
5. **Strive for Perfection**. Continuous Improvement. Good enough is never enough.

Toyota Principles

1. CHALLENGE: Form a long-term vision, meeting challenge with courage and creativity to realise your dreams. Create Value through Manufacturing and Delivery of Products and Services.
2. KAIZEN: Improve your business operations continuously, always driving for innovation and evolution. Build Lean Systems and Structure. Promote Organisational Thinking.
3. GENCHI GENBUTSU: Go to the source to find the facts to make correct decisions, build consensus, and achieve goals at our best speed.
4. RESPECT: Respect others, make every effort to understand each other, take responsibility and do your best to build mutual trust.
5. TEAMWORK: Stimulate personal and professional growth, share the opportunities of development, and maximise individual and team performance.

Toyota House

Toyota, the world's leading exemplar of Lean, has developed the Toyota Production System (TPS) often illustrated as a house with two pillars: **Just in Time (JIT)** and **Jidoka**.

JIT and Jidoka, combined with a culture of ***waste elimination*** and ***continuous improvement*** help ensure a Lean organisation's productivity and competitiveness.

Toyota Production System: Two Pillars

Just in Time

- *Just-in-time (JIT*) is a strategy to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby minimising inventory.
- For *JIT* to work, we need steady production, no machine breakdowns, reliable suppliers, and quick machine set-ups.
- In reality even Just-in-Time needs some Just-In-Case inventory (Buffer Stock).

Jidoka

- *Jidoka* regards the use of machines and manpower, using people for the unique tasks they are able to perform and allowing machines to self-regulate the quality.
- Technically, *jidoka* uses tactics such as *poka-yoke*, (methods of fool proofing the process) and *andons* (visual displays such as lights to indicate process status especially process abnormalities), whereby no bad parts are allowed to progress.

Suppliers' Typical Concerns with JIT

- **Diversification** – risk of having only one or very few customers.
- **Scheduling** – customers may not always place standard size orders on suppliers.
- **Changes** – customer's sudden product specification changes may mean suppliers get insufficient lead time.
- **Lot Sizes** – delivery of too many small lots too often, may mean uneconomical transport operations.
- **Holding Costs** – supplier needs to hold inventory to ensure continuity of supply.

Despite these concerns, several US manufacturers are now finding that the balance of market power is shifting towards component suppliers. (*Dominion 8 Nov 2017*)

JIT Problem at Toyota

Toyota's JIT concept almost came to a crashing halt in February 1997.

A fire at a sole supplier's plant decimated its capacity to provide P-valves for Toyota vehicles.

Toyota ran out of P-valves after just one day. Production lines were then shut down for two days until an alternative supplier was found.

Other suppliers for Toyota also had to stop supply because the Toyota didn't need other car parts.

The two-day shutdown cost Toyota $15 billion in revenue and 70,000 cars behind production.

Toyota Crisis!?

- In 2009 a Lexus vehicle faulty accelerator got stuck causing a fatal accident and the recall of over 4 million vehicles.
- Did an employee fail to pull the cord, stop the line, and have everybody, literally everybody in the plant, wait until that one person resolves the problem?
- Toyota attempted to cover up the problem, but has learnt from this experience, and has reapplied its quality principles to regain customers' confidence and remain the world's largest automotive manufacturer.
- This Toyota crisis does not seem to have caused people to think negatively of Lean.

Reasons for Safety Stock (Buffer Stock)

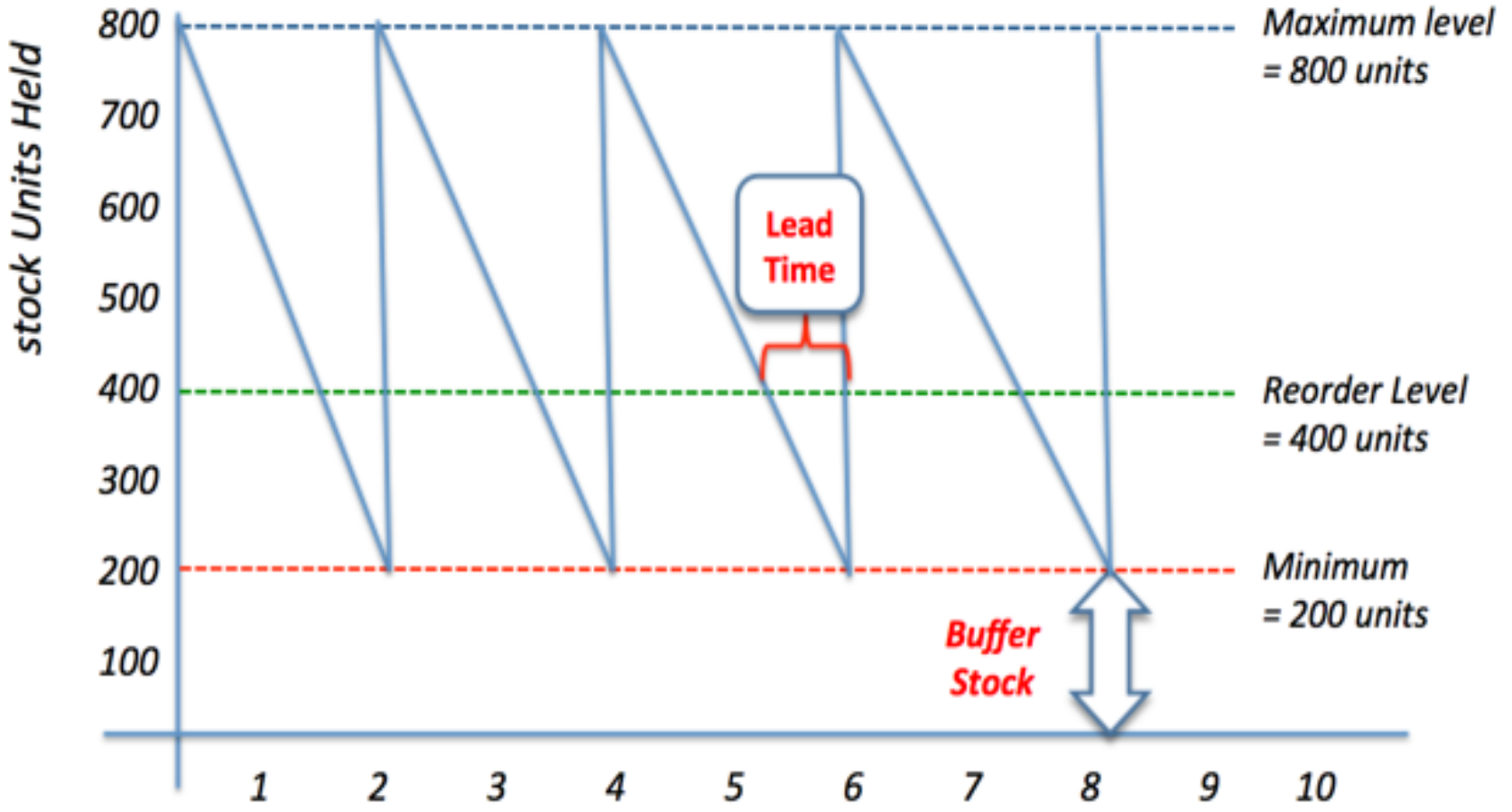
1. To protect against variation in supply and/or demand.
2. Needed when actual product demand is bigger than forecast.
3. To avoid stock-outs and thus prevent disruptions to manufacturing.
4. Maintain customer service levels.

Minimising Inventory

- Inventory is expensive – warehousing, insurance, obsolescence, theft, damage, evaporation, space, handling, security, special environment (eg, cool storage)…
- Thus, inventory costs need to be weighed against stock-out costs.
- A JIT inventory is the minimum needed to keep manufacturing processes running.

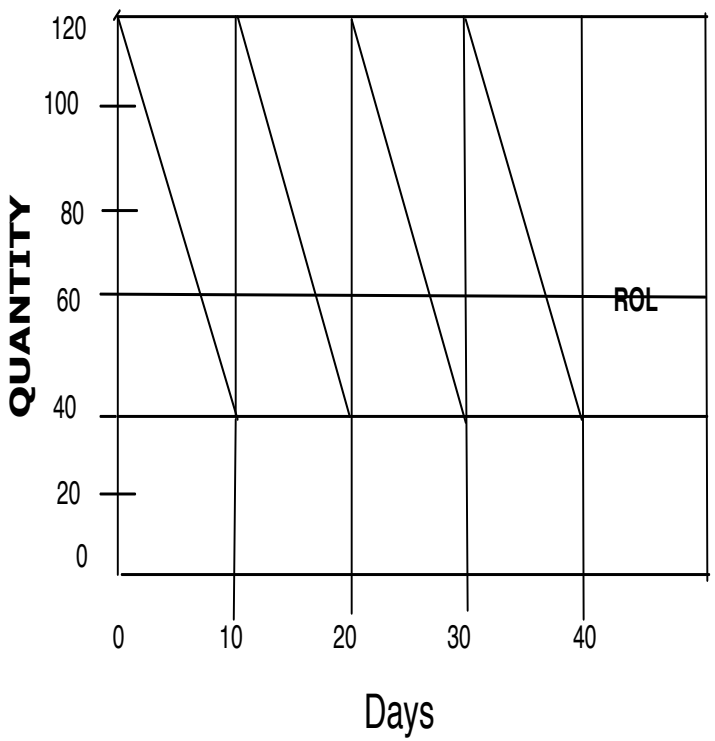
Inventory “Saw Tooth” Graph

Even Just-in-Time Needs some Just-In-Case Inventory – Buffer Stock



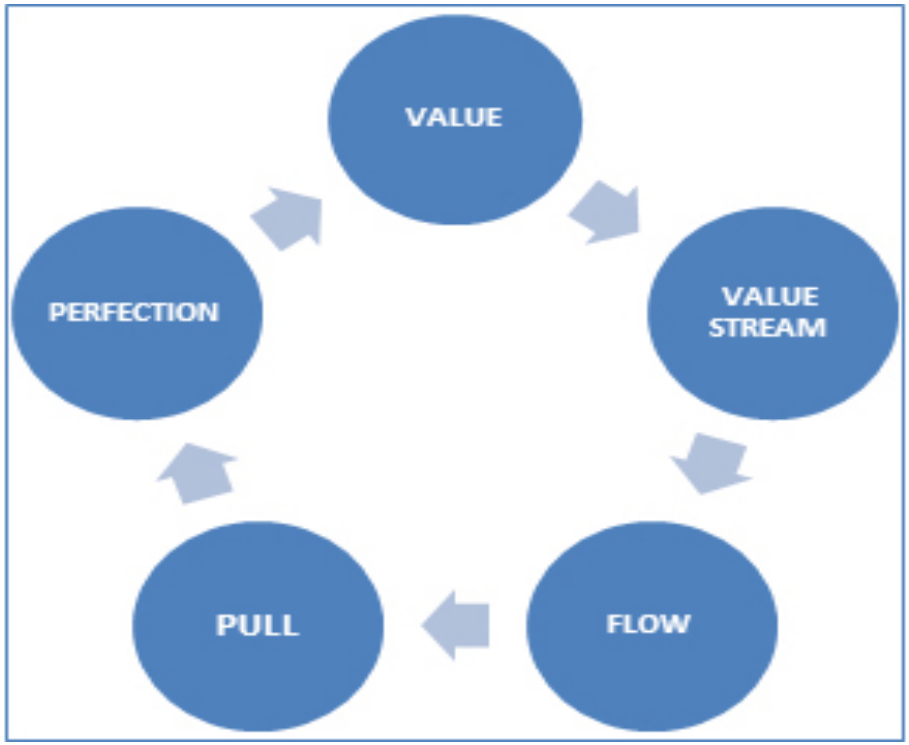
Inventory Quiz

JIT is minimising inventory, however some stock will usually need to be held on site for some items. ROL = Reorder Level



1. What is the safety or buffer stock? In days? In stock?
2. What is the average active stock? (Half of the operating or working stock, but excludes safety stock). In days? In stock?
3. What is the average total inventory? (Half the operating stock plus safety stock). In days? In stock?
4. What is the daily issue rate? (Based on active stock)
5. What is the order quantity? (Maximum active stock)
6. What is the lead-time? (Time from ROL to delivery)
7. What is the stock turn? (Frequency per year that total stock is issued)

Lesson 3: Five Critical Improvement Concepts



1. Specify **Value**

Value is identified from the standpoint of the end customer. Lean identifies three types of work:

1. **Value-added work** – work that the customer is willing to pay for.

2. **Business necessary work** – work that must be done to comply with legislation.

3. **Non-value added work (*muda*)** - wasteful activities that add no value to the product or service.

FULFILLING CUSTOMER NEEDS SUPERSEDES EVERYTHING EXCEPT SAFETY

2. Map the **Value Stream**

The idea is to draw, on one page, a "map" of the current flow of material/product through the manufacturing (or administrative) process.

The goal is to identify every step that does not create value and then find ways to eliminate those wasteful steps.

Value-stream mapping is sometimes referred to as process re-engineering.

Ultimately this exercise also results in a better understanding of the entire business operation.

VALUE STREAM MANAGER HAS FULL ACCOUNTABILITY

3. Create **Flow**

After the waste has been removed from the value stream, we ensure the remaining steps flow smoothly with no functional barriers, interruptions, delays or bottlenecks.

Make the value-creating steps occur in tight logical sequence so the product will flow smoothly through manufacturing steps to the customer.

When a system is working well, or having “good” flow, it tends to move steadily and predictably, whereas, “bad” flow means the work starts and stops.

Every time there is a breakdown in the flow, chances of accumulating waste increase.

THE FASTER PRODUCTS AND PROCESSES FLOW THE LOWER THE COSTS

4. Establish **Pull**

With improved flow, time to market (or time to customer) can be dramatically improved. A pull system means making a product at the same rate at which it is being sold.

Also, internal customers pull value from the next upstream process activity.

As a result, products don't need to be built in advance or materials stockpiled, creating expensive inventory.

EMPOWER THE PEOPLE IN THE COMPANY

5. Seek **Perfection**

Steps 1-4 is a great start, but the fifth step is perhaps the most important: making lean thinking and process improvement part of your corporate culture.

Lean is not a static system and requires constant effort and vigilance to perfect.

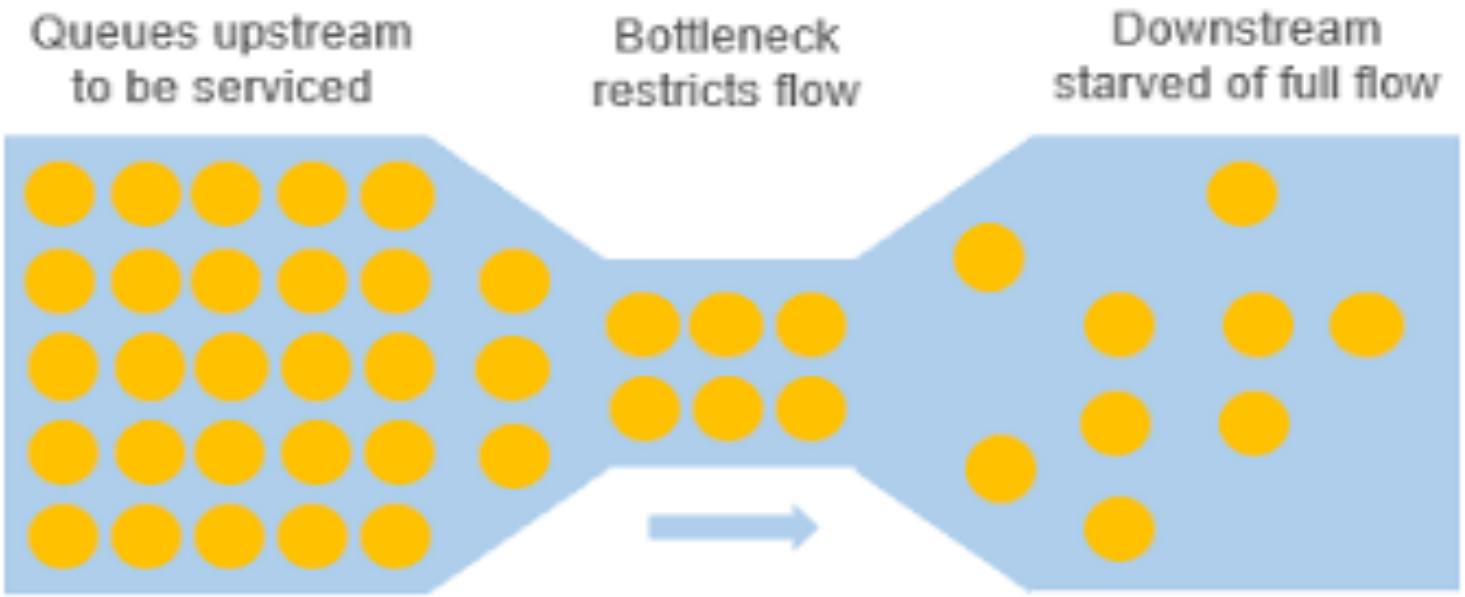
Lean experts often say that a process is not truly lean until it has been through value-stream mapping at least half a dozen times.

As wasted steps are removed and flow and pull are introduced, the improvement process is repeated aiming at perfection.

PLAN - DO - CHECK - ACT

Theory of Constraints

The TOC is a management concept explained by Dr Goldratt in his book “The Goal.” The TOC recognises that every process has an activity or bottleneck that limits the throughput of the entire process. The top priority for acceleration is always the current constraint. Optimising non-constraints will not help.



Lesson 4: Understanding Value with the Kano Model

The Kano model is a theory of product development and customer satisfaction developed in the 1980s by Professor Kano.

Kano – Customer's Voice and Satisfaction Categories

This model helps define the customer's "voice" (requirements) to deliver the most satisfying product, process or service, where requirements are prioritised into three categories as:

1. **Must Haves Basic:** A basic requirement of the customer. If this quality level isn't met the customer will be dissatisfied.
2. **Expected Quality Satisfiers:** A primary satisfier where the more of these requirements that are met, the more satisfied the customer.
3. **Exciting Quality Delighters:** These requirements do not cause dissatisfaction if not present, but will delight customers if present.

Prioritising Requirements

- For instance, in a car, the wheel is a basic item. A sunroof is likely to be a satisfier. Being very silent is an requirement that delights a client that appreciates it.
- The recommendation is to have all basic items, some satisfiers, but do not leave some delighters out if you want to positively impress your client.
- However, complexity increases faster than the number of features.
- Fewer features will be easier to build, easier to test, and have less risk. Many features are rarely or never used.
- A tool that helps prioritise requirements is a *Paired Comparisons Matrix*.

Despite Six Sigma (Minuscule Deviation) Some Thoughts on Requirements

- **Where product performance would not be adversely affected**, use off-the-shelf components rather than one-off specially manufactured items to save cost, reduce lead-times and help ensure future availability.

- Where possible specify with figures in preference to adjectives and adverbs – that is, be precise and measurable:

  Rather than "light" better to state "not more than 10 grams."

  Rather than "quickly" better to state "not less than 10 kilometres per hour."

- **Where product performance would not be adversely affected**, to help minimise cost and time, provide a range rather than a single figure – that is, allow some latitude or tolerance:

  Rather than "100 grams" better to state "98 – 102 grams."

  Rather than "50 metres per second" better to state 48 – 52 metres per second.

Lesson 5: Types of Waste

Identification of value versus waste from the end customer's perspective is a key principle in Lean.

Waste is defined as "*any activity which does not add value to the product or service provided for the customer*."

A first step in adopting Lean is to identify and attack waste.

Waste Identification

Many studies have shown that we only add value to a product for about 5% of the time, and the rest of the time is wasted!

The Lean philosophy identifies three main forms of waste (3Ms):

1. *Mura* is waste due to production inconsistency.
2. *Muri* is waste due to overburdening people, equipment or system.
3. *Muda* is waste due to non-value-adding activities.

The Eight Wastes – *"DOWNTIME"*

1. **D**efects – Products that don't meet the customer required specifications or quality standards.
2. **O**verproduction – Exceeding demand or producing more than was ordered or specified.
3. **W**aiting – Process bottle-necks, long changeover times and set-ups, and approval queues.
4. **N**on-Utilised Talent – Ineffectively use of human resources.
5. **T**ransportation – Inefficient shipping or methods of movement.
6. **I**nventory – Holding a surplus of product or raw material.
7. **M**otion – Unnecessary moving of product, material or people.
8. **E**xtra Processing – Doing more to a product than the customer needs – unneeded features and functions.

Another Waste

Resource Waste – failing to make best use of gas, electricity, and water. Also, off-cuts and other by-products are often incinerated or sent to a landfill when they could be better used elsewhere.

Toyota 5S Method of Waste Elimination

1. **Sort** - All unneeded tools and supplies are removed from the work area.
2. **Set in Order** – "A place for everything and everything is in its place" is this house-keeping mantra.
3. **Shine** - The work area is cleaned and kept clean as work is performed.
4. **Standardise** – Cleaning is consistently applied.
5. **Sustain** – The 5S habit is maintained.

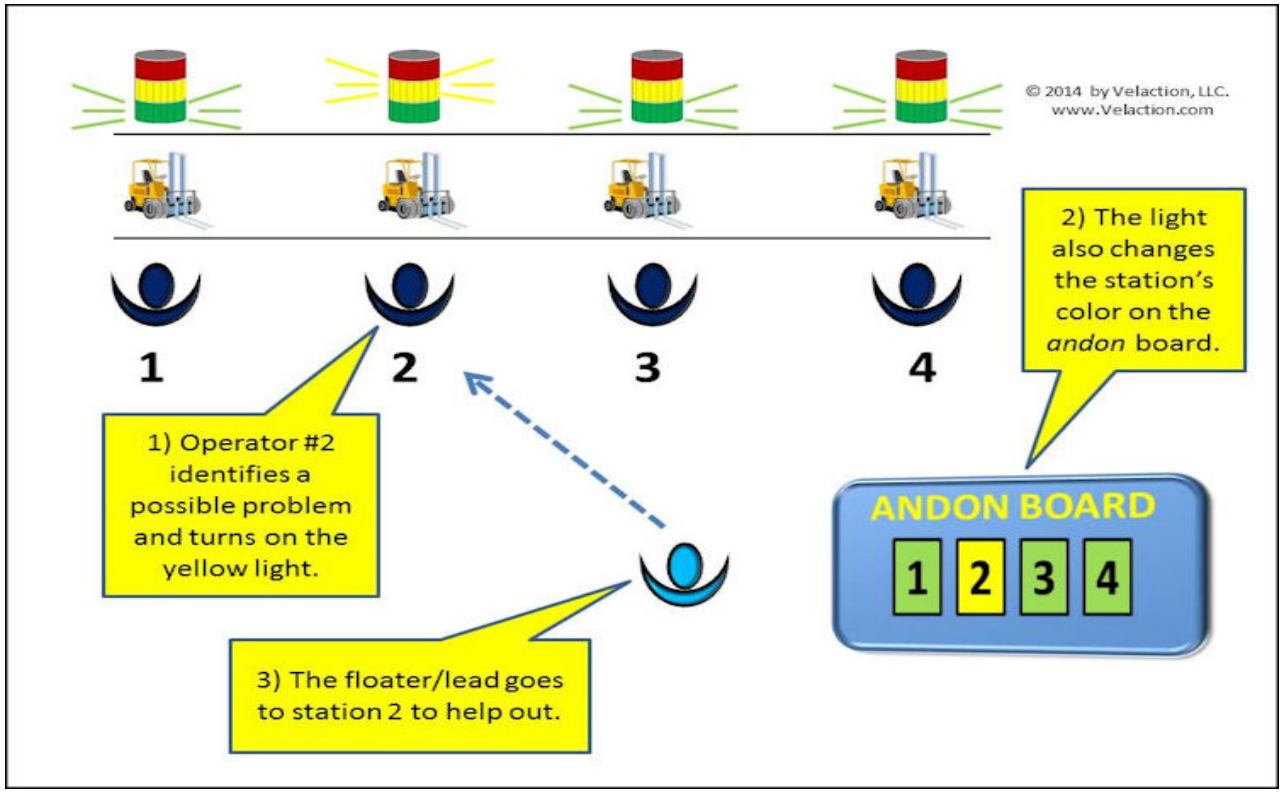
As a consequence of 5S, work areas are kept safe and free of hazardous. Prominent warning signs are put in place, and protective clothing, goggles and footwear are worn as appropriate.

Step 1. Sort

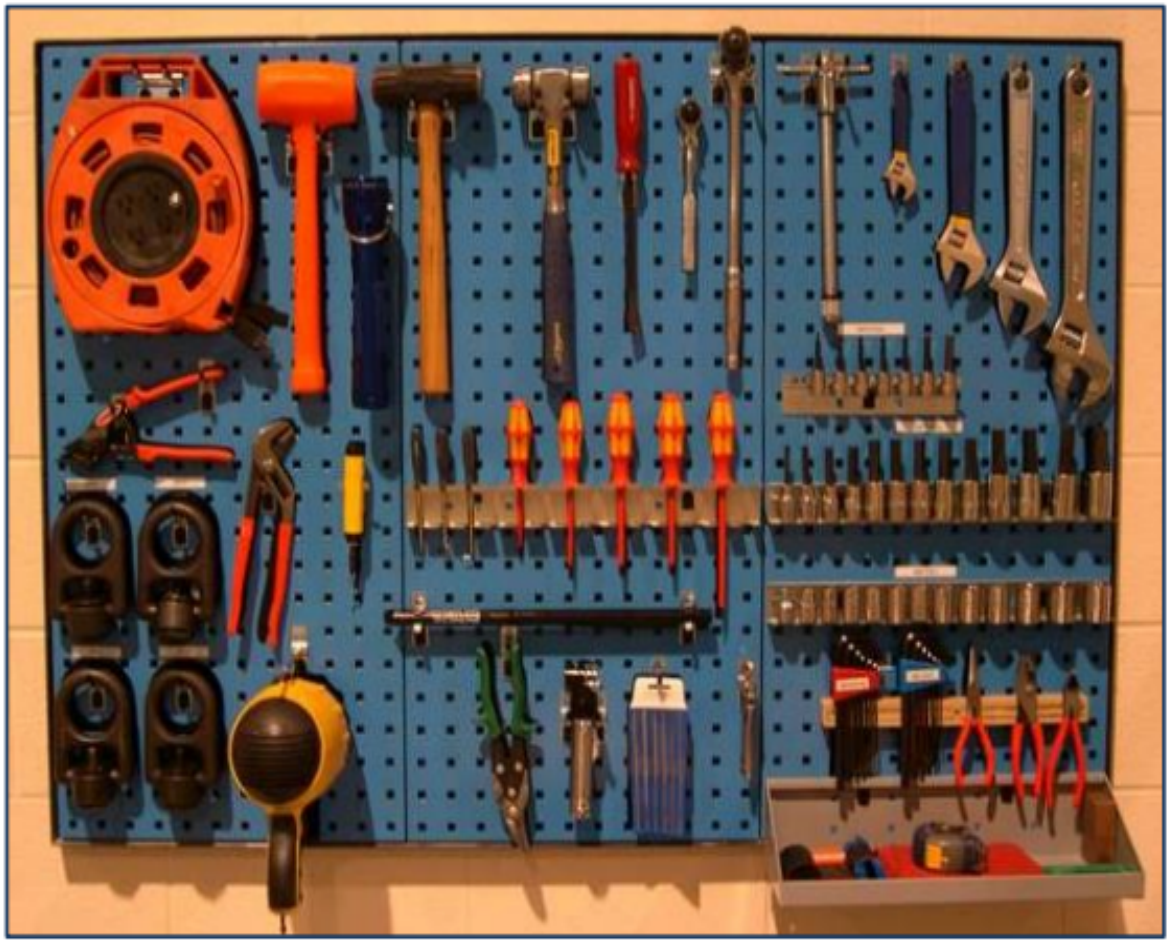
- Segregate what is needed, needed later, and not needed. *"When in doubt, move it out."*
- Remove all items from the workplace that are not needed for current operations to thus create more workspace and improve safety.
- Target excess inventory, obsolete items, and unneeded tools, equipment, pallets, shelving, machinery, desks, chairs and documents.
- Red Tags may be used for tagging and logging unneeded items for disposal.
- Useful to take before and after pictures as a visual record of progress.

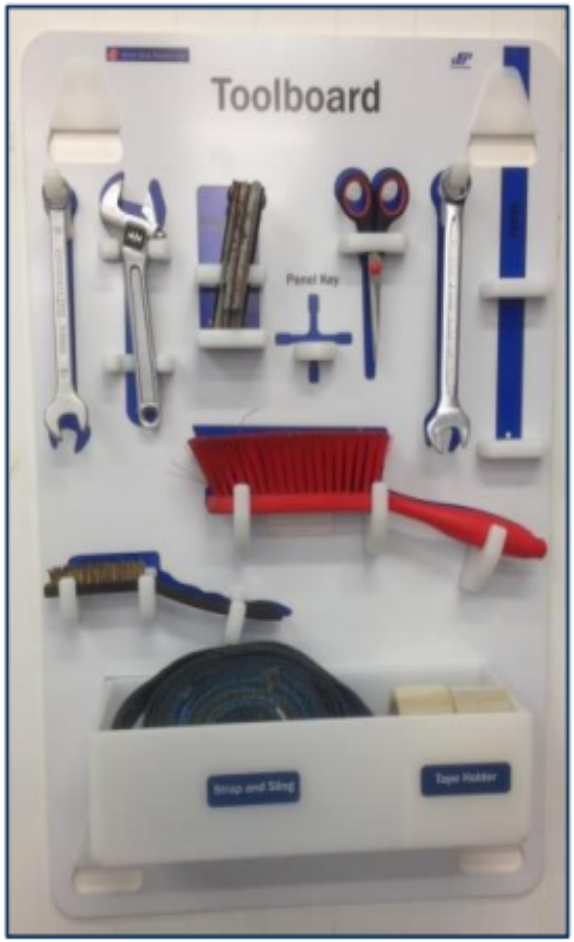
The Visual Workplace

Andon lights are triggered manually or automatically when a machine performance drops below a certain pace or when maintenance is due.



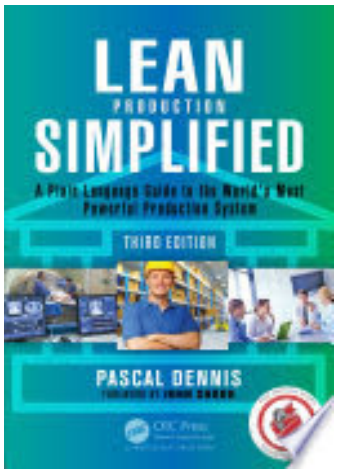
Lean Tool Board





Workplace Labels

In his book "*Lean Production Simplified*" Pascal Dennis recommends Lean visuals for kindergartens.



Step 2. Set in Order (Straighten)

- Arrange needed items so that they are easy to find, use and put away.
- Eliminate duplicate items.
- Wherever practicable the most frequency used items are positioned closest to the operator.
- Maximum use is made of signs, shadow boards and visual metrics.

Before and After

Step 3. Shine

- A clean and tidy workplace facilitates operations and safety, and creates a good image for workers and customers. Workers develop a sense of pride about their work site and service standards. Also, problems are more evident in a clean workplace (eg, oil leaks).
- The initial clean is in depth targeting storage areas, equipment and surrounds. Thereafter the challenge is regular housekeeping and leaving the workplace tidy at the end of each shift. *"Clean and stow as we go"*.
- Cleaning and inspection checklists may be developed that include "Shine Targets".

Step 4. Standardise

- Establish high standards and clear procedures to maintain the first three disciplines (sort, set-in-order, shine).
- Integrate these first three S requirements into employees' job descriptions and regular work activities.
- As a result of standardisation, all employees trained to do a particular job should be able to work efficiently at any work station.
- Allocate responsibilities, areas, and provide the necessary resources.

Standardised Work Chart

Acme Corp.

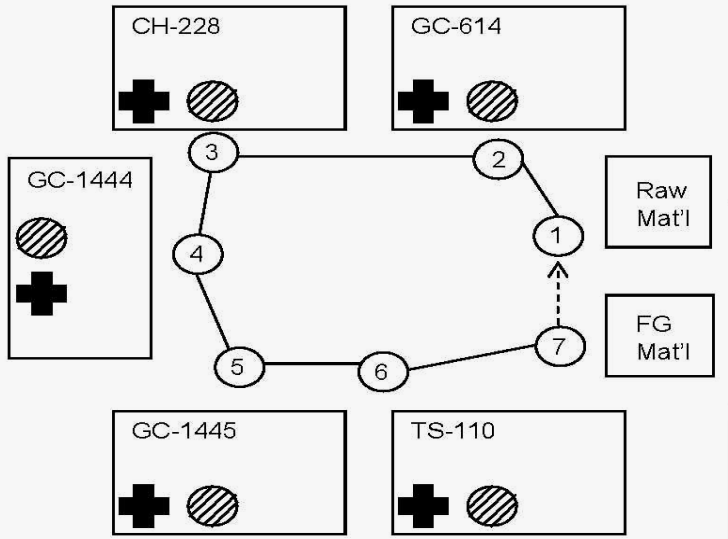
Standardized Work Combination Table

Date:	By:	Approved By:	Plant: Acme	Product: 8" Pinion Gear
			Area: Gear Machining	Op. _1_ of _1_
			Process: Gear cutting exercise	Pg. _1_ of _1_
			Shifts: 2	Takt Time: 46 secs. / Cycle Time: 46 secs.
			Volume: 600	

No.	Major Steps	MAN TIME	AUTO TIME	WAIT TIME	WALK TIME
1	Pick up raw material	1	--	--	2
2	Unload, load part and start M/C GC614	5	38	--	2
3	Unload, load part and start M/C CH228	6	7	--	2
4	Unload, load part and start M/C GC1444	6	38	--	2
5	Unload, load part and start M/C GC1445	6	30	--	2
6	Unload, load part and start M/C TS110	7	3	--	2
7	Pack FG in pallet	1	--		2
			X		X

Working Sequence
Walking
Return to Start

Safety | SWIP | Quality (QC)



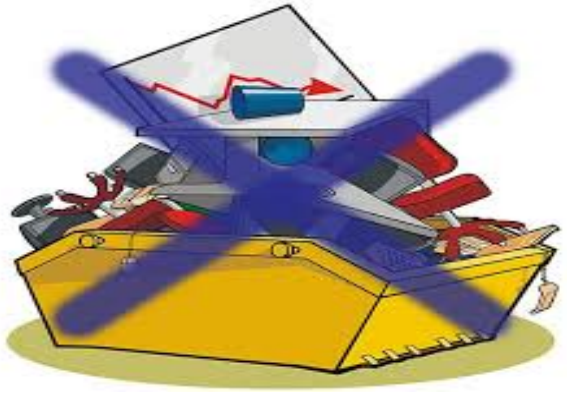
Step 5. Sustain

- Sustain the positive changes made.
- Encourage on-going creativity and spontaneity rather than compulsion.
- Recognise and celebrate successes such as extra space, improved machine maintenance, enhanced productivity, fewer accidents and mistakes.
- Management undertake regular audits – a “Waste Walk” or “Gemba Walk”.

Pilot 5S Project

- 5S is a useful first stepping stone towards implementing lean, because 5S can be a stand alone implementation (with or without lean).
- Don't implement 5S throughout the entire organisation in one go.
- Select an untidy area so as to clearly show what can be achieved.
- Include people from outside the area to join the 5S team as they will then have some experience when it comes to implementing 5S in their own areas.
- The 5S team must have a clear understanding of the various Lean Wastes.

Workplace Waste Identification Exercise



Working in teams of two or three members, each team is to select a work area and identify, classify and record waste. Rule up your record sheet thus:

Site:_____	Inspector:_____	Date:_____
Waste Description	Waste Classification	Suggested Action

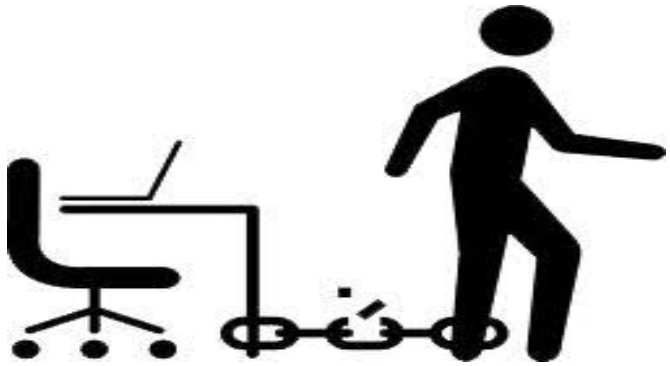
We will then reassemble here in 25 minutes and hear the results of your waste identification survey.

Gemba Walk

https:/www.creativesafetysupply.com/content/public/Guide-Gemba.pdf

- Reports, although useful, are not always a full and timely description of the work situation.
- The idea of the gemba walk is simple: **go to the place, look at the process, and talk with the people**.

Gemba Walk Process & Protocols



1. Inform site(s) in advance of the Gemba Walk schedule.
2. Arrive at the agreed time wearing any required Personal Protective Equipment (PPE).
3. Introduce yourself and request the process owner to accompany you on the walk. Show respect.
4. Walk through the process site and ask open-ended questions and listen to the answers.
5. Once you have captured your observations, validate your findings, conclusions and recommendations with those doing the work.
6. Encourage feedback from those inspected on the conduct of the walk.

Gemba Walk: Example Questions

- Can you show me how you perform this task?
- What is working well?
- Is the job always done this way?
- Are standardised procedures being followed?
- Which activities add value?
- Which activities do not add value?
- Are expected levels of output being met?
- Are there variations in the process?
- Are there abnormalities in products?
- Is tidiness or cleanliness maintained?
- Is all machinery in good working order?
- Do workers need further training or more support?
- What documentation is needed?
- Are all tasks done safely?
- Is there any wasted time or resources?
- What would you change about this work if you could?

Lesson 6: Creating a Lean Enterprise

A lean organisation understands customer value and focuses its key processes to continuously increase it.

The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste.

Taking the “Lean Leap”

A useful acronym for the way an organisation can implement Lean is LEAP:

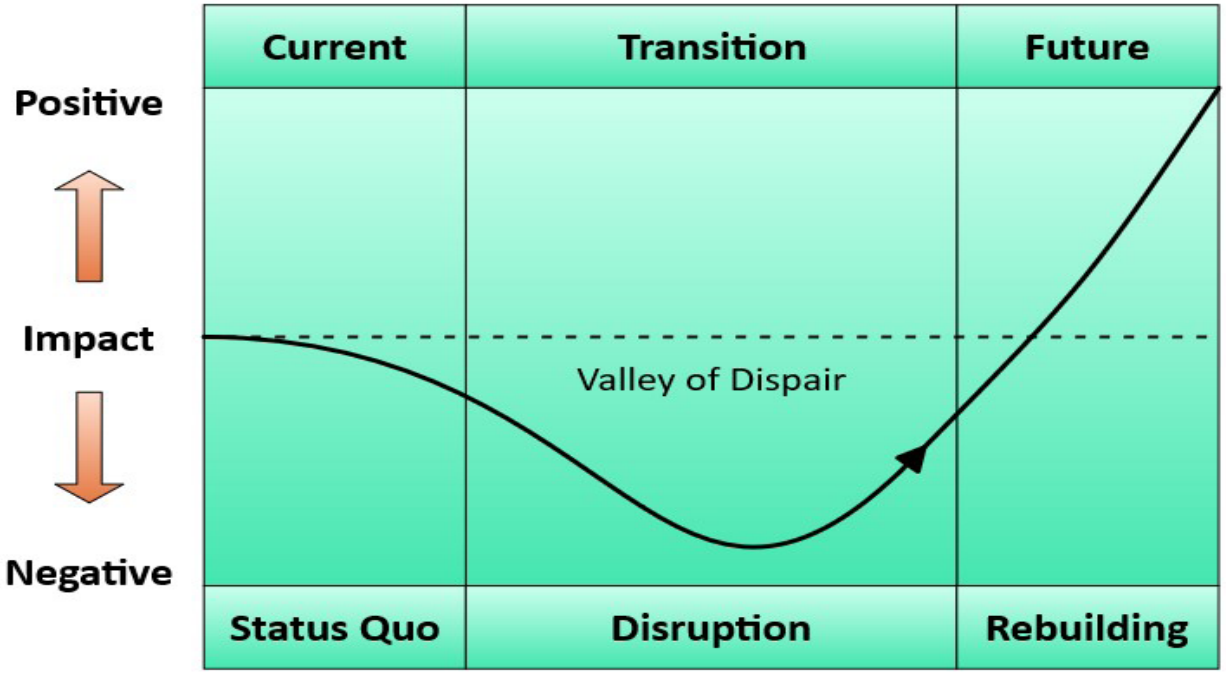
- **Learn it:** Learn your customers’ requirements and educate partnership suppliers.
- **Explain it:** Convert the customer requirements into product or service specifications.
- **Adapt it:** Eliminate all but value-adding activities and convert specifications into products through validated processes.
- **Provide it:** Provide products to the customers at the right time, in the right quantity and at the right place.

Typical Lean Transformation Steps

1. Sell Lean to employees and familiarise them with the tools and techniques involved.
2. Undertake Value Stream Mapping (VSM) to identify areas for improvement.
3. Implement improvements identified through VSM and roll out Lean projects.
4. Continue expanding Lean by value stream across the organisation. Also apply Lean to administrative functions.
5. Develop a production growth strategy given the newly freed up capacity.
6. Extend Lean to the organisation's suppliers.

Impact of Change

Lean means change. Most people are apprehesive about change.The change curve is a popular model used to understand the stages of personal transition and organisational change:



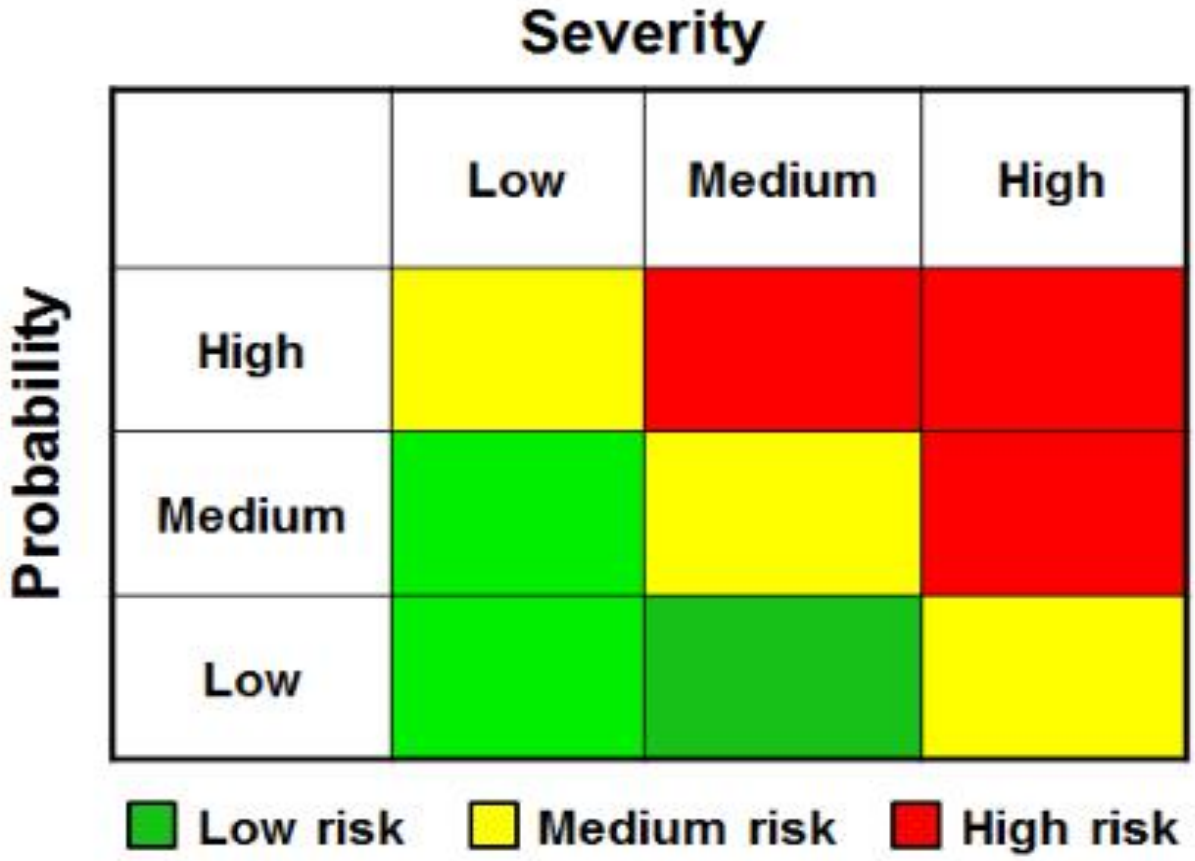
Change Management Strategies

Change management is key to embedding the change to Lean. The goal is to reach the point when employees have stopped thinking about Lean as anything other than normal practice.

- Communication is vital. Address employees' fears. Appoint visible and powerful change advocates. Sell workers on the benefits - *WIIFM*. But do anticipate and prepare for objections.
- Plan for and publish early change successes. Acknowledge, reward and celebrate such successes and evidence of buy-in.
- Train, coach and mentor. Prepare too for counselling and stress management.
- Assess the success of the change initiative, watch for signs of a relapse to the old ways, and take early corrective action as required to sustain the change.

Transition Risk Management Exercise

Use for qualitative assessment of Lean transition risks.



Total Preventative Maintenance

To lessen the risk of equipment breakdown, Lean advocates a proactive Total Preventative Maintenance (TPM) programme.

Typically a one-week workshop, comprised of operators, maintenance personnel and supervisors, implement a maintenance programme to maximise the operational effectiveness of equipment, where Operational Equipment Effectiveness (OEE) is:

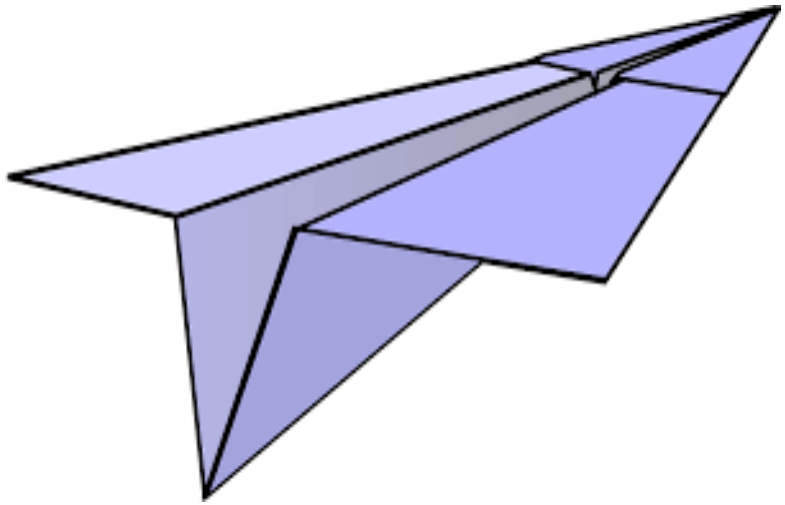
Performance x Availability x Quality

Performance concerns running speed.
Availability concerns breakdowns and product changeovers.
Quality concerns rejects.

If Performance is 95%, Availability is 90%, and Quality is 99%
OEE = 0.90 x 0.95 x 0.99 = 84.6%

Day Two

Lean Process Improvement



- Welcome back (*a trainer's KPI*).
- We will kick off the day with a team exercise designed to demonstrate the benefit of "one piece flow" over batch production.

One Piece Flow

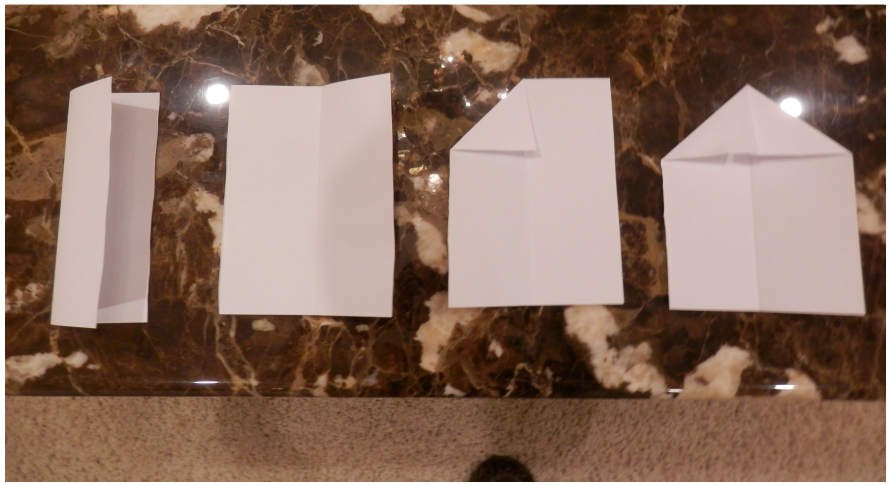
One Piece Flow is where batch sizes are replaced by working on one item at a time, which is claimed to reduce manufacturing defects, minimise inventory and space requirements, and improve safety and workers' morale.

The practice also is called *continuous flow*, *single-piece flow*, and *make one - move one*.

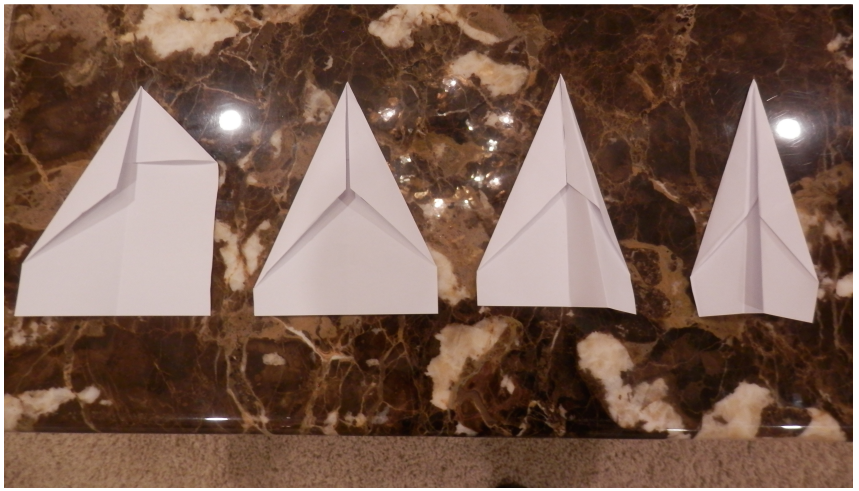
Paper Airplane Production Game
Batch Production vs One Piece Flow

Department One → **Department Two**

Complete a batch of 5 part aircraft before passing them to Department Two.



On receipt of all 5 part aircraft, complete their manufacture.



Now repeat the exercise, but pass on each part aircraft individually – one piece flow. Once constructed, remember the flight test.

Lesson 7: The Plan, Do, Study, Act (PDSA) Cycle

Plan-Do-Check-Act is a planning and problem solving process used for the continual improvement of processes and products.

PDCA Cycle

Deming was an American engineer, statistician, professor, author, lecturer, and management consultant.

- PDCA, or Plan-Do-Check-Act, was made popular by Dr William Edwards Deming, who is considered by many to be the father of modern quality control. PDCA is also known as the Deming Wheel.

- PDSA, or Plan-Do-Study-Act, other than a slight name change, is the same iterative problem-solving/planning cycle as PDCA and is also used for continuously improving a process or product.

- Thus the PDSA or PDSA cycles are for developing change - by planning it, trying it, observing the results, and acting on what is learned.

PDCA Four Steps

1. **Plan:** Includes defining the problem, often using tools such as the 5 Why's, and a fishbone diagram, then evaluating alternative solutions, perhaps using a decision-matrix, to settle on a solution.

2. **Do:** While Step 1 should be done methodically, implementation is typically completed quickly.

3. **Check:** Verification of the solution by monitoring results.

4. **Act:** Making necessary adjustments to the solution based on what was discovered during Step 3 and then recording a standarised procedure.

PDCA is a cyclical Lean process for product and process improvement.

Kaizen = Continuous Improvement

Kaizen (*Continuous Improvement*) is where all employees work together to achieve regular, incremental improvements to manufacturing processes.

- **As an action plan**, Kaizen is about organising events focused on improving specific work areas.
- **As a philosophy**, Kaizen is about building a culture focused on improvements.

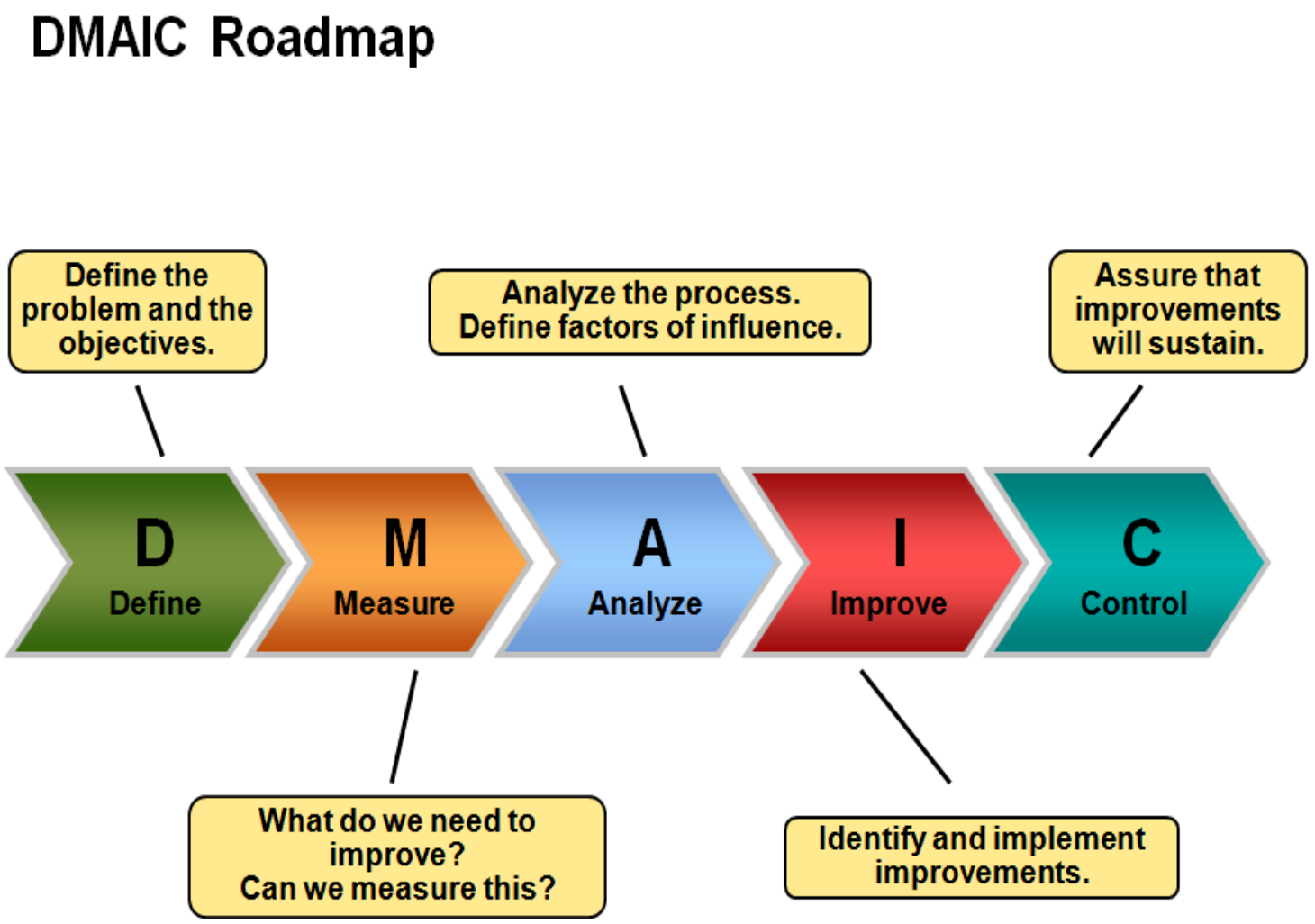
Gemba and Kaizen work together. Gemba requires that managers actually go to where the process that is to be subject to Kaizen is to be undertaken, rather than rely on reports.

Lesson 8: Using the R-DMAIC-S Model

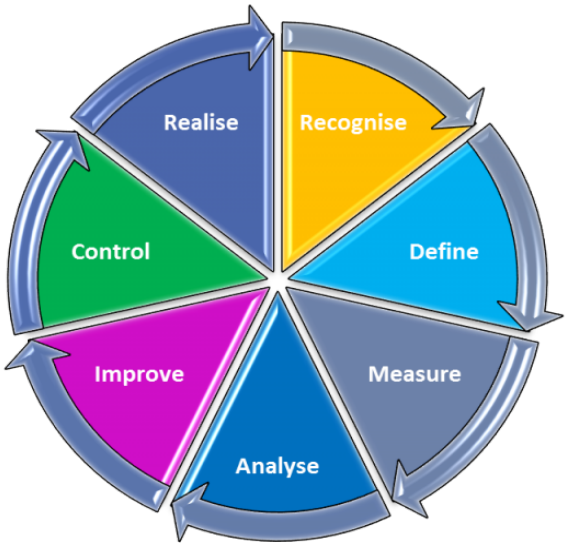
Recognise - Define - Measure - Analyse - Improve - Control – Sustain.

This is an advanced version of PDSA used for more significant or complex problems, often when a huge amount of data is available.

DMAIC Cycle and Exercise



R-DMAIC-**S**



A variation of the DMAIC process adds a further two further steps:

- **R**ecognise - be aware of the need or opportunity for change by continuously seeking to identify problems.
- **S**ustain - retain the benefits of the change and identify new opportunities for further improvement.

Lesson 9: Lean Thinking Tools

5 Why's, 5W-2H, Cause and Effect Diagrams, Decision Matrix, SMED, Takt Time, Check Sheets, Scatter Diagrams, Pareto Charts, Relationship Charts, JIT and EOQ, and Kanban.

5 Why's Example

Ask "Why?" five times to discover the true cause of a problem. For example:

1. **Why** are the customers returning the product?

Answer: 90% of the returns are for dents in the control panel.

2. **Why** are there dents in the control panel?

Answer: The control panels are inspected prior to shipping. Thus, they must be damaged during shipping.

3. **Why** are they damaged during shipment?

Answer: Because they are not packed to the packaging specification.

4. **Why** are they not packed per the packaging specification?

Answer: Because shipping does not have the packaging specification.

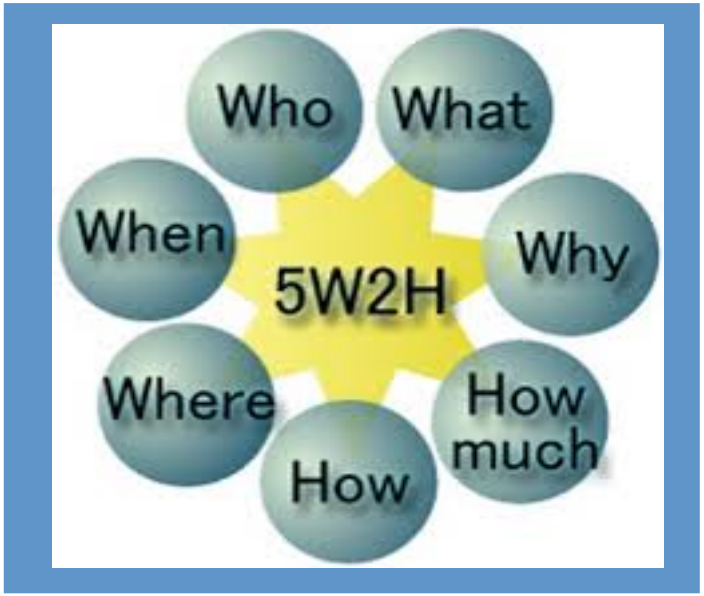
5. **Why** doesn't shipping have the packaging spec?

Answer: Because it is not part of the normal product release process.

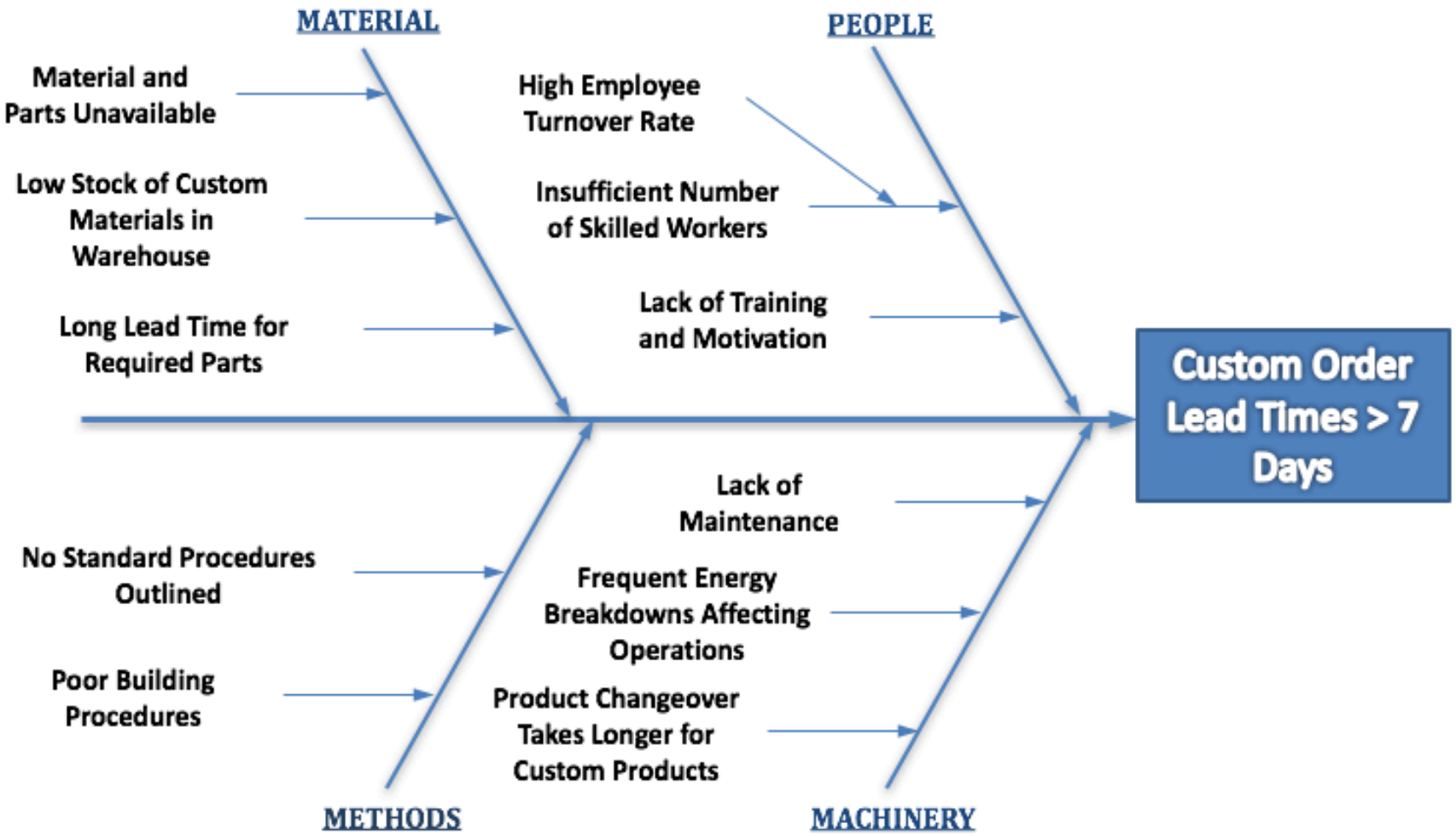
5W-2H

5W-2H problem solving gets its name from the initials for each of the elements that compose it. They are basic questions for any business process or action plan:

- **What?**
- **When?**
- **Who?**
- **Where?**
- **Why?**
- **How?**
- **How much?**



Fishbone Diagram

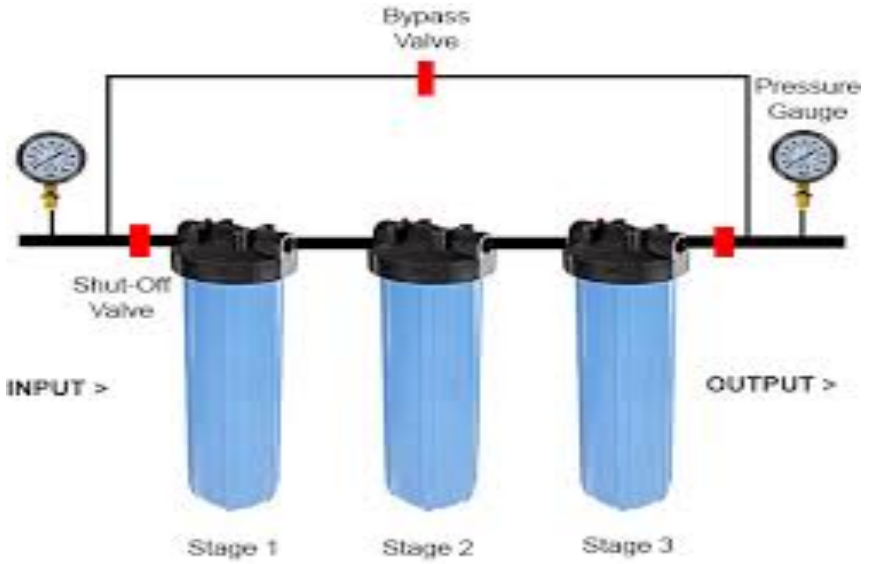


Cause and Effect Diagram Exercise

Create a Cause and Effect (Fish-Bone) diagram that categorises each of these 16 issues, using headings
Material, Method, Machine, People

- Incorrect measurements
- Antiquated scales
- Poor instructions
- Damaged raw material
- Misread display
- Inadequate clean up
- Incorrect maintenance
- Inadequate flow controls
- Variabilty
- Damaged equipment
- Technician calculation off
- Jars mislabeled
- Temperature controls off
- Incorrect weights
- Priority miscommunication
- Inadequate instructions

Root Cause Exercise



- The purpose of this exercise is to evaluate information to determine the root cause(s) of a process problem, which is key to determining what should be done to address it.
- One Lean approach is develop a Cause and Effect Diagram and another technique is to ask “Why?” five times to help us get to the root of the problem. See following slides.
- In this exercise your job is to identify the most likely cause of the problem, and then decide how the problem might most economically, effectively, simply, safely and quickly be eliminated. The 5W-2H provide the essentials for an action plan.

Decision Matrix

- This tool is used to evaluate possible solutions.
- We first identify, prioritise and weight relevant selection attributes and then evaluate possible solutions against these attributes.
- There is an exercise in the workbook designed to familiarise you with this tool. We will tackle it tutorial style.

SMED
(Single-Minute Exchange of Dies)

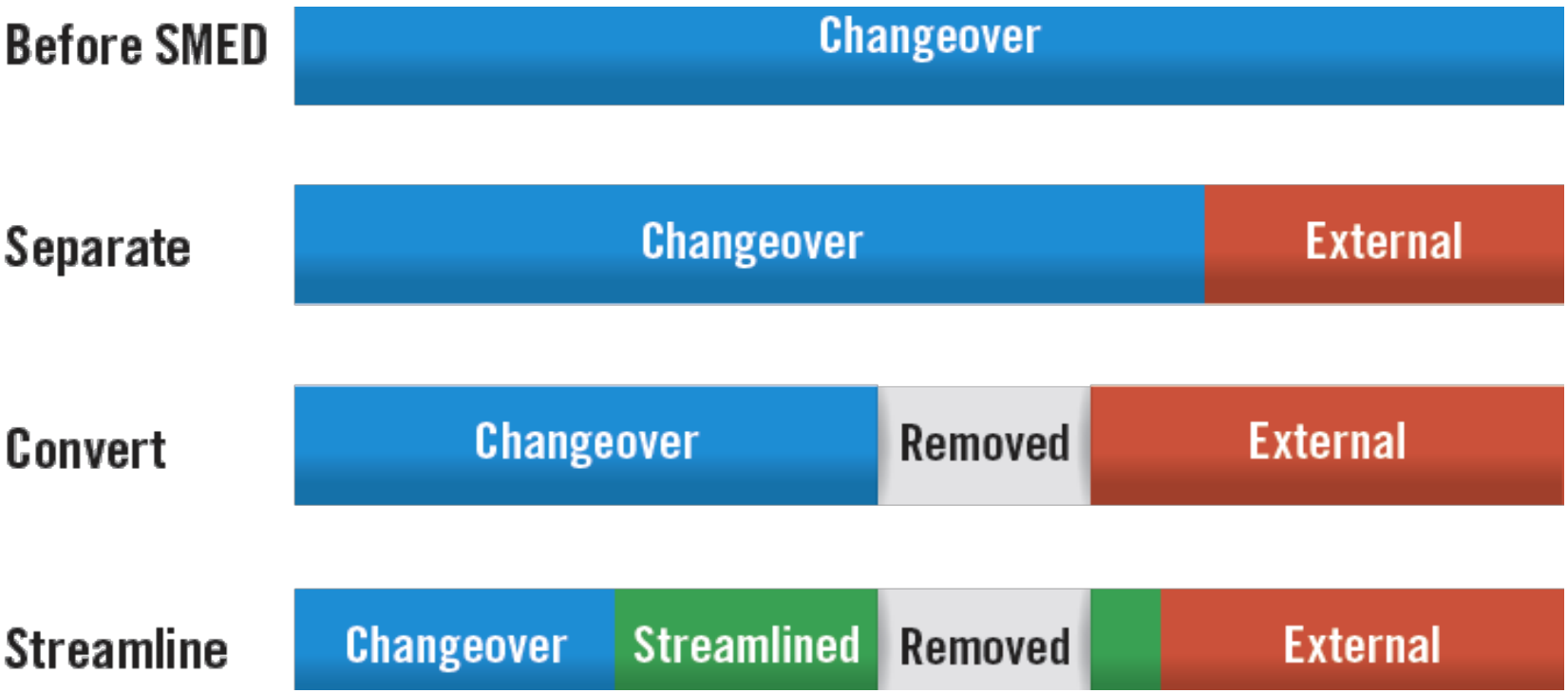
In manufacturing, converting a line from running one product to another can take a few minutes or several weeks.

SMED is a Lean system for reducing this changeover time or down time by converting as many changeover activities as possible to "external" (ie, performed while the process is still running), and to streamline the remaining steps by eliminated unnecessary steps.

Consider the example of changing a car tyre: For many people, changing a single tire can easily take 30 minutes. For a race car pit crew, changing four tires usually takes less than 5 seconds.

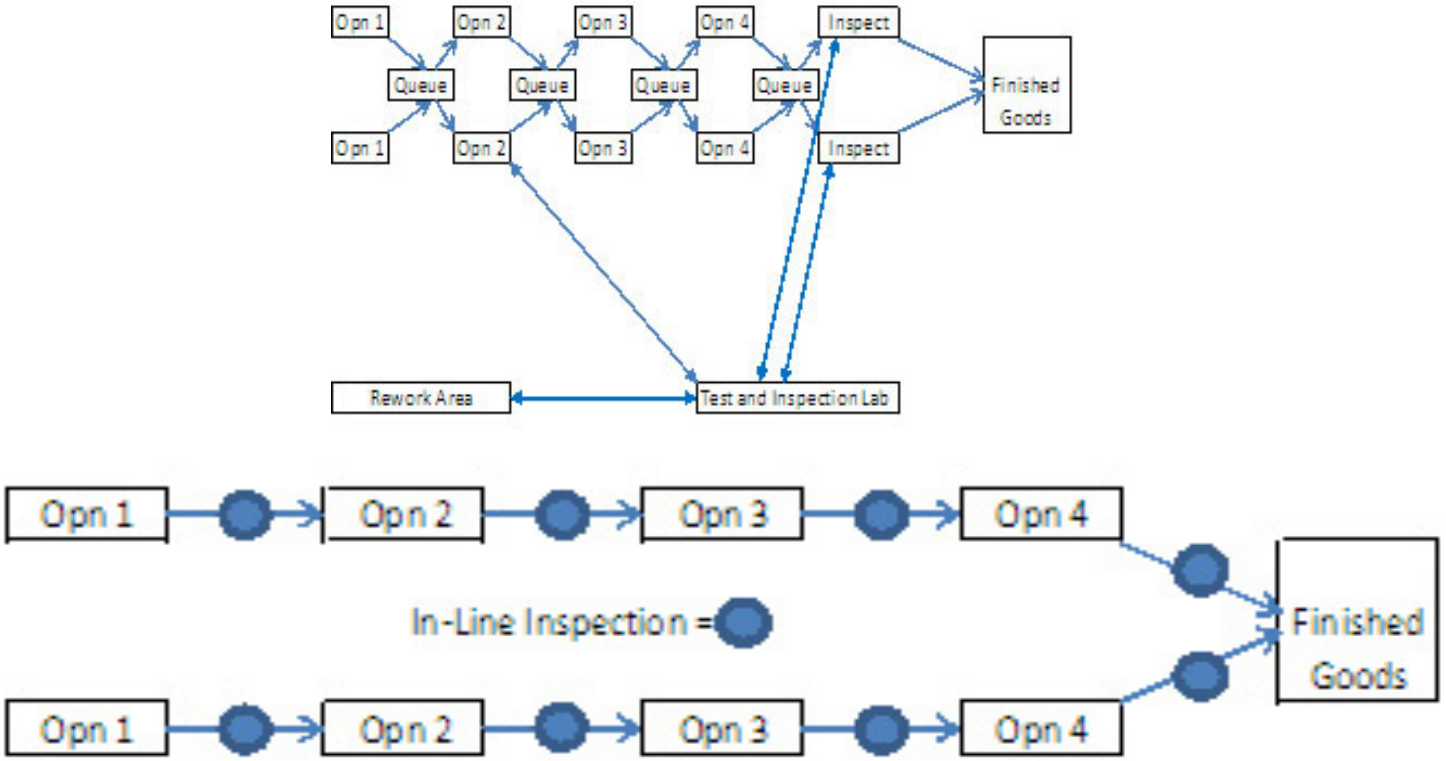
SMED Elements

The changeover process is broken into a sequenced list of steps called elements: Separate (move elements to external), Convert (modify elements so they can be external, or remove them completely), and Streamline (complete elements faster).

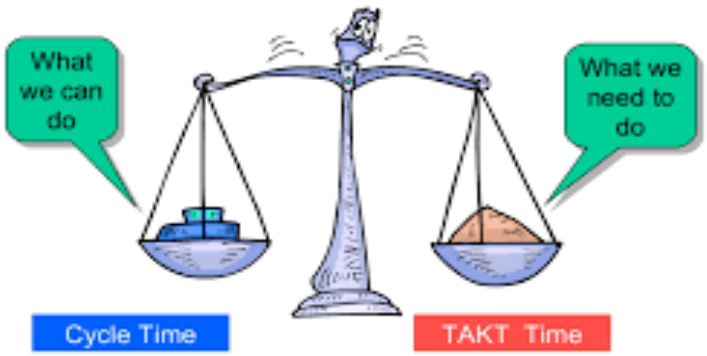


In-Line Inspection

Lean removes the need for separate testing and inspection labs.
In-line inspection allows workers to perform inspections directly on the line to ensure the accuracy of in-process work.



Takt Time



Takt time (German word for the baton) is the average rate at which we must produce product based on customer requirements and available working time. For example, if our daily order is 890 units and we operate two 445 minute shifts, our takt time is 890/(445 + 445) = 1 minute.

Exercise One

A sofa factory works 5 days a week from 8:30 to 16:30 with a 30 minutes break for lunch. 90 sofas have to be produced in a week. What is the Takt Time (time to produce each sofa)?

Takt Time Exercise One: Solution

- Available Time: 8 hours - 30 min (break) = 480 min – 30 min (break) = 450 min a day X 5 days = 2250 min
- Customer's request = 90 sofas
- Takt Time is = 2250 / 90 = 25 min = 1500 sec
- In other words the factory has to produce 1 sofa every **25 minutes** (or 1500 sec) to deliver to the customer on time.

Exercise Two: Takt Time

- A Personal Computer factory works 5 days a week from 8:30 to 16:30 with a 30 minutes break for lunch.
- 180 Personal Computers have to be produced in a week.
- What is the Takt Time for the Personal Computer factory?

Takt Time Exercise Two: Solution

- Available Time: 8 hours - 30 min (break) = 480 min – 30 min (break) = 450 min a day x 5 days = 2250 min
- Customer's request = 180 Personal Computers
- Takt-Time is = 2250 / 180 = 12.5 min = 750 sec
- In other words the factory has to produce 1 Personal Computer every **12.5 minutes** (or 750 sec) to deliver to the customer on time.

Often Takt Time is expressed in seconds rather than minutes.

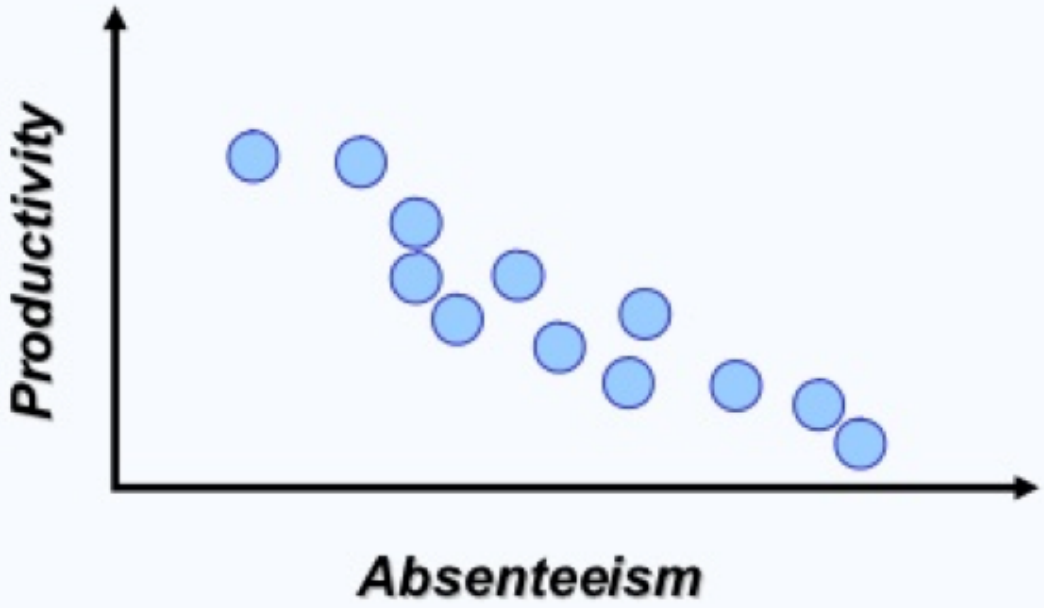
Check Sheet

Check Sheet: An organized method of recording data

	Hour							
Defect	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
A	///	/		/	/	/	///	/
B	//	/	/	/			//	///
C	/	//					//	////

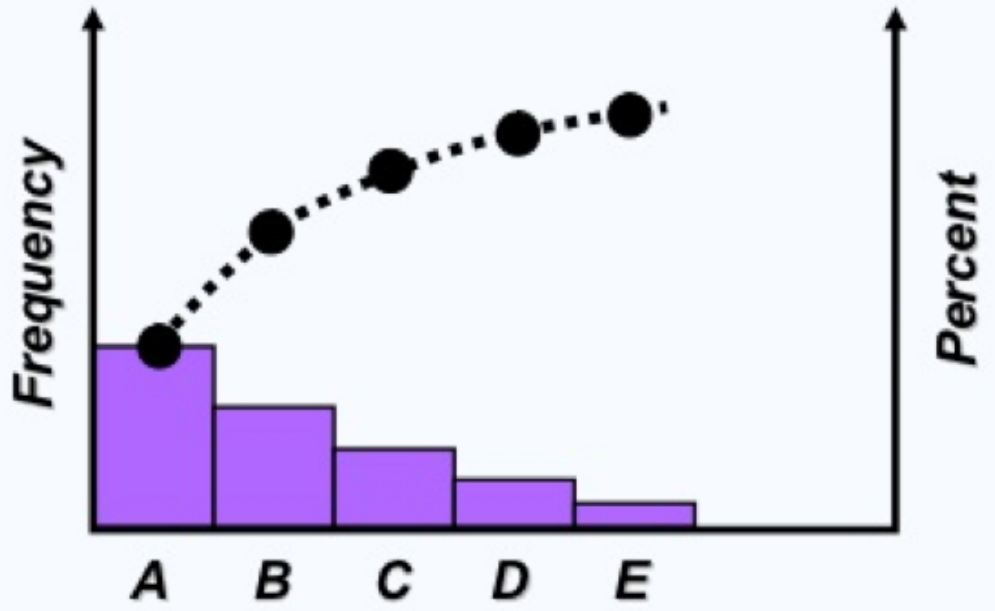
Scatter Diagram

Scatter Diagram: A graph of the value of one variable vs. another variable



Pareto Chart

Pareto Chart: A graph to identify and plot problems or defects in descending order of frequency



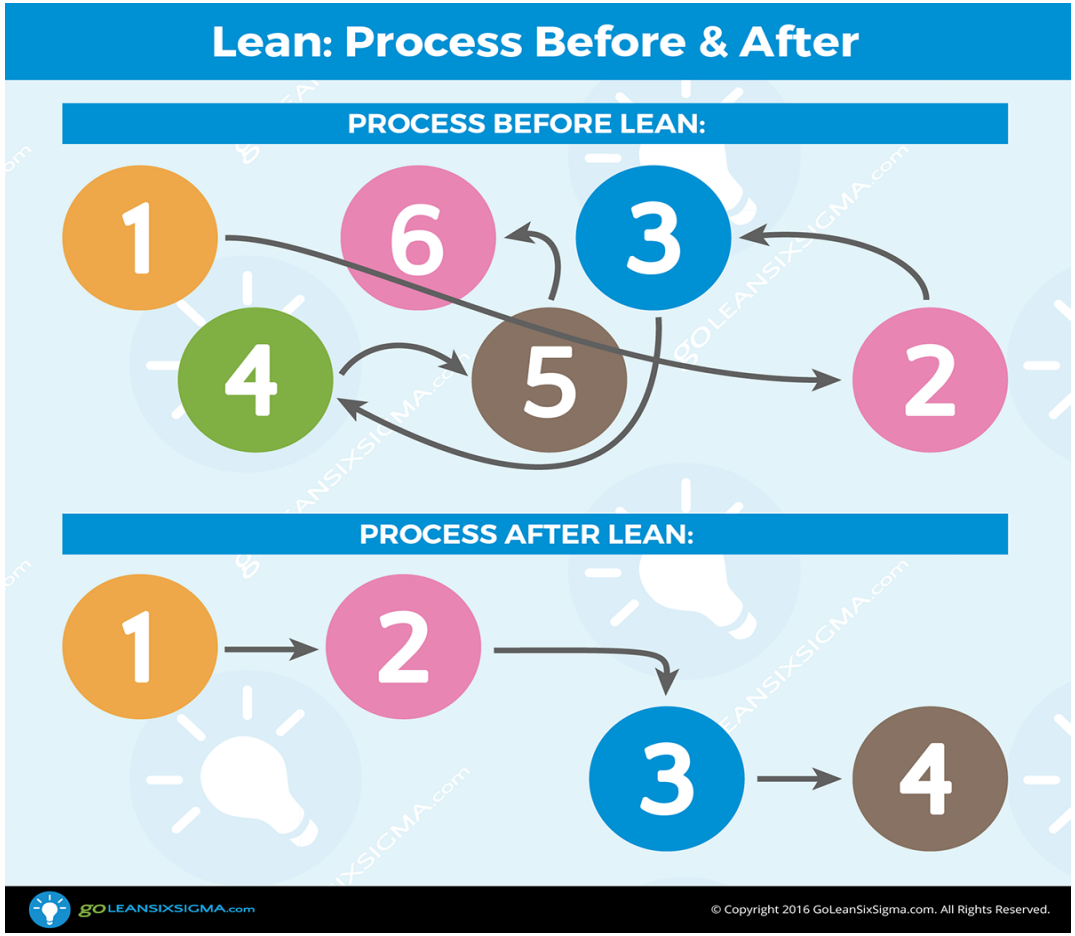
Pareto Chart Exercise

Develop a Pareto chart for following causes of poor exam results:

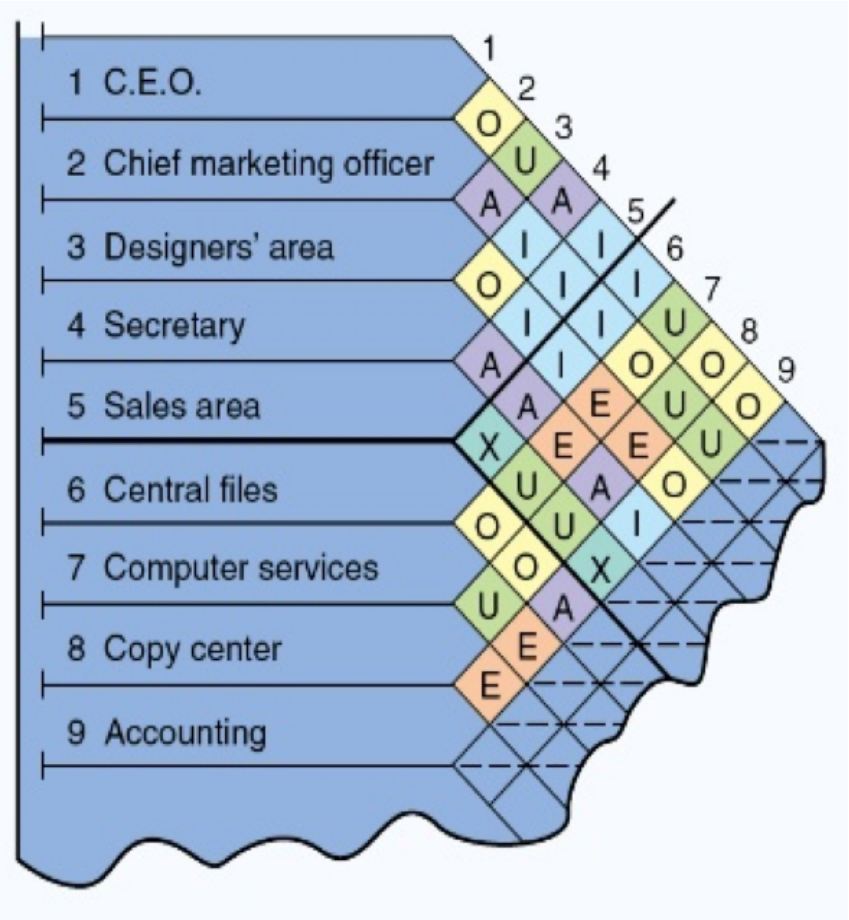
Reason for Poor Results	Percentage
Insufficient time to complete exam	20
Late arrival at exam	10
Difficulty understanding questions	33
Insufficient study	12
Studied wrong material	3
Forgot the exam date	5
Felt ill during exam	6
Exam room distractions	10
Fell asleep	1

Lean Layout (Spaghetti Chart)

Lean layouts reduce wasteful movement by combining operations and minimising travel distances between operations.

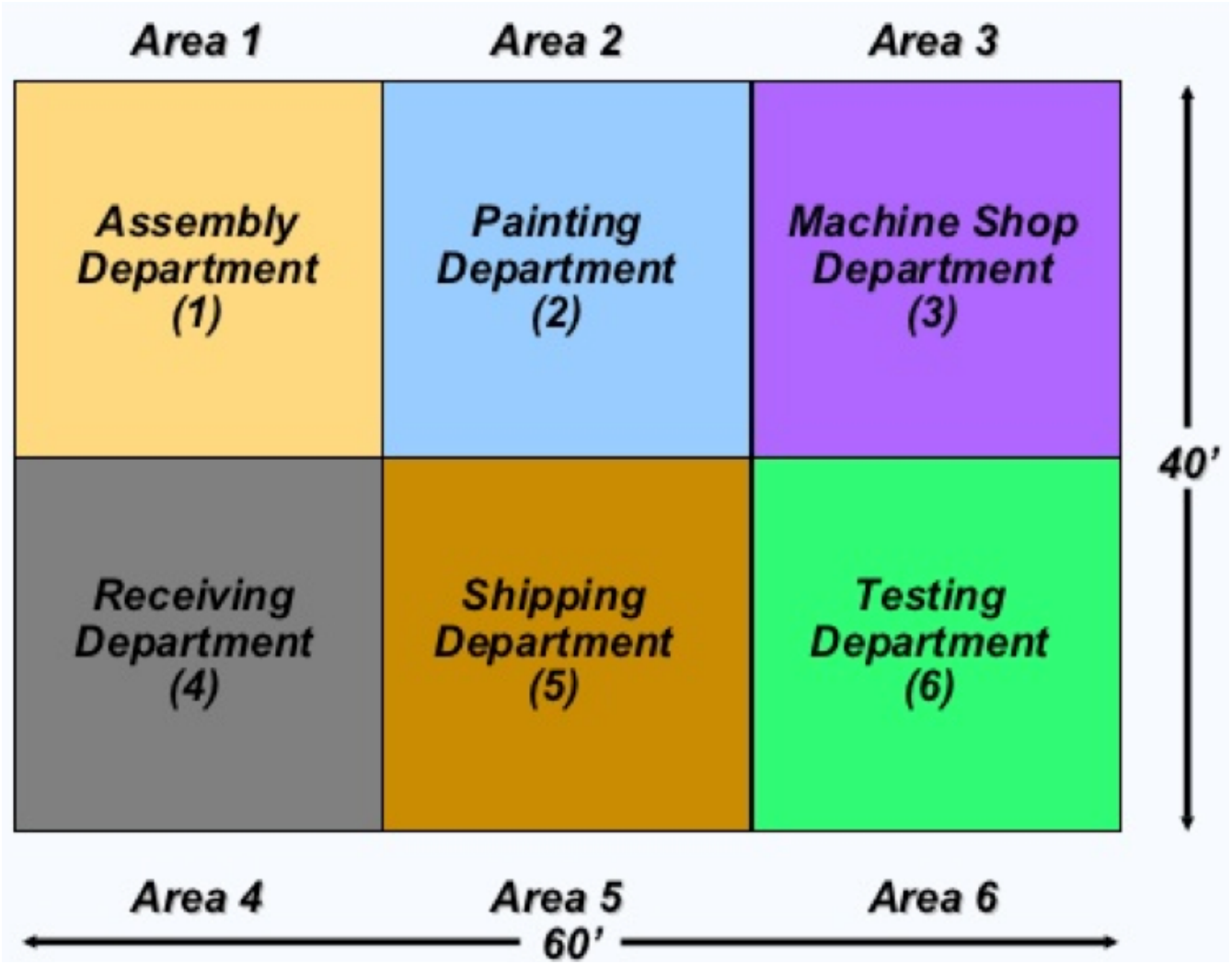


Relationship Chart

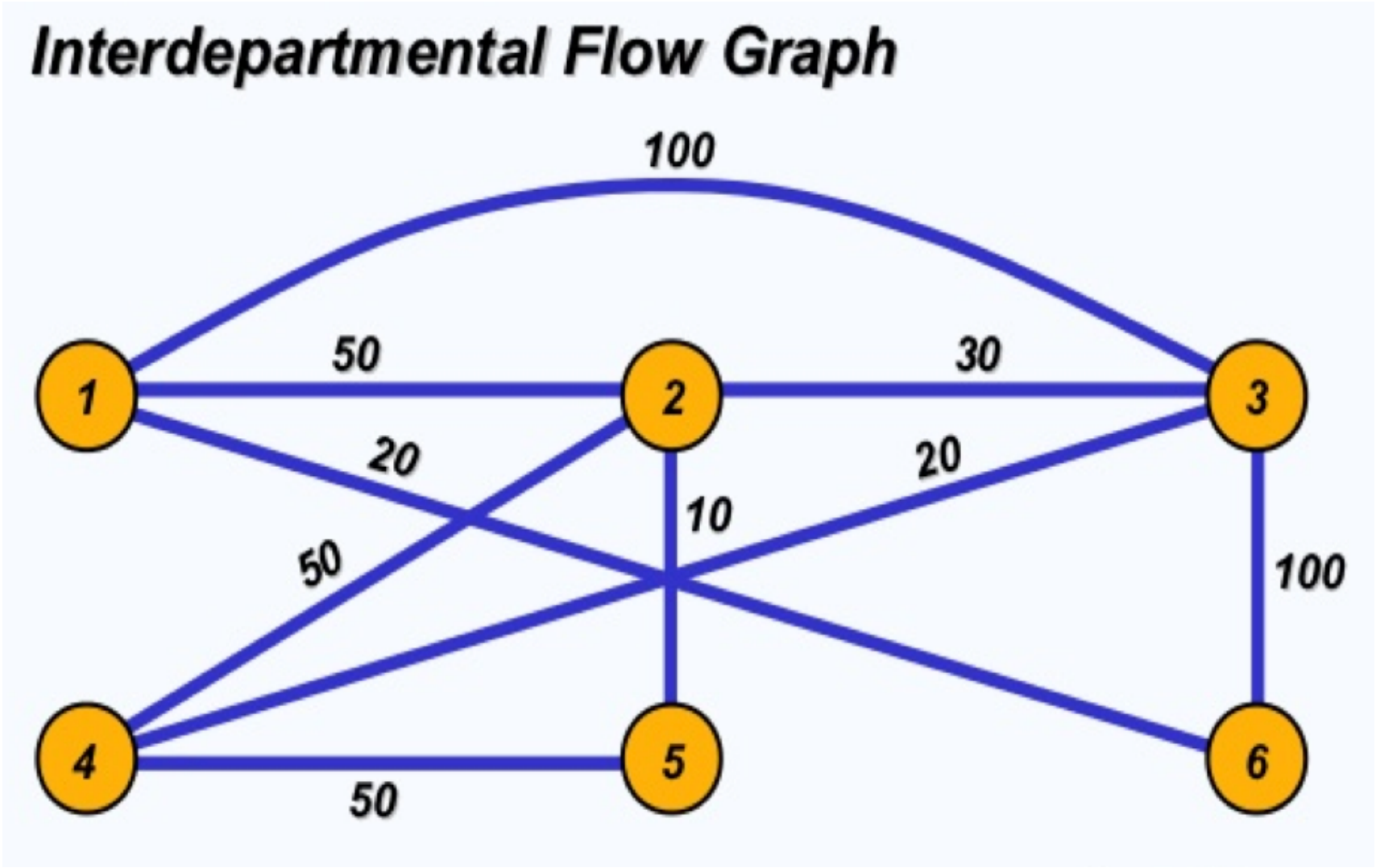


Value	CLOSENESS
A	Absolutely necessary
E	Especially important
I	Important
O	Ordinary OK
U	Unimportant
X	Not desirable

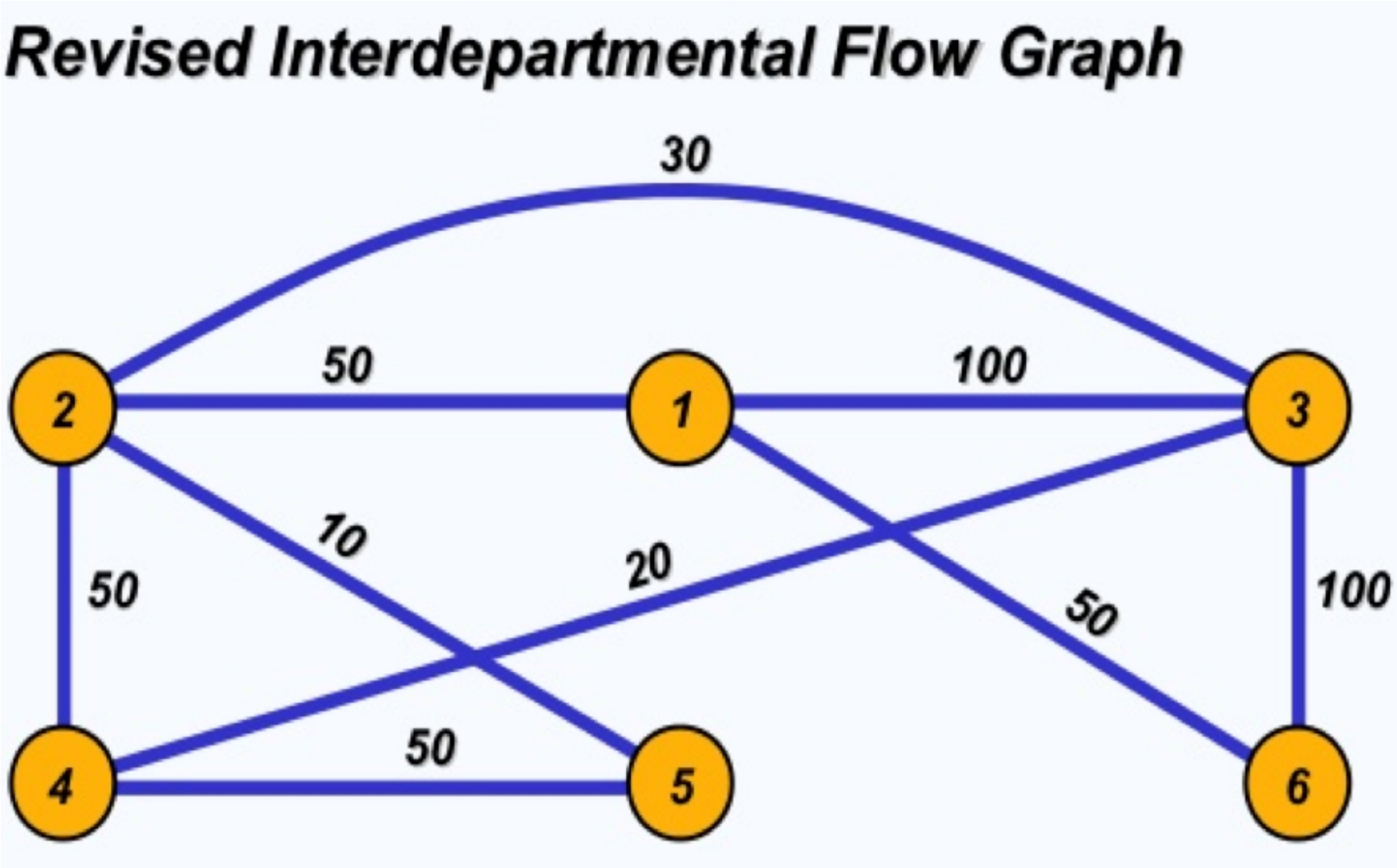
Process Layout Example



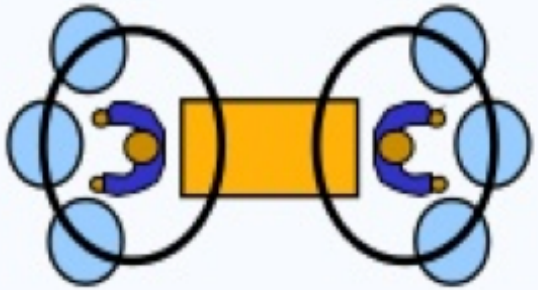
Process Layout Example



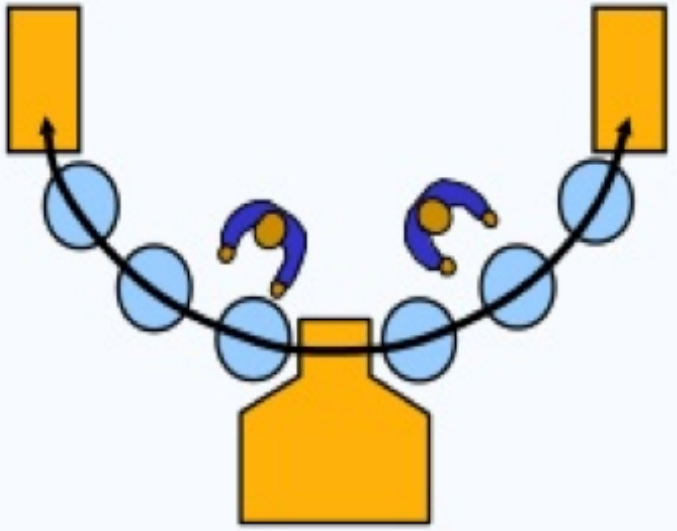
Process Layout Example



Improving Work Cell Layout



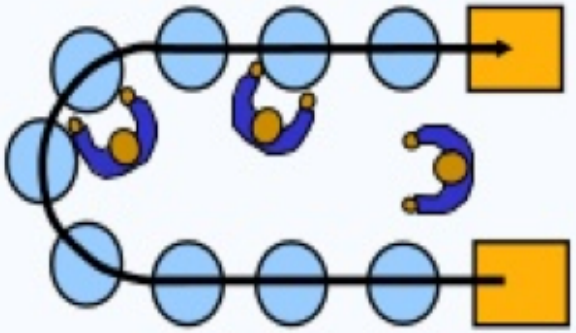
Current layout - workers in small closed areas. Cannot increase output without a third worker and third set of equipment.



Improved layout - cross-trained workers can assist each other. May be able to add a third worker as additional output is needed.

Improved Work Cells

Current layout - straight lines make it hard to balance tasks because work may not be divided evenly



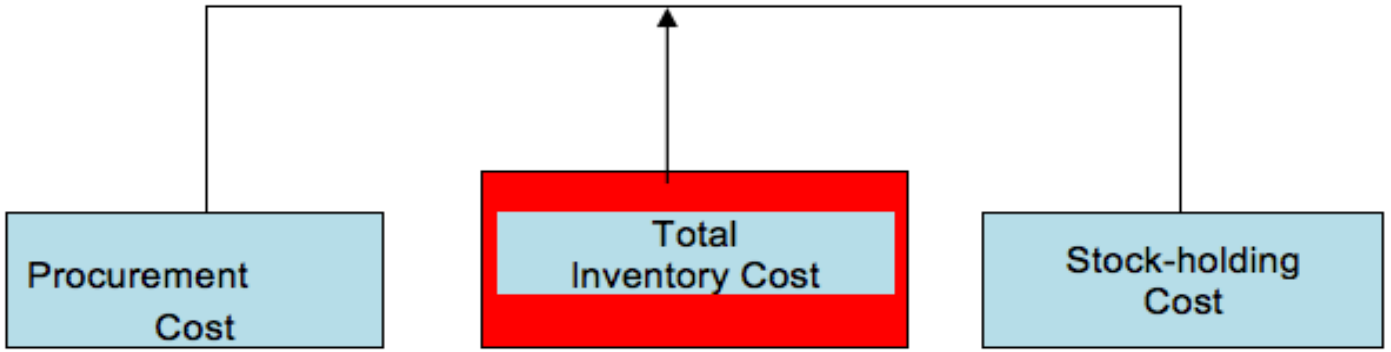
Improved layout - in U shape, workers have better access. Four cross-trained workers were reduced.

U-shaped line may reduce employee movement and space requirements while enhancing communication, reducing the number of workers, and facilitating inspection

Figure 9.10 (b)

JIT and EOQ

EOQ (Economic Order Quantity) is the lot size ordered at any one time that minimises the ordering and inventory costs. Both JIT and EOQ are intended to reduce costs and increase a company's profitability. JIT is often preferred for inventory items with higher purchase prices, holding costs, or ordering costs. Some companies use both JIT and EOQ depending on the items procured.



EOQ Formula

$$EOQ = \sqrt{\frac{2 \times A \times S}{I}}$$

Where A is actual order cost

S is annual sales (number)

I is annual cost to hold item

EOQ Exercise

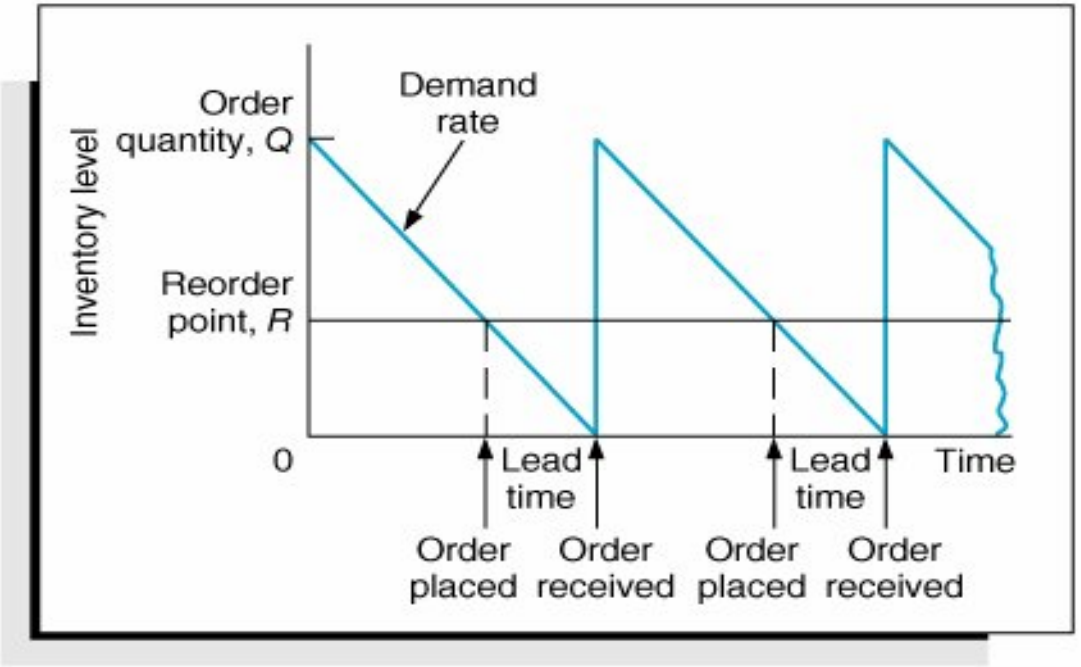
1. Calculate EOQ or optimum lot size given:

D (annual demand)= 2000 rivets

S (cost to order)= $50

I (holding cost) = $2

2. And how many full cartons would we order given 50 items per carton (CUQ)?



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Kanban Process

- Toyota line-workers use a kanban (card) to signal steps in their manufacturing process.
- The idea is to deliver what each process step needs only when it needs it. In Japanese, the word “kan" means "visual" and "ban" means "card," so kanban refers to visual cards.
- The downstream customer must await the kanban card from the upstream customer to provide more parts, thus executing “JIT” and the “pull” system to avoid excessive inventory in the work area.

Lesson 10: Kaizen Events

A Kaizen Event is an action that is taken to improve processes. There are five levels of Kaizen events.

Kaizen Events

Kaizen events have evolved a large number of names - Kaizen Blitz, Kaizen Burst, Focused Improvement Workshops, Kaizen Workshops, Continuous Improvement Workshops, Accelerated Improvement Events, and Rapid Process Improvement Workshops – all of which apart from their scale and scope are essentially undertaken in the same manner.

Kaizen and PDCA Cycle

Routinely a Lean organisation runs a Kaizen Event (improvement project) to identify and remove waste from a selected process by applying the **PDCA Cycle** (or PDSA Cycle).

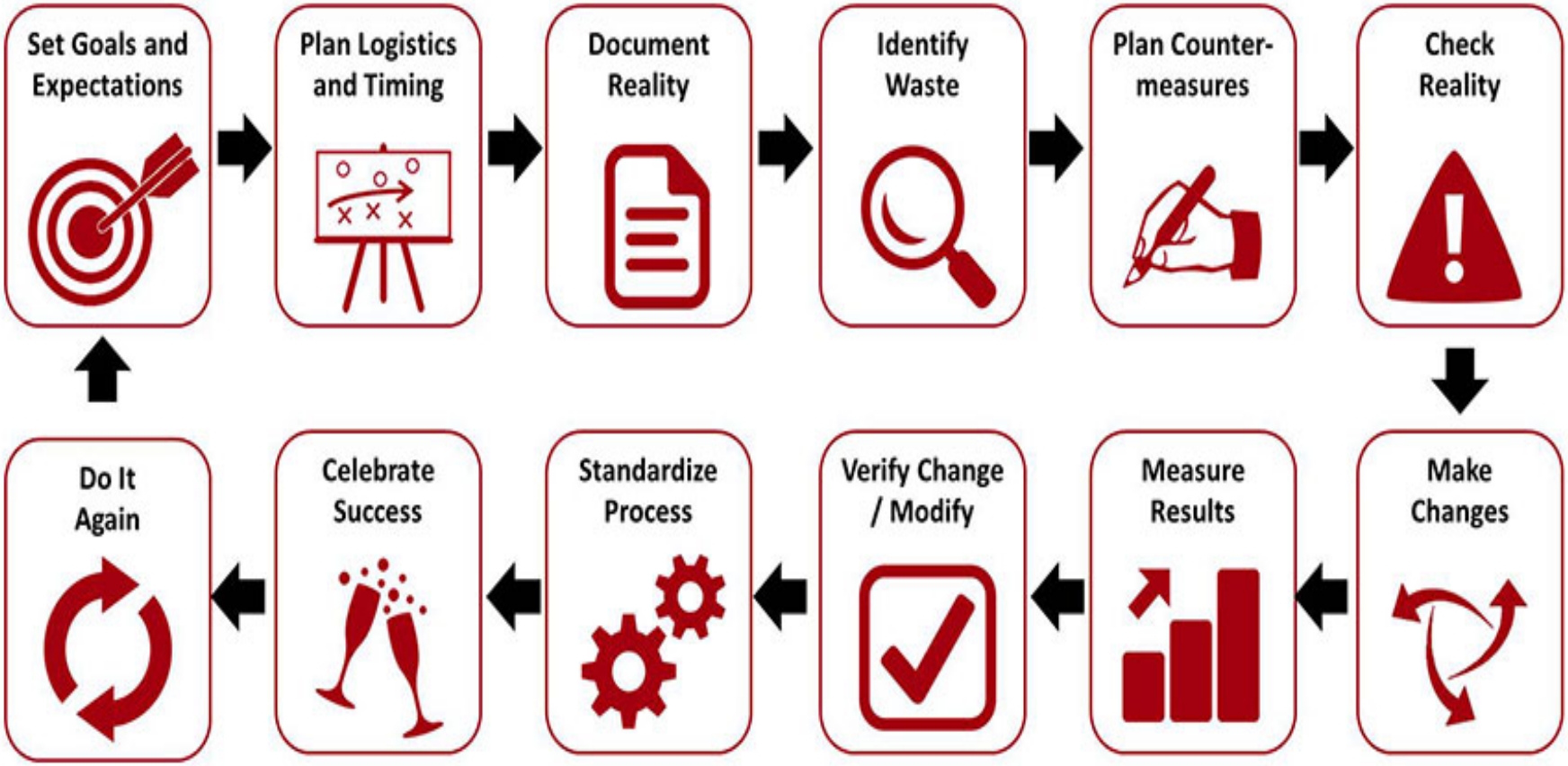
Hierarchy of Kaizen Events

Event Level	Description
1	Individual Kaizen
2	Kaizen Work Team
3	Kaizen Blitz Group
4	Value Stream Kaizen Group
5	Supply Chain Kaizen Group

Kaizen Events are conducted at five levels of scale and scope.
A Kaizen Board tracks the event status:

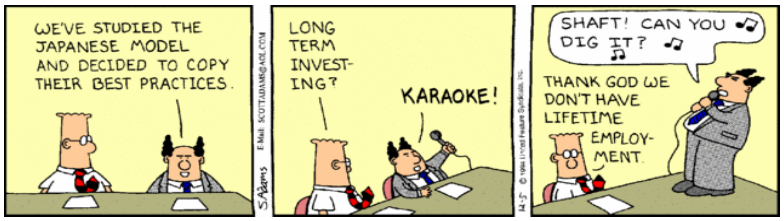
Undertaking a Kaizen Blitz Event

Appoint a team leader, gather the team, define what is to be improved, and undertake any necessary pre-event training.



Example Kaizen Event Timetable

DAY	EVENT ACTIVITIES
1	Gather and train Kaizen Event team, plan the event, visit the site, and collect data.
2	Analyse collected data.
3	Physically improve the site layout/process.
4	Further refine site layout/process and prepare new standardised instructions.
5	Present solution to management and hold a team celebration function.

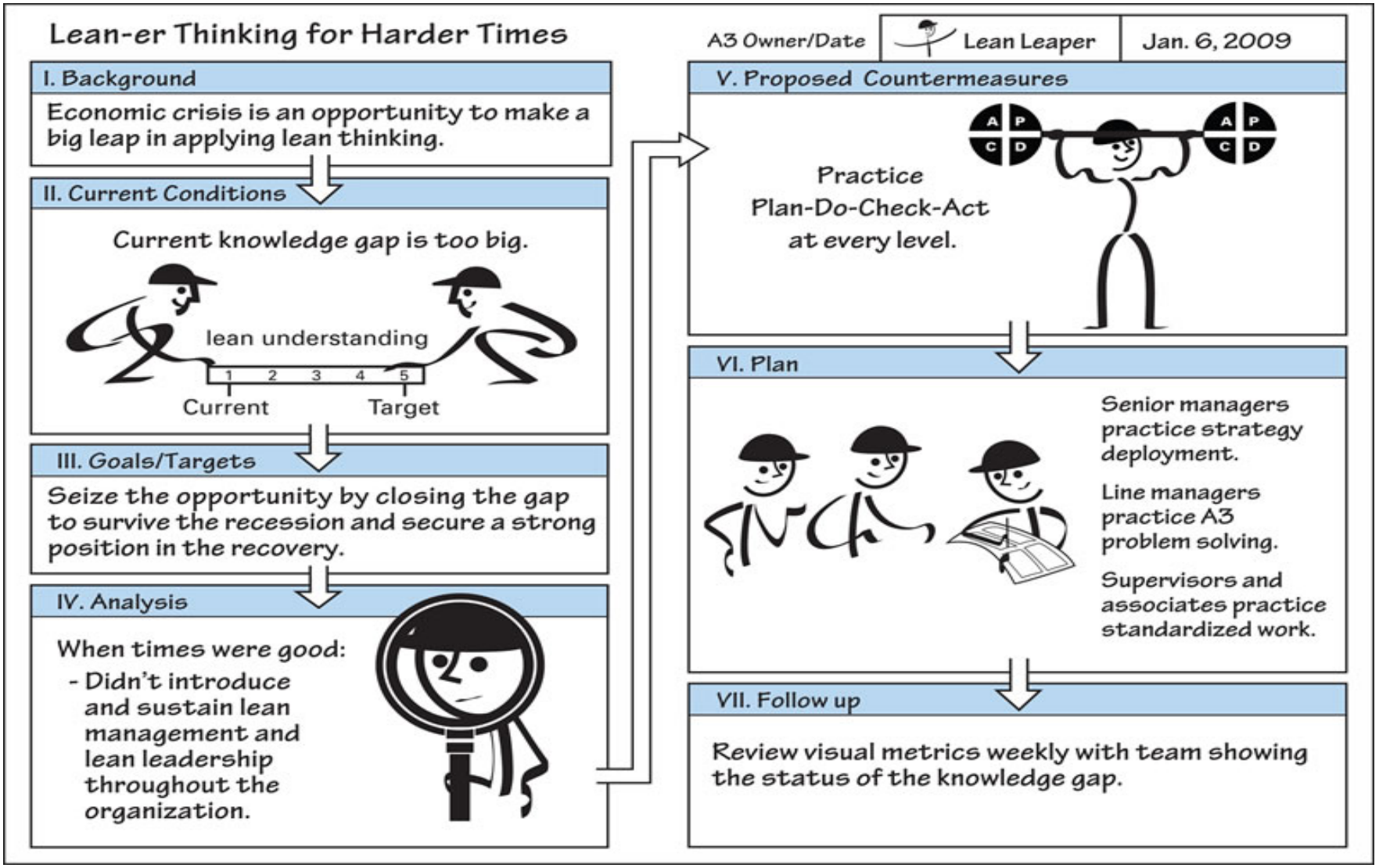


A-3 Kaizen Worksheet

During a Kaizen Event a worksheet is used, showing all relevant information on a single piece of A-3 size paper:

- **Background**
- **Current Conditions**
- **Goals / Targets** using SMART criteria.
- **Analysis** of the problem perhaps using the 5 W's (*what*, *where*, *when*, *why*, *who*), 2H's" (*how*, *how many*), and root cause analysis.
- **Proposed Countermeasures**
- **Plan** showing who is to do what, when, and implement plan.
- **Follow Up** after implementation to check the effectiveness of the solution.

Example A-3 Problem Solving Sheet



Lesson 11: Data Gathering and Mapping

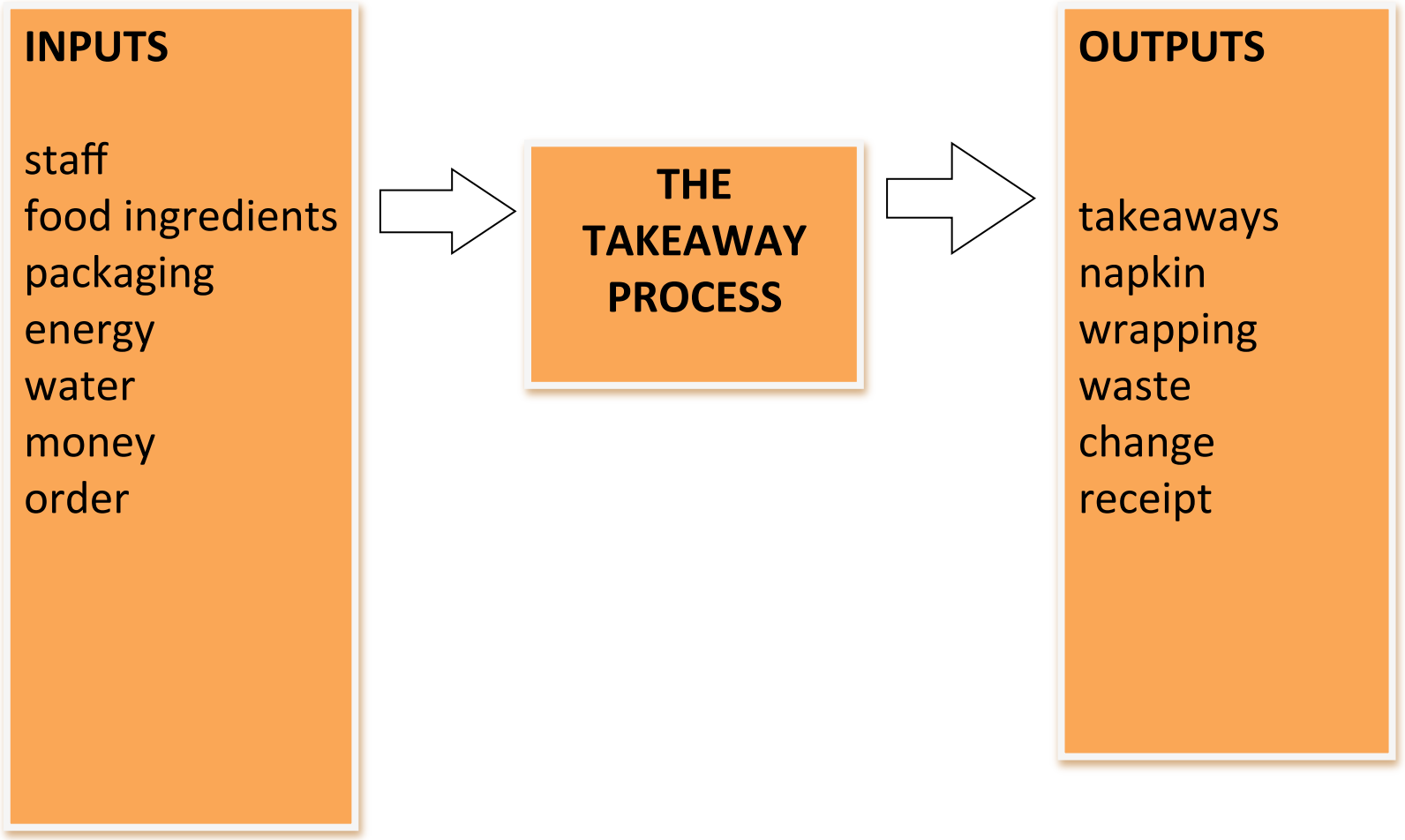
Lean data tools, including flow charts, Ishikawa (cause and effect or fishbone) diagrams, SIPOC charts, value stream maps, and data analysis.

Process Exercise

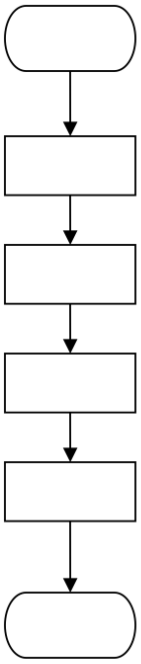
Part of an organisation's supply system is the order-filling process that turns an order into delivered goods. In what sequence might the following activities occur? Assume there are no resource constraints, which means some activities might be done concurrently. **Draw a plausible sequence using post-it notes and arrows to link the activities:**

- Invoicing
- picking
- packing
- despatching
- replacing stock
- receiving payment
- receiving order
- checking credit
- updating ledger
- providing receipt

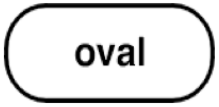
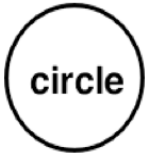
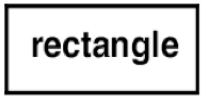
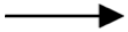
Process Inputs and Outputs



SIPOC Chart

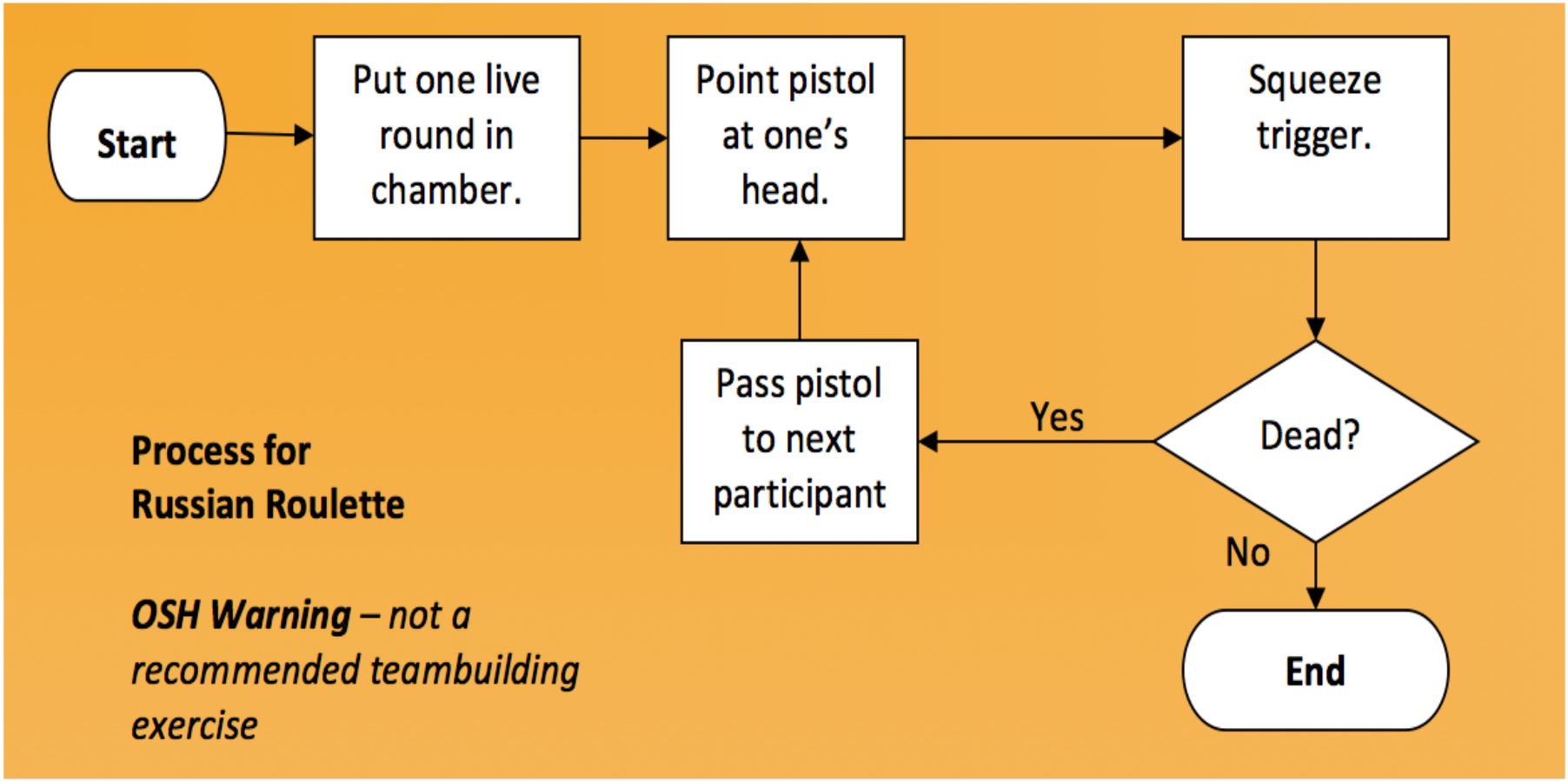
SIPOC CHART				
Process Name:			**Date:**	
Process Purpose:				
SUPPLIERS	**INPUTS**	**PROCESS**	**OUTPUTS**	**CUSTOMERS**
				

Flowchart Basic Symbols

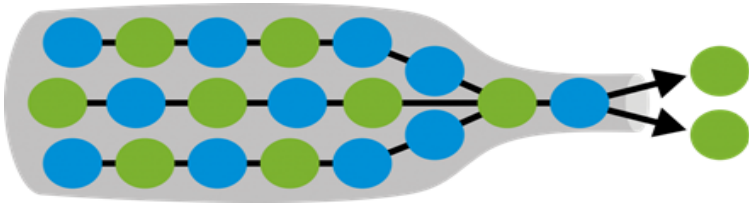
	Oval shape for start or end or a process (eg, bell rings). Trigger activity or terminator.
	Circle means 'go to' next page, process, or level of detail. It's a connector. Drill-down facility.
	Rectangle is an activity, usually described in verb-noun format (eg, phone customer). Might include identification code.
	Diamond shape denotes a decision box, including a 'closed' question with two or three options (eg, does the machine work?). Yes route usually out of the bottom. Yes/No Go/No Go True/False
	Arrow shows the direction of flow from one activity to the next.

Example Flowchart

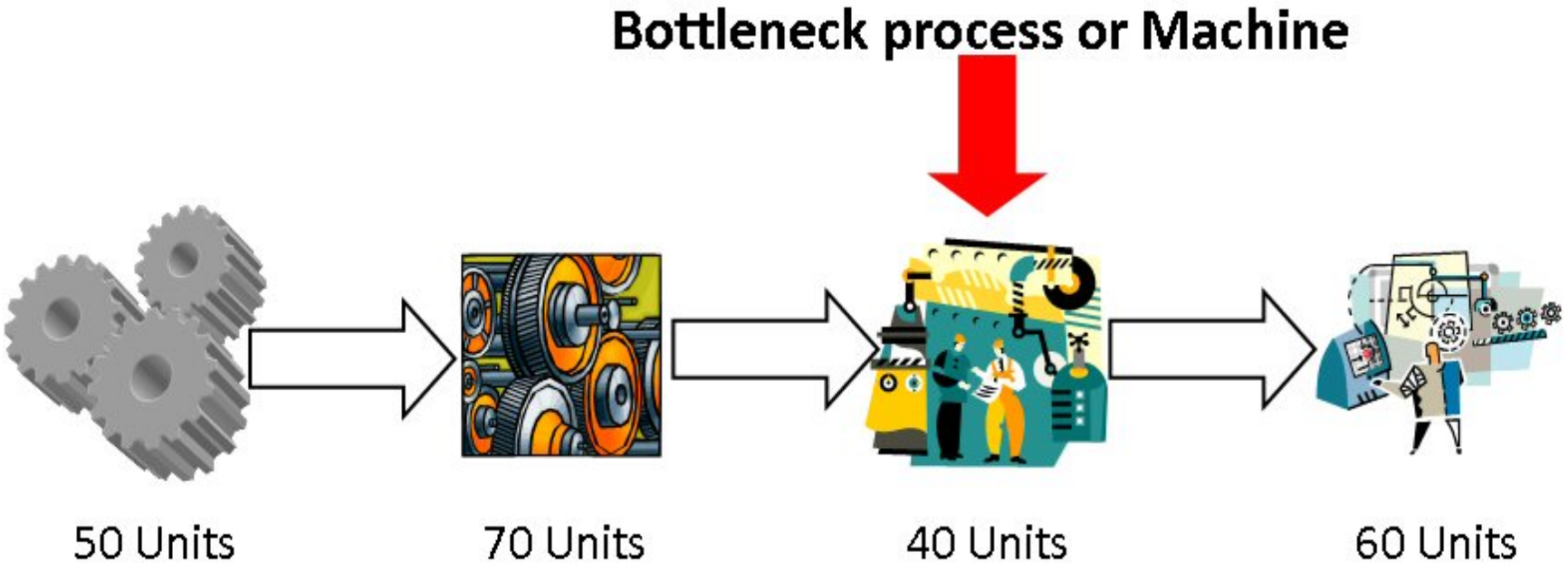
Where is the mistake ??

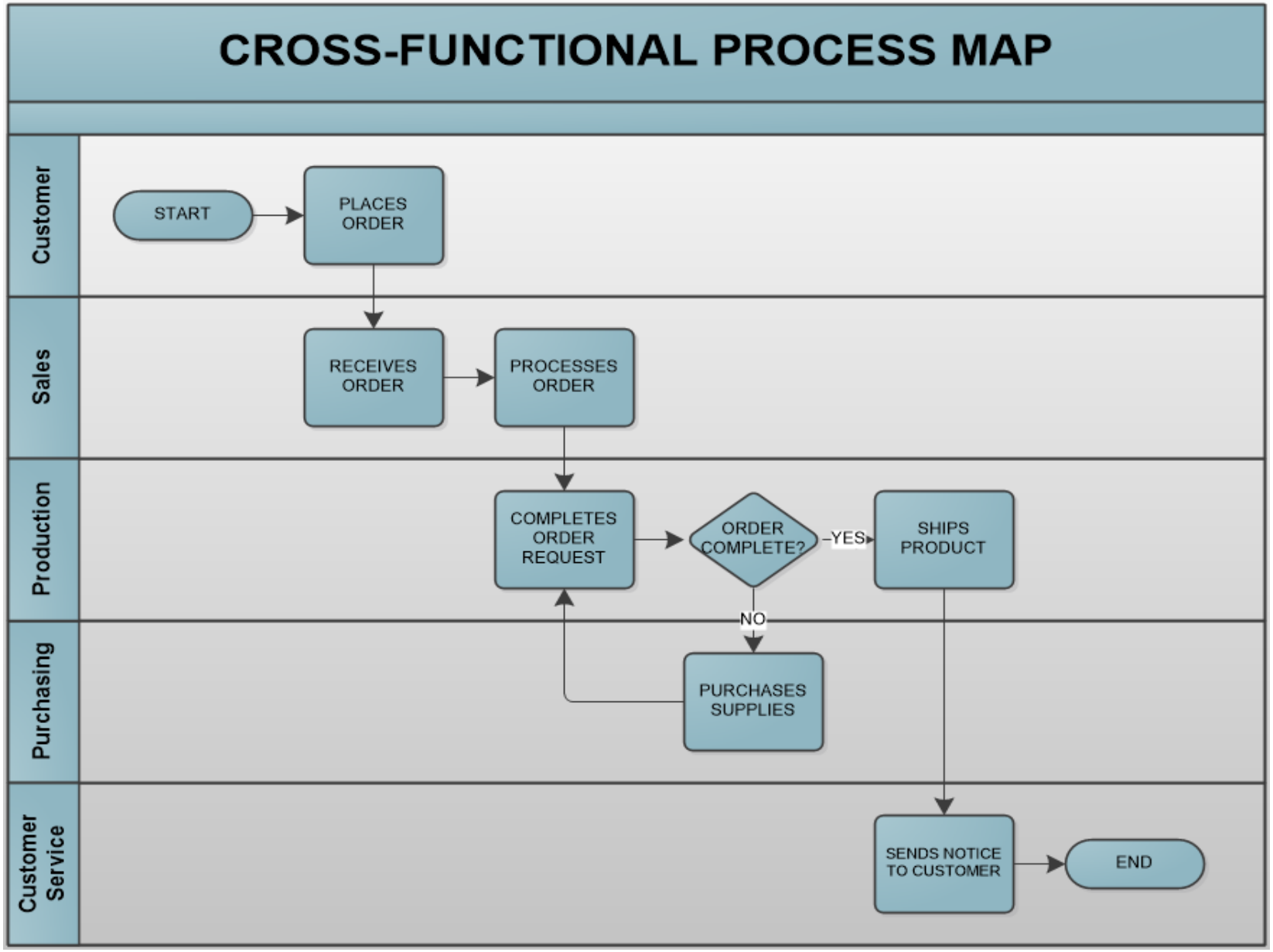


Process Bottlenecks



A process bottleneck determines the process capacity.
In what two basic ways might this bottleneck be resolved?



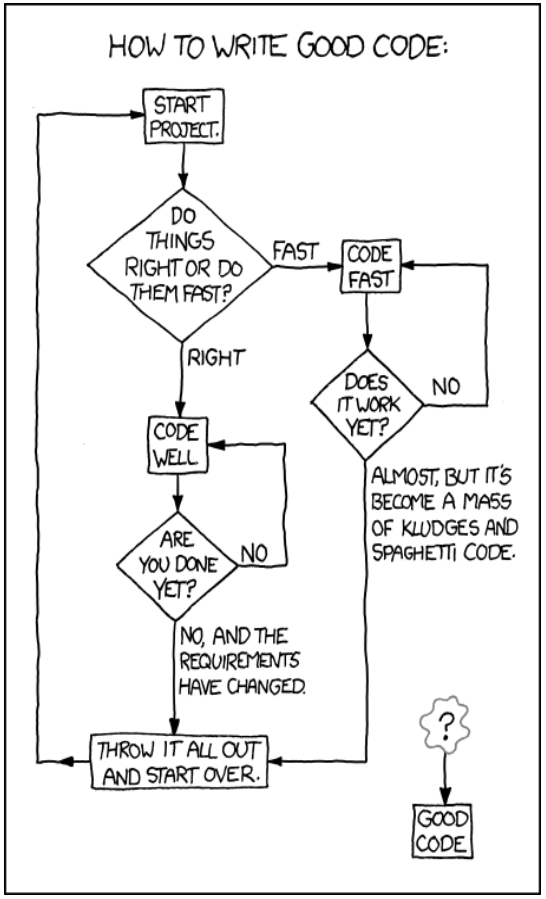


Cross-functional Flowchart Design

- Swim lanes show responsibilities, which might be individuals, groups, or functional areas.
- Diagram may have vertical or horizontal swim lanes.
- Usually the customer swim lane is the top one.
- Arrows pin-point where responsibilities are transferred.
- Flowcharts might be ‘as-is’ and ‘to-be’.
- Sometimes flowcharts are called blueprints.
- Process cycle time is determined by longest pathway from start to finish.

A Cross-Functional Flowchart or Process Map

Preparing a Flowchart



- State process name and purpose at top of diagram.
- Use simple language. Verbs-noun tasks.
- Process steps usually flow top to bottom and left to right.
- Draw arrows vertically or horizontally.
- Post-it Notes often useful to develop flowchart.
- Avoid arrows crossing where possible.
- Keep process updated. Record version/date.
- Include performance measures (KPIs).
- Document any process assumptions.
- Process steps/activities might be codified.
- MS Visio – a diagramming and graphics application is useful.

Flowchart Exercise

Develop a flowchart based on the following description about turning on the television set:

- First step after "Start" is "Switch on TV".
- If the picture comes on, check the quality of the picture. If the picture is good, watch the programme. However, if the picture is no good adjust controls. If the picture is still unsatisfactory, call the TV repair service.
- If after switching on the TV, the picture does not appear, check that the TV is plugged in. If it is, then call the TV repair service. If the TV is not plugged in, plug it in and check if the picture appears. If it doesn't appear call the TV repair service. If the picture does appear, check whether or not the picture is good. If the picture is good, watch the programme. If the picture isn't good, call the TV repair service.

Flowchart Exercise: Airport Security Screening

Prepare a flowchart to show the activities and decisions that should in your opinion occur during a passenger security check from when passenger profiling may occur in the queue at the screening point until the passenger enters the sterile departure lounge, unless of course they need to be detained. Don't show the disposal of relinquished items.

You have four people to employ as a screen team. An x-ray unit and a magnetometer have been properly set up. The process should map all main activities including physical searches if unauthorised, unidentified or suspicious items are detected by x-ray, magnetometer or hand-held metal detector (wand).

Document your process assumptions, performance targets, and suggest those passengers to be excused the process, if any.

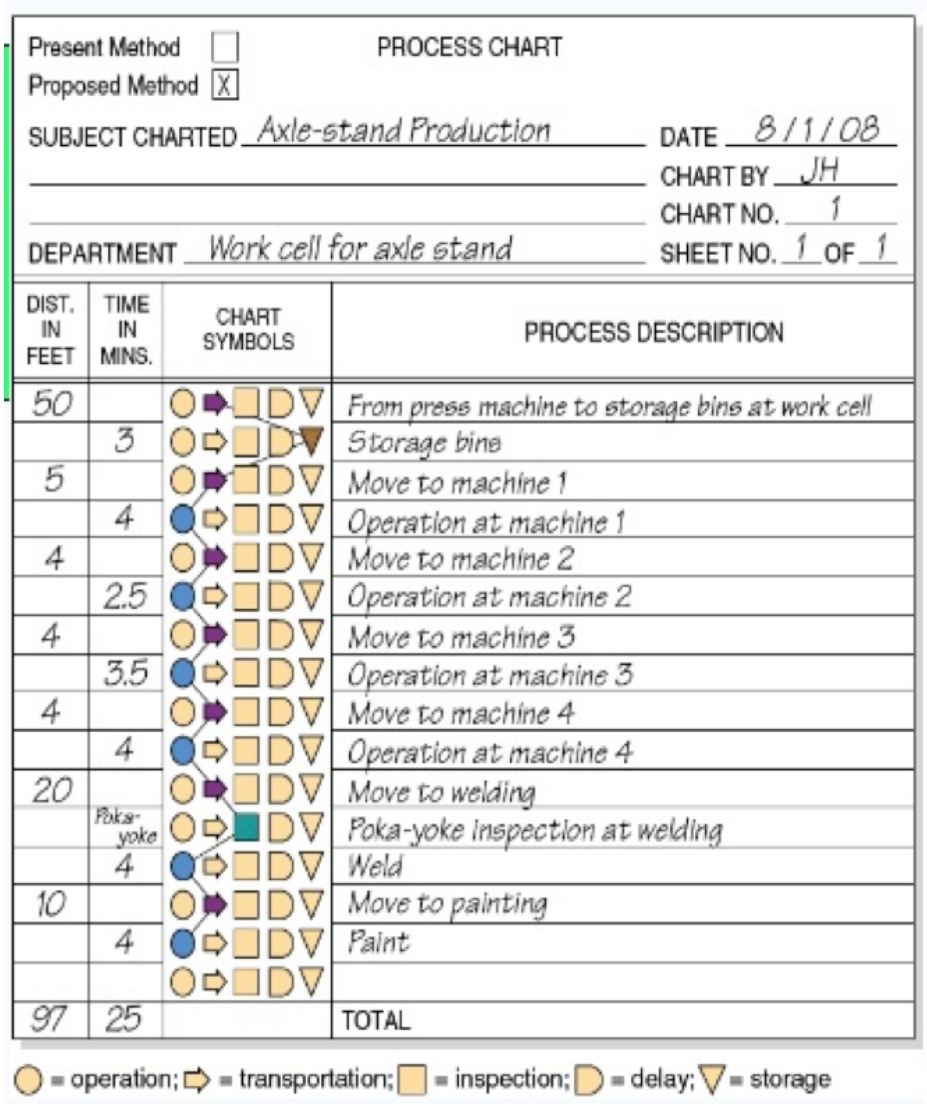
Flowchart Design Exercise

"Whatever the outcome of police enquiries, we are unlikely ever to get to the bottom of the muddled account of who noticed Coral Burrows was absent, who put a tick marking her absent in this or that column, who would have contacted her mother to ask where she was. It's been a stuff-up. The buck has to stop somewhere, and in this case it stopped with South Featherston School's board of trustees. They were responsible for ensuring that a foolproof process was in place to identify Coral's absence and telephone Coral's family. There was no suitable process."

Sunday Star Times Editorial 21 September 2003

Your job is to develop a fool-proof, preferably idiot-proof, best-practice process illustrated by flowchart that shows how a child's absence from primary school is to be reported. Please include such activities as speaking to siblings (if any) and checking the school grounds. And what to do if no one answers the phone at home. Once completed you should analyse your process from a risk perspective and make changes where appropriate to prevent such potential process problems. **It could be your child!**

Process Chart



Present Method [ ] PROCESS CHART
Proposed Method [X]

SUBJECT CHARTED Axle-stand Production DATE 8/1/08
CHART BY JH
CHART NO. 1
DEPARTMENT Work cell for axle stand SHEET NO. 1 OF 1

DIST. IN FEET	TIME IN MINS.	CHART SYMBOLS	PROCESS DESCRIPTION
50			From press machine to storage bins at work cell
	3		Storage bins
5			Move to machine 1
	4		Operation at machine 1
4			Move to machine 2
	2.5		Operation at machine 2
4			Move to machine 3
	3.5		Operation at machine 3
4			Move to machine 4
	4		Operation at machine 4
20			Move to welding
	Poka-yoke		Poka-yoke inspection at welding
	4		Weld
10			Move to painting
	4		Paint
97	25		TOTAL

○ = operation; ⇨ = transportation; □ = inspection; D = delay; ▽ = storage

The Value Stream

- The value stream includes all of the activities, materials, people, and information required to transform a customer request into a good or service with the value they want, when they want it and how they want it.
- Value Stream Mapping is used to analyse the flow of materials and information. We improve the value stream by removing waste.

Value Stream Principles

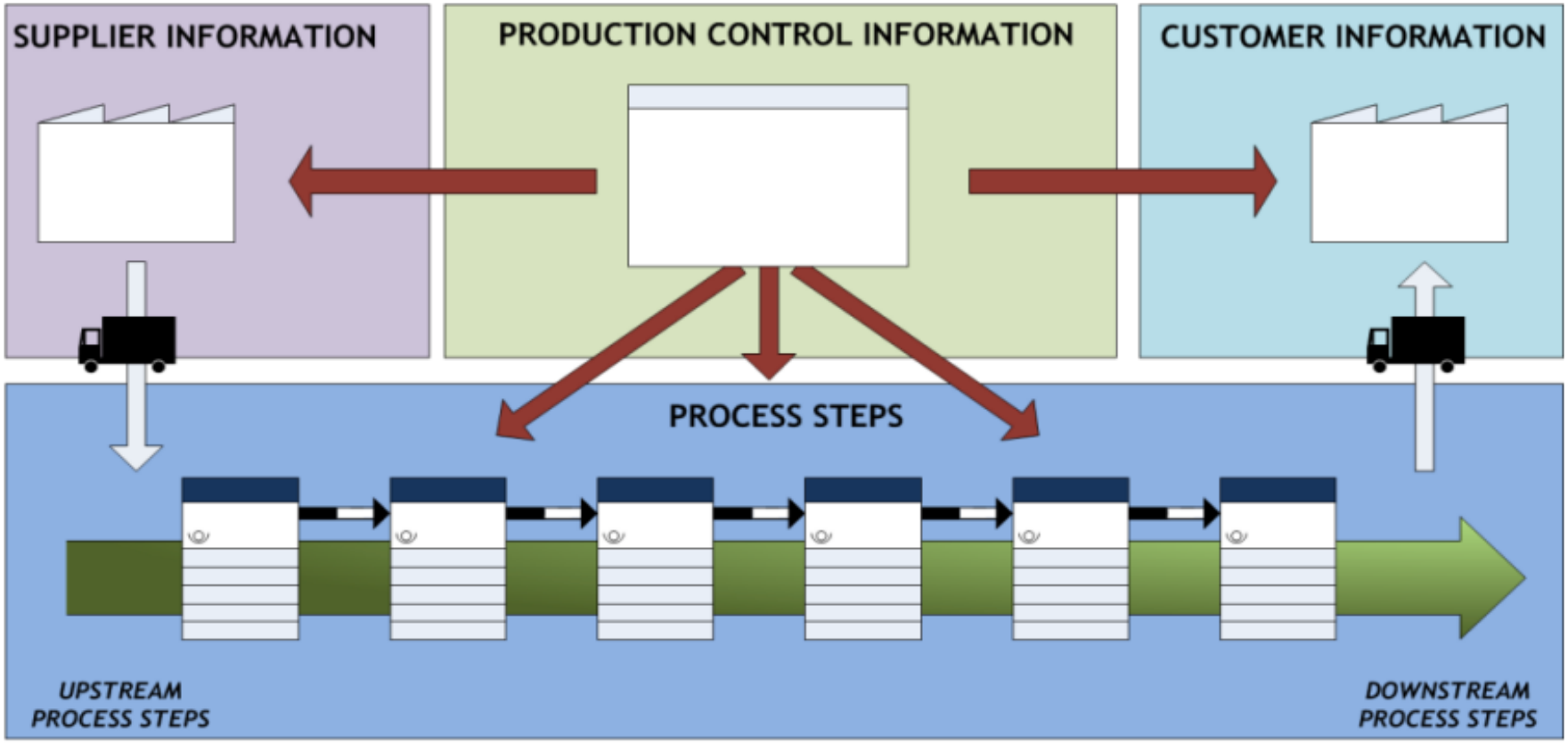
1. Specify value from the standpoint of the end customer by product family.
2. Identify all the steps in the value stream for each product family, eliminating whenever possible those steps that do not create value.
3. Make the value-creating steps occur in tight sequence so the product will flow smoothly toward the customer.
4. As flow is introduced, let customers pull value from the next upstream activity.
5. As value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, begin the process again and continue it until a state of perfection is reached in which perfect value is created with no waste.

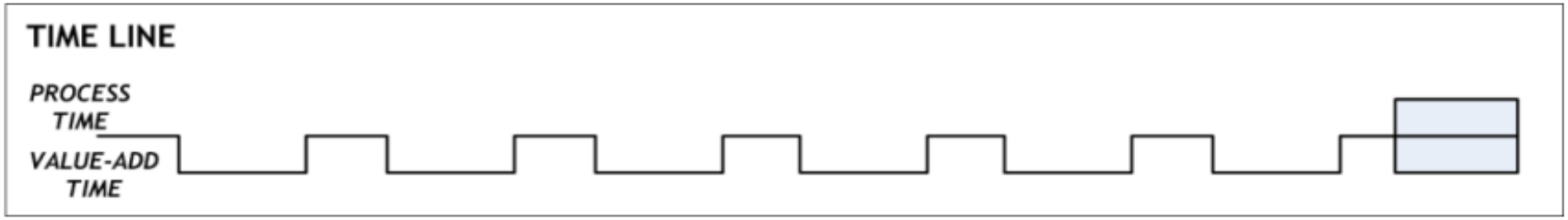
Value Stream Mapping Process

On average, less than 10% of what we do adds value to the customer. Value Stream Mapping (VSM) is a key technique in the lean toolbox, which focuses on which steps in a process add value and which don't. Identify the target product or process.

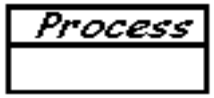
1. Define the scope of the mapping project and prepare a charter.
2. Map the "as-is" process using Post-It Notes.
3. Collect relevant process data such as demand rate, batch size, number of operators, inventory size, cycle time, changeover time, rework, uptime %, time and run frequency.
4. Design an improved "to-be" state by eliminating waste, redrawing the map and calculating the reduced total product cycle time.
5. Implement a project plan to implement the improved process.
6. Repeat the process every 3-6 months.

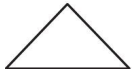
Value Stream – Key Elements

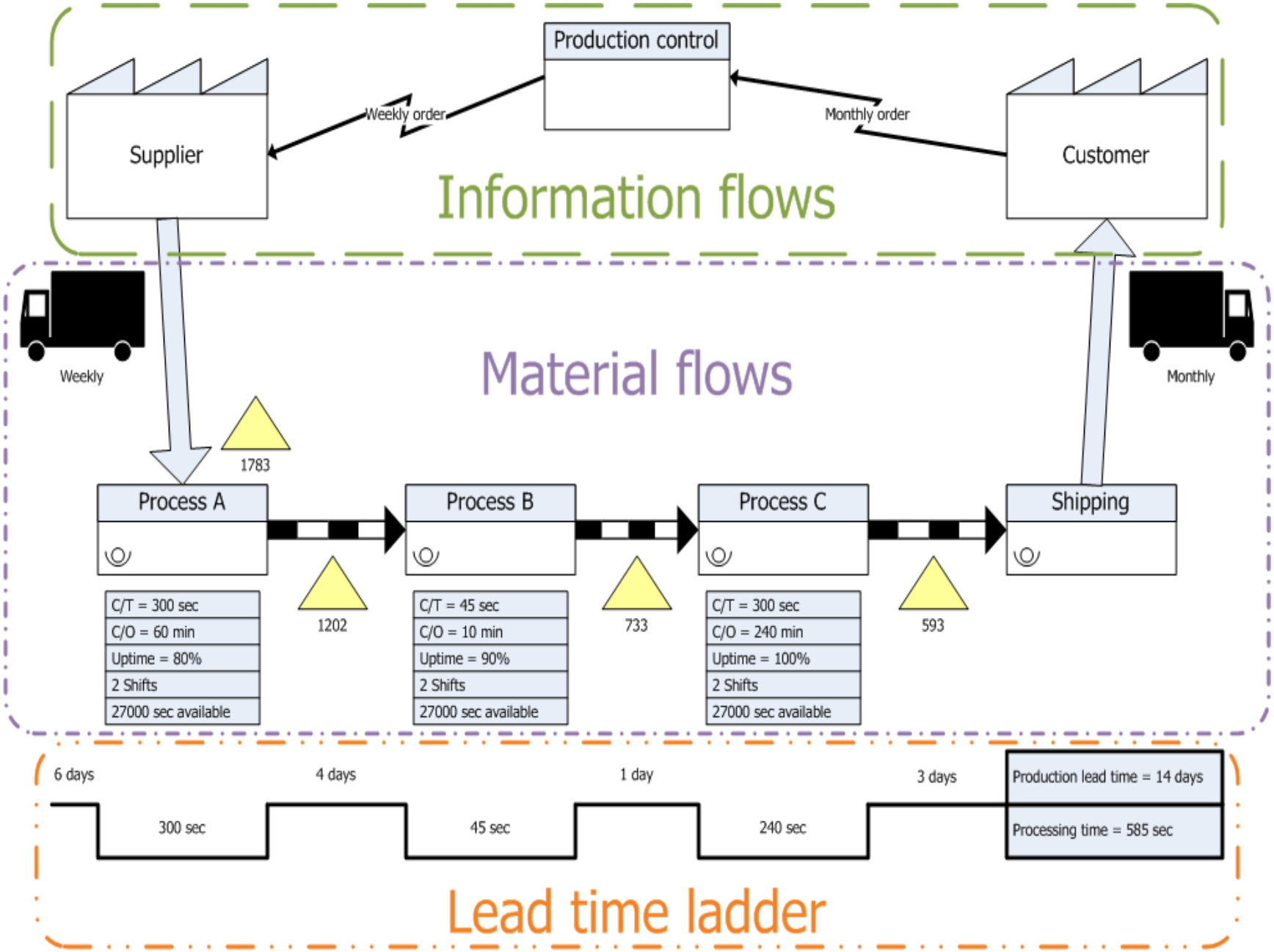


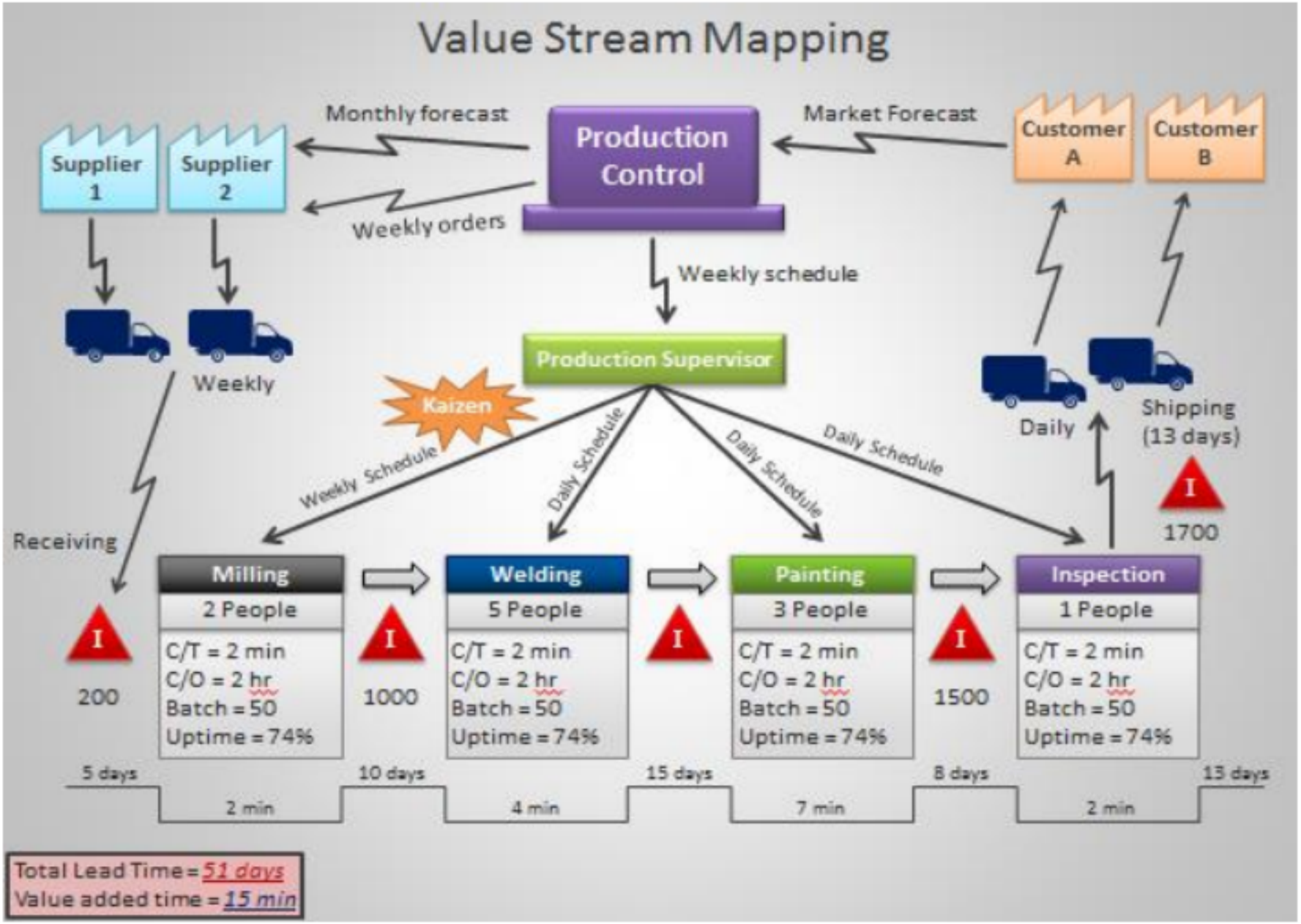


Value Stream Symbols and Abbreviations

- Customer or Supplier 
- Process 

- Push Arrow 
- Shipments 
- Operator 
- Inventory (buffer/units waiting) 
- C/T or CT = Cycle Time
- C/O or CO = Process Changeover Time
- BS = Batch Size Uptime = machine in use time





Little's Law

John Little's Law captures the relation between Flow Time (T), Throughput Rate (R) and Work-in-Progress (WIP) (average inventory within the process), where:

$$WIP = R \times T \text{ or } T = I/R.$$

Thus, if we know any two of these variables we can determine the third. For example, a manufacturer has throughput of 30 units/hour, and it takes 0.5 hours for a unit to go through the process. On average, how many units are in the process?

$$I = R \times T = 30 \text{ toys/hour} \times 0.5 \text{ hours} = 15 \text{ toys}$$

Application of Little's Law leads to waste elimination and smoother material flow. However, process use must be less than 100% or else the line will grow to infinity – "WIP Explosion!"

Process Analysis: Example of Little's Law

At the cafe, people arrive at 30/hour. On average there are 8 people waiting in the queue to be served. Once an order is placed, it takes an average of 5 minutes to be served. Given these figures we can determine those figures shown in red. To speed the process we need to reduce waiting time (buffer).

Action	Inventory	Throughput (Number/Hour)	Throughput Number/Minute	Flow Time (Minutes)
Waiting (Buffer)	8	30/Hour	0.5 Minutes	16
Being Served (Activity)	2.5	30/Hour	0.5 Minutes	5
Totals	10.5	30/Hour	0.5 Minutes	21

Value Stream Mapping Projected Results

Metric	Current State	Projected Future State	Projected % Improvement
Lead Time (Request to Invoice Duration)			
Actual Process Time			
Percent Activity			
Number of Handoffs			
Labour Effort (Total Person Hours of Work)			
Freed Process Capacity			
Freed Process Capital $			

Lesson 12: Lean Implementation

1. Introduce lean training to ensure a basic understanding of the principles and tools involved.
2. Identify which aspects of the business most need improvement.
3. Understand the customer requirements and how they are at present being met (or are not being met).
4. Map the selected value stream.
5. Implement improvements and measure their impact on the business.

My Improvement Plan (MIP)

- CHALLENGE: What is the existing method or work process I want to improve?
- IMPROVE: What is not working in the existing method or process? Describe flaws and quantify if possible. How will the methods and process work with your proposed change?
- GENCHI: What observations have you done by going to the source of the problem in your project?
- RESPECT: List who is affected by the change you are proposing. Consider how they could be involved.
- TEAM WORK: Review your list of individuals above. Who can you work with to implement the change swiftly

Behaviours of a Lean Leader

- They understand what their customers value.
- They improve the effectiveness of how the business satisfies the customer.
- They their people in the process of planning, problem solving and decision making, challenging them to participate actively in fixing issues and improving processes.
- They continually challenge the status quo.
- They focus on process and results.
- They understanding the value stream.
- They model Lean behaviours.
- They find lessons in every “failure” knowing that blame does not foster improvement or innovation.
- They respect standards and question when the organisation is deviating from those standards

Lean Implementation Fears

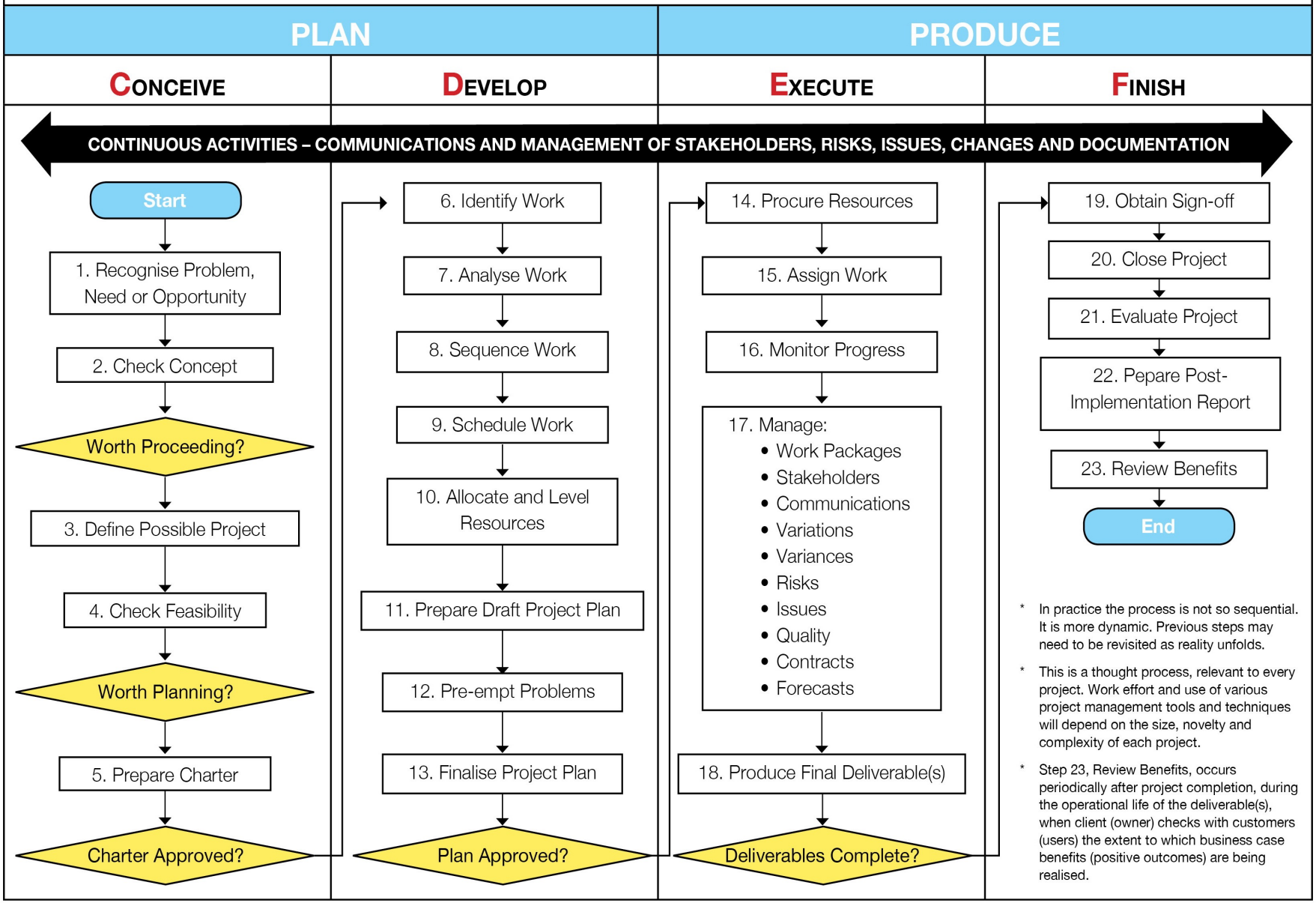
- Fear that the constant focus on improvement and elimination of waste becomes an obsession that causes stress to the workforce.
- Fear that standardised work methods will be dehumanising.
- In a JIT system, traffic jams and other issues can delay the arrival of supplies and thereby hold up production.
- Being human, employees might have some days where they do not work at their productive best.
- If one individual on the workforce fails to adopt lean practices, the entire Lean system could be jeopardised.
- When Lean benefits start emerging in terms of efficiency, workers may start sensing the risk of losing their jobs.
- To cut inventory, Lean requires frequent deliveries from suppliers, but this volume of traffic may be uneconomical for suppliers.
- "Humble people who want to learn" translated from Orwellian language to normal language means "Obedient people who will do as they are told." Lean is just a sweat shop.

Project Management Principles

Introducing Lean is a project. While these project management principles may not guarantee success, we ignore them at our peril:

1. Regularly reappraise the justification for our project.
2. Have a sponsor who gives us clear direction and support.
3. Agree and unambiguously define roles and responsibilities.
4. Communicate with stakeholders early and often.
5. Use a disciplined approach from start to finish (next slide).
6. Pre-empt problems and address issues promptly.
7. Check progress regularly and take timely corrective action.
8. Manage change to ensure effective adoption.
9. Remember ultimate project success is benefits realised.
10. Capture lessons and learn from each project.

GENERIC CDEF PROJECT MANAGEMENT LIFECYCLE



Thanks very much for your attention and all the best implementing Lean.

Keep on improving!