The LeanMan

Lean Factory Simulation Kits

Lean Principles

Training Guide

The Evolution of Lean

Lean Factory Simulation Kits

WARNING – KIT CONTAINS SMALL PARTS.

KEEP AWAY FROM YOUNG CHILDREN

Lean Mfg.

- A Few Definitions of Lean Manufacturing:
  - **Lean Production** (a term coined by IMPV researcher John Krafcik[1]) is “lean” because it uses less of everything compared with mass production - half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time.
  - Also, it requires keeping far less than half the needed inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products.

[1] [*The Machine That Changed The World (New York: HarperPerennial, 1991)*]

Lean Mfg.

- A Few Definitions of Lean Manufacturing:
  - **Leanness** (as in lean mfg.) is concerned with doing everything with less. Less waste, less travel, less space, less excess inventory, less cycle time, etc.
    - This definition is useful for learning to see the value stream, and to learn to distinguish value-adding from non value-adding activities.
    - The transition from Batch ‘n Queue to Lean Pull-Demand teaches the value of streamlining the process, and thus eliminating the waste.

Lean Mfg.

- A Few Definitions of Lean Manufacturing:
  - **Lean manufacturing** is being very good at doing the things you can control.
    - This definition is useful for learning to see the advantage of flexible cross training.
    - The simulations teach the team to see how non value-adding activities such as kitting and de-kitting materials can be eliminated by establishing point of use inventories.
    - Much of the waste of waiting, transportation, and storage can be eliminated by embedding operations in-line to the process that may otherwise be treated as outside process steps.

Lean Mfg.

- A Few Definitions of Lean Manufacturing:
  - **Lean initiatives** embrace doing everything with less, and concentrating on speed.
    - This definition is useful for learning to think lean, and to use those thoughts in making daily *good* decisions.
      - Focus on what you can control and do those things well.
      - Take under your own control everything you can.
      - Provide contingency planning for those things that must remain outside your control.
      - Use Kaizen events to listen to the voice of the many.
      - Keep changes within reason and share the rationale.
      - Keep driving for continuous improvement.

Lean Mfg.

- A Few Definitions of Lean Manufacturing:
  - **Lean is all about timing**, and time has become the key performance driver of manufacturing strategies for high performance companies.
    - This definition is useful for learning to see the advantages of very short cycle times, and the ability for production to track sales closely.
      - The initiative of build only what is sold, not forecast, eliminates the waste of overproduction.
      - The initiative of very short mfg cycle times (conversion of raw material to finished goods) satisfies the increasingly short lead times expected by the marketplace.

Lean Mfg.

- So What is Lean?
  - **Lean Is:**
    - "***A philosophy***" - Of producing what's needed, when it's needed with the least amount of resources at the pull of the customer
    - ***"A Methodology"*** - To see the value stream through a new set of eyes and to identify and eliminate waste in a structured and proactive approach
    - "***A set of tools***" - That can be deployed across the entire business enterprise to objectively assess the current state, and to continuously improve
  - **Lean is not:**
    - Just one piece flow
    - Just for the factory

Lean is enterprise wide Value Stream improvements

Batch ‘n Queue Mfg.

- Manufacturing History
  - The Existing Culture of Manufacturing, often referred to as *batch and queue*, dates back to 1911 when Frederick Winslow Taylor published his studies[1] on how individuals should perform work.
  - Taylor observed the activities of workers who shoveled coal in steel mills in Bethlehem, PA. He analyzed the movements of the most efficient workers, determined the optimum size shovel for the density of the material to be transferred and level of exertion required with each shovel full, and then set a pace that provided consistent transfer of material over the entire work day.
  - Taylor demonstrated that it was possible to increase efficiency of production without variation due to worker fatigue and without investing in new equipment.

[1] [*The Principles of Scientific Management (New York: Harper & Brothers, 1911)*]

Batch ‘n Queue Mfg.

- Taylor’s *One Best Way*
  - Taylor’s application of scientific principles to how work is performed became known as the ‘One Best Way’ process. This scientific method became the basis for industrial engineering.
  - Taylor’s theory claimed any large organization could be broken down into functional divisions, each division into departments, and each department into functions which could then be more easily analyzed and optimized for some valued metric, such as labor cost.
  - The success of Taylor and the industrial engineering movement drove manufacturers to break operations down into functional departments, each dept optimized for it’s own #1 value metric, and each operating to a best way process (or std practice) set in stone.
  - This established the culture for manufacturing well into the mid 1980s.

Batch ‘n Queue Mfg.

- Taylor’s *One Best Way*
  - The concepts taught to industrial engineers, to manufacturing managers, and to line supervisors over the years was to optimize each individual function in a process for it’s own ‘One Best Way.’
  - The idea was that if the individual parts of the operation were each optimal, then the whole of the operation must be optimal. Sort of a ‘blinders on’ approach for each function to focus on self needs.
    - **Machine shops set functions like mills together, all lathes, all drill presses, etc. They then moved large batch jobs of material from one function to the next to optimize the machine run time without regard for other factory costs.**

Batch ‘n Queue Mfg.

- Taylor’s *One Best Way*
  - With this approach, activities across the production area were reviewed and “improved” to optimize each individual activity.
    - **Example, larger work order quantities simplify picking job kits.**
    - **Populating the same component on a large batch of circuit board assemblies all in a row, then the next component and so on, optimizing the workers time and efficiency.**
    - **Keeping a large batch job together minimizes handling.**

Batch ‘n Queue Mfg.

- Taylor’s *One Best Way*
  - While the valued metric is indeed optimized, it comes at a cost. Since each function in the transformation process is optimized for it’s own #1 value, the coordination between functions become dependent upon a mutually agreed upon exchange.
  - Usually, this exchange requires some excess of time, space, and material in a “buffer zone” between the two functions.
    - **Example, if the stock room does cycle count in the first two hours of the day, and picks kits after cycle count is finished, then their first kit of the day is not available until some time around mid day.**
    - **If the assembly operation starts at 6:00 am, then it needs to have kits available to the shop by 6:00 am.**
    - **The optimized solution is to have the kits picked a day in advance and stored in a queue area in the shop.**

Batch ‘n Queue Mfg.

- Taylor’s *One Best Way*
  - As the number of functions in the transformation process increase, the excess of time, space and material is amplified at each exchange if each functional area is to be kept continuously utilized.
  - The time, space and material is further amplified to cover for supply chain delays and material quality problems. Often this excess is called just-in-case inventory.
  - Taylor’s methods can be summarized in the collection known as Taylor’s Rules.

Batch ‘n Queue Mfg.

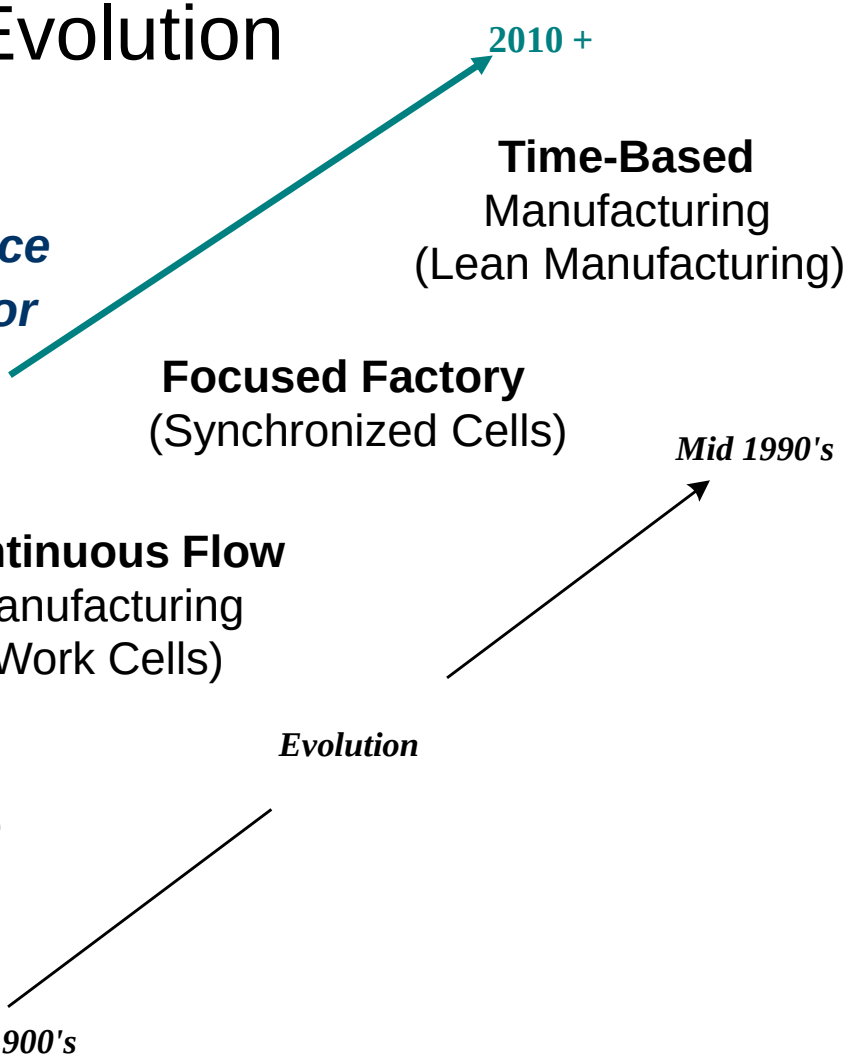
- Taylor’s Rules:
  - **Reductionism**: The decomposition of systems into component parts or elements, which are dealt with in isolation without regard to upstream or downstream processes.
  - **Optimization of Components**: It is believed that optimizing each individual element of the system will lead to optimization of the system as a whole.
  - **One Best Way**: There is only one best way of doing something, and that way is determined thru analysis by educated “outsiders” to the process.
  - **Mechanistic Model of People**: Technology is addressed in a vacuum, without regard for people. The assumption is people are only motivated by financial reward and are therefore nothing more than complex machines to follow rigorously the “best way” process.

Batch ‘n Queue Mfg.

- Taylor’s rules:
  - **Hierarchical Centralized Style**: Everyone is an employee and employees do what they are told. Employees are not expected to question decisions or contribute their experience to the decision-making process. Decisions should be taken centrally by an elite few, the rest are to just follow instructions.
  - **Separation of Thinking and Doing**: Everything that needs to be done can be worked out through analysis. There is no need to pay attention to experience, tacit knowledge, intuition, and so on. The one best way will be provided.
  - **Individual Reward for Individual Effort**: Reward people for what they do as individuals, not for what they do as part of a team.

Manufacturing Strategy Evolution

Time has become the key performance driver of manufacturing strategies for high performance companies.



Lean Mfg.

- Why do Lean Manufacturing?
  - The concept that Taylor's approach missed was that while improving the process steps at the individual level, it was creating havoc on the overall door-to-door process of the whole. The assumption that the whole of the operation would, by default, become optimized was *wrong* !
    - **Large work order kits cause huge amounts of material to stack up in queue areas waiting for someone to touch it, and take up large sections of floor space with holding racks.**
    - **Populating all circuit cards in parallel cause the subsequent workers in the process sequence to have to wait, which lengthens cycle time, causing customers to have to wait weeks.**
    - **Keeping large batches of material together causes excess inventory at each stage in the process, which consumes vast amounts of working capital ($$$) tied up sitting in the shop.**

Lean Mfg.

- Why do Lean Manufacturing?
  - Another concept of Taylor was supervisors “think” and workers “work.”
  - The lean visionaries in the early 1980’s based their ideas on the concept that workers actually could think, and in fact often did. The revolutionary idea was that someone who ran a process day in and day out just might know a thing or two more about how the process should run than some industrial engineer who occasionally dipped his toes in when there was a problem.

Lean Mfg.

- Why do Lean Manufacturing?
  - Workers who apply lean concepts in their daily duties very often think of better ways to operate their process. Instead of the 'One Best Way' handed to them by an industrial engineer, they continually come up with '***One Better Way***. '
  - This isn't to say that shop operations should be a free-for-all, but with mutual respect and a common goal both the worker and the engineer should be able to make continuous improvements together.
  - Taylor's idea of documenting standard work wasn't wrong; it was the execution of holding the document unchangeable that held back the potential for continuous improvements.

Lean Mfg.

- Evolution into Lean Thinking
  - Some of the concepts developed by Taylor are actually part of today's lean thinking. Like organizing the know-how of those workers who can perform a task efficiently and promote sharing of knowledge. Only lean lets the worker voice their ideas for change and not just demonstrate the process.
  - Another Taylor concept was the idea that increasing physical effort was fruitless; the required solution was to work more effectively using known effective methods. To understand this effort required task analysis, task observation, the seeking of ideas, and experimentation.

These are the things we do in a Kaizen event!

Lean Mfg.

- Evolution into Lean Thinking
  - The result of analysis is what Taylor called standard work, to which he believed the workers must rigorously abide to assure both cost and quality. This is consistent with the lean requirement of discipline to the agreed upon flow. Standard work is still part of lean, but it includes a mechanism for recognizing continuous improvements offered up by the team.
  - Continuous improvement should not be the act of letting everyone work according to his own notion, but instead should be an act of collective team consensus to remove barriers to success.

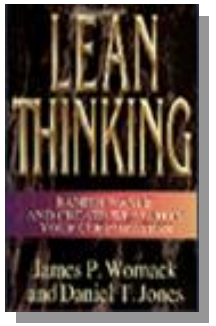
Lean Mfg.

- Evolution into Lean Thinking
  - Lean manufacturing looks at the production process with a different set of eyes from those relevant during the last 100 years.
  - Lean looks at the entire transformation process from door-to-door and attempts to optimize for the good of the whole, rather than the good of the individual.
    - **Picking kits from a point of use area gives maximum control of the timing of the process to the team.**
    - **Building in one piece flow quickly feeds work to all members of the team, not just one person.**
    - **One piece can move at a higher velocity to Finished Goods, satisfying the customer's need for product faster.**
    - **Faster flow enables the shop to build only what is sold, holding WIP Inventory and finished goods at a minimum level.**

Lean Mfg.

- Five Principles of Lean
  - Specify **Value** of the Product
  - Identify the **Value Stream** for Each Product
  - Enable the Products to **Flow** Without Interruptions
  - Allow the Customer to **Pull** Value From the Stream
  - Continuously Improve … Pursue **Perfection**

Lean Thinking : Banish Waste and Create Wealth in Your Corporation by James P. Womack, Daniel T. Jones



Lean Mfg.

- Lean Principles

Traditional Manufacturing	Lean Manufacturing
Infrequent Set-ups and Long Runs	➔ *Quick Set-ups and Short Runs*
Functional Focus	➔ *Product Focus*
If It Ain't Broke, Don't Fix It!	➔ *Fix It So It Doesn't Break*
Specialized Workers	➔ *Multi-functionally Skilled People*
Good Enough	➔ *Never Good Enough*
Run It - Repair It	➔ *Do It Right the First Time*
Layoff	➔ *New Opportunities*
Management Directs	➔ *Leaders Teach*
Penalize Mistakes	➔ *Retrain*
Make Schedule	➔ *Make Quality*

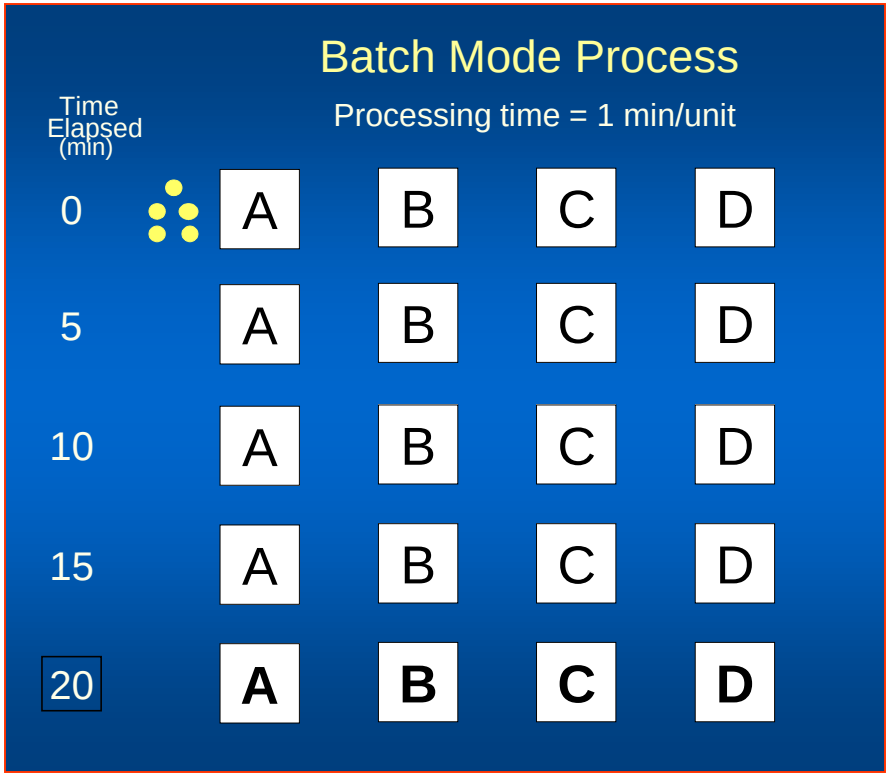
Lean Mfg.

- Lean Principles

Traditional Manufacturing	Lean Manufacturing
Delegate	➔ *Support*
Fear Failure	➔ *Taste of Success*
Inspect Defects Out	➔ *Manufacture Quality In*
Push Systems	➔ *Pull Systems*
Fix Blame for Problems	➔ *Problems are Opportunities*
Not Invented Here (N.I.H.)	➔ *Creative Idea Sharing*
Superstars	➔ *Teamwork*
We/They	➔ *Support at the Source*
Results Focus	➔ *Process Focus*
Best for Me	➔ *Best for Customer*

Batch ‘n Queue Mfg.

- Taylor’s Manufacturing Flow

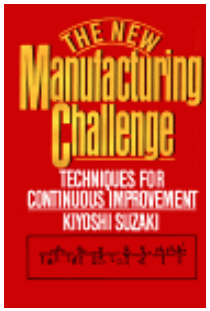


1st Piece moves to next process in 5 minutes, last operation complete in 20 minutes

A, B, C and D are different operations in the process

The typical Batch ‘n Queue “push” process flow.

Note the idle time of each functional area waiting for material to arrive, and also note the amount of material at each function “untouched” while each piece is individually processed.



Reference: New Manufacturing Challenge: Techniques for Continuous Improvement by Kiyoshi Suzaki

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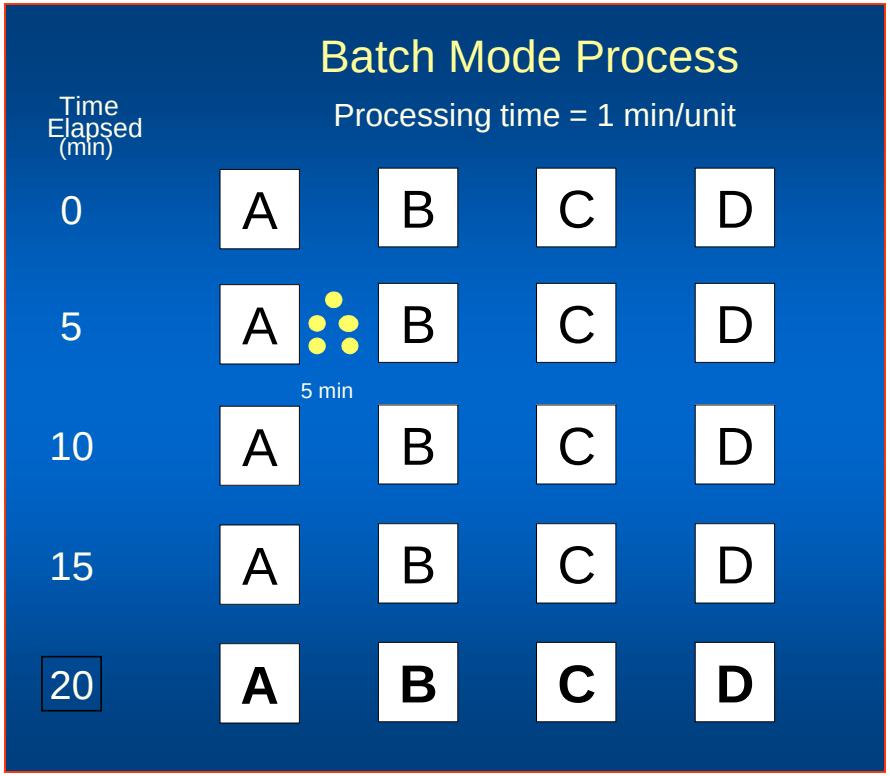

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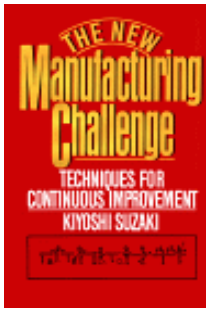

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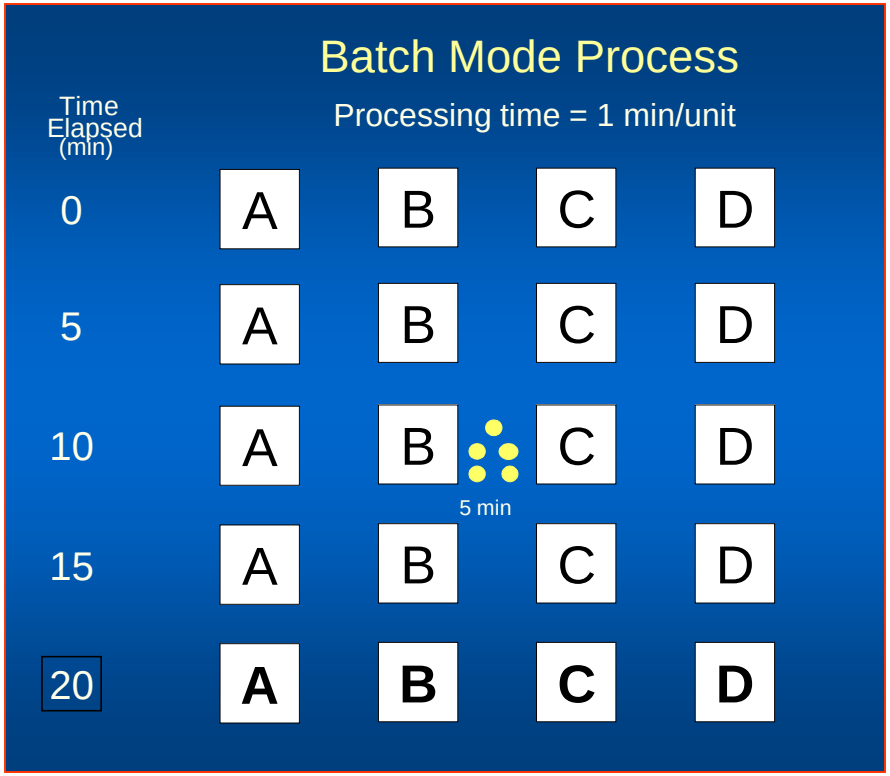

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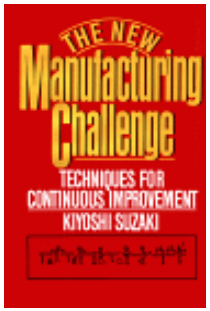

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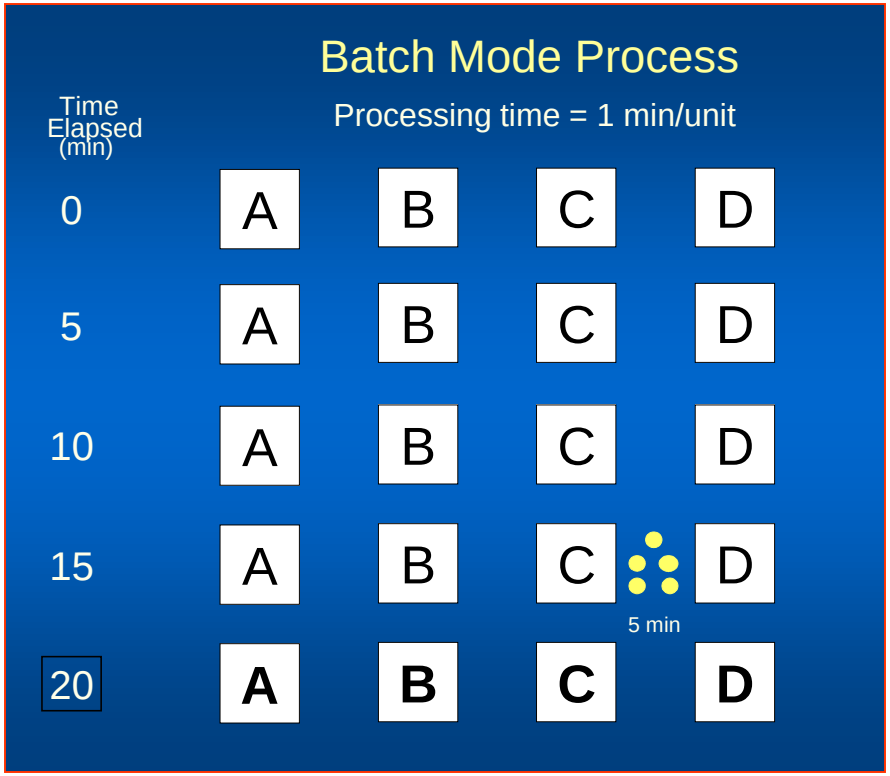

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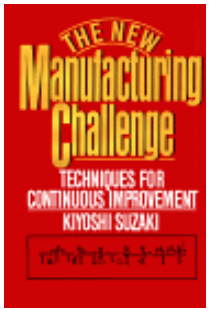

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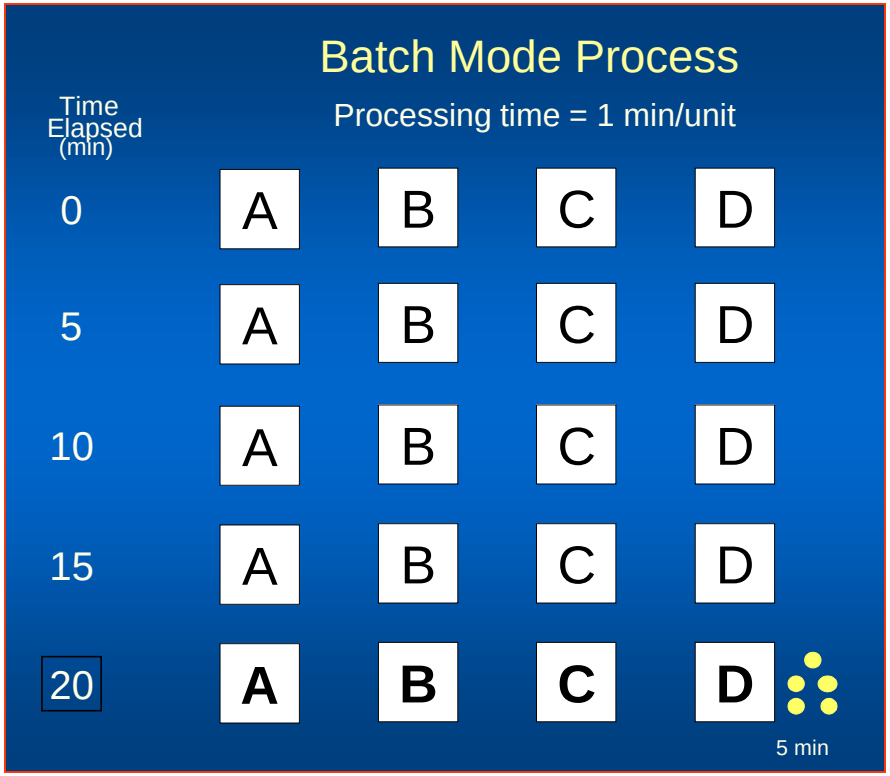

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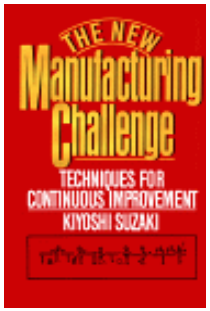

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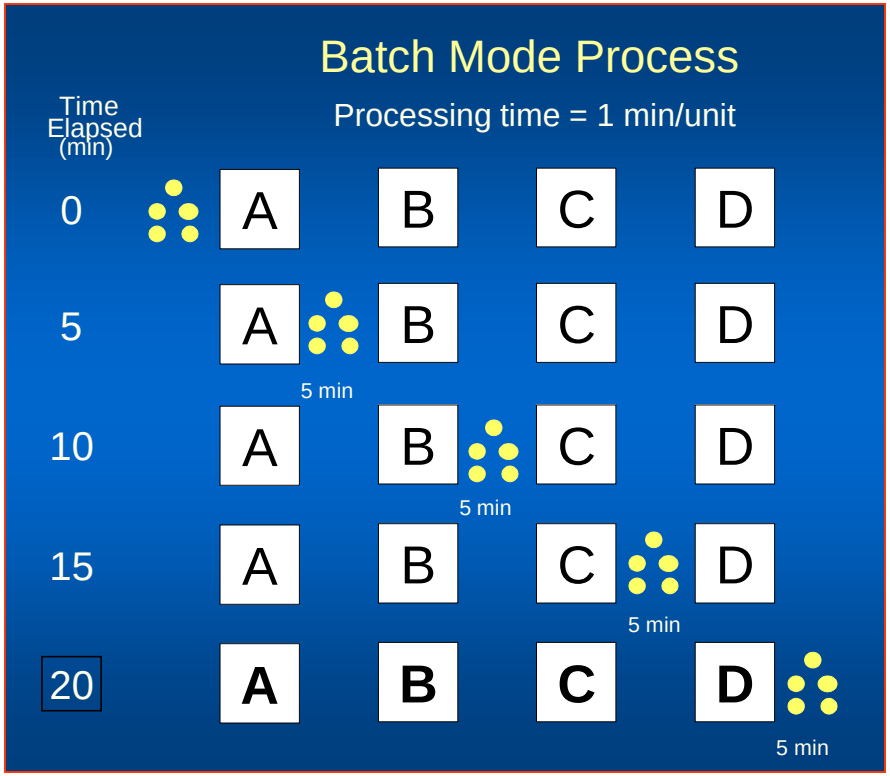

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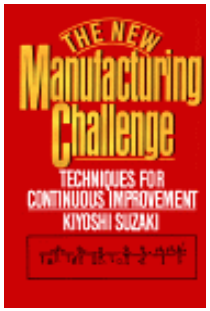

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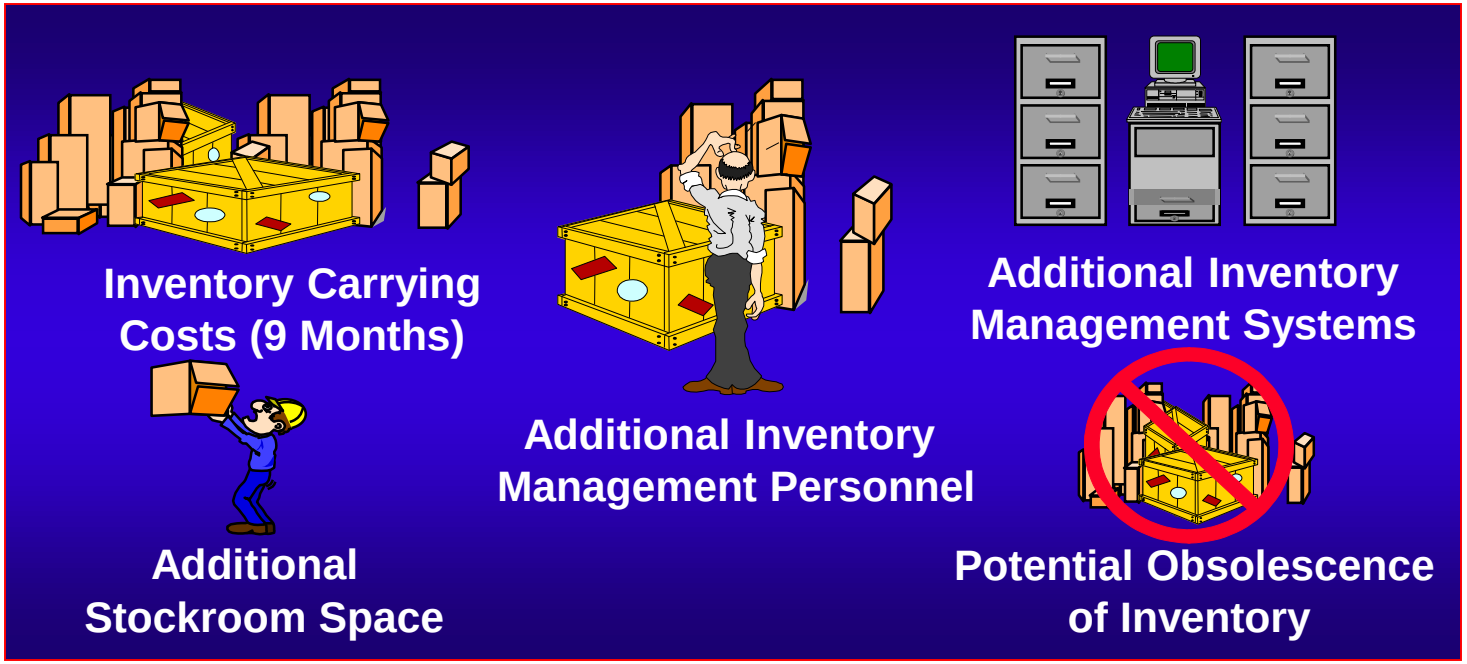
Lean Principles

- Batch ‘n Queue
  - Traditional thinking said the cost of producing parts was less when economy of scale was applied to a process step.
  - The larger the batch size, the cheaper the piece part cost.



In reality, all these fixed costs increased.

Lean Principles

- Looking for Value
  - What is Value Added?
    - **Activity That Changes Form, Fit or Function and for *Which the Customer is Willing to Pay***
  - All other activities are Non-Value Added
    - **Pure Waste**
    - **Required or Incidental Waste**

Lean Principles

What is Waste?

WASTE (lean definition): anything other than the minimum amount of equipment, materials, parts, space, and worker's time, which are absolutely essential to add value to the product. The Japanese word for this waste is *muda*.

"If it doesn't add value - - it's waste."

Lean Principles

What is Required Waste?

The goal is to do only **Value Adding** (VA) activities that actually go directly into producing the product or service.

The opportunity is to eliminate the **Non Value Adding** (NVA) activities that are associated with producing the product or service.

The NVA time can be broken into two parts: About 75% is **INCIDENTAL** time that is non-value adding but necessary, and 25% is **PURE WASTE** and therefore presents an opportunity for elimination.

Lean Principles

~~7~~ 8 Kinds of Waste

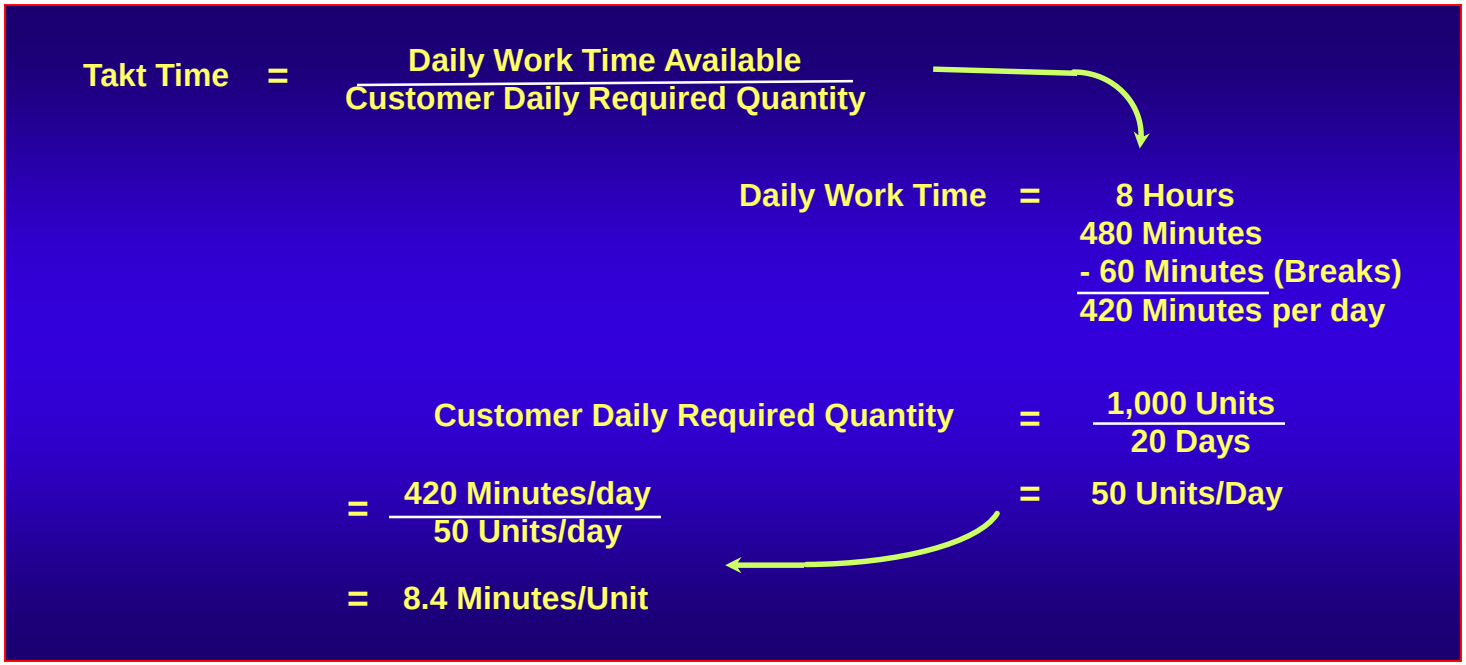
- Waste of Overproduction
- Waste of Time (Idle)
- Waste In Transportation
- Waste of Processing (Too Much)
- Waste of Stock on Hand (Inventory)
- Waste of Movement (Worker)
- Waste of Making Defective Products
- Waste of the Intellectual Talents of Workers

Lean Principles

- Flow
  - After wasteful steps are eliminated, make the value-creating steps flow without interruption
  - Continuous Flow is more efficient than Batch ‘n Queue
    - **Takt Time dictates the production rate**
  - Products flow continuously with no detours, back-flows, scrap or waiting
  - Supported by Cellular Manufacturing methods
  - Physical relocation and organization of tools represents one of the most common, visible first steps to leanness

Lean Principles

- Takt Time
  - Takt Time is the rate at which each product needs to be completed to meet customer requirements.
  - Takt Time is subject to change every month.



Takt Time determines the rate of production

Lean Principles

- Takt Time and Cycle Time

$$\text{Takt Time} = \frac{\text{Total Daily Working Time}}{\text{Total Daily Customer Demand}}$$

Cycle Time = Manual + Walking + Waiting Time

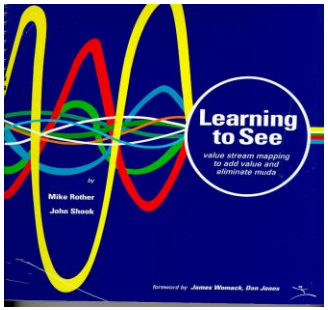
(for one cycle of work sequence)

Lean Principles

- One-Piece Flow - Takt Time / Work Distribution

Lean Principles

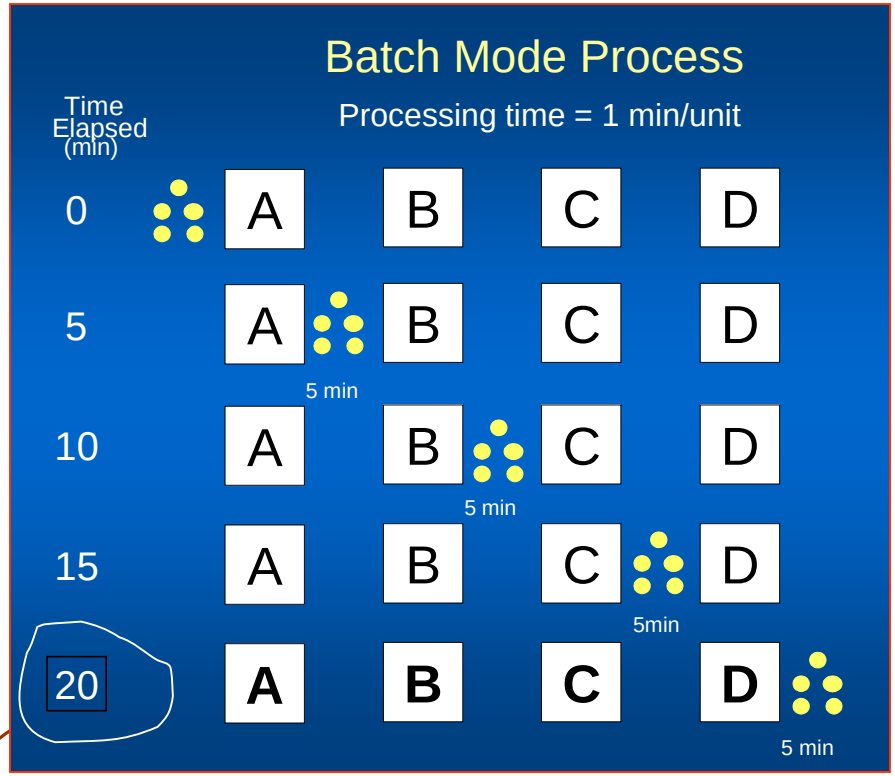
- Value Stream
  - Select product families for the Value Stream analysis
  - Establish Value Stream mapping team(s)
  - Map the Value Streams
    - **Current State**
    - **Future State**
  - Analyze Value Stream(s)
    - **Value Added**
    - **Non-Value-Added**
      - Required Waste
      - Pure Waste
  - Develop continuous improvement plans

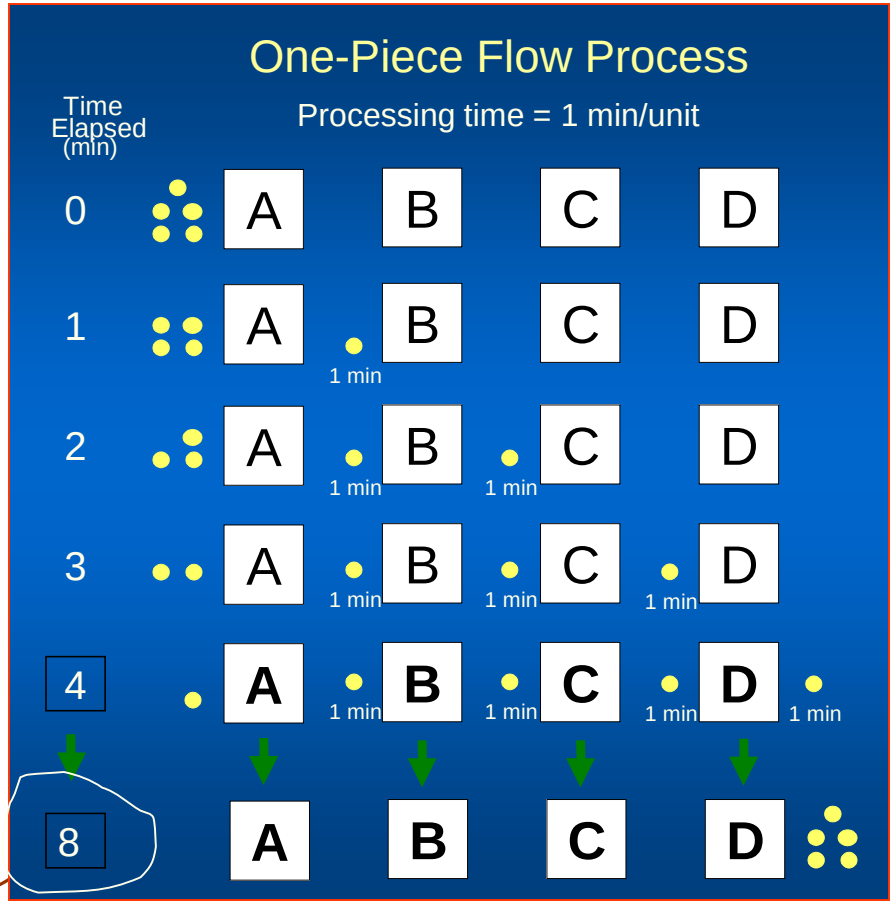


A Value Stream Mapping guide book by Mike Rother and John Shook

Starting to Flow

- Transitioning from Batch to One-Piece Flow





1st Piece moves to next process in 5 minutes, last operation complete in 20 minutes

That's 60% faster!!

1st Piece moves in 1 minute, last operation complete in 8 minutes.

A, B, C and D are different operations in the process

Lean Principles

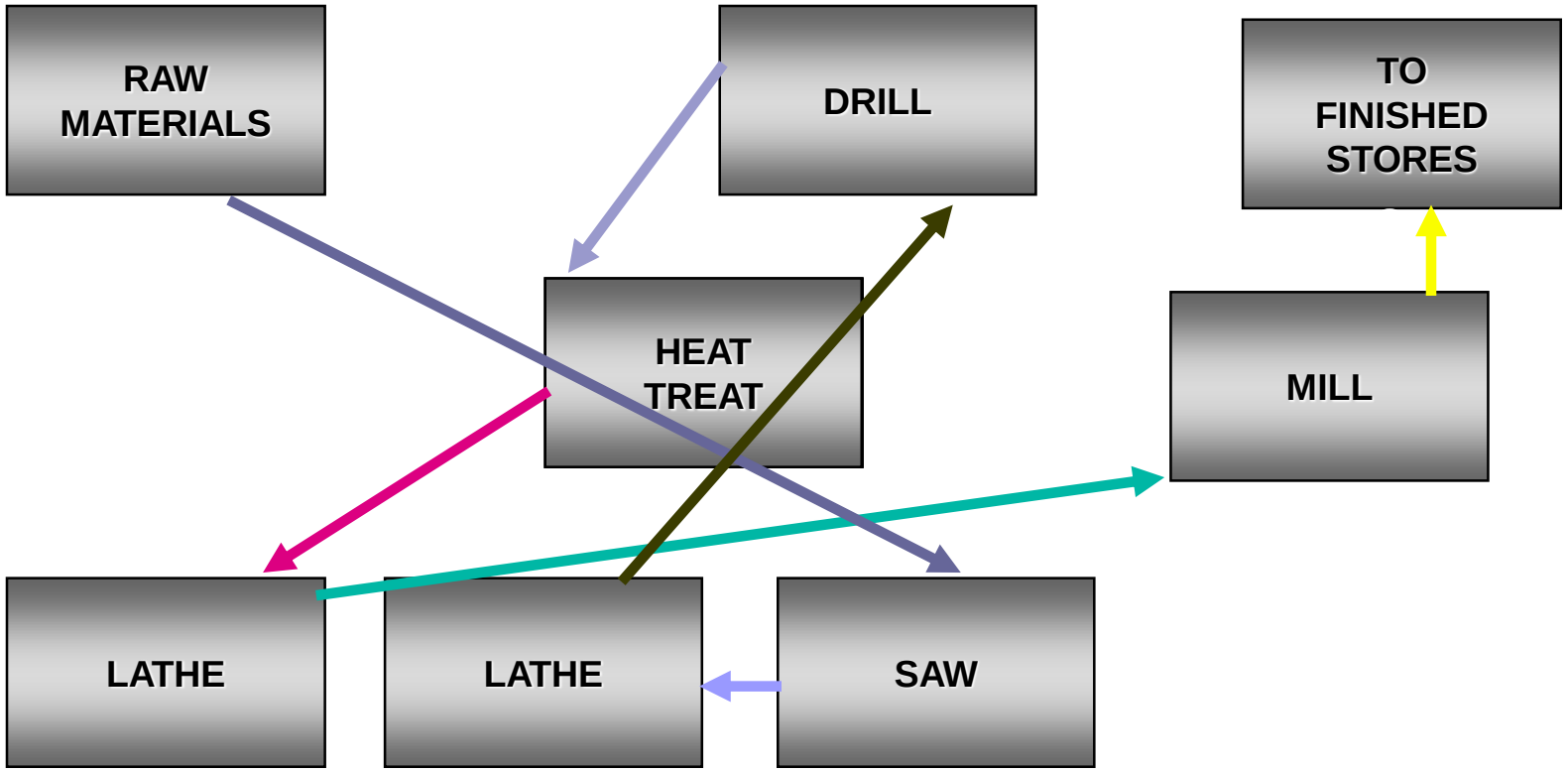
- One-Piece Cellular Flow
  - Multi-skilled operators and managers
  - Standard processes and operations
  - Customer linked to process
    - Daily Schedule
  - Linked to suppliers
    Small batch to one-piece flow
  - Machines placed in a “product-oriented” flow pipe-line to keep each operator productive

It is not possible to have a consistent Cycle Time without a consistent work sequence and method. Documenting the steps carried out by people and machines helps ensure that work is done the same way each time.

Encourage Continuous Improvement - but not anarchy. Each suggested process or flow change must be carried out with team consensus.

Lean Principles

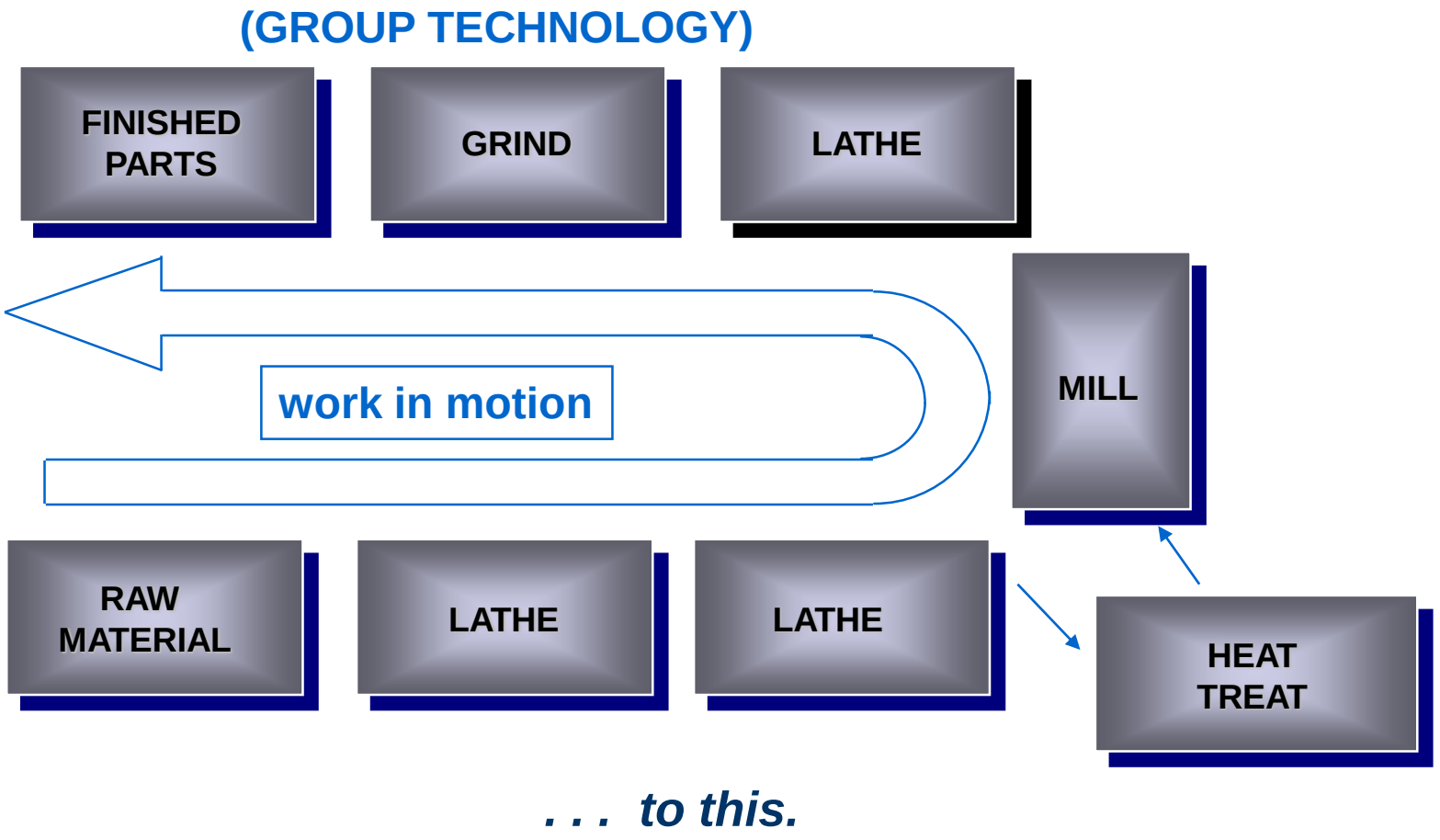
- One-Piece Cellular Flow



Go from this . . .

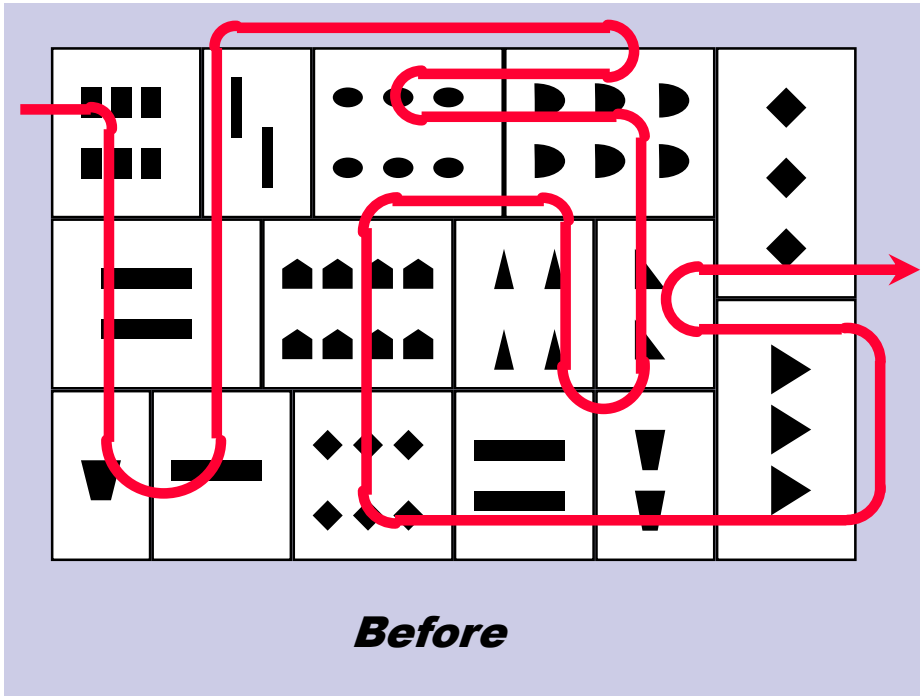
Lean Principles

- One-Piece Cellular Flow

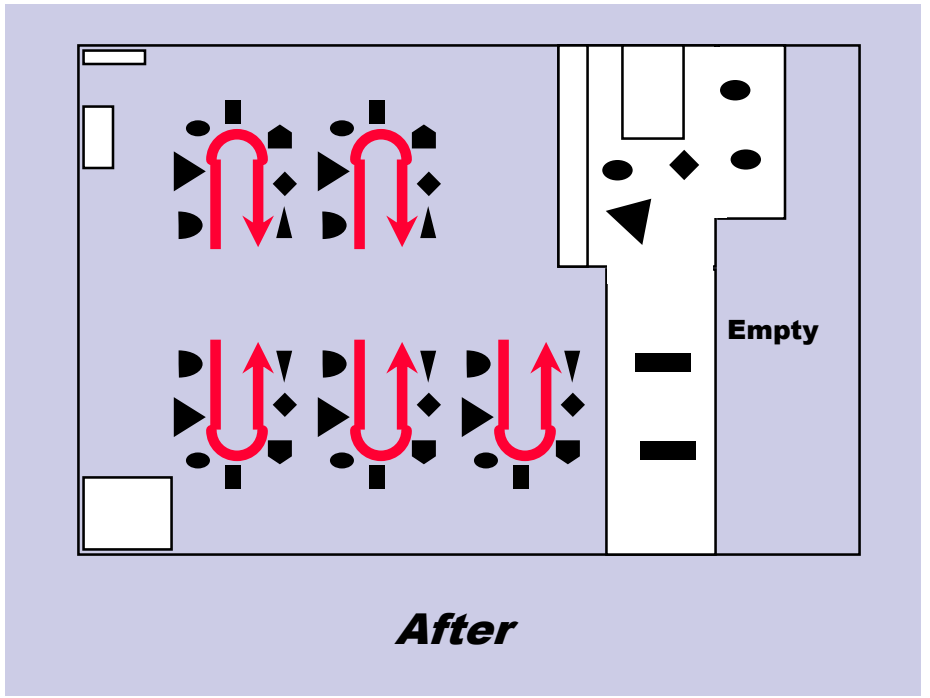


Lean Principles

- One-Piece Cellular Flow



Before



After

When manufacturing flow in this plant is reorganized, production lead times, space requirements, and the distances material travel are greatly reduced.

Lean Principles

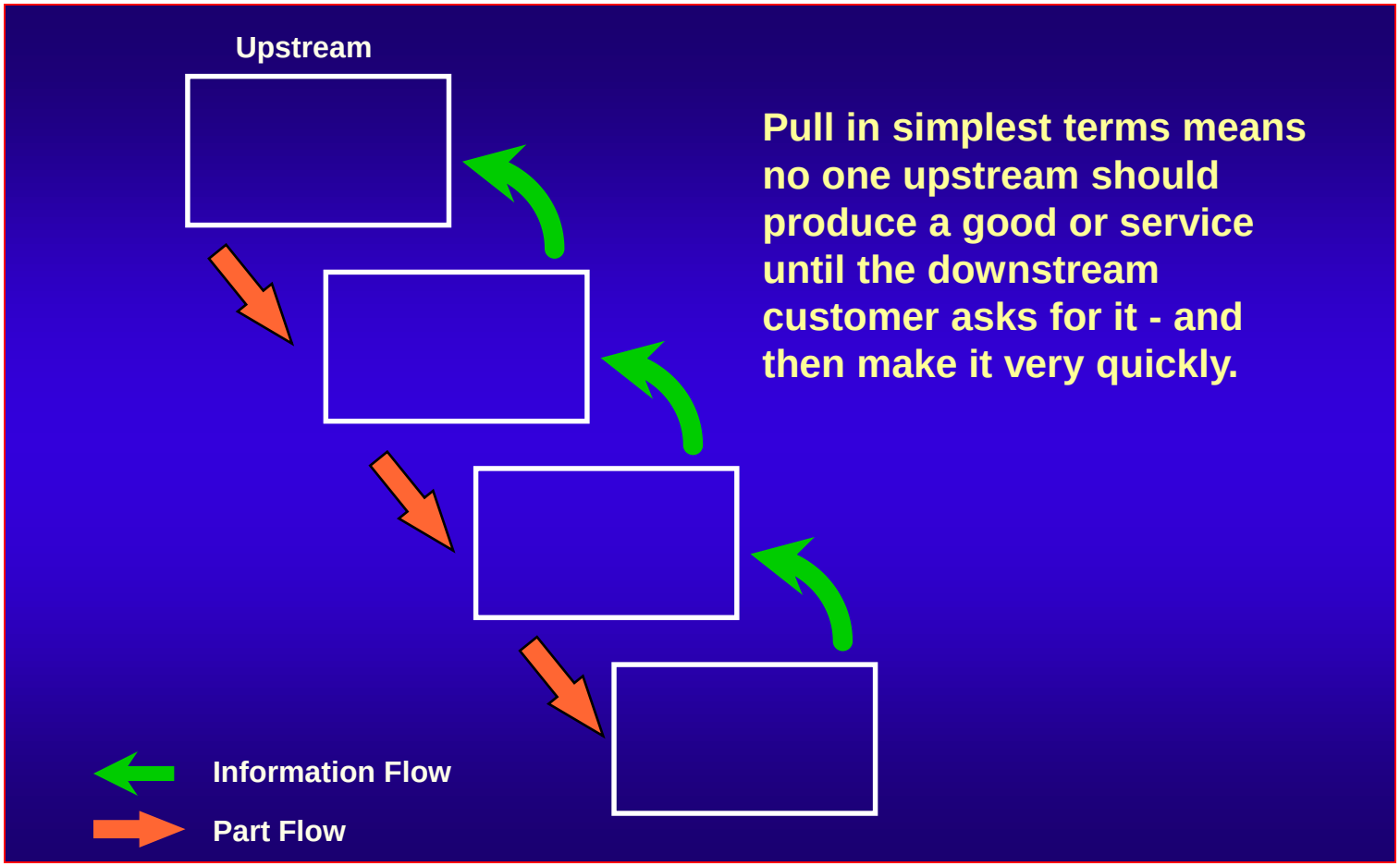
- Pull / Kanban System
  - A self-regulating, visual control system that focuses on the production floor and makes it possible to respond to changes quickly and efficiently. Produces only what the customer asks for.
  - A subsequent (downstream) process withdraws items from a preceding (upstream) process only at the time needed and in the quantity needed. Goods are only produced when asked for by the succeeding operation. Advantage: internal inventories are reduced.
  - The use of Kanban (‘Kän-bän) cards and Just-in-time (JIT) are examples of a Pull System

Lean Principles

- Pull / Kanban System
  - A Kanban Card (or other visual cue) serves as an authorizing device governing what to produce, when to produce it, in what quantity, by what means and how to transport it. No overproduction (building too much) or over progression (building too soon) will occur.
  - One-Piece Flow is the quickest way for material to get from Point A to Point B, with the shortest lead-time and least amount of WIP.

Lean Principles

- Pull / Kanban System



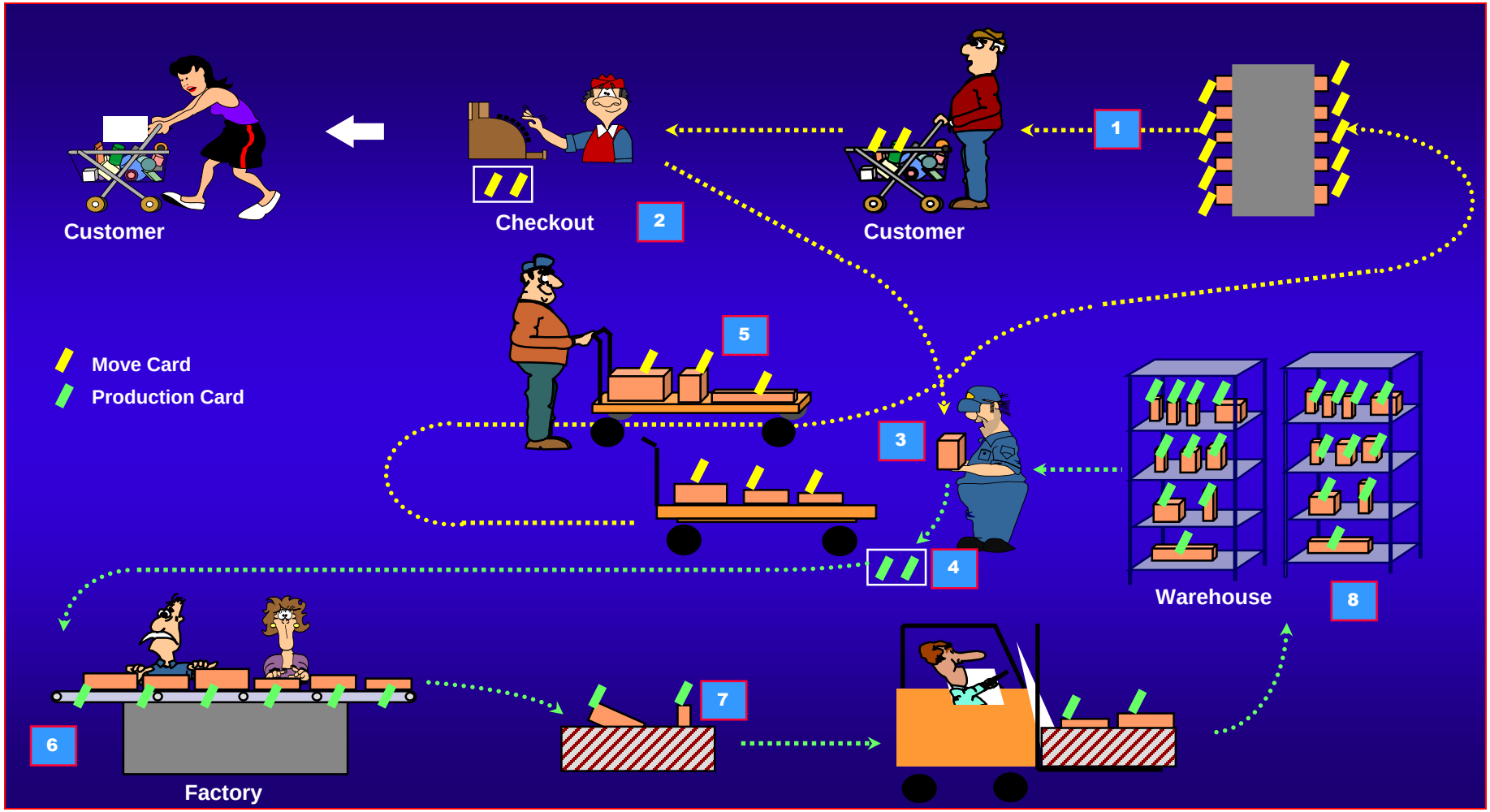
Lean Principles

- Pull / Kanban System
  - The use of kanban signals to balance flow through the transformation process is an essential part of lean.
  - The control of work in process inventory is another essential element, and will be particularly difficult when transitioning from areas of batch processing into a one piece flow area.
  - A coordinating element that may help minimize inventories and still provide adequate flow control is the use of “supermarket” buffer inventories at strategic locations, with kanban signals providing the coordination.

An excellent reference for creating level pull is this guide book by Art Smalley

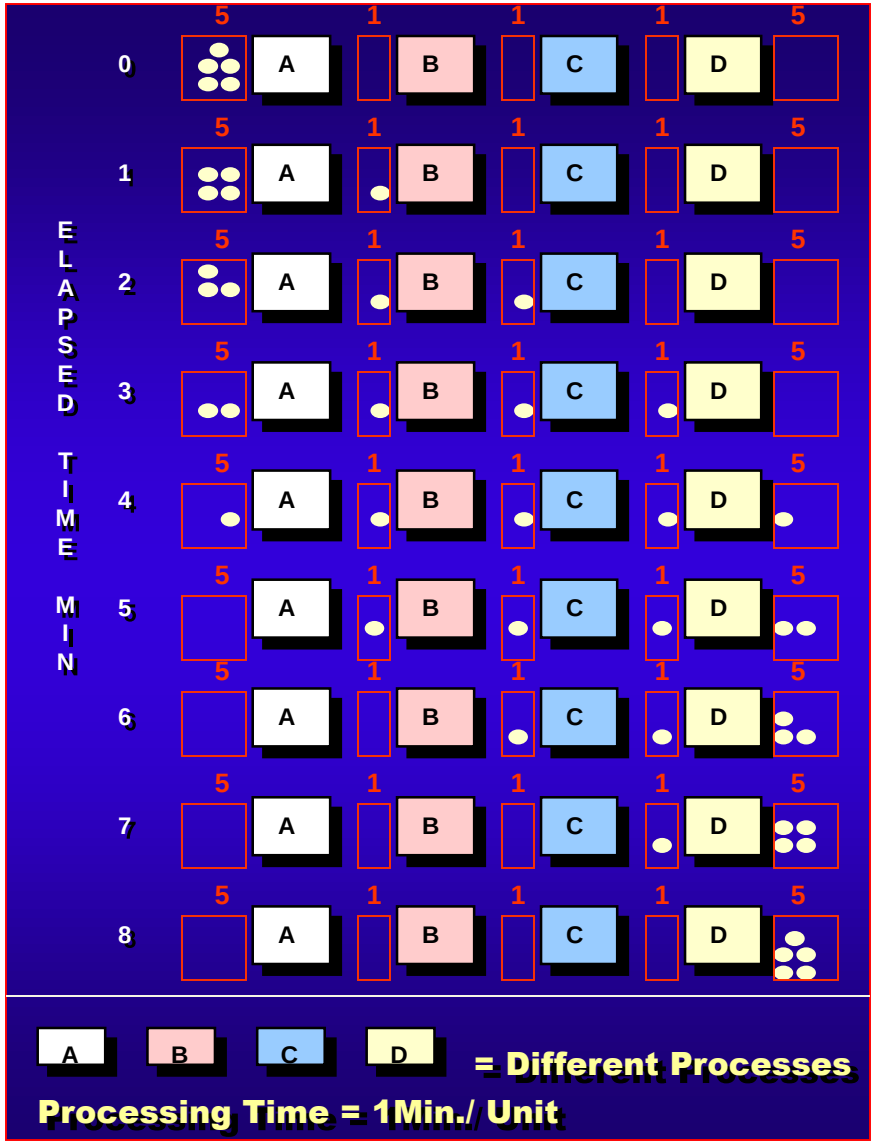
Lean Principles

- Supermarket concept and use of Kanban



Adding Flow Control

- One-Piece Flow with a Pull System
  - A simple pull system can be implemented by setting the minimum and maximum number of items allowed in front of each process step.
  - This is often implemented with a Kanban Square outlined in red tape near each process output, with labeling for max. quantity. The process just has to keep the kanban full.
  - ***Caution:*** A pull system requires an advanced and stable manufacturing environment and should be one of the last pieces of the puzzle to be implemented.



Lean Principles

- Evolution into Lean Manufacturing
  - The next step after implementing one-piece continuous flow goes back to the definition of Lean Mfg.: ***'lean is being very good at doing the things you can control.'***
  - Coupled with our ultimate goal of ***speed*** as the desired outcome, keeping the decision process as small as possible becomes essential to realizing full success with lean.
  - That means enabling ***good*** decision-making at the lowest levels possible.

Lean Principles

- Evolution into Lean Manufacturing
  - Since the company's organizational environment was created out of Taylorian thought, every function outside the production team will be optimizing for their own best interest, including resource availability and timeliness of response.
  - If key decisions are left to others outside our control, we risk achieving our own goal.
  - Until the enterprise wide value stream is made to be effectively lean, we can start by focusing on what we can control.

Lean Principles

- Evolution into Lean Manufacturing
  - Using lean tools, such as the Kaizen Event, we look at the total transformation process, and assess those areas or procedures that present bottlenecks which restrict the flow. They become the ***key processes*** that stand as barriers to our success.
  - Kai means “to take apart or change” and Zen means “to make better”. Kaizen is only one of the many continuous improvement tools available to analyze the processes of work.
  - By taking on some additional authority, as well as the responsibility, for key bottleneck activities in the transformation process, we can better control our own destiny and maximize throughput for ***speed***.

Lean Principles

- Evolution into Lean Manufacturing
  - Authority over material availability may be one way to eliminate waste and provide the work cell with additional control. Point of use inventory is one of the most difficult improvements to achieve, but well worth the effort.
  - Another huge cultural barrier is the notion that quality must be ***"inspected in"*** by a second set of eyes. This detection method can leave much to be desired. The customer is better served when quality is built into the process using prevention techniques.
  - Certified Operators that carry both process and quality certified inspection (CI) training will provide the ability to ***"build quality in."***

Lean Principles

- Evolution into Lean Manufacturing
  - Mistake proofing (Poka Yoke) uses wisdom and ingenuity to create devices that allow you to do your job 100% defect-free 100% of the time

Lean Principles

- How good an inspector are you?
  - As demonstrator of the effectiveness of 100% visual inspection, determine the number of f's in the following paragraph. Read through and count the f's.

The necessity of training farm hands for the first class farms in the handling of farm live stock is foremost in the minds of farm owners. Since the ancestors of the farm owners trained the farm hands for the first class farms in the handling of farm live stock, the farm owners felt they should carry on with the family tradition of training farm hands for their first class farms in the handling of farm live stock because they believe it is the foundation of good fundamental farm management.

Lean Principles

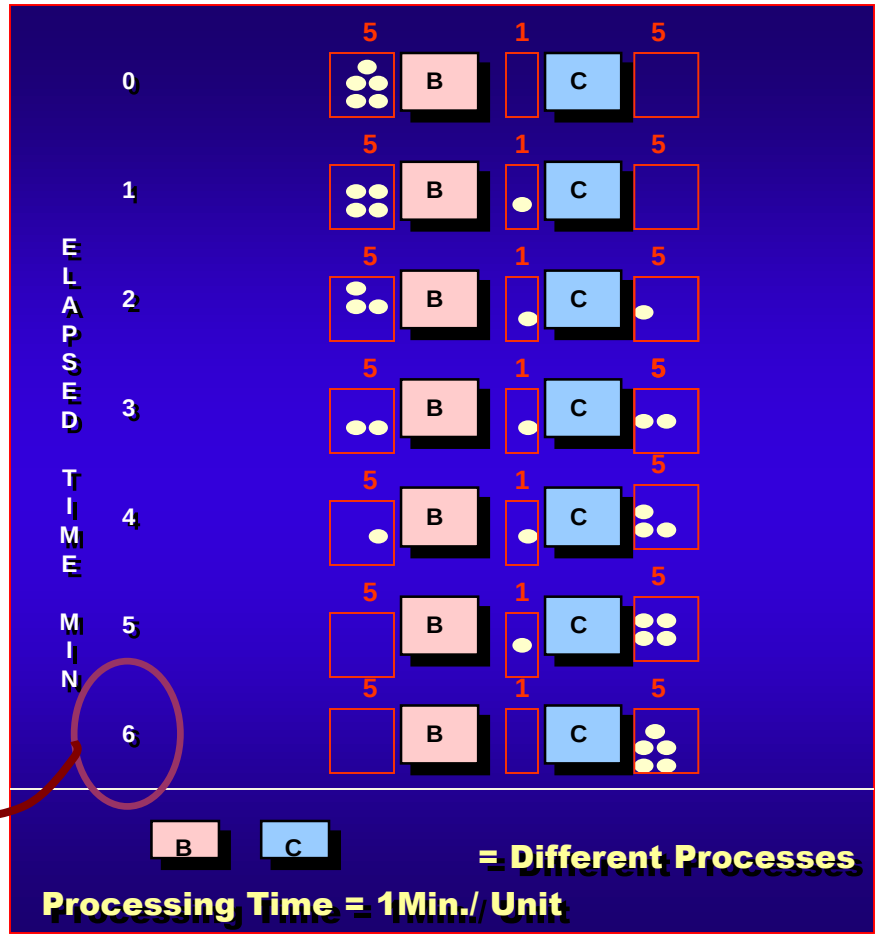
- How good an inspector are you?
  - Here it is again, with a little help. As a further demonstration of the ineffectiveness of 100% visual inspection, see if you can catch them all with the f's highlighted.

The necessity **o**f training **f**arm hands **f**or the **f**irst class **f**arms in the handling o**f** **f**arm live stock is **f**oremost in the minds o**f** **f**arm owners. Since the ancestors o**f** the **f**arm owners trained the **f**arm hands **f**or the **f**irst class **f**arms in the handling o**f** **f**arm live stock, the **f**arm owners **f**elt they should carry on with the **f**amily tradition o**f** training **f**arm hands **f**or their **f**irst class **f**arms in the handling o**f** **f**arm live stock because they believe it is the **f**oundation o**f** good **f**undamental **f**arm management.

Lean Principles

- Lean Flow
  - This final flow uses a Pull System, CI Operators, and Point of Use material control.
    - Adding POU, the 1st kit operation “step A” is eliminated.
    - Adding Certified Operators, the 4th inspection “step D” is eliminated.
    - Using the Kanban square flow control, work stays balanced through assembly “steps B and C”.
    - 1st piece to customer in 2 minutes, balance in 6.

A pull system with Point of Use inventory and Certified Operators enables the team to be the best at what they can control .



That’s 25% faster than One-Piece Flow alone!!

Lean Principles

- Lean Manufacturing
  - Let's put the theories into practice with . . .

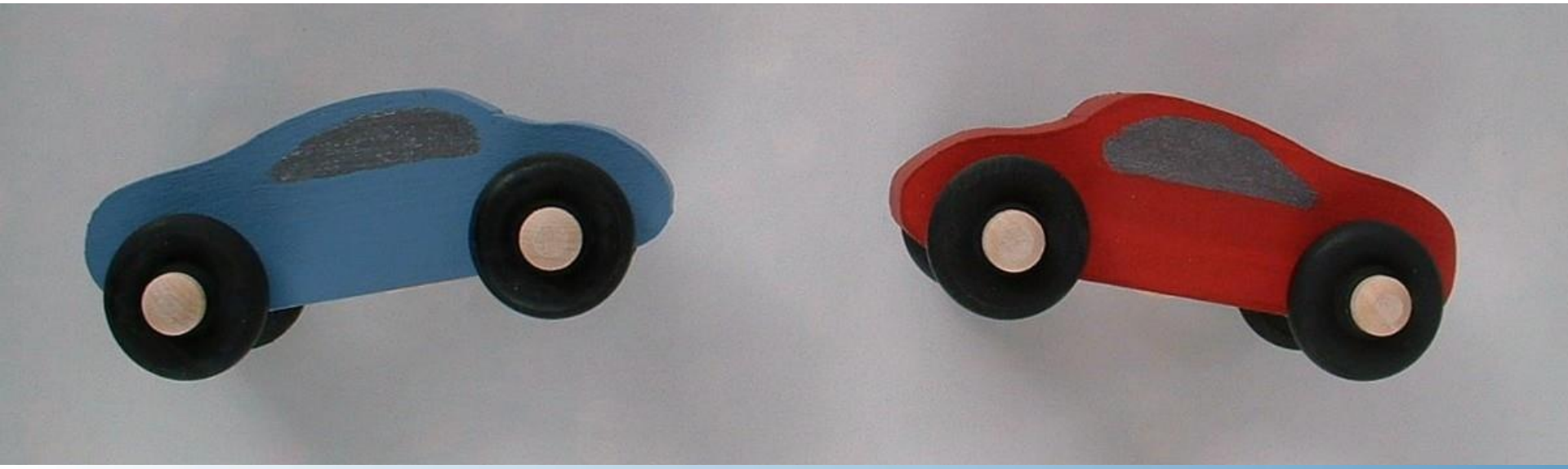
    The LeanMan Factory Simulation Kit

The LeanMan

Lean Factory Simulation Kits

Lean Factory Simulation Kit

Training Guide



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- Creating Level Pull, Author: Art Smalley, Publisher: The Lean Enterprise Institute
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