The LeanMan

Lean Factory Simulation Kits

# Lean Principles

## 2-Event Training Guide

Learning to see the waste

# Lean Factory Simulation Kits



**WARNING – KIT CONTAINS SMALL PARTS.**

**KEEP AWAY FROM YOUNG CHILDREN**

# A Definition of Lean Manufacturing:

**Leanness** (as in lean mfg.) is concerned with concentrating on increasing production velocity while eliminating the wasteful activities that impede the speed of operations.

- The transition from the Batch ‘n Queue methods of the last century to the Lean Pull-Demand methods of today requires that we understand the value stream process, and that we be able to identify any non-value adding activity in that stream.
- Distinguishing value-adding from non value-adding activities is not always obvious, given that some non-value adding activity is still going to be required in our process. Our opportunity is to eliminate those that are not required. They are pure waste.
- So for our first assignment: *We must learn to see the waste!*

# Looking for Value

- What is Value Added?
  - **Activity That Changes Form, Fit or Function and for Which the Customer is Willing to Pay**
    - **inserting a screw into a chassis**
- All other activities are Non-Value Added
  - **Pure Waste**
    - **looking around for a screwdriver**
  - **Incidental Waste (**required but not really adding value**)**
    - **picking up the screw and the screwdriver**

The LeanMan

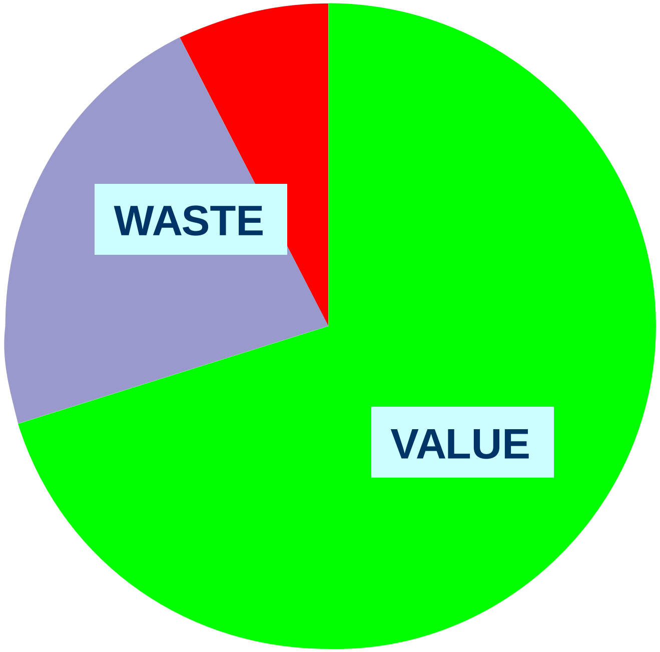
# What is Waste?

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."*

# Waste - Where is it?




WASTE: waiting for materials, watching machines run, producing defects, looking for tools, fixing broken fixtures or cables, producing unnecessary items, etc…

WASTE: transportation, storage, redundant inspection and rework, etc…

WASTE: unnecessary movement of anything, set up activities, searching for documents, etc...

The LeanMan

# 8 Kinds of Waste*

**Overproduction**

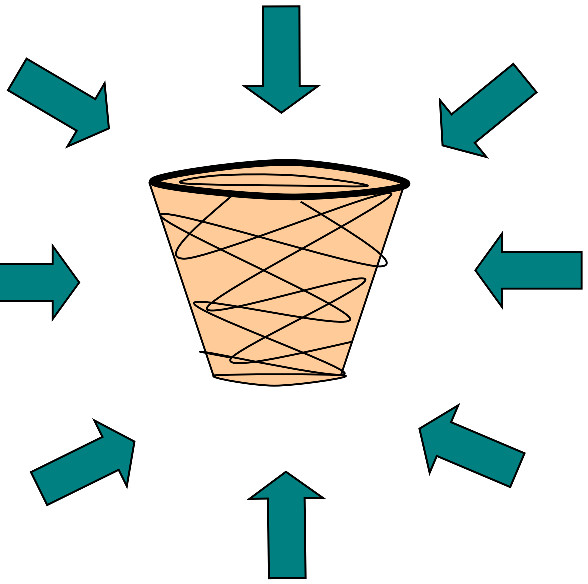
Producing too much, or producing too soon

**Intellect**

Any failure to fully utilize the time and talents of people

**Conveyance**

Any nonessential transport is waste



**Motion**

Any motion that does not add value

**Inventory**

Any more than the minimum to get the job done

**Correction**

Any rework or repair

**Waiting**

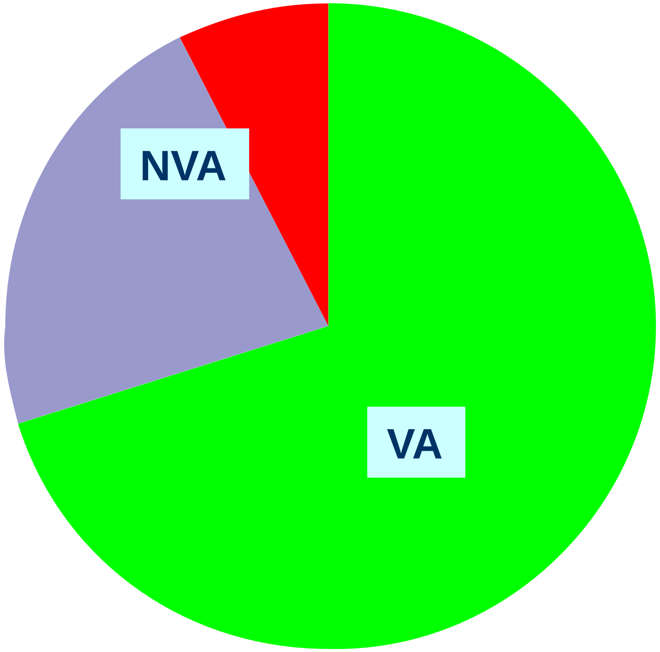
Waiting on parts, waiting for a machine to finish a cycle

**Processing**

Over processing

* **Some Lean Thinkers say there are only seven – but we believe unused Intellect is also a waste**

# Waste - Non-Value Adding




The goal is to do only **Value Adding** activities that actually go directly into producing the product

The opportunity is to eliminate as many of the **Non Value Adding** activities associated with producing the product as practical.

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.

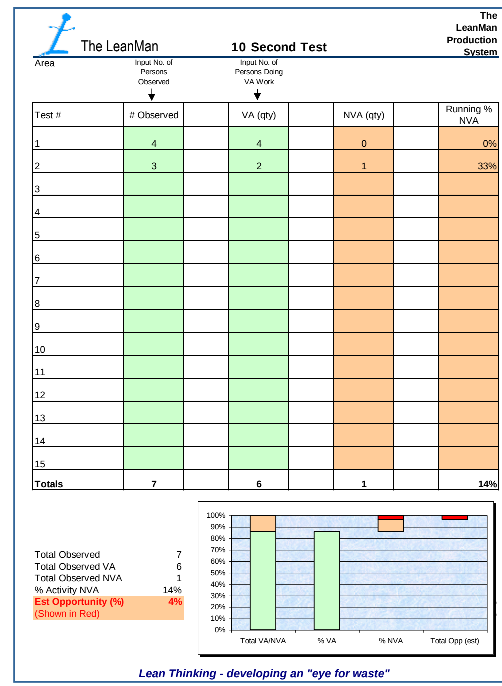
 

# The 10-Second Test – how to look for waste

- The 10-Second Test is a lean technique used to observe the Value Adding versus Non-Value Adding activities in a work area in order to see where waste may be occurring.

## How to

- Pick a work area to observe
- Count the number of people in the work area
- Do NOT disturb the operators, you need true data
- Watch the group you counted for 10 seconds.
    - **If at any time during the 10 seconds, a person adds value to the product, then they are considered to be doing Value Added (VA) work.**
- Record the number observed, and the number doing VA activity, then Sum totals on the form provided.



The LeanMan **10 Second Test** **The LeanMan Production System**

Area

Input No. of Persons Observed

Input No. of Persons Doing VA Work

| Test # | # Observed | | VA (qty) | | NVA (qty) | | Running % NVA |
|---|---|---|---|---|---|---|---|
| 1 | 4 | | 4 | | 0 | | 0% |
| 2 | 3 | | 2 | | 1 | | 33% |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | | | | | |
| **Totals** | **7** | | **6** | | **1** | | **14%** |

| | |
|---|---|
| Total Observed | 7 |
| Total Observed VA | 6 |
| Total Observed NVA | 1 |
| % Activity NVA | 14% |
| **Est Opportunity (%)** (Shown in Red) | **4%** |

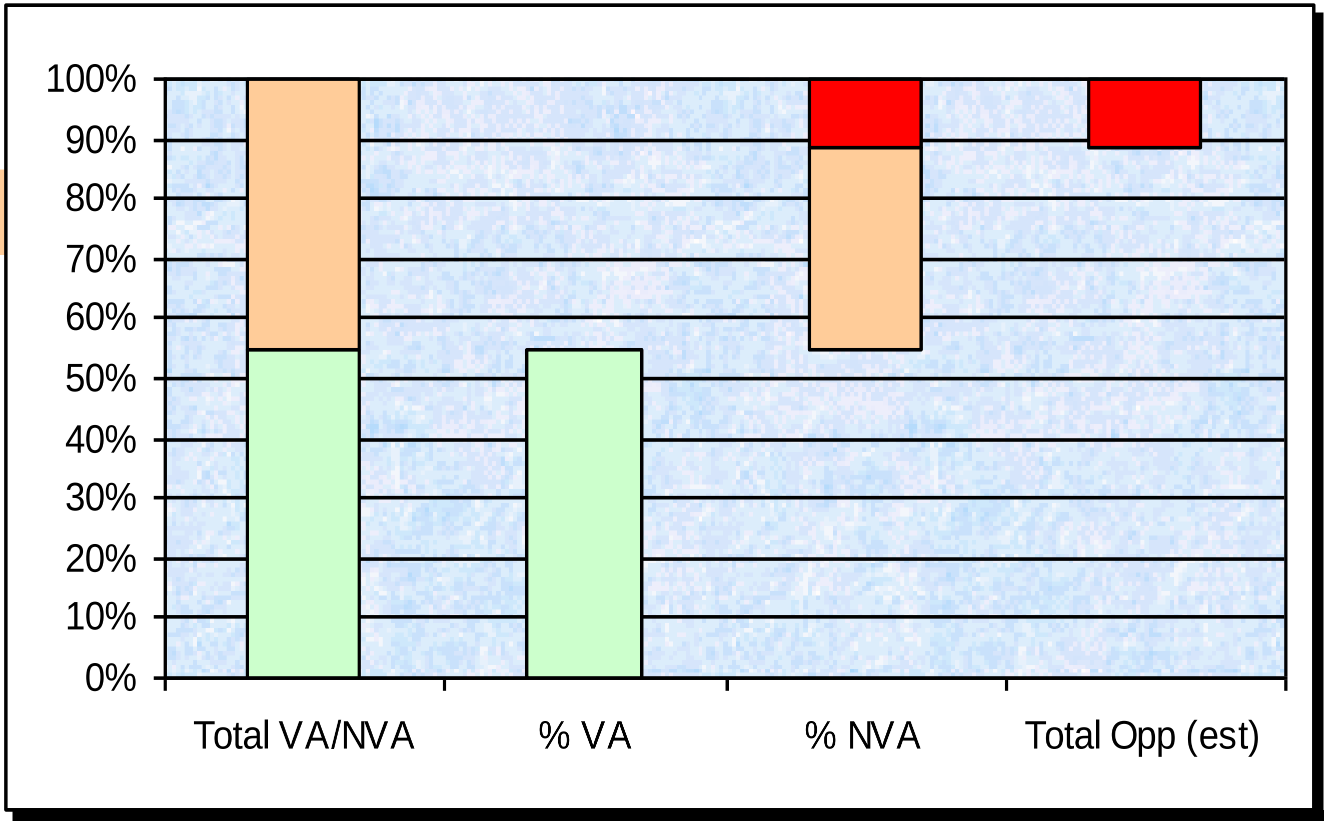


***Lean Thinking - developing an "eye for waste"***

The LeanMan

# Lean Thinking - *developing an "eye for waste"*

| | |
|---|---|
| Total Observed | 42 |
| Total Observed VA | 23 |
| Total Observed NVA | 19 |
| % Activity NVA | 45% |
| **Est Opportunity (%)** | **11%** |
| (Shown in Red) | |



# The 15 Minute Observation

- When the 10-second test observations reveal work areas consistently indicating a high NVA activity level, implement a 15-Minute Observation.
- **The 15-Min Observation team might consist of:**
  - **operator familiar with work transactions,**
  - **materials person familiar with material transactions**
  - **process engineer familiar with the process.**
- **The observers watch the work cell function over a period of time, taking particular note of any non-value adding activities. They are asked not to disturb the workers with questions, but simply make notes of any questionable activity for later discussion.**
  - **Look for organization and housekeeping (5-S)**
  - **Look for work balance between operators (TAKT flow)**
  - **Look for material flow, queue areas, snags or problems**
  - **Look for communication methods, signals, verbal and nonverbal**
  - **Look for value-adding and non value-adding activities**
- **After the observation period, the observation team and workers discuss the observations, clarify activities, and look for opportunities for improvement.**

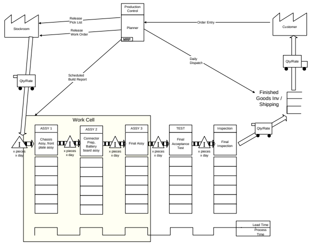
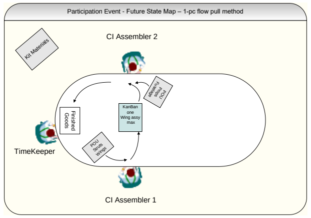
The LeanMan

# The Kaizen Event

- The 15-Min Observation team will determine if a Kaizen event should be held. Reasons may be to reset the basic understanding of the purpose of the line; to get cell member ownership of the process; to rebalance the line to current demand conditions; or to refresh Lean Principles training.
- The event would entail:
  - **Re-training of the cell team on Lean Principles. Use the Factory Simulation Kit to practice the Lean Principles and to get the team to think lean while they experimented with different flow methods to optimize the work cell**



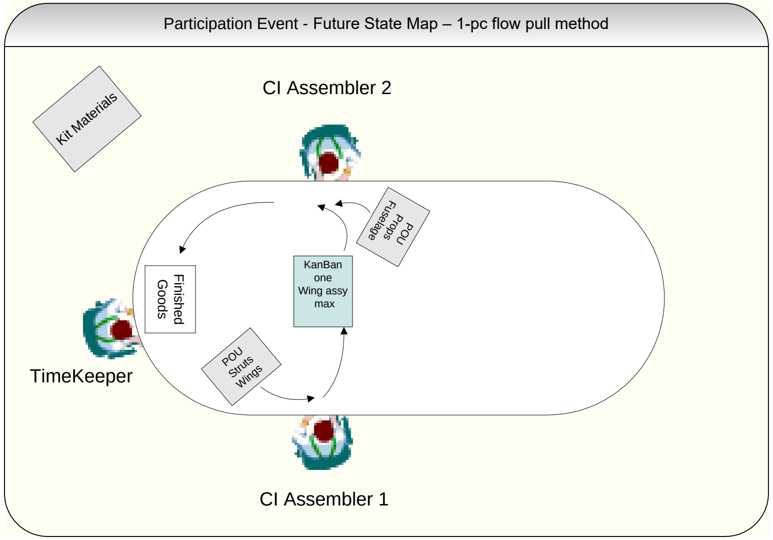
  - **Creation of a current and future value stream map (VSM) with simulation of current and future flow methods to determine the best balance.**

# Current and Future state simulation results

- **One piece flow using assembly people with inspection certification.**
- **Point-of-Use (POU) inventory to eliminate delays caused by others outside the cell's control, which improves overall utilization of each cell worker.**
- **Pull system with kanban for subassembly replenishment creating the necessary communication link to coordinate material delivery and smoothen flow.**




| | Total Shipped | In FGI | Total Items Completed | In Rework | In WIP | Cycle Time | 1st PC to FGI in SEC | 1st PC to Customer in SEC |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| **Current State** | **15** | **2** | **17** | **6** | **2** | **1.7** | **120** | **170** |
| | | | | | | (sim run time / #cars) | | |
| **Future State** | **21** | **2** | **23** | **2** | **1** | **2.3** | **50** | **98** |
| | | | | | | (sim run time / #cars) | | |
| | =(21/15)-1 | | =(23/17)-1 | =(6-2)/6 | =(2-1)/2 | =(2.3/1.7)-1 | =(120-50)/120 | =(170-98)/170 |
| | | | | | | | | |
| **Improvement** | **40.0%** | | **35.3%** | **66.7%** | **50.0%** | **35.3%** | **58.3%** | **42.4%** |

# Lean Eyes:  VA / NVA

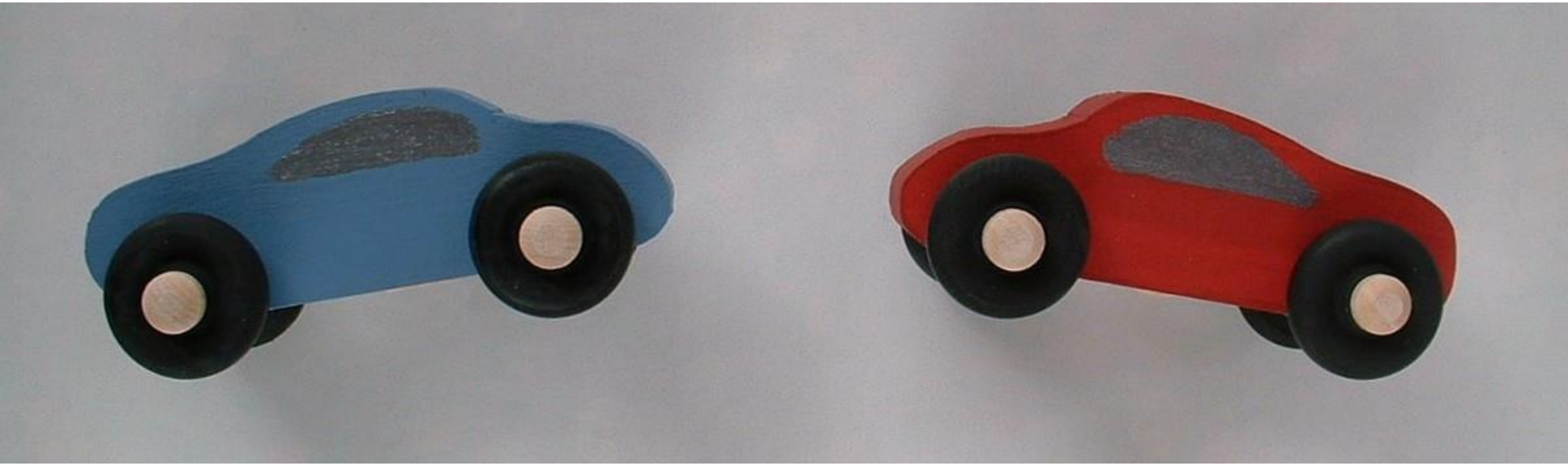
- The ability to recognize the VA and NVA activity in the shop is the basic starting point for implementing Lean Manufacturing.

- The ability to eliminate waste in production requires each team member at every level to develop Lean Eyes as part of the Lean Thinking tool kit.

- With thoughtful consideration, little bits of pure waste can be eliminated to make your jobs easier, the team more productive, the company more competitive, and our customer more satisfied.

# Participation Event

**Lean Factory Simulation Kit**

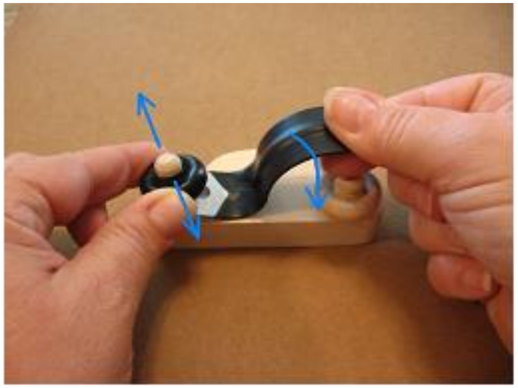


# A word about safety and ergonomics:

- The simulation exercises use small components to produce toy cars. They are attractive to small children, therefore use caution when storing the components and keep them away from small children to prevent choking.
- The wooden pegs used to mount the wheels are made of a hard wood and should provide stable use over a long time. However, all wood will absorb moisture in high humidity conditions causing a slight swelling of the fibers and resulting is a tight fit of the wheel assembly. If this happens, the pegs may be baked in a 300º F oven for 10 minutes to remove the excess moisture.
- If a tight peg / wheel assembly is difficult to remove, use the wheel extraction tool provided. Follow the instructions as shown.

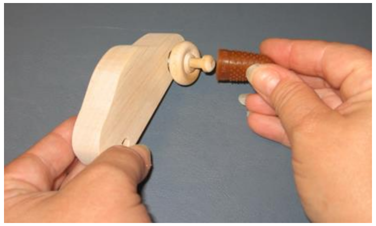
To remove a tight wheel assembly, gently slide the wheel extraction tool under the wheel and around the axle peg.

Slowly pry up against the underside of the wheel or disk, with the tip of the tool centered with the peg, to bring the peg straight out of the hole.



Gently rock the axle back and forth while pressing downward on the extraction tool handle. Use care not to flip the wheel and disk into the air. Do not bend the tool – press slowly and rock the peg loose.

- When inserting the wheel / peg assembly onto the car body, use a slight clockwise twist of the peg to ease insertion. Use the ergonomic tool provided to grip the peg and prevent finger soreness over the duration of the simulation event.



# Notes for the car material kit:

- The car kit consists of several car bodies, sets of wheels, axle pegs and disk brakes.

- The kit provides plastic bags that are used to pick one piece kits of material when simulating a stockroom operation.

- The wheel-axle subassembly holding fixtures simulate shop fixturing activity and are used to pass completed subassemblies to the next operation step, and then empty fixtures are returned back upstream after use.

- There are two types of quality non-conformance used in the simulation. They are the painted wheel, and the non-rotating wheel.
  - The painted wheels supplied in the kit are used to inject a quality nonconformance into the material stream.
  - The non-rotating wheel is a random quality defect caused by workmanship. This naturally occurring non-conformance is used to simulate a learning curve and the value of various inspection techniques.

Car Kit Contents:

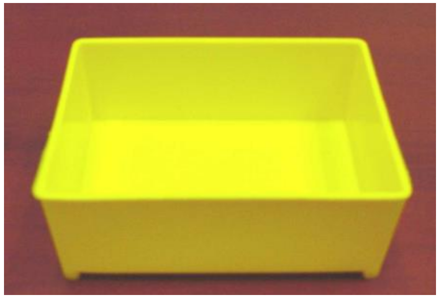
2 complete and painted cars
20 car bodies unpainted
80 wheels unpainted
80 axle pegs
80 disk breaks
8 wheels painted black (quality)
5 plastic kit bags (Picked Kit Inv.)
5 large plastic containers (POU Inv.)
5 tooling pallets (wheel/axle subassy)
4 small plastic containers (POU Inv.)
1 Stopwatch
1 organizer with polycarbonate cover
1 Participation Event Training Guide
1 Wheel extraction tool
1 Ergonomic peg tool

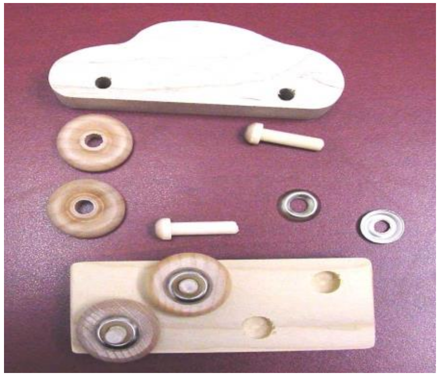
# Kit Features:

**The KIT**: The stock keeper will pick a 3 pc KIT, placing all parts for one car into a bag, and place the three bags into a container. To simulate real shop conditions, each bag of parts should be as uniform as possible, i.e., zip-locking each bag will require a consistent amount of time, and will keep the metrics accurate.

**The TOTE Batch Container**: the role of the batch container in the exercise is to simulate more of the non value-adding steps performed in the shop, such as circulating containers back upstream. The stock keeper eventually has to wait for the containers and bags to return before delivering more kits.



**The FIXTURE**: the role of the fixture used to hold the subassembly of the wheel & break & axle is another example of non value-adding activity in the shop, particularly when components must travel long distances to their final assembly point. In this exercise, the subassemblies are mounted onto the fixture and passed to the final assembly point. The fixture must then be returned back upstream.

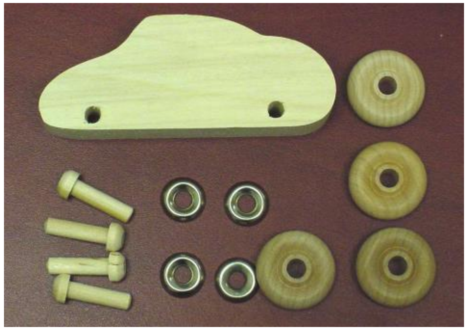


# Notes for assembling the car kit:

- The axle is inserted through the wheel, through the disk with the flat side toward the wheel, and into the car body. Use a clock-wise rotation of the axle as it is inserted into the car body. Inserting the axle too far will press the round side of the disk to the car body and act as a break, preventing the wheel from rotating. This feature is used as a quality non-conformance during simulation.
  - To loosen or remove the wheel, use a counter-clockwise rotation of the axle as you pull it out and away from the car body. The fit of the axle to the body is an intentional slip-fit.

- The disk brake components are included in the kit for two purposes.
  - First, they provide an unwanted random breaking action that simulates a quality defect and thus demonstrates the skill of the assembler.
  - Second, they provide a dexterity barrier for the person picking the material from the container, since they tend to stack together. This feature nicely simulates the natural variability of picking kits of small components.



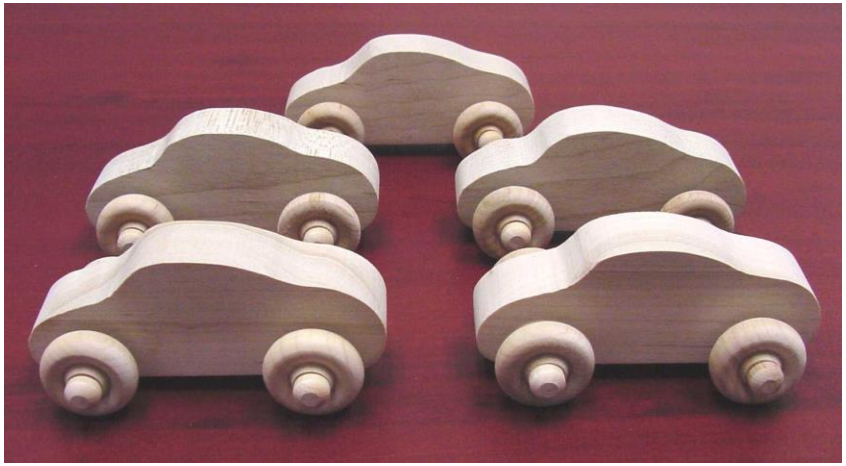
A picked 1-pc kit contains 1 car body, 4 axles, 4 disk brakes and 4 unpainted wheels. A non-conforming quality defect may be introduced by substituting a painted wheel into the kit.

# Participation Event #1

The first event, MRP Batch ‘n Queue, shows the effects of moving large batches of product through several stages. The factory process consists of a three piece batch assembly that begins with a set of components picked by the material warehouse into a three piece kit. The kit passes to two assembly stages, the first stage assembles all of the wheel, axle and disk subassembly components together, and then passes the entire batch to the second stage for attachment of four each of the subassemblies to each of the three car bodies. The batch of assembled cars then passes to final inspection and then to the finished goods warehouse.

Notice how the down stream team sits and waits for the upstream stage to complete it’s task. Notice the NVA activity of returning empty batch containers back upstream. Have the observer participants perform the 10-second test every two minutes and plot the results.



# Batch Mode – 3 piece Batch 'n Queue PUSH Method

**Step 1**: STOCK KEEPER: pick a 3 pc KIT, place all parts for one car into a bag and place three bags into a container. Container is moved to step 2. Randomly substitute a black wheel into one of the kits in each batch until told to no longer do so by the inspector.

**Step 2**: SUBASSEMBLER 1: unpack kits and return containers to step 1. Assemble all wheel & break & axle subassemblies and place onto holding fixtures. When all 12 wheel subs are complete, move the 3 sub assy fixtures and 3 car bodies as a batch to step 3. Note: build using the painted wheel if supplied.

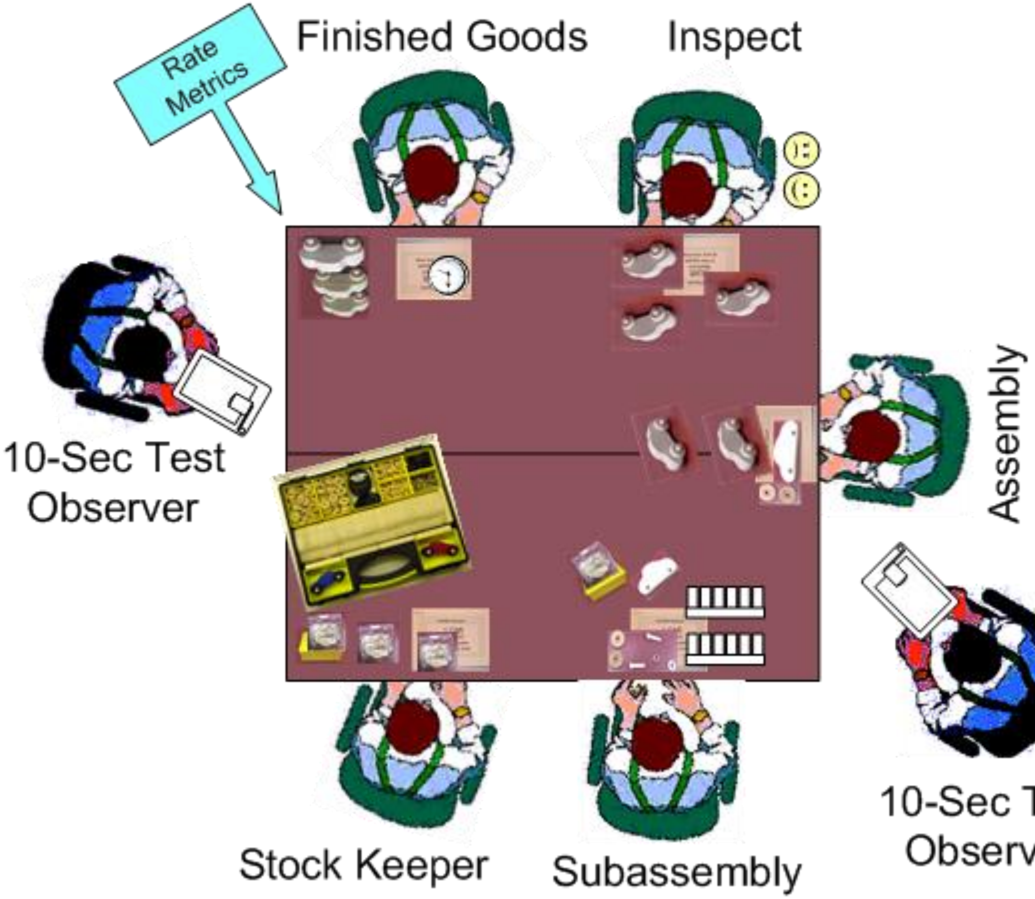
**Step 3**: ASSEMBLER 2: Assemble 4 wheel subs to each car body. Return each empty holding fixture to step 2. Cars move as a 3-pc batch to step 4 after the 3rd car is complete. If a reject car is returned from step 4, repair it. Ask the stock keeper for any necessary new (unpainted) parts. Move the car(s) to step 4 after repair.

**Step 4**: QUALITY INSPECTOR – all four wheels must rotate freely, all wheels plain (not painted). If any cars are reject, move the reject car back to step 3 for repair. Once 3 cars pass inspection, move the batch of 3 to Finished Goods. Keep track of the number of rejects. Once a non-conforming wheel (black) is found at inspection notify the stock keeper to stop inserting black wheels into any new kits.

**Step 5**: FINISHED GOODS / **Timekeeper:** Call START and after 10 minutes, call STOP. If necessary to complete the first delivery to finished goods, allow up to 4 minutes of overtime. Record the time the 1st car batch reaches finished goods. Complete the metrics calculation form for exercise "Batch 'n Queue".

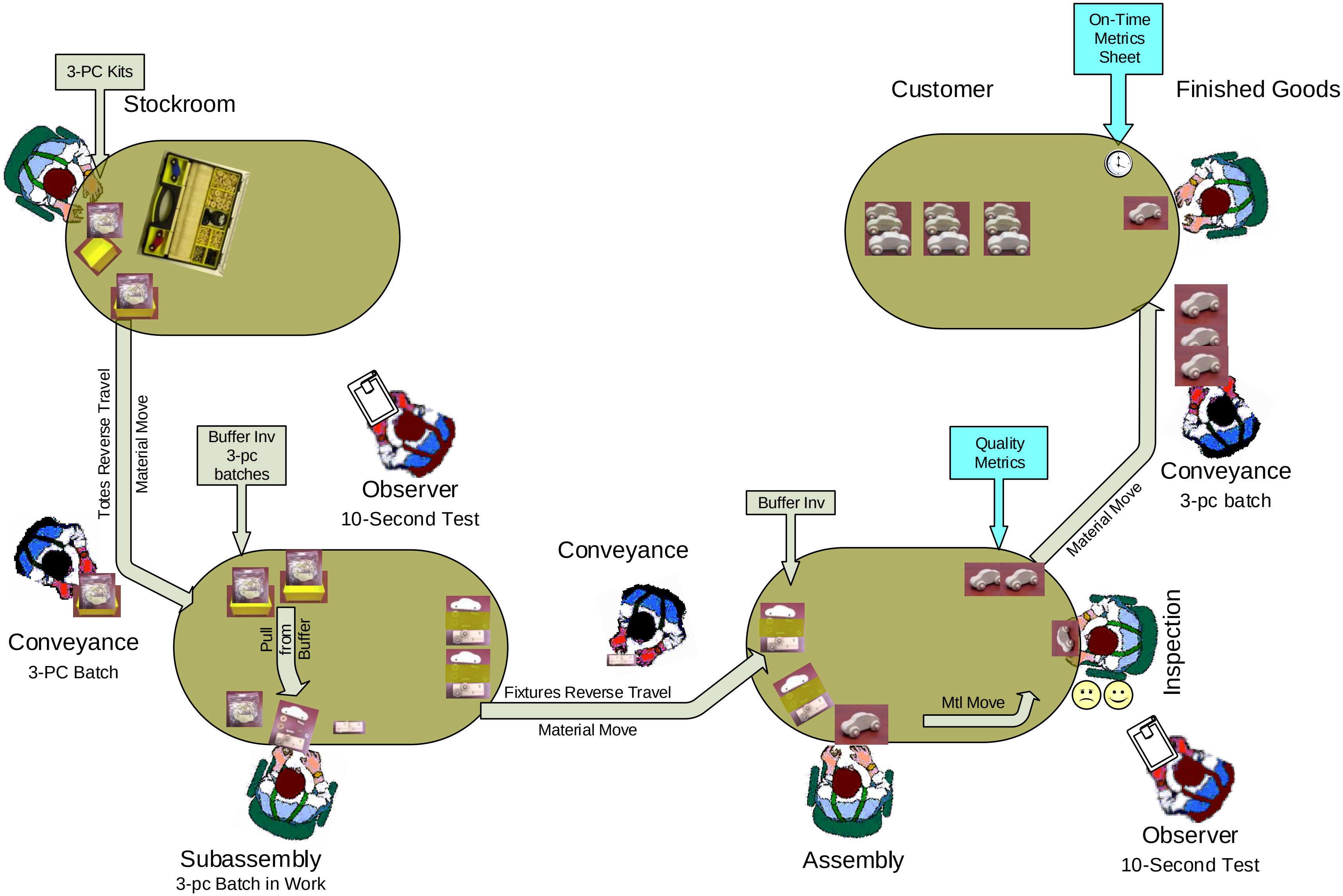
 

The LeanMan




**Learning to See the Waste – Exercise #1 Batch 'n Queue**




Alternate LTSTW Setup with additional participants

# Batch Mode – 3 piece Batch 'n Queue PUSH Method – alternate setups

The table arrangement shown works well in a small training room. If space permits, I recommend you simulate your real spatial conditions in your shop. For instance, often there is quite a distance between the material stockroom and the shop area. In that case, move the stock keeper and the material kit to another table some distance from the assembly table, and include a person to act as material mover between the two areas. The workers call out "Conveyance" to call the material mover to action when needed. *Notice that often the Conveyance person is busy elsewhere and the worker waits for the action to be accomplished.* Highlight if possible any real world problems with this arrangement, such as communication issues, delays, material moving equipment, kit release methods and planning parameters used to control material flow in this environment.

Often the subassembly area is located at a distance from the final assembly area in a Batch 'n Queue shop. Try to simulate your own shops strategy in placement of operations and the material mover system.

In many shops, the quality inspection function is in a separate area and under different management than operations. Often there is a second level of review before material can be dispositioned for rework, and usually there is a non conforming material report (NMR) to be completed before initiating rework. If your company uses such practices, it may be of benefit to add those requirements to the simulation. Have the quality function performed at a separate table and have a simulated NMR form completed for each car returned to the assembly area for rework

If your company uses a final ship table inspection area to re-inspect any product before receiving it to the finished goods warehouse, add that additional function to the simulation as well. It typically is at another area in the shop away from assembly. If using multiple simulation kits in parallel with a large class, try setting up a single quality inspection and finished goods inspection area to service all teams, and observe the impact to flow.

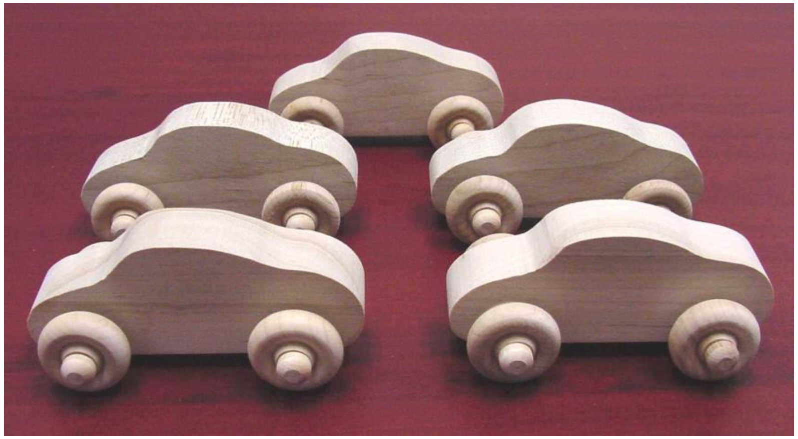
Bottom line, the idea behind the simulation exercise is to condense into a small area like a training room all of the process flows required to produce your product so they may be seen and observed for impact on the five Lean Principles of VALUE, VALUE STREAM, FLOW, PULL and PERFECTION.

# Participation Event #2

The second event, adding local control with point-of-use inventory and built in quality, shows the advantage of becoming lean. Event #2 controls the flow of material using a kanban square between operation steps to signal “what” and “now many” items care permitted at any one time. This will help to see the balance in the flow and to develop takt time.

Notice the elimination of NVA activities associated with de-kiting and returning empty containers. Have the observer participants perform the 10-second test every two minutes (5 times in 10 minutes) and plot the results. Compare the plots to event #1.



# Lean Mode – 1 pc Lean Flow (use POU, Certified Assembler)

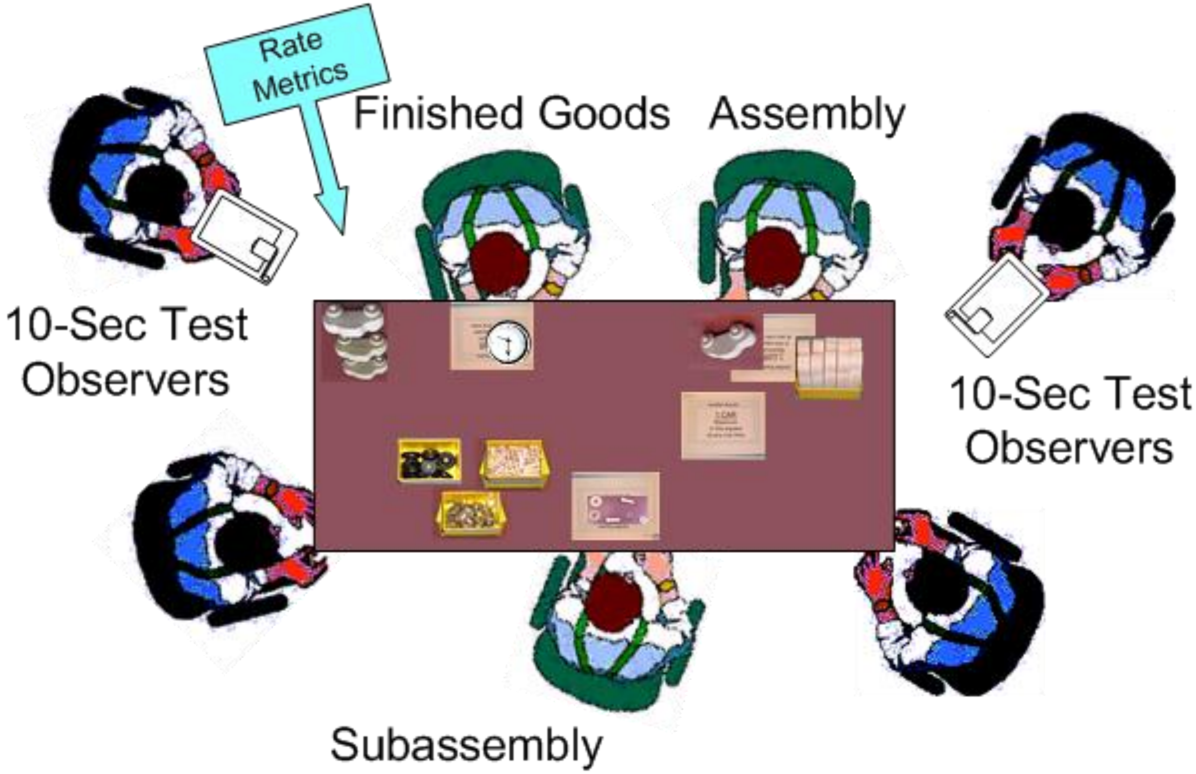
**STOCK KEEPER & QUALITY INSPECTOR** : not needed.
Mix the black painted wheels into the container with plain wheels and place the containers of wheels, axles, and breaks into a point of use (POU) inventory area next to step 1. Place the container of car bodies in a POU area next to step 2. Place the Kanban square between the two stages. Train (certify) the Assembler 1 and 2 participants to inspect for and reject any black painted wheels during the picking process, and to repair non-rotating wheels before passing any assembled car to the next step.

**Step 1**: CERTIFIED SUBASSEMBLER 1: Look at supplied material as it is picked and reject any defect (black wheel). Assemble wheel & break & axle sub and move the sub to step 2's kanban square. Repeat, trying to maintain 4 of the subs in the kanban square, but no more than 4.

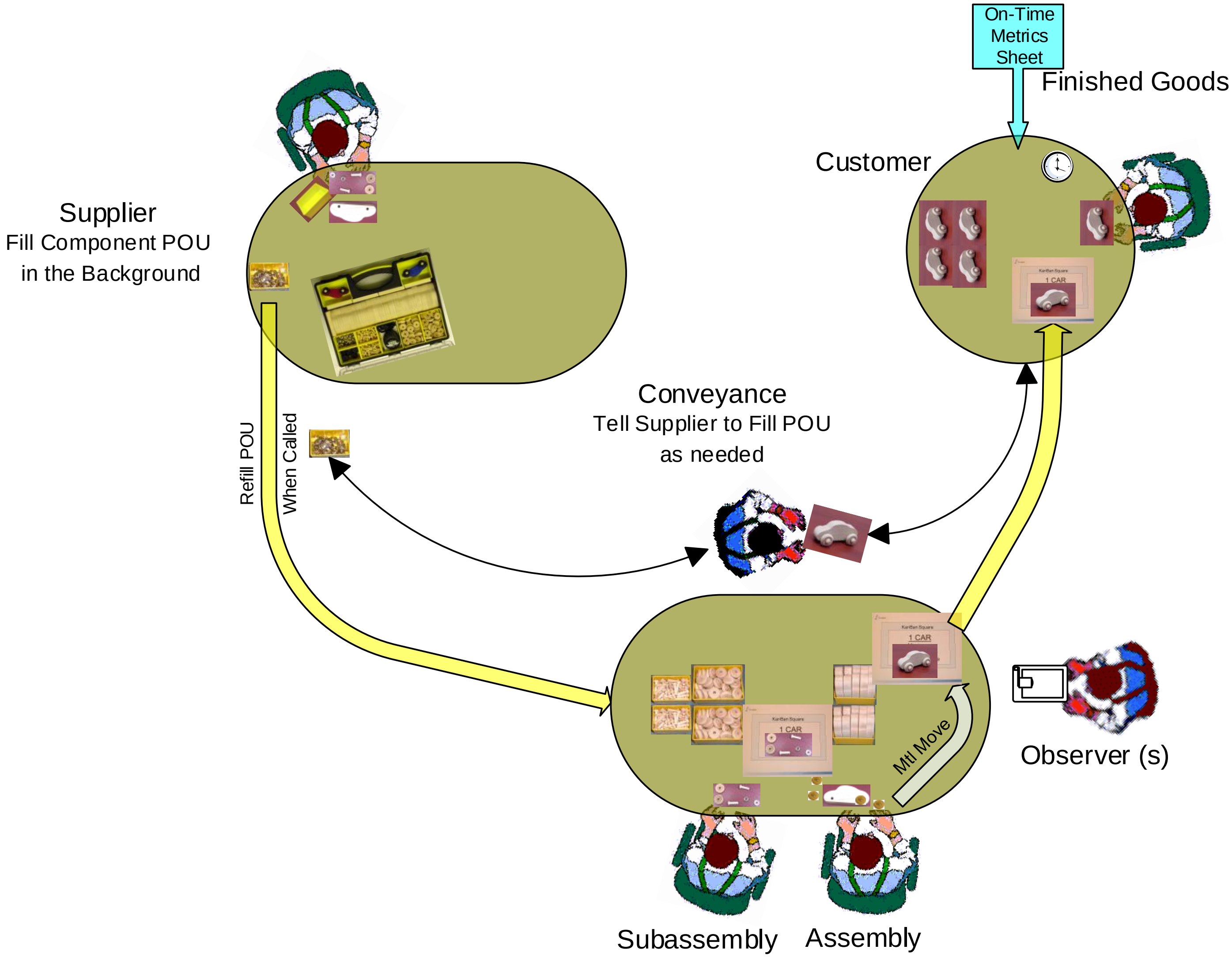
**Step 2**: CERTIFIED ASSEMBLER 2: Look at supplied material as it is picked from the *kanban* square and reject any defect (black wheel) to assembler 1. Pull from the kanban square and assemble 4 of the wheel subs onto the car body. Perform final inspection - the four wheels must rotate freely and all wheels plain (not painted). Adjust as required. Once a car passes inspection, move it to Finished Goods. Repeat until Timekeeper calls STOP.

**Step 3**: FINISHED GOODS / **Timekeeper:** Call START and after 10 minutes, call STOP. If necessary to complete the first delivery to finished goods, allow up to 4 minutes of overtime. Record the time the 1st car reaches finished goods. Complete the metrics calculation form for exercise "Lean".




**Learning to See the Waste – Exercise #2 Lean Flow**




Alternate LTSTW Lean Setup with additional participants

# Lean Mode – 1 pc Lean Flow – alternate setups

In a lean flow system, the material is usually moved to the shop into a Point of Use (POU) area of the work cell, usually split out by operation step and located within reach of each operator. The stock keeper function, if still exits, is to replenish the POU inventory as a background function, often on another shift or by rapid swap of rolling carts, so as to essentially appear nonexistent. So eliminate the stock keeper from the simulation team. Another lean flow concept is to build quality into the product – not inspect it in. So train the assembly operators to perform the quality inspection process, and eliminate the quality inspector person from the simulation team. Highlight if possible any real world problems or improvements with this arrangement, such as communication issues and planning parameters used to control material flow in this environment.

The Lean flow method can use MRP to drive purchasing to bring in material to a forecast date, or it can be set up to use signals to the supplier to deliver more material as POU levels drop to trigger points. The shop disconnects from the MRP signal to build and instead takes it signal from shipping (the customer). When the finished goods area diminishes by one car, the void pulls another car from final assembly, which pulls from subassembly, and each operator picks the material from their POU as needed. No more containers to kit or de-kit or move back upstream to be refilled. This pulling of each job naturally optimizes for shop capacity and flow, and the flexible cross training of operators in the work cell helps to optimize touch labor for optimal labor balance. The result is a more even flow which eliminates inventory build up between operations as each operator naturally adjusts to maintain balance. Each functional operation step now has a common set of priorities and authority to balance flow.

Bottom line, again the idea behind the simulation exercise is to condense into a small area like a training room all of the process flows required to produce your product so they may be seen and observed for impact on the five Lean Principles of VALUE, VALUE STREAM, FLOW, PULL and PERFECTION.

# Calculations

## Measure and Calculate the results:

| | Total Cars Completed | Number Reworked | Number In WIP | Rate Cars/Minute | 1st PC to FGI in SEC |
|---|---|---|---|---|---|
| **Batch 'n Queue "A"** | ________ | ________ | ________ | ( total # cars / sim run time) ________ | (time in sec) ________ |
| | | | | | |
| **Lean "B"** | ________ | ________ | ________ | ( total # cars / sim run time) ________ | (time in sec) ________ |
| | | | | | |
| | =B/A*100 | =A/B*100 | =A/B*100 | =B/A*100 | =A/B*100 |
| | | | | | |
| **Improvement** | % | % | % | % | % |

**Timekeeper:**

Exercise #A: Place the participant instruction placemats with the Batch ‘n Queue steps face up.
Call START and run the simulation for 10 minutes, then call STOP. Overtime up to 4 minutes may be permitted to deliver at least one batch to finished goods. Record the time the 1st car reaches finished goods. Complete the metrics calculation form for each exercise.

Exercise #B: Turn the participant placemats over so the Lean Flow instructions are face up.
Call START and run the lean flow simulation for 10 minutes, call STOP. Record the time the 1st car reaches finished goods. Complete the metrics calculation form for each exercise

Note: the alternate Financial Metric Sheet may be used in place of this format.

| Financial Chart<br>Learning to See the Waste | Run 'A'<br>Batch 'n Queue | | Run 'B'<br>Lean Flow | |
|---|---|---|---|---|
| | | $ | # | $ |
| # Cars delivered x $500 ea = **Total Sales =** | | | | |
| | | | | |
| Cost of Goods Sold | | | | |
| Sales Material = # cars sold x $100 ea | | | | |
| Labor = # workers x $165 ea | | | | |
| Labor OT = # minutes OT x $40 ea worker | | | | |
| Overhead = # Chairs used x $10 ea | | | | |
| Scrap = # nonconforming cars x $100 each | | | | |
| **Total of COGS =** | | | | |
| | | | | |
| Capital Charges | | | | |
| Work in Process | | | | |
| Stockroom = # undelivered kit bags picked x $100 ea | | | | |
| Wheel/Axle/Brake Subassy = # Subassembly Items built x $10 ea | | | | |
| Car Assy = # Undelivered cars built x $60 ea | | | | |
| Inspection = # Cars in inspection x $100 ea | | | | |
| Ship = # Cars in Finished Goods x $100 ea | | | | |
| Facilities | | | | |
| # Tables used x $15 ea | | | | |
| # Fixtures used x $10 ea | | | | |
| **Total Capital Charge =** | | | | |
| | | | | |
| Sales – COGS – Capital Charges =**EVA =** | | | | |

The LeanMan

# 10 Second Test

The LeanMan Production System

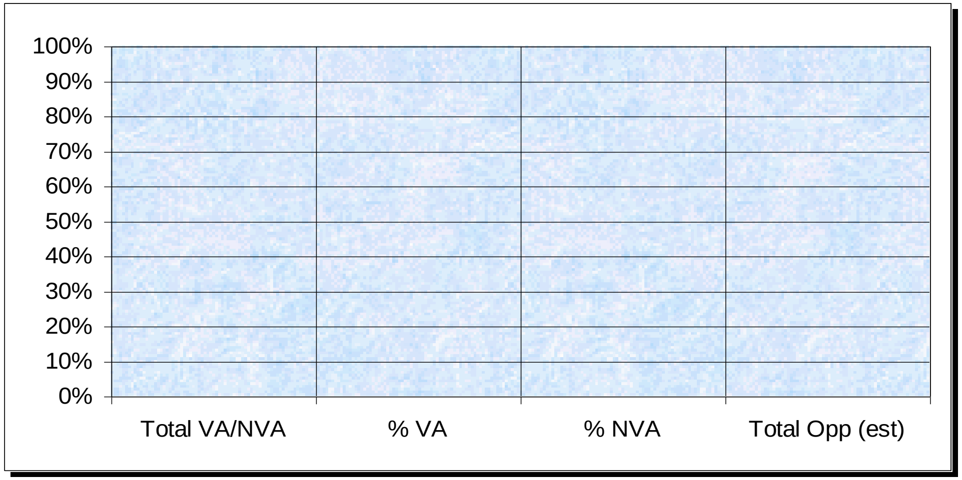
Area

Input No. of Persons Observed

Input No. of Persons Doing VA Work

| Test # | # Observed | | VA (qty) | | NVA (qty) | | Running % NVA |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| **Totals** | | | | | | | |

Total Observed ____________
Total Observed VA ____________
Total Observed NVA ____________
% Activity NVA ____________
**Est Opportunity (%)** ____________
(Shown in Red - 25% of NVA)




***Lean Thinking - developing an "eye for waste"***

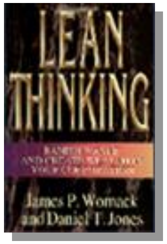
 

The LeanMan

# References:

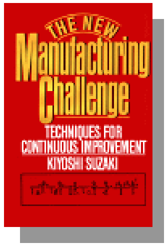
- Lean Thinking

  Author: Daniel Jones, James Womack
  Publisher: Simon & Schuster
  Publication Date: 9/9/1996



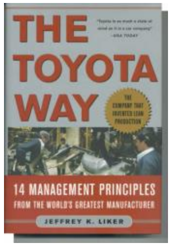

- New Manufacturing Challenge: Techniques for Continuous Improvement

  Author: Kiyoshi Suzaki
  Publisher: The Free Press, a division of Simon & Schuster
  Publication Date: 1987




- The Toyota Way

  Author: Jeffrey K. Liker
  Publisher: McGraw-Hill
  Publication Date: 2004




- Lean Factory Simulation Kits by The LeanMan, LLC

  Lean Principles Training Guide: The Evolution of Lean.
  Lean Principles Training Guide: Teaming with Success.
  Lean Principles Training Guide: Developing Lean Eyes.

  www.TheLeanMan.com