The LeanMan

Lean Factory Simulation Kits

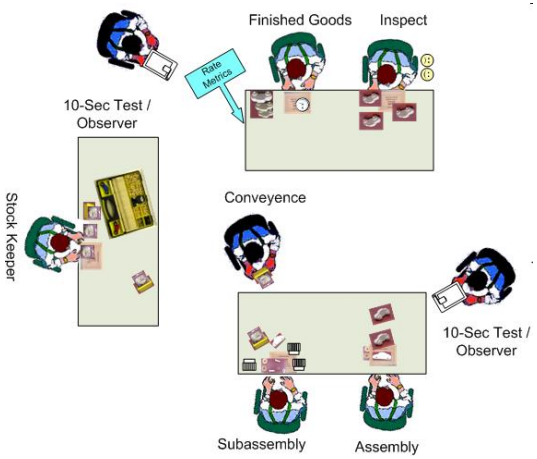
Lean Principles

Facilitator Instructions

Lean Factory Simulation

Facilitator Instructions:

- The exercises should be held in a training room with a tables and chairs for the hands-on participants. The other participants form the observation team, and stand around the table behind the seated operators. Their job is to make observations about the process, the material flow, the occurrence of value-adding and non value-adding activities, and in general work with the facilitator to gather information to be used after the simulation for further discussion.
- Each of the four exercises is intended to be run in sequence, and the facilitator's notes key off each other in that sequence. The transition from Taylor's division of labor principles to Lean principles tends to follow these four steps outlined in the exercises, as company's take small incremental improvements. Feel free to adjust for your needs.
- The greatest lesson to be learned from the simulations is that not all change is lean, and that without keeping an eye on the whole value stream, you may end up with isolated islands of perfection (work cells) linked by systems that are optimized for their own self interest (purchasing, receiving, stockroom, inspection, etc.) without concern for your "island's" needs. Value stream mapping is essential to prevent such unwanted and wasteful results.



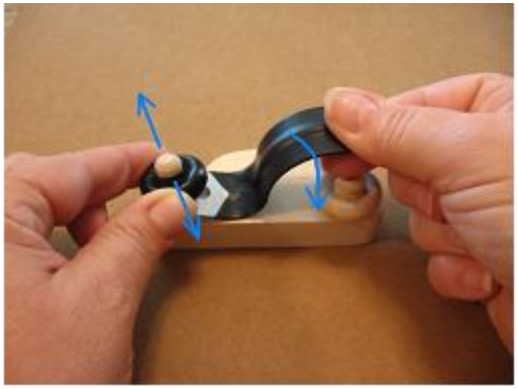
- The facilitator's talking points are things to look for, and point out as they happen during the simulation exercise. The facilitator should move about the class room and talk about each process type as it is being simulated. The talking points are not all inclusive, but are a start. Adlib your own comments about what is happening, and try to inject humor. The observers should be taking notes for later discussion, and perhaps hold a Kaizen event to see what improvement the team may make to the process.
- The placemats for each hands-on participant should be printed out, and laminated if possible. They will greatly aide the timing of the exercise and provide a level of comfort for hesitant participants. It is not recommended running the exercise without them. Feel free to edit them with your company's own logo. And of course, you should customize the exercises to include any of your company's process methods you wish to emphasize.
- The Deluxe Kit comes with the Lean Principles Training Guide: Learning to See the Waste. On it you will find forms and instruction for the 10-Second Test and the 15-Minute Observation. They provide an excellent method for teaching your employees to develop lean eyes, and work well with the four simulation exercises.

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.

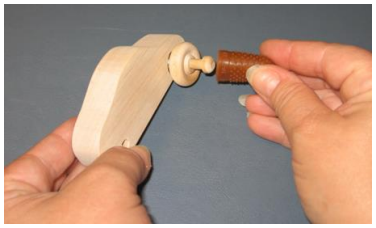
To remove a tight wheel assembly, gently slide the wheel extraction tool under the wheel and around the axle peg.

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.



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Lean Factory Simulation

Exercise #1 Batch ‘n Queue

Facilitator Instructions:

- **Exercise Number 1 - Batch 'n Queue - Taylor's Division of Labor.**
  - The first event, MRP driven Batch 'n Queue, shows the effects of moving large batches of product through several stages. 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, and the delays this can cause. Notice the piles of inventory build up between stages as work imbalance causes material to "buffer" along the flow.
  - Event Options: This event may be run with a single 3-piece batch run down the line, but it is more effective to operate with a series of 3-piece batches continually pushed down the line at the natural pace of the person picking the kits, one job right after another. In this way the points about inventory buffering and line imbalance become most obvious. The facilitator notes assume a continuous operation for 4 minutes plus 4 minutes of OT as required to achieve a delivery to finished goods. Stop after 4 minutes of OT even if no delivery has been made.
  - SET UP and Preparation
    - Requires 5 participants to run the exercise and any number of participants in the NVA observation team.
    - Place the five **Batch 'n Queue** place mats in numbered order around the tables with five chairs as shown in the presentation materials.
      - Position #1. STOCKKEEPER Place the kit of materials in front of this person with the lid open. Get out the five plastic zip lock bags from under the car bodies, and use one large yellow plastic container as a tote box.
      - Position #2. SUBASSEMBLY Place the five subassembly fixtures at this position
      - Position #3. ASSEMBLY - no set up req'd
      - Position #4. INSPECTION - no set up req'd
      - Position #5. TIMEKEEPER Place the metric sheet here, along with the stopwatch
      - Conveyance Person – Optional person to move material, totes, etc between work stages. This simulates one of the 8-Wastes of Production.
    - Have the five participants sit and read the process on their placemat, and tell the observer team to stand behind the participants and watch the action. Tell the timekeeper to call start when ready and start the timer. Tell everyone to follow their process.
    - ***Hand out one of the 10-Second Test forms (deluxe kit only) to the observer team and ask them to perform the 10-Second Test about every minute or so and record the results.***
  - *NOTE: don't take up time explaining the exercise in detail - just get them started. The initial confusion will quickly settle out as activities become obvious. Remind them to read their place mat instructions if they seem stalled.*

Facilitator Instructions:

- **Exercise Number 1 - Batch ‘n Queue - Taylor’s Division of Labor**.
  - Facilitator talking points:
    - **Step 1**: STOCK KEEPER: pick a 3 pc KIT, place all parts for one car into a bag and place three bags into a large yellow container. Container is moved to step 2. Quality Nonconforming: substitute a black wheel into one of the three kits for each batch and observe its affect on flow.
    - Notice when the factory starts up, no one down stream is working.
    - Everyone except the stock keeper starts out the “day” idle, even though the 3-piece batch may be optimum for someone picking kits, it’s not optimum for the value stream (everyone else). The usual result in the shop is the need to buffer kits by picking them a day or two ahead.
    - Notice how the upstream process stops when waiting for totes and bags to return from downstream. This type of problem will cause the shop to buy more totes and fixtures to accommodate all of the excess material the system is pushing through the shop.
    - Picking kits into bags and then into totes and then de-kiting right away at the next step is a lot of double handling of material
    - Did this person hold all 3 kit bags in the batch before moving on to the next step?
    - How is the work load of the Stock Keeper in a Batch ‘n Queue method? Can the stock keeper easily keep up with demand?
    - Could this same stock keeper also pick batch kits for a few other production lines and still keep up with demand? If this same stock keeper were picking kits for 10 different lines, would each line be satisfied with there batch flow?
    - What is the effect of distance between the stockroom and the work area? How well did the Conveyance Person keep up with flow? Did you need two people?

Facilitator Instructions:

- **Exercise Number 1 - Batch ‘n Queue - Taylor’s Division of Labor**.
  - Facilitator talking points:
    - **Step 2**: ASSEMBLER 1: unpack kits and return containers to step 1. Assemble all wheel & break & axle subassemblies, place on holding rack (rack is small wood block with four depressions to hold the subassembly). When all 12 subs are complete, the sub assys and remaining kit parts (car bodies) move as a batch to step 3. Note: build using the painted wheel if supplied, since you are not trained to inspect.
    - Notice as the factory starts to run, no one down stream is working. Everyone except the stock keeper starts out the “day” idle, even though the 3-piece batch may be optimum for someone building subassemblies, it’s not optimum for the value stream (everyone else).
    - Notice how the upstream process work is constrained by the reverse flow of containers and bags. Work stops when no totes and bags are returned from downstream. What is uppermost in the mind of the assembler? Returning totes and bags, or building subassemblies? The work focus is definitely blurred. Different people performing this simulation will make their own unique decisions on what to do first.
    - Picking kits into bags and then into totes and then de-kiting right away at the next step is a lot of double handling of material.
    - Notice the non-conforming quality defect passes right through this process, since the assembler isn’t expected to inspect. Taylor’s division of labor says a second person somewhere downstream will be better qualified to inspect.
    - Notice any other workmanship quality defect, watch for wheels facing inward, or disks placed on backwards. Did this person read the instruction process place mat? Or did this person assume an understanding of the process.
    - Did this person hold all 3 racks of subassemblies before moving on to the next step?

Facilitator Instructions:

- **Exercise Number 1 - Batch ‘n Queue - Taylor’s Division of Labor**.
  - Facilitator talking points:
    - **Step 3**: ASSEMBLER 2: unpack subassemblies and return fixture rack to step 2. Assemble the 4 wheel subs to each car body. All cars move as a batch to step 4 after the 3rd car is complete. If a reject car is returned, repair it. Ask the stock keeper for any necessary new (unpainted) parts. Move the car(s) to step 4 after repair.
    - Notice as the factory continues to run, there are still people down stream not working.
    - Fixturing material and subassemblies are necessary when the material or subassembly must travel some distance to the next assembly point, or must wait in queue for some period of time waiting to be used. It’s a lot of double handling of material and equipment.
    - Notice the non-conforming quality defect passes right through this process as well, since the assembler isn’t expected to inspect.
    - Notice any other workmanship quality defect, such as wheels that won’t rotate.
    - When a nonconforming car is returned from inspection, what did it do to the flow? What decisions were made by the assembler concerning new work versus old repair? Now many nonconforming wheels were in WIP before the inspector returned the first one?
    - Did this person read the instruction process place mat? Or did this person assume an understanding of the process. Did this person hold all 3 sets before moving on to the next step?
    - How has standard work been defined in this Batch ‘n Queue? Is the touch labor required to assemble the car consistent throughout the exercise?
    - Was a Conveyance Person assigned to move materials between Assembly and Inspection? How did the batch move of material affect this person work load?

Facilitator Instructions:

- **Exercise Number 1 - Batch 'n Queue - Taylor's Division of Labor**.
  - Facilitator talking points:
    - **Step 4**: QUALITY INSPECTOR – all four wheels must rotate freely, all wheels plain (not painted). If any cars are reject, identify the reject car and move it back to step 3 for repair. Once all cars pass inspection, move the batch to Finished Goods. Variation – lot reject entire batch to step 3 upon 1st reject condition (without further inspection of remaining cars in the batch). Keep track of the number of rejects.
    - Notice now the factory is running at each stage. Are there still periods when people upstream are not working?
    - How is the flow of bags, containers, and fixture racks back upstream working out? Any work stoppages?
    - What does the WIP look like? Are there piles of material sitting idle along the flow? How is the balance of worker time?
    - What has been the effect of non-conforming quality defects passing through assembly to inspection? Do you agree with Taylor - that a dedicated inspector is the "one best way" process?
    - Notice any other workmanship quality defect, such as wheels that won't rotate. Are inspectors allowed to do minor rework at your company? Or do they push the defect back upstream for rework? For fun, have your inspector fill out your company's non-conforming material report form, and have a "quality manager" sign it before processing the rework. How would this affect the flow?
    - Did this person read the instruction process place mat? Or did this person assume an understanding of the inspection process. Did this person hold all 3 sets before moving on to the next step?

Facilitator Instructions:

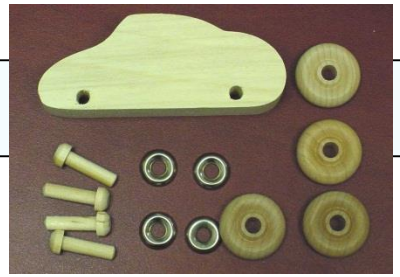
- **Exercise Number 1 - Batch ‘n Queue - Taylor’s Division of Labor**.
  - Facilitator talking points:
    - **Step 5**: Timekeeper: record the start and stop time, and the time the 1st car (batch) reaches finished goods. Record the time for the quality defect (painted wheel) from injection into the stream to repair. **Call STOP when 4 minutes are up if a delivery has been made, or call “Overtime” and allow up to 4 more minutes to attempt a delivery.**
    - Metrics: Measure total time and the number of rejects. Calc Cycle Time = # cars / #minutes.
    - ***Deluxe Kit 10-Second Test Form:***
      - ***Complete the 10-Second Test form with the VA/NVA observations. Plot the results or use the excel spreadsheet provided if a laptop is available (built in calculations and plots). What percentage of time was pure waste?***
      - ***Record NVA observations on flow for later comparison.***
      - ***Have the observation team question the participants on any part of the process to confirm the observations.***
      - ***Hold a Kaizen event with the participants and observation team to discuss how they would improve the batch ‘n queue process (stay with batch ‘n queue methods for purposes of this exercise, and see how much improvement can be made)***

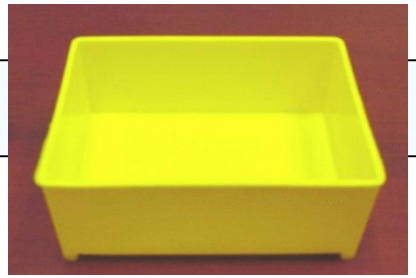
Batch ‘n Queue - Step 1

Stockroom:

1 Pick 3 kits, placing material for each car into a plastic bag, zip lock the bag and place into large yellow container.
2 Move the batch of 3 cars to the next operation
3 Repeat operation when the empty containers are returned from next op.

NOTE: randomly insert a painted wheel into <u>one</u> of the kits in each batch of three until told to stop by the inspection person.





Batch ‘n Queue - Step 2

Wheel / Axle / Brake subassembly:

1 Remove material from plastic container. *Return empty containers to previous op.*
2 Assemble wheel onto axle, curved side of wheel toward axle hub.
3 Slip disk brake onto axle, flat side to wheel’s flat side. Place sub assembly onto fixture by pressing the rounded hub into the fixtures recessed hole.
4 Place 4 subassemblies onto each fixture.
5 Pass entire batch to next operation when all three are complete.

Batch ‘n Queue - Step 3

Car assembly:

1 Remove each wheel subassembly from holding fixture and attach to car body, use clockwise twist as you insert the axle peg. *Return empty holding fixture to previous op.*

2 Move the completed batch of 3 cars to the next operation when all 3 are complete.

Ergonomic Assembly Tool

Use of the tool is highly encouraged to prevent sore fingers over the duration of the simulation event.

Batch ‘n Queue - Step 4

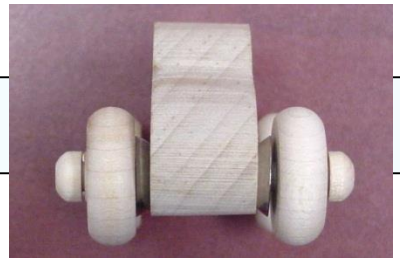
Inspection Criteria:

1 All 4 wheels rotate freely.

2 All 4 wheels unpainted.

Return any reject to previous operation for repair, ***and tell the stock keeper to stop using painted wheels***

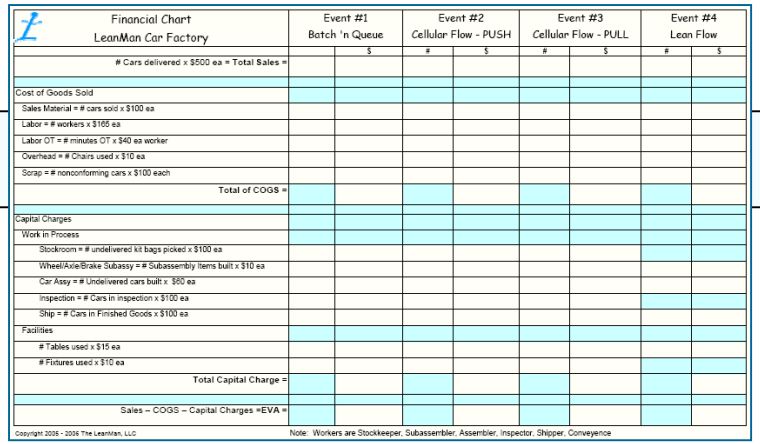
3 If acceptable, pass completed cars in a batch of three pieces to Finished Goods



Batch ‘n Queue - Step 5

Finished Goods / Timekeeper

1 Start the exercise by starting the stopwatch and calling go.
2 Record the metrics in the spaces provided on the metric sheet for exercise 1. Pay attention to the time when the first set of cars reaches Finished Goods and record the time.
3 When ten minutes are up - call stop. Complete the metrics by recording the number of cars in WIP, Quality Defects, etc.



Financial Chart LeanMan Car Factory	Event #1 Batch 'n Queue		Event #2 Cellular Flow - PUSH		Event #3 Cellular Flow - PULL		Event #4 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 =								

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Note: Workers are Stockkeeper, Subassembler, Assembler, Inspector, Shipper, Conveyence

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Exercise #2 Continuous Flow (push)

Facilitator Instructions:

- **Exercise Number 2 - Continuous 1-Piece Flow - MRP Push Method**.
  - The second event, MRP driven Continuous Flow, shows the MRP method of releasing jobs to the shop without regard for resource availability, and the effects of overproduction which simply means producing more sooner or faster than the next stage requires. Notice that although all of the team members are more quickly put to work, inventory still piles up between stages. Notice work is uneven.
  - Event Options: This event may be run with just three 1-piece jobs run down the line, but it is more effective to operate with a continuous series of 1-piece jobs pushed down the line at the natural pace of the person picking the kits, one job right after another. In this way the points about inventory buffering and line imbalance become most obvious. The facilitator notes assume a continuous operation for 4 minutes plus 4 minutes of OT as required to achieve a delivery to finished goods. Stop after 4 minutes of OT even if no delivery has been made.
  - SET UP and Preparation
    - Requires 5 participants to run the exercise and any number of participants in the observation team.
    - Place the five **Continuous Flow - PUSH** place mats in numbered order around the tables with five chairs. Arrange the assembly and inspection tables into a workcell. See suggested layout in the presentation materials.
      - Position #1. STOCKKEEPER Place the kit of materials in front of this person with the lid open. Get out the five plastic zip lock bags from under the car bodies, and use one large yellow plastic container as a tote box.
      - Position #2. SUBASSEMBLY Place the five subassembly fixtures at this position
      - Position #3. ASSEMBLY - no set up req'd
      - Position #4. INSPECTION - no set up req'd
      - Position #5. TIMEKEEPER Place the metric sheet here, along with the stopwatch
      - Conveyance Person – Optional person to move material, totes, etc between work stages.
    - Have the five participants sit and read the process on their place mat, and tell the observer team to stand behind the participants and watch the action. Tell the timekeeper to call start when ready and start the timer. Tell everyone to follow their process.
    - ***Hand out one of the 10-Second Test forms (deluxe kit only) to the observer team and ask them to perform the 10-Second Test about every two minutes and record the results.***
  - *NOTE: don't take up time explaining the exercise in detail - just get them started. The initial confusion will quickly settle out as activities become obvious. Remind them to read their place mat instructions if they seem stalled.*

Facilitator Instructions:

- **Exercise Number 2 - Continuous 1-Piece Flow - MRP Push Method**.
  - Facilitator talking points:
    - **Step 1**: STOCK KEEPER: pick a 1 pc KIT, place all parts for one car into a bag and place the bag into a large yellow container. Container is moved to step 2. Quality Nonconforming: substitute a black wheel into every third kit produced.
    - Notice when the factory starts up, no one down stream is working. Everyone except the stock keeper starts out the "day" idle, even though the 1-piece flow is supposed to improve the value stream (everyone else). The result is there is still a need with 1-piece flow to buffer kits by picking them a day or two ahead.
    - Notice how the upstream process stops less frequently to wait for totes and bags to return from downstream, but the frequency of returns has increased. What is the effect on the stock keeper and first assembly persons time compared to Batch 'n Queue methods?
    - Picking kits into bags and then into totes and then de-kiting right away at the next step is a lot of double handling of material.
    - How does the work load of the Stock Keeper in a 1-piece flow compare to the Batch 'n Queue. Can the stock keeper keep up with demand? Or are kits pilling up at the next op?
    - If this same stock keeper were picking kits for 10 different lines, would each line be satisfied with changing to a 1-piece PUSH flow? Would changing to 1-piece PUSH flow require the company to hire more stock keepers?
    - What is the effect of 1-pc batch size on material movement? How well did the Conveyance Person keep up with flow?

Facilitator Instructions:

- **Exercise Number 2 - Continuous 1-Piece Flow - MRP Push Method**.
  - Facilitator talking points:
    - **Step 2**: ASSEMBLER 1: unpack kit and return container and bag to step 1. Assemble all wheel & break & axle subassemblies, place on holding rack (rack is small wood block with four depressions to hold the subassembly). When all 4 subs are complete, move the subassembly fixture and car body to step 3. Note: build using the painted wheel if supplied.
    - Notice as the factory starts to run, the people down stream start working much quicker than with Batch ‘n Queue, although there is some delay until the line fills with work.
    - Notice how the upstream process work is still constrained by the reverse flow of containers and bags, even though there are plenty of bags. Work stops when no totes are returned from downstream. What is the difference for the assembler with this flow method over Batch ‘n Queue. Is it better?
    - Picking single kits into a bag and then into totes and then de-kiting right away at the next step is still a lot of double handling of material.
    - Notice the non-conforming quality defect passes right through this process, since the assembler isn’t expected to inspect. Taylor’s division of labor says a second person somewhere downstream will be better qualified to inspect.
    - Notice any other workmanship quality defect, watch for wheels facing inward, or disks placed on backwards. Did this person read the instruction process place mat? Or did this person assume an understanding of the process. Did changing to a 1-piece PUSH flow improve the ability to follow process instructions?

Facilitator Instructions:

- **Exercise Number 2 - Continuous 1-Piece Flow - MRP Push Method**.
  - Facilitator talking points:
    - **Step 3**: ASSEMBLER 2: unpack subassemblies and return fixture rack to step 2. Assemble the 4 wheel subs to the car body. Move the car to step 4. If a reject car is returned, repair it. Ask the stock keeper for any necessary new (unpainted) parts. Move the car to step 4 after repair.
    - Notice as the factory continues to run, people down stream are working sooner than with Batch 'n Queue.
    - Notice how the upstream process work is still constrained by the reverse flow of fixture racks. How has the line balanced itself? Are piles of inventory standing idle in some places, while other steps need more work?
    - Fixturing material and subassemblies is necessary when the material or subassembly must travel some distance to the next assembly point, or must wait in queue for some period of time waiting to be used. It's a lot of double handling of material and equipment. Did the need for fixturing change just by going to a 1-piece PUSH flow?
    - Notice the non-conforming quality defect passes right through this process as well, since the assembler isn't expected to inspect.
    - Notice any other workmanship quality defect, such as wheels that won't rotate.
    - When a nonconforming car is returned from inspection, what did it do to the flow? What decisions were made by the assembler concerning new work versus old repair? Now many nonconforming wheels were in WIP before the inspector returned the first one? Now does this compare to the Batch 'n Queue flow?
    - How has standard work been defined in this 1-Piece PUSH method? Is the touch labor required to assemble the car consistent throughout the exercise? Is it different from the Batch 'n Queue?

Facilitator Instructions:

- **Exercise Number 2 - Continuous 1-Piece Flow - MRP Push Method**.
  - Facilitator talking points:
    - **Step 4**: QUALITY INSPECTOR – all four wheels must rotate freely, all wheels plain (not painted). If a car is rejected, move it back to step 3 for repair. Once a car passes inspection, move it to Finished Goods. Variation – allow the inspector to rework the minor rejects (wheels won't rotate). Keep track of the number of rejects.
    - Notice now the factory is running at each stage. Are there still periods when people upstream are not working?
    - How is the flow of bags, containers, and fixture racks back upstream working out? Any work stoppages?
    - What does the WIP look like? Are there piles of material sitting idle along the flow? How is the balance of worker time? Which step has the most idle time?
    - What has been the effect of 1-piece flow on the number of non-conforming quality defects passing through assembly to inspection? Did it improve over Batch 'n Queue? Do you agree with Taylor - that a dedicated inspector is the "one best way" process when dealing with 1-piece jobs?
    - Notice any other workmanship quality defect, such as wheels that won't rotate. Are inspectors allowed to do minor rework at your company? Or do they push the defect back upstream for rework? How would this affect the flow?

Facilitator Instructions:

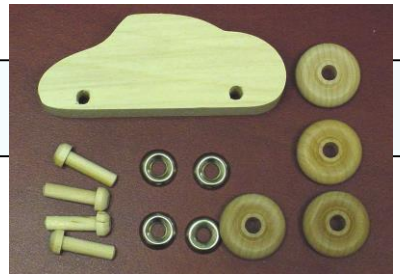
- **Exercise Number 2 - Continuous 1-Piece Flow - MRP Push Method**.
  - Facilitator talking points:
    - **Step 5**: Timekeeper: record the start and stop time, and the time the 1st car reaches finished goods. Record the time for the 1st quality defect (painted wheel) from injection into the stream to repair. **Call STOP when 4 minutes are up if a delivery has been made, or call "Overtime" and allow up to 4 more minutes to attempt a delivery.**
    - Metrics: Measure total time and the number of rejects. Calc Cycle Time = # cars / #minutes.
    - ***Deluxe Kit 10-Second Test Form:***
      - ***Complete the 10-Second Test form with the VA/NVA observations. Plot the results or use the excel spreadsheet provided if a laptop is available (built in calculations and plots). What percentage of time was pure waste? How did this compare to Batch 'n Queue?***
      - ***Record NVA observations on flow for later comparison.***
      - ***Have the observation team question the participants on any part of the process to confirm the observations.***
      - ***Hold a Kaizen event with the participants and observation team to discuss how they would improve the continuous 1-piece flow PUSH process (stay with 1-piece push methods for purposes of this exercise, and see how much improvement can be made)***

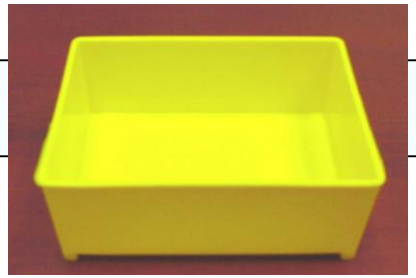
Continuous 1-Piece Flow - MRP Push Method
Step 1

Stockroom:

1 Pick 1 kit, placing material for the car into a plastic bag, zip lock the bag and place into large yellow container.
2 Move the 1-piece job to the next operation
3 Repeat operation when the empty container is returned from the next op.

NOTE: insert a painted wheel into every third kit until told to stop by the inspection person.

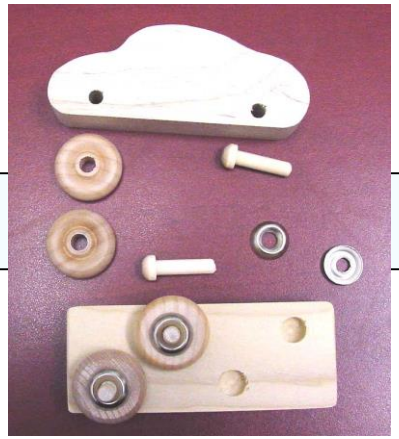




Continuous 1-Piece Flow - MRP Push Method
Step 2

Wheel / Axle / Brake subassembly:

1 Remove material from plastic container. *Return empty container and bag to previous op.*
2 Assemble wheel onto axle, curved side of wheel toward axle hub.
3 Slip disk brake onto axle, flat side to wheel's flat side. Place sub assembly onto fixture by pressing the rounded hub into the fixtures recessed hole.
4 Place 4 subassemblies onto each fixture.
5 Pass the fixture and car body to next operation when complete.



Continuous 1-Piece Flow - MRP Push Method
Step 3

Car assembly:

1 Remove each wheel subassembly from holding fixture and attach to car body, use clockwise twist as you insert the axle peg. *Return empty holding fixture to previous op.*

2 Move the completed car to the next operation when complete.

Ergonomic Assembly Tool

Use of the tool is highly encouraged to prevent sore fingers over the duration of the simulation event.

Continuous 1-Piece Flow - MRP Push Method
Step 4

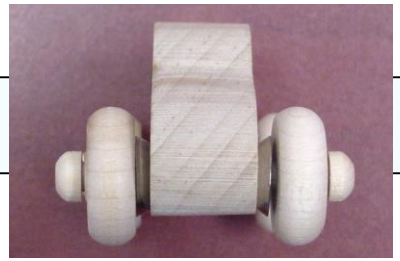
Inspection Criteria:

1 All 4 wheels rotate freely.

2 All 4 wheels unpainted.

Return any reject to previous operation for repair, ***and tell the stock keeper to stop using painted wheels***

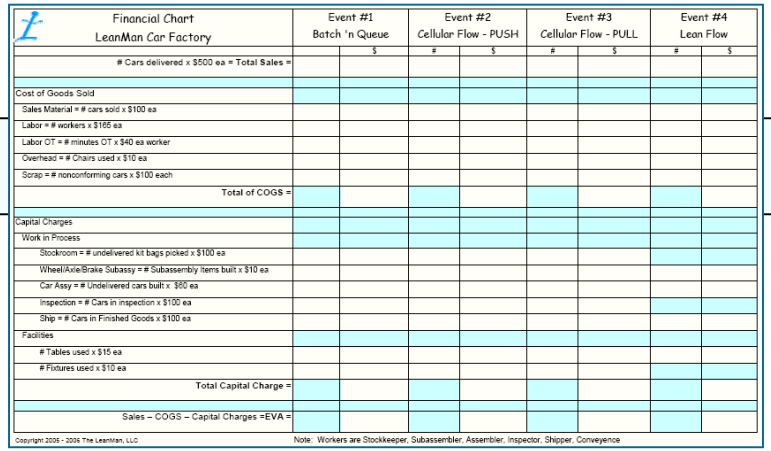
3 If acceptable, pass completed car to Finished Goods



Continuous 1-Piece Flow - MRP Push Method
Step 5

Finished Goods / Timekeeper

1 Start the exercise by starting the stopwatch and calling go.
2 Record the metrics in the spaces provided on the metric sheet for exercise 2. Pay attention to the time when the first car reaches Finished Goods and record the time.
3 When 4 minutes are up - call stop. (Allow up to 4 minutes OT to achieve a delivery) Complete the Financial Metrics sheet



Financial Chart LeanMan Car Factory	Event #1 Batch 'n Queue		Event #2 Cellular Flow - PUSH		Event #3 Cellular Flow - PULL		Event #4 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 =								

Note: Workers are Stockkeeper, Subassembler, Assembler, Inspector, Shipper, Conveyence

The LeanMan

Lean Factory Simulation Kits

Lean Principles

Facilitator Instructions

Lean Factory Simulation

Exercise #3 Continuous Flow (pull system)

Facilitator Instructions:

- **Exercise Number 3 - Continuous 1-Piece Flow - Pull System**.
  - The third event, Continuous Flow with pull system, shows how the MRP method of releasing jobs to the shop can be tempered with a pull system to coordinate resource availability. A kanban pull signal added to Continuous Flow begins to coordinate each team member, controls inventory better, and shows where some obvious balance opportunities exist.
  - This event is more effective to operate with a continuous series of 1-piece jobs pulled through the line at the natural pace of the kanban control, one job after another. In this way the points about inventory buffering and line balance become most obvious. The facilitator notes assume a continuous operation for 4 minutes plus 4 minutes of OT as required to achieve a delivery to finished goods. Stop after 4 minutes of OT even if no delivery has been made.
  - SET UP and Preparation
    - Requires 5 participants to run the exercise and any number of participants in the observation team.
    - Place the five **Continuous Flow - PULL SYSTEM** placemats in numbered order around the tables with five chairs as shown in the presentation materials. Place the **KanBan Square** signal mats at the input to process steps 2,3,and 4
      - Position #1. STOCKKEEPER Place the kit of materials in front of this person with the lid open. Get out the five plastic zip lock bags from under the car bodies, and use one large yellow plastic container as a tote box.
      - Position #2. SUBASSEMBLY Place the five subassembly fixtures at this position
      - Position #3. ASSEMBLY - no set up req'd
      - Position #4. INSPECTION - no set up req'd
      - Position #5. TIMEKEEPER Place the metric sheet here, along with the stopwatch
      - Conveyance Person – Optional person to move material, totes, etc between work stages.
    - Have the five participants sit and read the process on their place mat, and tell the observer team to stand behind the participants and watch the action. Tell the timekeeper to call start when ready and start the timer. Tell everyone to follow their process.
    - ***Hand out one of the 10-Second Test forms (deluxe kit only) to the observer team and ask them to perform the 10-Second Test about every two minutes and record the results.***
  - *NOTE: don't take up time explaining the exercise in detail - just get them started. The initial confusion will quickly settle out as activities become obvious. Remind them to read their place mat instructions if they seem stalled.*

Facilitator Instructions:

- **Exercise Number 3 - Continuous 1-Piece Flow - Pull System**.
  - Facilitator talking points:
    - **Step 1**: STOCK KEEPER: pick a 1 pc KIT, place all parts for one car into a bag and place the bag into a large yellow container. If the next step kanban square is empty, move the kit container into the step 2 kanban square. You may pick another kit, but must wait for the kanban to be empty to deliver it. Quality Nonconforming: substitute a black wheel into every third kit produced.
    - Notice when the factory starts up, no one down stream is working, as in the PUSH method.
    - Everyone except the stock keeper starts out the “day” idle, even though the 1-piece flow is supposed to improve the value stream. The result is there is still a need with 1-piece flow to buffer kits by picking them a day or two ahead if you want the line to start up each day with work.
    - Notice how the upstream process stops less frequently to wait for totes and bags to return from downstream, and unlike the push method, the pull system regulated the exchange frequency. What is the effect on the stock keeper and first assembly persons time compared to Batch ‘n Queue or PUSH methods?
    - Picking kits into bags and then into totes and then de-kiting right away at the next step is still a lot of double handling of material.
    - How does the work load of the Stock Keeper in a 1-piece flow PUSH compare to the 1-piece flow PULL? Can the stock keeper keep up with demand more easily? Notice the lack of excess material in the stream - only the kanban quantities are present.
    - If this same stock keeper were picking kits for 10 different lines, would each line be satisfied with changing to a 1-piece PULL flow? Would changing to 1-piece PULL flow require the company to hire more stock keepers? Would the stock keeper be better able to adjust and balance work load?
    - What is the effect of 1-pc batch size on material movement when regulated by the kanban? How well did the Conveyance Person keep up with this flow?

Facilitator Instructions:

- **Exercise Number 3 - Continuous 1-Piece Flow - Pull System**.
  - Facilitator talking points:
    - **Step 2**: ASSEMBLER 1: pull the kit from the input kanban square, unpack kit and return container and bag to step 1. Assemble all wheel & break & axle subassemblies, place on holding rack (rack is small wood block with four depressions to hold the subassembly). When all 4 subs are complete, move the subassembly fixture and car body into step 3's input kanban square, but only when it is empty. Note: build using the painted wheel if supplied.
    - Notice how the upstream process work is still constrained by the reverse flow of containers and bags, but there is less confusion and less material in the flow. What is the noticeable difference for the assembler with this flow method over the PUSH method. Is it better?
    - Picking single kits into a bag and then into totes and then de-kiting right away at the next step is still a lot of double handling of material.
    - Notice the non-conforming quality defect passes right through this process, since the assembler isn't expected to inspect. Taylor's division of labor says a second person somewhere downstream will be better qualified to inspect.
    - Notice any other workmanship quality defect, watch for wheels facing inward, or disks placed on backwards. Did this person read the instruction process place mat? Or did this person assume an understanding of the process. Did changing to a 1-piece PULL flow improve the ability to follow process instructions?

Facilitator Instructions:

- **Exercise Number 3 - Continuous 1-Piece Flow - Pull System**.
  - Facilitator talking points:
    - **Step 3**: ASSEMBLER 2: pull the subassembly fixture and car body from the input kanban square, unpack subassemblies and return fixture rack to step 2. Assemble the 4 wheel subs to the car body. Move the car into step 4's kanban square, but only if it is empty. If a reject car is returned, repair it. Ask the stock keeper for any necessary new (unpainted) parts. Move the car to step 4 after repair.
    - Notice as the factory continues to run, people down stream are working about as quickly as in the PUSH method, but notice with the PULL system there is less material building up in buffers.
    - How has the line balanced itself with the PULL system? Are some people idle while others need more work? Are the kanban signals holding some material back until needed?
    - Fixturing material and subassemblies is necessary when the material or subassembly must travel some distance to the next assembly point, or must wait in queue for some period of time waiting to be used. It's a lot of double handling of material and equipment. Did the need for fixturing change just by going to a 1-piece PULL flow?
    - Notice the non-conforming quality defect passes right through this process as well, since the assembler isn't expected to inspect.
    - Notice any other workmanship quality defect, such as wheels that won't rotate. Has workmanship changed with Batch 'n Queue? With PUSH ? With PULL?
    - When a nonconforming car is returned from inspection, what did it do to the flow in a PULL system? Does it cause the input kanban to remain full while the rework is occurring, thus stopping the line upstream? What decisions were made by the assembler concerning new work versus old repair? Now many nonconforming wheels were in WIP before the inspector returned the first one? Now does this compare to the PUSH flow?
    - How has standard work been defined in this 1-Piece PULL method? Is the touch labor required to assemble the car consistent throughout the exercise? Is it different from the Batch 'n Queue? Or from the 1-Piece PUSH?

Facilitator Instructions:

- **Exercise Number 3 - Continuous 1-Piece Flow - Pull System**.
  - Facilitator talking points:
    - **Step 4**: QUALITY INSPECTOR – all four wheels must rotate freely, all wheels plain (not painted). If a car is rejected, move it back to step 3 for repair. Once a car passes inspection, move it to Finished Goods. Variation – allow the inspector to rework the minor rejects (wheels won't rotate). Keep track of the number of rejects.
    - Notice now the factory is running at each stage. Are there still periods when people upstream are not working?
    - How is the flow of bags, containers, and fixture racks back upstream working out? Any work stoppages?
    - What does the WIP look like? Are there piles of material sitting idle along the flow? How is the balance of worker time? Which step has the most idle time?
    - What has been the effect of 1-piece flow on the number of non-conforming quality defects passing through assembly to inspection? Did it improve over Batch 'n Queue? Do you agree with Taylor - that a dedicated inspector is the "one best way" process when dealing with 1-piece jobs?
    - Notice any other workmanship quality defect, such as wheels that won't rotate. Are inspectors allowed to do minor rework at your company? Or do they push the defect back upstream for rework? How would this affect the flow?

Facilitator Instructions:

- **Exercise Number 3 - Continuous 1-Piece Flow - Pull System**.
  - Facilitator talking points:
    - **Step 5**: Timekeeper: record the start and stop time, and the time the 1st car reaches finished goods. Record the time for the 1st quality defect (painted wheel) from injection into the stream to repair. **Call STOP when 4 minutes are up if a delivery has been made, or call "Overtime" and allow up to 4 more minutes to attempt a delivery.**
    - Metrics: Measure total time and the number of rejects. Calc Cycle Time = # cars / #minutes.
    - ***Deluxe Kit 10-Second Test Form:***
      - ***Complete the 10-Second Test form with the VA/NVA observations. Plot the results or use the excel spreadsheet provided if a laptop is available (built in calculations and plots). What percentage of time was pure waste? How did this compare to Batch 'n Queue?***
      - ***Record NVA observations on flow for later comparison.***
      - ***Have the observation team question the participants on any part of the process to confirm the observations.***
      - ***Hold a Kaizen event with the participants and observation team to discuss how they would improve the continuous 1-piece flow PULL process (stay with 1-piece pull methods for purposes of this exercise, and see how much improvement can be made)***

Continuous 1-Piece Flow - Pull System
Step 1

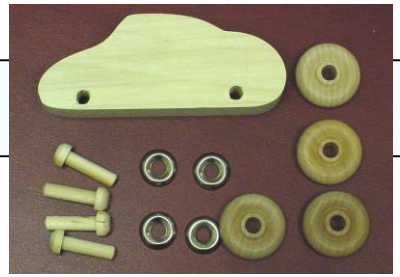
Stockroom:

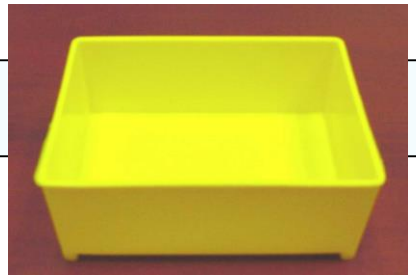
1 Pick 1 kit, placing material for the car into a plastic bag, zip lock the bag and place into large yellow container.

2 Move the 1-piece job into step 1's KanBan Square, but *only* if it is empty.

3 Repeat operation when the empty container is returned from the next op.

NOTE: insert a painted wheel into every third kit until told to stop by the inspection person.





Continuous 1-Piece Flow - Pull System

Step 2 Input Kanban

Maximum:
1 Car kit

Place this Square between the Stockroom and Subassembly positions

Continuous 1-Piece Flow - Pull System
Step 2

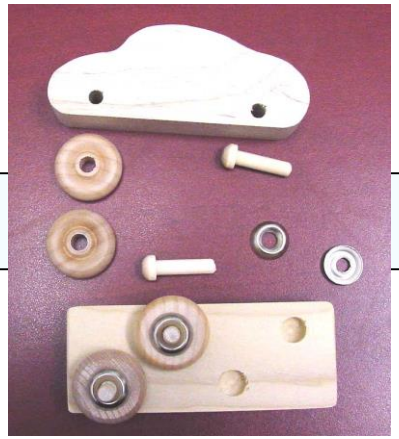
Wheel / Axle / Brake subassembly:

1 Pull the kit from the KanBan Square, remove bag from plastic container empty bag. *Return the empty container and bag to previous op.*

2 Assemble wheel onto axle, curved side of wheel toward axle hub. Slip disk brake onto axle, flat side to wheel's flat side. Place sub assembly onto fixture by pressing the rounded hub into the recessed hole.

4 Place 4 subassemblies onto each fixture.

5 Pass the fixture and car body into step 3's KanBan Square, but only if it is empty.



Continuous 1-Piece Flow - Pull System

Step 3 Input Kanban

Maximum:
1 subassembly fixture
and 1 Car Body

Place this Square between the Subassembly & Car Assembly positions

Continuous 1-Piece Flow - Pull System
Step 3

Car assembly:

1 Pull the fixture and car body from the KanBan Square, remove each wheel subassembly from holding fixture and attach to car body, use clockwise twist as you insert the axle peg. *Return empty holding fixture to previous op.*

2 Move the completed car into step 4's KanBan Square when complete, but only if it is empty.

Use of the tool is highly encouraged to prevent sore fingers over the duration of the simulation event.

Continuous 1-Piece Flow - Pull System

Step 4 Input Kanban

Maximum:
1 completed Car
(or 1 repaired car)

Place this Square between the Car Assembly and Inspection positions

Continuous 1-Piece Flow - Pull System
Step 4

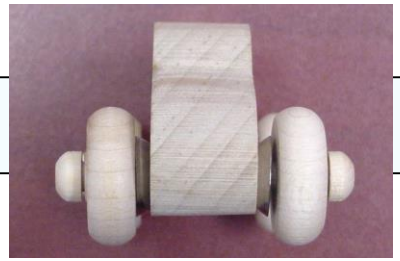
Inspection Criteria:

1 All 4 wheels rotate freely.

2 All 4 wheels unpainted.

Return any reject to previous operation for repair, ***and tell the stock keeper to stop using painted wheels***

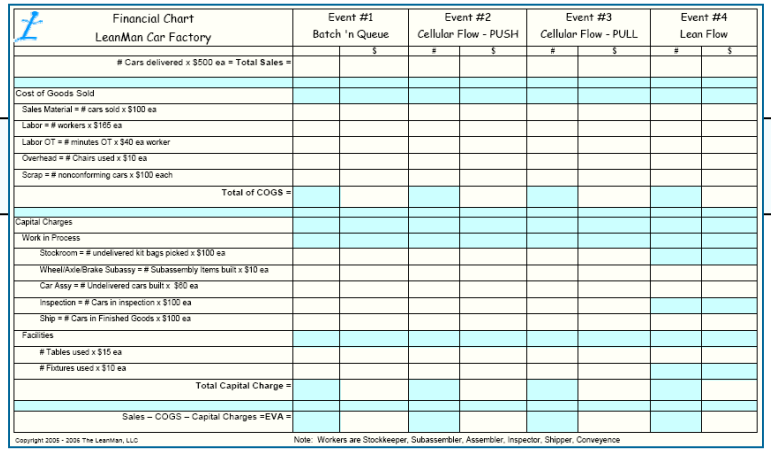
3 If acceptable, pass completed car to Finished Goods



Continuous 1-Piece Flow - Pull System
Step 5

Finished Goods / Timekeeper

1 Start the exercise by starting the stopwatch and calling go.
2 Record the metrics in the spaces provided on the metric sheet for exercise 3. Pay attention to the time when the first car reaches Finished Goods and record the time.
3 When 4 minutes are up - call stop. (Allow up to 4 minutes OT to achieve a delivery) Complete the Financial Metrics sheet



Financial Chart LeanMan Car Factory	Event #1 Batch 'n Queue		Event #2 Cellular Flow - PUSH		Event #3 Cellular Flow - PULL		Event #4 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 =								

Note: Workers are Stockkeeper, Subassembler, Assembler, Inspector, Shipper, Conveyence

The LeanMan

Lean Factory Simulation Kits

Lean Principles

Facilitator Instructions

Lean Factory Simulation

Exercise #4 Lean Flow

Facilitator Instructions:

- **Exercise Number 4 - Lean Flow**
  - The fourth event, Lean Flow with pull system, adding local control with point-of-use inventory and built in quality, shows the advantage of becoming lean. Notice the elimination of NVA activities associated with de-kiting and returning empty containers.
  - This event is more effective to operate with a continuous flow through the line at the natural pace of the kanban control, one job after another. In this way the points about inventory buffering and line balance become most obvious. The facilitator notes assume a continuous operation for 4 minutes plus 4 minutes of OT as required to achieve a delivery to finished goods. Stop after 4 minutes of OT even if no delivery has been made.
  - SET UP and Preparation
    - Requires 3 participants to run the exercise and any number of participants in the observation team.
    - Place the three **Lean Flow** place mats in numbered order around a single table with three chairs. Place the **Lean Flow KanBan Square** signal mat at the input to process step 2.
      - Position #1. SUBASSEMBLY Place the yellow containers of wheels, axle pegs and break disks into a Point of Use inventory area in front of this person. Mix the painted wheels into the containers with the plain wheels.
      - Position #2. ASSEMBLY Place the car bodies into a POU inventory area in front of this person.
      - Position #3. TIMEKEEPER Place the metric sheet here, along with the stopwatch
    - The two assembly operators are now trained Certified Inspectors, and are expected to build quality in as they perform their tasks.
    - Have the three participants sit and read the process on their place mat, and tell the observer team to stand behind the participants and watch the action. Tell the timekeeper to call start when ready and start the timer. Tell everyone to follow their process.
    - ***Hand out one of the 10-Second Test forms (deluxe kit only) to the observer team and ask them to perform the 10-Second Test about every two minutes and record the results.***
  - *NOTE: don't take up time explaining the exercise in detail - just get them started. The initial confusion will quickly settle out as activities become obvious. Remind them to read their place mat instructions if they seem stalled.*

Facilitator Instructions:

- **Exercise Number 4 - Lean Flow**
  - Facilitator talking points:
    - **Step 1**: ASSEMBLER 1: pick a wheel, axle peg and disk from the Point of Use inventory. Assemble the wheel & break & axle subassembly and place it into step 2's input kanban square, but only if it holds less then four subassemblies. Note: inspect as you go, and reject the painted wheel if picked.
    - Notice how everyone in this lean flow begins to work almost at once, and work develops a natural balance. Notice how difficult it is to keep four subassemblies in the KANBAN square as they are quickly used by the final assembly stage.
    - Notice nothing travels back upstream to interfere with the flow
    - Picking material from the POU inventory eliminates the double handling of parts
    - Quality nonconforming material (black wheels) are found and removed from the flow immediately
    - Quality mistakes still happen - but now they are a function of workmanship and more easily resolved. Taylor's division of labor says a second person somewhere downstream will be better qualified to inspect, but in most instances, the additional skills required to perform inspection is consistent with the set of skills necessary to perform the process operation.
    - Notice any other workmanship quality defect, watch for wheels facing inward, or disks placed on backwards. Did this person read the instruction process place mat? Or did this person assume an understanding of the process. Did changing to a Lean Flow improve the ability to follow process instructions?

Facilitator Instructions:

- **Exercise Number 4 - Lean Flow**
  - Facilitator talking points:
    - **Step 2**: ASSEMBLER 2: Pick the car body from the POU material and pick each wheel subassembly from the KanBan square as needed, inspecting for (and rejecting) any with a painted wheel. Attach each wheel subassembly to the car body, use clockwise twist as you insert the axle peg, and inspect for freely rotating wheel. Adjust as required. Move the car to the Finished Goods area when complete
    - Notice as the factory continues to run, both assembly steps are working about as quickly as possible and there is less material building up in buffers. Notice the KanBan quantity. Does it ever reach four?
    - How has the line balanced itself with the Lean system? Is one person idle while other needs work? Is the kanban signal really necessary in a lean flow? Why would you still need it to hold material back?
    - What happens to totes, containers, fixture racks and such in a 1-piece lean flow?
    - Notice the non-conforming quality defects in this process. Are some types of wrong material still likely to get by the CI assembler? What does this mean for the receiving inspection process in a lean enterprise?
    - Notice any other workmanship quality defect, such as wheels that won't rotate. Has workmanship changed with Lean Flow?
    - What differences are there between the 1-piece PULL flow and the Lean Flow? Is ownership of the process more evident? Has decision making been pushed down to the root level? If the workcell operators are expected to make good decisions, what additional training do they need?
    - How has standard work been defined in this Lean Flow method? Is the touch labor required to assemble the car consistent throughout the exercise? Is it different from the Batch 'n Queue? Or from the 1-Piece PUSH? Or the 1-Piece Pull? Touch labor really doesn't change between any of the methods, but the amount of time spent on waste activities declines dramatically.
    - Taylor said that "supervisors think - workers work" What would be some differences in how a supervisor might supervise a lean flow compared to Batch 'n Queue? To 1-Piece PUSH? To 1-Piece PULL? As decision making is pushed lower and lower into the organization, does the supervisor's role seem to shift from one of 'director' to one of 'mentor and coach'?

Facilitator Instructions:

- **Exercise Number 4 - Lean Flow**
  - Facilitator talking points:
    - **Step 3**: Timekeeper: record the start and stop time, and the time the 1st car reaches finished goods. Record the time for the 1st quality defect (painted wheel) from injection into the stream to repair. **Call STOP when 4 minutes are up, use up to 4 minutes of OT if necessary to make delivery.**
    - Metrics: Measure total time and the number of rejects. Calc Cycle Time = # cars / #minutes.
    - Notice the increase in frequency of repetitive motions - discuss ergonomics and safety in a lean flow
    - How many cars were delivered in the 4 minutes? Was there an obvious improvement in the *speed* of operations right from the start?
    - Compare the metrics and discuss the observations for all four exercise simulations.
    - ***Deluxe Kit 10-Second Test Form:***
      - ***Complete the 10-Second Test form with the VA/NVA observations. Plot the results or use the excel spreadsheet provided if a laptop is available (built in calculations and plots). What percentage of time was pure waste? How did Lean Flow compare to Batch 'n Queue? To 1-piece PUSH? To 1-piece PULL?***
      - ***Record NVA observations on flow for later comparison.***
      - ***Have the observation team question the participants on any part of the process to confirm the observations.***
      - ***Hold a Kaizen event with the participants and observation team to discuss how they would improve the continuous 1-piece Lean Flow process (stay with Lean Flow methods for purposes of this exercise, and see how much improvement can be made)***

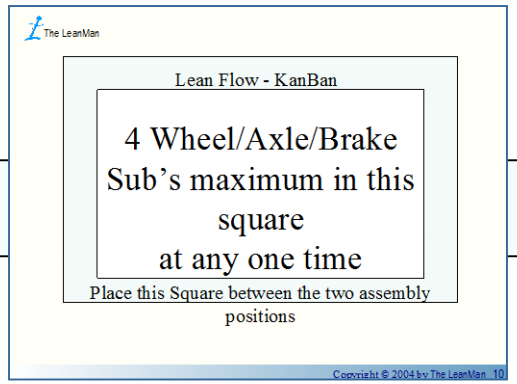
Lean Flow
Step 1

Wheel / Axle / Brake subassembly:

1 Pick material from the POU bins, inspecting for nonconforming material (discard and do not use and painted wheel)

2 Assemble wheel onto axle, curved side of wheel toward axle hub.

3 Slip disk brake onto axle, flat side to wheel's flat side. Place sub assembly into the KANBAN square. *No more then 4 at any one time*



Lean Flow
KanBan

Maximum:
4 Wheel/Axle/Brake
Sub's in this square
at any one time

Place this Square between the Subassembly & Car Assembly positions

Lean Flow
Step 2

Car assembly:

1 Pick the car body from the POU material and pick each wheel subassembly from the KanBan square as needed, inspecting for (and rejecting) any with a painted wheel.

2 Attach each wheel subassembly to the car body, use clockwise twist as you insert the axle peg, and inspect for freely rotating wheel. Adjust as required.

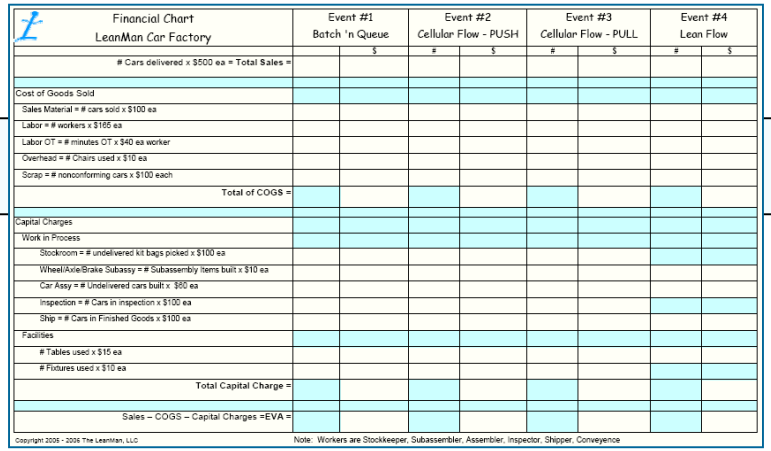
3 Move the car to the Finished Goods area when complete.

Use of the tool is highly encouraged to prevent sore fingers over the duration of the simulation event.

Lean Flow
Step 3

Finished Goods / Timekeeper

1 Start the exercise by starting the stopwatch and calling go.
2 Record the metrics in the spaces provided on the metric sheet for exercise 4. Pay attention to the time when the first car reaches Finished Goods and record it.
3 When 4 minutes are up - call stop. (Allow up to 4 minutes OT to achieve a delivery) Complete the Financial Metrics sheet



Financial Chart LeanMan Car Factory	Event #1 Batch 'n Queue		Event #2 Cellular Flow - PUSH		Event #3 Cellular Flow - PULL		Event #4 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 =								

Note: Workers are Stockkeeper, Subassembler, Assembler, Inspector, Shipper, Conveyence

Financial Chart LeanMan Car Factory	Event #1 Batch 'n Queue		Event #2 Cellular Flow - PUSH		Event #3 Cellular Flow - PULL		Event #4 Lean Flow	
		$	#	$	#	$	#	$
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Capital Charges								
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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 =**								
Production Velocity (4 minute run plus OT)								
Number of Minutes Worked plus OT								
Number of Cars Produced (sold + FG Inv)								
Production Rate =								

Note: Workers are Stockkeeper, Subassembler, Assembler, Inspector, Shipper, Conveyence

Financial Chart is available as an Excel File on the CD