The LeanMan

Lean Factory Simulation Kits

Lean Principles

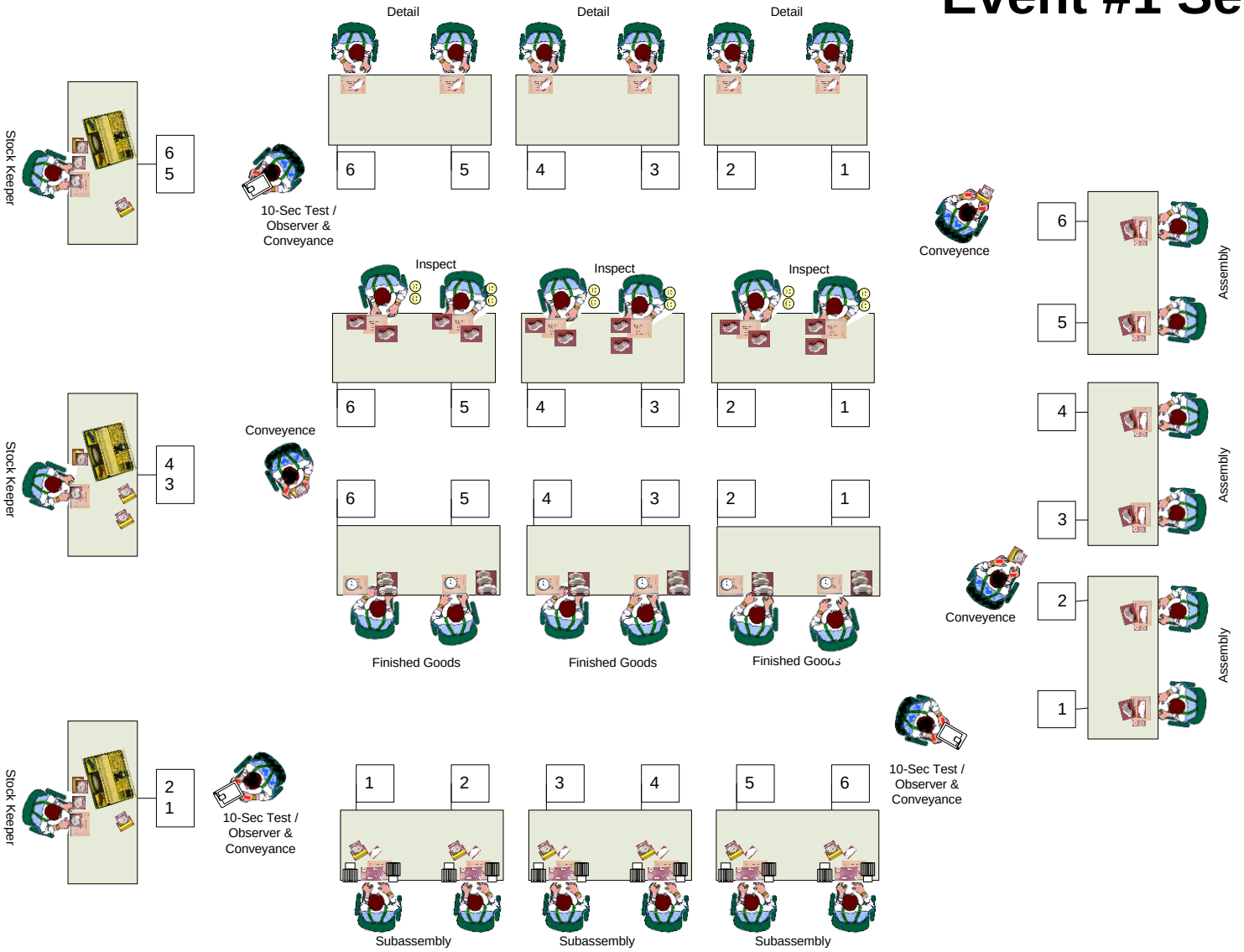
Participant Instruction Placemats

Lean Car Factory Simulation

Event #1 Batch ‘n Queue

Large Group Version

Event #1 Setup



Factory Simulation – Exercise #1 2-PC Batch 'n Queue PUSH

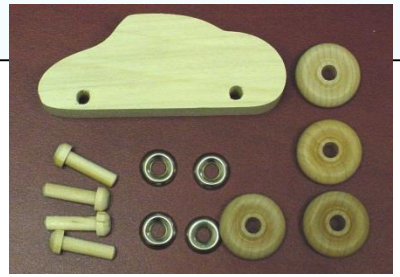
Six teams organized traditionally by functional department

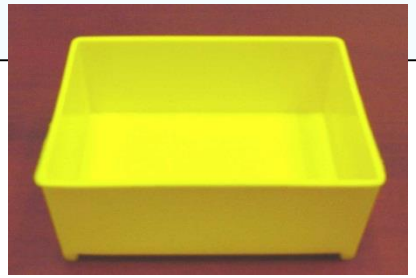
Department #1
Batch ‘n Queue

Stockkeeper:

1 Pick 2 kits, placing material for each car into a plastic bag, zip lock the bag and place the 2 bags into large yellow container.
2 Move the batch of 2 cars to the output and call “conveyance.” When supporting two teams, alternate delivery to each team in a round-robin fashion.
3 Repeat the operation as quickly as possible, but you may need to wait for the return of empty containers.

NOTE: insert one painted wheel into 1 of the 2 kit bags in each batch job for each team until told to stop by the team’s inspection person (via conveyance).





Department #2

Batch ‘n Queue

Wheel / Axle / Brake Subassembly:

1 Remove material from plastic container. Place empty containers in Dept output for return.

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 fixture’s recessed hole.

4 Place 4 subassemblies onto each fixture.

5 Place the car bodies into a tote and place with the set of loaded fixtures into the output and call “conveyance.”

Department #3

Batch ‘n Queue

Car Assembly:

1 Remove each wheel subassembly from holding fixture and attach to car body, use clockwise twist as you insert the axle peg. Place empty holding fixture in department output area.

2 Move the completed batch of cars to the Dept output and call “conveyance”

3 If a car is returned for repair, determine the rework (loosen the wheel or replace a black wheel with a new plain wheel from stock – call conveyance to obtain a wheel)

Ergonomic Assembly Tool

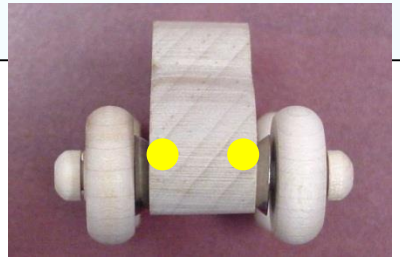
Use of the tool is highly encouraged to prevent sore fingers over the duration of the simulation event.

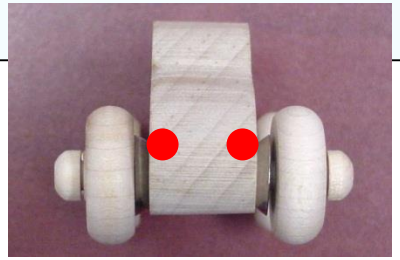
Department #4

Batch ‘n Queue

Car Detail:

1 Apply two yellow stick-on dots to the front of the car as headlights.
2 Apply two red stick-on dots to the back of the car as tail lights.
3 Move the completed batch of cars to the dept output and call “conveyance”





Department #5

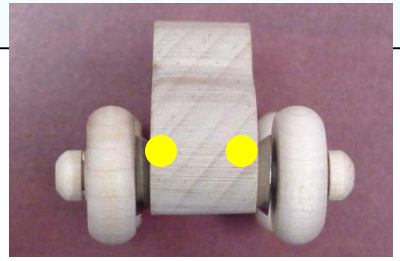
Batch ‘n Queue

Inspection Criteria:

1 All 4 wheels rotate freely.

2 All 4 wheels unpainted. Return any rejected cars to Dept #3 Assembly for repair, ***and tell the stock keeper to stop using painted wheels.***
(the conveyance person carries the message)

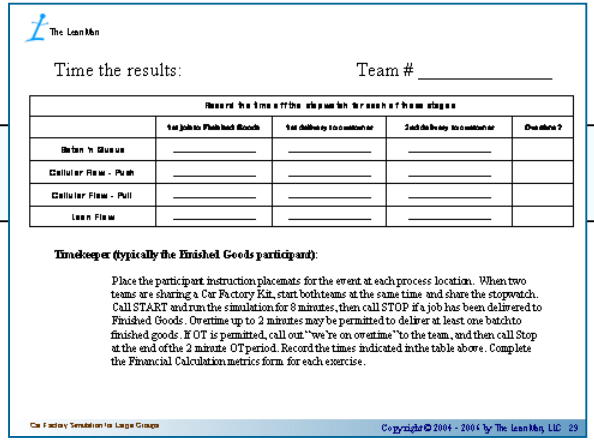
3 If the batch is acceptable, pass completed cars to the dept output to be delivered to Dept #6 Finished Goods. Call “conveyance.”



Department #6
Batch ‘n Queue

Finished Goods / Timekeeper

1 Start the exercise by starting the stopwatch and calling go.
2 Deliver cars in sets of 3, the first at 4.0 minutes and the 2nd at 8.0 minutes. Do not deliver early.
3 Record the metrics in the spaces provided on the *time the results* form for event 1. Follow the instructions on the form for event timing requirements.
4 Complete the Financial chart with the help of the facilitator and the team.


The LeanMan

Time the results: Team # _____

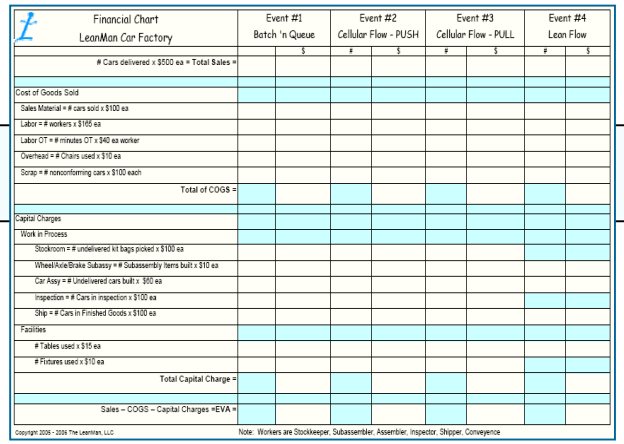
Record the times of the stopwatch for each of these stages				
	1st job to Finished Goods	1st delivery to customer	2nd delivery to customer	Overtime?
Batch ‘n Queue	_____	_____	_____	
Cellular Flow - Push	_____	_____	_____	
Cellular Flow - Pull	_____	_____	_____	
Lean Flow	_____	_____	_____	

Timekeeper (typically the Finished Goods participant):

Place the participant instruction placemats for the event at each process location. When two teams are sharing a Car Factory Kit, start both teams at the same time and share the stopwatch. Call START and run the simulation for 8 minutes, then call STOP if a job has been delivered to Finished Goods. Overtime up to 2 minutes may be permitted to deliver at least one batch to finished goods. If OT is permitted, call out "we're on overtime" to the team, and then call Stop at the end of the 2 minute OT period. Record the times indicated in the table above. Complete the Financial Calculation metrics form for each exercise.

Car Factory Simulation for Large Groups

 29


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, Conveyance

The LeanMan

Lean Factory Simulation Kits

Lean Principles

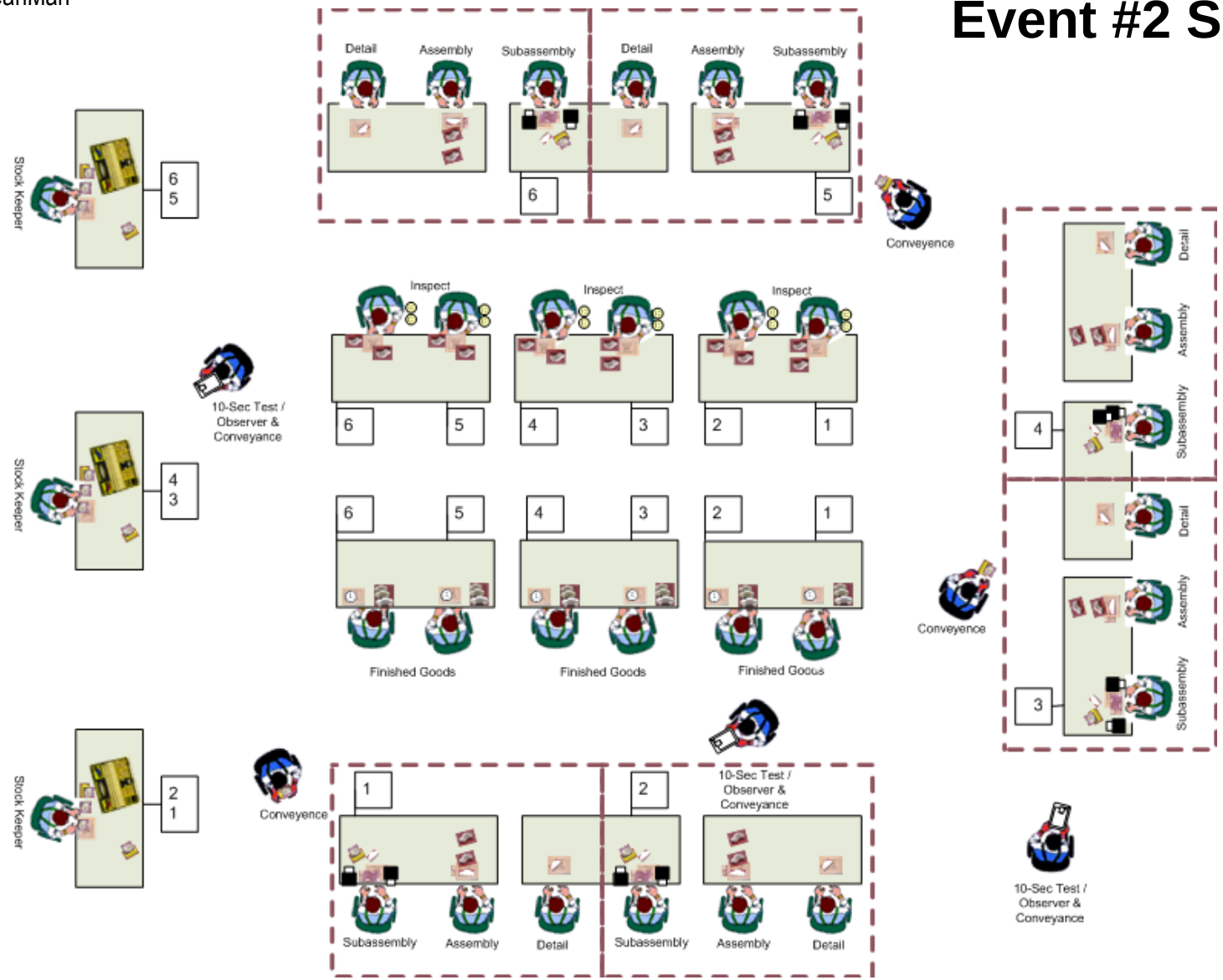
Participant Instruction Placemats

Lean Car Factory Simulation

Event #2 Cellular Flow (push)

Large Group Version

Event #2 Setup



Factory Simulation – Exercise #2 2-PC Batch and 1-pc Work Cell PUSH

Six assembly teams organized in work cells, supported by functional departments

Department #1

Cellular Flow - Push

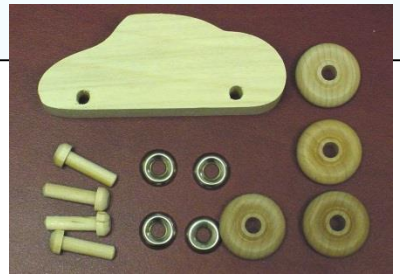
Stockkeeper:

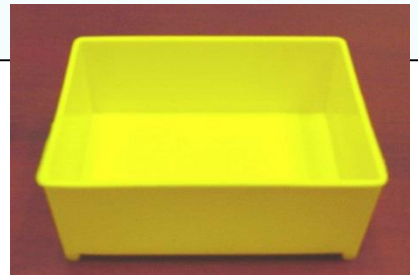
1 Pick 2 kits, placing material for each car into a plastic bag, zip lock the bag and place the 2 bags into large yellow container.

2 Move the batch of 2 cars to the output and call "conveyance." When supporting two teams, alternate delivery to each team in a round-robin fashion.

3 Repeat the operation as quickly as possible, but you may need to wait for the return of empty containers.

NOTE: insert one painted wheel into 1 of the 2 kit bags in each batch job for each team until told to stop by the team's inspection person (via conveyance).





Department #2

Cellular Flow - Push

WORK CELL - SUBASSEMBLY:

1 Remove material from plastic container. Place empty containers in Work Cell output for return and call “Conveyance.”

2 Assemble wheel onto axle, curved side of wheel toward axle hub, slip disk brake onto axle, flat side to wheel’s flat side, and place sub assembly onto fixture by pressing the rounded hub into the fixture’s recessed hole.

3 Place 4 subassemblies onto a fixture. And slide the loaded fixture and a car body to the Assembly person.

4 Repeat for the next set of material in the batch.

Department #3

Cellular Flow - Push

WORK CELL - ASSEMBLY:

1 Remove 4 wheel subassemblies from holding fixture and attach to car body, use clockwise twist as you insert the axle peg. Slide empty holding fixture back to the subassembly area in the cell.

2 Move the completed cars to the Detail area in the cell output and repeat for the next car in the batch.

3 If a reject batch is returned from inspection, correct any non-rotating wheels or replace any painted wheels. Call conveyance to obtain a new wheel from stock.

Ergonomic Assembly Tool

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

Department #4

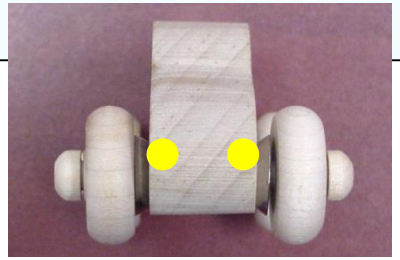
Cellular Flow - Push

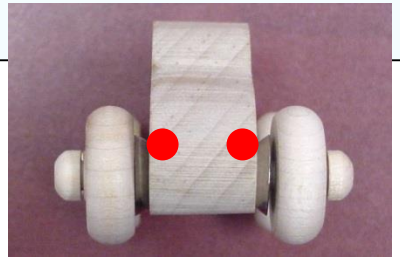
WORK CELL DETAIL:

1 Apply two yellow stick-on dots to the front of the car as headlights.

2 Apply two red stick-on dots to the back of the car as tail lights.

3 Move the completed car into the dept output. Repeat the process for each car in the batch job. When all cars are complete, call “conveyance” to move the batch to the next department.





Department #5

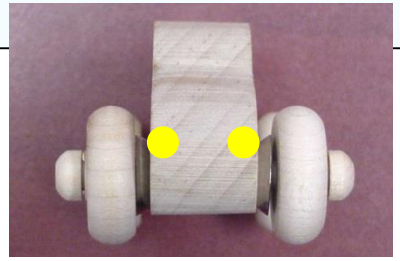
Cellular Flow - Push

Inspection Criteria:

1 All 4 wheels rotate freely.

2 All 4 wheels unpainted. Return any rejected cars to the Work Cell for repair, ***and tell the stock keeper to stop using painted wheels.***
(the conveyance person carries the message)

3 If the batch is acceptable, pass completed cars to the dept output to be delivered to Dept #6 Finished Goods. Call "conveyance."

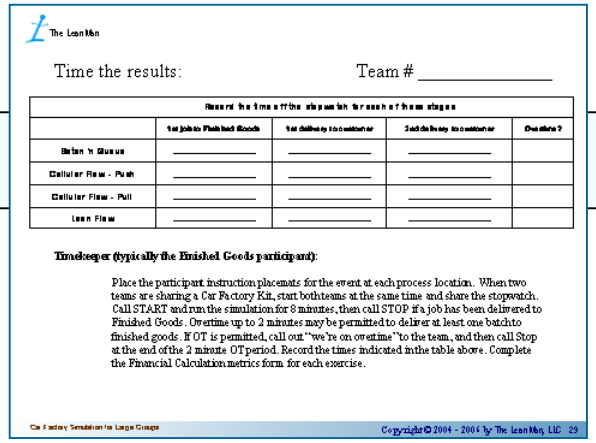


Department #6

Cellular Flow - Push

Finished Goods / Timekeeper

1. Start the exercise by starting the stopwatch and calling go.
2. Deliver cars in sets of 3, the 1st at 4.0 minutes and the 2nd at 8.0 minutes. Do not deliver early.
3. Record the metrics in the spaces provided on the *Time the results* form for event 2. Follow the instructions on the form for event timing requirements.
4. Complete the Financial chart with the help of the facilitator.



The LeanMan

Time the results: Team # _____

Record the times of the stopwatch for each of these stages

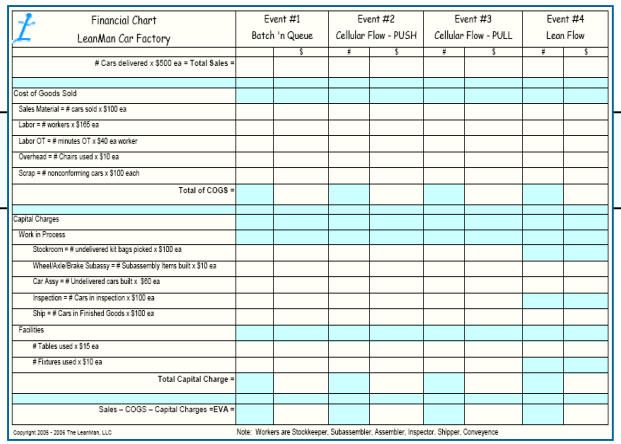
	1st job to Finished Goods	1st delivery to customer	2nd delivery to customer	Overtime?
Batch 'n Queue	_____	_____	_____	
Cellular Flow - Push	_____	_____	_____	
Cellular Flow - Pull	_____	_____	_____	
Lean Flow	_____	_____	_____	

Timekeeper (typically the Finished Goods participant):

Place the participant instruction placemats for the event at each process location. When two teams are sharing a Car Factory Kit, start both teams at the same time and share the stopwatch. Call START and run the simulation for 8 minutes, then call STOP if a job has been delivered to Finished Goods. Overtime up to 2 minutes may be permitted to deliver at least one batch to finished goods. If OT is permitted, call out "we're on overtime" to the team, and then call Stop at the end of the 2 minute OT period. Record the times indicated in the table above. Complete the Financial Calculation metrics form for each exercise.

Car Factory Simulation for Large Groups

 29



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, Conveyance

The LeanMan

Lean Factory Simulation Kits

Lean Principles

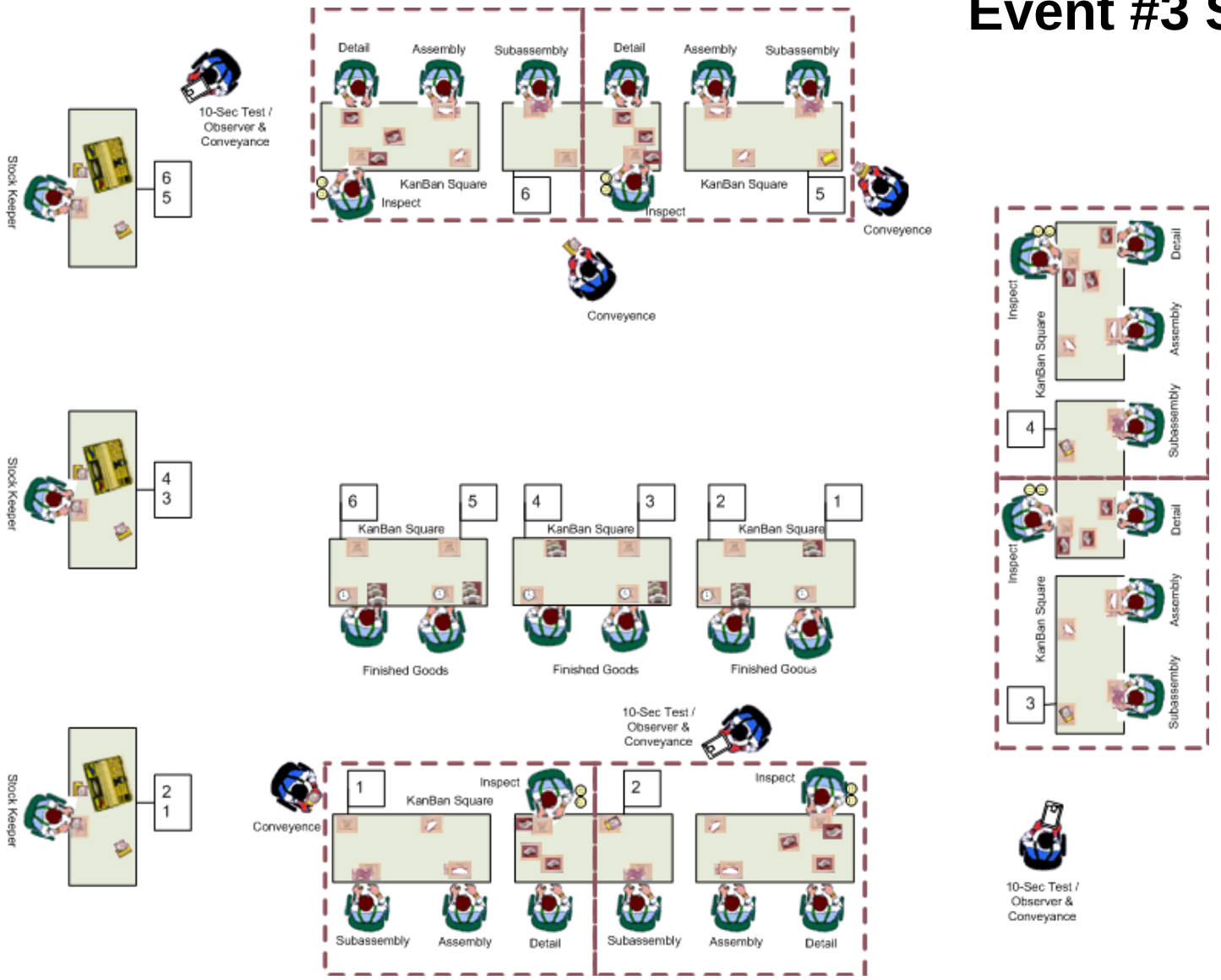
Participant Instruction Placemats

Lean Car Factory Simulation

Event #3 Continuous Flow (pull system)

Large Group Version

Event #3 Setup



Factory Simulation – Exercise #3 1-PC PULL

Six assembly teams organized in work cells with kanban squares

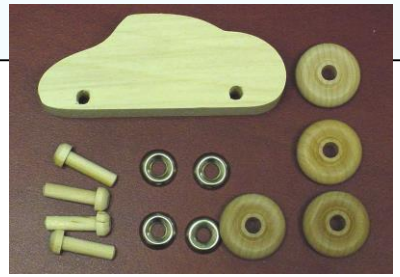
Department #1

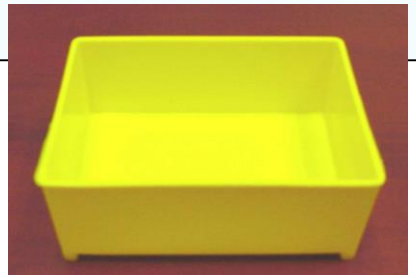
Continuous Flow - Pull

Stockkeeper:

1 Pick a kit for 1 car into a plastic bag, zip lock the bag and place the bag into a large yellow container.
2 Move the job to the output kanban and call "conveyance." When supporting two teams, use a kanban square for each team and keep each at it's max limit if possible.
3 Repeat the operation as quickly as possible, but you do not exceed the kanban limit.

NOTE: insert one painted wheel into every other kit bag for each team until told to stop by the team's inspection person (via conveyance).





Department #1

Continuous Flow - Pull

Maximum:

1 Job

in this square

at any one time

Place this kanban at output from Stockroom

Department #2

Continuous Flow - Pull

Maximum:

1 Job

in this square

at any one time

Place this kanban at input to Subassembly

Department #2

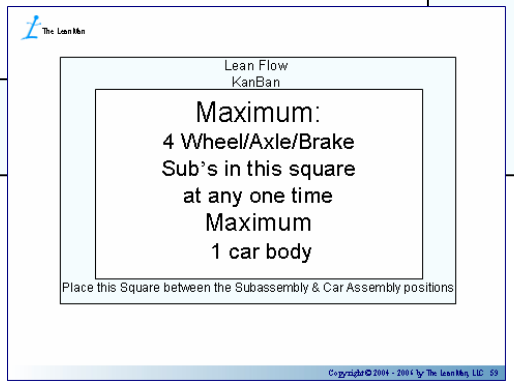
Continuous Flow - Pull

WORK CELL - SUBASSEMBLY:

1 Pull a kit from the kanban input. Remove material from plastic container. Place empty container in Work Cell output for return and call "Conveyance."

2 Assemble wheel/ axle/ brake and place sub assembly into the kanban square. Do not exceed 4 subs at any one time. Place a car body into the kanban

4 Pull and repeat for the next set of material, always keeping the downstream kanban full.



Department #3

Continuous Flow - Pull

Maximum:

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

Maximum

1 car body

Place this kanban between the Subassembly & Assembly positions

Department #3

Continuous Flow - Pull

WORK CELL - ASSEMBLY:

1 Pull a car body and subs one at a time from the input kanban and attach each to the car body, use clockwise twist as you insert the axle peg.
2 Move the completed car to the input kanban for the Detail person.
3 Pull and repeat for the next set of material, always keeping the downstream kanban full.

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

Department #4

Continuous Flow - Pull

Maximum:

1 car

in this square

at any one time

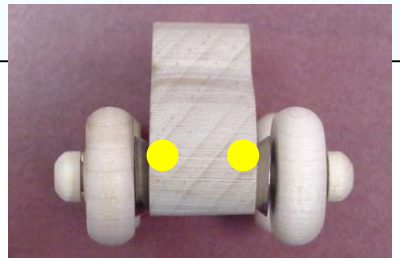
Place this kanban between Assembly and Detail

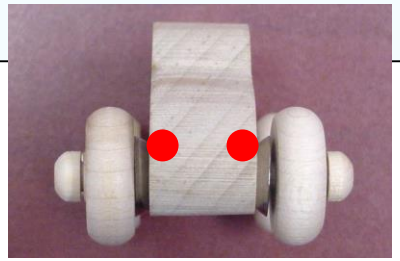
Department #4

Continuous Flow - Pull

WORK CELL DETAIL:

1 Pull the next car from the kanban and apply two yellow stick-on dots to the front of the car as headlights.
2 Apply two red stick-on dots to the back of the car as tail lights.
3 Move the completed car into the Inspection kanban.
4 Pull and repeat for the next set of material, always keeping the downstream kanban full.





Department #5

Continuous Flow - Pull

Maximum:
1 car
in this square
at any one time

Place this kanban between Detail and Inspection

Department #5

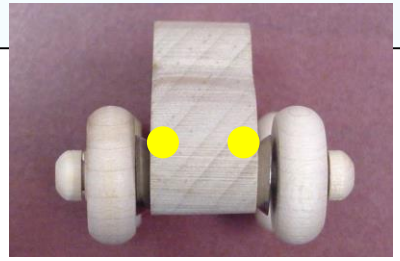
Continuous Flow - Pull

WORK CELL INSPECTION:

1 Pull the next car from the kanban. All 4 wheels must rotate freely.

2 All 4 wheels unpainted. Return any rejected cars to the Assembler for repair, ***and tell the stock keeper to stop using painted wheels.***
(the conveyance person carries the message)

3 If the car is acceptable, place the car in the Work Cell output and call “conveyance.”



Department #6

Continuous Flow - Pull

Maximum:

3 cars

in this square

at any one time

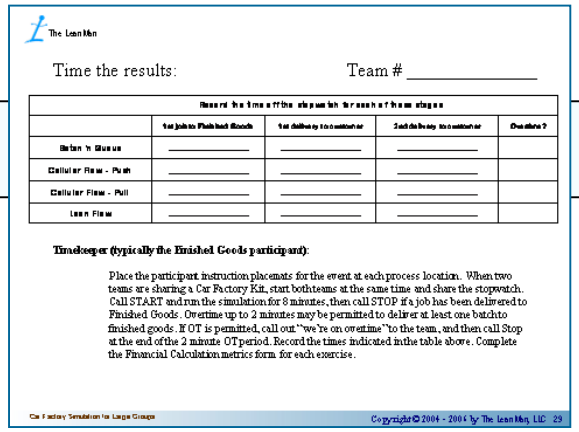
Place this kanban between Inspection and Finished Goods

Department #6

Continuous Flow - Pull

Finished Goods / Timekeeper

1. Start the exercise by starting the stopwatch and calling go.
2. Deliver cars in sets of 3, the 1st at 4.0 minutes and the 2nd at 8.0 minutes. Do not deliver early
3. Record the metrics in the spaces provided on the time the results form for exercise 2. Follow the instructions on the form for event timing requirements.
4. Complete the Financial chart with the help of the facilitator.



The LeanMan

Time the results: Team # _____

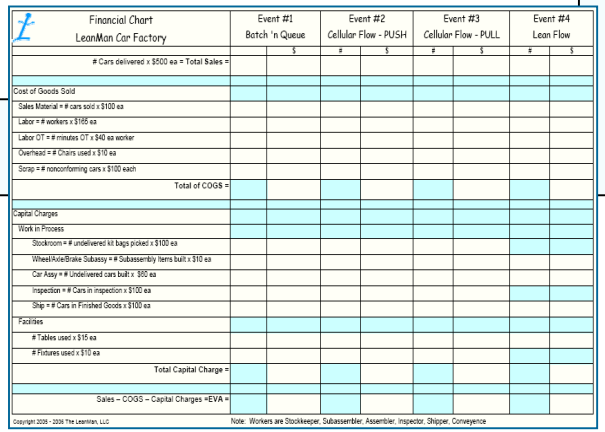
	1st job to Finished Goods	1st delivery to customer	2nd delivery to customer	Overtime?
Batch 'n Queue	_____	_____	_____	
Cellular Flow - Push	_____	_____	_____	
Cellular Flow - Pull	_____	_____	_____	
Lean Flow	_____	_____	_____	

Timekeeper (typically the Finished Goods participant):

Place the participant instruction placemats for the event at each process location. When two teams are sharing a Car Factory Kit, start both teams at the same time and share the stopwatch. Call START and run the simulation for 8 minutes, then call STOP if a job has been delivered to Finished Goods. Overtime up to 2 minutes may be permitted to deliver at least one batch to finished goods. If OT is permitted, call out "we're on overtime" to the team, and then call Stop at the end of the 2 minute OT period. Record the times indicated in the table above. Complete the Financial Calculation metrics form for each exercise.

Car Factory Simulation for Large Groups

 29



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, Conveyance

The LeanMan

Lean Factory Simulation Kits

Lean Principles

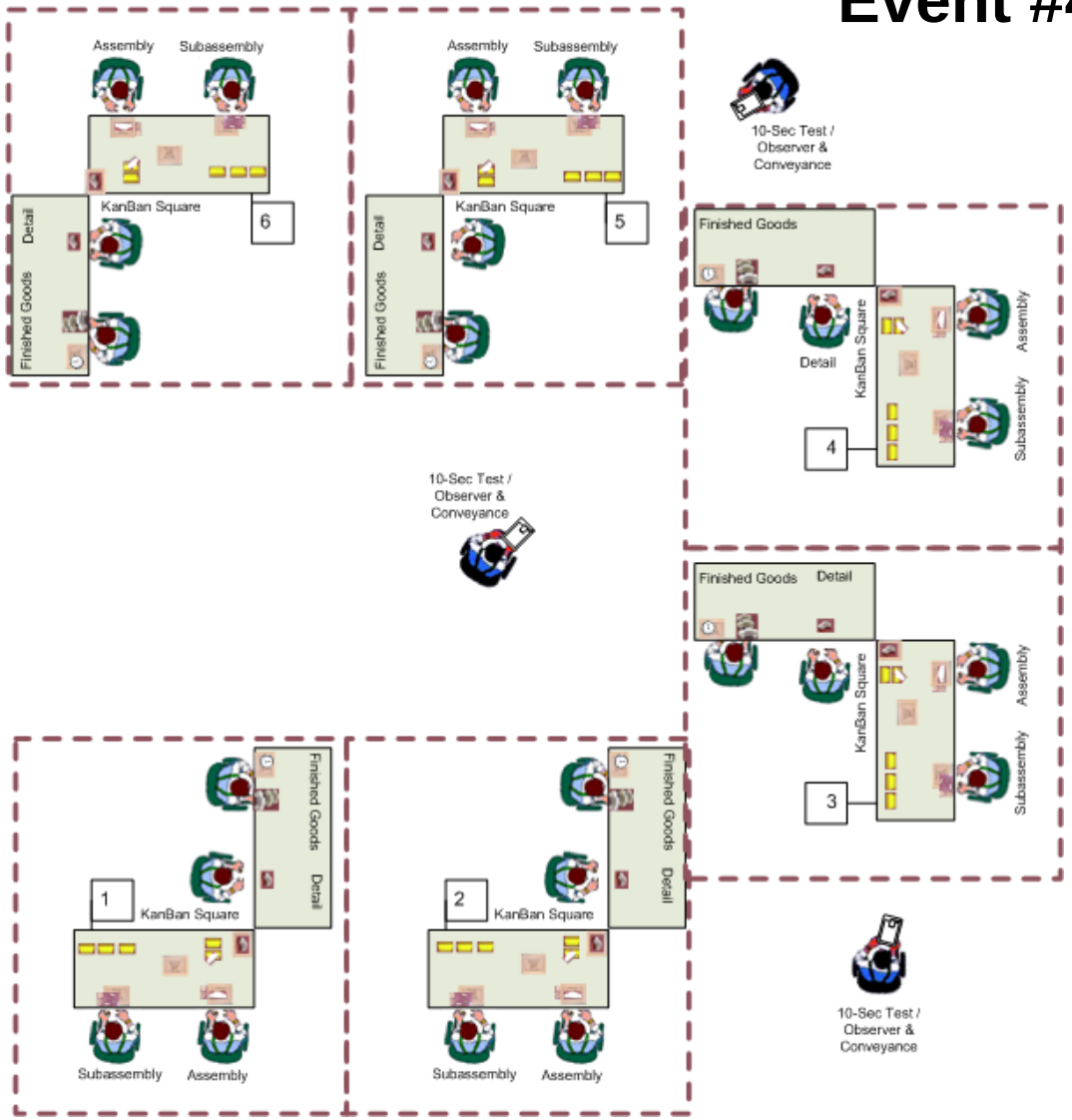
Facilitator Instructions

Lean Car Factory Simulation

Event #4 Lean Flow

Large Group Version

Event #4 Setup



Factory Simulation – Exercise #4 Lean FLOW

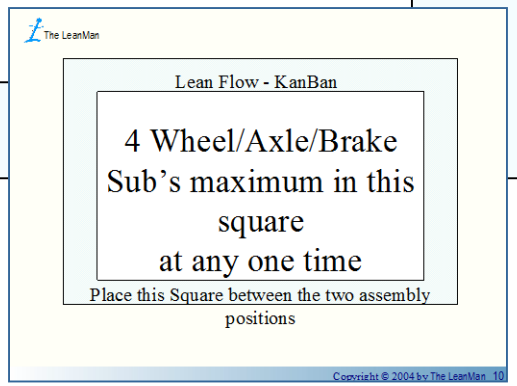
Six assembly teams organized in work cells with kanban squares, POU inventory and CI assembly

Work Cell
Lean Flow

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, slip disk brake onto axle, Place sub assembly into the KANBAN square. *No more then 4 at any one time*



Work Cell

Lean Flow

Maximum:

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

Place this kanban between the Subassembly & Car Assembly positions

Work Cell
Lean Flow

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 Place sub assembly into the kanban square. No more then 1 at any one time

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

Work Cell

Lean Flow

Maximum:

1 car

in this square

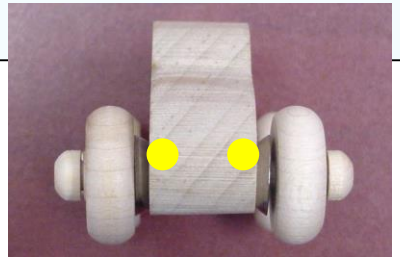
at any one time

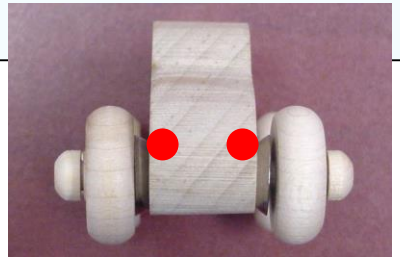
Place this kanban between the Car Assembly and Detail positions

Work Cell
Lean Flow

WORK CELL DETAIL:

1 Pull the next car from the kanban and apply two yellow stick-on dots to the front of the car as headlights.
2 Apply two red stick-on dots to the back of the car as tail lights.
3 Move the completed car into the Inspection kanban.
4 Pull and repeat for the next set of material, always keeping the downstream kanban full.





Work Cell

Lean Flow

Maximum:

3 cars

in this square

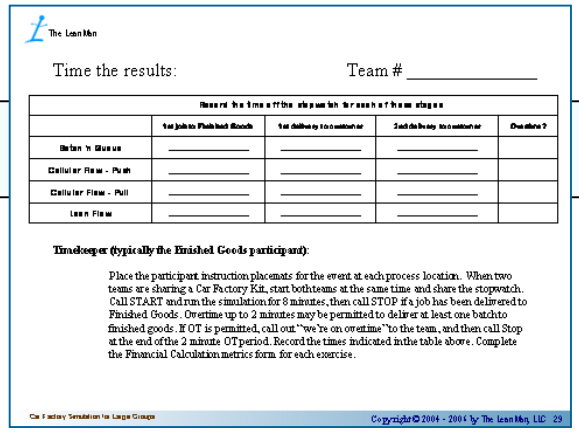
at any one time

Place this kanban between Car Detail and Finished Goods

Department #6
Lean Flow

Finished Goods / Timekeeper

1 Start the exercise by starting the stopwatch and calling go.
2 Deliver cars in sets of 3, the 1st at 4.0 minutes and the 2nd at 8.0 minutes. Do not deliver early.
3 Record the metrics in the spaces provided on the time the results form for exercise 2. Follow the instructions on the form for event timing requirements.
4 Complete the Financial chart with the help of the facilitator.


The LeanMan

Time the results: Team # _____

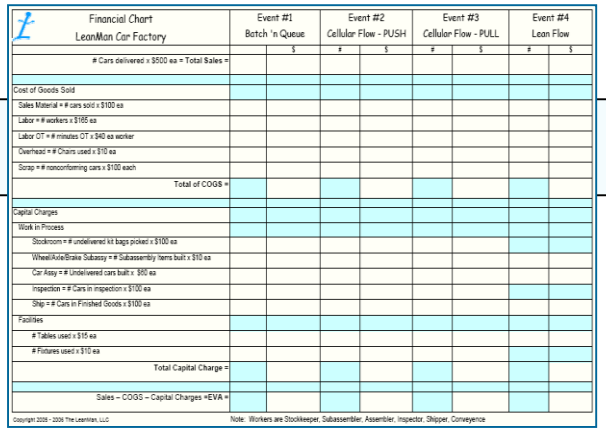
	1st job to Finished Goods	1st delivery to customer	2nd delivery to customer	Overtime?
Batch 'n Queue	_____	_____	_____	
Cellular Flow - Push	_____	_____	_____	
Cellular Flow - Pull	_____	_____	_____	
Lean Flow	_____	_____	_____	

Timekeeper (typically the Finished Goods participant):

Place the participant instruction placemats for the event at each process location. When two teams are sharing a Car Factory Kit, start both teams at the same time and share the stopwatch. Call START and run the simulation for 8 minutes, then call STOP if a job has been delivered to Finished Goods. Overtime up to 2 minutes may be permitted to deliver at least one batch to finished goods. If OT is permitted, call out "we're on overtime" to the team, and then call Stop at the end of the 2 minute OT period. Record the times indicated in the table above. Complete the Financial Calculation metrics form for each exercise.

Car Factory Simulation for Large Groups

 29


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, Conveyance

Time the results: Team # _____

Record the time off the stopwatch for each of these stages				
	1st job to Finished Goods	1st delivery to customer	2nd delivery to customer	Overtime?
Batcn 'n Queue	_____	_____	_____	
Cellular Flow - Push	_____	_____	_____	
Cellular Flow - Pull	_____	_____	_____	
Lean Flow	_____	_____	_____	

Timekeeper (typically the Finished Goods participant):

Place the participant instruction placemats for the event at each process location. When two teams are sharing a Car Factory Kit, start both teams at the same time and share the stopwatch. Call START and run the simulation for 8 minutes, then call STOP if a job has been delivered to Finished Goods. Overtime up to 2 minutes may be permitted to deliver at least one batch to finished goods. If OT is permitted, call out “we’re on overtime” to the team, and then call Stop at the end of the 2 minute OT period. Record the times indicated in the table above. Complete the Financial Calculation metrics form for each exercise.

Financial Chart LeanMan Car Factory Large Group	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								
Car Detail = # Undelivered cars detailed x $10 ea (if used)								
Inspection = # Cars in inspection x $100 ea								
Total WIP Inventory		$ -		$ -		$ -		$ -
FGI = # Cars in Finished Goods x $100 ea (not part of WIP)								
Facilities								
# Tables used x $15 ea								
# Fixtures used x $10 ea								
Total Capital Charge =								
Sales – COGS – Capital Charges =**EVA =**								
Production Velocity (8 minute run plus OT)								
Number of Minutes Worked								
Number of Cars Produced (sold + FG Inv)								
Production Rate =								

Note: Workers are Stockkeeper, Subassembler, Assembler, Detailer, Inspector, Shipper, Conveyence
items in transit are assumed to be at the output where they were picked up by conveyance

Financial Chart is available as an Excel File on the CD

