

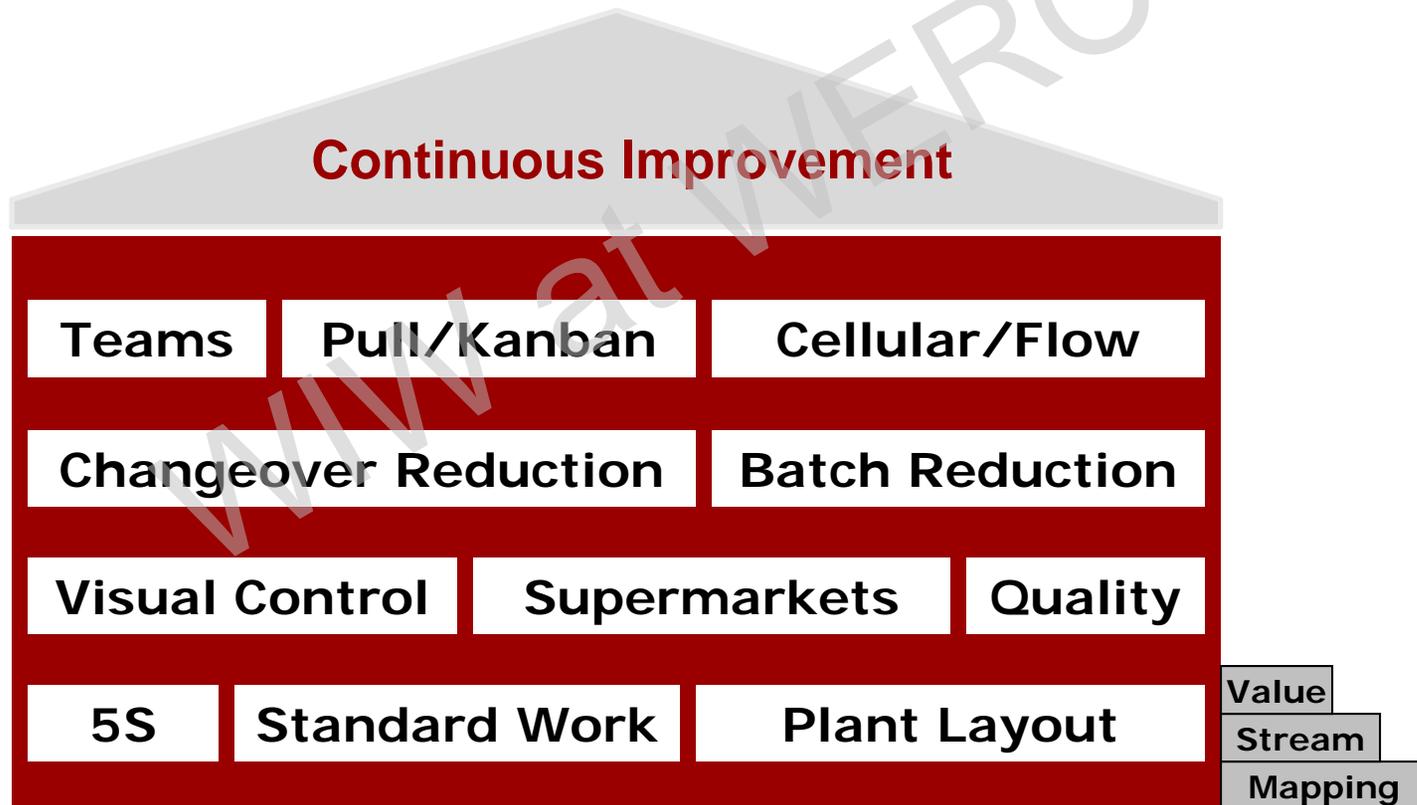
# Lean Manufacturing

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*Overview and  
Perspectives on Lean  
Methods and Tools*

# Lean Building Blocks



# 5 "S" – The 5 Pillars of the Visual Workplace

- **Sort** – Organization by placing red tag on all unneeded items and moving them to a temporary area to be disposed, sold, or given away. “When in doubt, through it out”
- **Set in Order** - Orderliness to the remaining items. “A place for everything and everything in its place”.
- **Shine** - Cleanliness inside and out. Dirt, grime, and oil are the first indicators of problems --- make it easy to see when things get dirty.
- **Standardize** – Create rules and audits for maintaining the first 3 S’s. Use visual controls.
- **Sustain** - Discipline to adhere to rules and audits. “It takes 21 days to break an old habit”.





# Place for everything



# Clean as a Hospital!





# Standard Work

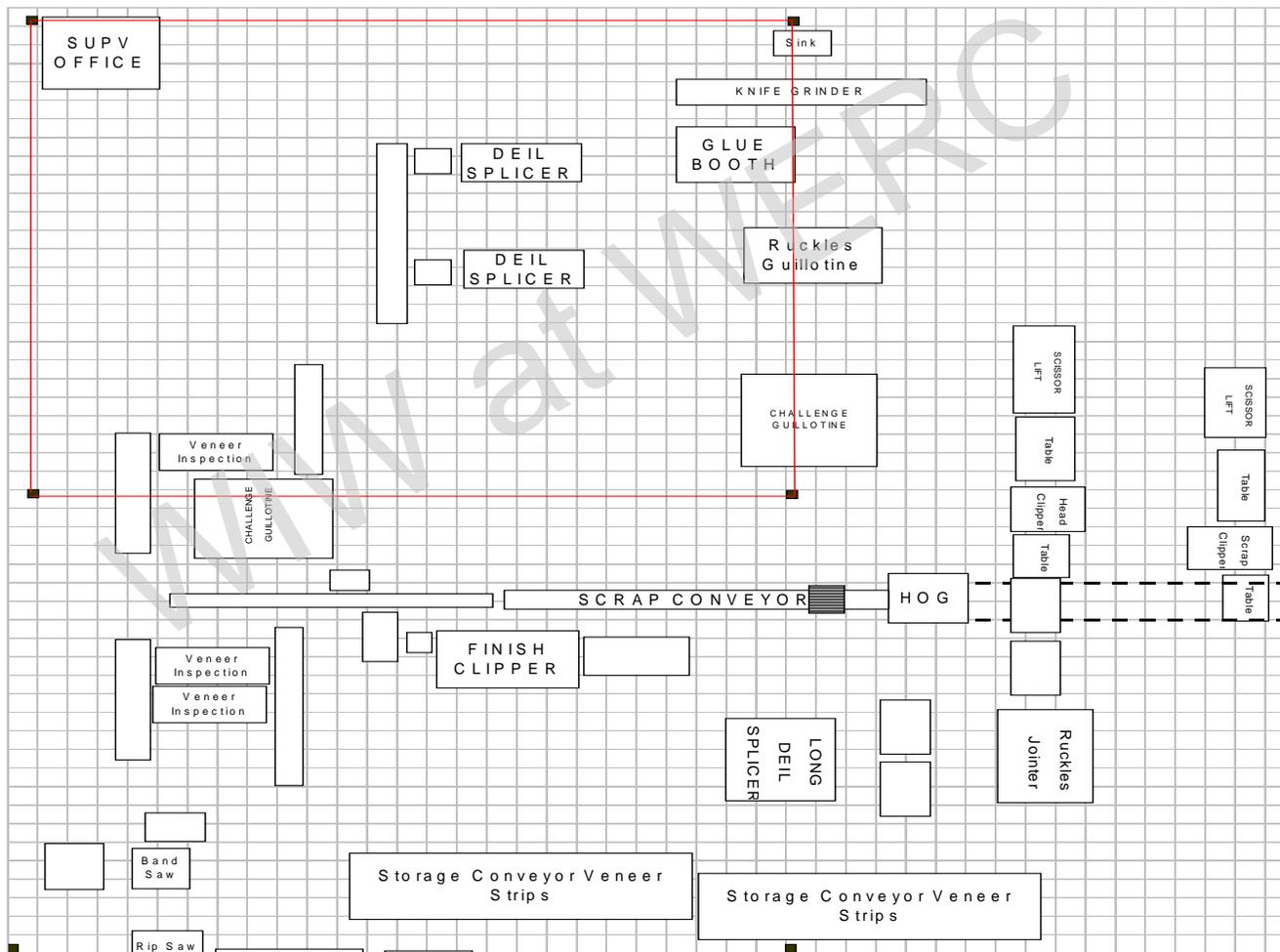
- Operations safely carried out with all tasks organized in the best known sequence, using the most effective combination of:
  - ✓ People
  - ✓ Materials
  - ✓ Methods
  - ✓ Machines

Approved By:	Group Leaders	Supvs.	Mgr.
	Date	4/16/2002	4/16/2002

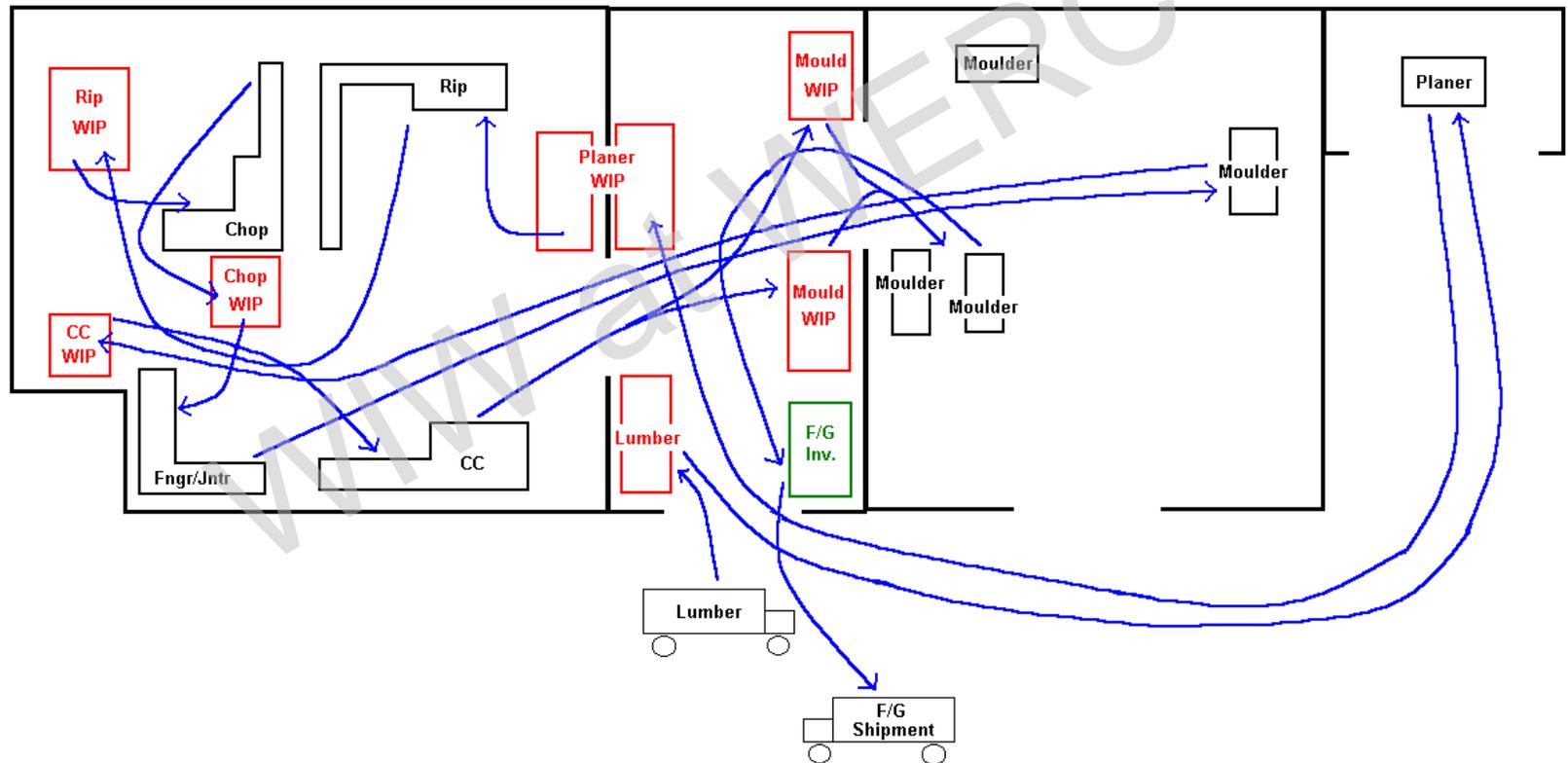
No.	Work Elements	Icon	KEY POINTS Safety, Quality, Technique, Cost	Time Elements			
				Auto	Manual	Wait	Walk
1	Pull veneer on to table	◆	Check for moisture and buckle Moisture content is to be not greater than 14% If MC is greater than 14% set aside for return to vendor				5
		+	Watch for splinters				
2	Cut to length	+	Use both safety buttons to operate head clipper		97		
		⦿	Cut to length to optimize yield and quality (Refer to cutting guidelines)				
3	Inspect and stack down	◆	Inspect cuts and re-cut if necessary				4
		+	Use proper lifting techniques				
		⦿	Stack off-fall onto carts				
		⦿	Sign first name to Kanban				
4	Return to number 1	⦿	Place scrap in proper area				7



# Plant Layout



# Spaghetti Diagram



# Visual Control







Visually controlled WIP off-fall

# Supermarkets

- Visual control --- Like shelves in a supermarket, stock is replenished based on demand (customers go there to “shop”)
- Communication between links in value stream (suppliers-customers) w/o a written production schedule
- “Supermarket” has limited capacity to minimize WIP and/or finished goods inventory
- “Kanbans” can be used to signal supplier process to produce more



**TREAD STOCK  
KANBAN**

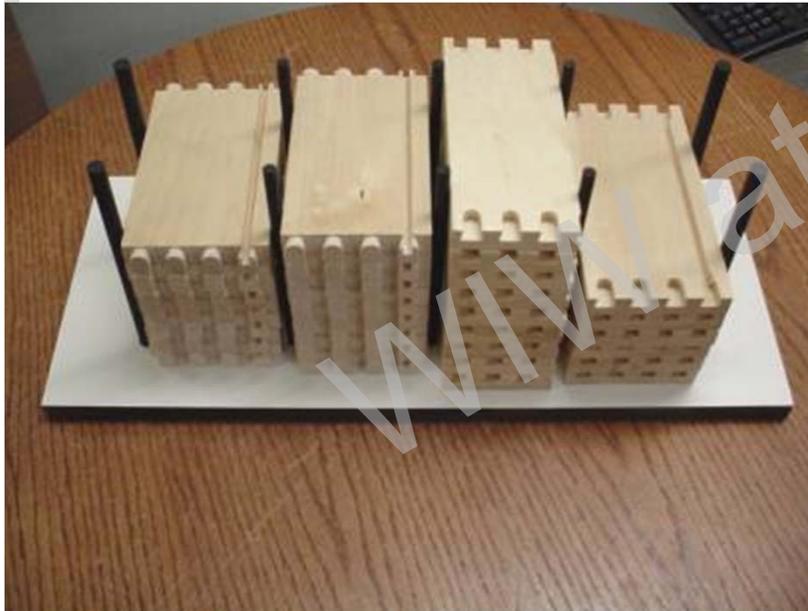
**SPECIES:** 5/4 RED OAK  
**SIZE:** 49"  
**SF PER PALLET:** 500  
**CARD NO:** 1 OF 9

Inventory tracking form with fields for:

- TICKET NUMBER: 887
- QUANTITY: 500
- PART NUMBER: 701
- QUANTITY: 500
- APPROVAL: [Signature]
- APPROVAL: [Signature]
- APPROVAL: [Signature]

www.atwerk.com

# Parts Supermarket



# Quality at the Source

- Source Inspection: Operators are certain that product they pass to the next workstation is of acceptable quality
- Operators must be given the tools to perform inspection
- Goof proof wherever possible!
- Samples or established standards can be used as visible tools
- Documentation defining quality inspection standards may need to be developed



# Goof Proofing



Before



After

me  
98  
9

curing  
umber that  
with oil.  
brown in  
meter.

ot stain is  
ple  
the back of

discoloration  
lighter  
heartwood is  
tending from

**Mineral Streak** – May be used in natural finished products (Summerhill) for face or back material.

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**Gray Color** – Materials that are light blue or gray may be used in medium finished products for face or back, or amounts are allowable if related to the backside.

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**Color** – Materials that are light blue or gray may be used in medium finished products for face or back, or amounts are allowable if related to the backside.

**Blue/Gray Color** – Materials that are light blue or gray may be used in medium finished products for face or back, or amounts are allowable if related to the backside.

www at WERC

Standardized Worksheet		Process	Gang Rips		Date:	08/01/03							
Plant Name:	Atkins Door Plant	Department:	Rough Mill Department 6		Page	1	Of 1						
Takt Time:	2.53 Secs. B/F	Part Name:	Rough Mill Stock		PPE:								
Cycle Time:	1.74 Secs. B/F	Document #	PC06.WI.7.5.1-08		Tools:								
Approved By:	Group Leaders Date:	Supvs. Date:			Mgr. Date:								
No.	Work Elements	Icon	KEY POINTS Safety, Quality, Technique, Cost	Time Elements									
				Auto	Manual	Wait	Walk						
1	Inspect machine	+	Keep hands clear of moving parts, pinch points and sawblades										
		⊘	Check machine to ensure Gang Rip is operational										
2	Set daily program	⊘	Set machine to rip sizes needed for days operation (See Supervisor or Group Leader)										
		🔧	Individual Spacers fabricated for each select cut										
3	Deal boards from Planner	⊘	Deal boards using foot control under terminal	4.9									
4	Deal single boards into Gang Rip staging area	+	Watch for splinters										
		+	Be careful not to mash fingers										
		⊘	Deal boards using foot control under terminal										
5	Determine cut of board using lasers and keyboard	⊘	Use keypad to operate lasers	7.1									
		◆	Place bowed wood in staging area properly										
		◆	Trim as little as possible off board to ensure high yield and efficiency										
6	Deal board into Gang Rip	+	Keep hands clear of all moving parts and pinch points	8.75									
		⊘	Deal boards using keypad										
		⊘	Check periodically to maintain steady flow of material to Moulder and Dept. 7										
		⊘	Buffer zone should be utilized to keep steady flow of material through Gang Rip										
7	Return to step 3												
KEY:	SAFETY /ERGO	+	IN-PROCESS STOCK	⊘	QUALITY CHECK	◆	POKA YOKE	🔧	Work Element Walking	→	Return to start	Totals	24.5

Work Area Layout

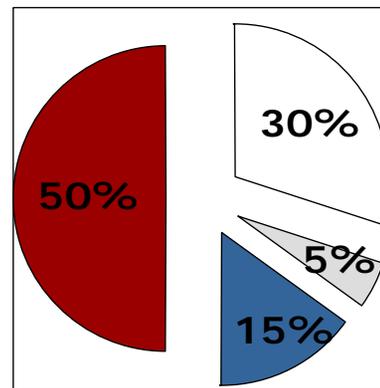
Total walking steps

0



# Changeover Reduction

- Definition: The time between the last good piece off the current run and the first good piece off the next run
- Before Shigeo Shingo's "Single Minute Exchange of Die" (SMED), typical setup tasks and time breakdowns:



- Preparation, after process adjustment, checking and moving materials, parts and tools
- Removing and mounting of parts and tools
- Machine measurements, settings, calibrations
- Trial runs and adjustments

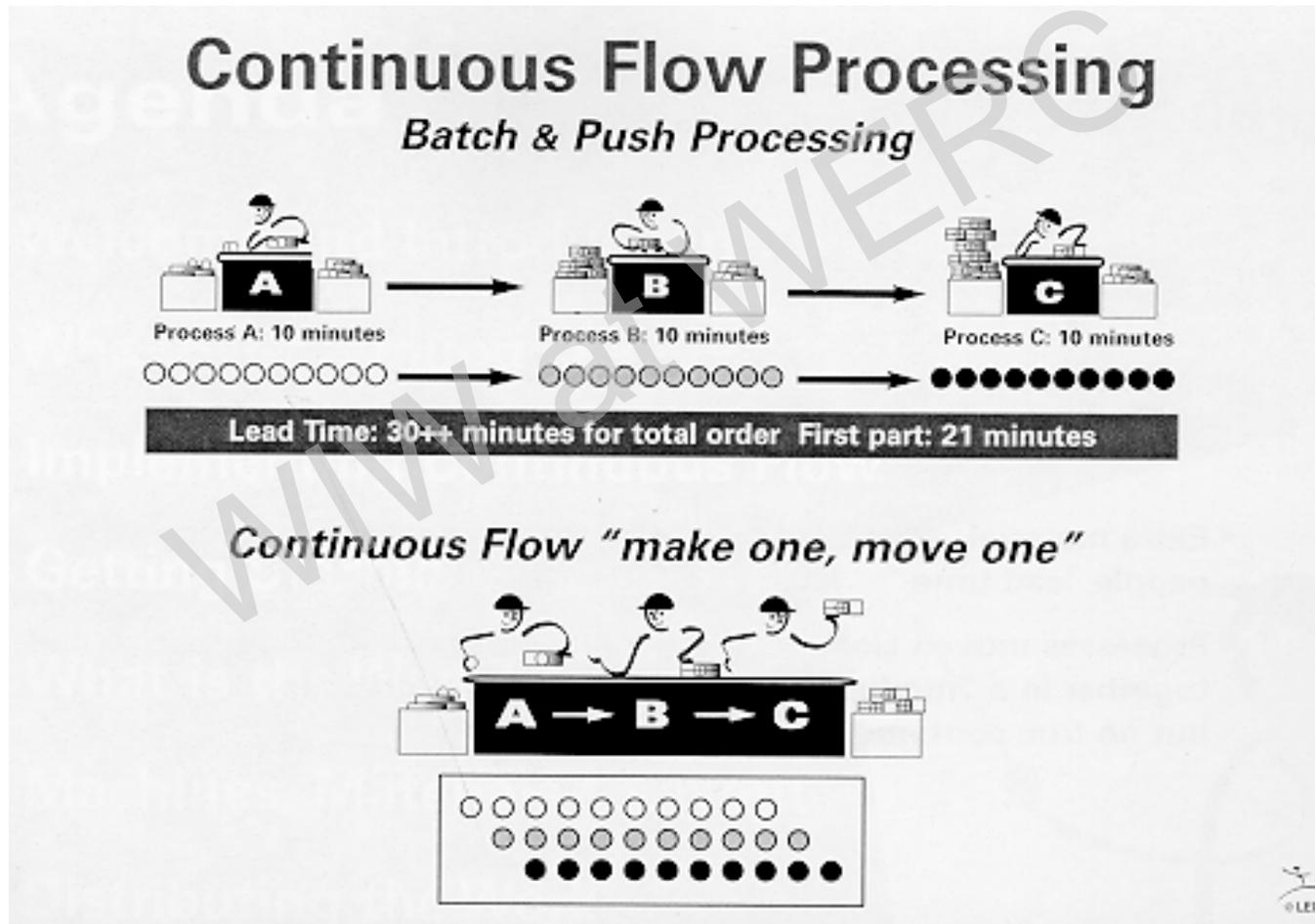
# Fake Flow

## Fake Flow



- Extra material, space, people, lead time
- Processes moved closer together in a "module," but no true continuous flow
- Stations operate independently as "isolated islands"
- Inventory accumulates between processes
- Operators process batches

# Impact of Batch Size Reduction



# Cellular Manufacturing

- Cells are “mini factories” within the system
  - ✓ Typically u-shaped
  - ✓ Cross-trained workers
  - ✓ Continuous or one-piece flow  
(i.e., no WIP)
  - ✓ Unique standard work and performance metrics
  - ✓ Built-in flexibility



Lathe



Sander

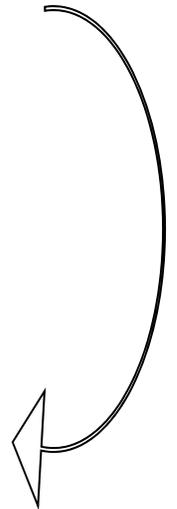
1- piece flow through Cell operations



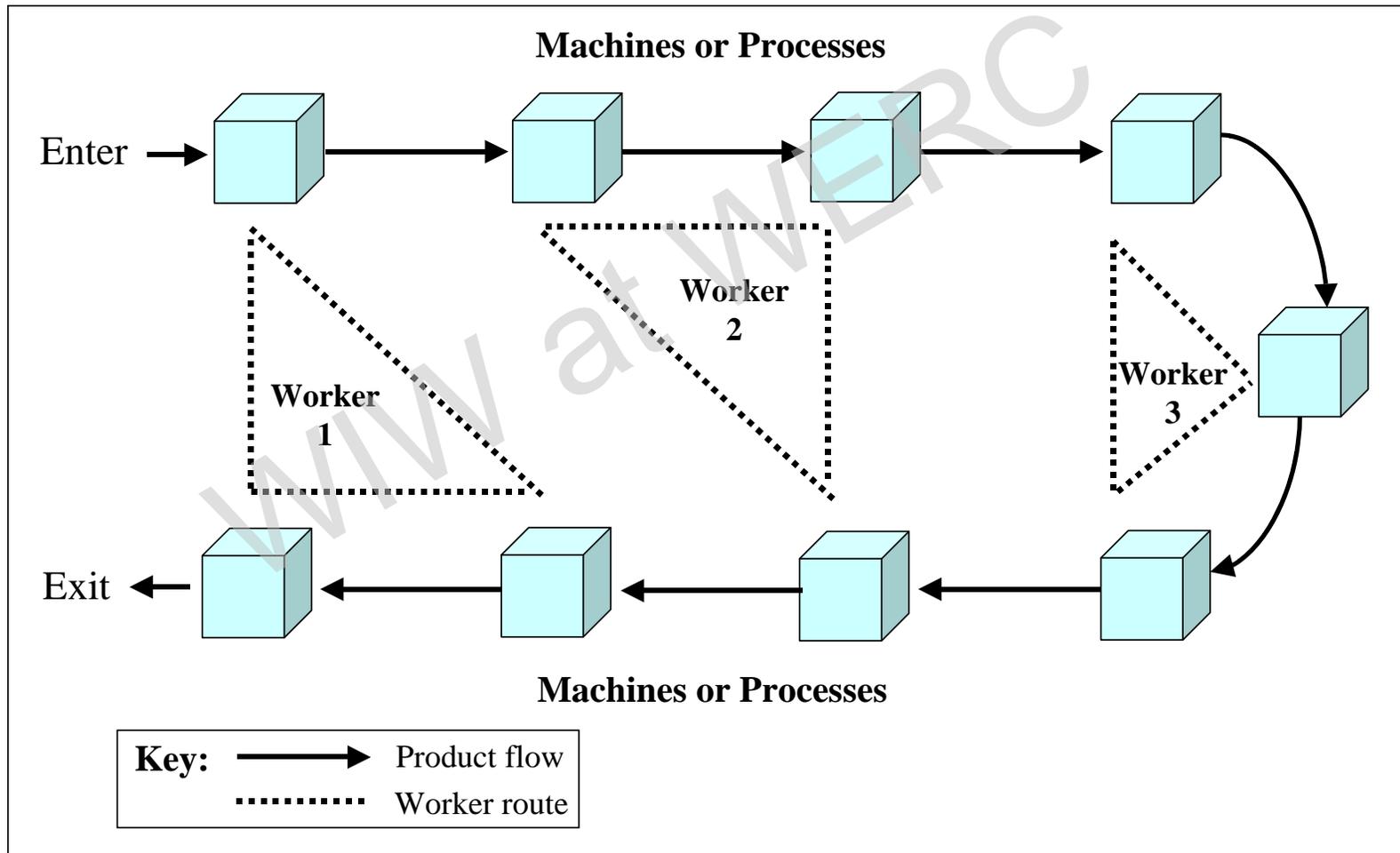
Pack



Router



# Cellular Manufacturing



# Implementing Cells

- ❑ Group Products
- ❑ Measure demand – Takt time
- ❑ Establish standard work elements
- ❑ Balance work elements
- ❑ Design cell layout

# Grouping Products into Families

		Assembly Steps & Equipment							
		1	2	3	4	5	6	7	8
PRODUCTS	A	X	X	X		X	X		
	B	X	X	X	X	X	X		
	C	X	X	X		X	X	X	
	D		X	X	X			X	X
	E		X	X	X			X	X
	F	X		X		X	X	X	
	G	X		X		X	X	X	

A Product Family

# Takt Time



- The production pace needed to meet demand
- The “heart beat” of the system
- Unique to each value stream/product family
- A method of smoothing production by synchronizing production with the rate of demand

# Example

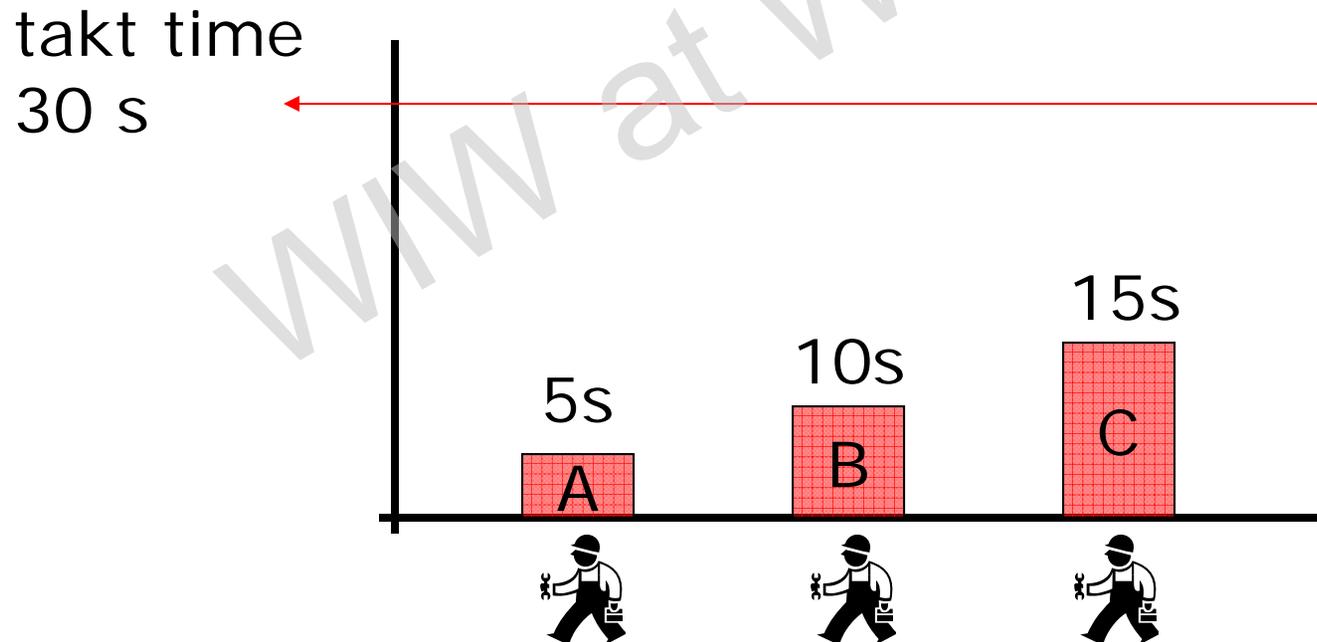
- Available work time/day = 460 min.
- Demand/day = 920 parts/day
  - ✓ Takt time = Available Time/Demand
  - ✓ Takt time =  $460/920 = 0.5$  min/part
  - ✓ Takt time = 30 seconds per part
- Interpretation:
  - ✓ Customer is buying a part every 30 s
  - ✓ Target rate of production should be a part every 30 s

# Study Work Elements

- Observe sequence of tasks each worker performs
- Break operations into observable elements
- Identify value added vs. non-value-added (NVA) elements and minimize NVA
- Study machine capacity, cycle times and changeover

# Staffing the Cell and Balancing the Work

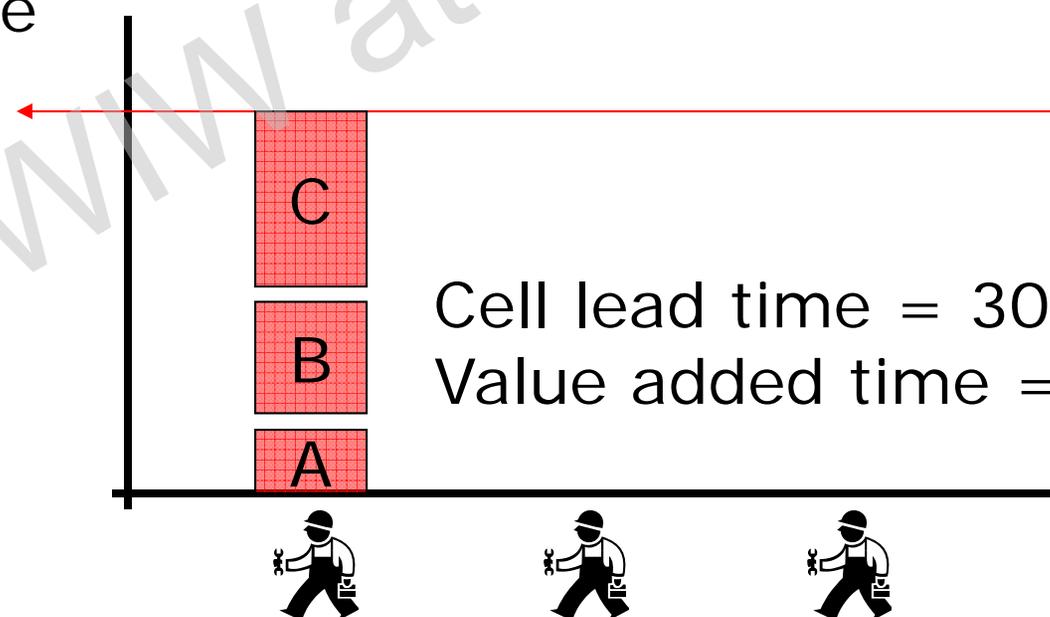
## Current Operator Balance



# Staffing the Cell and Balancing the Work

After a cellular redesign...

takt time  
30 s



Cell lead time = 30 s  
Value added time = 30 s

# Design and Construct Cell

- Goals
  - ✓ Flexibility, make one-move one, visual controls, standard work, Point-of-Use-Storage
- Simplify flow, materials flow one way
- Minimize material handling (eliminate NVA)
- Make use of people 100 percent
  - ✓ A machine can wait on a person but a person should never wait on a machine

# Push vs. Pull Systems

## ■ Push System

- ✓ Resources are provided to the consumer based on forecasts or set schedules

## ■ Pull System

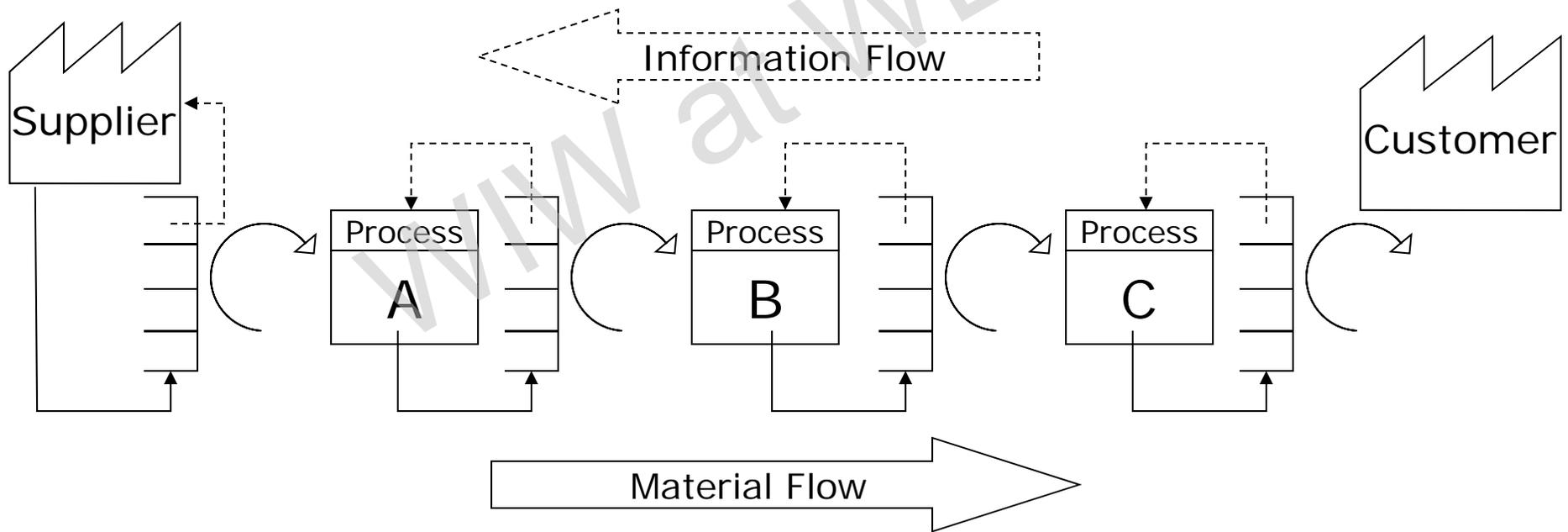
- ✓ A method of controlling the flow of resources by replacing only what has been consumed

# Pull Systems



- Flexible and simple method of controlling and balancing the flow of materials and information
  - ✓ Eliminates/reduces the 7 forms of waste
- Characteristics of pull systems:
  - ✓ Production based on actual consumption
  - ✓ Small batches
  - ✓ Low inventories
  - ✓ Visual controls
  - ✓ Better and simpler communication

# Pull System Illustration



# Kanban Pull System Example – line balancing



# Teams ---

## Lean Workforce Practices

- Rotation of highly specified jobs
- Cross-trained and multi-skilled employees
- Embrace and live the continuous improvement (lean) philosophy
- Process quality, not inspection
- Participation and empowerment

# Leadership Development Through Teams



## Front Row

- Viral Shah
- Sarah Moore
- Dee Dee Mullins
- Dennis Armstrong

## Back Row

- Leon Powers – Facilitator
- Greg Akers
- Earl Kline
- Dave Prater - Team Leader



# The Challenge

“Change is never easy... particularly when things are going well”

“By re-inventing ourselves...and our companies...regularly...we will better serve our customers...prosper...and preserve our planet for future generations.”

***Fujio Cho***  
***Past President***  
***Toyota Motor Corporation***



# Additional Resources

- "The Machine that Changed the World", Womack, Jones, and Roos. 1990. Lean Enterprise Institute, Brookline, MA. 323 p. ISBN: 0-89256-350-8
- "Lean Thinking: banish waste and create wealth in your corporation", Womack and Jones. 2003. Simon and Shuster, New York, NY. ISBN: 0743249275
- Rother and Shook. 1999. Learning to See. Version 1.3. Lean Enterprise Institute, Brookline, MA.
- Rother and Harris. 2001. Creating Continuous Flow. Version 1.0. Lean Enterprise Institute, Brookline MA.
- "The Toyota Way Fieldbook". Jeffrey K. Liker and David Meier. 2006. McGraw Hill. 475 p. ISBN: 0-07-144893-4
- Better Thinking, Better Results. Bob Emiliani. 2007. The Center for Lean Business Management, LLC.

# Web Resources

- Lean Enterprise Institute:  
[www.lean.org](http://www.lean.org)
- National Quality Program:  
[www.quality.nist.gov](http://www.quality.nist.gov)
- Shingo Prize:  
[www.shingoprize.org](http://www.shingoprize.org)
- American Society for Quality:  
[www.asq.org](http://www.asq.org)
- National Performance Review:  
[govinfo.library.unt.edu/npr/index.htm](http://govinfo.library.unt.edu/npr/index.htm)

# Virginia Tech Resources



**LEAN**<sup>™</sup>  
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is a platform for **lean practitioners** to cultivate knowledge and experience regarding lean transformations

**LEAN**<sup>™</sup>  
© Virginia Tech

is a **student-driven**, faculty-supported initiative to help organizations become more efficient and more competitive

➔ **Contact us at [www.vtlean.org](http://www.vtlean.org)**

# How do you get started?

- Create a sense of urgency
- Get the right people on the bus and in the right seats
- Value Stream Mapping (VSM)
- Kaizen Events
  - ✓ 5S
  - ✓ Setup time reduction
- Create a learning environment for sustainable change

# Conclusions

## *Lean Thinking*

- ✓ How do we deliver value the customer wants?
- ✓ Quality is free
- ✓ Reducing environmental impact is free
- ✓ Workers are experts
- ✓ Mistakes are studied to guide improvement
- ✓ Inventory is waste
- ✓ Do it right the first time

## *Traditional*

- ✓ How do we sell our products to customers?
- ✓ Quality costs
- ✓ Reducing environmental impact costs
- ✓ Managers are experts
- ✓ Mistakes are accepted as part of the business
- ✓ Inventory is value
- ✓ It's close enough

# THANK YOU!



*"The significant problems we face cannot be solved by the same level of thinking that created them"*

Albert Einstein