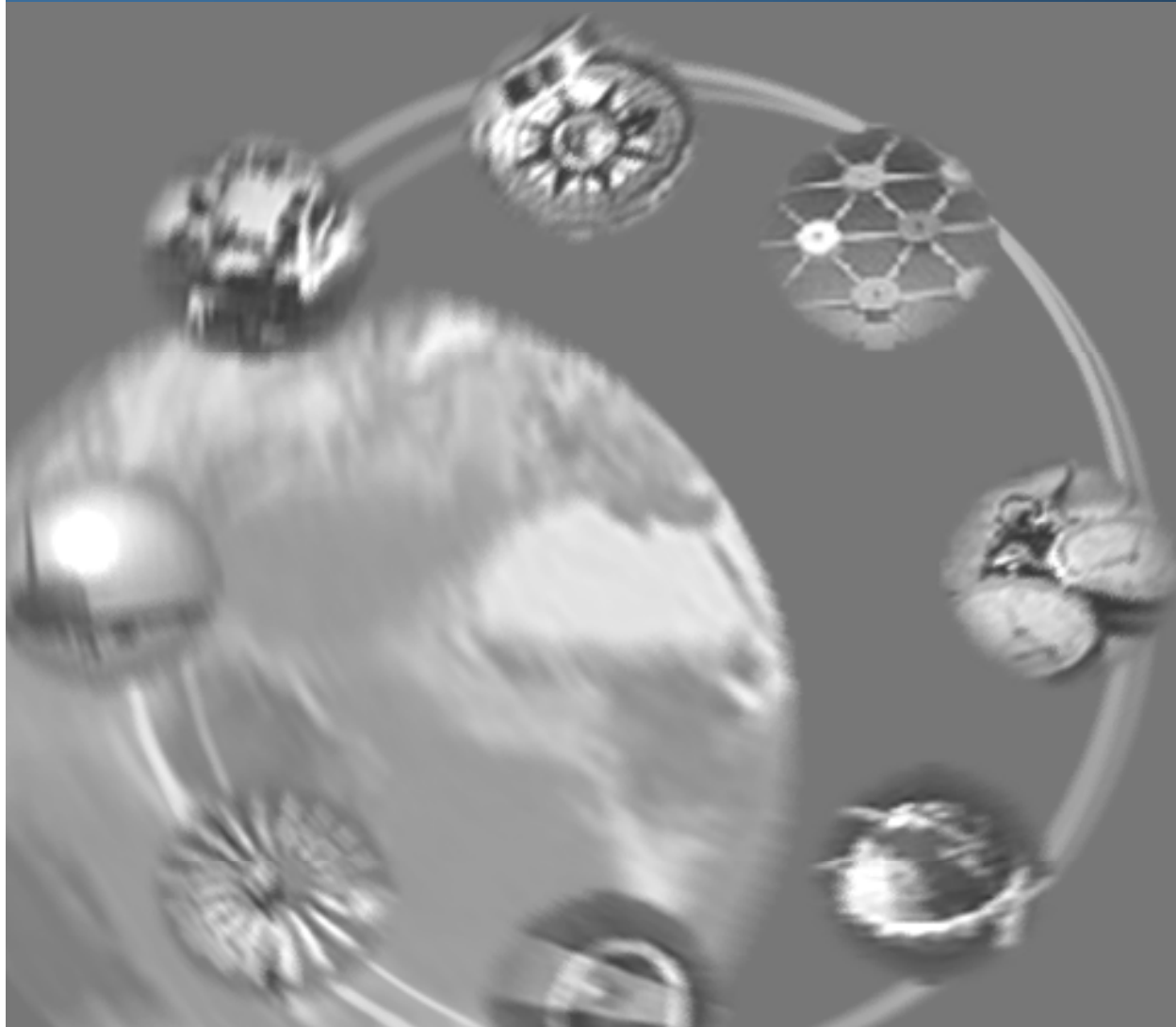


Lean Construction

4013.407 Building Construction Technology



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건설기술연구실

Discussion



고려대학교
KOREA UNIVERSITY

번개

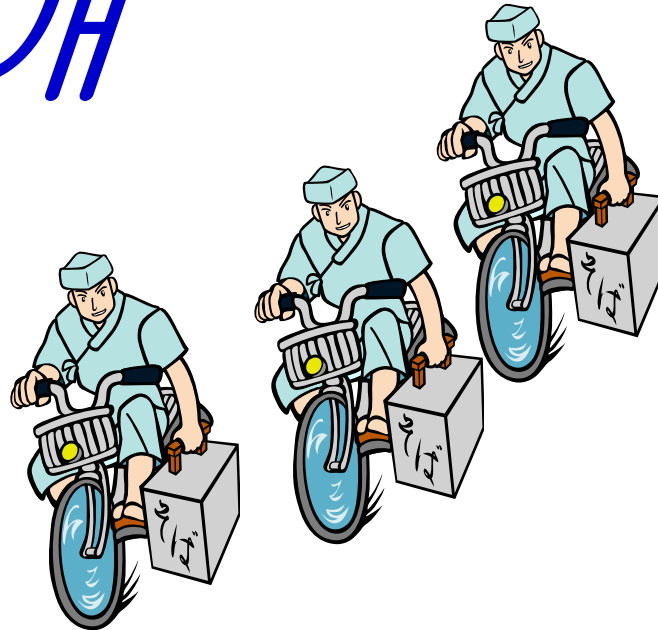
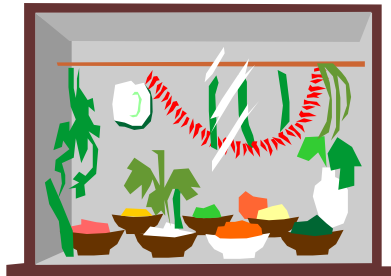


Table of Contents

What is "Lean"?

1

2

Improvement by Lean

Lean Principles

3

4

Tools for Lean

Application Examples

5

1. The Last Planner System
2. Value Stream Mapping

1. Parade Game
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What is “Lean”?

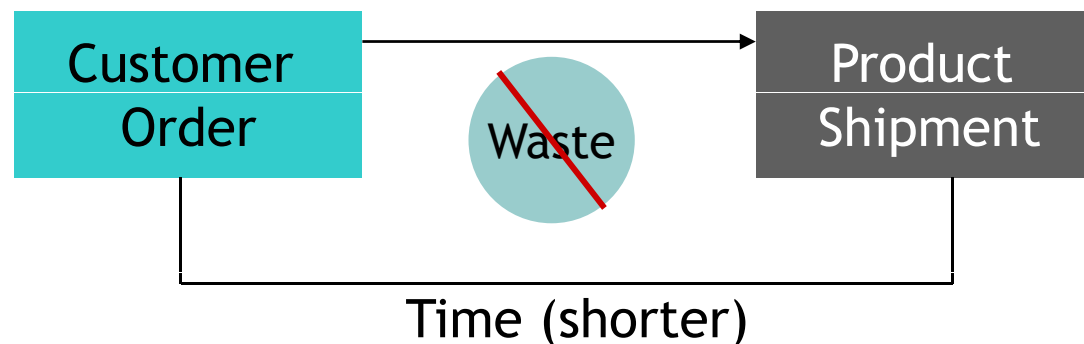
- **The Lean Idea**

- Meet requirements of a unique customer
- Deliver it instantly
- Maintain no inventory

- “Give customers what they want, deliver it instantly, with no waste”

- **Lean production**

a production philosophy which shortens the time line between the customer order and the product shipment by eliminating waste and maximizing value to the customer

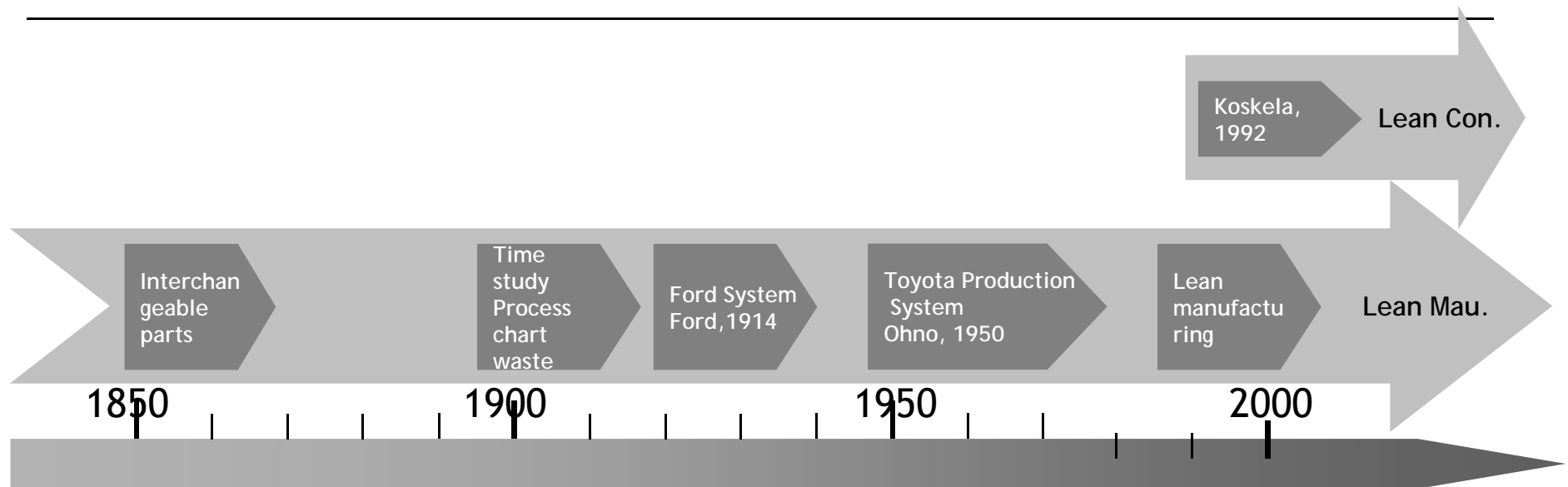


What is “Lean Construction”?

Lean Construction

Greg Howell and Glenn Ballard	<ul style="list-style-type: none">▪ Has a clear set of objectives for the delivery process▪ Is aimed at maximizing performance for the customer at the project level▪ Designs concurrently product and process▪ Applies production control throughout the life of the project
Womack & Jones 1996	<ul style="list-style-type: none">▪ LEAN construction is a way of creating wealth and eliminating waste across the industry

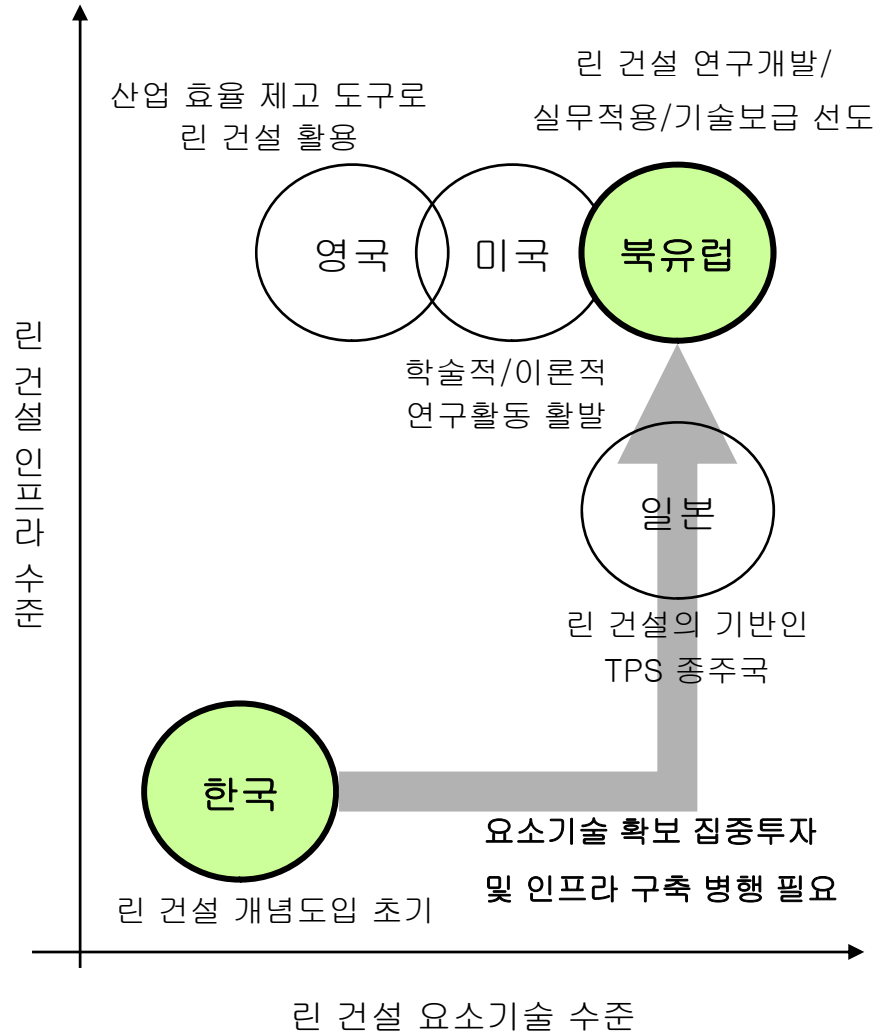
History of Lean



- **Eli Whitney; interchangeable parts**
- **Frederick W. Taylor; Standardized work & Time study**
- **Frank Gilbreth; Process charts, motion study**
- **Lillian Gilbreth; idea of “eliminating waste”**
- **Ford System, 1914; assembly lines, flow lines, Manufacturing strategy**
- **Toyota Production System, 1950, Ford idea+ Takt time, J-I-T**
- **Lean Production System American, 1980’s**
- **“the machine that changed the world”, 1990**
- **Lean Construction, 1992, Koskela**

린 건설 기술개발 현황

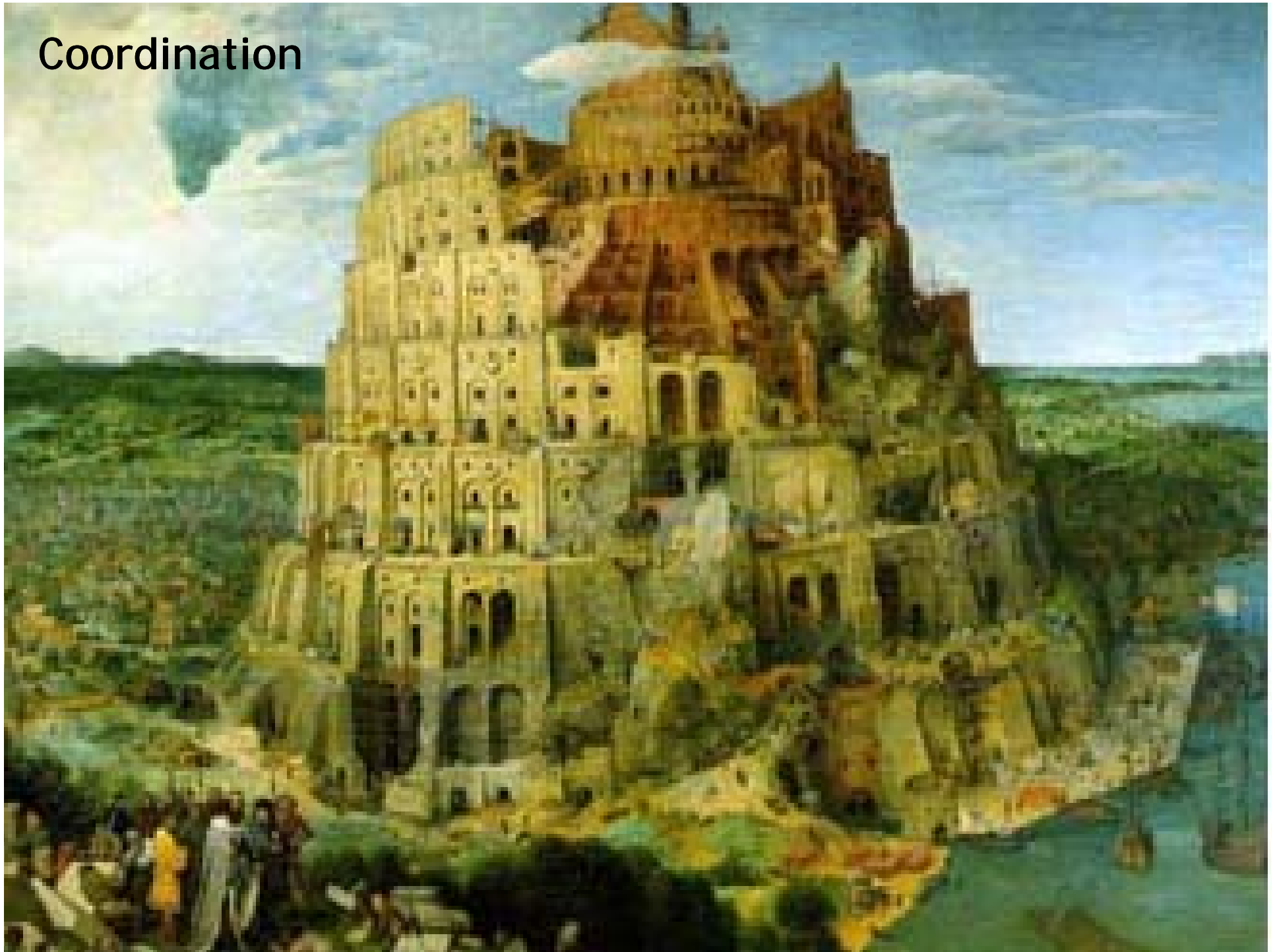
- 국외 린 건설 기술 현황
 - 북유럽 중심으로 각국의 린 건설 기술 개발 및 적용 활발
- 국내 린 건설 기술 현황
 - 개념 도입 초기
- 향후 전망
 - 초기에 집중 투자 필요
 - 요소기술 확보 및 인프라 구축 병행
 - 세계적 수준 달성 가능성 높음



Flow



Coordination



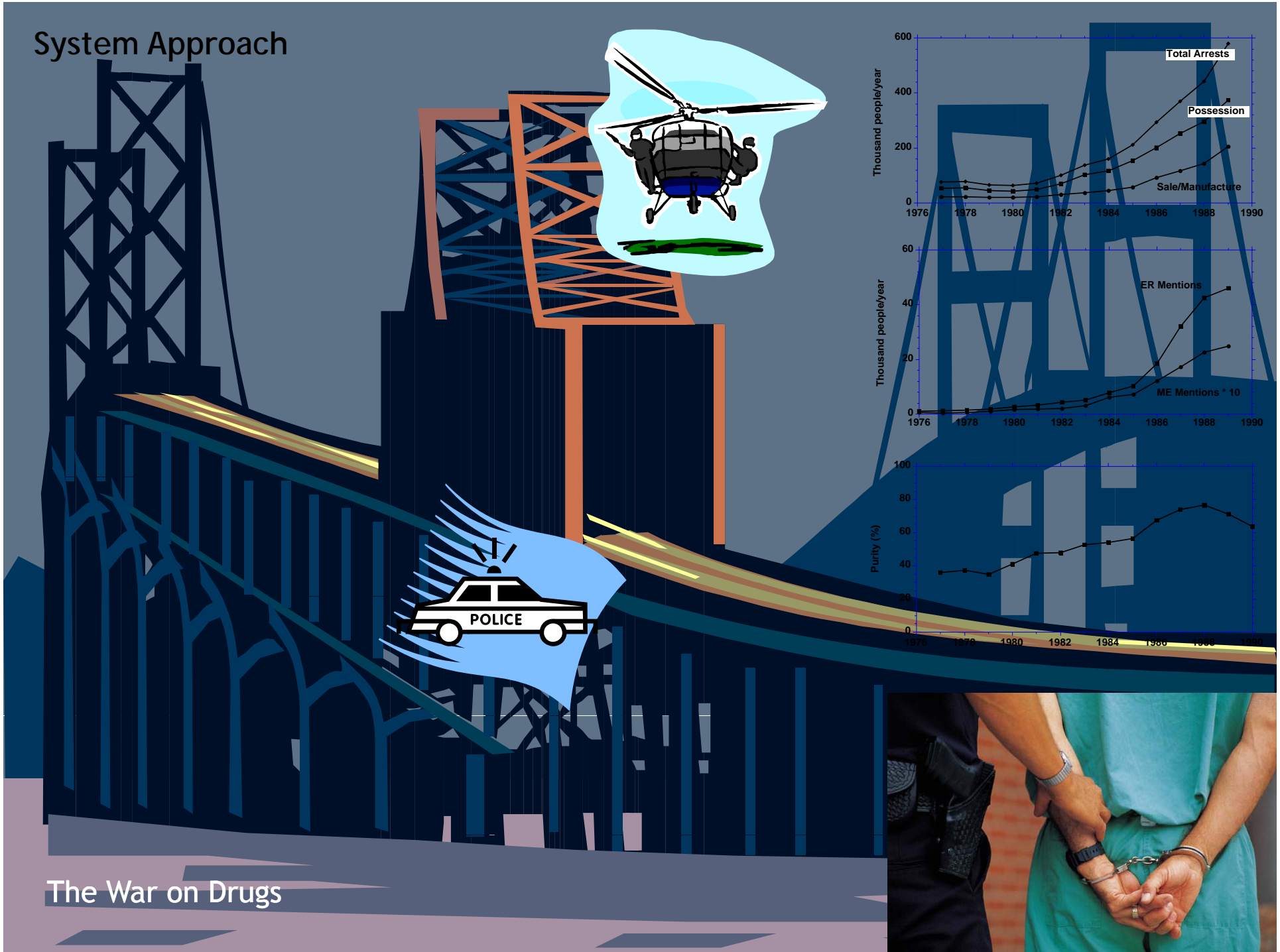
Push



Pull



System Approach



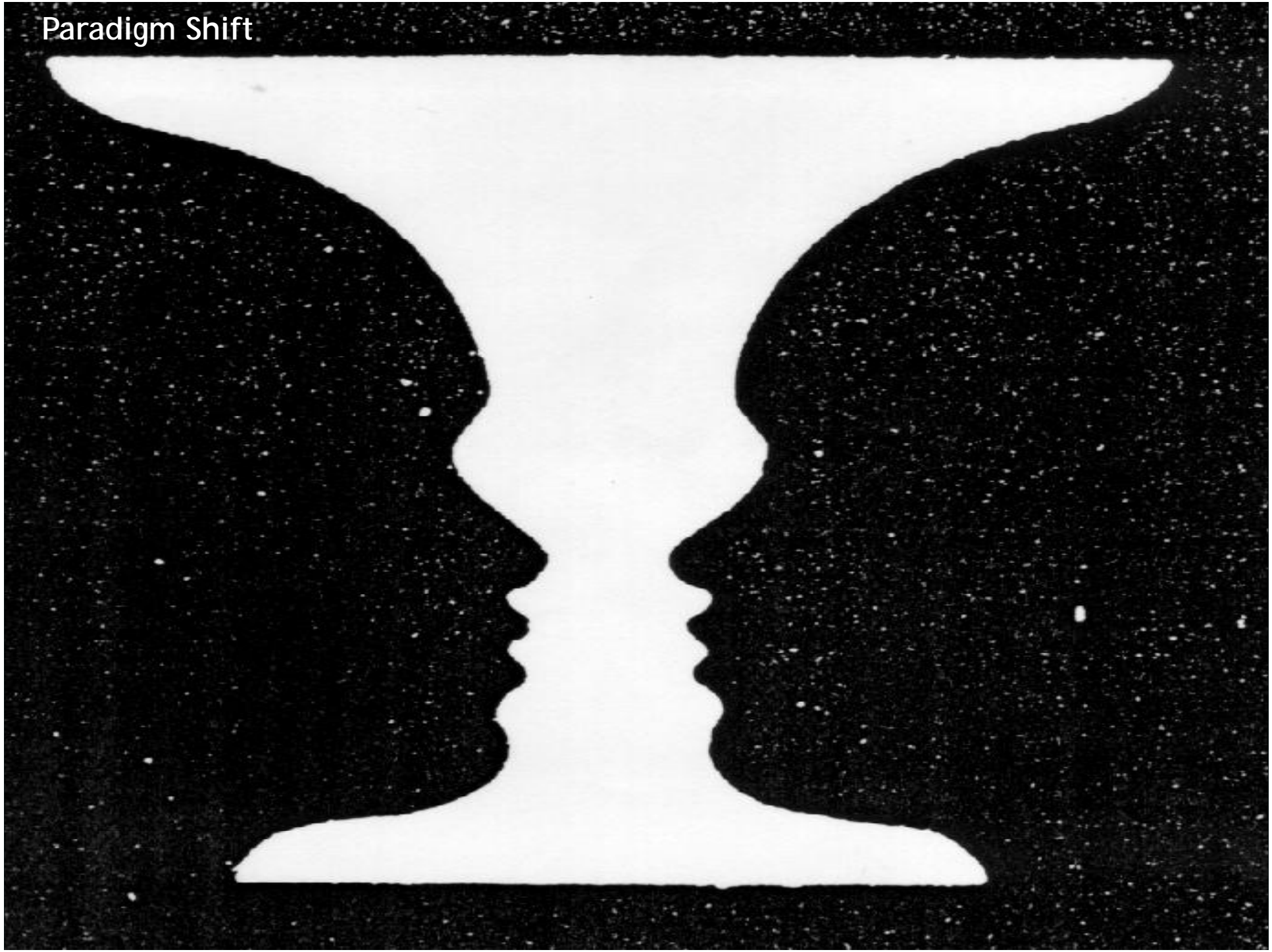
Decentralization



Centralization



Paradigm Shift



Definition

Pull VS Push

Pulling

Initiating the delivery of input based on the readiness of the process into which they will enter for transformation into outputs

Pushing

Releasing materials, information, or directives possibly according to a plan but irrespectively of whether or not the downstream process is ready to process them

Push system schedules the release of work based on demand
Pull system authorizes the release of work based on system status

from Hopp and Spearman 1996 P.317

Flow

- A term used to describe the throughput of an entire process (set of activities)
- Seven flows towards the perfect execution of a work package
 - Previous work
 - Space
 - Crew
 - Equipment
 - Information
 - Materials
 - External condition(koskela, 2000)
- Flow=Work flow (material, equipment, information) +Labor flow

Work flow

- The movement of information and materials through a network of production units, each of which processes them before releasing to those downstream.
- The movement of materials, information, and equipment through a system
(Womack and Jones, 1996)

Labor flow

- involves the tracking and allocation of the labor resource to various tasks and work assignment
- The interaction of the crew with other crew and other work

Times



- Cycle time

The time it takes a product to go from beginning to end of a production process

- Idle time

- Waiting time

- Traveling time

- Takt time

The time in which a unit must be produced in order to match the rate of customer demand

$$\text{Takt Time} = \frac{\text{Available Time}}{\text{Unit Demand}}$$



Table of Contents

What is “Lean”?

1

2

Improvement by Lean

Lean Principles

3

4

Tools for Lean

Application Examples

5

1. The Last Planner System
2. Value Stream Mapping

1. Parade Game
2. Precasting and Installation of Pile Foundations

Paradigm Shift

Contents	Tradition/Current	Lean
Planning	Knowing	Learning
Uncertainty	External	Internal
Control	Tracking	Steering
Coordination	Following Orders	Making and Keeping Commitments
Goal of Supervision	Point Speed	Reduce Variation Increase system throughput
Optimization	A specific activity	The entire project
Schedule Viewpoint	"Push"-CPM Required start dates for activities	"Pull"-LPS When its completion is required by a successor activity
Production System	Conversion Production	Flow Production
Production Process	Speed Measured by productivity	Reliability Measured by cycle time, defection rate, variation and PPC ratio
Customer	Successor process workers	Owner or final consumer

린 개념 타산업 적용 효과



일반적으로 **도요타 생산방식(Toyota Production System)**, 린 생산방식 (Lean Production System), 도요타주의(Toyotism) 등으로 불리우는 일부 일본 자동차메이커의 생산시스템은 수십 년에 걸쳐 서서히 구축되어 온 진화의 결과이며 1990년 초까지 국제경쟁력의 배경이 되었다. 결국 일본 자동차산업의 경쟁력은 '린 생산방식'이라는 생산·구매·개발 등의 총체적 시스템의 강점으로 지적할 수 있다.

(*'The Machine That Changed The World'*, 1990)

현재 미국 내 일본산 자동차 점유율은 30%를 넘어섰으며, 그 중 도요타가 12%대의 점유율로 전세계 시장점유율 목표인 10%획득치를 세계최대시장에서 넘어 섰다. 다음은 도요타 자동차의 세계시장 점유율의 추이이다.

- 1948년 : 0.6%
- 1970년 : 18%
- 1980년 : 28%
- 1990년 : 28%
- 2000년 : 18% (자국 내 생산 기준: 해외생산 별도)

린 건설 적용 사례 효과

- 미국의 Productivity Inc.
 - 84%의 작업낭비요소의 제거
 - 65%의 Lead Time 감소
 - 41%의 품질 향상
 - 67%의 생산성 향상
- 미국의 Boldt 건설회사
 - 약 20%의 공기향상
 - 공사금액 \$14million(168억원)의 교도소공사에서 4개월의 공기단축, 22% 공사비 감소
 - 공사금액 \$12million(144억원)의 대학부설빌딩 공사에서 6개월의 공기 단축, 20%의 공사비 감소
 - 콘크리트 공사의 경우 25%의 생산성 향상
- 미국의 Linbeck 건설회사
 - 일반 프로젝트 완료 확률은 40%이나, 린 건설 적용 프로젝트의 완료 확률은 80~90% 임
 - 평균 10~30%의 공사비와 공기단축
- 덴마크 건설대기업 MT Højgaard사
 - 건설공사의 리스크가 기존 대비 1/3 줄어듦.

Table of Contents

What is "Lean"?

1

2

Improvement by Lean

Lean Principles

3

4

Tools for Lean

Application Examples

5

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2. Value Stream Mapping

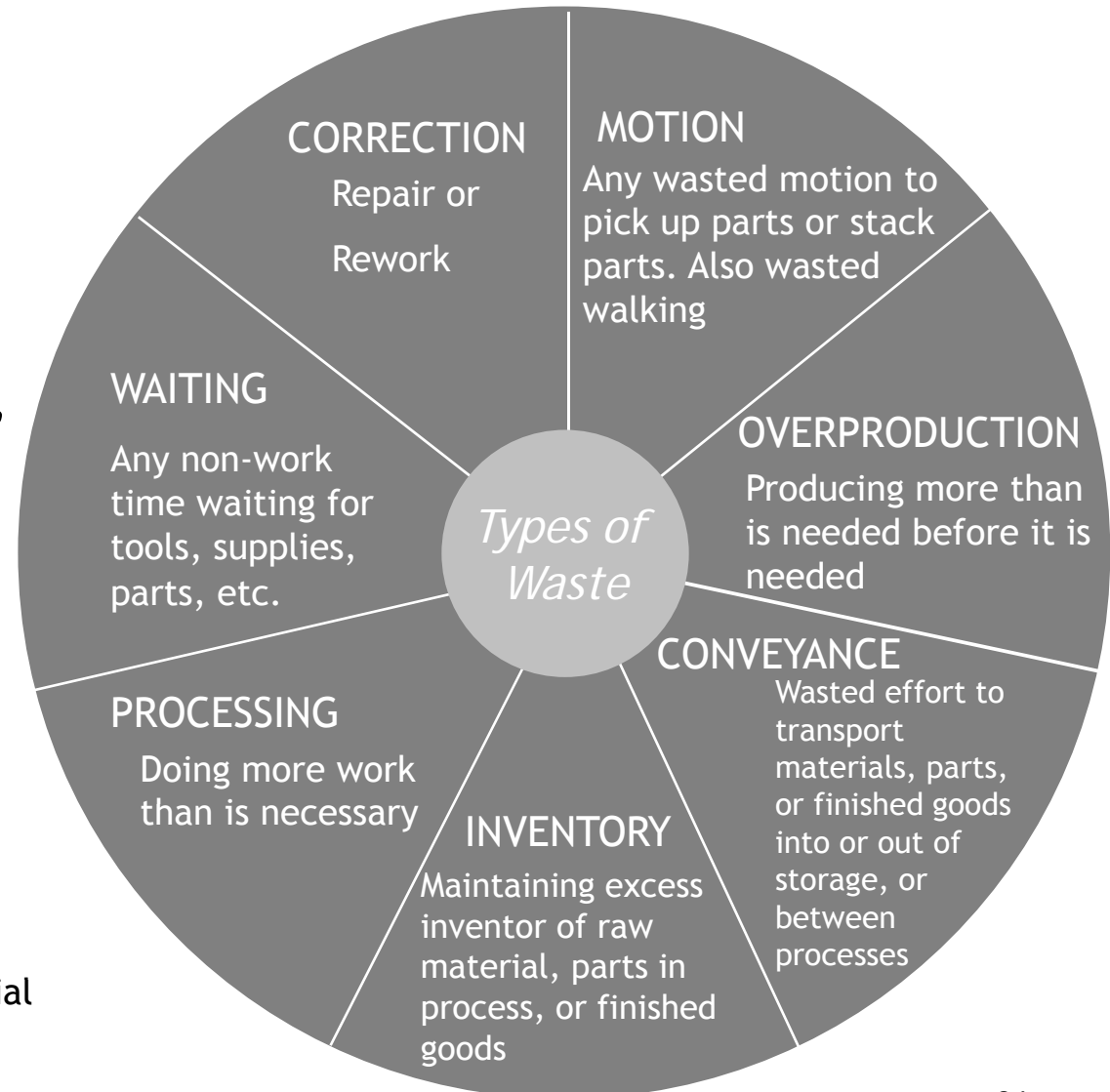
1. Parade Game
2. Precasting and Installation of Pile Foundations

Lean principles

- Precisely specify value by specific product
- Identify the value stream for each product
- Make value flow without interruptions
- Let the customers pull value from the producer
- Pursue perfection

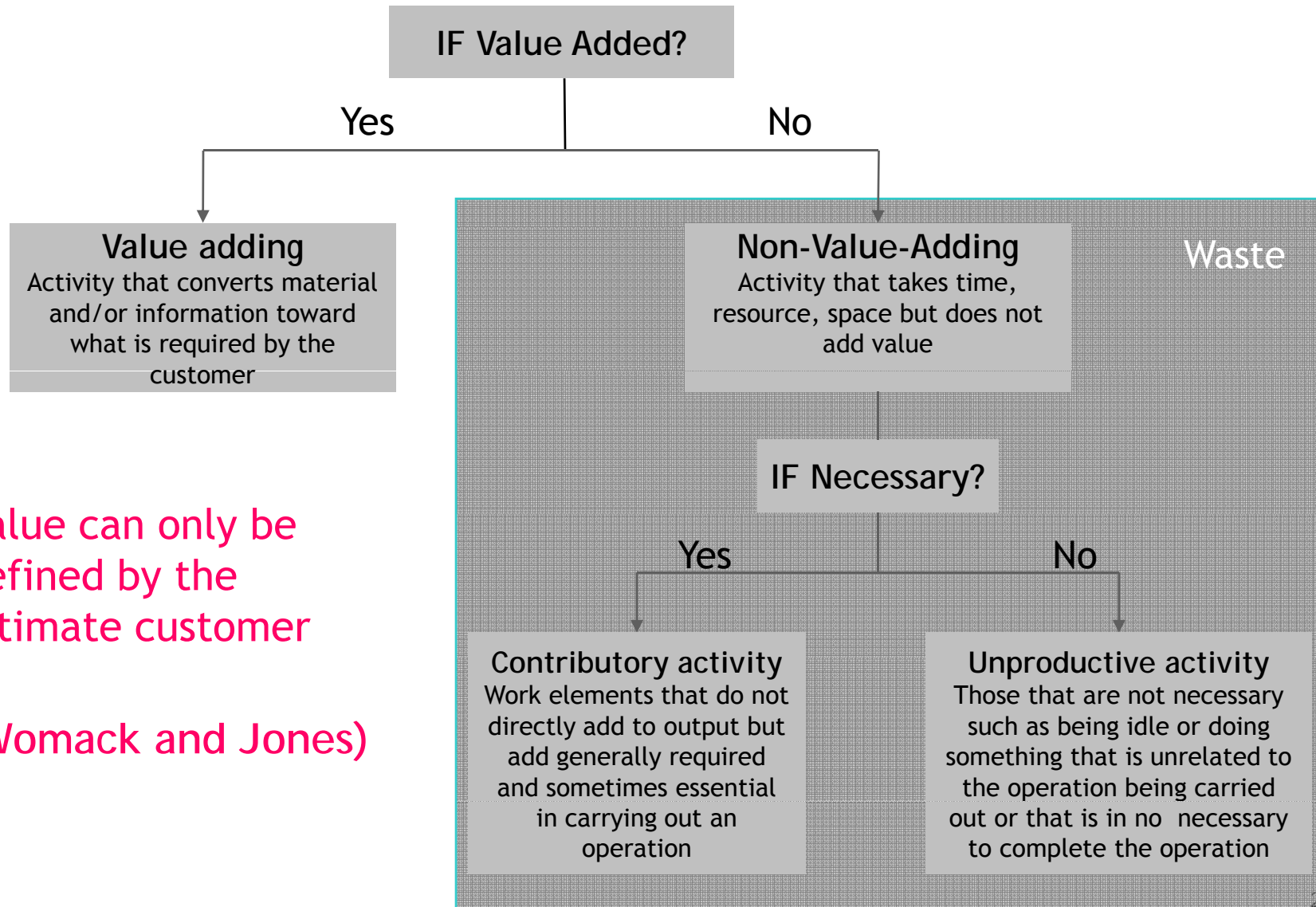
Waste

- Waste: Number of defects, rework, number of design errors and omissions, number of change orders, safety costs, excess consumption of materials, etc. (Koskela, 1992)
- Waste is anything that adds to the time and cost of making a product but does not add value to the product from the customer's point of view.



Kentucky Center for Experiential Education 1998 / Shingo 1989

Value



Value can only be defined by the ultimate customer

(Womack and Jones)

Table of Contents

What is “Lean”?

1

2

Improvement by Lean

Lean Principles

3

4

Tools for Lean

Application Examples

5

1. The Last Planner System
2. Value Stream Mapping

1. Parade Game
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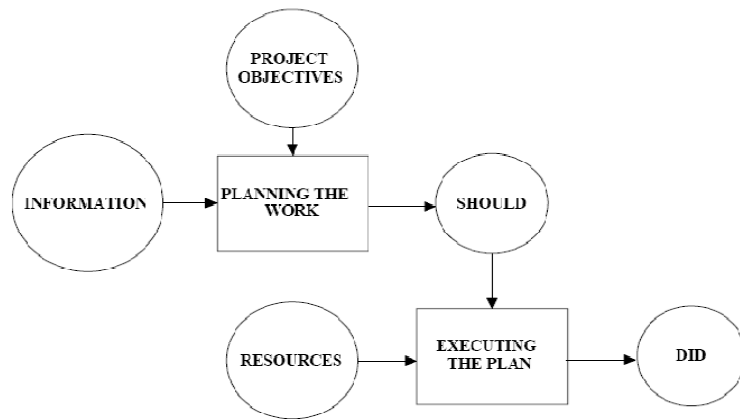
The Last Planner System

The Last Planner System

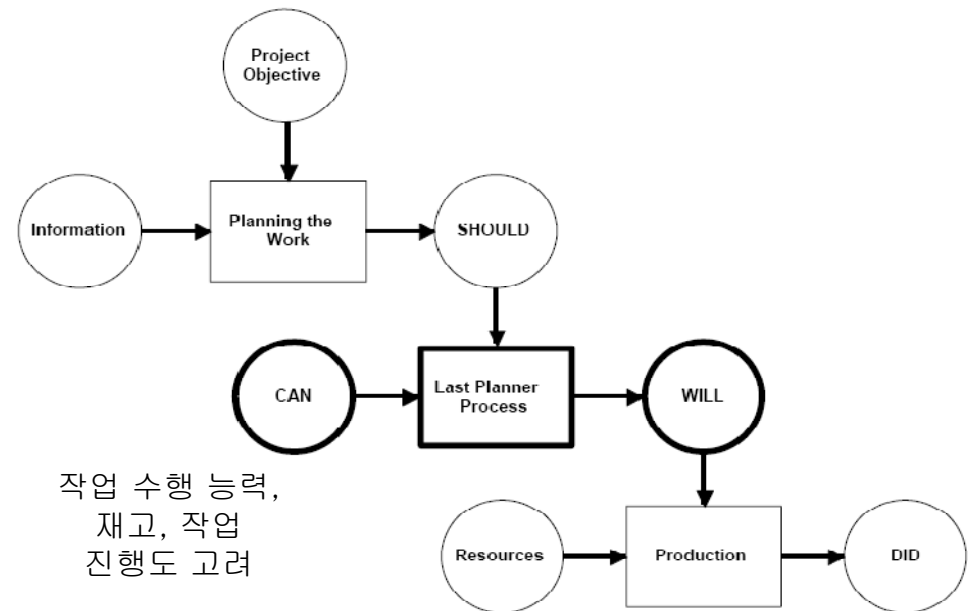
- The Last Planner System
 - The Last Planner production control system is a philosophy, rules and procedures, and a set of tools that facilitate the implementation of those procedures. The system has two components: production unit control and work flow control

- Lookahead Process
 - Purposes of Lookahead Process
 - Shape work flow sequence and rate
 - Match work flow and capacity
 - Maintain a backlog of ready work
 - Develop detailed plans for how work is to be done

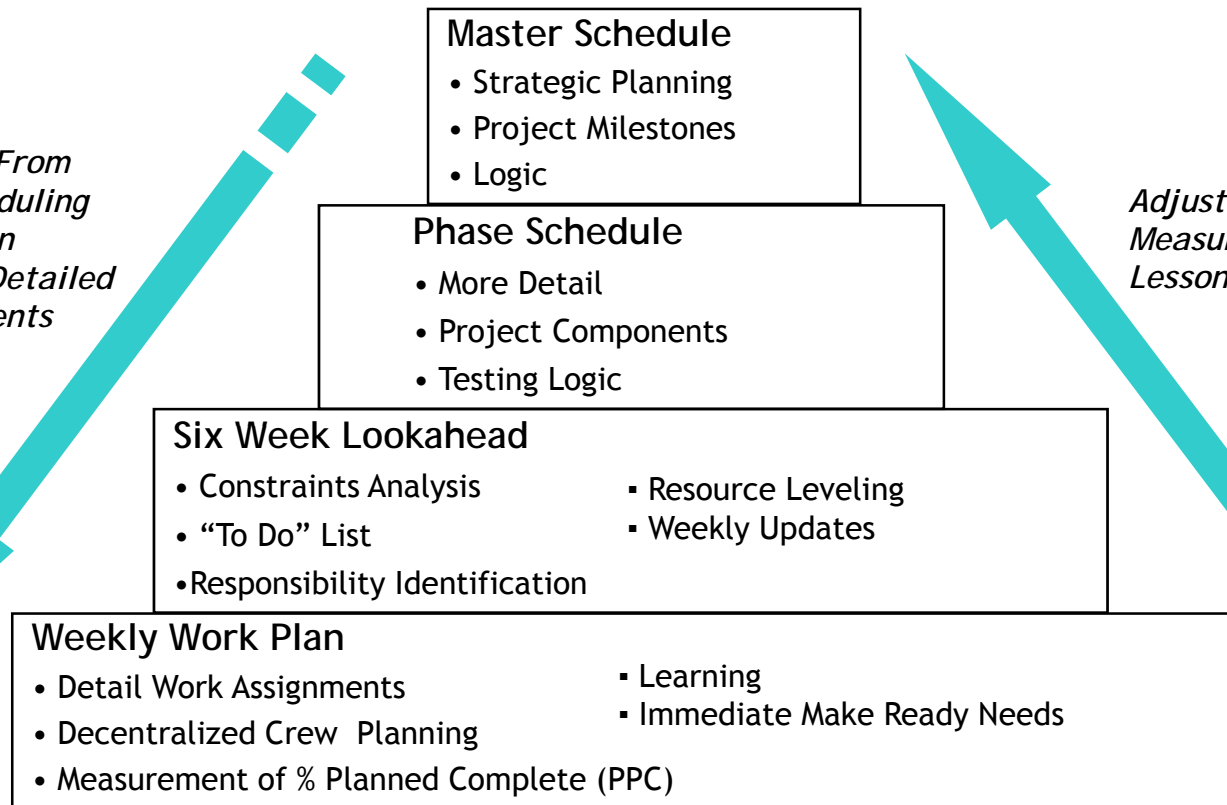
- A Traditional (Push) Planning System



- The last Planner (Pull) System



*Drilling Down From
Strategic Scheduling
Into Production
Planning and Detailed
Work Assignments*

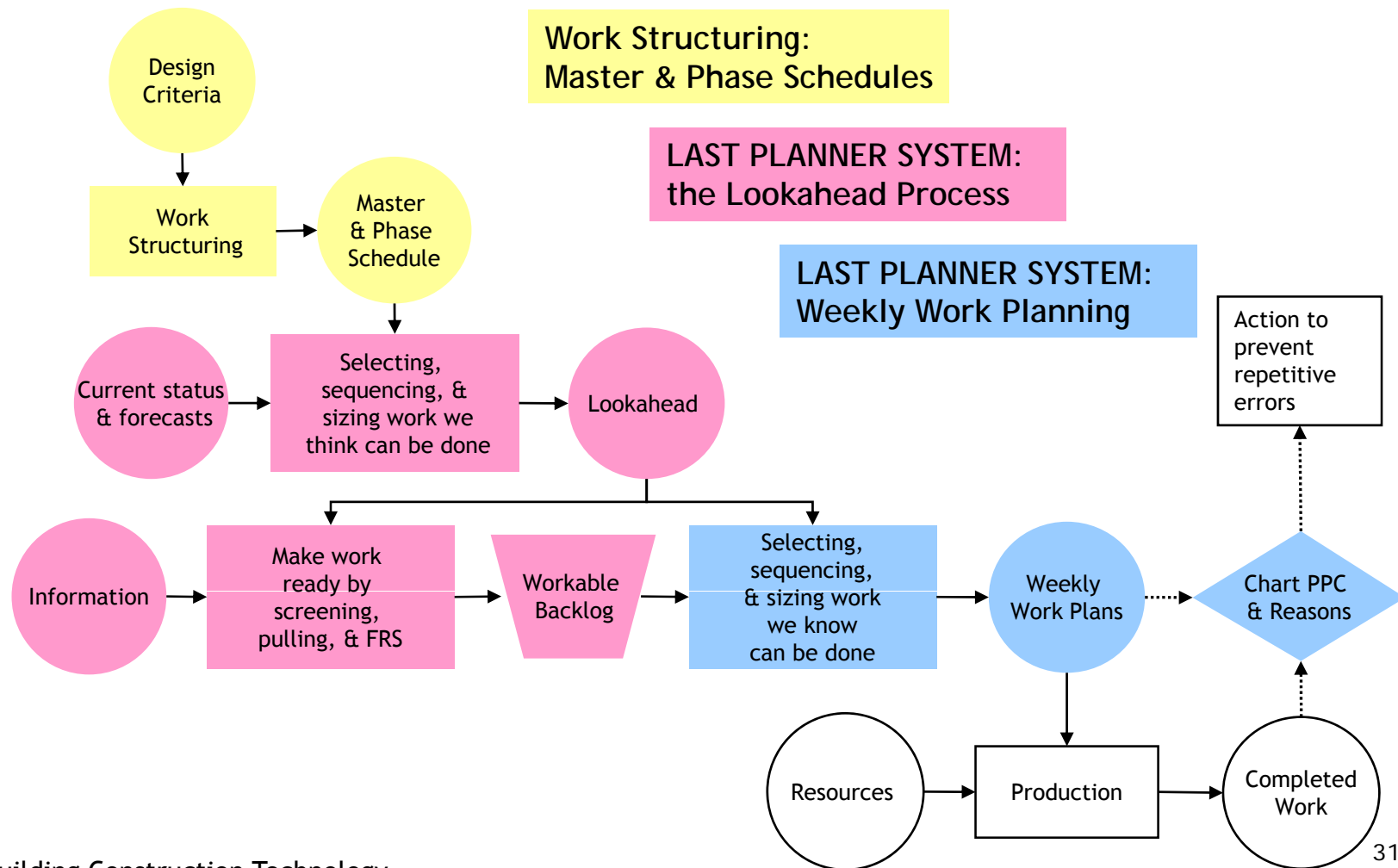


*Adjusting the Plan Through
Measured Progress and
Lessons Learned*

- Slide Provided by OscarJ. Boldt Construction -

The Last Planner System

- The Last Planner System Process

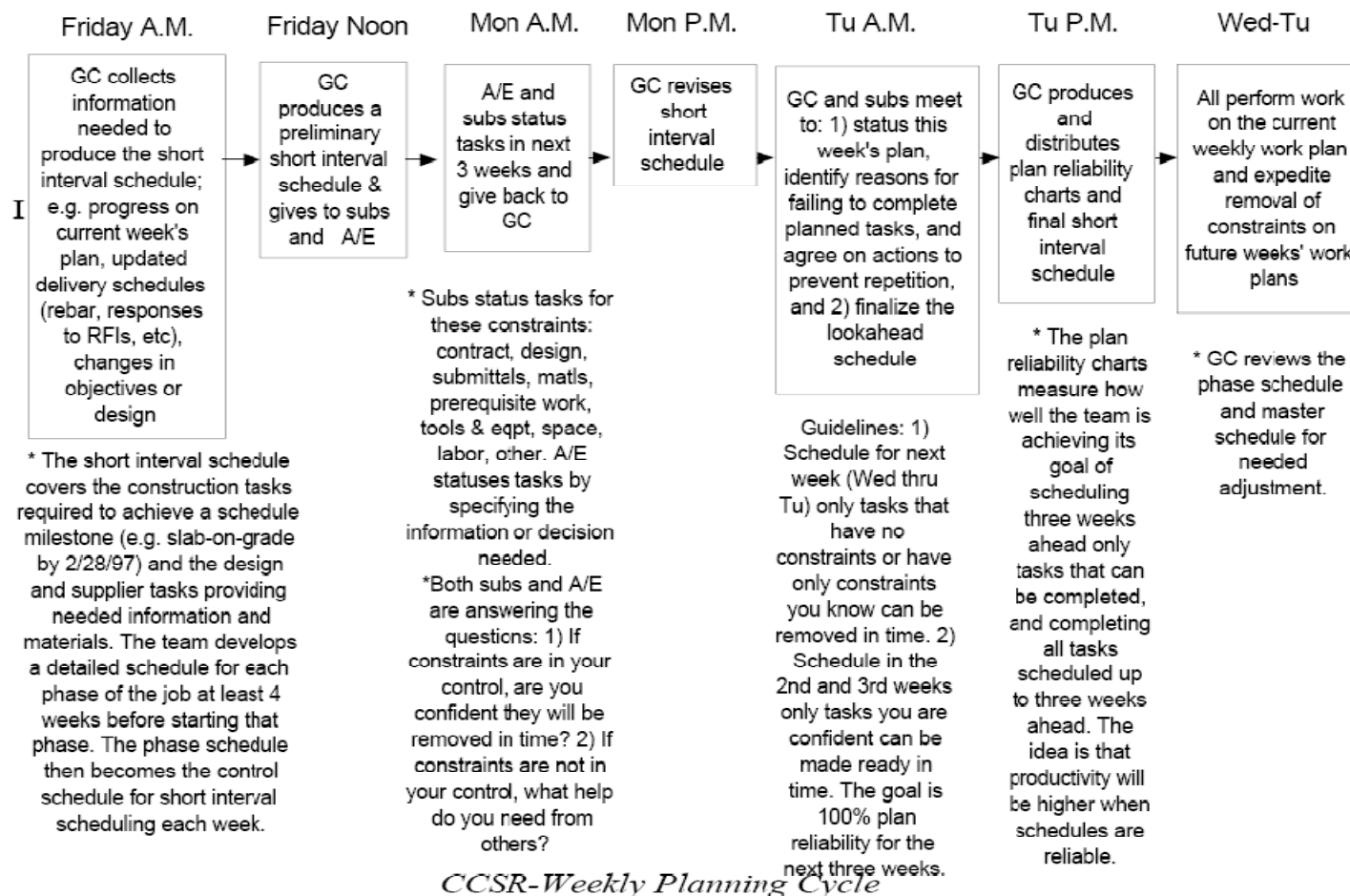


- Lookahead Process
 - Engineering Lookahead Schedule

PROJECT: Pilot						5 WK LOOKAHEAD									
ACTIVITY	1/13/97		1/20/97		1/27/97		2/3/97		NEEDS						
	M	T	W	T	F	S	M	T		W	T	F	S		
Scott's crew															
"CUP" AHUs-10 CHW, 2 HW	X	X	X	X	X	X	X	X	X	X	X	X	X	X	CHW delivers 1-8-97 thru 1-13. HW delivers 1-20.
Punch, label, & tag AHUs											X	X	X		Materials on site
Ron's crew															
DI Steam to Humidifier			X	X	X										Materials on site
DI Steam Blowdown	X	X													Check material
DI Steam Cond. to coolers (13)						X	X	X	X	X	X	X	X	X	Material on site
Charles' crew															
200 deg HW 1-"H"	X	X	X												Matl delivery 1-8-97
200 deg HW 1-"B" & 1-"D"						X	X	X	X	X	X	X	X	X	Release matl for 1-15-97
1st flr 200 deg HW guides & anchors	X	X	X	X	X						X	X	X	X	Material on site. Need West Wing flr covered.
Richard's crew															
2-"A" HW & CHW	X	X	X	X	X										Control valves for added VAV coils
CHW in C-E-G tunnels	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Need tunnels painted & release materials
Misc FCUs & cond. drains in "I", "J", & "K" 1st flr						X	X	X	X	X	X	X	X	X	Take off & order materials
Punch, label & tag						X	X	X	X	X	X	X	X	X	Material on site

The Last Planner System

- The Last Planner System Case (CCSR Project)
 - CCSR Weekly Planning Cycle



Value Stream Mapping

Value Stream Mapping

- Value Stream Mapping Definitions
 - Value Stream is the flow of all of the activity and value added needed to fulfill a request. i.e. Order's or Product's Path, all steps, from Beginning to End.
 - Value Stream Mapping (VSM) are drawings that makes the flow of material and information visible following a product's path from beginning to end.
 - Current State Maps describes the process as it is today.
 - Future State Maps describe the ideal state based on applying lean principles.

번호	기호(Symbol)	의미
1		작업
2		각 공정간에 쌓여있는 재고를 의미 (Work-In-Process, WIP)
3		현장으로 자재의 이동
4		각 작업자간의 정보의 흐름
5		재고에 의한 밀어내기식 생산 (Push-driven System)
6		슈퍼마켓(Supermarket) - 생산량을 요구에 따라 조절
7		공정에서 필요 시 슈퍼마켓으로 보내는 인출칸반
8		요구한 양에 알맞은 물품을 생산을 조절하는 생산칸반
9		슈퍼마켓으로부터 재료의 물리적인 당김생산 (Pull-driven System)

Value Stream Mapping

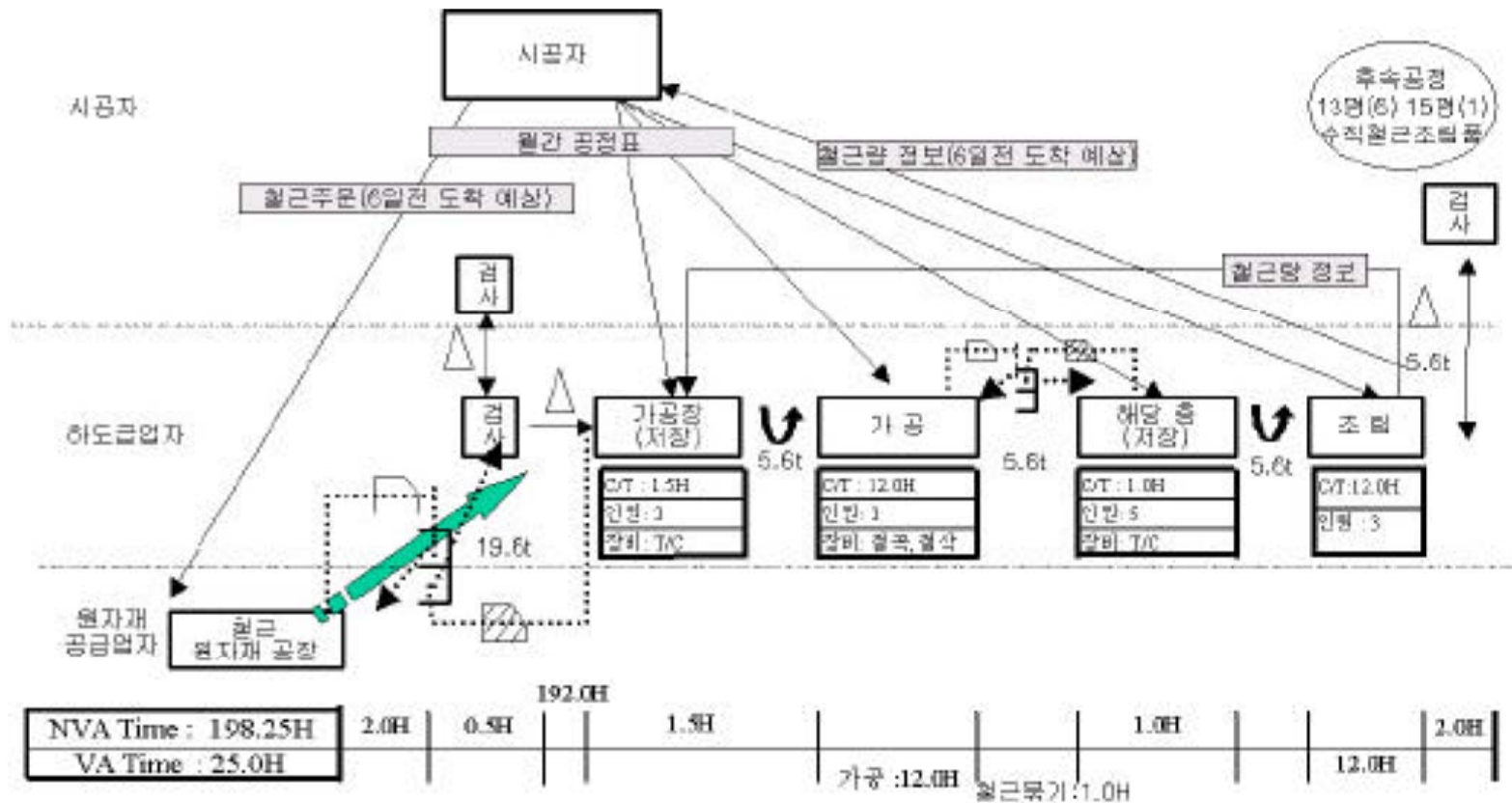


Table of Contents

What is “Lean”?

1

2

Improvement by Lean

Lean Principles

3

4

Tools for Lean

Application Examples

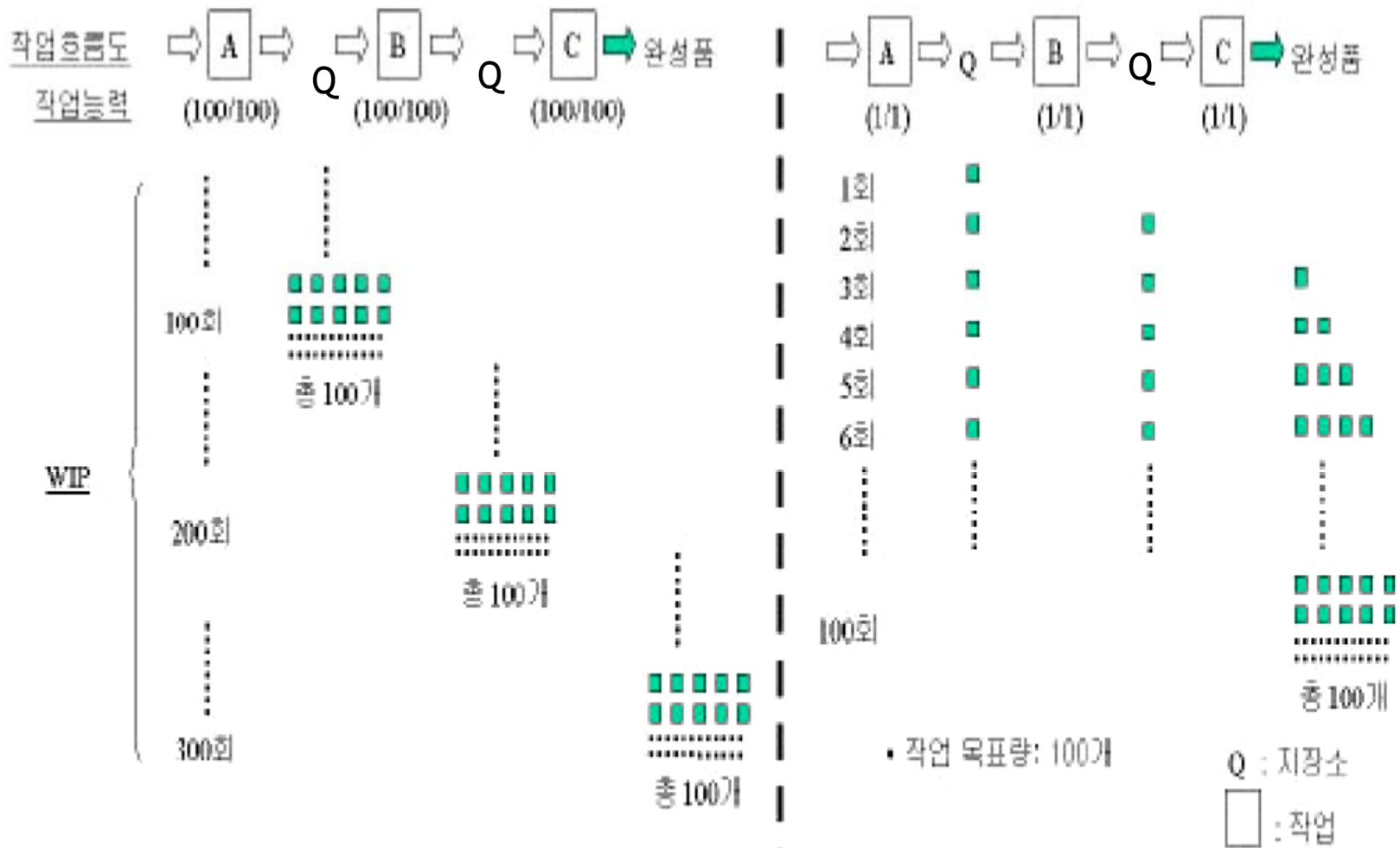
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2. Value Stream Mapping

1. Parade Game
2. Precasting and Installation of Pile Foundations

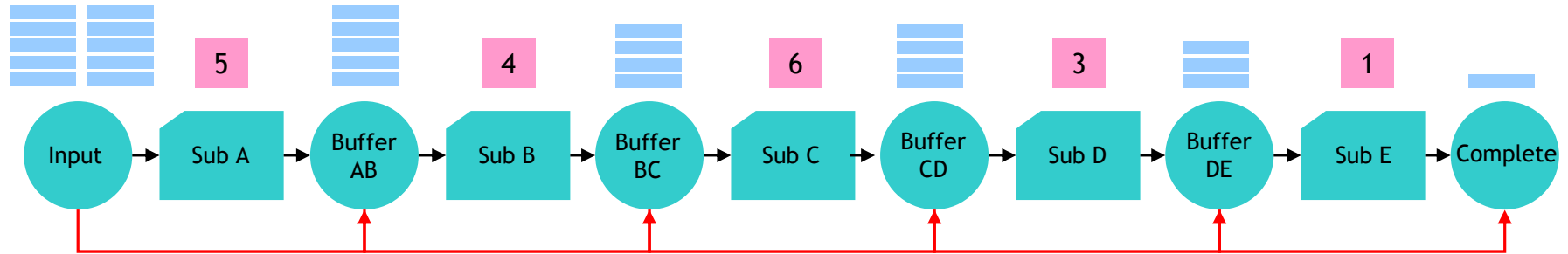
Parade Game

Batch & Queue Vs Flow



Parade Game

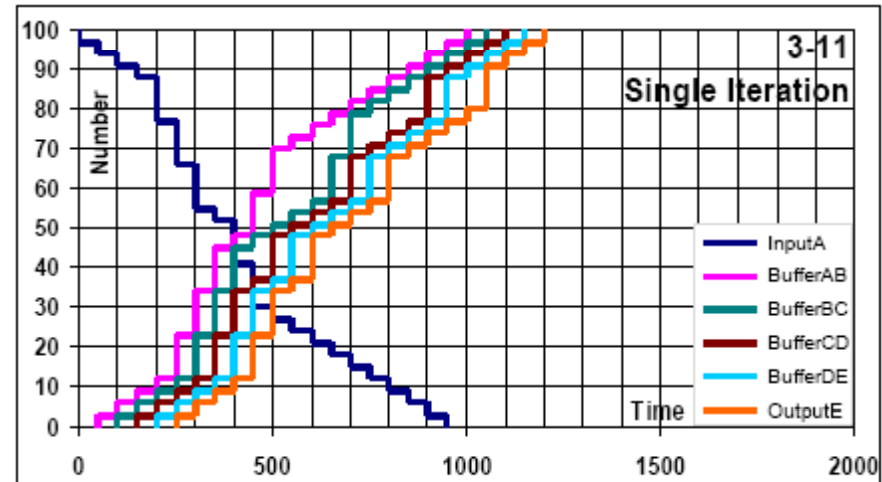
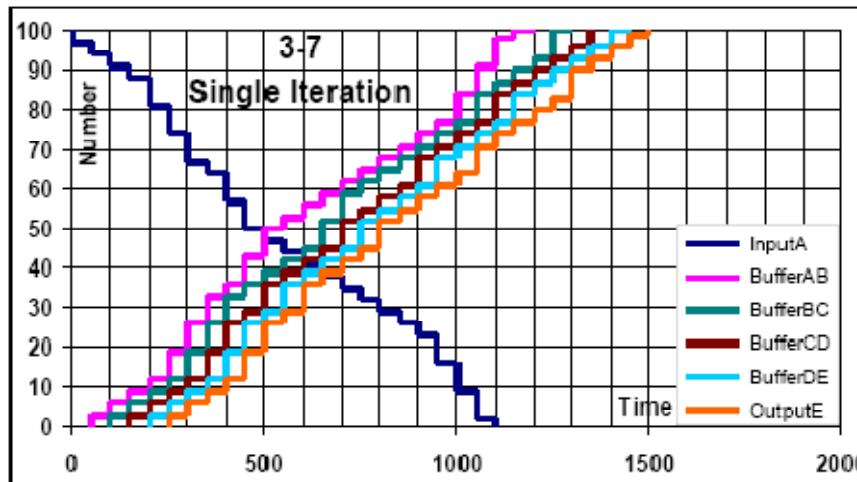
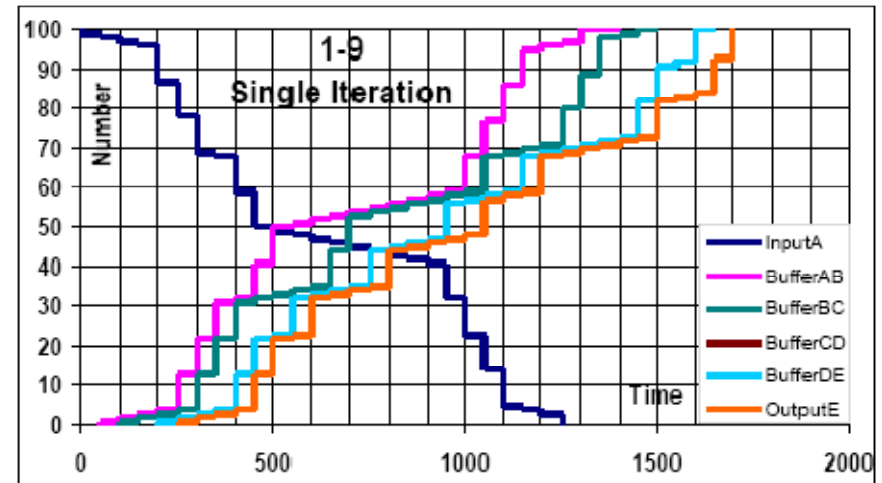
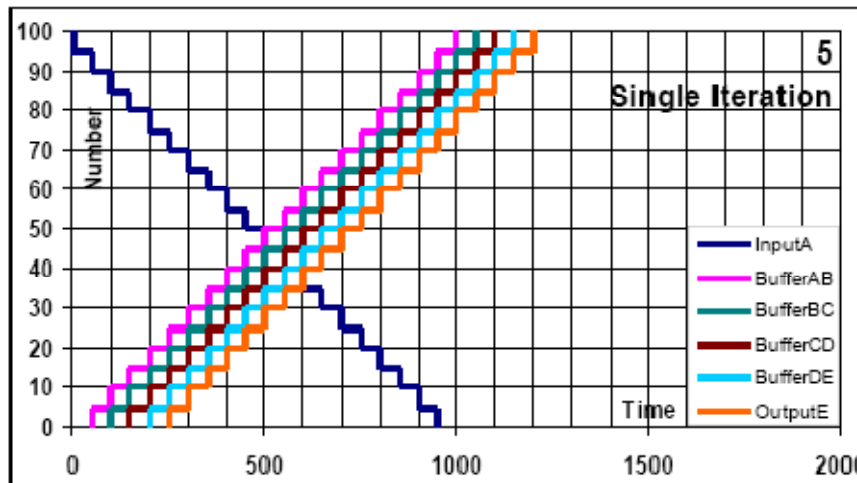
- Parade Game



Type of Die	Numbers on Faces
A	5, 5, 5, 5, 5, 5
B	4, 4, 4, 6, 6, 6
C	3, 3, 3, 7, 7, 7
D	2, 2, 2, 8, 8, 8
E	1, 1, 1, 9, 9, 9

Parade Game

- Simulation Iterations



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