اجرا و مدیریت پروژه به روش اصول ناب
(Lean Project Management)

فصل اول: مفاهیم، اصول و ابزارهای روش ناب (Lean)

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طراحی، پیاده سازی و مدیریت پروژه‌ها باید به شکل بهینه ای صورت گیرد تا بتواند با کاهش اتلافات، هزینه های پروژه را کاهش دهد. در واقع پروژه ها میتوانند به روش اجرای مبتنی بر اصول ناب (LPDS) پیاده سازی شده و این اصول میتوانند در پروژه ها (Lean Project Management) و بخصوص در صنعت ساخت (Lean Construction) تحولات ساختاری و هزینه ای را ایجاد نمایند. بکارگیری اصول ناب میتواند باعث بهبود فرآیندها، افزایش بهره وری، کاهش هزینه‌ها و افزایش درآمدها در پروژه ها شده و ساختار یکپارچه و نوینی را در پروژه ها ایجاد نمایند. علاوه بر این، اصول ناب یکی از الزامات پیاده سازی پروژه به روش BIM بوده و باید قبل از تدوین روش اجرای مبتنی بر بیم (BIM-Based Delivery System)، این ساختار را فرا گیریم. ارتباط تنگاتنگ این اصول با مدلسازی اطلاعات ساختمان (BIM) و روش انجام تجمیعی پروژه (IPD)، یک ساختار متفاوتی را ایجاد خواهد نمود، تا پروژه به شکلی متفاوت و با بالاترین سطح بهره وری طراحی، پیاده سازی و مدیریت گردد. البته باید آگاه باشیم که پیاده سازی این روش در پروژه ها به همان شکل تولیدی ممکن نبوده و چرخه حیات Lean Project Delivery System یا روش اجرای مبتنی بر اصول ناب را ایجاد مینماید. چرخه ای که از مرحله طراحی تا بهره برداری ادامه داشته و تکنیکهای زیادی از جمله برنامه ریزی Last Planner را در خود جای میدهد. لازم به ذکر است که "دوره فرآیند یکپارچه برنامه ریزی، زمانبندی، ارزیابی و کنترل پروژه" پیشنیاز این دوره بوده و این دوره نیز یکی از پیشنیازهای دوره جامع مدیریت BIM است که در آینده در موسسه ACEMI برگزار میگردد.

آنچه خواهید آموخت

در این دوره نه تنها مفاهیم، اصول و ابزارهای روش ناب (Lean) را فرا میگیرید، بلکه مختص پروژه ها کارایی و پیاده سازی این رویه ها را خواهید آموخت. این دوره ما را یک قدم دیگر به روش اجرای مبتنی بر BIM نزدیک کرده و ارتباط روش IPD و سیستمهای مختلف پروژه با یک ساختار بهینه را به ما می آموزد. در واقع در این دوره:

۱. مفاهیم و اصول ناب را همراه با مزایای آنها فرا میگیرید.

۲. تکنیکها و روشهای اصول ناب را فرا گرفته و یاد میگیرید که چگونه از این تکنیکهای کاربردی در زندگی، صنعت و پروژه استفاده نمایید.

۳. نحوه پیاده سازی این تکنیکها در پروژه ها را فرا گرفته و میتوانید به شیوه ای کاربردی اقدام به پیاده سازی مفاهیم اصول ناب و تکنیکهای فراگرفته شده، در پروژه ها و از فاز طراحی تا انتهای فاز بهره برداری نمایید.

۴. ارتباط این ساختار را با مدلسازی اطلاعات ساختمان (BIM) و روش انجام تجمیعی پروژه (IPD) فرا گرفته و پیشنیاز ساختار مدیریت جامع BIM را می آموزید.

اجرا و مدیریت پروژه به روش اصول ناب (Lean Project Management)

مهم‌ترین سرفصل‌ها

۱. مفاهیم، اصول و ابزارهای روش ناب (Lean)

- ✓ **کلیات، تاریخچه و اصول ناب:** فلسفه تولید سنتی، تولید نوین، مدیریت پروژه سنتی، مدیریت پروژه نوین، تعریف اصول ناب، تاریخچه، بررسی مبانی و مفاهیم اصول ناب، بررسی اصول ۱۴ گانه ناب، توصیه های کلیدی و ...
- ✓ **مفاهیم فرآیند جریان (Flow)، کشش (Pull)، کانبان (Kanban)، زمان تکت (Takt time) و بهنگام (JIT):** بررسی صنعت ساخت به عنوان یک فعالیت و یک جریان، مفاهیم تولید انبوه، مشکلات موجود در تولید انبوه، تعریف جریان، تعریف کار در جریان، مفهوم جریان ادامه دار، ابزارهای پیاده سازی جریان ادامه دار، همراه با مثالهای متعدد و ...
- ✓ **شناسایی و تشخیص اتلاف به کمک Gemba walk:** تعریف اتلاف، معرفی انواع منابع اتلاف، نحوه دسته بندی و شناسایی فعالیتها با ارزش افزوده و بدون ارزش افزوده، نحوه یافتن اتلافات، همراه مثالهای متعدد و ...
- ✓ **مفهوم انحراف یا تغییرات به عنوان منبع اتلاف:** تعریف انحرافات، بررسی انحرافات در پروژه و صنعت ساخت، شناسایی انواع دسته های انحرافات در تولید، اتلافات در جریان کار، نحوه استفاده از استراتژی اصول ناب برای کاهش انحرافات، استراتژی، همراه با مثالهای متعدد و ...
- ✓ **چرخه بهبود مداوم (PDCA):** معرفی چرخه بهبود مداوم، بررسی ۱۲ گام برای ایجاد چرخه بهبود مداوم، استاندارد اجرایی برای پیاده سازی PDCA به صورت مفصل و همراه با معرفی و آموزش انواع تکنیکهای کار استاندارد، روشهای 5S و کانبان و مدلسازی اطلاعات ساختمان (BIM) و روش برنامه ریزی کشش (PULL) و روش نقشه برداری جریان ارزش و دیاگرام Swim lane، آنالیز پارتو (Pareto)، همراه با مثالهای متعدد و ...
- ✓ **نقشه برداری جریان ارزش فعلی (VSM) و تدوین جریان ارزش آتی (FVSM):** بررسی سیستم مدیریت بلندمدت، سیستم مدیریت ارزش، معرفی سه بخش اصلی روش VSM، گامهای اجرایی برای پیاده سازی نقشه برداری VSM، نحوه بهبود جریان ارزش، نحوه ترسیم جریان ارزش آتی FVSM، همراه با مثالهای متعدد و ...
- ✓ **انتخاب بر اساس سیستم تصمیم گیری مزایا (CBA):** معرفی سیستمهای تصمیم گیری، معرفی روش دو لیسته برای تصمیم گیری، گامهای اجرایی برای تدوین جدول تصمیم گیری با استفاده از سیستم CBA، آموزش سیستم تصمیم گیری در تصمیمات پیچیده با هزینه یکسان و غیریکسان، آموزش مدلهای تصمیم گیری در انواع حالتهای مختلف به صورت ترسیم جدولی و گرافیکی، همراه با مثالهای متعدد و ...
- ✓ **حل مشکل و گزارش دهی بر اساس روش A3:** معرفی روش گزارش دهی A3، مدل تصمیم گیری بر اساس A3، انواع فرمتهای فرآیند A3 همراه با گامهای هفتگانه اجرایی این روش، ارتباط روش گزارش دهی A3 با چرخه بهبود مداوم PDCA، آموزش کامل نحوه پیاده سازی سیستم A3 در دو فرمت خاص، همراه با مثالهای متعدد و ...
- ✓ **مفهوم همکاری و رقابت:** اصول و مبانی رقابت و همکاری و تفاوت این دو در سازمانها، شرح مفهوم رقابت و همکاری، موارد مرتبط با مدیریت در ارتباط با همکاری و رقابت، معرفی روش انجام تجمیعی پروژه (IPD)، همراه با مثالهای متعدد و ...
- ✓ **سیستم Last Planner:** چرایی استفاده از سیستم LPS، نحوه توسعه و تدوین سیستم LPS، هشت جزء اصلی در سیستم LPS، بررسی ساختار LPS، همراه با مثالهای متعدد و ...

۲. بکارگیری مفاهیم و اصول روش ناب در مدیریت پروژه (Lean Project Management)

- ✓ **بررسی نحوه بکارگیری اصول روش ناب در مدیریت پروژه:** بررسی پیشینه صنعت ساخت و گزارشات مربوط به رونق، بهره وری، اتلافات و نیروی انسانی در این صنعت، معرفی و بررسی اصول ناب در صنعت ساخت (Lean Construction)، بررسی اساس و مبانی Lean Construction و مقایسه آن با سیستم اصول ناب در تولید، مقایسه سیستم مدیریت سنتی در صنعت ساخت با سیستم اصول ناب در صنعت ساخت، بررسی ارزش و تاثیرات Lean Construction، همراه با مثالهای متعدد و ...
- ✓ **استفاده از اصول روش ناب در مرحله طراحی (Design) پروژه:** اصول و مبانی ناب در مرحله طراحی و ساخت در پروژه ها، معرفی سیستم روش اجرای ناب (LPDS)، معرفی مرحله به مرحله و گام به گام روش اجرای LPDS، آموزش فرآیند طراحی بر مبنای سیستم LPDS، آموزش Lean Design، بکارگیری ابزارها و تکنیکهای متعددی چون BIM، سیستم LPS برای برنامه ریزی در فاز طراحی، روش طراحی TVD در طراحی در سیستم LPDS، همراه با مثالهای متعدد و ...
- ✓ **استفاده از اصول روش ناب در مرحله ساخت/اجرا (Construction) پروژه:** آموزش مرحله تامین و تدارکات در فاز ساخت/اجرا در روش LPDS، استفاده از روش کانبان در فاز ساخت/اجرا، آموزش ساختار Lean Assembly در فاز ساخت/اجرا، آموزش ساختار بکارگیری و بهره برداری در فاز ساخت/اجرا، بکارگیری سیستم LPS برای برنامه ریزی در فاز ساخت/اجرا، همراه با مثالهای متعدد و ...
- ✓ **یکپارچگی اصول روش ناب با مدلسازی اطلاعات ساختمان (BIM):** معرفی مدلسازی اطلاعات ساختمان (BIM)، ارتباط بین اصول ناب و BIM، رویه اجرایی پیاده سازی BIM در ارتباط با اصول ناب، کیوسک BIM در روش اجرای LPDS در پروژه، بررسی نمونه های موردی استفاده از BIM در روش اجرای LPDS در پروژه ها، همراه با مثالهای متعدد و ...
- ✓ **اندازه گیری عملکرد و میزان پیشرفت پروژه به کمک روش ناب:** نحوه پیاده سازی یک برنامه اجرایی مناسب برای اندازه گیری عملکرد در روش Lean، اندازه گیری در فاز ساخت/اجرا در سیستم روش اجرای LPDS، معرفی شاخصهای متعدد اندازه گیری و نحوه محاسبه با این شاخصها در سیستم LPDS، همراه با مثالهای متعدد و ...
- ✓ **روش انجام تجمیعی پروژه (IPD) و ارتباط آن با روش ناب:** بررسی تاریخچه روش اجرای IPD، بررسی چهار مرحله ایجاد ارزش در روش انجام تجمیعی پروژه (IPD)، روشهای کاربردی برای پیاده سازی IPD، بررسی ارتباط بین اصول ناب (Lean) و روش انجام تجمیعی پروژه (IPD) همراه با نمونه های موردی، به همراه مثالهای متعدد و ...
- ✓ **استفاده از سیستم Last Planner برای برنامه ریزی و کنترل پروژه:** مبانی تکمیلی و پیشرفته در استفاده از سیستم LPS برای برنامه ریزی و کنترل پروژه، بررسی انواع شاخصهای سیستم LPS برای کنترل پروژه، تعریف شاخصهای جدید و پیشرفته LPS برای کنترل پروژه، نحوه بکارگیری چارچوب مناسب برای بکارگیری شاخصهای جدید و پیشرفته LPS در کنترل پروژه، تاثیرات بکارگیری سیستم LPS در مدیریت زمان، هزینه و کیفیت در زمان کنترل پروژه، همراه با مثالهای متعدد و ...
- ✓ **مطالعه موردی استفاده و پیاده سازی روش ناب در پروژه ها توسط شرکتهای متفاوت:** بررسی چندین مطالعه موردی برای اثبات اثربخشی کامل سیستم اصول ناب در پروژه ها

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Road map

مهارتهای سخت (Hard Skills) - سطح کارشناسی و اجرایی

ارائه گواهینامه حضور بر اساس حضور بیش از ۶۰ درصد در دوره
و گواهینامه حرفه ای بر اساس قبولی در آزمون برای هر دوره

دپارتمان	سطح ۱	سطح ۲	سطح ۳	سطح ۴	سطح ۵
مدیریت پروژه		راهنمای PMBOK	متدولوژی Prince2	استاندارد مدیریت ساخت CMAA	
مدیریت مالی و هزینه	مدیریت مالی و هزینه پروژه ارزیابی اقتصادی پروژه			تامین مالی پروژه	
مدیریت برنامه ریزی و زمان بندی	برنامه ریزی و کنترل پروژه نرم افزار MSP نرم افزار Primavera				
مدیریت کیفیت			مدیریت کیفیت پروژه		
مدیریت قرارداد	آنالیز تاخیرات پروژه	مدیریت ادعاء و اختلافات			اجرای پروژه به روش CM
مدیریت ایمنی			مدیریت ایمنی پروژه		
مدیریت طرح و برنامه		مدیریت پروژه به روش Lean دفتر مدیریت پروژه PMO	مدیریت چابک Agile		مدیریت طرح
مدیریت پایداری			مدیریت پایداری پروژه		
مدیریت ریسک		مدیریت ریسک پروژه			
مدیریت اطلاعات	مدیریت اسناد و مدارک پروژه	نرم افزار Power BI			
مدلسازی اطلاعات ساختمان (BIM)		نرم افزارهای BIM		مدیریت BIM در پروژه	

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Other resources

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فصل اول: مفاهیم، اصول و ابزارهای روش ناب (Lean)

بخش اول: کلیات، تاریخچه و اصول ناب

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What we will learn?

- Introduction to Lean
  - Overview
  - History
  - Review of Lean
  - Review of Lean principles
  - Final notes

Introduction To Lean

(Overview)

Traditional production philosophy

- It is a **conversion** of an **input to an output**
- It can be **subdivided** into **sub-processes**
- The **cost of the total project** can be **minimized** by minimizing the **cost of each sub-process**
- The **value of the out of a process** is associated with **cost (value) of inputs** to that process.

So, what is important here?

Traditional production philosophy

So, traditional model looks at the value of inputs, instead of looking at the value of the process.

Traditional model looks into sub-process to minimize the cost, but what if problem happens to one activity (this is a process)?

There is no flexibility in the traditional model!

Traditional production philosophy

So, we need new philosophy and body of knowledge.

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New production philosophy

- It implies a **dual view** of production
  1. Conversion
  2. Flow
     - Although **only conversion activities add value** to the **material or piece of information** being transformed
       efficiency is attributable to both, conversion and flow,

- Its **activities** are controlled for **minimal variability** and **cycle time**,
  improved continuously with respect to **efficiency** by **implementing new technology**.

New production philosophy

Due to these traditional managerial principles,

flow processes have not been controlled or improved in an orderly fashion.

New production philosophy vs. traditional production philosophy

The traditional production philosophy

Production activities are:
- conceived as sets of **operations or functions**, which are
- controlled, operation-by-operation, for **least costs**, and
- improved **periodically** with respect to **productivity** by implementing **new technology**.

The new production philosophy

Production activities are:
- conceived as material and information **flow processes**, which are
- controlled for minimal **variability and cycle time**, and
- improved **continuously** with respect to **waste and value**, and periodically with respect to efficiency by implementing new technology.

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Project

So, how about projects?

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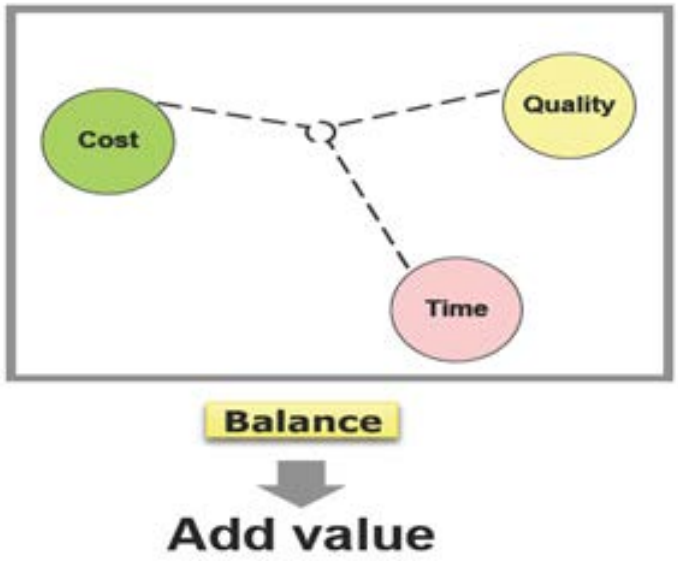
Project

- **The solution to a problem or the satisfaction of a need under:**
  - Budget
  - Time frame
  - Quality requirements
- **Features**
  - Unique
  - Dynamic (changes)
  - Complex (several construction participants)
  - Process (series of steps)
  - Temporal (Start – End)
  - Uncertainty
  - Etc.



Can we reach to this value with traditional principles?

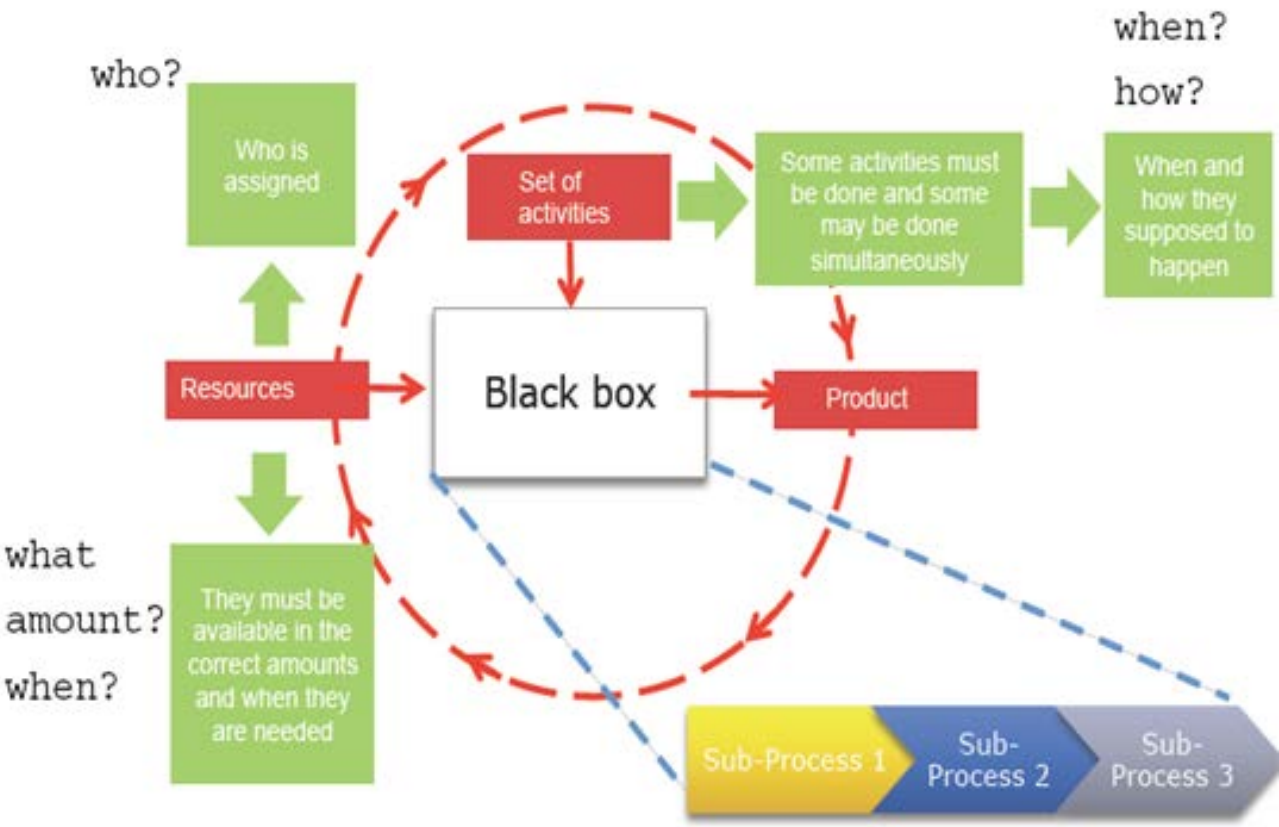
Project: Traditional philosophy

- Reasoning behind planning in construction

- **Input:** **Resources** (who is assigned, what amount should be available, when they have to be available)

- **Process:** **Set of activities** (when and how they supposed to happen)

- **Output:** **Product**



Project: Traditional philosophy

- **We currently manage the projects** in a **mass production way** which means

  focusing on activities and **reducing the time and cost** of **one by one activity**

  This will **conceal the waste generated** between **continuing activities** by

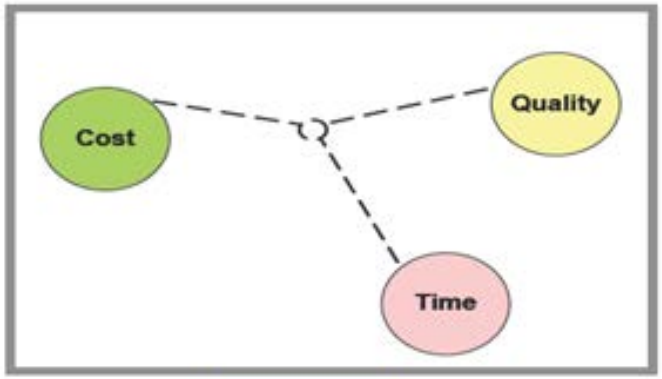
  1. **Unpredictable release of work** and
  2. **Arrival** of **needed resources**

*In this way, there will be **no flexibility and variation possibility** **if something happens** in executing of the project.*

So, we need new philosophy and body of knowledge.

Project: New philosophy

1. **New philosophy: Set of beliefs and values**
2. **New body of knowledge**
   - ❖ Principles
   - ❖ Techniques
     - ❑ *Features*
       - ❖ *Unique*
       - ❖ *Dynamic (changes)*
       - ❖ *Complex (several construction participants)*
       - ❖ *Process (series of steps)*
       - ❖ *Temporal (Start – End)*
       - ❖ *Uncertainty*
       - ❖ *Etc.*



So, we need new philosophy and body of knowledge.

This is lean!

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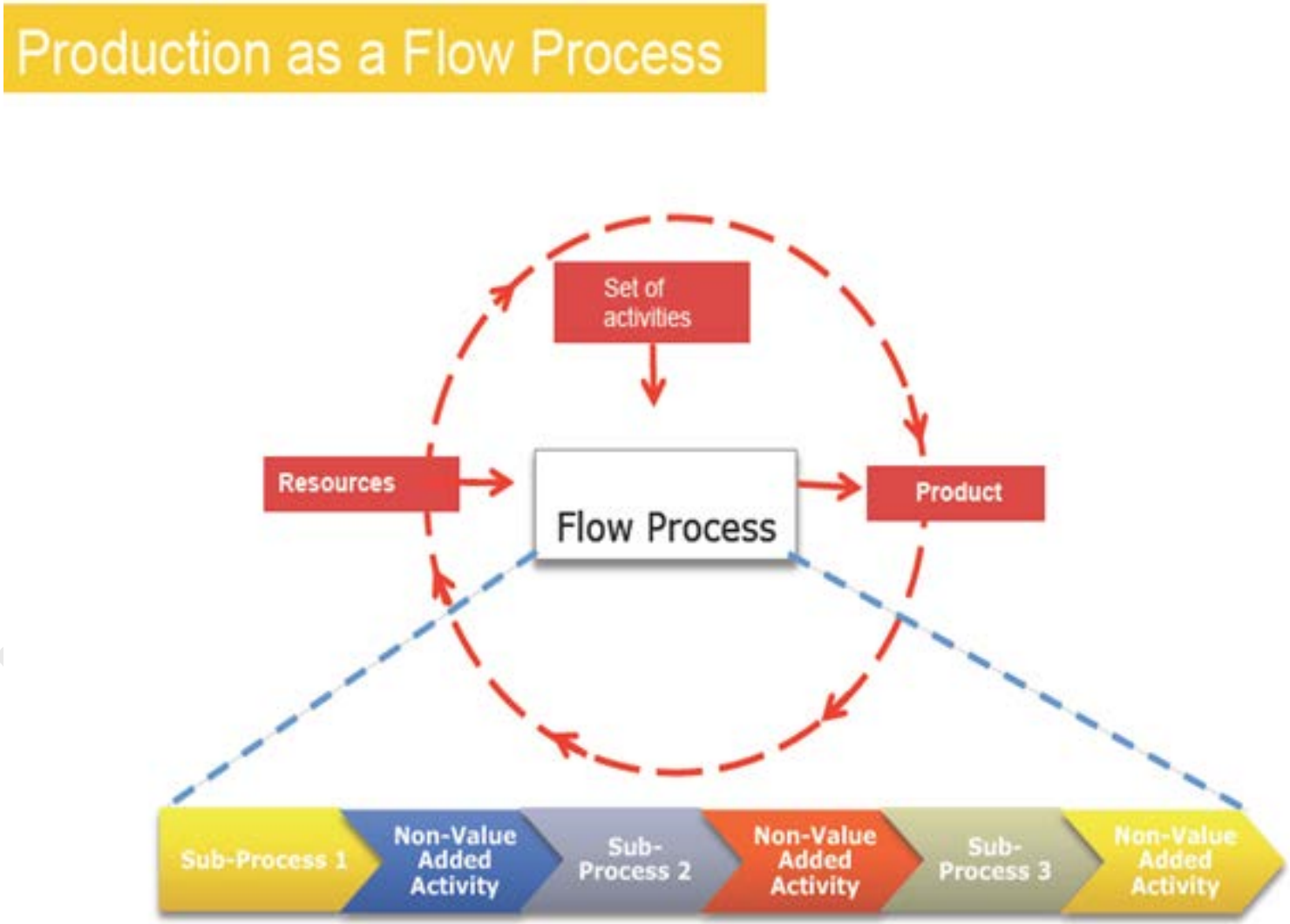
Project: New philosophy

- *For using this new philosophy*,
  - We need to have **better communication** with **customers** to adjust the requirements of the project with their needs
  - We should **identify and eliminate** **non-value adding activities**
  - **Actual construction** should be viewed as **flow processes** consisting of **both waste and conversion activities**, not just conversion processes.

*For example, **waste activities** such as waiting, storing inventory, moving material, and inspection are **not generally modeled by CPM** or **other control tools** and*

*we have to **eliminate the waste between them**.*

Project: New philosophy



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Project: New philosophy

So, we need new philosophy and body of knowledge.

What is lean?

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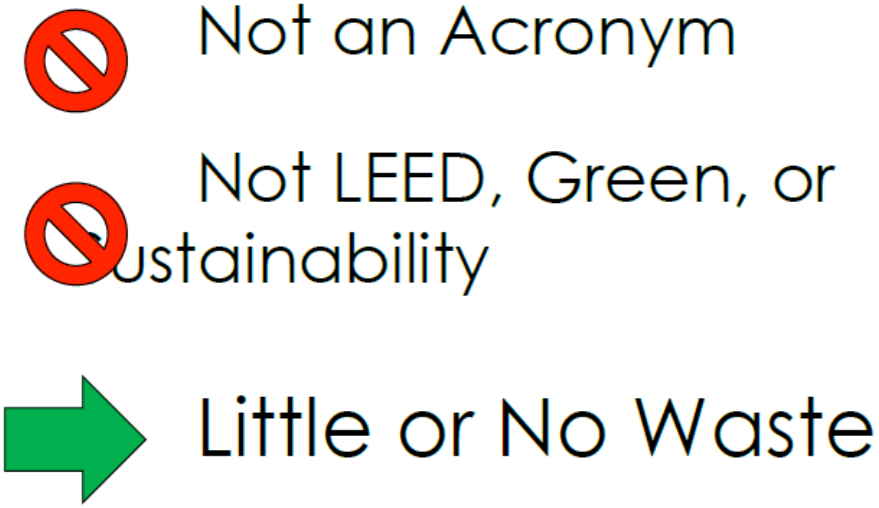
Lean

Before go forward, the key point here is:

Adjust your way and process in construction (cost, quality and time) with customer demand



Introduction To Lean

(History)

Brief history of lean movement

- The term **"Lean"** was fabricated by **James Womack** while he studied **Toyota's production system.**

- **1913: Ford created the moving assembly line**
  - Then Ford developed mass production
  - Dominated the manufacturing industry but was not lean

Brief history of lean movement

- **1939-1945: After World War II, Toyota perfected continuous process flow**
  - Was also able to expand options and selections
  - Exceeded other companies in terms of efficiency and quality

Brief history of lean movement

- **1941-1945: Problem**
  - The solution:
    - ✓ Training within industry service
    - ✓ 600 industrial engineers
    - ✓ 3 core training programs
      - o Job instruction (how to teach)
      - o Job relations (communication)
      - o Job methods (waste reduction)

Mass production introduced!

Brief history of lean movement

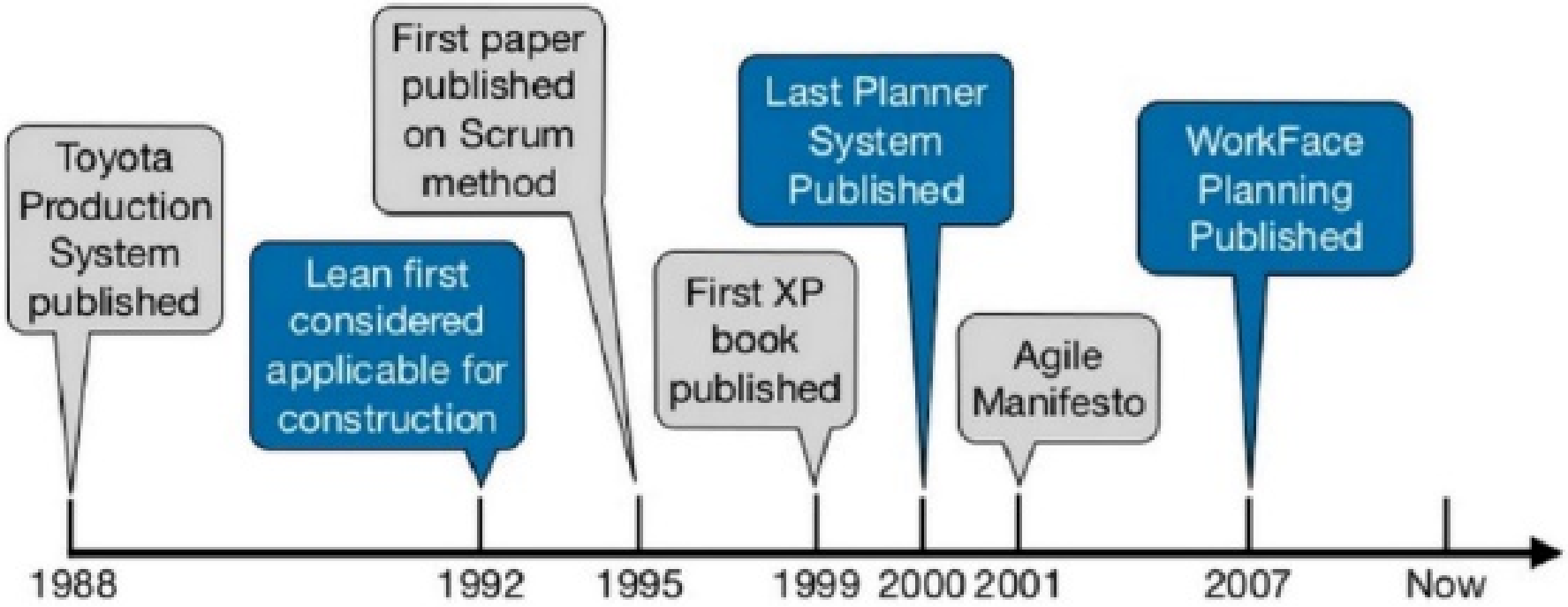
- **1988-1990: Toyota production system published and Womack initiated research to discover Toyota's advantage**
  - Predicted that lean would be adopted quickly the U.S. – but it wasn't
  - Lean has become prevalent in manufacturing but is still evolving

- **Late 1990s: Lean construction began to evolve, but it was slow to be adopted**
  - Greg Howell and Glenn Ballard are considered the founders-formed Lean Construction Institute

- **2000: Ballard developed the Last Planner System**
  - A Lean tool unique to construction

2007+: More widespread adoption of Lean resulting from the poor economy and competition

Brief history of lean movement



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Brief history of lean movement

ASSIGNMENT 1-1-1:

1. **Meet your team members online, read File #1, and talk about the differences between Lean Approach and Traditional Approach in project.**
   - ❖ **You can think of your project or any other projects as an example.**
2. **Try to write differences in two columns (Limited to two pages)**
3. **Send your paper (in PDF format) to ralavipour@gmail.com**

Due on the next week (next week with similar day)

Introduction To Lean

(Review of Lean)

Lean – Heart of Lean systems

- Eliminating
  - Waste
  - Unevenness
  - overburdening

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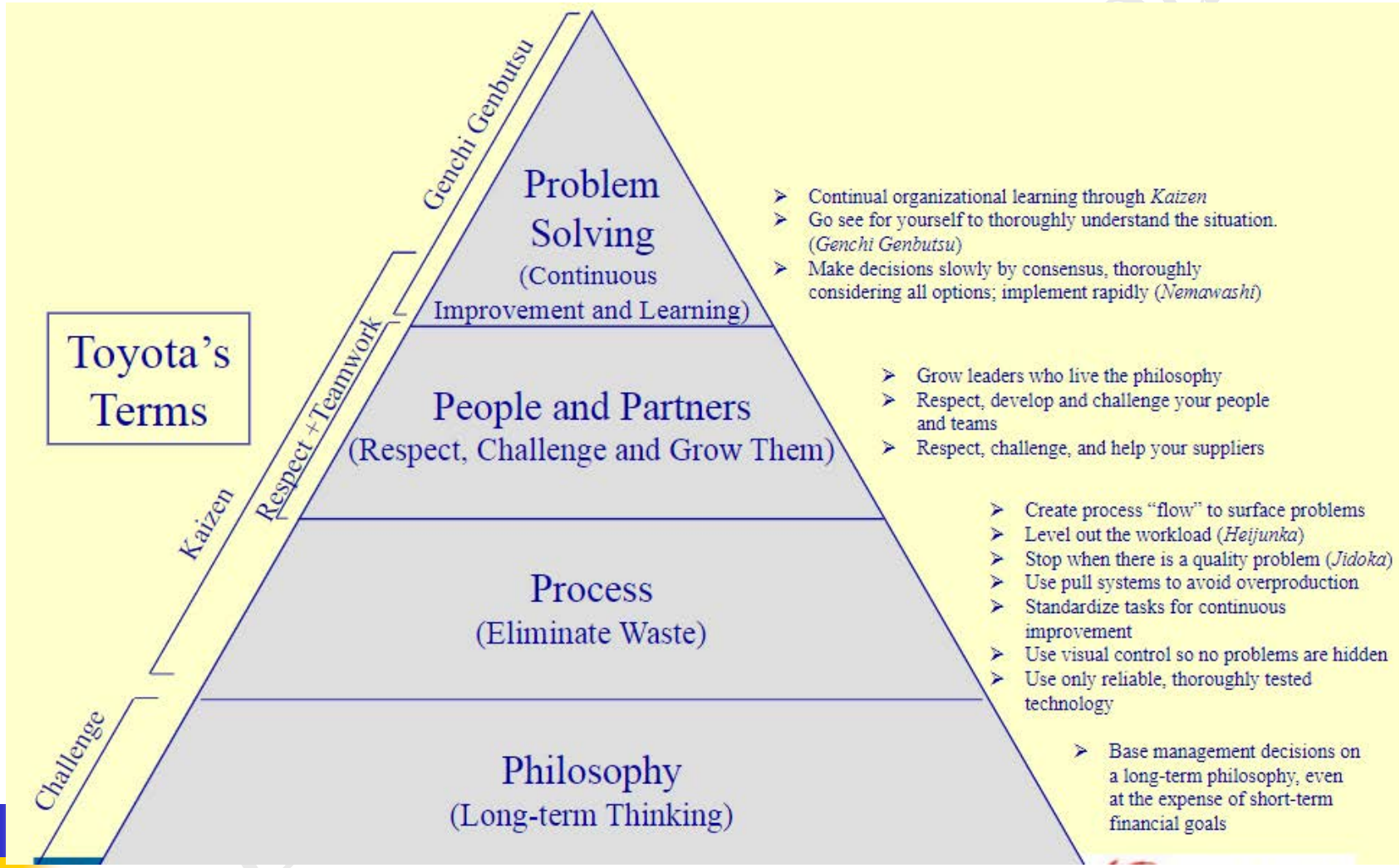
Lean – Principles

- **The basic principles that make up a lean production system include:**
  1. Base management decisions on a long-term philosophy, even at the expense of short-term financial goals
  2. Create process "flow" to surface problems
  3. Use pull systems to avoid overproduction
  4. Level out the workload (*Heijunka*)
  5. Stop when there is a quality problem (*Jidoka*)
  6. Standardize tasks for continuous improvement
  7. Use visual control so no problems are hidden
  8. Use only reliable, thoroughly tested technology
  9. Grow leaders
  10. Respect, develop, and challenge your people and teams
  11. Respect, challenge and help your suppliers
  12. Go see for yourself to understand the situation (*Genchi Genbutsu*)
  13. Make decisions slowly by consensus, thoroughly considering all options; implement rapidly (*Nemawashi*)
  14. Continual organizational learning

Lean – Principles (4P Model of the Toyota way

- **All 14 principles can be categorized into:**
  1. Philosophy (long-term thinking)
  2. Process (eliminate waste)
  3. People and partners (respect, challenge and grow them)
  4. Problem solving (continuous improvement and learning)

Lean – Principles (4P Model of the Toyota way)



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Lean – Effects of lean

Remember the key point?

Adjust your way and process in construction (cost, quality and time) with customer demand

Now, another key point here is:

Using lean principles is a key that leads to shorter time, higher quality, lower cost, while improving safety and morale.

How? Let's see!

Lean – Enterprise

- A Lean enterprise
  - Understand what their **customers value**
  - Pursues the identification of **waste**
  - Continuously eliminates waste from the **value stream**
  - Strives for **continuous** value stream workflow
  - **Pulls** (rather than pushes) work through the system
  - Pursues **excellence**

Lean is a set of tactical principles and a set of tools

What tools needed to reach the lean principles?

Let's see!

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Lean – Summary of Lean Tools

- **"Becoming lean requires a gradual mind shift, but is enabled by proven tools including these:" (ReAlignment Group, Ltd)**
  - The Gemba Walk
  - Value Stream Mapping
  - PDCA improvement cycles
  - A3 Problem Solving and Analysis
  - Choosing by Advantages – decision making
  - Target Value Design
  - Set-based Design
  - Pull Planning – Last Planner System
  - 5S and Visual Control
  - Standardized Work
  - Parade of Trades Game
  - 5 Whys
  - Kaizen Events
  - Plus/Deltas
  - BIM
  - IPD
  - Etc.

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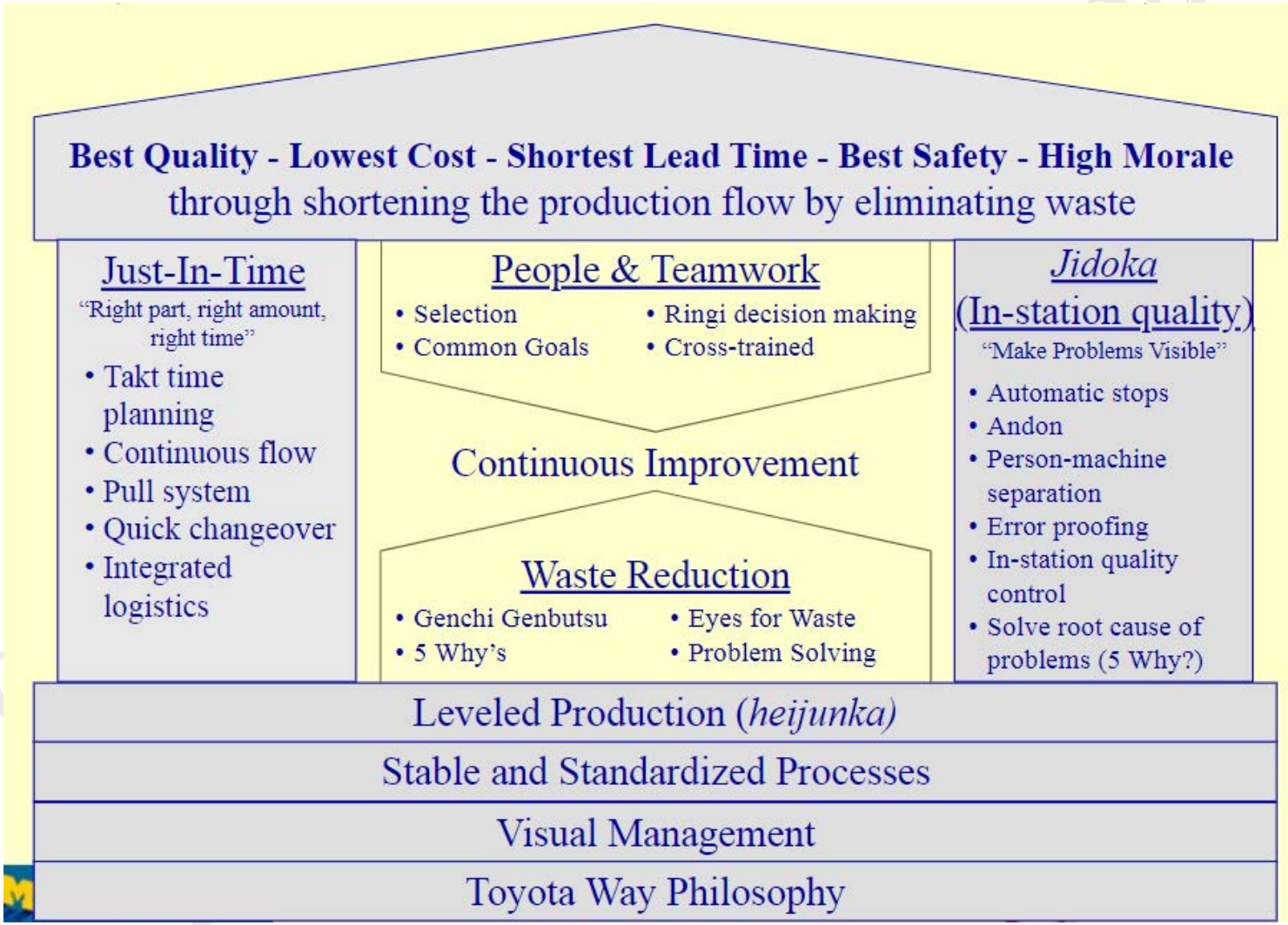
Lean – Toyota production system (TPS)



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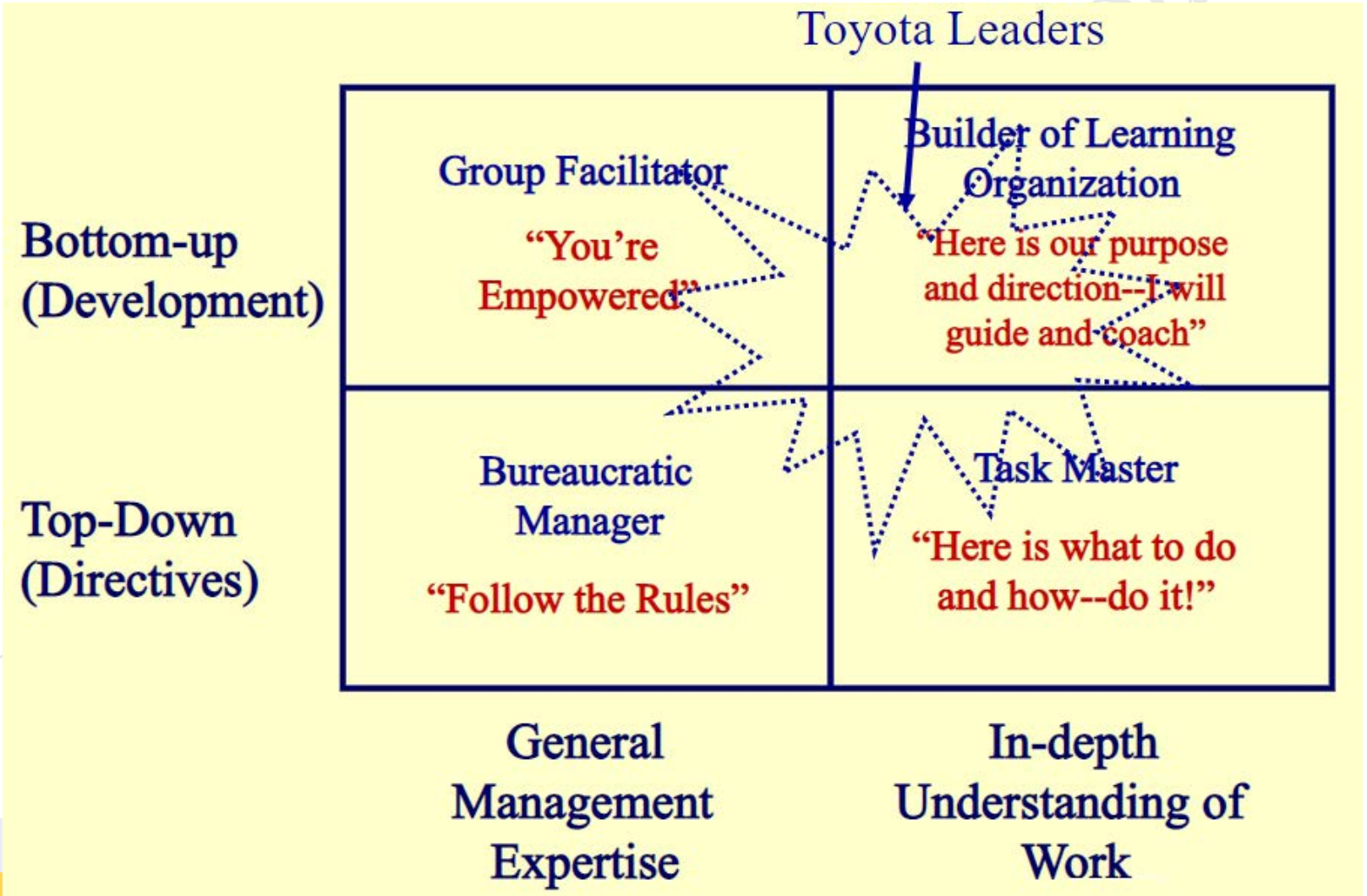
Lean – Toyota leadership model



Introduction To Lean

(Review of Lean Principles)

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Lean – Summary of the 14 Lean Principles

❖ **The summary of lean principles include:**

1. Define value, map the value stream, and identify/eliminate waste
2. Establish continuous process flow
3. Implement pull planning and scheduling
4. Level the workload
5. Solve quality problems immediately (stop-the-line)
6. Standardize work tasks and processes
7. Implement visual control
8. Use only reliable technology, processes, practices, and people
9. Develop exceptional leadership
10. Develop exceptional people
11. Develop collaborative relationships and build trust
12. Go to Gemba: See for yourself to understand the problem
13. Make decisions slowly by consensus and implement rapidly
14. Develop an excellent organization through continuous improvement and reflection

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Principle 1

- **Term: Long term philosophy**
  - Base management decisions on a long-term philosophy, even at the **expense of short-term financial goals.**

- **Tool: Value Stream Mapping**

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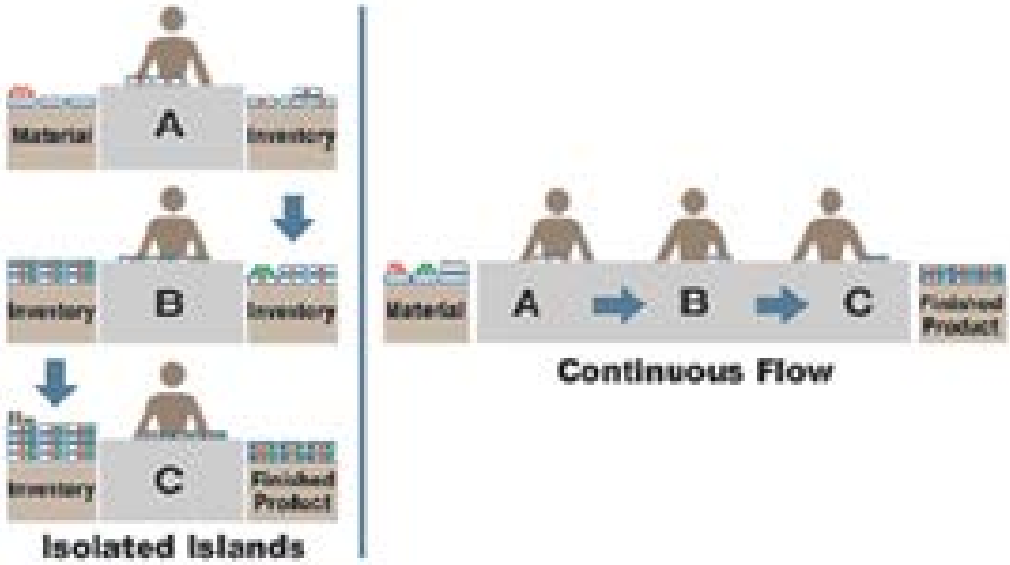
Principle 2

- **Term: Establish continuous process flow**
  - Brings problems to **surface**
  - **Redesigns** the process to achieve **highly value added**

- **Tool: One process flow, Takt Time, Kanban, and Value Stream Mapping (VSM)**



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Principle 3

- **Term: Implement pull planning and scheduling**
  - Minimizes the work **in process** and **warehousing inventory**
  - Provides **customer** what they **need**

- **Tool: Last Planner System**

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Principle 4

- **Term: Level the workload**
  - Eliminates **overburden** to people and equipment
  - Eliminates **unevenness** in the schedule
  - Looks for achieving **high reliability** rather than achieving **high speed**

- **Tool: Parade of Trades Game and**

  Level out the workload *(heijunka)*

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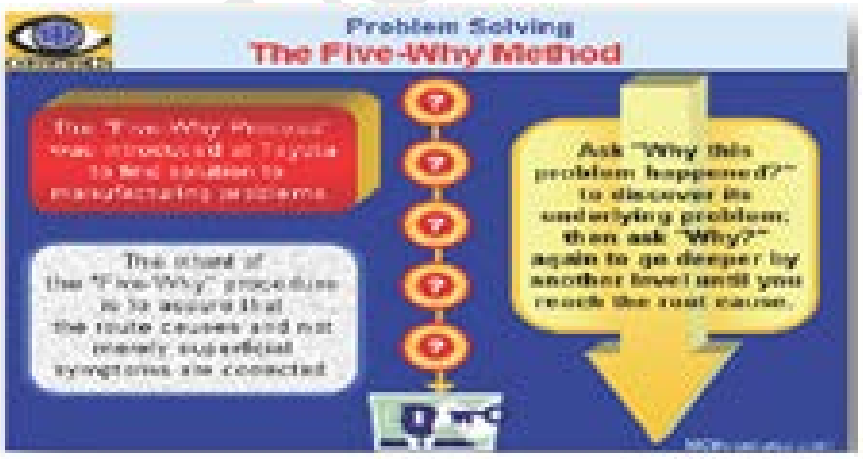
Principle 5

- **Term: Solve quality problems immediately (Stop-the-line)**
  - Finds quality for customers as a driver for value
  - Builds a culture of fixing problems

- **Tool: 5 Whys Process and Mistake-Proofing Devices, Stop When There Is A Quality Problem (*Jidoka*)**



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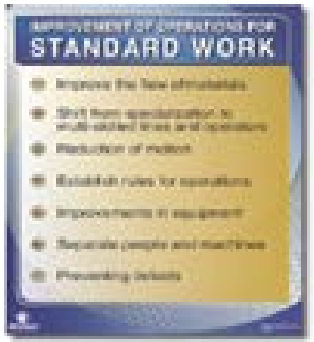
Principle 6

- **Term: Standardize work tasks and processes**
  - Uses stable, repeatable **methods** whenever possible to increase predictability
  - Captures the **learning** about a process by **standardizing best practices**
  - Allows **creative** and individual expression to improve on the standard, then incorporate it into a **new standard**
  - Uses **checklists** and **procedural descriptions** to show in **pictures** and tell in **text** how to complete a task
- **Tool: Standard Operating Procedures / Work Instructions**



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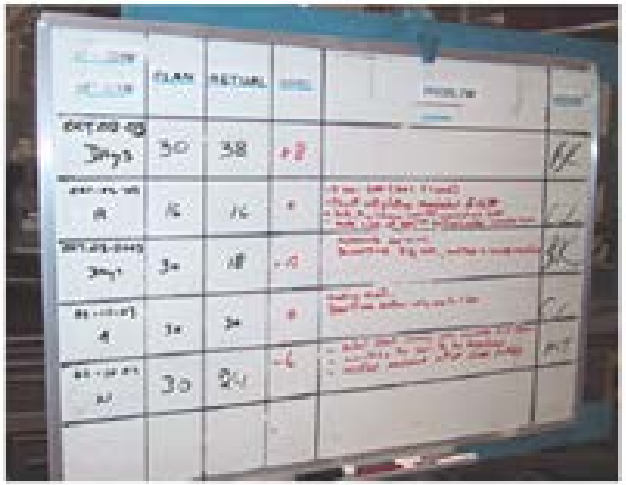
Principle 7

- **Term: Implement visual control**
  - Uses **simple visual indicators** to help people determine whether they are in standard conditions or not
  - Designs simple visuals (keep your **site organized**)

- **Tool: Visual Management**



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Principle 8

- **Term: Use only reliable technology, processes, practices and people**
  - Uses **technology** to support activities (not to replace people)
  - Encourages **innovation**

- **Tool: Building Information Modeling (BIM)**

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Principle 9

- **Term: Develop exceptional leadership**
  - **Find** leaders
  - **Grows** leaders
  - Who? Places the **highest value** on team members

- **Tool: Leadership and soft-skills**

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Principle 10

- **Term: Develop exceptional people**
  - **Creates** exceptional people
  - **Trains** exceptional individuals
  - **Promotes** effective team work

- **Tool: Soft-skills**

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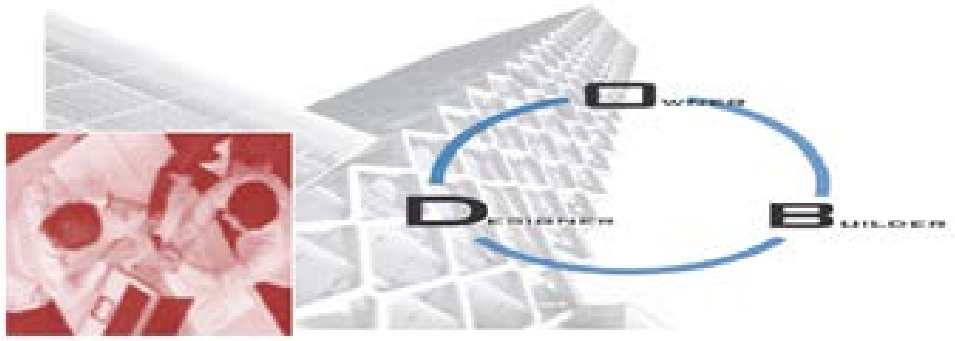
Principle 11

- **Term: Develop collaborative relationships and build trust and respect**
  - Benefits **internal and external** network
  - Looks for **maintaining capability**

- **Tool: Integrated Project Delivery**



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Principle 12

- **Term: Go to Gemba: See for yourself to understand the problem**
  - **Solve** problems and **improve** processes
  - Has an **understanding** of situations

- **Tool: The Gemba Walk (*Genchi Genbutsu)***

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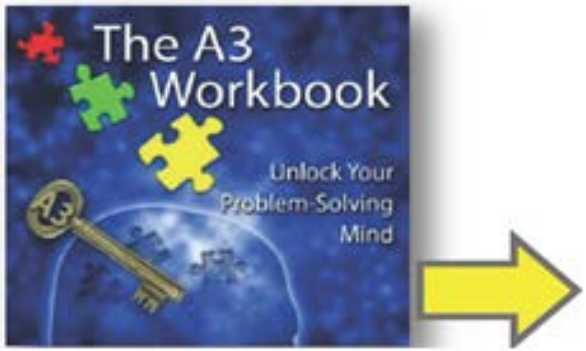
Principle 13

- **Term: Make decisions slowly by consensus and implement rapidly**
  - Considers alternatives
  - Discuss problems and potential solutions

- **Tool: CBA, A3, and make decision slowly by consensus (*Nemawashi)***



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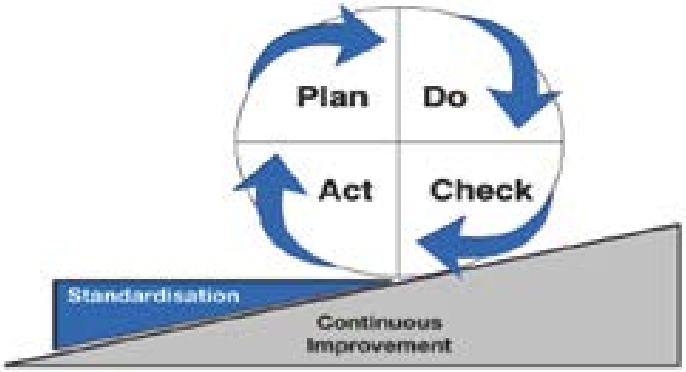
Principle 14

- **Term: Develop and excellent organization through contiguous improvement and reflection**
  - Looks for the root cause of inefficiencies and apply countermeasures
  - Exposes failures and design a process of improvement

- **Tool: PDCA and Kaizen Events**



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Principles

Now, another key point here is:

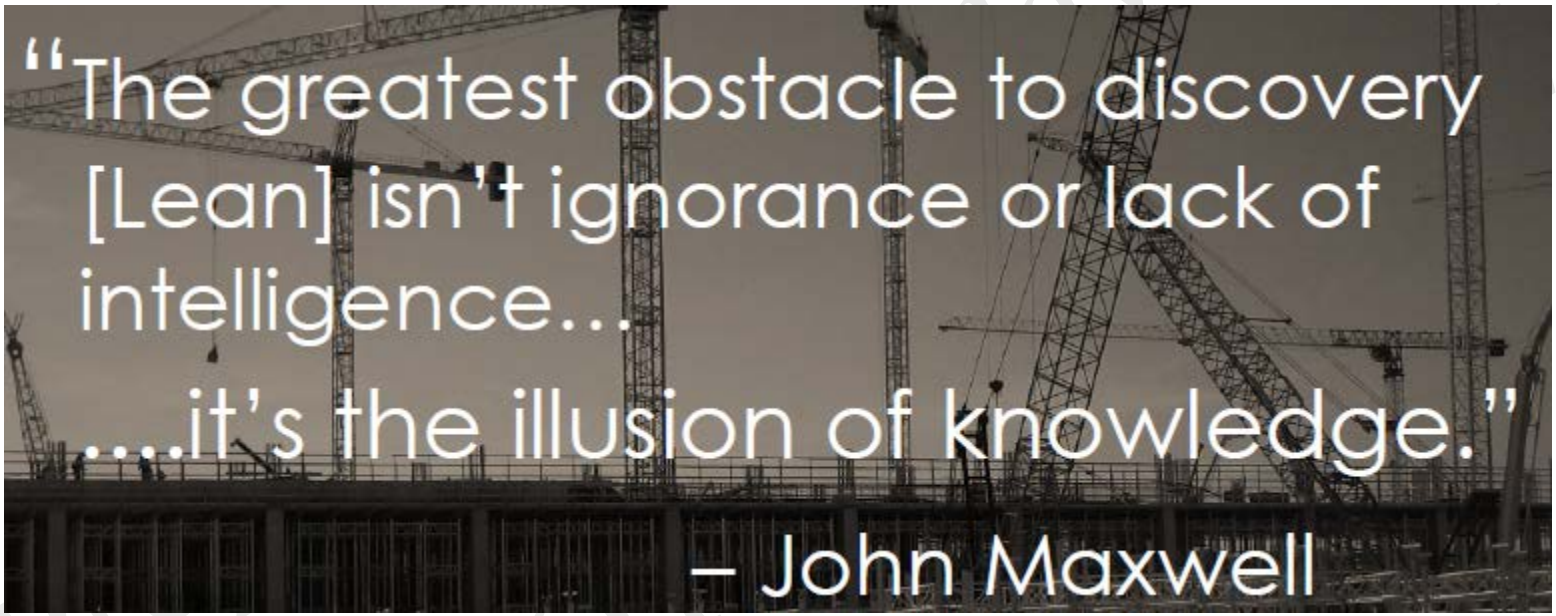
Lean is not only about imitating the tools used by Toyota in a particular manufacturing process.

Lean is about developing principles that are right for your organization and diligently practicing them to achieve high performance that continues to add value to customers and society.

Introduction To Lean

(Final Notes)

Biggest obstacle to Lean



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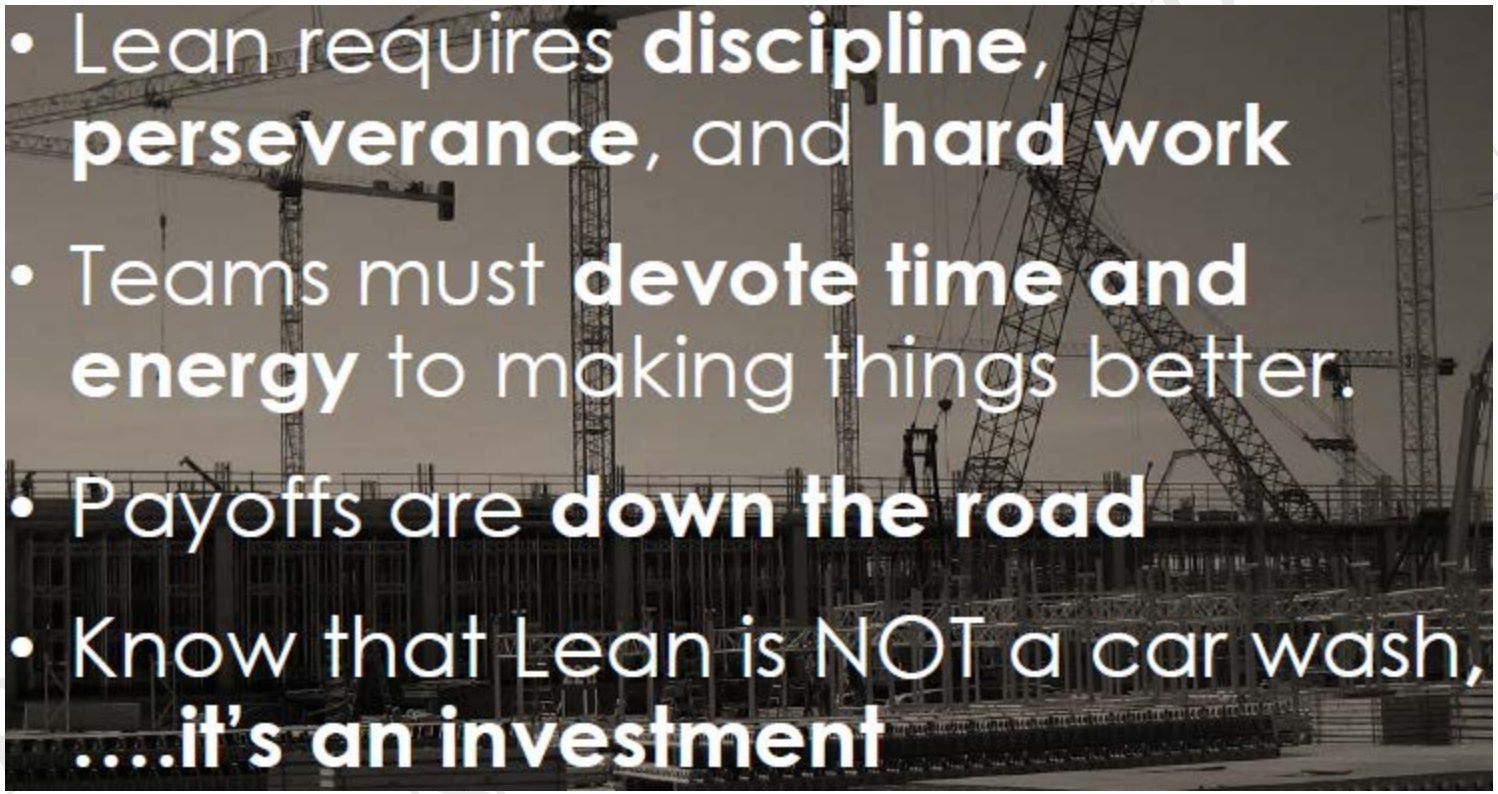
Cautions



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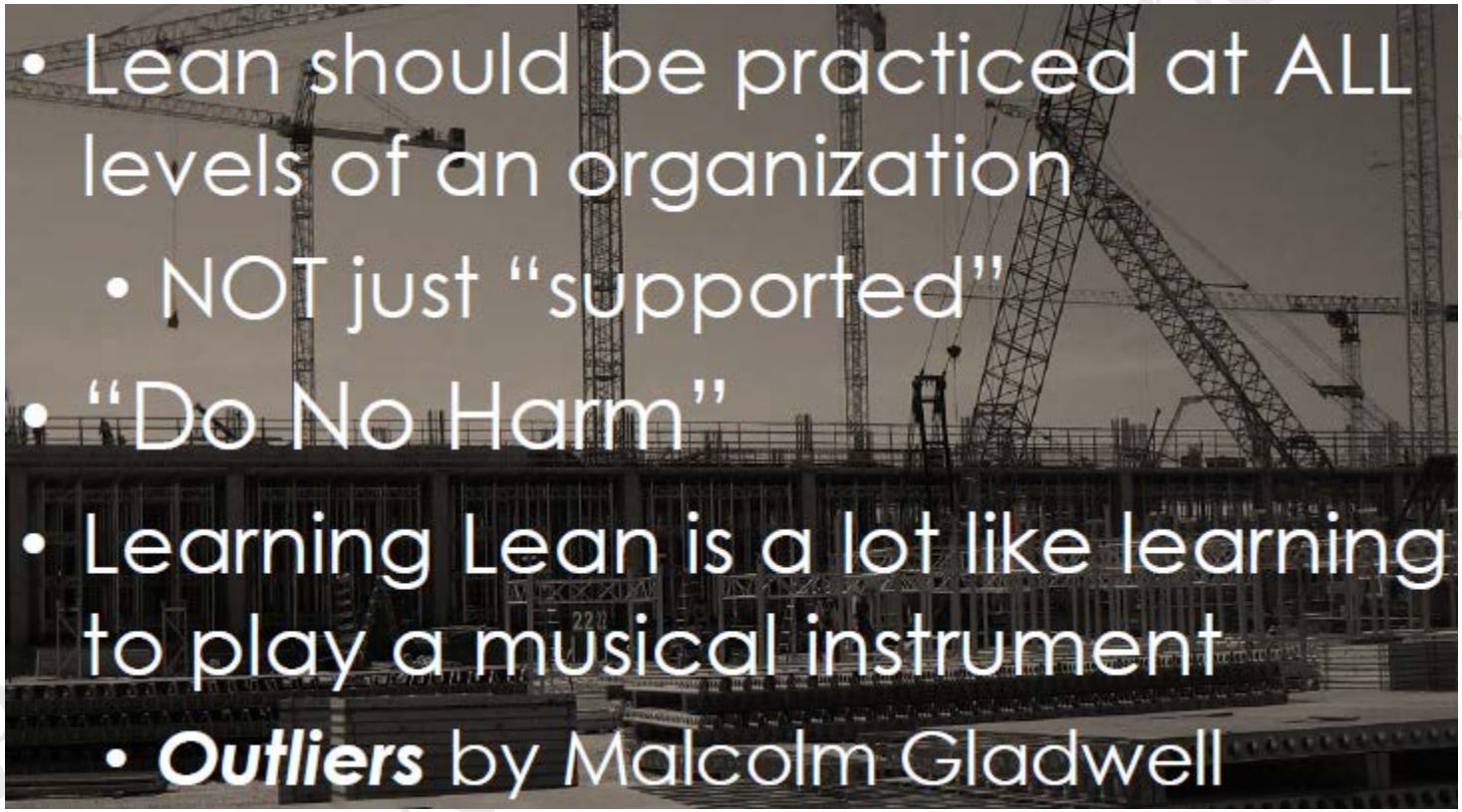
Lean leadership



اجرا و مدیریت پروژه به روش اصول ناب
(Lean Project Management)

فصل اول: مفاهیم، اصول و ابزارهای روش ناب (Lean)

بخش دوم: مفاهیم فرآیند جریان (Flow)، کشش (Pull)، کانبان (Kanban)، زمان تکت (Takt Time) و بهنگام (JIT)

ارائه دهندگان:

سید محمدرضا علوی‌پور

(PhD, PMP, CMIT)

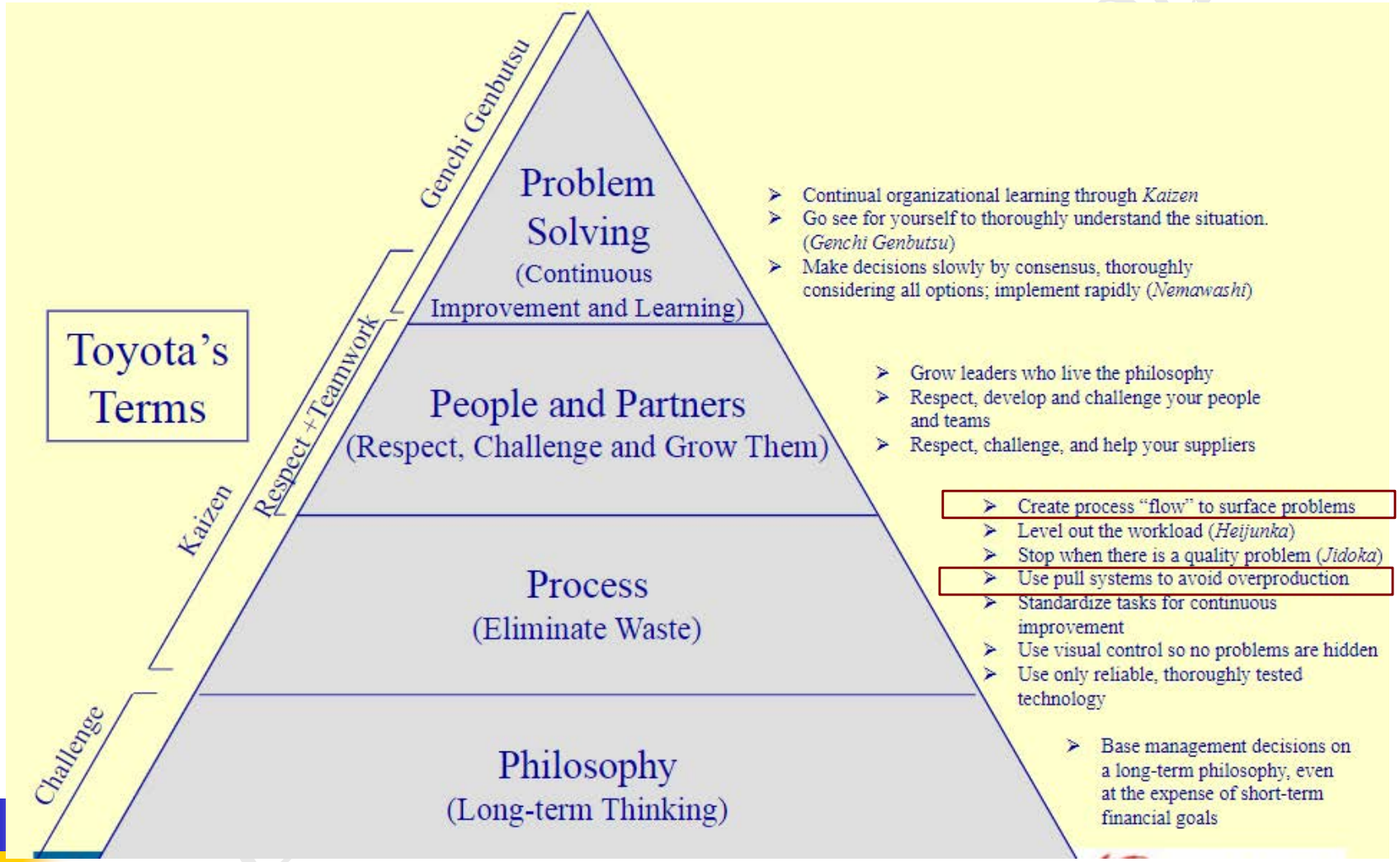
کامبیز کردانی

(M.Sc., PMP)

What we will learn?

- Construction as an activity
- Construction as a flow
- Continuous process flow and pull concepts
  1. Concepts, tools, and techniques
     - ✓ Mass production
     - ✓ Flow
     - ✓ Work in process (WIP)
     - ✓ Buffers
     - ✓ Continuous flow
     - ✓ Takt time
     - ✓ Pull system
     - ✓ Push system
     - ✓ Just in time (JIT)
     - ✓ Kanban
     - ✓ Implementing continuous flow
  2. Case study

Lean – Principles (4P Model of the Toyota way)



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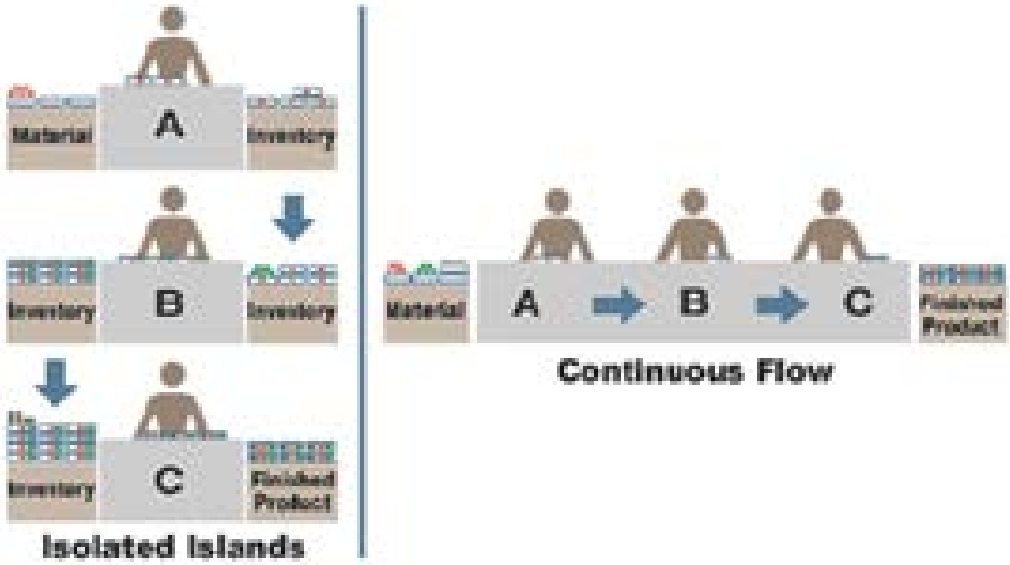
Principle 2

- **Term: Establish continuous process flow**
  - Bring problems to surface
  - Redesigns the process to achieve highly value added

- **Tool: One process flow, Takt Time, Kanban, and Value Stream Mapping (VSM)**



Principle 3

- **Term: Implement pull planning and scheduling**
  - Minimize the work in process and warehousing inventory
  - Provides internal customer what they need

- **Tool: Last Planner System**

Construction

(As an Activity)

Construction as an activity

- The **conceptual basis** of construction projects is **conversion oriented** (activity oriented).
  - Activities are **not planned in the flow** itself

So, what is the problem?

Construction as an activity

Sequential methods of design

- **Few or no iterations** in the design process (poor deviation detection)
- **Constraints** are not taken into account in the design phase
- **Little feedback** for specialists (poor process transparency)
- **Suboptimal solutions** (optimization in some units)
- Poor **constructability**
- Lack of **innovation and improvement**

Construction as an activity

- **There is a considerable waste in construction**
  - Poor quality (risk factors, such as lack of safety)
  - Loss of value (value is function of performance and quality)

Construction as an activity

*There is a **need to re-conceptualize construction** as a **flow***

Construction

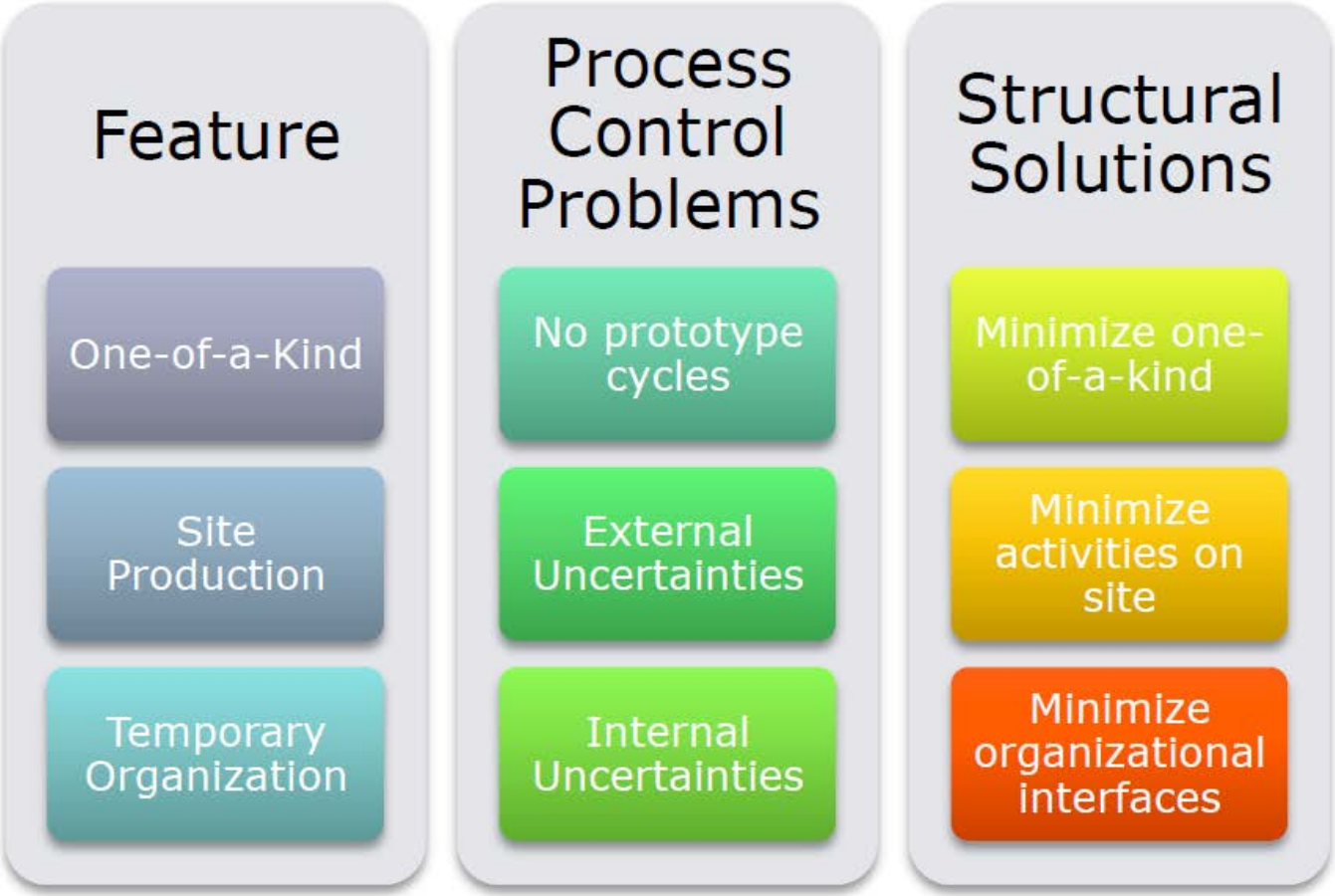
(As a Flow)

Construction as a flow

- There are **two main processes** in construction projects
  1. **Design**
     - **Stage wise refinement** of **specifications**
  2. **Construction**
     i. Material processes
        - ✓ **Transfer of material** to the site including **processing and assembling**

     ii. Work processes of teams
        - ✓ **Temporal** and **spatial** flows

Construction as a flow

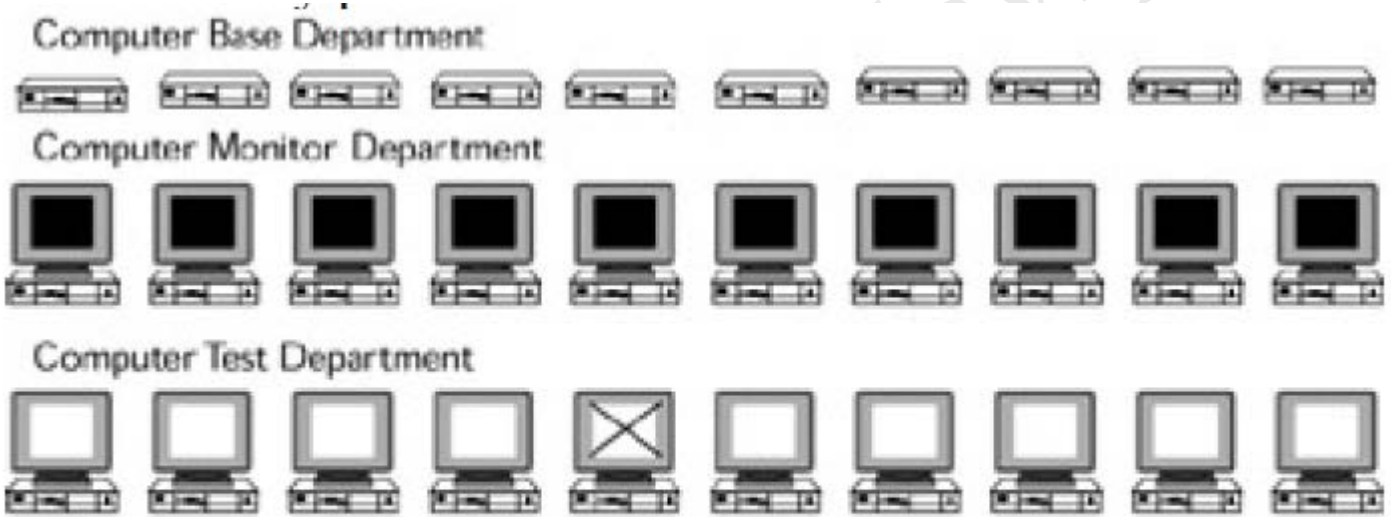


Adapted from (Koskela, 1992)

Continuous Process Flow and Pull Concepts

(Concepts, Tools, and Techniques)

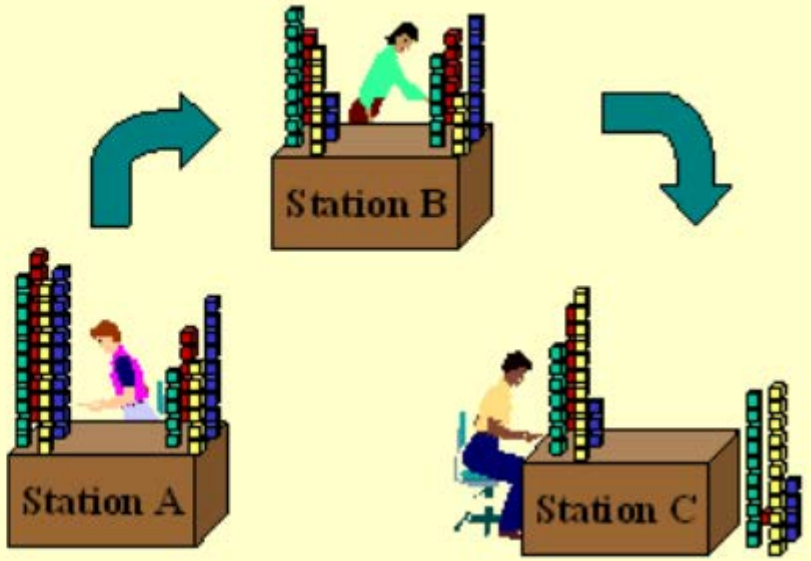
Batch processing (Mass production)



- Complete processing of first batch of 10 takes 30 minutes
- First good computer ready in 21 minutes (plus transport time)
- There are at least 21 sub-assemblies in process at a time

Batch processing (Mass production)

Teams and
Batch & Queue



So, what is the problem?

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Batch processing (Mass production)

What batches are found in construction industry?

What batches are found in construction industry?

- Request for information (RFIs)
- Drawings waiting for review and approval
- Scheduling large pours of concrete rather than smaller ones
- Delivery of all the light fixtures rather than just the ones you need
- …and any more

Why is this problematic?

What is the problem with mass production

- **Mass production** thinking **sets up departments** of mechanical engineering, electrical engineering, accounting, purchasing and etc. together **separately**.
- The **mass production system guarantees overproduction** in large batches, which in turn
  1. **Guarantees inventory sitting idle** and
  2. More importantly **hiding problems**.
  3. **Product** being made for a customer does **not live in just one department**.
     - ✓ It must **move across departments** to become what the customer wants.
     - ✓ Yet many value streams cross through these departments, **causing a delay each time** a process **enters a new department**.

So, what flow means?

What flow means?

- Flow means the **whole process** should take a **few hours or days**,

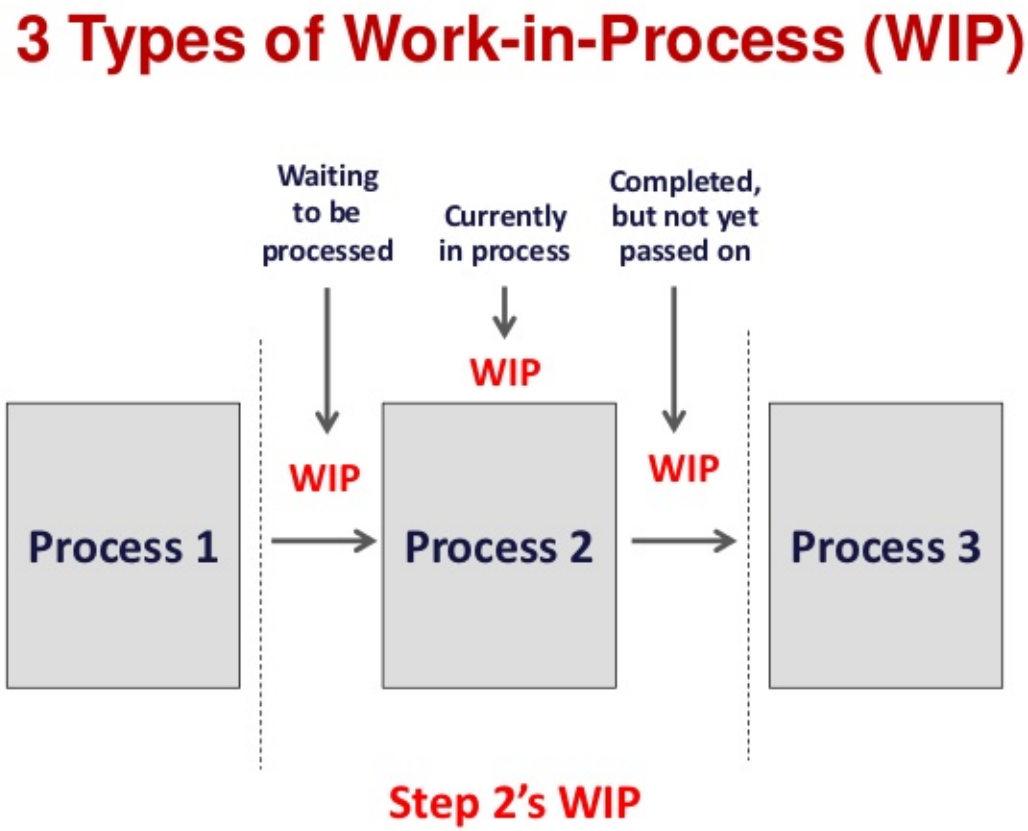
  rather than a few weeks or months in the example.

- **Flow at Toyota** means that
  - Using **small lots**,
  - Having **processes close together** and
  - Keeping the material moving through processes **without interruption**

    is **better than producing large batches** of stuff and having them **sit and wait**.

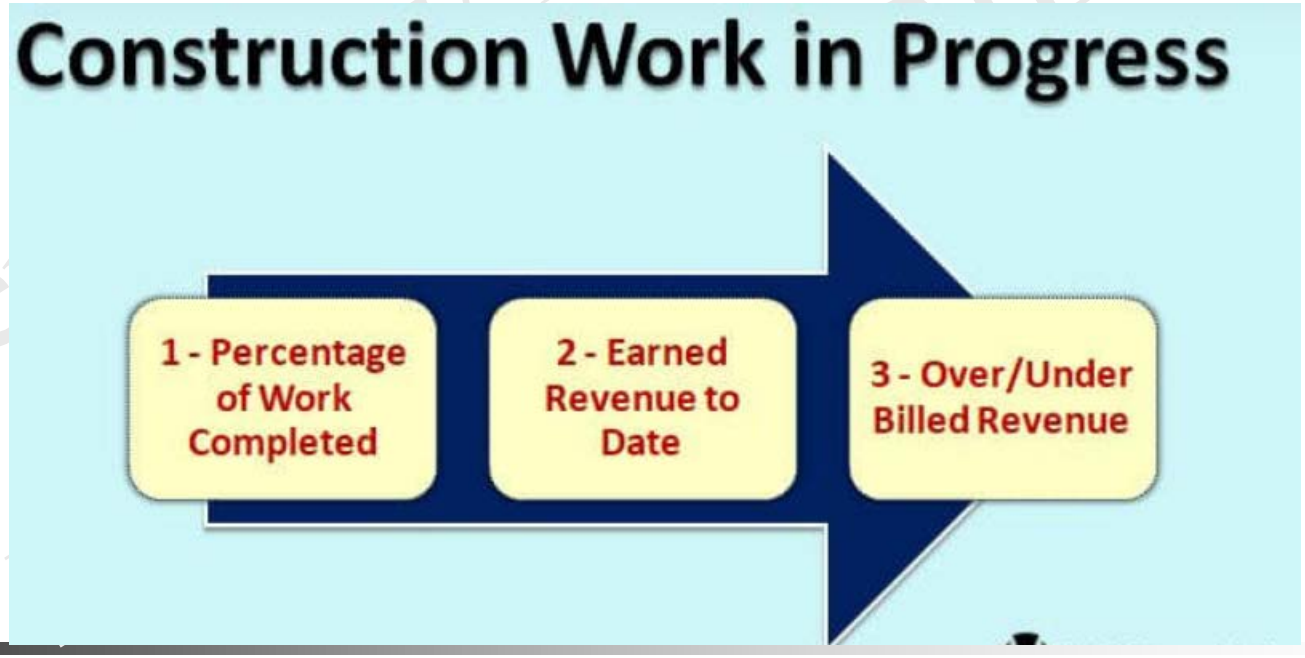
Work in Process (WIP)

- **Work** that is **incomplete and sitting** in the queue.
  - Material that has entered the **design or construction process** but is **not yet finished product.**



Work in Process (WIP)

- **Work in process (WIP)** therefore refers to **all materials and partly finished products** that are at **various stages of the design or construction** process
  - **Some operations** use **work in progress** between production steps **in order to**
    1. **Meet peak demand** or
    2. **Volatile (suddenly changed) demand patterns**.



Buffers

- **Buffer Inventory**:
  - A **store** of **goods or work** made available when **"customer orders" vary**, causing **sudden increase in demand**.

In construction**, having a **list of other work** that **workers can perform** if their **planned task cannot** be completed is a type of **"buffer"

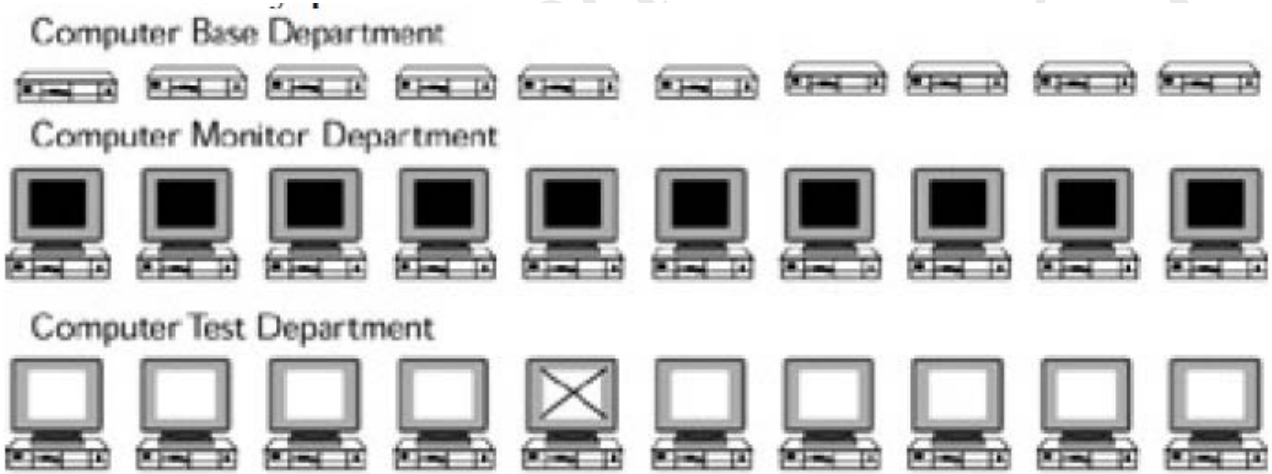
So, let's continue with one piece flow!

Continuous flow

Product requires three processes that take one minute each
(One-Piece Flow Production Cell)

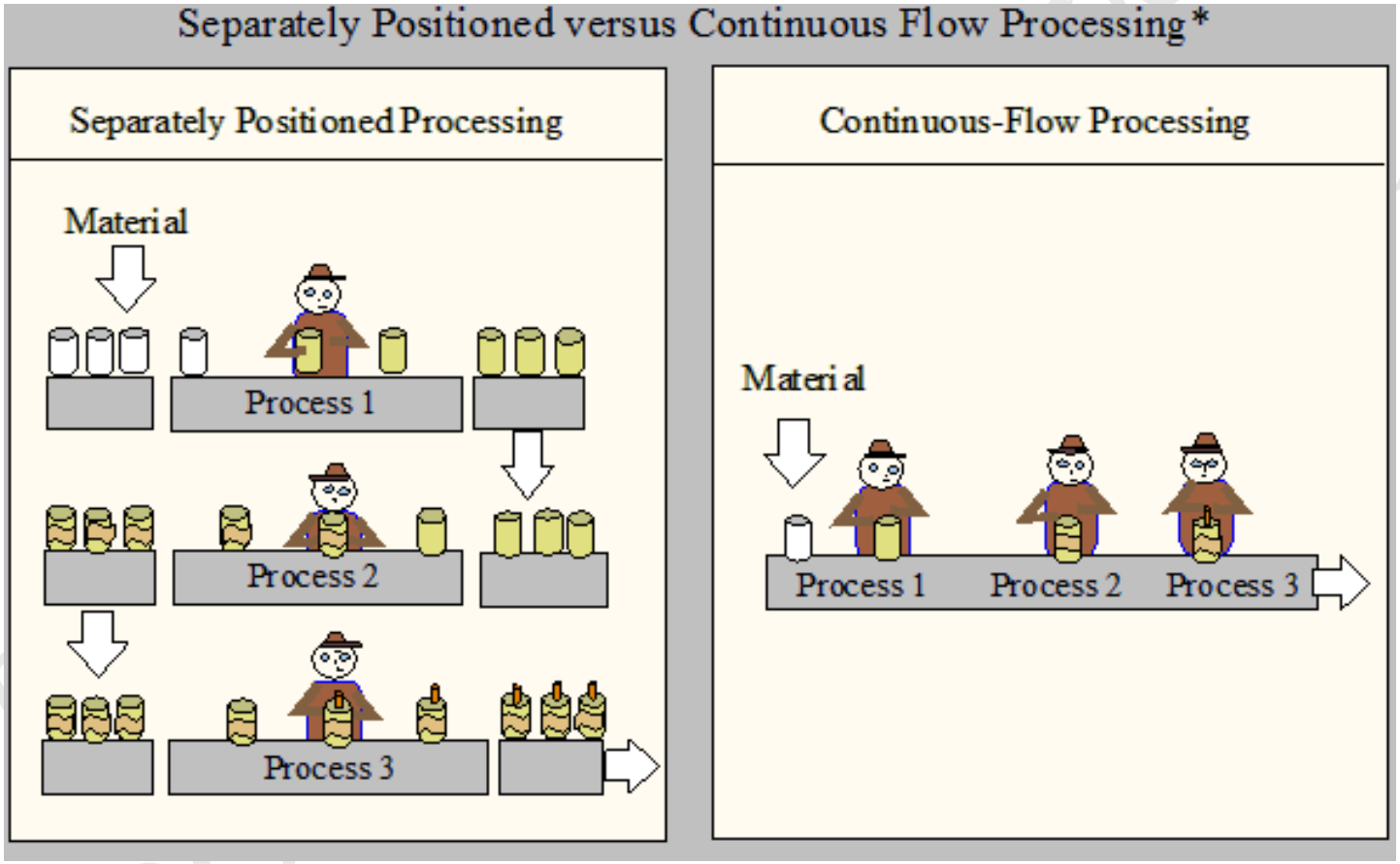
- First part ready in 3 minutes
- 10 completed in 12 minutes
- Only 2 sub-assemblies in process at a time.

- In a **one-piece flow**, you physically **line up the processes** in the **sequence** that will produce the customer`s order in the **shortest time**.



- Complete processing of first batch of 10 takes 30 minutes
- First good computer ready in 21 minutes (plus transport time)
- There are at least 21 sub-assemblies in process at a time

Continuous flow



Continuous flow

From the 1960s to the 1980s, this system evolved into the highly successful TPS that provided a competitive advantage through

1. **Outstanding levels of production,**
2. **High quality, and**
3. **Low costs.**

So, what are the goals and benefits of one piece flow more in depth?

Continuous flow – Goals

1. **Minimize the movement** of materials and workers by proper sequencing and position of work activities
2. **Release work** (information/materials/) from one work activity to the next using a one piece flow
3. **Minimize batch sizes** to **reduce cycle time**
4. Make **every person responsible** for **quality**
5. **Balance the workload**

6. **Encourage/enable workers** to **help each other** in order to maintain steady work flow
7. **Stop the line** rather than **release defective work** to the **next worker** or "customer"
8. **Minimize change** over time to allow one piece flow
9. Make the **process transparent** so the state of the system can be **seen by anyone** from anywhere

Continuous flow – Benefits

- Builds in quality and reduces rework
- Creates real flexibility
- Creates higher collaborative atmosphere
- Creates higher productivity
- Frees up floor space
- Improves morale
- Reduces cost of inventory

Kother and Harris (2002) and other authors.

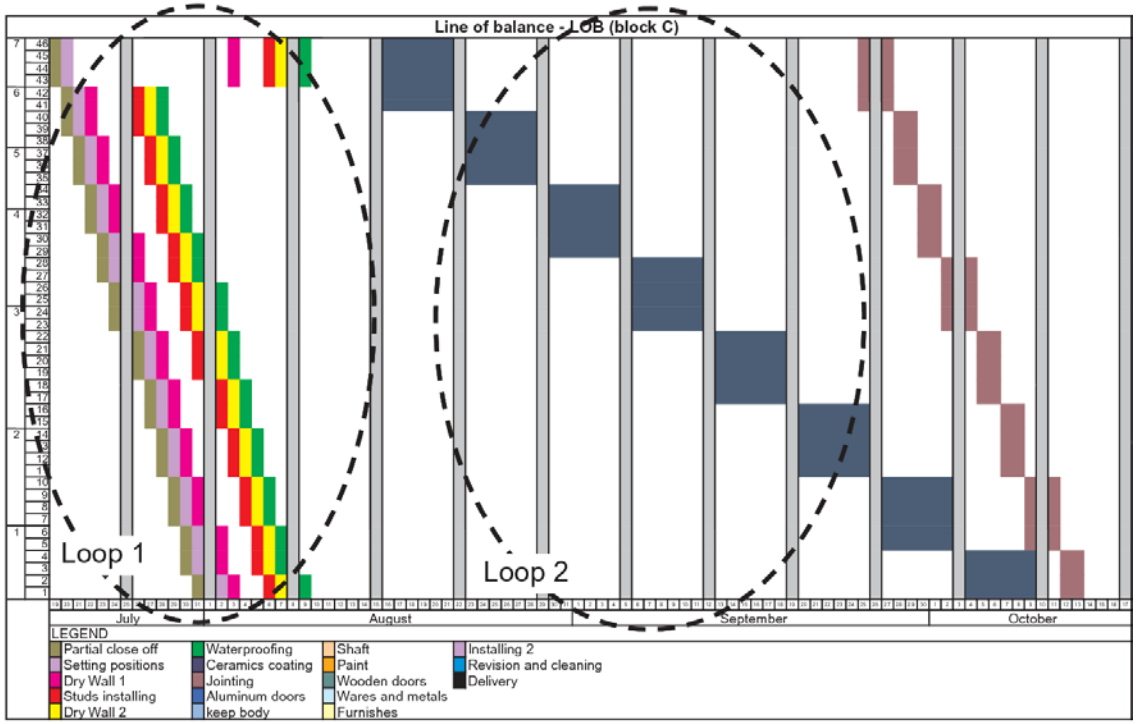
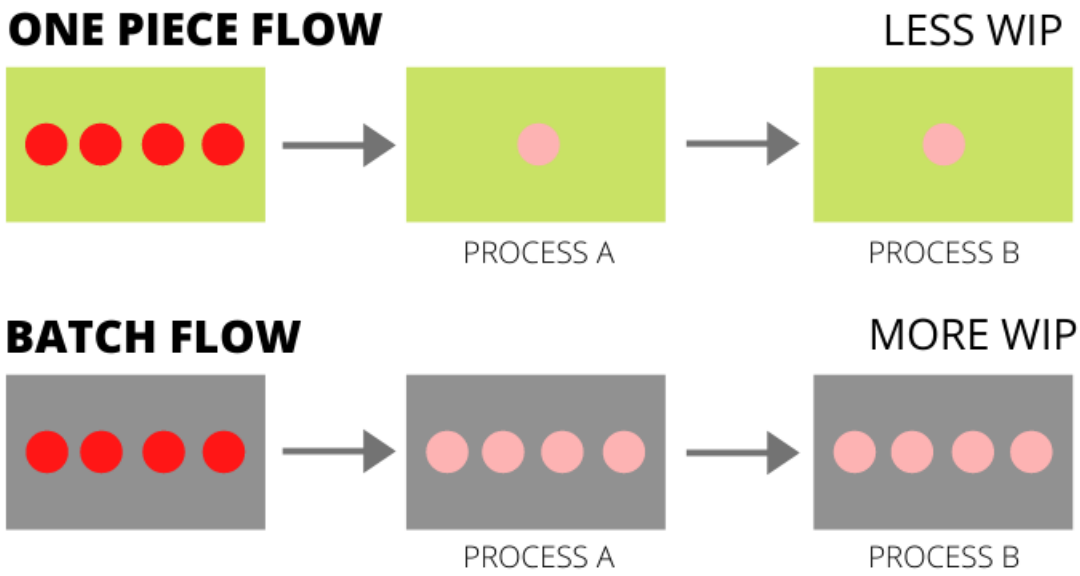
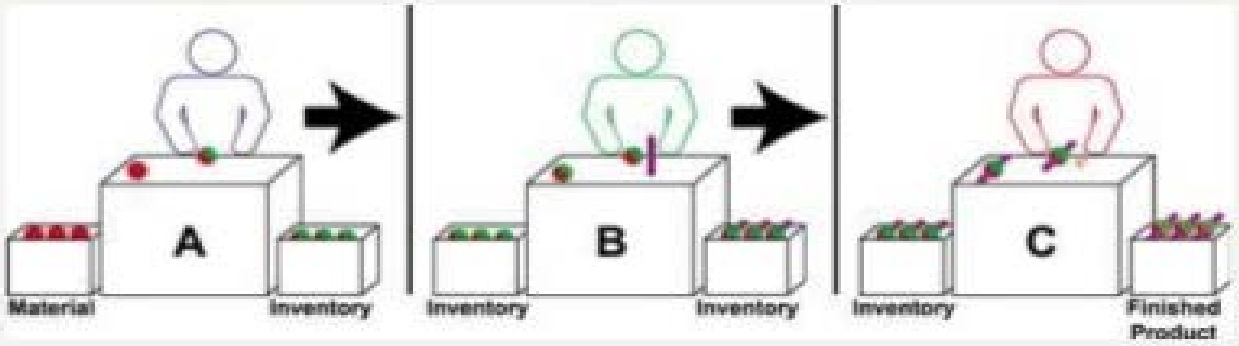


Figure 1: Extract of Line of Balance—LOB (Block C)

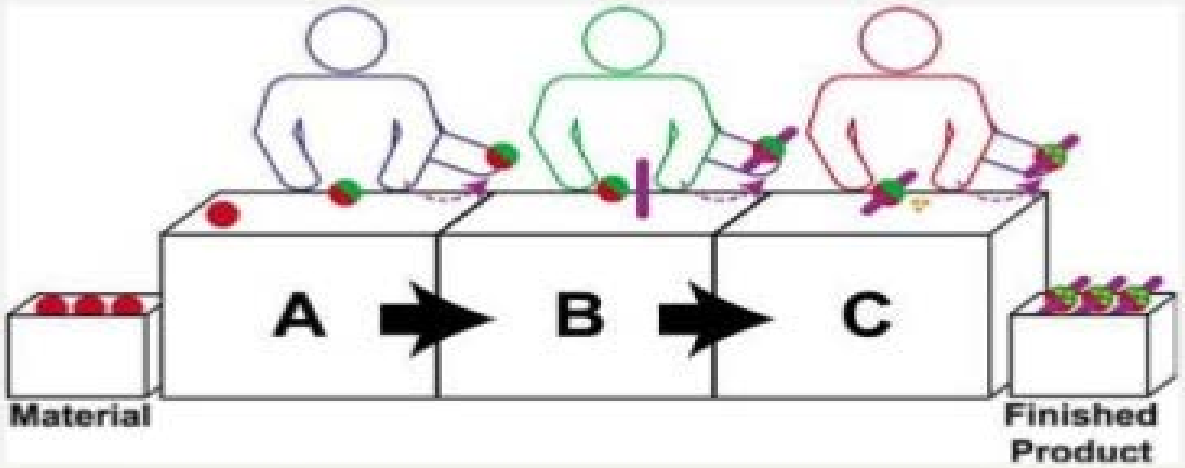
Continuous flow – Benefits



Continuous flow – Benefits

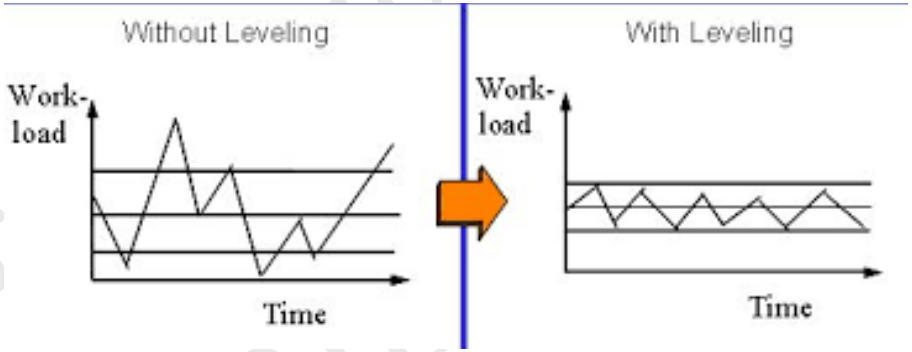


Traditional Batch Manufacturing



Continuous flow – Tools to create

- Takt Time (build to pace of **customer demand**)
- Pull system (**Kanban**)
- Leveled schedules (**heijunka**)
- Vale-Stream Mapping (**VSM** or lean vision)



Supported by:

- Built-in quality
- Total productive maintenance
- Continuous improvement (Kaizen)
- Workplace organization (5S)
- Standardized work

One-piece flow and continuous improvement (Kaizen) go hand in hand!

Continuous flow – Tools to create

Let's look at some of the tools!

Continuous flow – Takt time

When you set up one piece flow, how do you know how fast should be?

- ***Takt*** is a **German word** for rhythm or meter.
- ***Takt*** is the rate of **customer demand** the **rate** at which the **customer is buying** product.

If we are working seven hours and 20 minutes per day (440 minutes) for 20 days a month and the customer is buying 17,600 units per month, then you should be making 880 units per day or one unit every 30 seconds.

- In a **true one-piece flow** process, every step of the process should be **producing a part every 30 seconds**.
  - ✓ If they are going **faster**, they will **overproduce**;
  - ✓ if they are going **slower**, they will create **bottleneck departments**.

Takt can be used to set the pace of production and alert workers whenever they are getting ahead or behind.

Continuous flow – Takt time

$$\text{TAKT TIME} = \frac{\text{Available Working Time Per Day}}{\text{Customer Demand Rate Per Day}}$$

$$\text{TAKT TIME} = \frac{600 \text{ seconds}}{10 \text{ buildings}} = 60 \text{ seconds/building}$$

Continuous flow – Takt time

- **Continuous flow and takt time** are most easily applied in **repetitive manufacturing** and **service operations**.
  - But **with creativity** the concepts can be extended to any projects with **repetitive activities** .

Key here is:

Doing one **piece flow + takt** means

1. **Reducing batch volume** in one piece and
2. **Adjusting** the **time of producing** in each by **customer needs**.

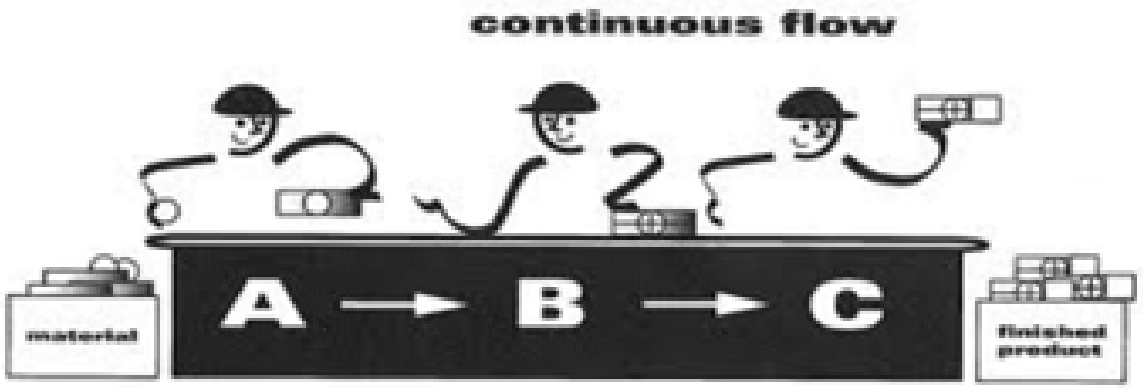
What is pull system?

Continuous flow – Pull system

- **Continuous process flow** is the Lean goal of **pulling** individual work activities through a **sequence of value-added activities**, quickly and **without interruption**

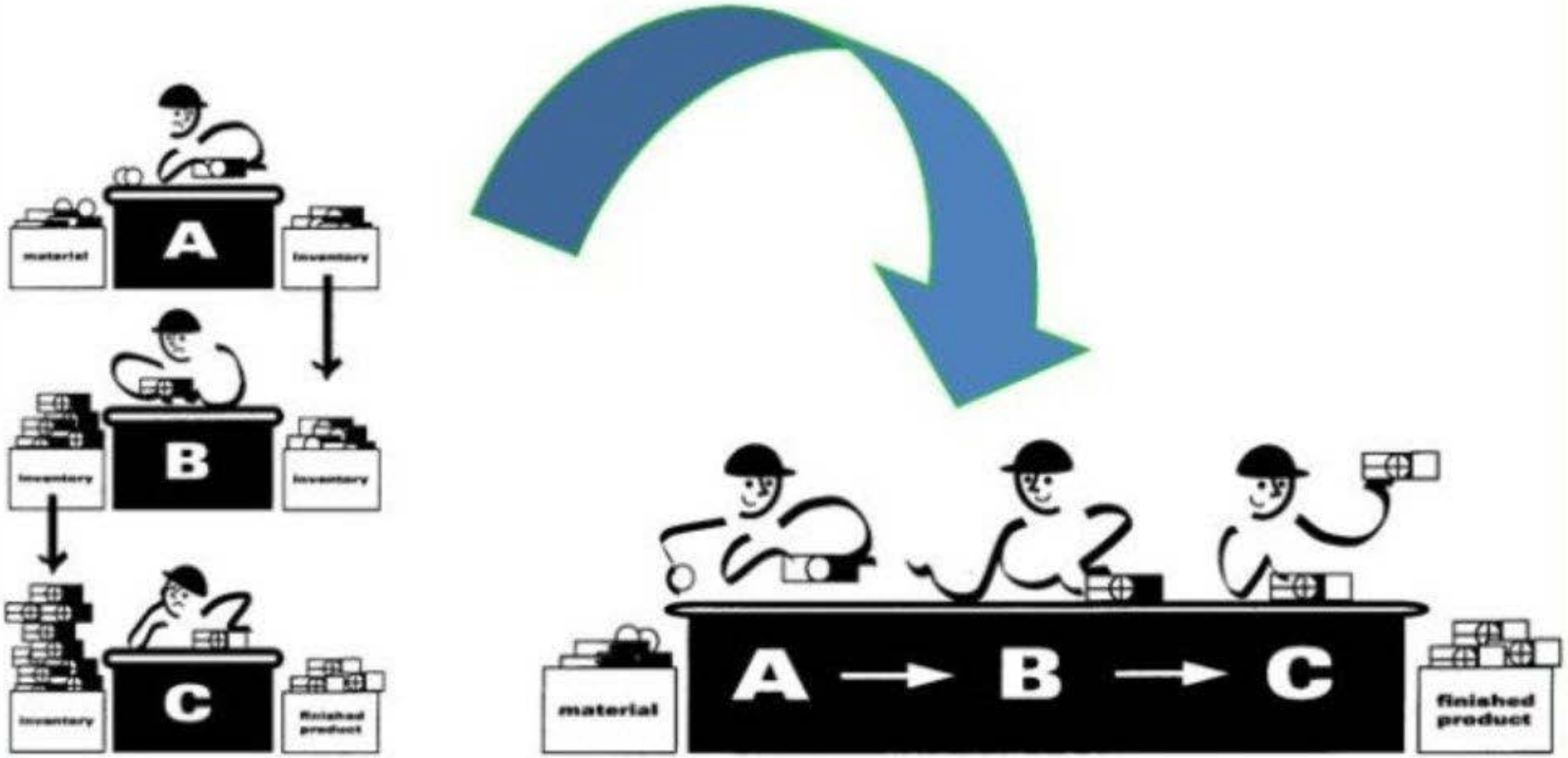
  *as **opposed** to moving **batches** of work **between stages** in a process.*

  *THIS IS EXACTLY THE MEANING OF **FINISH TO START LOGIC***



This needs a *Pull* work!

Continuous flow – Pull system



Continuous flow – Pull system

What does it mean to Pull the work?

- There is a **flow of work** that goes through a **number of stages** until it is completed.
  - Think about the **steps involved** in **installing drywall** in a room in order to make the **room ready to be painted**: **Name the steps**

- When work is **completed in the current stage**, it goes to the **next stage**

- When someone needs **new work to do**, or when **new work needs to be completed**, a **signal** is sent to **trigger preparation** for **performing the new work**
  - A **signal is sent** to **request or prepare** for **more materials**, **information**, etc.
    - ✓ *In construction, the schedule is typically the "pull" mechanism*

Continuous flow – Pull system

See Video 1

Continuous flow – Push system

- A **push system** means making a product in which the **production is not based on actual demand.**
  - A **piece of work** is **prepared and pushed** on to the **next trade regardless** of
    1. Whether that work is **along the critical path** or
    2. **Needed** at that moment

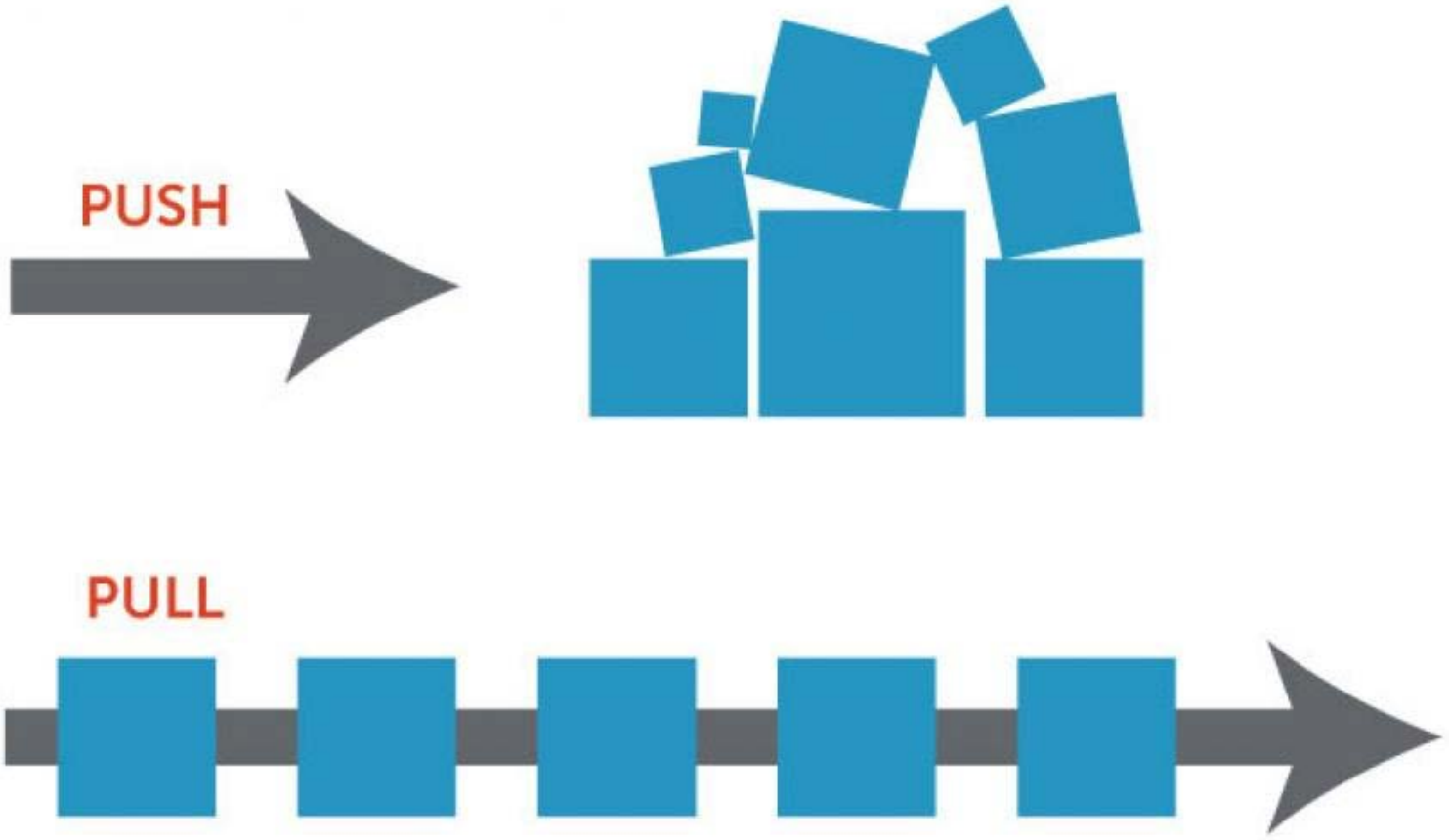
    *In reality, a **hybrid** between push and pull systems may be **needed**.*

Continuous flow – Push system: Examples

Carpet installed before paint

Drywall installed before conduit

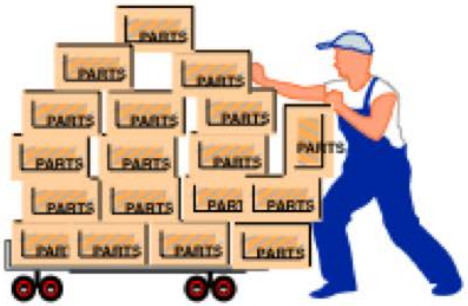
Continuous flow – Comparison between push and pull systems



Continuous flow – Comparison between push and pull systems

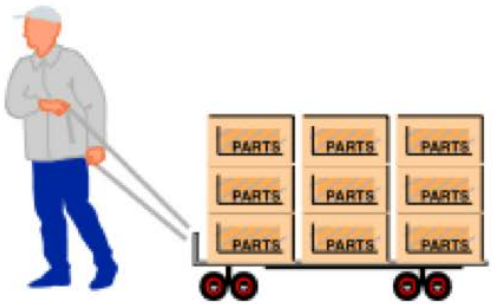
Push vs. Pull

Make all we can just in case.



- Production Approximation
- Anticipated Usages
- Large Lots
- High Inventories

Make what's needed when we need it



- Production Precision
- Actual Consumption
- Small Lots
- Low Inventories

Continuous flow – Comparison between push and pull systems

While gains can be derived by improving the performance of individual trade work assignments,

this improvement may not be reflected in the overall completion of a project;

hence, lean construction seeks to optimize the entire project.

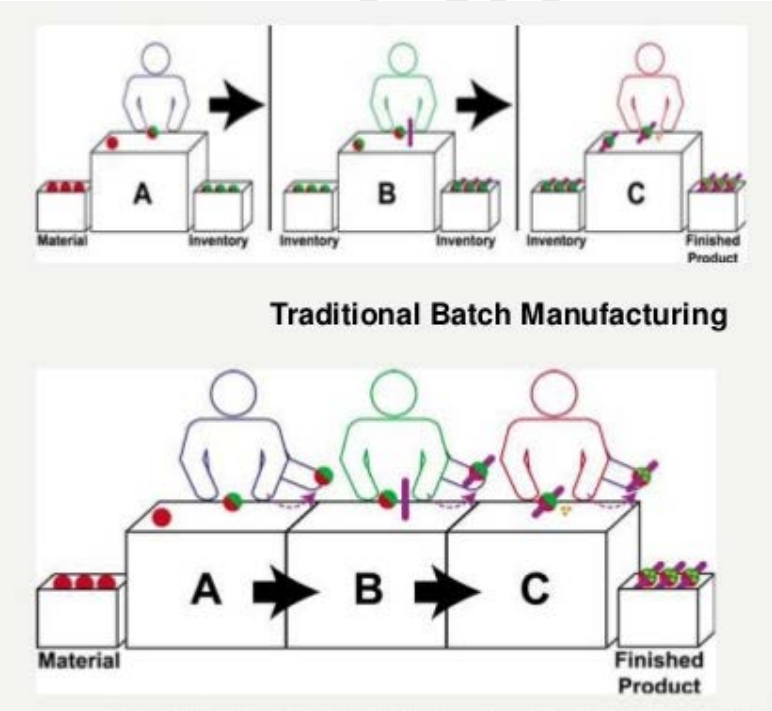
Continuous flow – Just-in-time (JIT)

- In the **just-in-Time (JIT) concept**,

  tasks are **released from each work station** when

  they are "**pulled" by a downstream station** and not before;

  this maintains a **one-directional flow** of work assignments.



Continuous flow – Just-in-time (JIT)

- **Whereas mass production is a so-called push system that dictates production volume based on market forecasts,**

  JIT is a pull system that responds to actual customer demand and enables the important lean concept of "Pull in Production".

1. **Mass production** emphasizes the production of the **largest possible quantities**.
2. **JIT**, on the other hand, seeks to **build small lots** that are better **capable** of providing **variety for the customer**.
   - **JIT** only commits the **resources needed** to meet the **actual demands**.

*In reality, a **hybrid** between push and pull systems may be **needed**.*

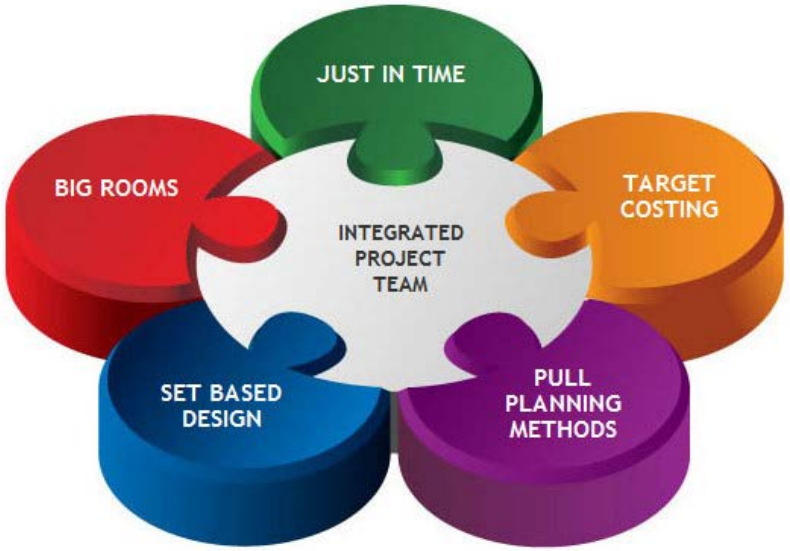
Continuous flow – Just-in-time (JIT)

- The **Toyota way** is **not** about managing **inventory**; it is about **eliminating it.**
  - In the Toyota way, **"pull" means** the ideal state of **just-in-time** manufacturing;
    1. What he or she wants,
    2. When he or she wants it, and
    3. What amount he or she wants.
       - ✓ If you can **take in a customer order** and **make a single product just** for that **order-using one-piece flow** production cell, this would be the **leanest imaginable system**.

Continuous flow – Just-in-time (JIT)

However, there is a **risk** **that inventories may fall** to **critically low levels.**

What should be done to be successful?



Continuous flow – Just-in-time (JIT)

To be successful

- **JIT** is dependent on **very high quality** and **reduced setup times** –

  the concept calls for **raw materials** and **components** to reach a production operation in **desired quantities** **when needed** and **not before**.

  - *The **supplier and customer** have to **work closely** for this to occur and there is **little to no inventory**.*
  - ***Production leveling** **accommodates** **fluctuations** in demand and the number of setup activities is reduced so that **little time is required** for **changing over** to different product mixes.*

The Kanban is one of the techniques that can help to implement this system

Continuous flow – Just-in-time (JIT)

To be successful

- With the **JIT system**,

  external suppliers delivered parts **directly to work stations without being warehoused**.

*Toyota's success was also due to **strategic relationships** with **suppliers**.*

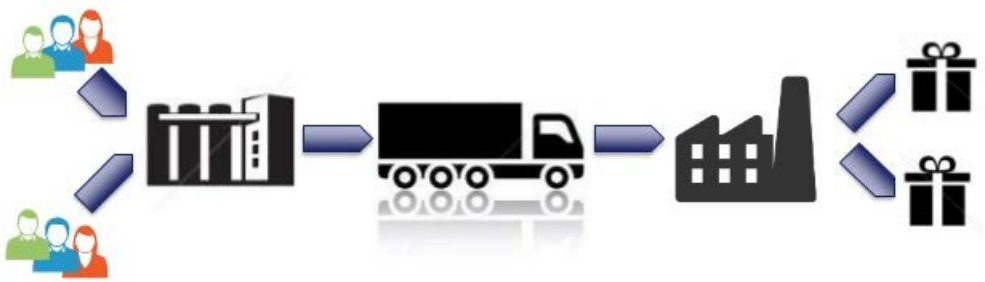
***Adversarial relationships** were considered **wasteful**; **instead**,*

- Toyota would pick **two or three suppliers** for each component and **guarantee them** a **specific volume of business**.
  - *This trusting relationship reduced waste, cut costs, promoted innovation, and increased profits for all stakeholders*

Continuous flow – Just-in-time (JIT)

Companies that have used the **Toyota approach** have **reduced setup times** by **90%** or more.

Omark Industries, one of the **earliest US companies** to adopt the **TPS** was able to reduce machine setup time from **8 hours to 64 seconds**.



Continuous flow – Just-in-time (JIT)

Lean construction seeks to adapt these principles to the construction environment.

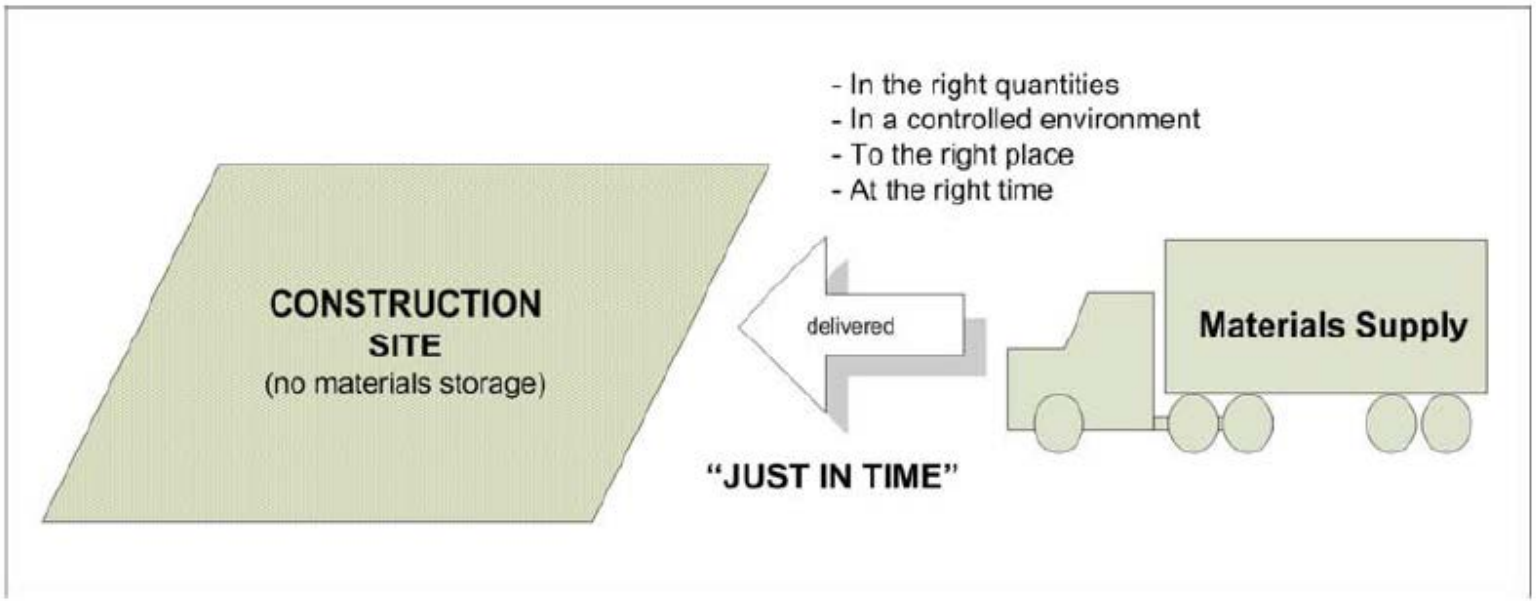
In effect it pushes for reliability and responding to downstream demand,

rather than

pushing for speed.

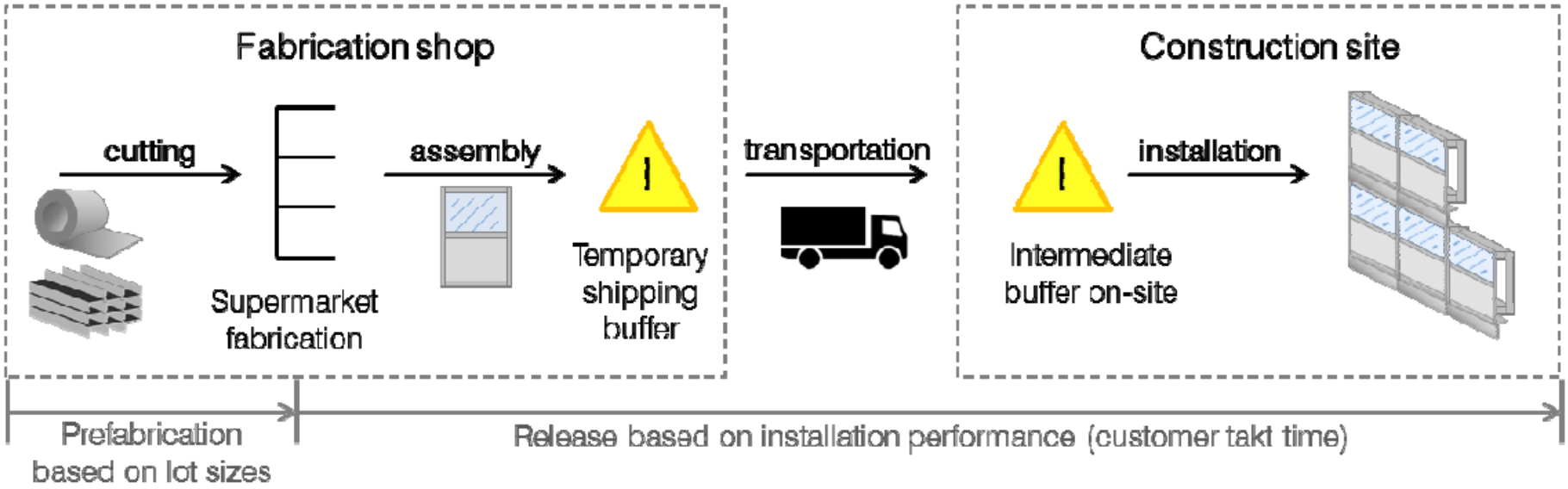
Can be used in every project delivery system?

Continuous flow – Just-in-time (JIT)



Continuous flow – Just-in-time (JIT)

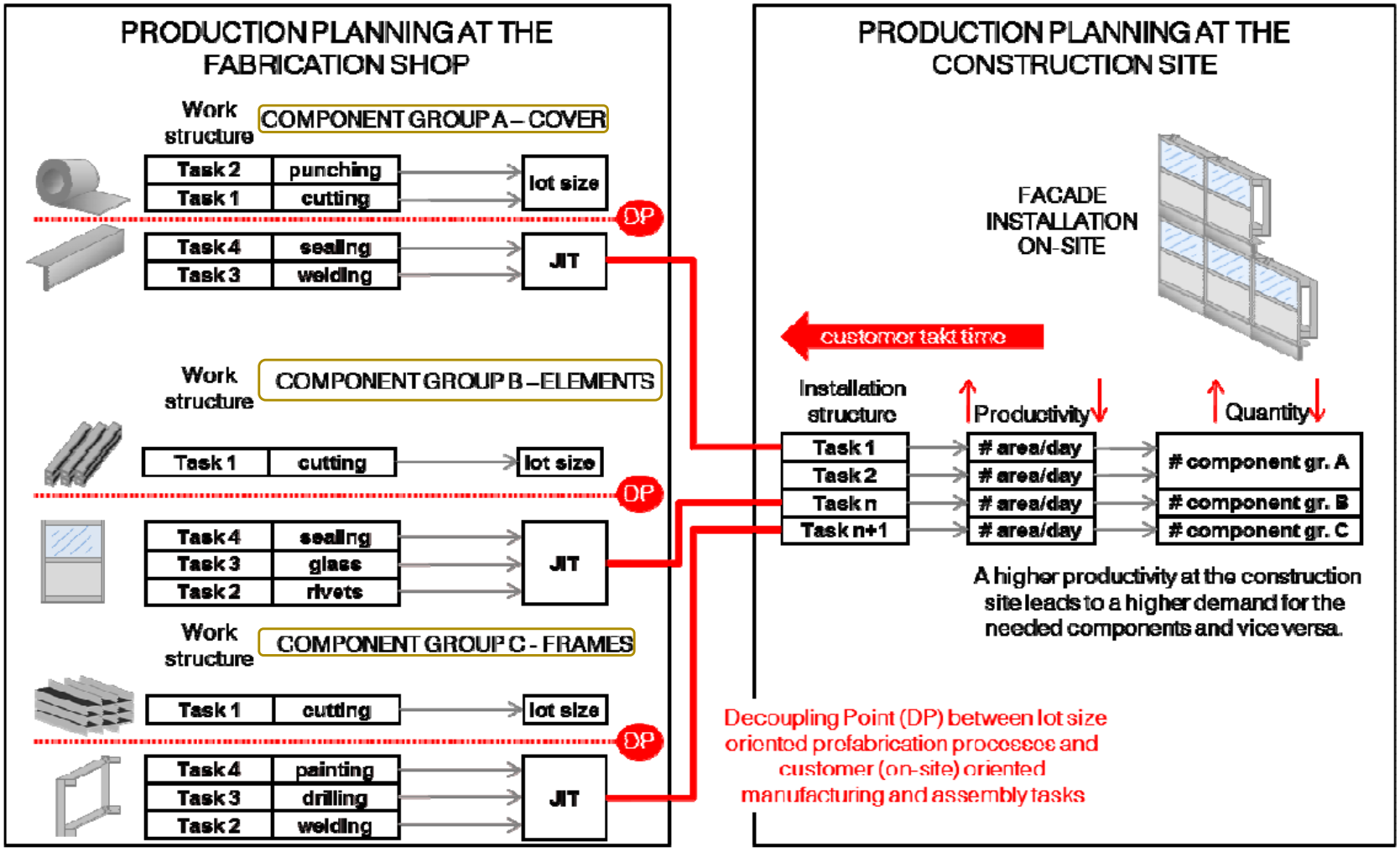
JIT can be achieved by using BIM due to ability of having prefabrication system



Prefabrication and Just-in-Time delivery of façade elements on the construction site – material flow

Continuous flow – Just-in-time (JIT)

JIT can be achieved by using BIM due to ability of having prefabrication system



Production planning on-site and in the fabrication shop

Continuous flow – Just-in-time (JIT)

Read File "Just in Time" document

Continuous flow – Just-in-time (JIT)

See Video 2

موسسه مهندسی و مدیریت ساخت علوی پور

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