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

فصل دوم: بکارگیری مفاهیم و اصول روش ناب در مدیریت پروژه (Lean Project Management)

بخش اول: بررسی نحوه بکارگیری اصول روش ناب در مدیریت پروژه

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What we will learn?

- Overview of the construction industry
  - Background of industry performance
  - Deficiencies in traditional project management
- Need for new approaches to construction
  - Review of lean construction
  - Foundation of lean construction
  - Lean construction vs. traditional construction
  - Lean construction value
  - Lean construction improvement

Overview of the Construction Industry

(Background of Industry Performance)

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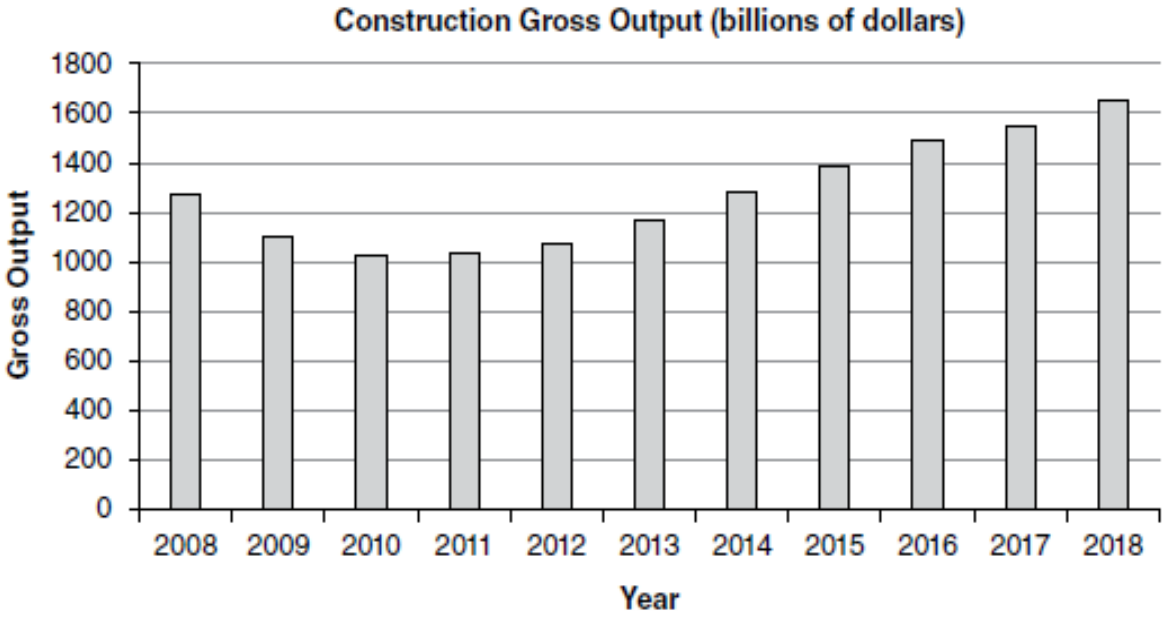
Construction size

- The **construction industry** has traditionally been one of the **largest industries** in the United States.
- As reported by the **Bureau of Labor Statistics (BLS)**,

  US Department of Labor, the value of construction in **2018 was $1,636.5 billion**, representing **4% of the gross domestic product (GDP)**



Source: Courtesy of Bureau of Economic Analysis, US Department of Commerce

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Construction employment

- The industry employed **approximately 7.4 million people** in **2018**
- The BLS report titled **"Industry employment and output projections to 2024"** forecasts that "the **construction industry** is projected to have the **largest industry increase in employment**,

  but construction employment is **not expected to reach pre-recession** levels **before 2024**."

Source: Courtesy of the US Department of Labor, Bureau of Labor Statistics

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Construction output

- **Real output** in the construction sector is projected to **grow 2.8% annually** **from 2014 to 2024**.

- Construction is projected to be the **fastest growing** of all of the **USA's goods-producing sectors** in terms of output and will **grow faster than the economy** as a whole.

- Construction is expected to be the **fourth fastest growing sector**.

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Construction productivity

- **Construction productivity** has been **lower than that of other industries**.

- The **BLS does not maintain** an **official productivity index** for the construction industry, the only major industry that is **not tracked consistently**.
  - **Productivity in construction** is usually **expressed in qualitative terms** and **cannot** be **analyzed scientifically**.

Several independent studies estimated that construction productivity increased between 1966 and 2003, at a rate of 33%, or 0.78% per year.

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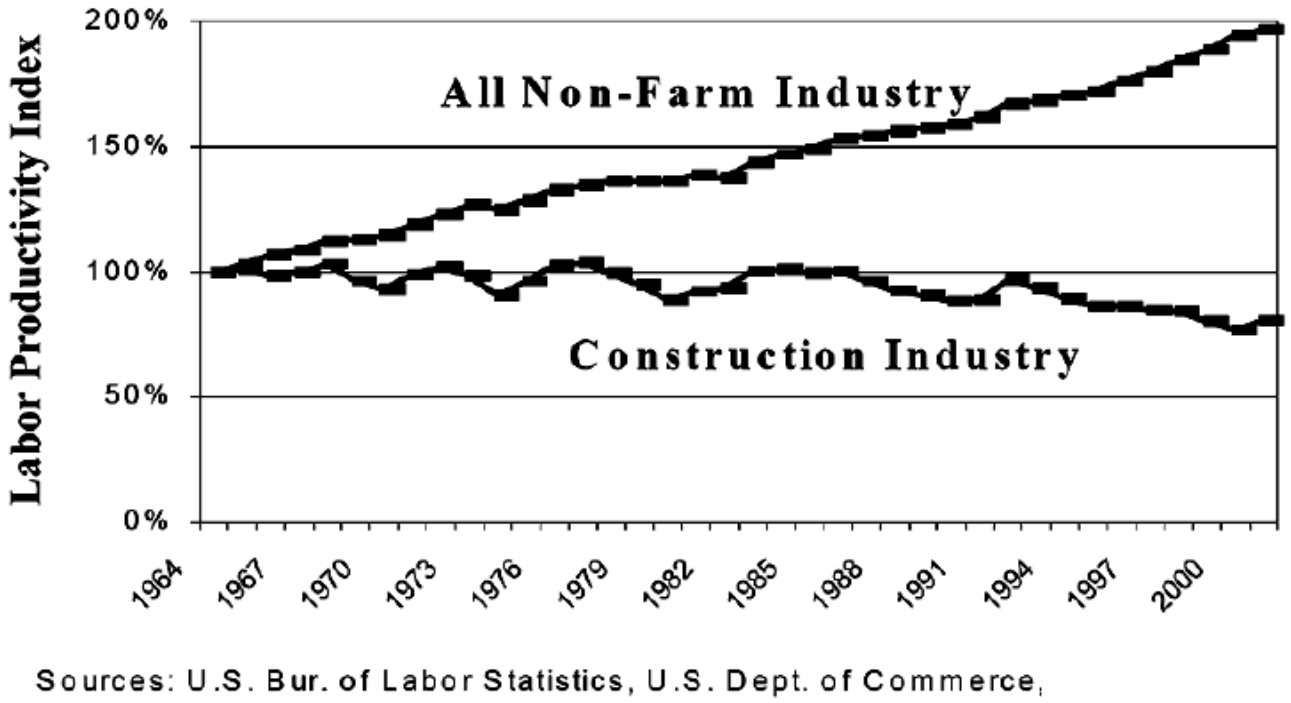
Construction productivity



Sources: U.S. Bur. of Labor Statistics, U.S. Dept. of Commerce,

Productivity improvement has **never been the focus** of the construction industry, probably **due to the lack of a model** that can **fit together all the fragmented components** of the **overall** construction process.

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Construction productivity

- The **comparatively poor performance** of the construction industry is borne out by a **small sample of well-known projects** in Table below.

Examples of problematic construction projects

Name of Project	*Budget $Millions*	*Final Cost $Millions*	*Percent Cost Growth %*
The Boston Big Dig (2005)	2600	14,600	460
Kennedy Center Parking Lot	28	88	210
Denver Airport (1995)	1700	4800	180
Capitol Hill Visitor Center (2008)	265	621	134
Hanford Nuclear Facility (2001)	715	1600	120
National Ignition Laser Facility	2100	3300	57

- They experienced **very significant cost and schedule growth**.

*But they were probably **able to sustain these impacts***

*because they were **government-sponsored projects**.*

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Construction productivity

- As reported by the **McKinsey Global Institute**,

  MGI Construction Productivity **Survey** was sent out in **August and September 2016**

  to **construction-industry CEOs** representing asset owners, engineering and construction firms, suppliers, other institutions to

  1. **Rank** the **relative importance of root causes** of low productivity and
  2. **Indicate** what their **companies were doing** to **address** them.

Let's see areas that have the greatest impact identified by this research!

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Construction productivity

- **Ten areas that have the greatest impact** on construction **productivity**:

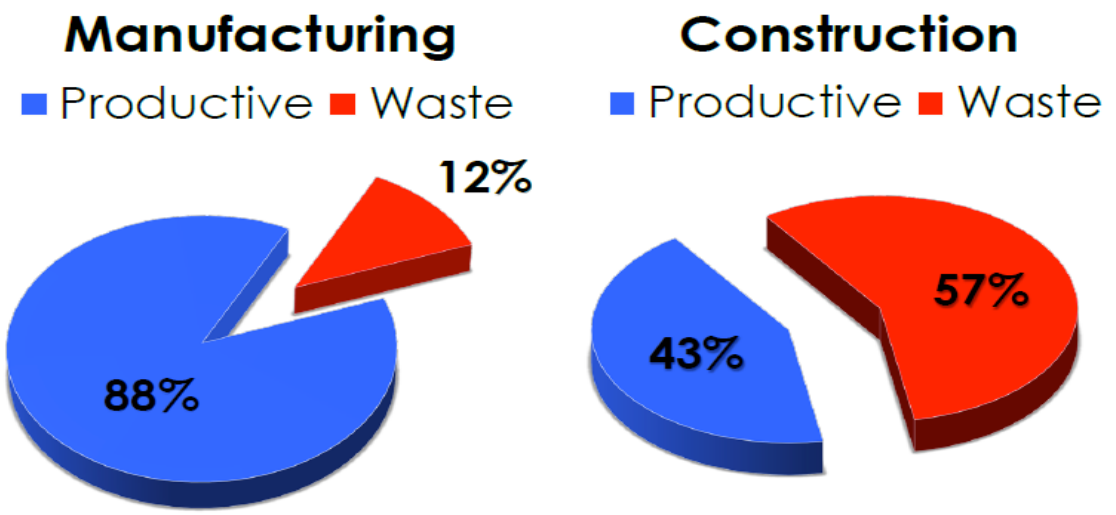
1. **Increasing** project and **site complexities**
2. **Extensive regulation**
3. Informality and potential for **corruption distort** the market
4. Construction is **highly fragmented**
5. **Contractual structures** and **incentives** are **misaligned**
6. **Customized** owner requirements
7. **Design** processes and **investment** are **inadequate**
8. **Poor project management** and execution basics
9. **Insufficiently skilled labor** at frontline and supervisory levels
10. The industry **underinvests** in digitization, innovation, and capital.

Construction waste

- There is **extensive waste** in the industry, in the **range of 25 to 50%** in coordinating labor and in managing, moving, and installing materials; a broad range of values for

  "wasteful activities" (1.6 to 93.1%, with an average of 49.6% (Horman and Kenley 2005).

- **2004 Construction Industry Institute (CII) Study**



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Construction waste

- The **US-based Building SMART Alliance at the National Institute for Building Sciences** estimates that

  more than 50% of the cost of a building is waste;

  compared to other industrial sectors, the construction sector has experienced **consistently rising costs over many years.**

Major reasons for wastes?

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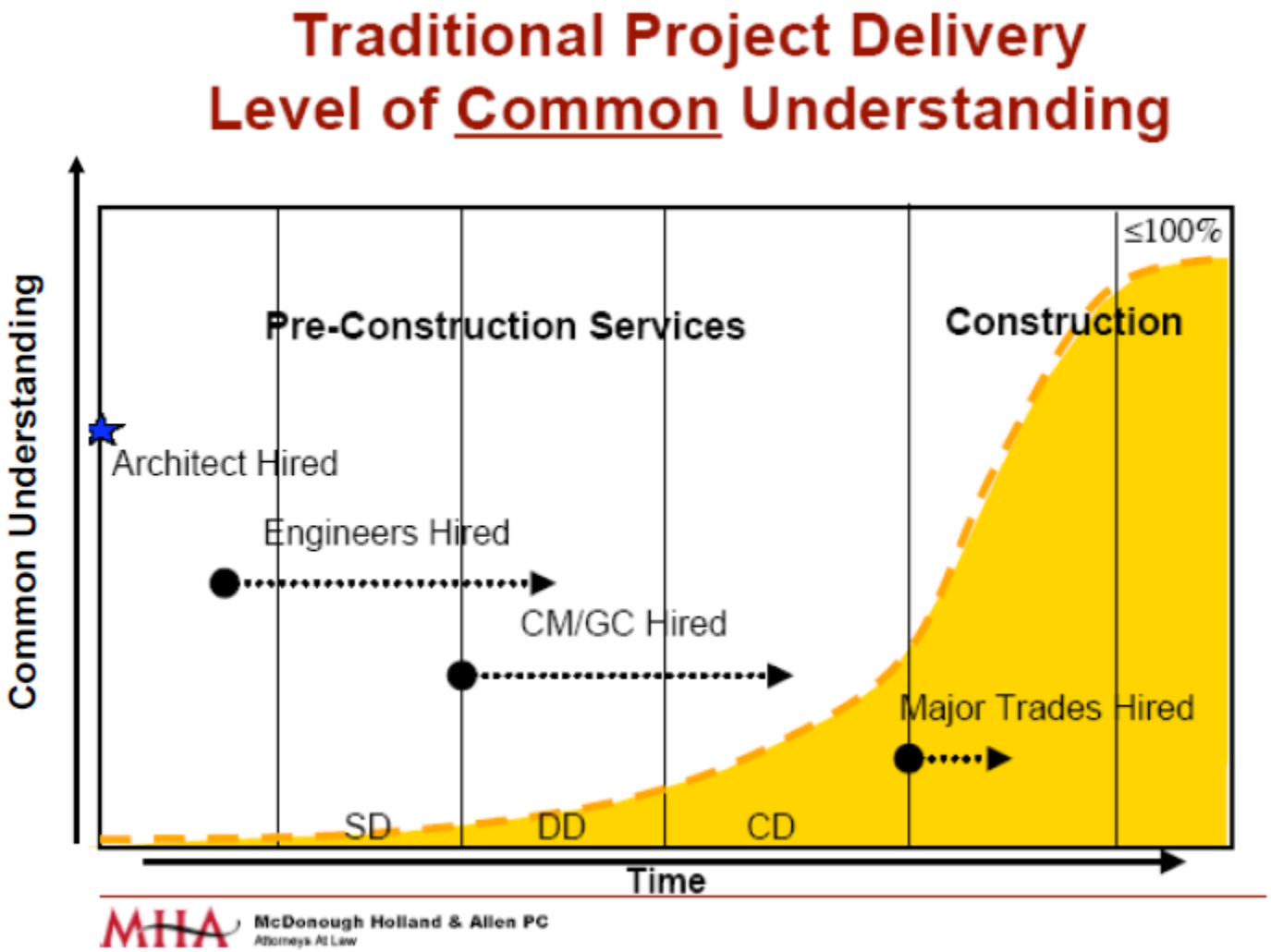
Construction waste

- The **Construction Industry Institute (CII)** estimates that in the United States,
  1. **10%** of project cost is spent in **one rework**.
  2. **Between 25 and 50%** of construction costs is lost to waste and **inefficiencies in labor and materials control.**
  3. Losses are incurred in **errors** in information **when translating designs to actual construction**.
     - Inadequate interoperability accounts for losses of **$17 to 36 billion per year**.
       - ✓ This problem is due to **communication difficulties** between **software** used by **different operators** in the design and construction supply chain.

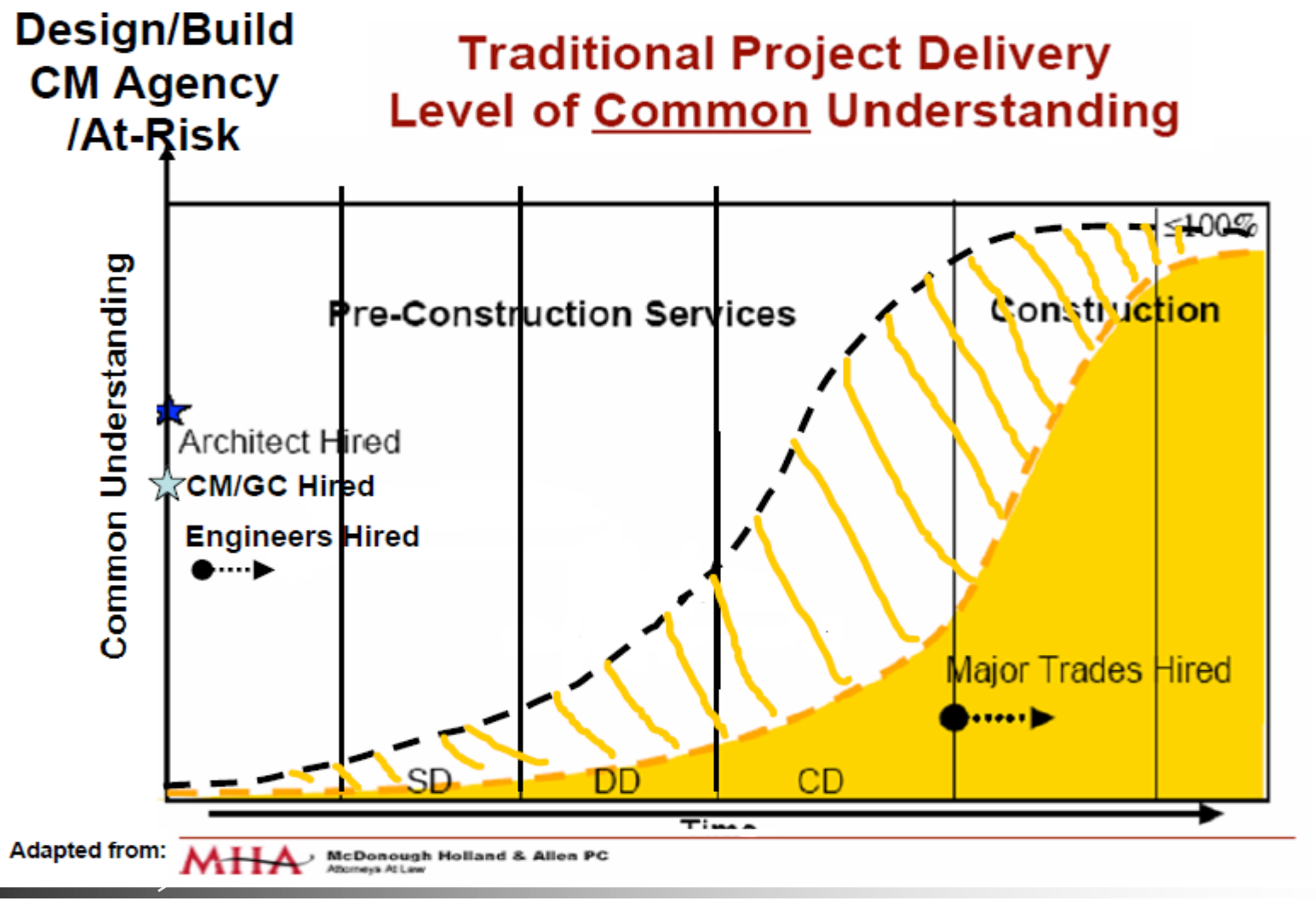
Overview of the Construction Industry

(Deficiencies in Traditional Project Management)

Deficiencies in traditional construction methods



Deficiencies in traditional construction methods



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Deficiencies in traditional construction methods

- Typically, projects are **subdivided into activities**
  1. Resource requirements and
  2. Time frames for each activity

  are placed on a **CPM chart**

  guided by a **master schedule.**

- **Constructors** are in fact **construction managers** who **subcontract** activities, generally by **discipline**.
- Once the **work starts**, CM attempts to **control it by comparing progress** with preplanned schedules, **usually at weekly meetings**.

What is the problem?

Deficiencies in traditional construction methods

- These actions represent the **"thermostat model"** (Hofstede 1978);

  performance is measured at the **output** of the controlled process.

  - The **possible variance** between a standard and the measured value is **used for <u>correcting</u>** the process.
    - ✓ *Unfortunately, **these efforts** to improve productivity have **limited impact** on the overall project.*

In traditional project management, CMs are often in a <u>reactive mode</u>, <u>adjusting</u> staffing or sequencing to maintain schedules.

- Attempts to **get back on schedule** may lead to
  - ✓ Cost overruns,
  - ✓ Quality deficiencies, or
  - ✓ Lapses in safety practices.

Deficiencies in traditional construction methods

- **Earned value analysis** helps project managers to **evaluate performance**.
  - However, these tools **do not control** project **variability**.

- **Traditional project management** also involves

  culture of "pushing" work assignments to **subcontractors** in order to meet the master schedule,

  whether or not these producers **have** all the **needed resources** to complete those assignments in a **given week**.

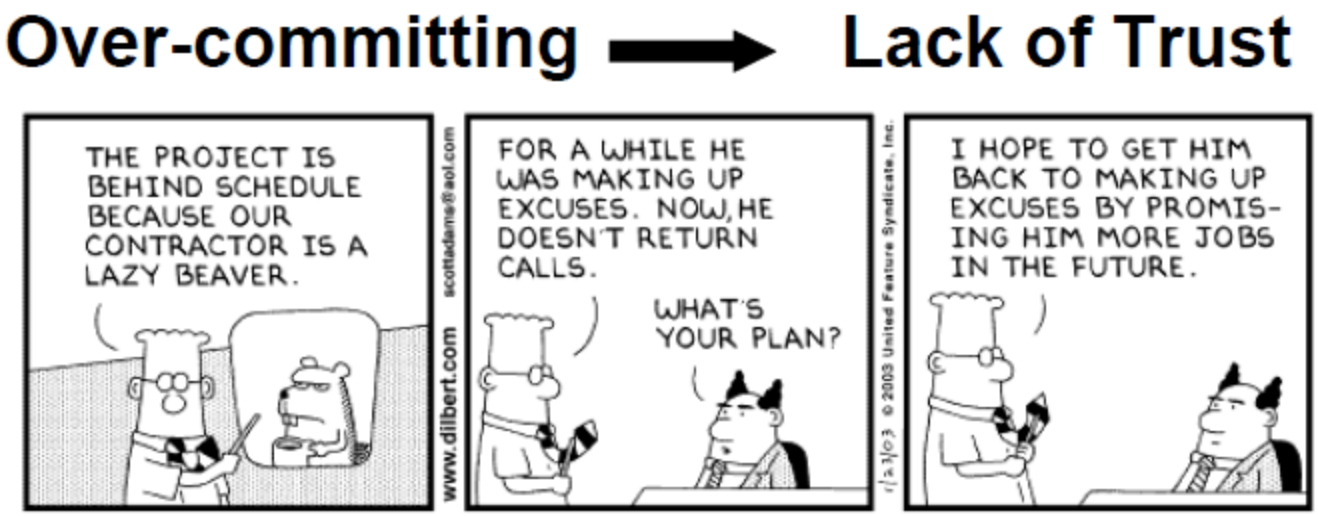
  *This tendency is the very **opposite of** the downstream **demand pull** required by the **Last Planner® System.***

Deficiencies in traditional construction methods

- By the time the variance is detected it may be too late for project to get back on track – Too sluggish of a response!!!

- Reporting an aggregate schedule/cost variance overlooks the mini-failures going on (many negatives variances could be offset by one large positive variances)

Deficiencies in traditional construction methods



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Construction business

- **Global competition** is increasing rapidly;

  in 2007 construction contracts **won by Chinese companies** increased in the United States and Europe by **160%**.

  In the case of the United States, this trend would **suggest that the competitiveness** of domestic construction organizations is **being challenged on its home turf.**

  - Construction spending is **moving** east to China, India, the Middle East, and Africa (CRIMEA).
  - Construction organizations that are the **most competitive** are **likely to benefit** from this trend.

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Construction business

- Clearly, **new approaches are urgently required** to **address** the construction **industry's ills**.

  Construction is said to need a **greater sense** of mission, focus, and industry support.

  - ✓ There are **several obstacles** to its **competitiveness** in the United States:
    - o Declining **productivity**,
    - o A **mindset** for minimum **first cost**, and
    - o Prescriptive **standards and codes** that **silence productivity**.

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Construction change

- There is **clearly a need for change** in the construction industry as many projects that have been delivered through **traditional forms of contract**

  have had **unsatisfactory outcomes** in **cost and schedule**.

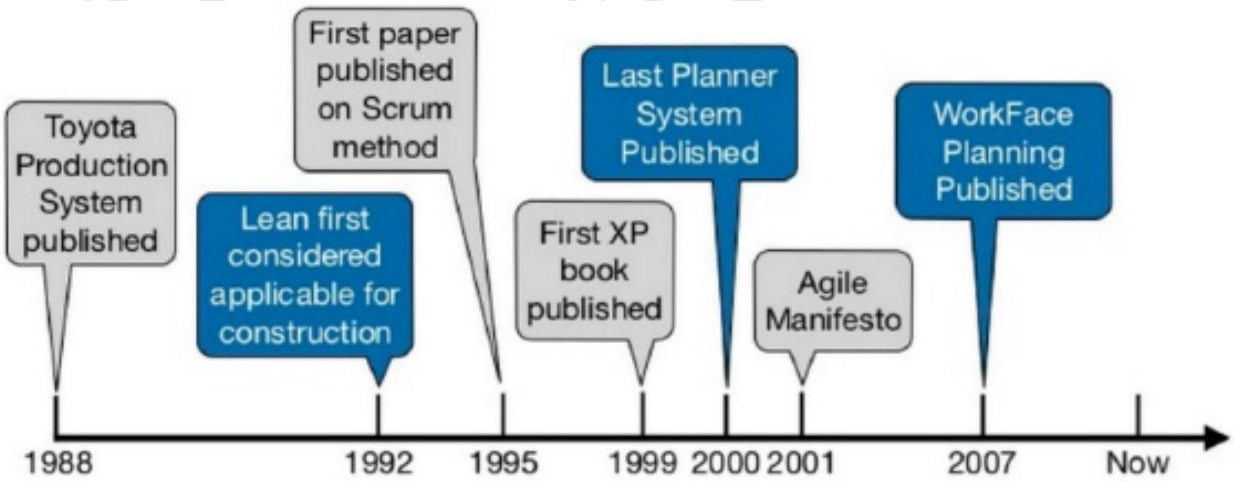
Could the advent of lean construction help?

Need For New Approaches To Construction

(Review of Lean Construction)

Lean construction history

- **Lean construction** is now **transforming** the construction industry.
- It came into **existence in 1993**, propelled by a **thesis by Lauri Koskela**, a researcher, who was **later joined by several other thought leaders** including Greg Howell and Glenn Ballard.
- **Lean construction** has been **gaining strength** during the **past two decades and beyond.**



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Lean construction definition

- **Lean construction (LC)** is an **innovative project delivery** approach that **addresses** many of the **shortcomings of traditional project management** as
  1. Construction Productivity
  2. Waste
     - It has **several interpretations**, including
       - ✓ Lean Project Delivery,
       - ✓ Collaborative Project Delivery, and
       - ✓ Integrated Project Delivery.

Lean construction definition

- The **following descriptions** are among the **most established examples to date**.

  - **Koskela et al. (2002)** described lean construction as

    *A way to **design production systems** to*

    ***minimize** waste of materials, time, and effort,*

    *in order to generate the **maximum** possible amount of **value**.*

Lean construction definition

- The **following descriptions** are among the **most established examples to date**.

  - The **Lean Construction Institute (Abdelhamid 2013):**

    *"Lean construction is a **production management-based project delivery system***

    *emphasizing the **reliable** and **speedy** delivery of **value**.*

    *It **challenges** the **generally-accepted belief** that*

    *there are always **trade-offs** between time, cost and quality."*

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Lean construction definition

- The **following descriptions** are among the **most established examples to date**.

  - The **Associated General Contractors of America (AGC 2013)** described Lean Construction as

    ***a set of ideas**, practiced by individuals in the construction industry, based on the holistic pursuit of **continuous improvements** aimed at*

    1. ***Minimizing costs** and*
    2. ***Maximizing value** to clients in all dimensions of the built and natural environment:*

       planning, design, construction, activation, operations, maintenance, salvaging, and recycling.

Lean construction definition

- The **following descriptions** are among the **most established examples to date**.

  - The **Construction Industry Institute (CII)** has defined it as

    *" the **continuous process** of*

    1. *Eliminating waste,*
    2. *Meeting or exceeding all customer requirements,*
    3. *Focusing on the entire value stream, and*
    4. *Pursuing perfection in the execution of a constructed project"*

    (CII Lean Principles in Construction Project Team – PT 191)

Lean construction definition

- An earlier **CII-sponsored study** headed by **Professor Victor Sanvido**, investigated project delivery methods (Sanvido and Konchar 1999).

  - The study findings identified **several critical keys** to **project success**:

  1. A knowledgeable, trustworthy, and decisive **facility owner/developer**;
  2. A **team** with relevant experience and chemistry assembled as early as possible, but certainly **before 25% of the project design** is complete; and
  3. A **contract** that encourages and **rewards organizations** for behaving as a team.

Lean construction applicability

- Applied to the **design, supply and construction** of a capital facility,

  Lean changes the way work is done throughout the **project-delivery process**.

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Lean construction applicability

- It compromise
  - Continuous improvement
  - Flattened organization structures
  - Elimination of waste
  - Teamwork
  - Efficient use of resources
  - Cooperative supply chain management

Lean Construction extends from the objectives of a Lean production system—maximize value and minimize waste—to specific techniques, and applies them in a new project delivery process.

Need For New Approaches To Construction

(Foundation of Lean Construction)

Lean construction vs. Lean production

But, how does the Toyota system, lean production, apply in construction?

The construction industry has rejected many ideas from manufacturing because of the belief that construction is different

Manufacturers make parts that go into projects

but

design and construction of unique and complex projects

in highly uncertain environments

under great time and schedule pressure

is fundamentally different from making tin cans

Lean construction vs. Lean production

- **Lean production** pursues the ideal to:

  (1) do what the customer wants,

  (2) in no time, and

  (3) with nothing in stores" (Tommelein 2015).

- **Lean construction** relates to both **design** and **construction** and seeks to

  1. Maximize value for project owners and
  2. Minimize wastes;

  these include **seven wastes**. (Womack and Jones 1996).

  IPD *is defined as a* ***delivery system*** *that seeks to align interests, objectives and practices,*

  even in a ***single business****, through a team-based approach.*

Lean construction vs. Lean production

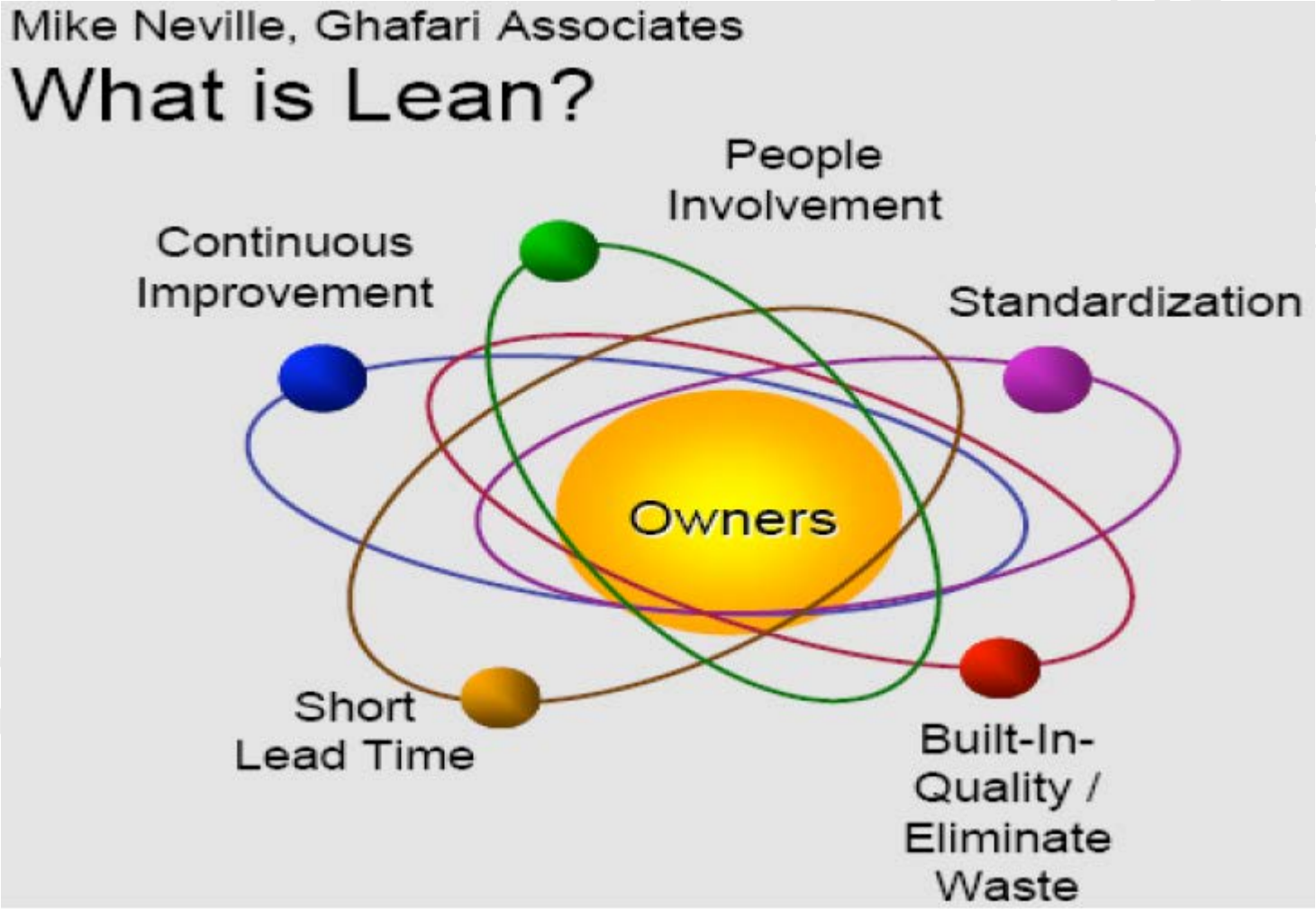
- **Managing construction under lean** is **different** because:

1. It has a **clear set of objective** for delivery process,
2. It is aimed at **maximizing performance for the customer** at the **project level**,
3. It **designs concurrently** product and process, and
4. It applies **production control** throughout the **life of the project**.

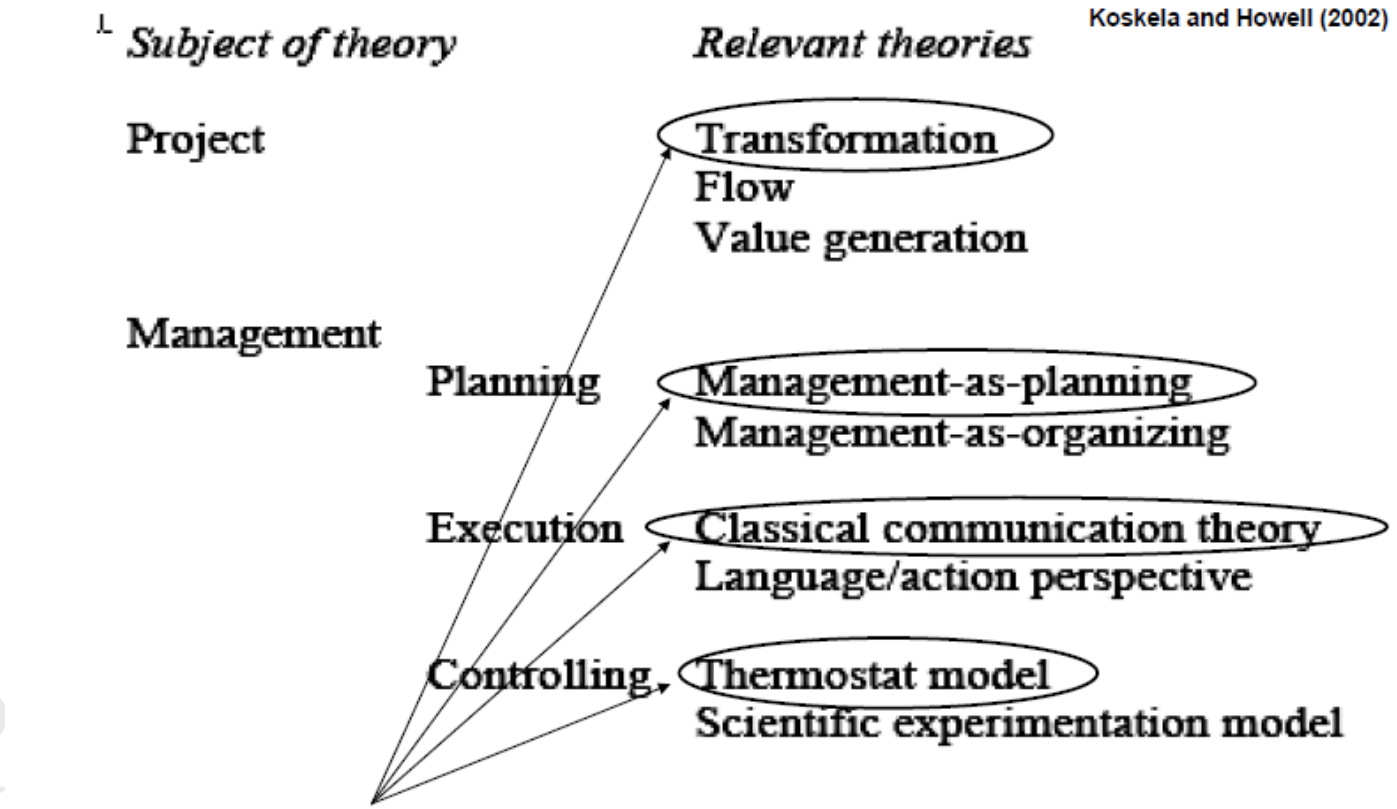
Lean construction fundamentals

- The **Construction Industry Institute (CII)** identified **five lean construction principles** in their study PT 191:
  1. Customer focus
  2. Culture and people
  3. Workplace organization and standardization
  4. Elimination of waste
  5. Continuous improvement and built-in quality

Lean construction fundamentals



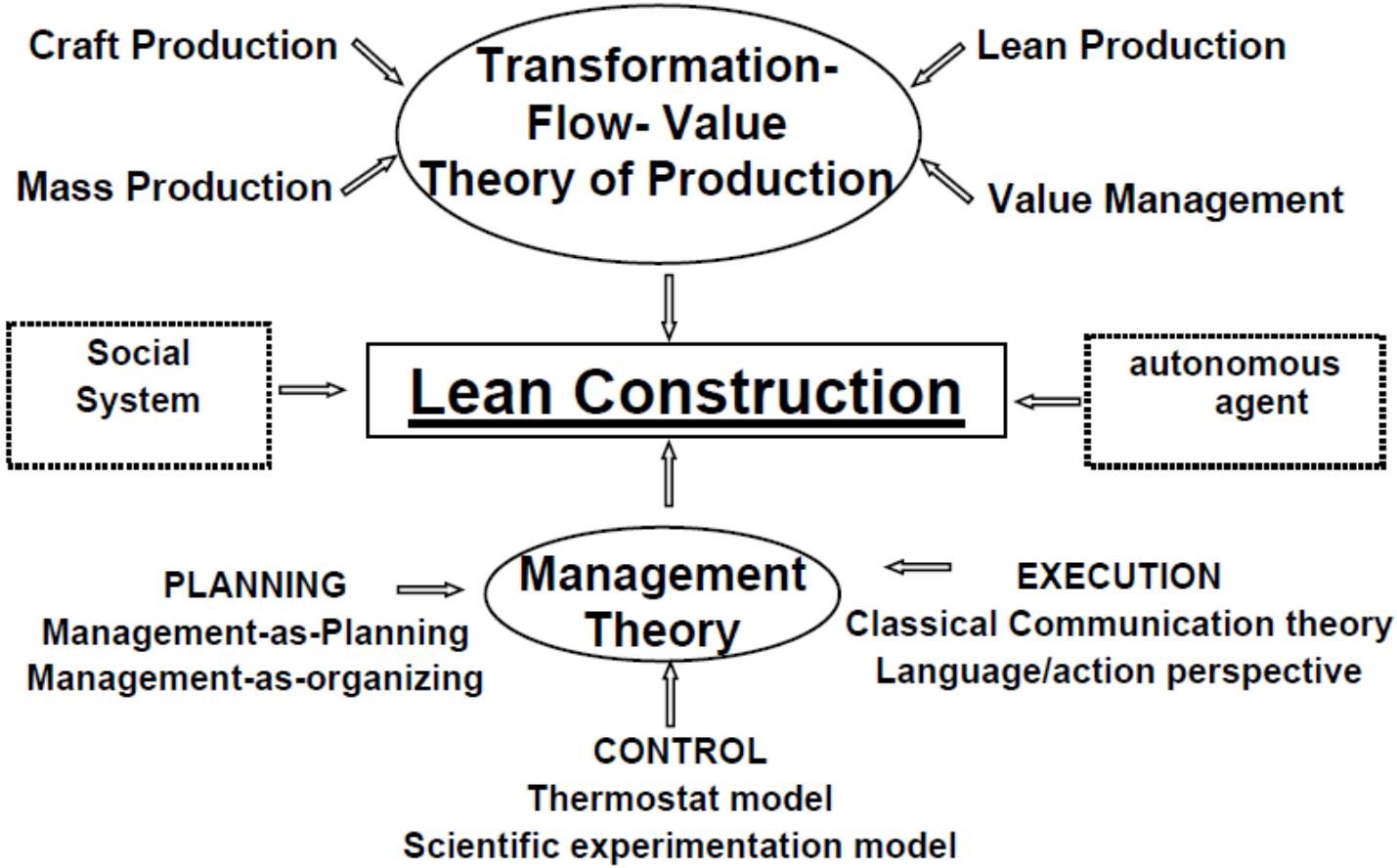
Lean construction fundamentals



Today's Construction Management Focus. The other theories of project and management need to be considered. That's what Lean Construction advocates and encompasses.

Koskela, L. and Howell, G., (2002). "The Underlying Theory of Project Management is Obsolete." Proceedings of the PMI Research Conference, 2002, Pg. 293-302.

Lean construction fundamentals



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Lean construction fundamentals

ASSIGNMENT 2-1-1:

1. Read the paper entitled: "Lean Construction" individually.
2. Meet your team members online and discuss the material presented in the paper.
3. Try to write about four following items in one page (do it with your team members):
   a) Brief summary of the paper
   b) Conclusion and light bulb moments
   c) Your questions
   d) How do the ideas can be applied in the construction?
4. Send your paper (in PDF format) to ralavipour@gmail.com

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

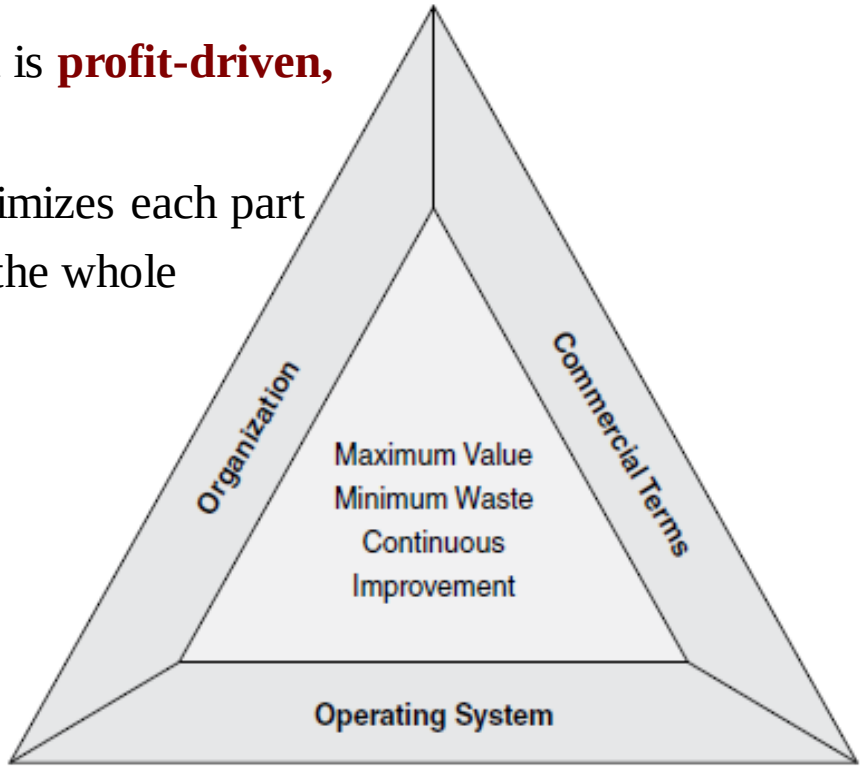
Need For New Approaches To Construction

(Lean Construction Vs. Traditional Construction)

Lean construction vs. traditional construction

- The **sides** include the **organization** and **commercial terms** which are both underlain by a **unique operating system**.

- For example, while **traditional construction** is **profit-driven,**
  Lean Construction is **value-driven**.
  - ✓ **Traditional Construction** optimizes each part
  - ✓ **Lean construction** optimizes the whole



The lean construction triangle

Source: Adapted from Mossman (2014)

Lean construction vs. traditional construction

Lean construction departs significantly from traditional project management practice.

- With lean methods performance is **optimized at the project level**,
  whereas **current project management** approaches
  reduce total performance by **attempting** to **optimize each activity**.

Does it replace CPM?

Lean construction vs. traditional construction

- Lean construction does **not replace CPM**,

  but it **works within them** to improve the delivery of short-term assignments.

  - **CPM** is seen as
    - ✓ **Playing** a **strategic role**,
    - ✓ **Identifying** major project **milestones** and
    - ✓ **Sequencing** of **critical activities**
  - **Lean planning** is seen as
    - ✓ **Tactical in nature**,
    - ✓ **Planning the work flow** for the next four or five weeks.

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Lean construction vs. traditional construction

- It is **difficult** for CPM to **plan and track** individual **short duration tasks**
  - Remember **short-interval schedule**?
    - ✓ The **"Last Planner"** concept relies on

      empowering the foreperson and crew leaders to

      decide on the **specific tasks** to be done in the following weeks,

      as they are closest to the work and ***trades become more familiar*** *with the work.*

Lean construction vs. traditional construction

- **Traditional construction** views projects as **controllable** and **relatively predictable**.
  - **Traditional construction** also views each project as **unique and not very adaptable** to the methods used in **continuous operations**.
    - ✓ These requirements seem to be **very firm and leave no room** for deviation.

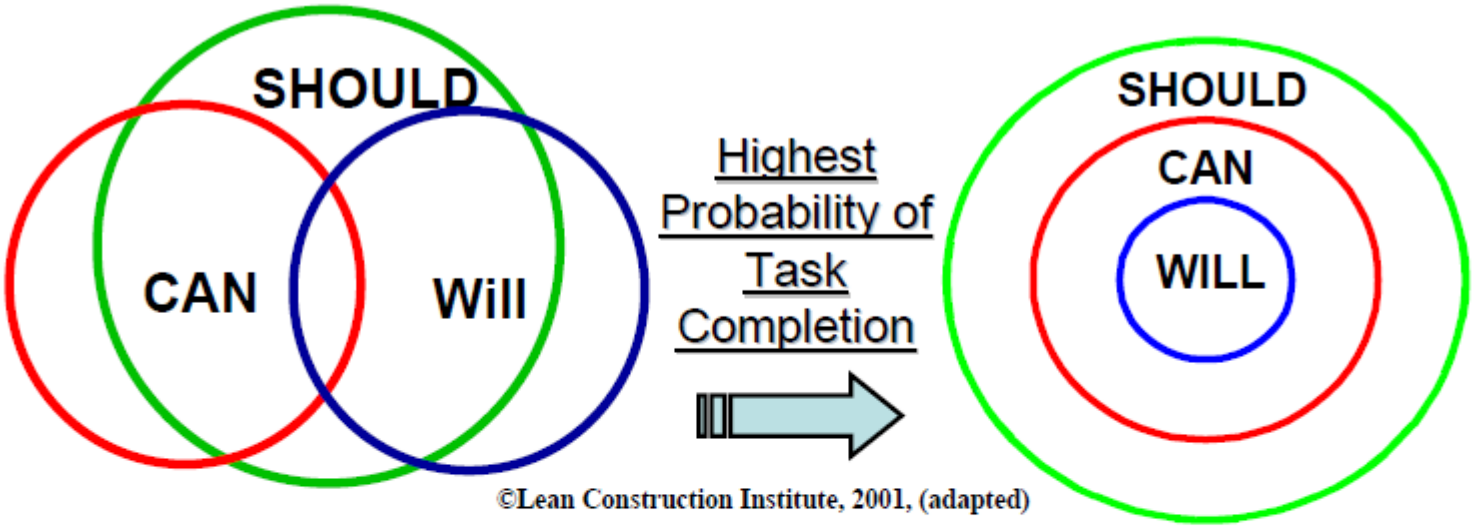
- **Lean construction** recognizes the planning that is so **important** to the **traditional construction** is often **limited in effectiveness** by **unplanned events** that occur in **almost every project**.
  - The **Last Planner® technique** for scheduling is **effective** because it focuses on a **short-time horizon** so it becomes a technique for **continuous production**.

Lean construction vs. traditional construction

- **Traditional construction** works well with projects that are **relatively simple and predictable**.
  - When there is a **lot of complexity and uncertainty**, **lean construction** is likely to be **more effective**.

- **Lean construction** focuses on **adding value** as **opposed** to **controlling** cost and schedule.
  - It also **focuses** on **flexibility and learning** in order to cope with **uncertainty and unplanned** events.
    - ✓ *This is especially important with **projects that are not routine and are very complex.***

Lean construction vs. traditional construction



©Lean Construction Institute, 2001, (adapted)

Current common practice is to make weekly production assignments (WILL) that may fall outside the ability of workers to perform (CAN). There is also instances when a commitment is made (WILL) for things that should not be done.

Need For New Approaches To Construction

(Lean Construction Value)

Typical value definitions

- **"Value"** – performance relative to **cost**;

  value engineering definition….**reducing cost** will give **better value**

  - **Value Engineering** is **improving the "Value"** by

    examining the **ratio of value function** to its **cost**.

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Value in construction

• (Koskela 2000).

- Value is generated through the interaction between customer and supplier, wherein the customers provide the requirements and the supplier delivers it.
- Principle: Elimination of value loss (realized outcome versus best possible) by ensuring customer needs and wants are captured & *challenged (*QFD, AHP, DCM)
- Practical contribution: Taking care that customer requirements are met in the best possible manner

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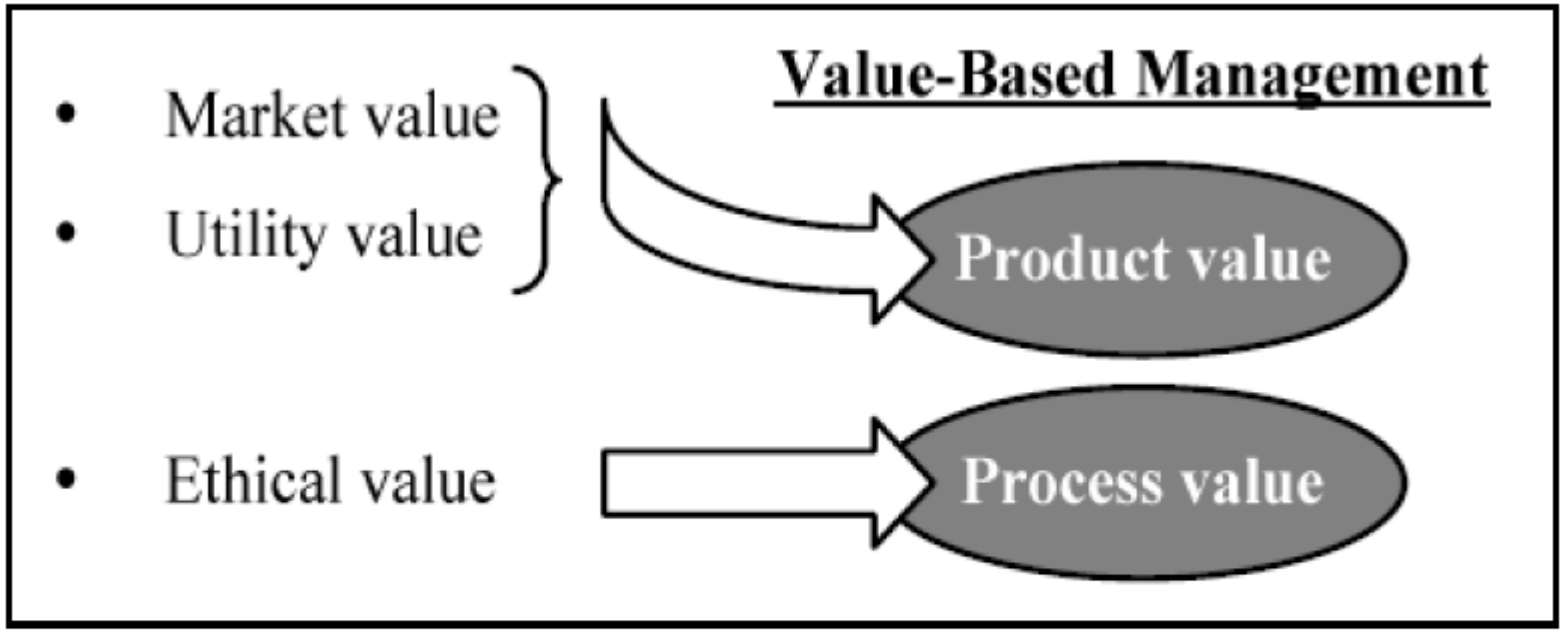
Value in construction

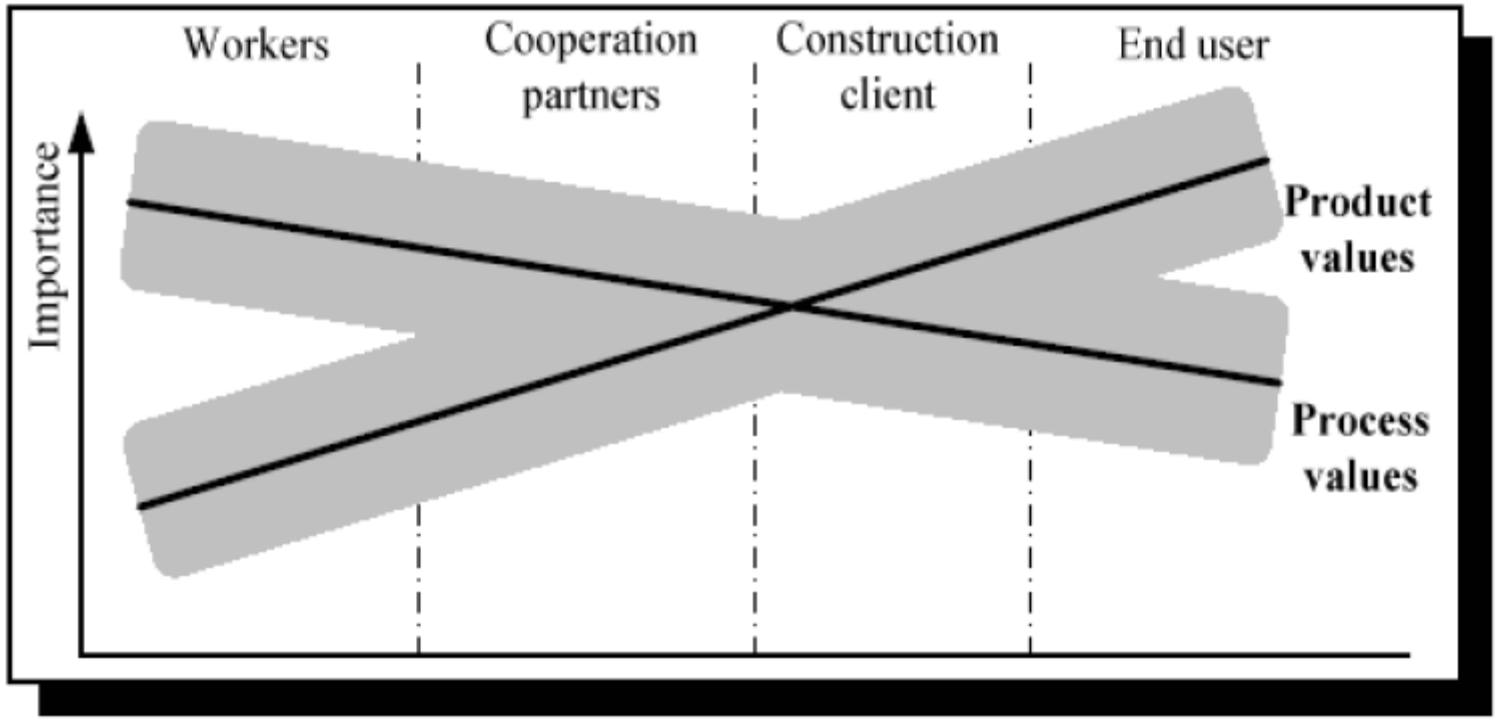
- "Value is what the customer says it is" – Greg Howell – co-founder Lean Construction Institute
- "Value is in the eye of the beholder"
- "The Client wants to know how you will add value to his project" President of Parsons Brinckerhoff Construction Services…Controlling time, cost, and quality is not enough…ENR Magazine, ….December 2, 2002

Value in construction



"VALUE-BASED MANAGEMENT IN THE SUPPLY CHAIN OF CONSTRUCTION PROJECTS" – IGLC12- 2004 - Søren Wandahl and Erik Bejder

Value in construction



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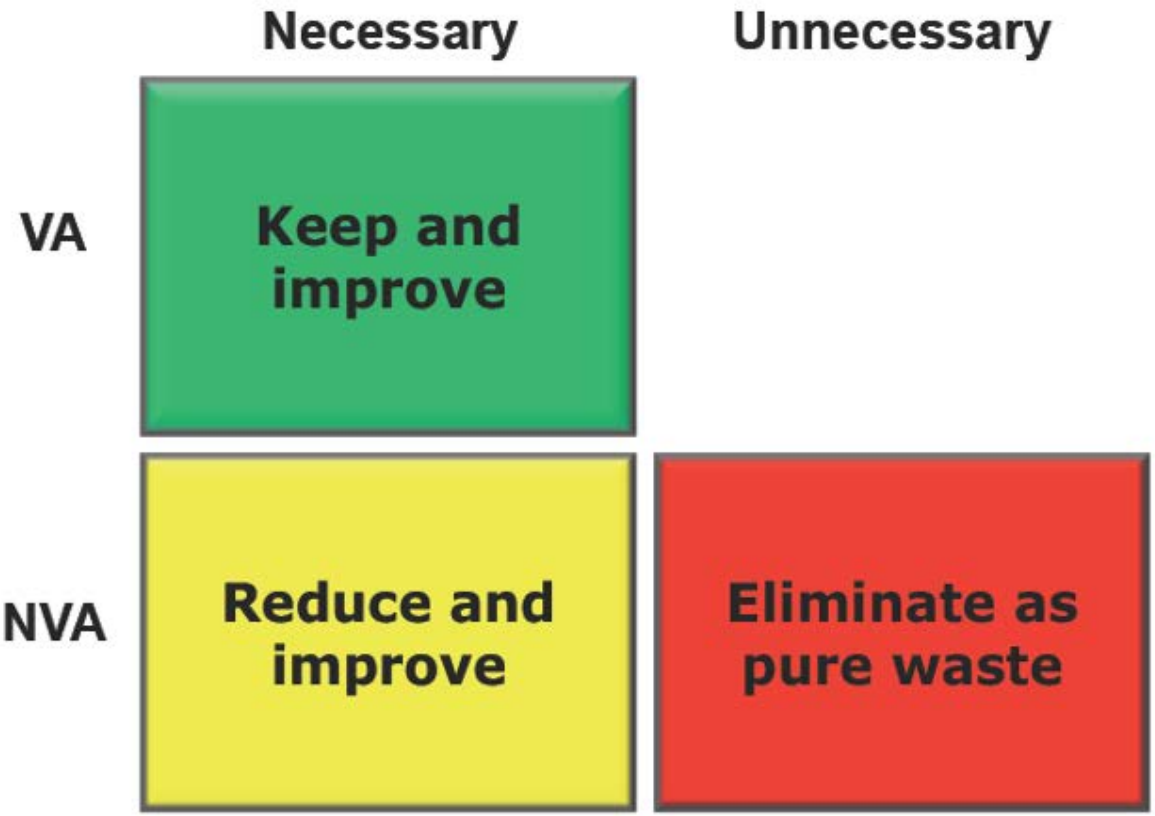
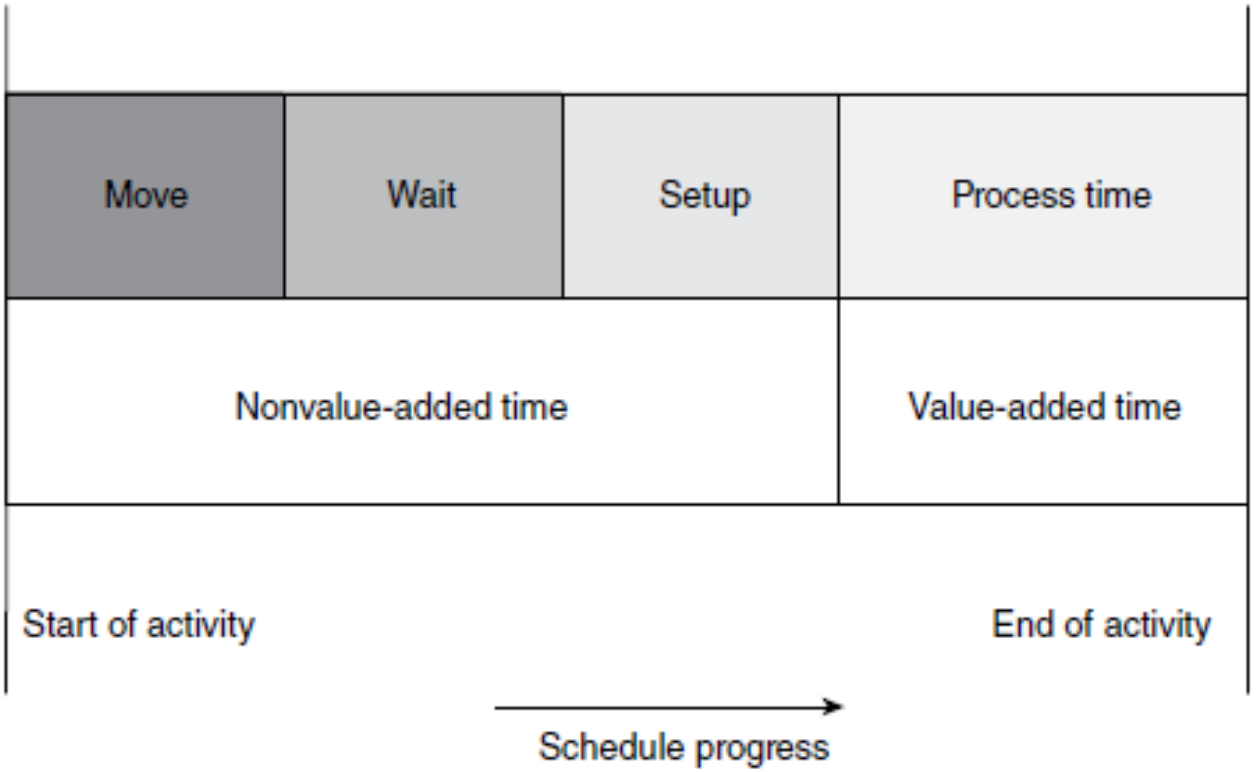
Waste and value identifications and orderings



Impact of value-added vs. non-value-added time in a typical construction process



8 types of waste

1. Defects / poor quality
2. Over-production
3. Waiting & delays
4. Non-utilized resources (usually human resources)
5. Transportation & handling
6. Inventory (excess inventory)
7. Motion (unnecessary movement)
8. Excess processing

How DOWNTIME adopted in Construction?

Reducing or eliminating waste

- **Adoption of the Toyota production system (TPS)** applies the principles used in manufacturing to the **construction environment**. The TPS addresses:

1. **Producing defective goods (waste of rejected production):**
   - Construction that **does not meet codes** may be **rejected by an inspector**.
     - ✓ It then has to be **corrected** by extensive, costly rework.
     - ✓ Construction **errors require correction** and inhibit downstream activities because of the **time delays** that usually result.

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Reducing or eliminating waste

- **Adoption of the Toyota production system (TPS)** applies the principles used in manufacturing to the **construction environment**. The TPS addresses:

2. **Overproducing:**

   - When **one discipline** is so absorbed in **self-interest**, it may seek to carry out **as much work as possible** between payment cycles

     without considering the impact on other disciplines or trades.

   - **More work** that has been completed, the **greater the dollar value of payment** requests.

     - *An **drywall contractor** may **exceed a schedule** and install drywall before an electrical subcontractor has **completed conduit work** for wall outlets or control devices.*

       To get back on schedule, some partial demolition may be needed.

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Reducing or eliminating waste

- **Adoption of the Toyota production system (TPS)** applies the principles used in manufacturing to the **construction environment**. The TPS addresses:

3. **Idle time waste (waiting time/queue time):**

   - **Poor coordination** results in significant lost/idle time in projects.

     *An **impending concrete pour** for a floor slab is planned by scheduling a team of journeymen and laborers who help to direct the pour from a concrete truck over the reinforcing bars and vibrate it to eliminate voids.*

     *A **motorized float** is used to level the surface. **If the crew foreman did not have a firm commitment from the supplier**, the crew could be **left waiting for an hour or more** because of a late delivery.*

     Ten workers at an average of $2,000 per hour incur an idle time waste of $200 per hour. If the pumping equipment and the vibrators are rented, the idle time incurs additional cost as well.

Reducing or eliminating waste

- **Adoption of the Toyota production system (TPS)** applies the principles used in manufacturing to the **construction environment**. The TPS addresses:

4. **Non-utilized resources:**
   - Data, product, people, etc. have not been used.
   - BIM model that produces data we do not need.
   - Standards that we do not need.
   - People that we cannot manage well
   - Information that is not important

Reducing or eliminating waste

- **Adoption of the Toyota production system (TPS)** applies the principles used in manufacturing to the **construction environment**. The TPS addresses:

5. **Transporting/conveyance waste:**
   - **Excessive transport of materials or equipment** does not add value, but consumes resources.
   - A **poor site layout** can result in **long-travel distances** to bring materials to the point of use.

     *For example, if **drain pipes for installation underground** are stored at a **location far from the planned excavation**, then the retrieval and transportation could incur **significant expense**.*

     ***A front-end loader** and its operator could consume **additional hours** in the process, whereas a more thoughtful location would reduce the transportation costs.*

Reducing or eliminating waste

- **Adoption of the Toyota production system (TPS)** applies the principles used in manufacturing to the **construction environment**. The TPS addresses:

6. **Inventory waste (having unnecessary stock on hand):**
   - **Holding excessive amounts of inventory** (materials and supplies) has negative consequences:
     a. The **cost of material is significant** and involves tying up **capital**;
        - This could **negatively impact cash flow**.
     b. **Storing excessive inventory** involves a carrying **cost for storage**.
     c. **Managing the storage** of materials long before they are needed runs the risk of **spoilage** or **"shrinkage"** (i.e., unexplained loss of material).

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Reducing or eliminating waste

- **Adoption of the Toyota production system (TPS)** applies the principles used in manufacturing to the **construction environment**. The TPS addresses:

7. **Wasted operator motion (using unnecessary motion):**
   - **Inexperienced trades** may **not be familiar** with best practices.
   - Poor job organization could cause the **operator to make additional steps** to carry out the job.

     *For example, **experienced trades use templates** for positioning bathroom fixtures, and setup kits with the appropriate tools and fasteners so that each installation proceeds quickly without risk of error or delay.*

     ***Inexperienced workers** have **difficulty in attaining similar levels** of productivity.*

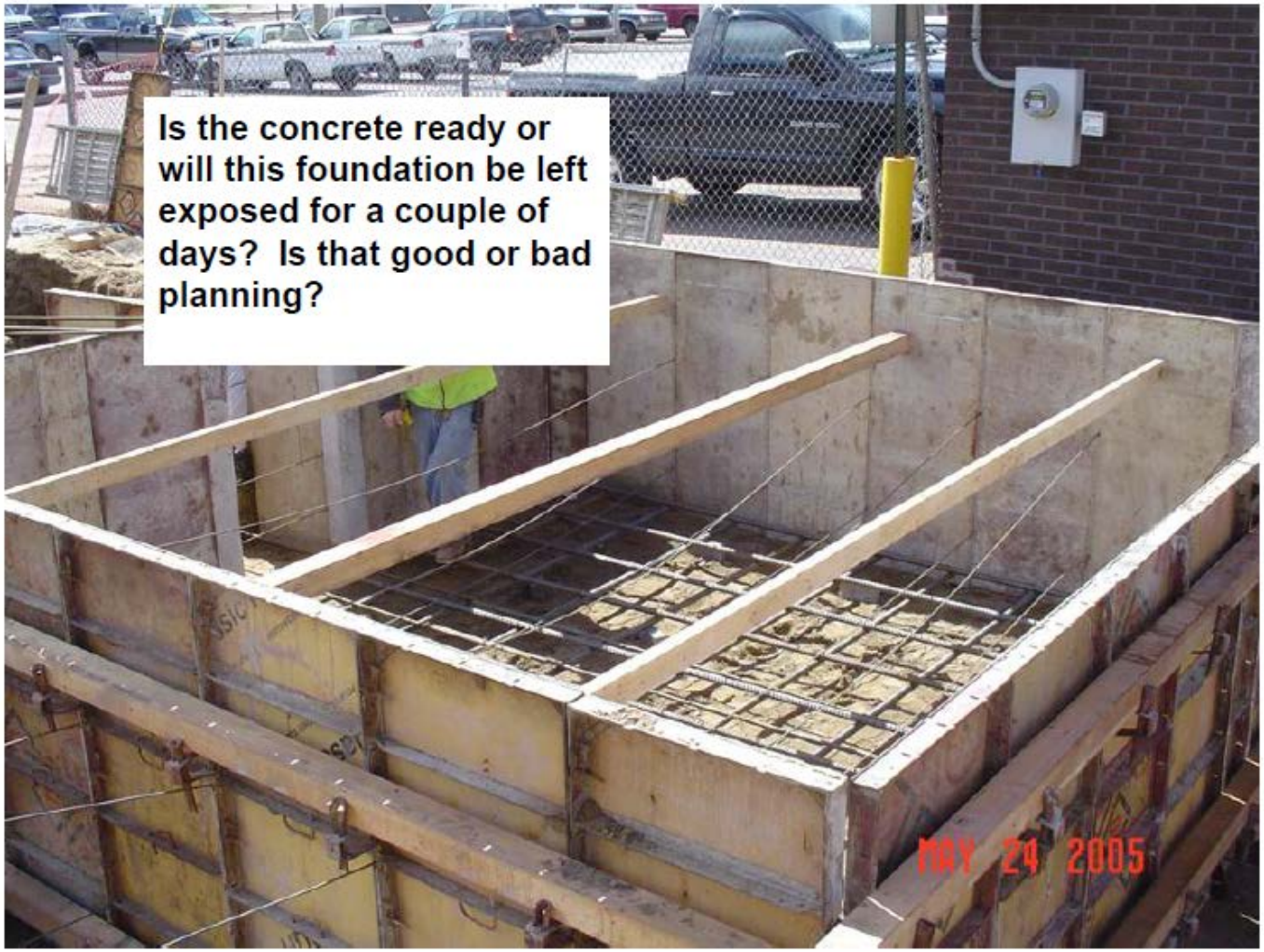
Reducing or eliminating waste

- **Adoption of the Toyota production system (TPS)** applies the principles used in manufacturing to the **construction environment**. The TPS addresses:

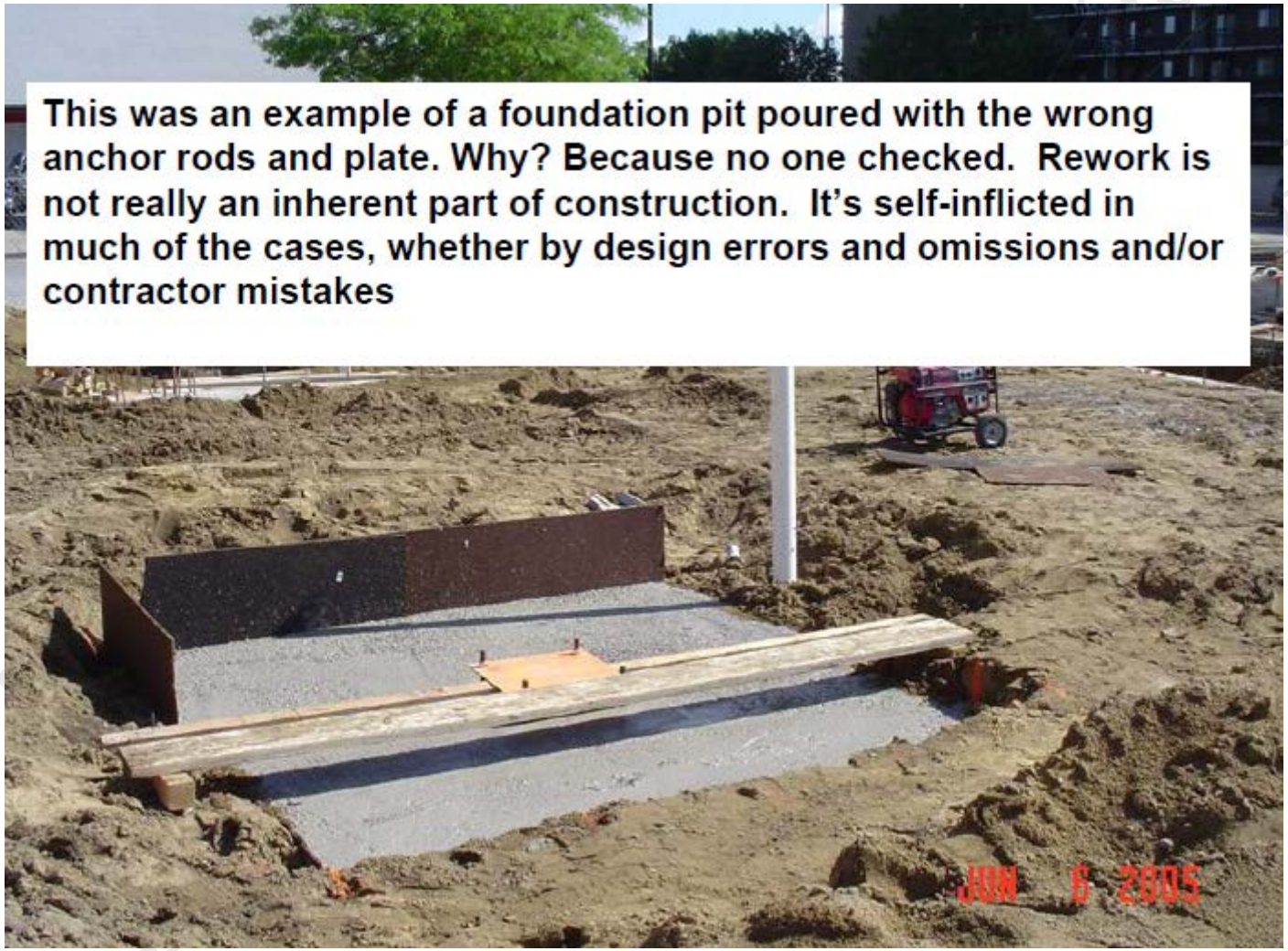
8. **Processing waste – waste in the work itself:**
   - Studies have pointed to **high levels of material waste** in construction, depending on the region involved.
   - **Bossink and Brouwers (1996)** found that 9% by weight of purchased materials are wasted.
   - In the **Dutch construction industry**, from 1 to 10% by weight of each material item becomes solid waste.
   - In **Brazilian construction**, 20–30% of purchased materials are not used and become waste.
   - As **material costs are 50–60% of project costs**, material waste can cause cost overruns. **Material waste could be due to:**

Design	Poor anticipation of design impacts
Procurement	Wrong material or suboptimal order quantities
Material handling	Damage due to poor handling
Operation	Mistakes, poor use of material sizes
Inefficiencies	Poor waste management

Reducing or eliminating waste



Reducing or eliminating waste



Need For New Approaches To Construction

(Lean Construction Improvement)

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Improvement made by lean construction

- The **lean methodology** has **undoubtedly proven** its validity as it has yielded **measurable improvements** in the form of
  - Lower project costs,
  - Shorter schedules,
  - Better quality and
  - Improved safety.

Any data to prove? Let's see some of them!

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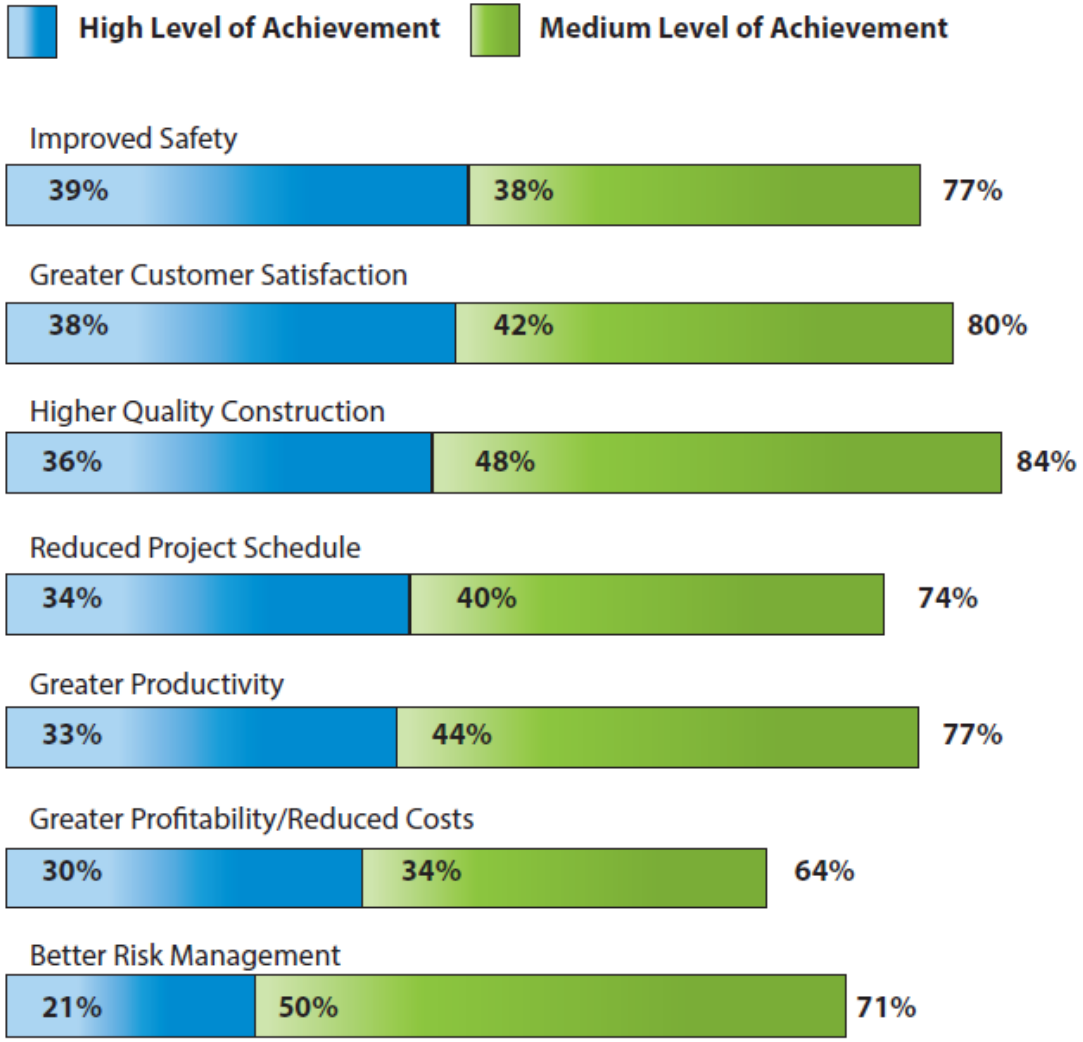
Improvement made by lean construction

- The **McGraw Hill Company's Smart Market Report (ENR 2013)** took a survey of construction providers.
  - It **cited many lean benefits** reported by survey respondents.
  - The **percentages of respondents** reporting medium and high levels of achievement were:
    - ✓ Higher quality construction 84%,
    - ✓ Greater customer satisfaction 80%,
    - ✓ Greater productivity 77%, and
    - ✓ Improved safety, 77%.

Let's see the more data…

Improvement made by lean construction

- **Source: McGraw Hill, 2013**



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Improvement made by lean construction

- **Lenn Ballard and Yong-Woo Kim (2007)** conducted a **major study** for **Construction Industry Institute (CII Report 234-11)** that saw **significant positive outcomes** with lean projects – both tangible and intangible.

- They documented
  - **Savings of 10% or more**
  - **High levels of satisfaction** for **owners** as well as **project team members**.
  - In some cases **both costs and schedules** were **reduced by 10% or more**.

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Improvement made by lean construction

- **Lean construction institute (LCI)** came into **existence** as a response to **industry concerns** over
  - Low construction productivity,
  - Commonly observed errors,
  - Delays,
  - Cost overruns, and
  - Safety incidents.

***Lean construction** aims to **address these interactions** in a **comprehensive manner**.*

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Lean Glossary

See the file entitled "LCI Glossary"

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

فصل دوم: بکارگیری مفاهیم و اصول روش ناب در مدیریت پروژه (Lean Project Management)

بخش دوم: استفاده از اصول روش ناب در مرحله طراحی (Design) پروژه

ارائه دهندگان:

سید محمدرضا علوی‌پور

(PhD, PMP, CMIT)

کامبیز کردانی

(M.Sc., PMP)

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What we will learn?

- Lean in design and construction
  - Concepts
  - Contract
  - Lean project delivery system (LPDS)
    - ✓ Life cycle
    - ✓ Definition phase
    - ✓ Design phase
      - o Some of tools and techniques

Lean in Design and Construction

(Concepts)

Lean design and construction

- **Lean design and construction** involve the **application of lean methods/techniques** to **design and construction processes**, in order to **derive the benefits** that have been clearly established in manufacturing operations.
  - Benefits include:
    - ✓ Lower costs,
    - ✓ Fewer delays,
    - ✓ Less uncertainty,
    - ✓ Less waste,
    - ✓ More efficient buildings/facilities, and
    - ✓ Higher user satisfaction.

Lean design and lean construction

- **Lean construction** much **like current practice** has the goal of

  *better **meeting customer needs** while **using less of everything**.*

But **unlike** current practice,

lean construction rests on **"physics"** of construction

That results in a **new project delivery system** that can be applied to **any kind of construction**

But particularly studied for complex, uncertainty, and quick projects

Goals?

Goals of Lean design and lean construction

- Achieve reliable **workflow**
- Minimize **waste**
- Optimize the **whole**, not the parts
- Develop a **discipline** of **learning** and **continuous** improvement
- Maximize **value** to the customer
  - Value includes:
    - ✓ Safer job sites (zero injuries)
    - ✓ Quality assurance (zero defects)
    - ✓ Sustainable (net zero efficiency)
    - ✓ Unique solution (pre-fabrication)

How?

Goals of Lean design and lean construction

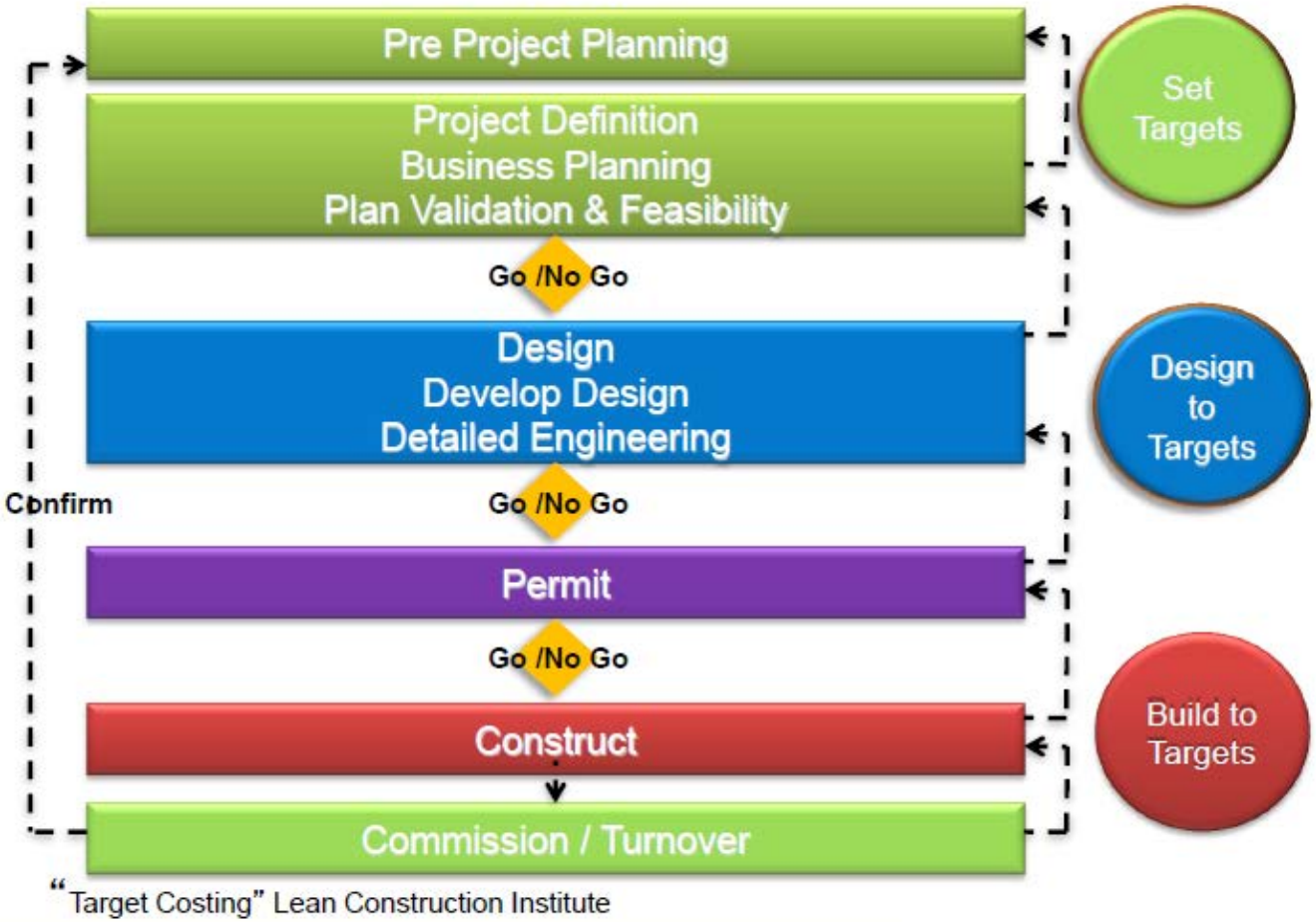
- **How?**
  - Start to develop an **awareness** about the **wastes**
    - ✓ We talked about this
  - As we get **better** at **identifying waste**
    - ✓ Practice **continuous improvement and learning**
    - ✓ Pursue **perfection**

Results?

Goals of Lean design and lean construction

- **Results:**
  - Reduce **time** to design and construct
  - Reduce **cost** to deliver projects
  - Improve **profitability**

Lean project work flow

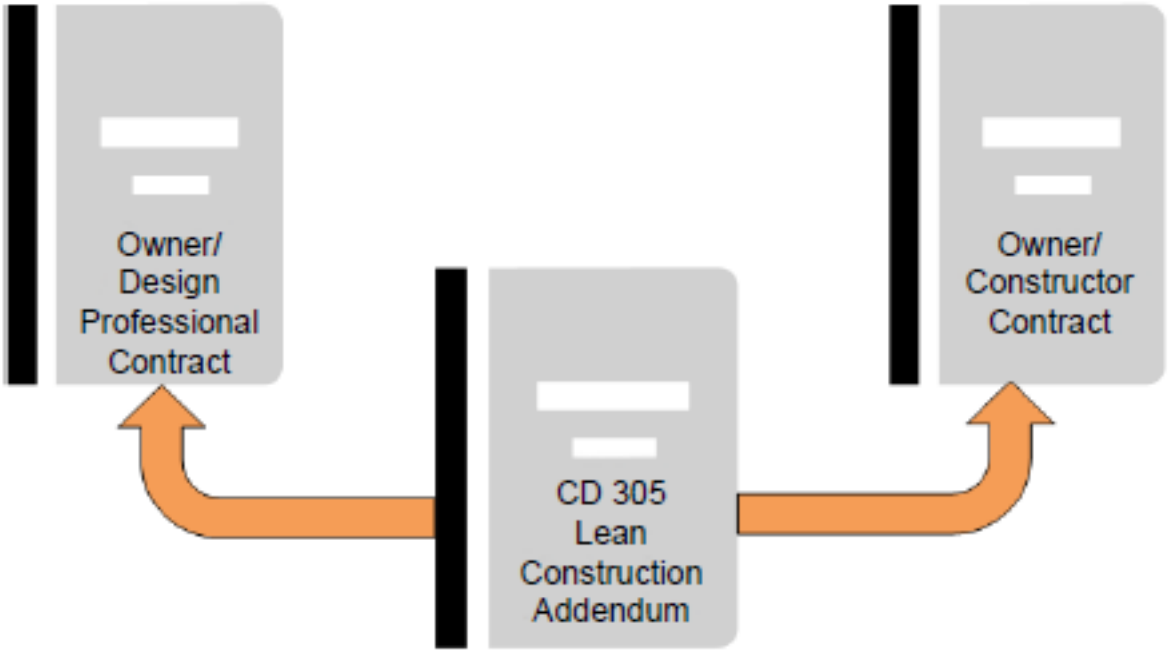


Lean in Design and Construction

(Contract)

Ways to contract for lean design and construction

What is the ConsensusDocs 305?



Ways to contract for lean design and construction

- **Integrated Project Delivery (IPD) agreement** (a/k/a IFOA)
  - e.g., CD 300 (2016 edition)
- **Custom-created** IPD-ish design & construction agreements
- **Vague references** to lean added to an owner's standard contract
- Now with CD305, an **industry standard form <u>outside</u> of IPD** that addresses a wide spectrum of lean practices

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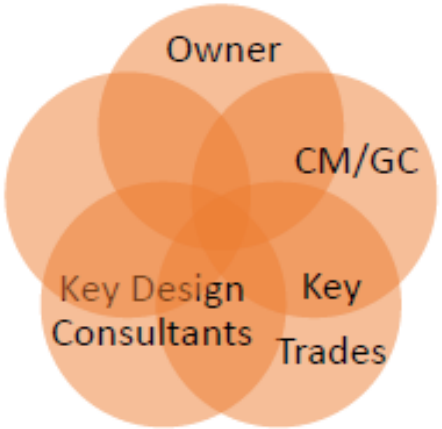
Addendum to what?

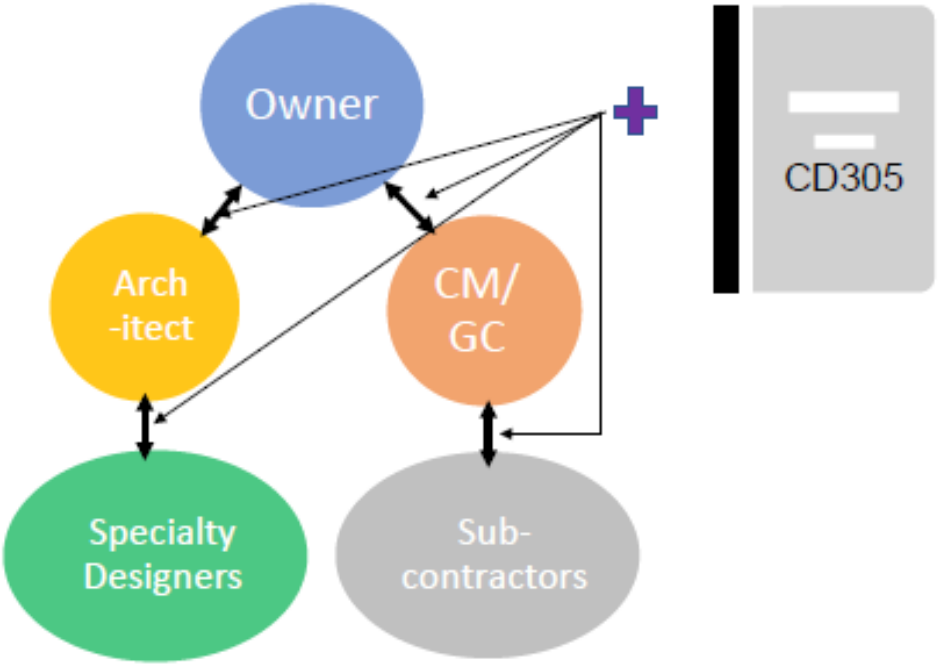
- **ConsensusDocs 305** can be used with:
  - consensusDocs 500 Agreement between **Owner & CM**
  - Other forms of **CM at Risk** contracts
  - Construction contracts under **Design-Bid-Build**
  - **Owner contracts** with **Design Professional**

Not intended for **Design-Build Prime Contracts**, but stay tuned

How is this different than IPD?



IPD



CD 305

It is an addendum, not a full contract!

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Addendum vs. silence

- Increase **alignment** among parties
- First **collaborative** act
- Parameters of **lean behavior and activities**
- Some lean methods will **conflict** with **standard contract language**, so **addendum overrides**
- Allows **enforcement** of lean requirements, but **take care**

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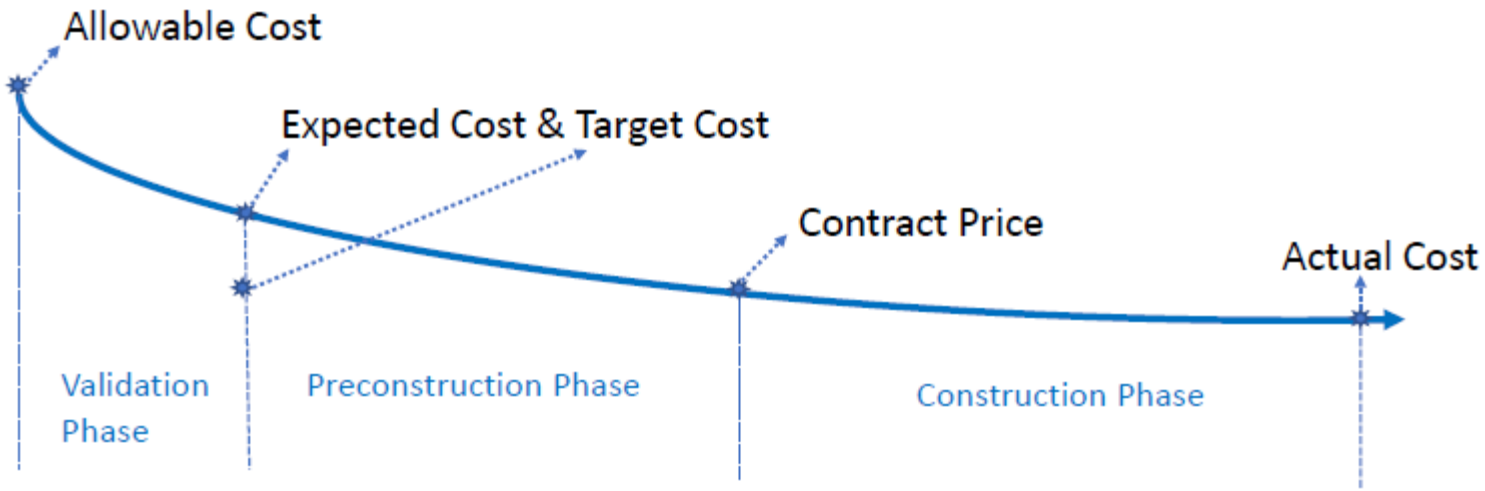
Using the CD 305

- **When?**
  - O/A/C are committed to lean, but one or more are not ready or able to enter an IPD agreement

- **How?**
  - Jointly negotiated, separately attached
  - Check-the-box

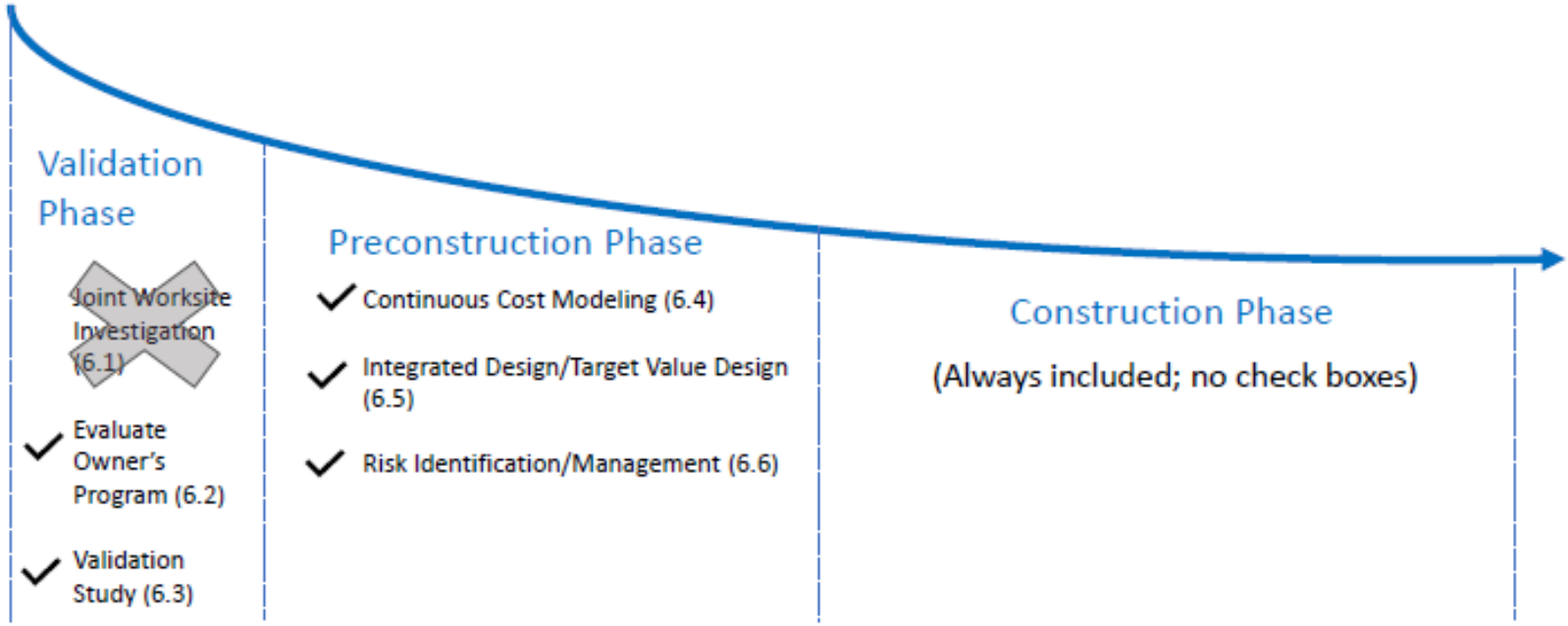
Typical chronology of IPD project



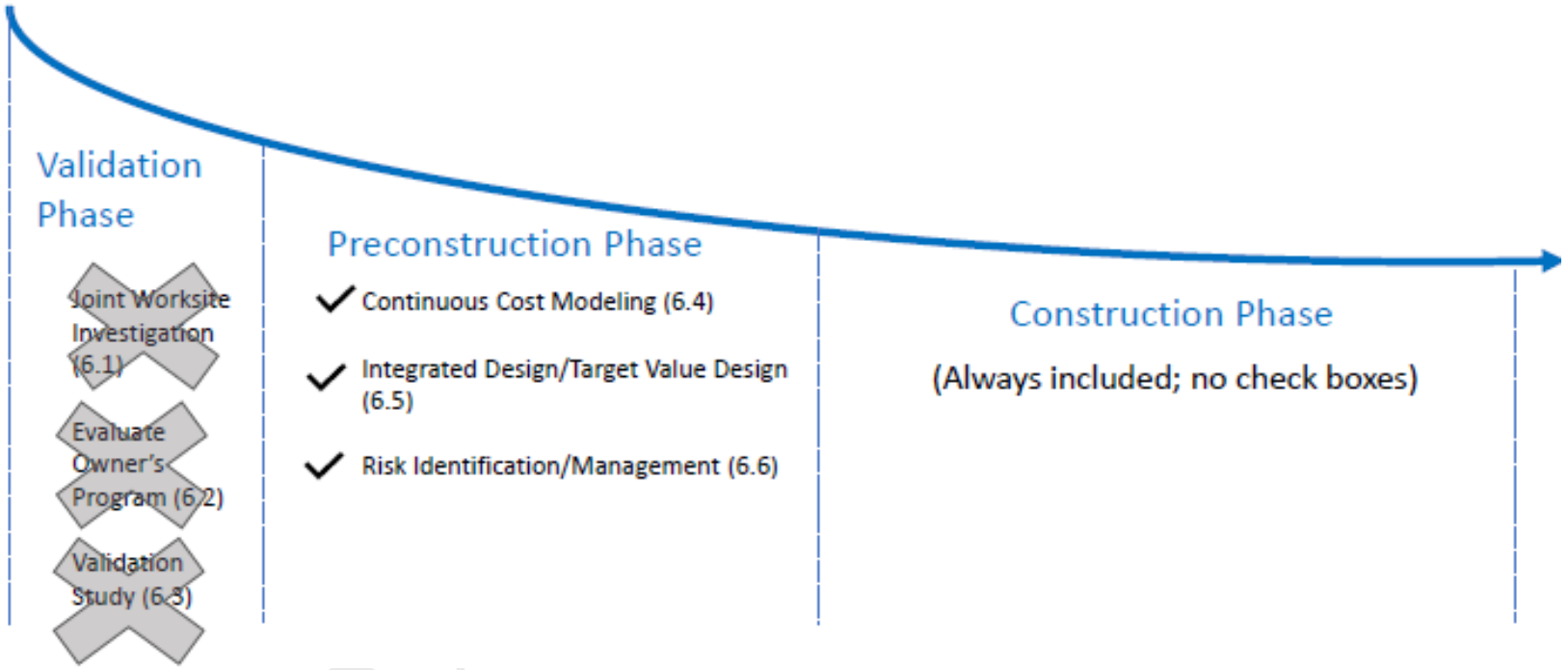
Expected Cost - An expression of the team's best estimate at the conclusion of the Validation Phase of what current best practice would produce as a price for the facility reflected in the accompanying basis of design documents. Typically, the Expected Cost will also be supported by benchmarking or other market data to calibrate the Expected Cost in light of the market context.

Target Cost - The cost goal established by the delivery team as the "target" for its design and delivery efforts. The Target Cost should be set at less than best-in-class past performance. The goal is to create a sense of necessity to drive innovation and waste reduction into the design and construction process.

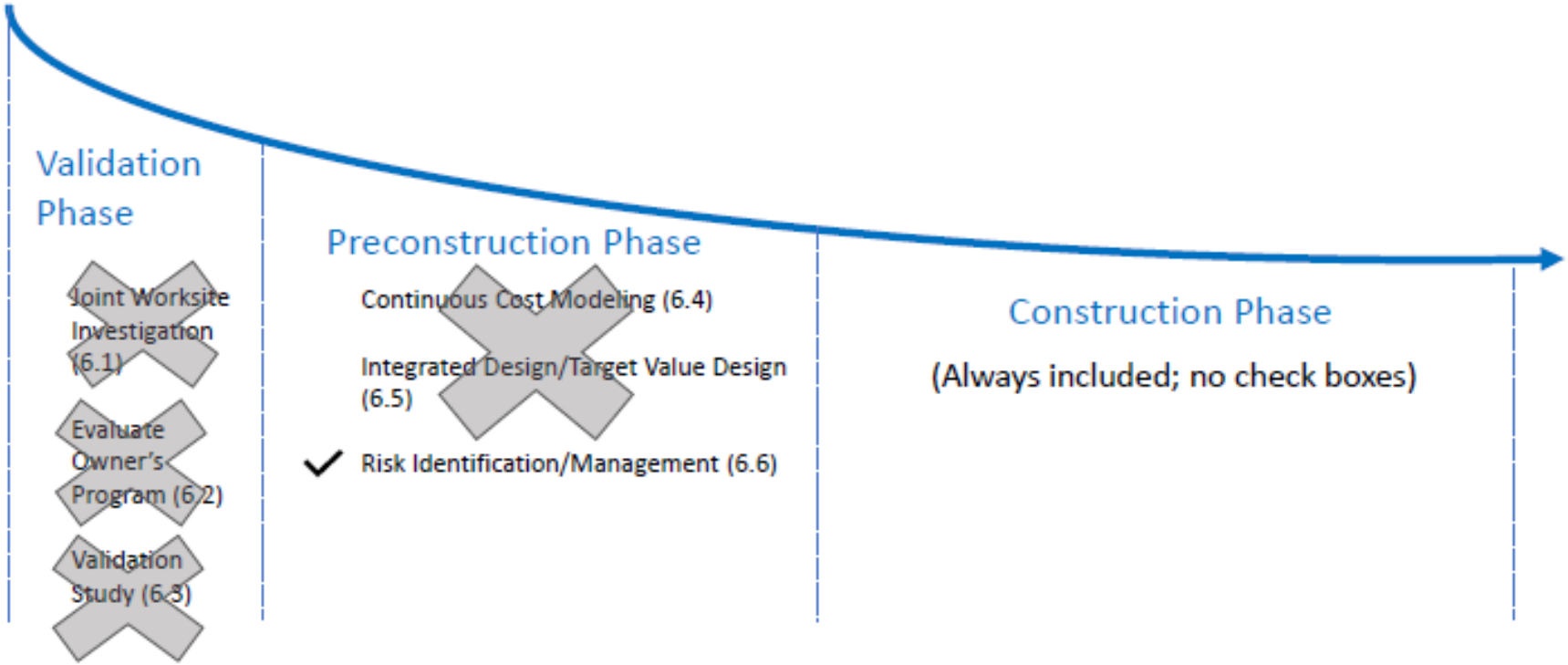
CD305 Check-the-Box Example 1



CD305 Check-the-Box Example 2



CD305 Check-the-Box Example 3



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What about incentives?

- **CD 305** does **not itself provide** for incentive compensation
- **Too much variability** to standardize **incentives**
- **CD305** does provide for **performance improvement program**, which individual projects could use as a platform for **incentive compensation**
- Provide for **incentives** through **amendment** to **owner contracts**

See files entitled “COD 305” and “COD 305-Guidebook”

Lean in Design and Construction

(Lean Project Delivery System)

Overview of lean project delivery system and its components

- **Poor design** and **documentation quality** have been identified as a **major factor** in **reducing** the overall performance and **efficiency** of construction projects.

- The **Lean Project Delivery System™ (LPDS)** provides a **means** of
  1. **Addressing** these shortcomings and
  2. **Improving** the entire design and construction process

  (Ballard 2000; Ballard and Howell 2003a).

Who developed LPDS?

Overview of lean project delivery system and its components

- The **Lean Project Delivery System™ (LPDS)** was developed by **Glenn Ballard in 2000** and subsequently refined.
  - Whereas **traditional industry** practice has **separated** the roles of designers and constructors,

    LPDS sees the activities of these professionals as a **continuum for project management** to **achieve three fundamental goals** (Koskela 2000):

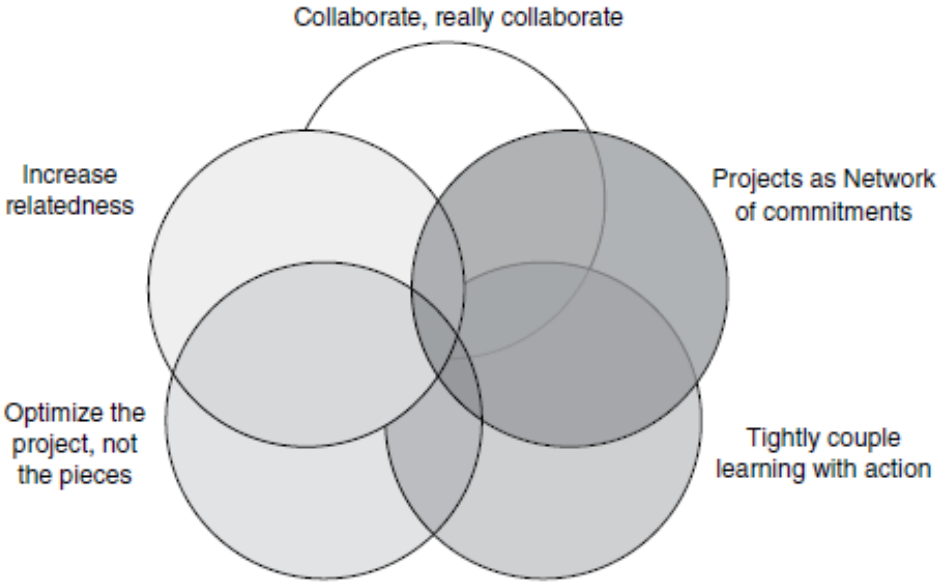
    1. Deliver the product,
    2. Maximize value, and
    3. Minimize waste.

What is the fundamental of LPDS?

Overview of lean project delivery system and its components

- **Fundamental to the LPDS** is the deployment of the **"Five Big Ideas":**
  1. Collaborate, really collaborate,
  2. Increase relatedness among all project participants,
  3. Projects as networks of commitments,
  4. Optimize the project, not the pieces, and
  5. Tightly couple learning with action.

- Set of **organizing concepts** that **support Lean Project Delivery.**



Source: The Five Big Ideas are the intellectual property of Lean Project Consulting

Structure of the lean project delivery system (LPDS)

- The **LPDS** comprises a **number of phases** that juxtaposes them in such a manner as to **apply production system design principles** to enhance **delivery of the entire project** from predesign to completion and use.
  - LPDS is structured to achieve the **Transformation, Flow, and Value (TFV) goals**.
    - ✓ The phases are:
      1. Project definition
      2. Lean design
      3. Lean supply
      4. Lean assembly
      5. Use/completion

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Structure of the lean project delivery system (LPDS)

Comparison of the LPDS with traditional systems

	Lean project characteristics	*Traditional project characteristics*
1	The focus is on the production system	The focus is on transactions and contracts
2	The TFV goal	The T goal
3	Downstream players are involved in upstream decisions	Decisions are made sequentially by specialists,
4	Design coordinates both the product and the process	Process design is done separately after product design
5	Design considers product life-cycle stages	Design does not consider life-cycle stages
6	Actions are taken at the last responsible moment	Actions are taken as soon as possible
7	Supply chain lead times are reduced systematically	Organizations accept market conditions, availability
8	Learning is included in projects, firms and supply chain management	Learning occurs sporadically
9	Stakeholder interests are aligned	Stakeholder interests are not aligned
10	Buffers are sized and located to absorb system volatility	Participants protect their interests with large inventories.

Source: Adapted from Table 14.2 of Koskela *et al.* 2002

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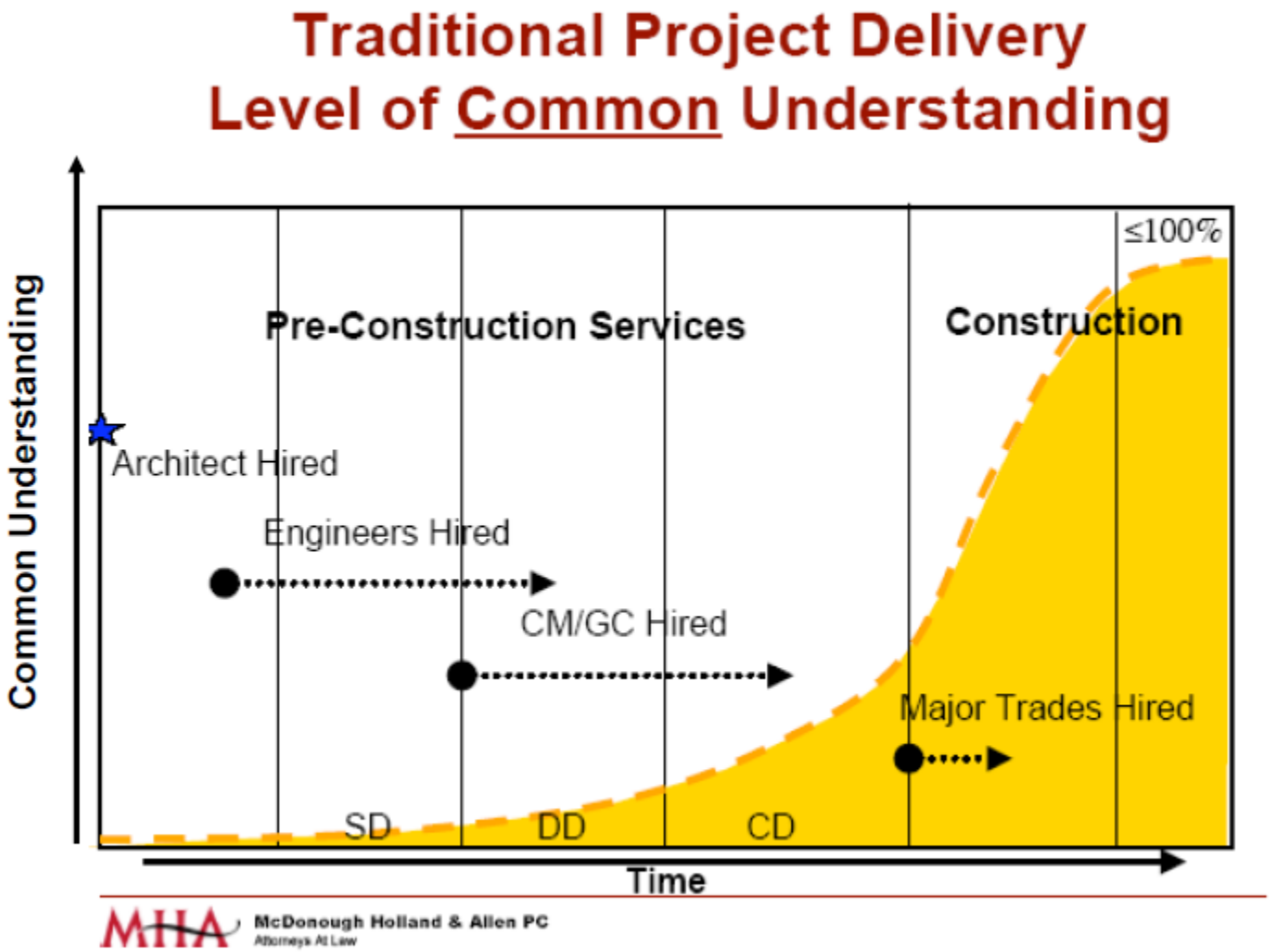
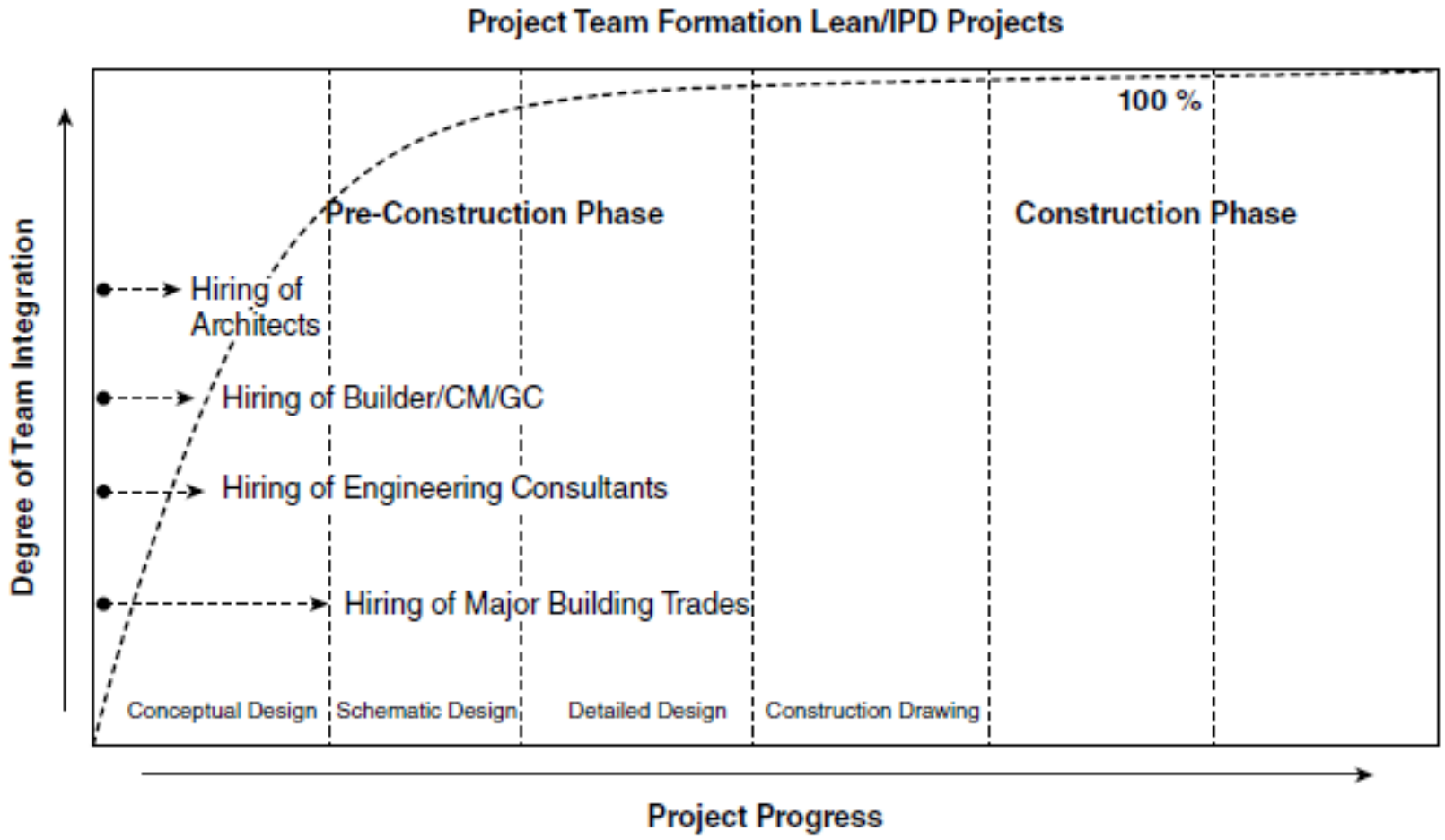
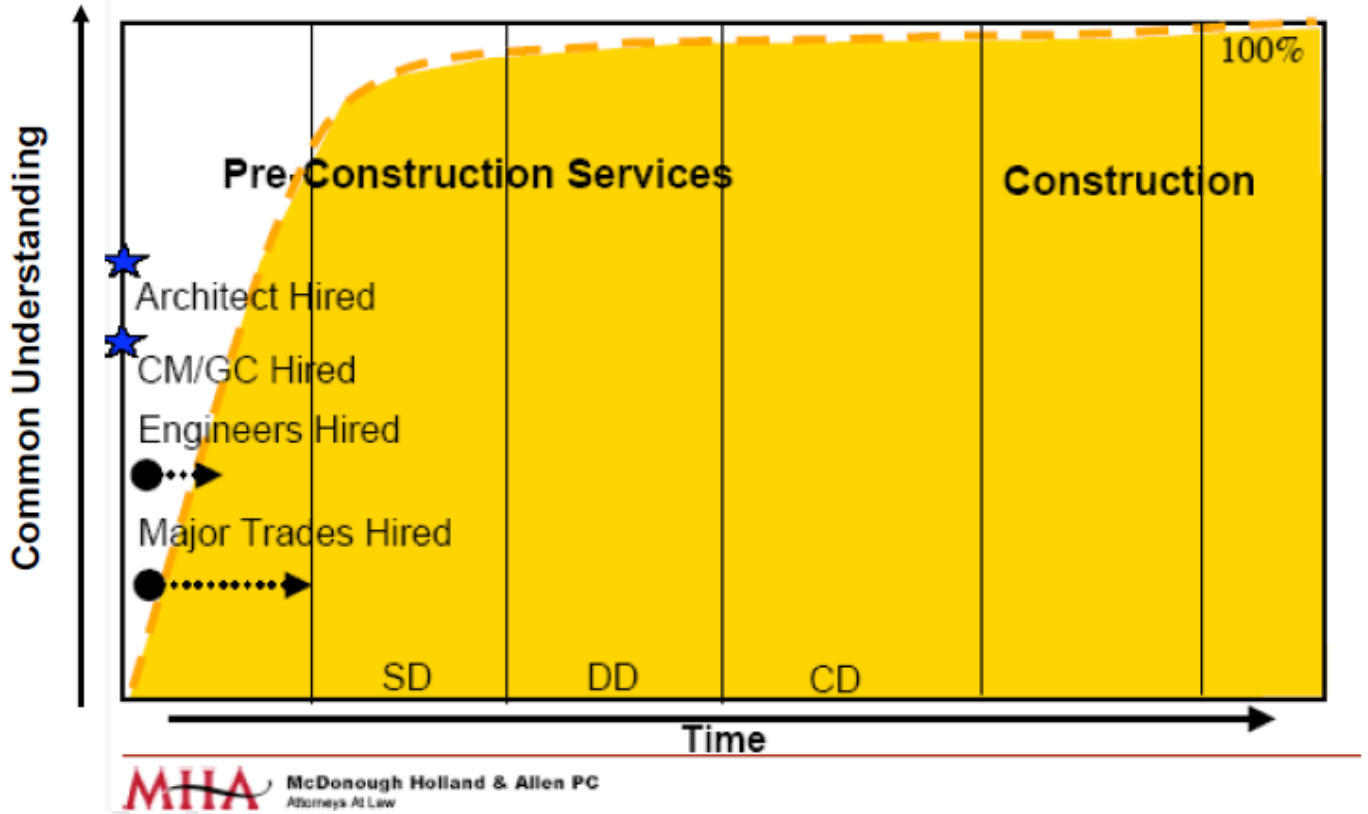
Traditional project delivery



Lean project delivery and team formation



Lean team formation



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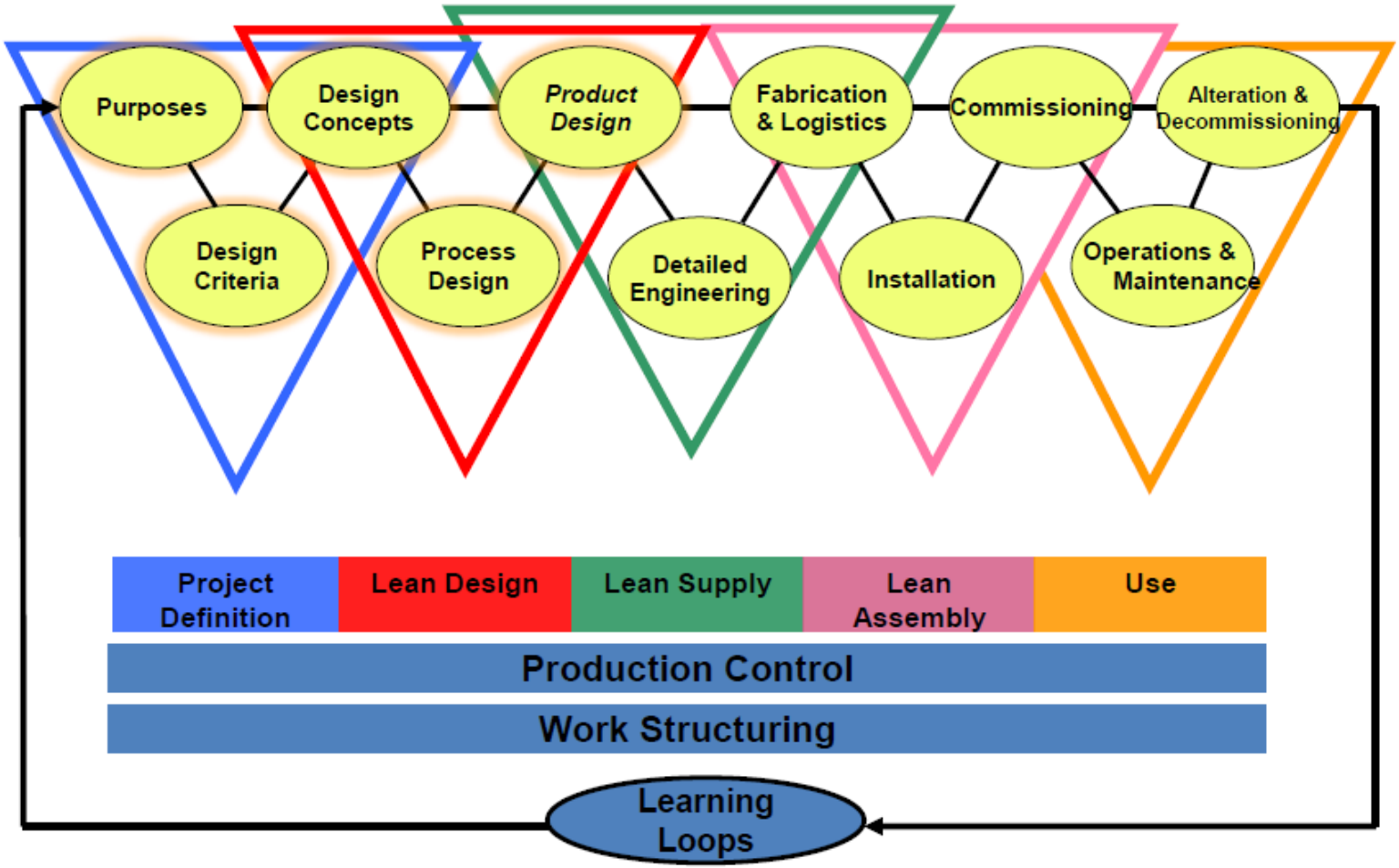
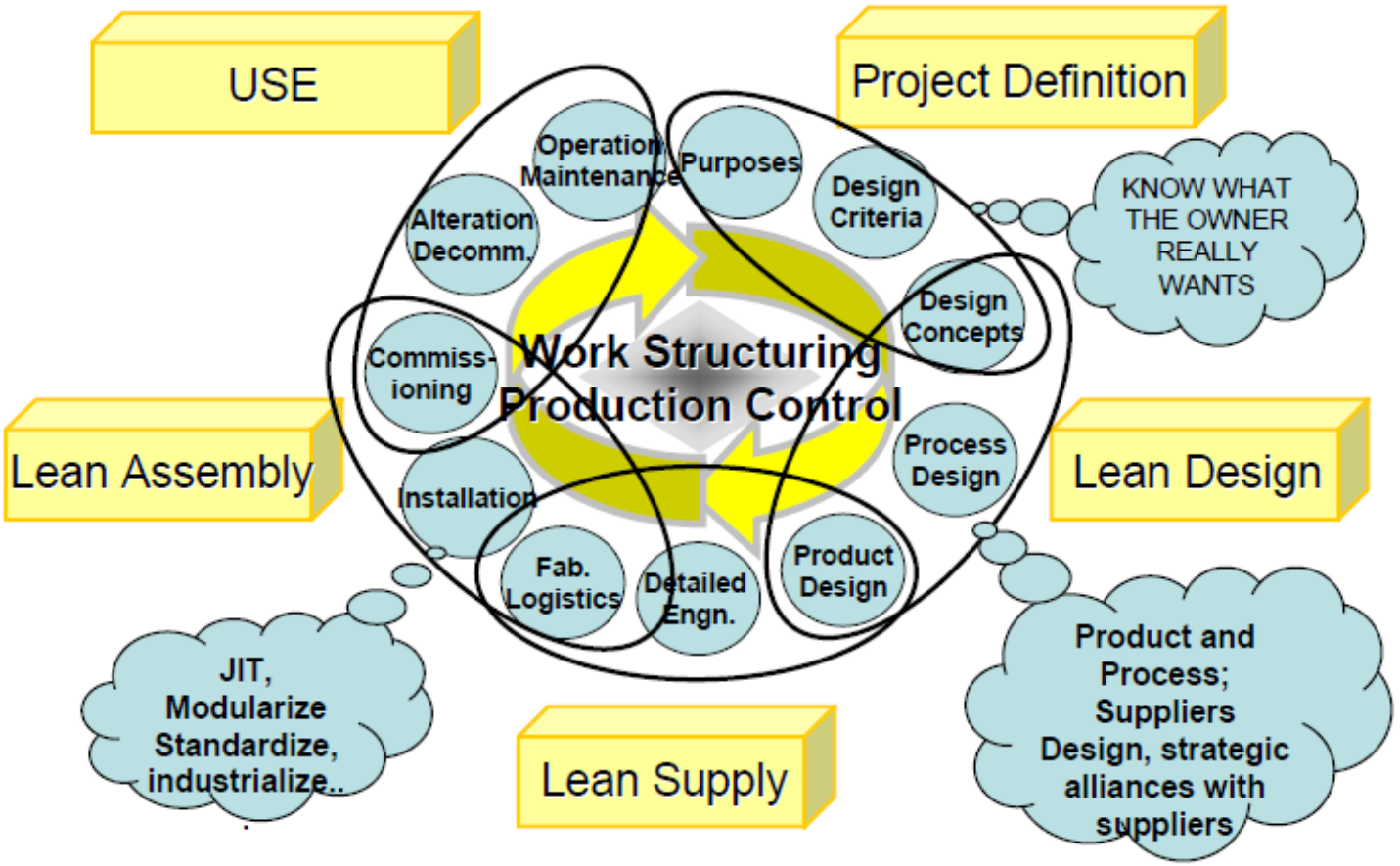
Structure of the lean project delivery system (LPDS)

- Source: Adopted from Ballard and Howell, Building Research and Information, 2003



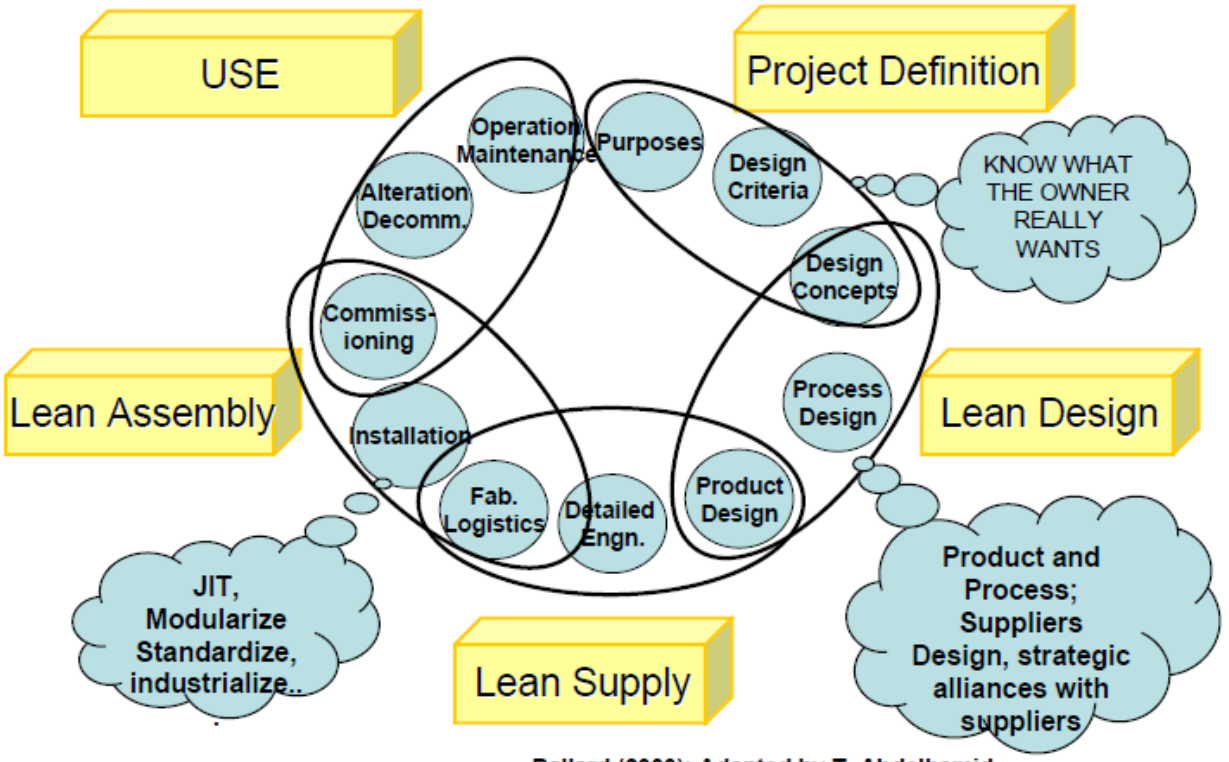
Structure of the lean project delivery system (LPDS)

Ballard (2000); Adapted by T. Abdelhamid



Structure of the lean project delivery system (LPDS)

We will discuss the components: Project Definition, Lean Design, Lean supply, Lean Assembly, and Use.



Ballard (2000); Adapted by T. Abdelhamid

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Project definition phase

- **Project definition** typically involves
  - Developing **project alternatives** at a conceptual level,
  - Analyzing **project risks** and the economic payoff, and
  - Developing a **financial plan**.

A decision is **made to proceed** if the owner considers conditions to be **favorable**;

a **plan is developed** for the organization and control of the project.

What is the difference between LPDS and traditional project definition?

Project definition phase

- **Traditionally**,

  project definition has been **established by the architect** (or engineer for non-building projects) **working alone** with the owner.

- In **lean project definition**,

  representatives of every stage in the life cycle of a facility are **involved**, including members of the production team that will design and build it.

  (Koskela et al. 2002).

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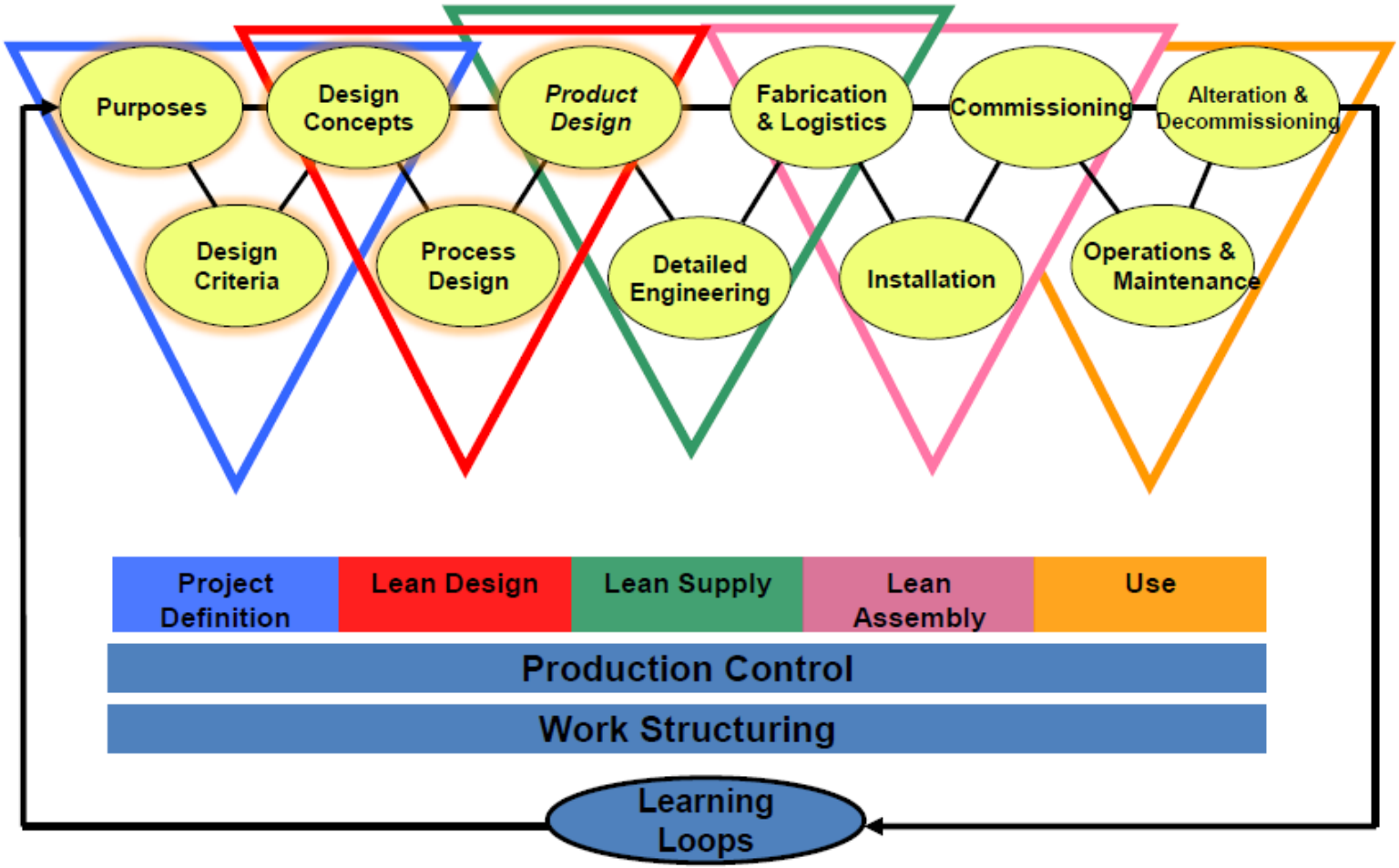
Structure of the lean project delivery system (LPDS)

- Source: Adopted from Ballard and Howell, Building Research and Information, 2003



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Lean design phase

- The lean design phase comprises:
  1. Conceptual design,
  2. Process design, and
  3. Product design.

*It builds on the **output** from the **project definition phase**,*

*but with a **deviation from traditional design** practice.*

What is the difference between lean design and traditional design?

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Lean design phase

- In **D-B-B projects**,

  architect provides preliminary drawings to the **other disciplines** at various stages in the design process and

  engineers apply their respective design parameters to the architectural framework.

  *Although this **work may benefit** from the **cost efficiencies of 3-D CAD** (or more advanced versions),*

  *process is **not generally interactive!***

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Lean design phase

- In **design-build (DB) projects**,

  a **single entity contracts** with the owner/client;

  there is an **interplay between designers and builders**, but

  1. **Owner/client** is **not generally included** in this process
  2. **Owner/client** does **not have a fiduciary relationship** with the designer of record.

Lean design phase

- In **CM@ Risk** the **builder** is brought on board

  with the **primary motive of becoming familiar** with the project and its environment;

  the **risk of unforeseen** conditions is reduced.

Lean design phase

- With **lean projects**,

  design is done with **both** the **construction product** and the **process** in mind.

  - **Constructability reviews** and **value engineering** are **not seen as tools** to apply in a problem-solving mode,

    but rather, are **continually integrated with decision-making** in the design process.

    - ✓ This is **accomplished with cross-functional teams** that include *architects, engineers, contractors, subcontractors, and various specialists*

      who **collaborate with each other and interactively** make decisions that are optimal for the product and the process.

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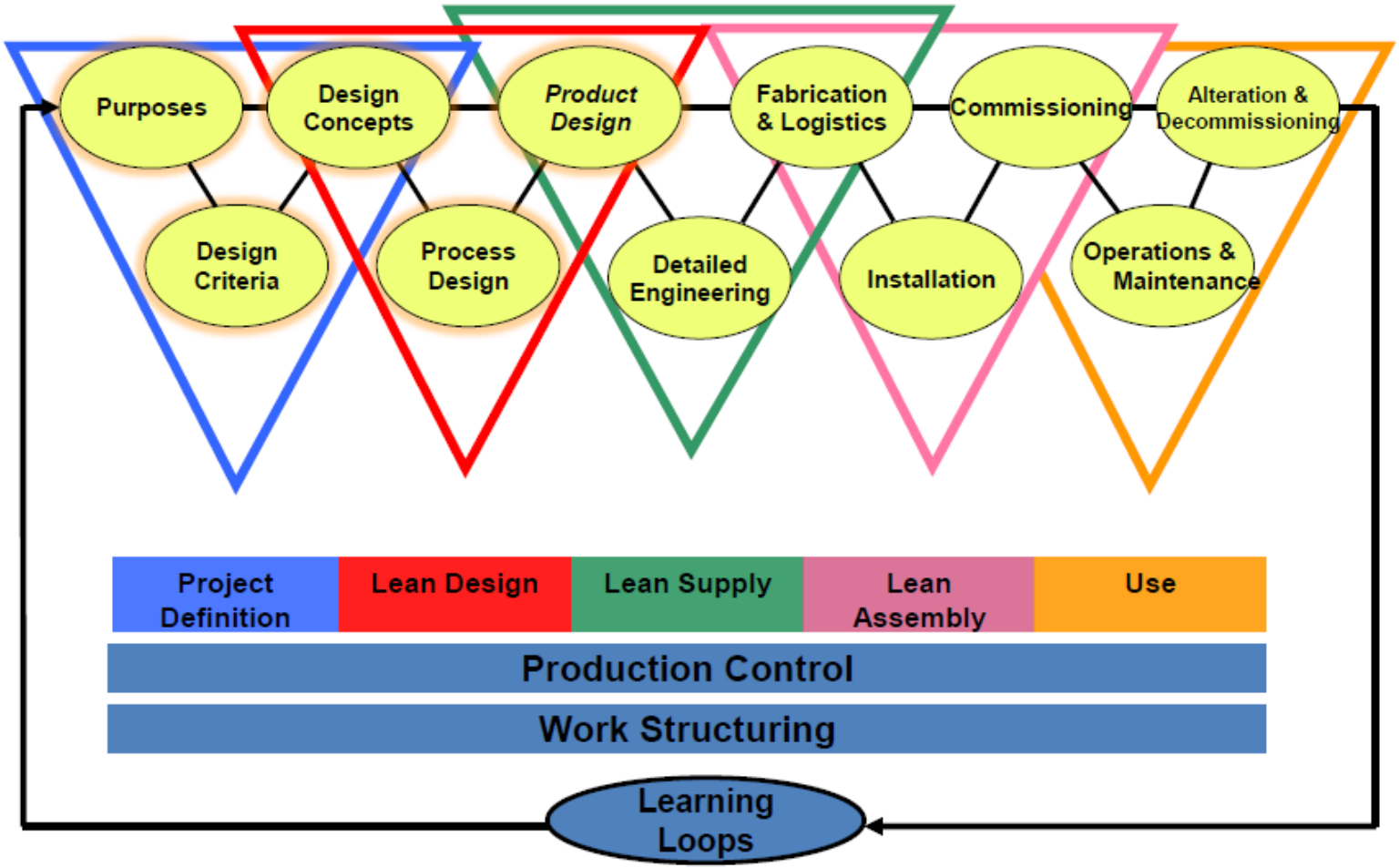
Structure of the lean project delivery system (LPDS)

- Source: Adopted from Ballard and Howell, Building Research and Information, 2003



Lean supply phase

- The third triad, **lean supply**,

  requires **up-front product** and **process design** to define

  1. What is needed and
  2. When it should be delivered.

- **Lean supply** also includes **reducing the lead time** for project information requirements.

- It involves the use of **supply chains** to **optimize the delivery** of materials, components and major building sub-assemblies

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Lean supply phase

- **Lean supply** to Do's
  - **Early applications of JIT** in construction should focus on **reducing on-site waste** and **operations variation** by:
    1. Selecting location and size of **material** - **inventory buffers** (Use Computer Simulation)
    2. Performing **risk analysis** - **schedule buffers** (Use Computer Simulation and Last Planner)
    3. Creating alternative work for **crews** - **capacity buffers** (Use Last Planner)
  - **Shift** detailed engineering to fabricators and installers.
  - **Structure** logistics so materials can be **pulled** to site in **small batches**.

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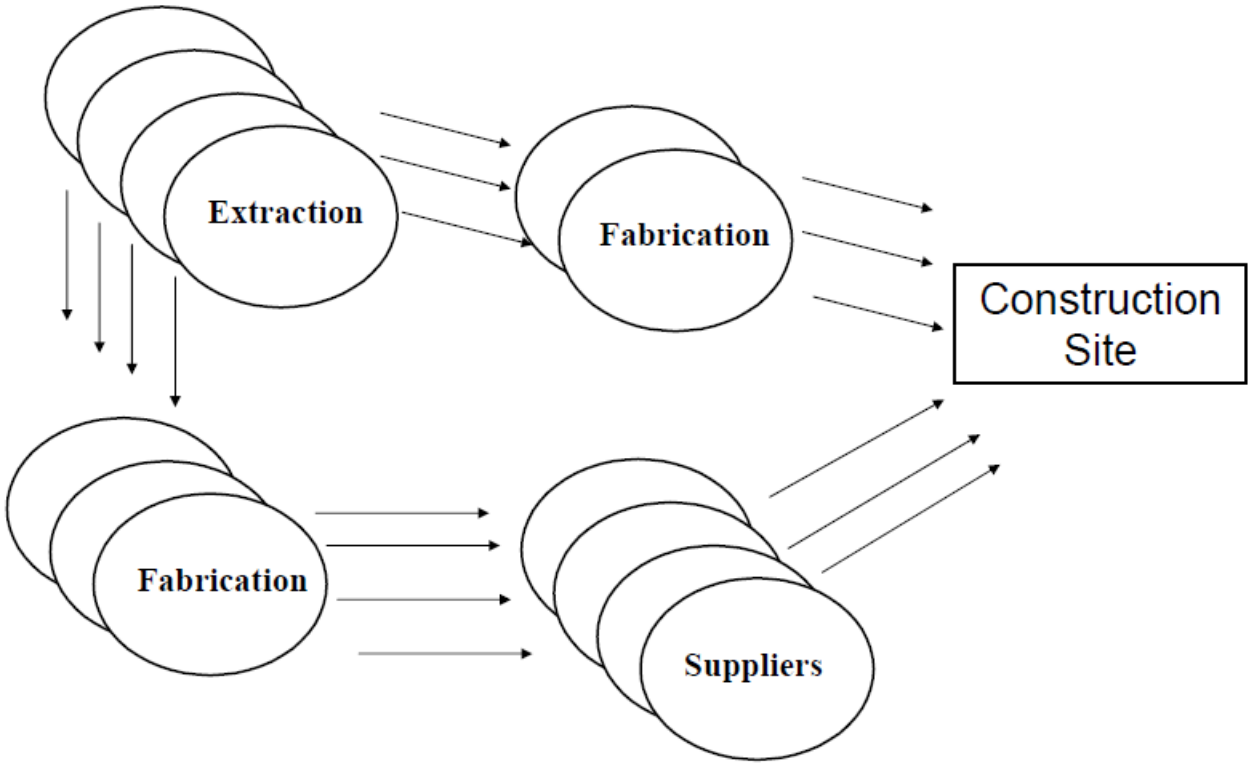
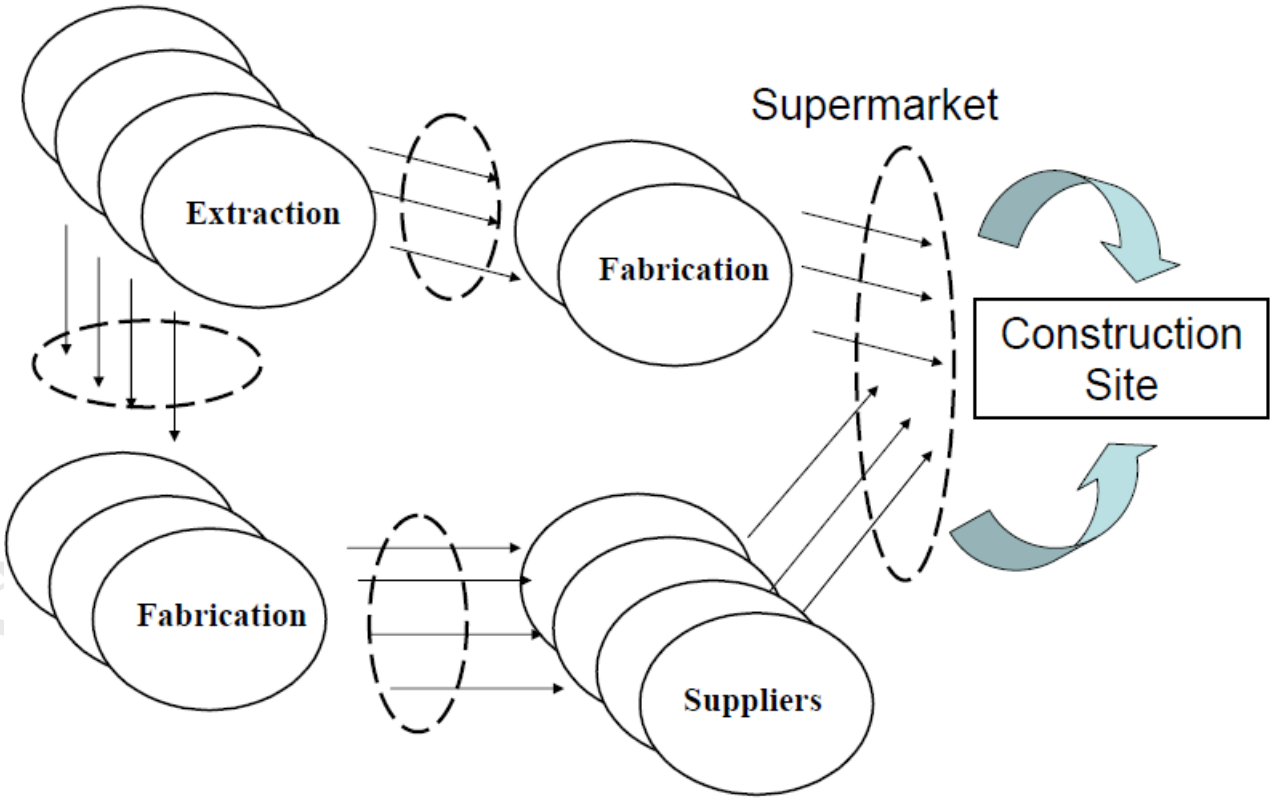
Lean supply phase

- Map the supply chain



Lean supply phase

- Map the supply chain



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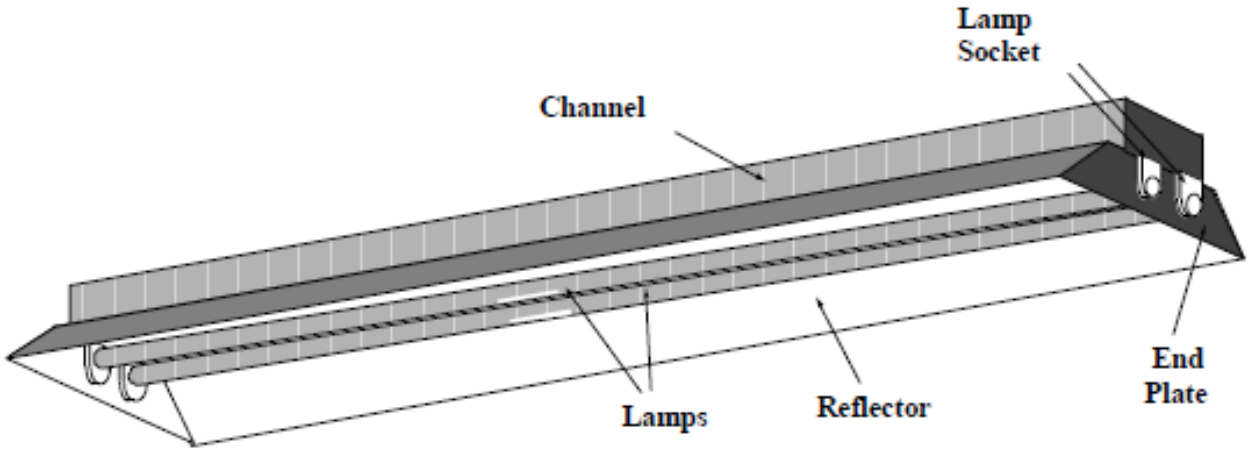
Lean supply phase

- At some point move to complete off-site assembly



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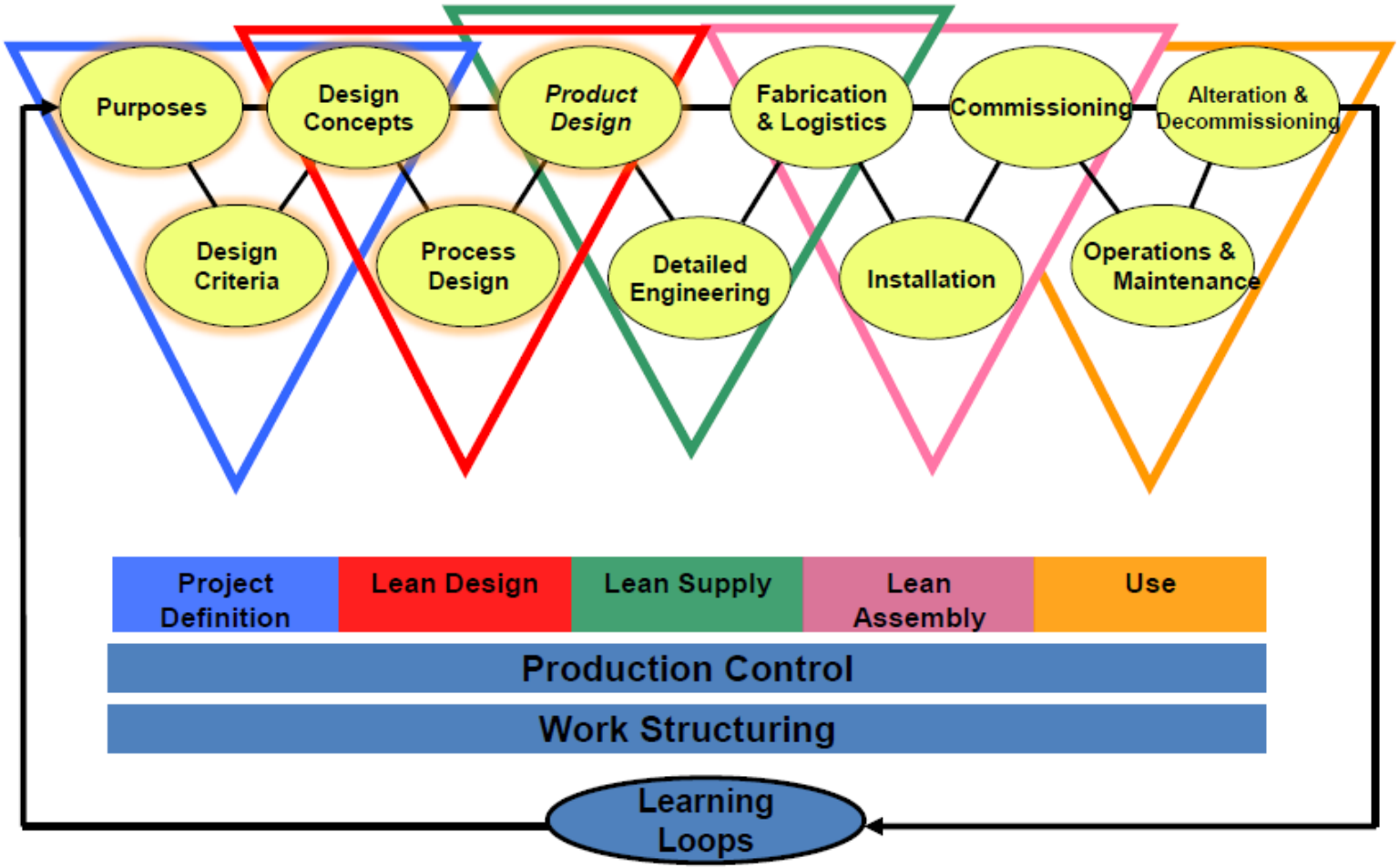
Structure of the lean project delivery system (LPDS)

- Source: Adopted from Ballard and Howell, Building Research and Information, 2003



Lean assembly phase

- **Lean assembly** is practiced in the **actual construction** of a project, putting
  1. Materials,
  2. Systems, and
  3. Components

  in place to create a completed facility.

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Lean assembly phase

- **Lean assembly** to Do's
  - **Standardize** and **industrialize**
    - ✓ Standardize the ingredients, not the recipe
  - Use **5S**
  - **Simplify site installation** to final assembly and test
  - " **Flow** where you **can**, **Pull** where you **must**"
    - ✓ Strive for **one-touch material handling**
    - ✓ Pull from **off-site suppliers**

What is the difference between prefabrication and field work?

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Lean assembly phase

- **Prefabrication** is a **production technique** that can **enable a contractor** to **operate in a lean manner** by **reducing** the many **nonvalue-added steps** that are required in field fabrication.

Whereas

- **Field work** contends with **uncertain conditions** such as weather, and limitations in the availability of skilled labor, material, and equipment, shop fabrication benefits from a **predictable, controlled environment**.

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Lean assembly phase

- The **commissioning process** **overlaps** in the last two triangles;

  it provides **quality assurance** before a facility is completed and accepted by the owner.

  - It **improves** the **probability** that the facility will meet the **owner's project requirements (OPR)** and

    performs as expected, to provide user satisfaction.

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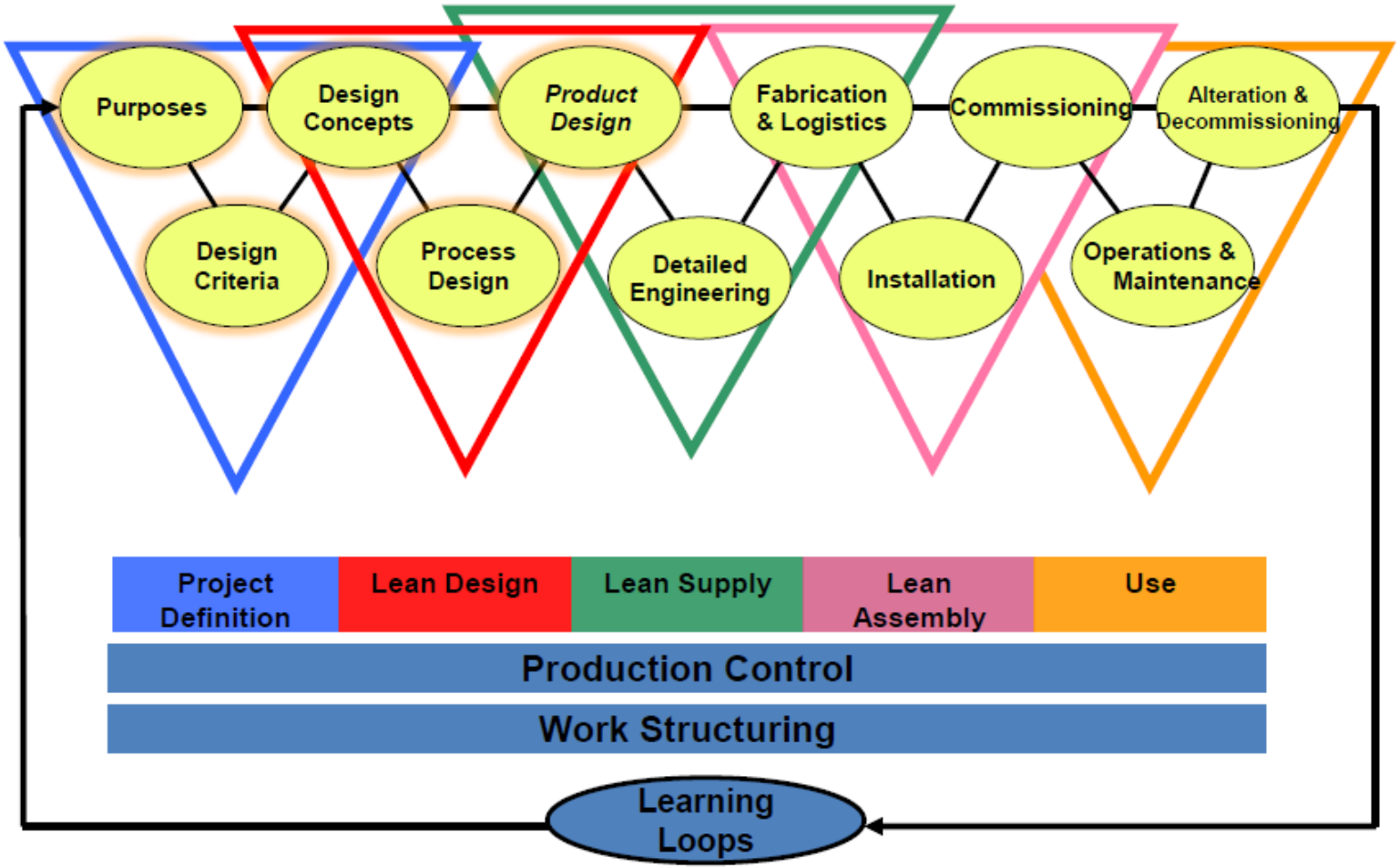
Structure of the lean project delivery system (LPDS)

- Source: Adopted from Ballard and Howell, Building Research and Information, 2003



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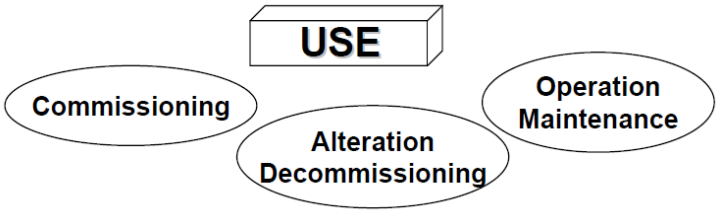
Lean use phase

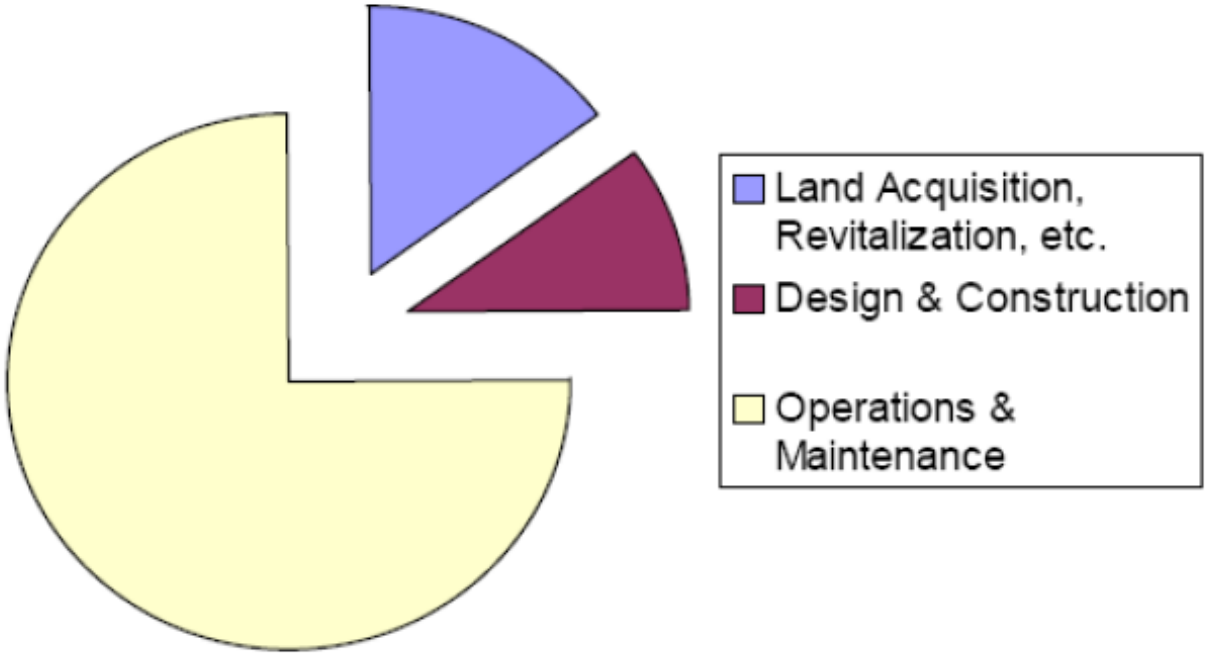
- The fifth triad, **"Use,"** refers to a **completed facility**.



- Following **successful commissioning**, **facility** should undergo a **protracted operations** and **maintenance phase** as it is used.

- **"Alteration and Decommissioning"** refer to a **future activity** when the facility may be
  1. Repaired,
  2. Renovated, or
  3. Taken out of service.

Lean use phase



U.S. Federal Facilities Council. (2001). "Sustainable Federal Facilities: a guide to integrating value engineering, life cycle costing, and sustainable development." Federal Facilities Technical Report No. 142. National Academy Press. Washington, DC.

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Lean use phase

"Operating expenses represent over 95 percent of building life cycle costs, yet operations and maintenance personnel are usually the last to be consulted during programming and design" (NIBS 2003)

- When **1% of upfront cost** are spent, 70% of the life cycle cost of a bldg. may have been committed (Romm 1994)

National Institute of Building Sciences. (2003). "Annual Report to the President of the United States."

Romm, J. (1994). Lean and Clean Management. Kodansha America Inc., New York.

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Structure of the lean project delivery system (LPDS)

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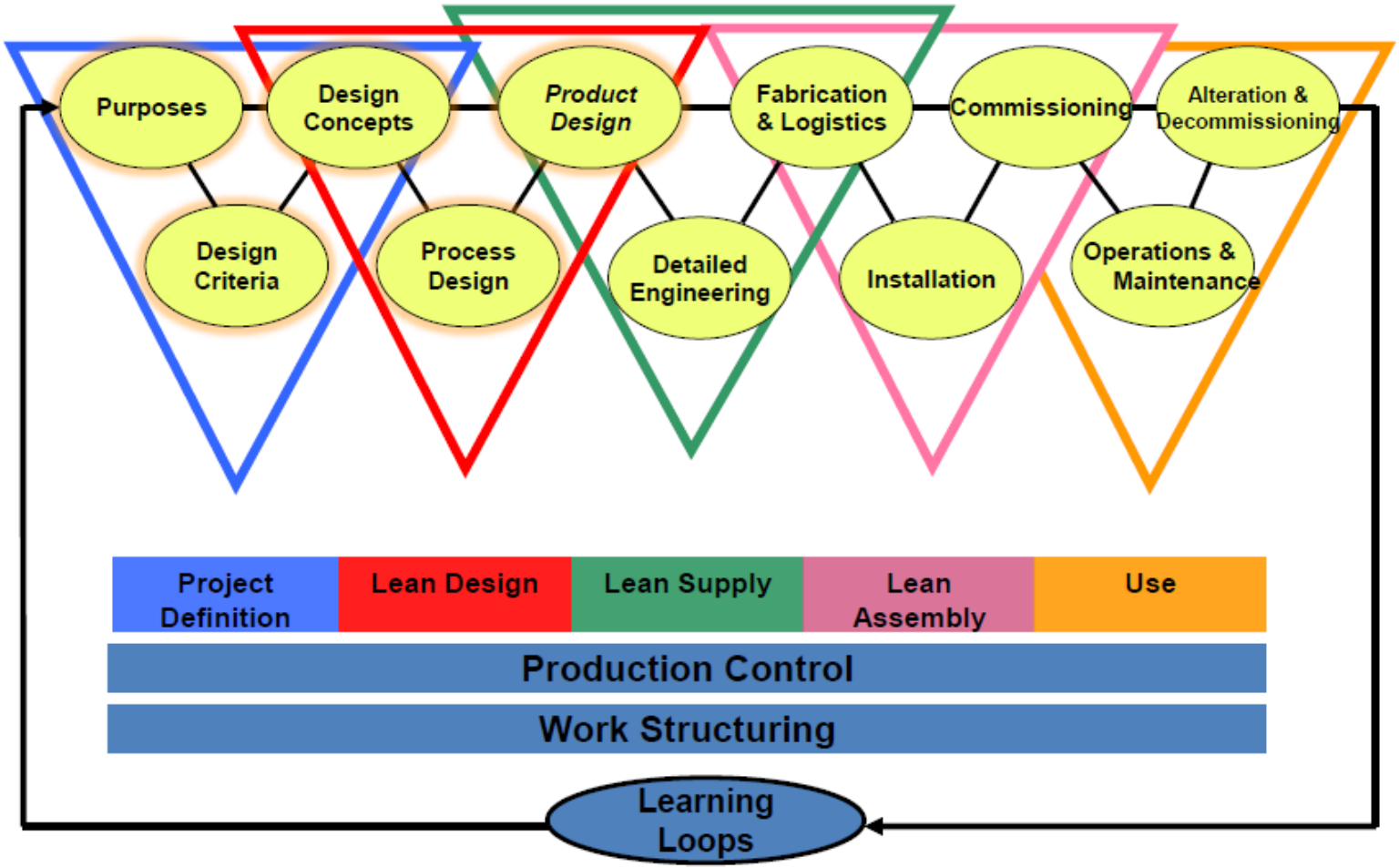

Learning loops

- **"Learning loops"**
  1. Span **all the activities** in the **five triads**, and
  2. Refer to the application of **root cause analysis** to the **Last Planner® System** on a **weekly basis** to review **Percent Plan Complete (PPC) values** and **commitment reliability**.

- **Learning** is also accomplished through **ongoing retrospectives** as well as the process of **post occupancy evaluation (POE)**.
  - In POE reviews a facility is **surveyed after occupancy/acceptance** to **review the consequences** of **decisions** made during the execution of the project.

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Production control

- **Production control** is represented as a **horizontal bar** that extends from the very inception of the project to its conclusion.

- **Lean production control** is achieved through
  1. **Systematic process** for making **assignments ready** to be performed,
  2. **Combined with explicit commitments by people** at the production level to what work will be released to **their customer processes** in the next plan period.
     - ❖ This is typically **"one week"**
     - ❖ It consists of **work flow control** and **production unit control**.

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Work structuring

- **Work structuring** and **production control** are used **throughout a project** to manage production.

- The term **work structuring** was developed by the **Lean Construction Institute** (Ballard 1999) to describe **construction-related process design**.

- It is a **process** of **subdividing work** so that
  1. **Pieces are different** from **one production unit** to the next to promote flow and throughput, and
  2. **Have work organized** and **executed** to benefit the **project as a whole**.
     - Work structuring is used as a part of the **Last Planner System (LPS).**

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Work structuring

Work Structuring - Designing the production system to determine who does what, when, where and how, usually by breaking work into pieces, where pieces will likely be different from one production unit to the next. The purpose of work structuring is to promote flow and optimize system throughput by focusing on handoffs and opportunities for moving smaller batches of work though the production system.

Lean Project Delivery System

(Project Definition and Design Phases)

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