The Last Planner System of
Production Planning & Control

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Trondheim, Norway
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Outline

• Peculiarities of ETO projects
• Characteristics of construction and shipbuilding
• Last Planner system
• Mini-cases
  – Construction
  – Oil field development
Peculiarities of ETO Projects

Its customers are individuals, not types.

One consequence is the need to understand exactly what this customer wants, what constraints define the design space in which to search, and what preferences should be used to select from design alternatives within the constrained space.

A second consequence is the customer’s active role during the production (designing and making) process, ranging at minimum from approval of design as it develops through stages; beyond that to direct participation in generation, evaluation and selection from design alternatives when projects are more complex and uncertain; and to evaluation and acceptance of the constructed asset.
Target Value Delivery

• A method of project delivery for ETO Projects adapted from manufacturing’s product development

• Assesses project viability; i.e., the probability of aligning ends, constraints, and means

• If viable, targets are set and the project is proactively steered to those targets

• Supported by aligning commercial interests of project team members and integrating them organizationally
Target Value Delivery

TARGET VALUE DESIGN CLUSTER GROUP WEEKLY UPDATE

Construction Estimate Total - Gap Analysis to Target Cost for Construction

- Clay Model Freeze
- End of DD's 5/12/08

Target Cost for Construction (normalized for changes in scope)

Added Value TC (Normalized)

TC for Construction (Normalized)

Variance to Target Cost

Added Value TC (Normalized)

($6,918,727)
Sutter Health

- 22 ‘lean’ projects delivered since 2005
- No projects over budget or schedule
- No sacrifice of scope or quality
- Average final cost: 3.4% below budget and 15% under market
Characteristics of Construction

1. When construction’s customers are individuals, construction is a type of ETO manufacturing.
2. Construction’s products are rooted in the earth.
3. Construction is a type of fixed position manufacturing.
4. Construction is highly specialized and involves numerous specialists in designing and making its products.
5. Construction’s projects are temporary organizations; typically with different participating companies from one project to the next.
Characteristics of Shipbuilding

1. When shipbuilding’s customers are individuals, customers are involved in the production process.
2. Shipbuilding’s *products are mobile*.
3. Shipbuilding is a type of fixed position manufacturing.
4. Shipbuilding is highly specialized and involves numerous specialists in designing and making its products.
5. Shipbuilding projects are temporary organizations, but *usually with the same participant companies from project to project*. 
Functions of Project Planning & Control

• Prior to Execution:
  – Risk Evaluation & Mitigation
  – Resource Acquisition/Allocation
  – Execution Strategies
  – Master Scheduling

• During Execution
  – Detailed Scheduling
  – Matching CAN with SHOULD
  – Matching DID with WILL
  – Learning from plan failures
Execution Strategy

• In what chunks will work be assigned to specialist production units (PUs)?
• How will work chunks be sequenced through various PUs?
• In what chunks will work be released from one PU to the next?
• Where will decoupling buffers be needed and how should they be sized?
• When will the different chunks of work be done?

“Chunk” is preferred to “batch” because the latter is commonly used to indicate multiples of an identical unit.
The Last Planner system of project planning & control

- Starting Points
- Functions
- Principles
- Metrics
Starting Points for Last Planner

• Stabilizing work processes is a prerequisite for continuous improvement.

• All plans are forecasts and all forecasts are wrong. The further into the future we try to forecast, the more wrong we will be. The greater the level of detail we try to forecast, the more wrong we will be.

• The norm in construction is highly detailed master schedules designed to limit discretion.

• Research on construction projects in the early 1990’s found that only half the tasks on weekly work plans were completed.
# Construction Weekly Work Plan

## 1 WEEK PLAN

<table>
<thead>
<tr>
<th>PROJECT: Pilot</th>
<th>ACTIVITY</th>
<th>Est</th>
<th>Act</th>
<th>Mon</th>
<th>Tu</th>
<th>Wed</th>
<th>Thurs</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
<th>PPC</th>
<th>REASON FOR VARIANCES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gas/F.O. hangers O/H &quot;K&quot; (48 hangers)</td>
<td>XXXX</td>
<td>XXXX</td>
<td></td>
<td></td>
<td>XXXX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No</td>
<td>Owner stopped work (changing elevations)</td>
</tr>
<tr>
<td></td>
<td>Gas/F.O. risers to O/H &quot;K&quot; (3 risers)</td>
<td></td>
<td></td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No</td>
<td>Same as above-worked on backlog &amp; boiler blowdown</td>
</tr>
<tr>
<td></td>
<td>36&quot; cond water &quot;K&quot; 42' 2-45 deg 1-90 deg</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chiller risers (2 chillers wk.)</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No</td>
<td>Matl from shop rcvd late Thurs. Grooved couplings shipped late.</td>
</tr>
<tr>
<td></td>
<td>Hang H/W O/H &quot;J&quot; (240'-14&quot;)</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooling Tower 10' tie-ins (steel) (2 towers per day)</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weld out CHW pump headers &quot;J&quot; mezz. (18)</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weld out cooling towers (12 towers)</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No</td>
<td>Eye injury. Lost 2 days welding time</td>
</tr>
<tr>
<td></td>
<td>F.R.P. tie-in to E.T. (9 towers) 50%</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

## WORKABLE BACKLOG

- Boiler blowdown-gas vents
- Rupture disks

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Functions of Project Planning & Control

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  – Matching CAN with SHOULD
  – **Matching DID with WILL**
  – Learning from plan failures

Last Planner
Matching DID with WILL

Rule: Include in daily work plans only tasks that are:

• Defined to convey what performers need to understand
• Sound
• Sequenced
• Sized to the capacity of performers
Impact of Last Planner on Formiconi’s Productivity

From “PARC: A Case Study” by Ballard, et al., IGLC1996
Impact of PPC on Productivity

\[ \text{Prod} = 0.530 + 1.095 \times \text{PPC} \]

<table>
<thead>
<tr>
<th>PPC Factor</th>
<th>Performance</th>
</tr>
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<tbody>
<tr>
<td>50%</td>
<td>.96</td>
</tr>
<tr>
<td>60%</td>
<td>.84</td>
</tr>
<tr>
<td>70%</td>
<td>.77</td>
</tr>
<tr>
<td>80%</td>
<td>.71</td>
</tr>
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</table>
# Matching CAN with SHOULD

## Last Planner-Lookahead

### Constraints Analysis

<table>
<thead>
<tr>
<th>Activity ID</th>
<th>Activity Description</th>
<th>Planned Start Date</th>
<th>Responsible Party</th>
<th>Contract / Change Orders</th>
<th>Design</th>
<th>Materials</th>
<th>Labor</th>
<th>Equipment</th>
<th>Prereq Work</th>
<th>Space</th>
<th>Sound?</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Rebar erection for 1st floor columns 5,6,7,8</td>
<td>1/15/2007</td>
<td>Rebar-sub</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Electrical inserts/rough-in for 1st floor wall w1</td>
<td>1/15/2007</td>
<td>Electrical Sub</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Formwork for 1st side for 1st floor wall w1</td>
<td>1/15/2007</td>
<td>GC</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Mechanical penetrations in 1st floor wall w1</td>
<td>1/15/2007</td>
<td>Mechanical</td>
<td>X</td>
<td>Shop Dwg approval</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Strip formwork for columns 1,2,3,4</td>
<td>1/15/2007</td>
<td>GC</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Electrical inserts/rough-in for columns 5,6,7,8</td>
<td>1/16/2007</td>
<td>Electrical Sub</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>GI couplers</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Formwork for 1st floor columns 5,6,7,8</td>
<td>1/17/2007</td>
<td>GC</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Inspection X</td>
</tr>
<tr>
<td>18</td>
<td>Formwork for 2nd side for 1st floor wall w1</td>
<td>1/16/2007</td>
<td>GC</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X Inspection X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Pull Planning: Detailed Planning
Functions of Project Planning & Control

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  - Matching DID with WILL
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Last Planner
The Last Planner® System of Production Control

**SHOULD**
- **Master Scheduling**
  - Set milestones and phase durations & overlaps
- **Phase Scheduling (pull)**
  - Specify handoffs & conditions of satisfaction between processes within phases

**CAN**
- **Lookahead Planning**
  - Identify & remove constraints
  - Breakdown tasks from processes into operations
  - Design operations

**WILL**
- **Weekly Work Planning**
  - Make reliable promises

**DID**
- **Learning**
  - Measure PPC, TMR & TA
  - Use 5 Whys to identify actionable causes
  - Act to prevent reoccurrence

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Last Planner Principles

1. Plan in greater detail as you get closer to doing the work – project/phases/processes/operations.

2. Produce plans collaboratively with those who will do the work.

3. Reveal and remove constraints on planned tasks as a team. Assume that constraints exist until you ‘know’ they don’t.

4. Make reliable promises.

5. When you don’t keep your promises, find root causes and preventions—learn from those breakdowns.

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Daily & Weekly Workflow Planning & Coordination
Measuring & Improving Performance – PPC Trend
Lookahead Metrics

- Tasks Anticipated (TA): What percentage of tasks in a plan for a day or week were anticipated in an earlier plan for that day or week?

- Tasks Made Ready (TMR): What percentage of tasks in an earlier plan for a day or week were included in a later plan for that day or week?
How Oil Field Development is Different

1. Oil field development’s customers are types, not individuals.
2. Oil field development can be understood as a multi-project processing system in which each well is a project, and each well has its own individual design and its specific route through the ‘workstations’ that constitute the system.
3. Oil field development is extractive, hence is location specific and involves processing but not assembly.
4. Oil field development is highly specialized and involves numerous specialists in designing and making its products, but typically with the same participating companies from well to well.
Managing the Entire Development Process

• Changes
  – Reduced batch sizes: financial packages (projects) & fracturing were reduced from 52 wells to 8
  – Last Planner
  – Well Mix: to approximate 2.3 wells/day takt time
  – Decoupling (Inventory) Buffer of drilled wells
  – Capacity Buffer (reduced regularly scheduled hours)
  – Substituted driller’s estimate of completion for drilling engineer’s after approx. 25% drilling duration
  – Learning from breakdowns through root cause analysis to reduce variation

• How did it work?
  – Release rate: PPC increased to 80-85%
  – WIP: reduced with smaller batch sizes
  – Cycle Time: reduced by 32% from spud to pipeline
  – Cost: reduced by 25%
Cycle Time for Wells online 1/1/2001 - 03/29/02

Implementation of Production Control has significantly reduced cycle time.
Thank you for your attention