Combating Uncertainty in the Workflow of Systems Engineering Projects

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Background

• For the past twenty years the construction industry has been examining its processes in the context of the changes and improvements seen in manufacturing production.
  – International Group for Lean Construction (IGLC)
  – Lean Construction Institute (LCI)
  – Glen Ballard, Gregory Howell, Lauri Koskela

• They developed a production planning and management method, known as the **Last Planner**, to address problems of high work flow variability and low productivity in the building construction lifecycle.

• This presentation examines the key principles of the Last Planner and looks for lessons that can be applied to Systems Engineering to reduce project variability.
Typical Construction Site

How does this apply to Systems Engineering?
What is the Last Planner?

• “The Last Planner is an active production control system that actively causes events to conform to plan rather than responding to after-the-fact detection of variance to plan.”

• Ballard’s choice of “Last Planner” as the title for his methodology reflects the hierarchy of planners in a complex system:

The person or group that creates immediate assignments is called the “Last Planner.”
Should-Can-Will

• Hierarchical levels of planning for construction production:
  – Initial Planning (Master Planning)
    • Should be done
  – Lookahead Planning (Look Ahead Window)
    • Can be done
  – Commitment Planning (Daily-Weekly Work Plan)
    • Will be done
Should-Can-Will

Hierarchical levels of planning for construction production:

- Initial Planning (Master Planning)
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  - Will be done

We have problems when we ignore the gap!
Should-Can-Will

• It's not just a question of more detail in the master schedule:
  – Master schedules do not include sufficient detail to reflect the true and relevant interactions and dependencies between production units.
  – Many key interactions not reflected in the plans at all.
  – There are limits to the detail that can be included and maintained in a master schedule.
The Last Planner System of Production Control
The Last Planner System of Production Control

• Five Principles of the Last Planner:
  
  – **Principle #1** - Work assignments should be sound regarding their prerequisites (shielding).
  
  – **Principle #2** - The realization of assignments is measured and monitored (PPC).
  
  – **Principle #3** - Causes for non-realization are investigated and those causes are removed (work flow).
  
  – **Principle #4** - Maintain a buffer of tasks which are sound for each crew (pull versus push).
  
  – **Principle #5** - The prerequisites of upcoming assignments are actively made ready (work flow).
The Last Planner

• The Last Planner implements these principles with a set of rules, procedures and tools directed at:
  – Work Flow Control
    • Improving work flow between production teams/units:
  – Production Control
    • Improving work flow within the “production teams/units.”

Variability = Uncertainty
Lookahead Process

Master Schedule

Tasks scheduled to start or stop in the look ahead window.

Week 5-4
Assignments that can be made ready

Week 3-2
Assignments that are ready

Week 1-0
Tasks translated into assignments

Feedback from teams on task completion and reasons for non-completion

Actions to Program Management and SEIT to maintain work flow

Backlog

Weekly Work Plan

Updates to the master schedule

Defined by seven steps performed on a weekly basis.
Lookahead Process

• The Lookahead Process helps the project accomplish six important functions:
  – Shape work flow sequence and rate
  – Match work flow and capacity
  – Decompose master schedule activities into work packages and operations
  – Develop detailed methods for executing work
  – Maintain a backlog of ready work
  – Update and revise higher level schedules as needed
Work Flow Control

• TFV View of Management
  • Transformation View
    – Focuses on identification of tasks within a project and the transformation of inputs to outputs.
    – Hierarchical decomposition and control
  • Flow View
    – Focuses on the movement of work and materials between resources.
    – Also focuses on the elimination of waste from the flow process
  • Value Generation View
    – Focuses on achieving best possible value from the point of view of the customer.

Managing Workflow versus Managing Tasks
Transformation View

• The key weakness of the Transformational View:
  – Views the entire project as individual tasks to be decomposed into smaller tasks, each minimized in terms of cost and schedule.
  – It ignores everything else.
  – Task based model of the project may not be a complete, accurate or up to date representation of the project.

• It creates an environment where:
  – Interaction between project management and executing organization takes on the characteristics of contract management.
  – The plan becomes the agreement
  – How the executing organization gets the job done is “their business”, as long as they meet their commitments of budget and schedule.

“...the conversion process model conceals everything that needs to be revealed..”
Work Flow View

- The flow view model brings visibility to time and work flow variability, the primary sources of waste.
  - Addresses flow of material and information (processing, inspection, moving and waiting)
  - Focuses on elimination of waste, time reduction, and variability reduction.
  - Brings continuous flow, pull production control, and continuous improvement into play.
  - Finally, it focuses on minimization of unnecessary activity.

The lookahead process implements a work flow view for the project.
Work Flow Control

• Work flow control acknowledges the space between production units:
  – Every production unit is a customer of someone else.
  – When upstream commitments are not met, the resulting unplanned variability flows to the next downstream production unit.
  – Sometimes this variability can be absorbed, sometimes it creates minor problems and sometimes the resulting impact is catastrophic.

• Work flow control is about preventing and mitigating the variability/uncertainty and its effects on the units downstream in the workflow.
Production Control

• Production control consists of production planning, material coordination, work load control, work order release and production unit control

• It is the progressively more detailed shaping and management of material and information flows.

• Methods for reducing work flow variability within the “production unit” include:
  – Shielding – enforcing quality criteria
  – Percent Plan Complete
  – Others (not presented here)
Shielding

- Shielding is achieved through enforcement of quality criteria on production assignments in the weekly work plan:
  - Definition
  - Soundness
  - Sequence
  - Size
Shielding

- Shielding is very much in contrast to the most common approach seen in construction production - flexibility.
  - reacting to whatever work, tasking or lack of work that flows to the production unit and mobilizing resources
  - adjusting work schedules or changing work sequence to match the latest events
- In other words, flexibility is accepting suboptimal work conditions within the production unit
Shielding

• Shielding may have negative consequences:
  – Reduced production capacity from task starvation
  – Schedule delay (may not be applicable to critical path)

• Refusing to shield may also have negative consequences:
  – Increased work in progress (WIP)
  – Lower quality, higher rework rates, lower throughput
  – Increased complexity of coordination
  – Less motivation by the project to correct the problems
Percent Plan Complete

\[ PPC = \frac{\text{Number of planned activities completed}}{\text{Total number of planned activities}} \]

- PPC is primarily related to Production Unit Control and maximizing efficiency of the production crews.
- It measures the production units ability to perform to their plan.
- PPC is reported and the metrics are used for root cause analysis to improve work flow.
Application the SE Lifecycle

- Can be applied to any workflow in the SE lifecycle where personnel, predecessor tasks, material, data or other elements are a precondition to task success.
- Applicable to any project element where performing to cost and schedule is paramount.
- Application can be expanded or focused on those aspect of the project that would benefit:
  - Integration and Test
  - Prototype/First Article Development
  - Workflows with complex team/group dependencies
  - Any work flow with subcontractors
- Can be used to protect low density, high value resources.
Barriers to Improvement

• Problems are ignored or not seen
  – Problems a direct result of the management model and are so systemic, they are viewed as “normal features of the business”

• “Can Do” culture
  – This culture makes it difficult for the subordinate team to refuse poor assignments
  – Fostered by the “hero culture” and “crisis junkies”

• Planning is hard work
  – There is often a resistance to perform continuous detail planning throughout the project
  – Most organizations find it easier to react to events than to work to prevent the problem in the first place