

# Combating Uncertainty in the Workflow of Systems Engineering Projects

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# Background



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- 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:

**This is hard!**

- Initial Planning (Master Planning)

- **Should be done**

- Lookahead Planning (Look Ahead Window)

- **Can be done**

- Commitment Planning (Daily-Weekly Work Plan)

- **Will be done**

We have problems when we ignore the gap!



# Should-Can-Will

- Its 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).



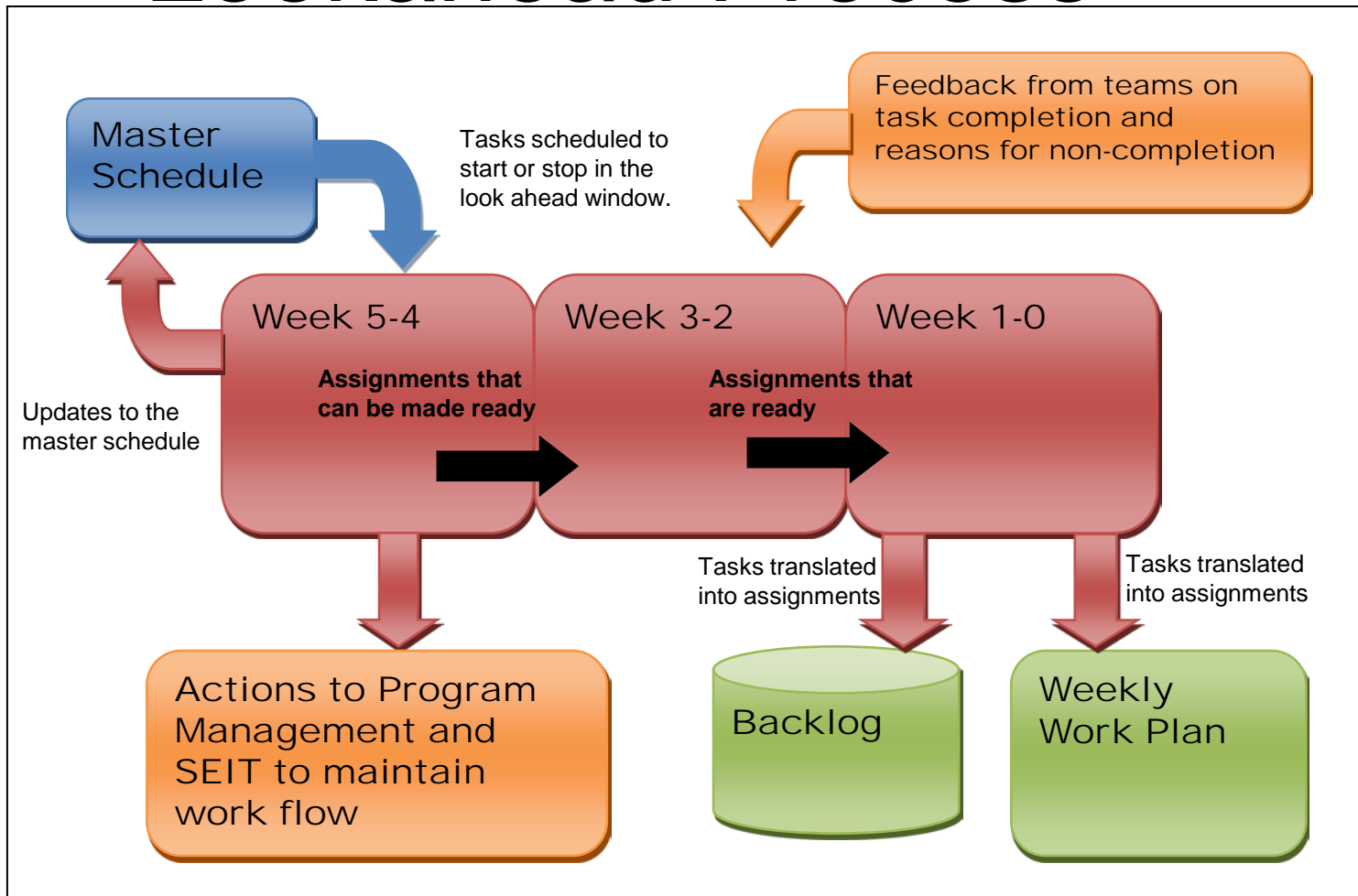
# The Last Planner

- 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



**Defined by seven steps performed on a weekly basis.**



# Lookahead Process

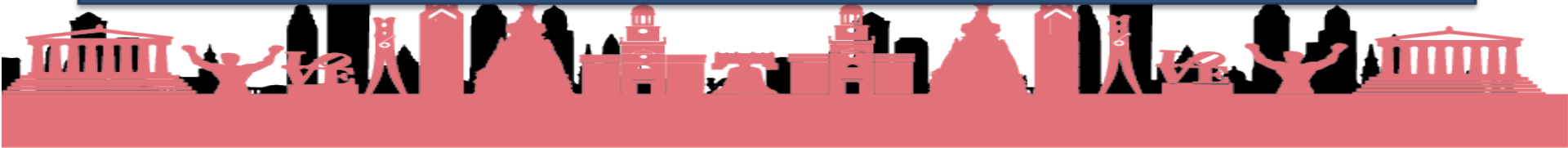
- The Lookahead Process helps the project accomplish six important functions:
  - Shape work flow sequence and rate
  - Match work flow and capacity
  - Decompose master schedule activities into work packages and operations
  - Develop detailed methods for executing work
  - Maintain a backlog of ready 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



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- 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

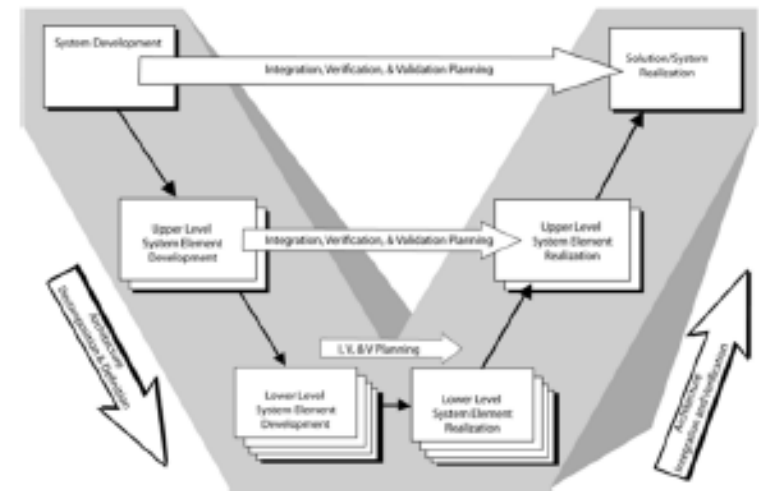
- The flow view model brings visibility to time and work flow variability, the primary sources of waste.
  - Addresses flow of material **and information** (processing, inspection, moving and waiting)
  - Focuses on elimination of waste, time reduction, and variability reduction.
  - Brings continuous 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



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- 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

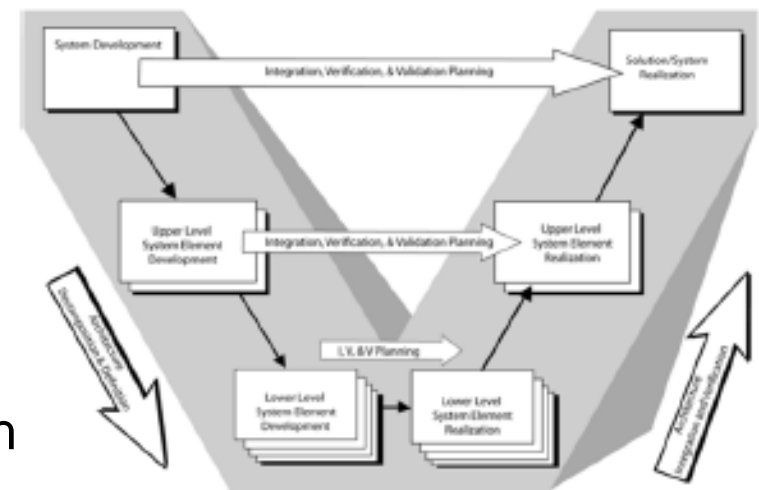
$$\text{PPC} = \frac{\text{Number of planned activities completed}}{\text{Total number of planned activities}}$$

- PPC is primarily related to Production Unit Control and maximizing efficiency of the production crews
- It measures the productions 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



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- **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

