Combating Uncertainty in the Workflow of Systems Engineering Projects

Barry Papke
L3 Communications
Greenville, TX 75402, USA
barry.papke@L-3com.com

Rick Dove
Stevens Institute of Technology
Hoboken, NJ 07030, USA
dove@parshift.com

INCOSE International Symposium
24-27 June 2013
Philadelphia, PA, USA

www.parshift.com/s/130624IS13-CombatingUncertainty.pdf

Background

The construction industry has been examining its processes in the context of the 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*, addressing high work flow variability and low productivity.

We examine the key principles of the Last Planner, looking for lessons that reduce project variability in Systems Engineering.

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**
- **Look Ahead 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**
- **Look Ahead Planning (Look Ahead Window)**
  - **Can be done**
- **Commitment Planning (Daily-Weekly Work Plan)**
  - **Will be done**

Should-Can-Will

Not just a question of more detail in the master schedule:

- Master schedules do not reflect the true and relevant interactions and dependencies between production units.
- Many key interactions not reflected at all.
- Detail that can be included and maintained in a master schedule is limited.

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 removed (work flow).**
- **Principle #4 - Maintain a buffer of tasks which are sound for each crew (pull versus push).**
- **Principle # 5 - Prerequisites of upcoming assignments are actively made ready (work flow).**

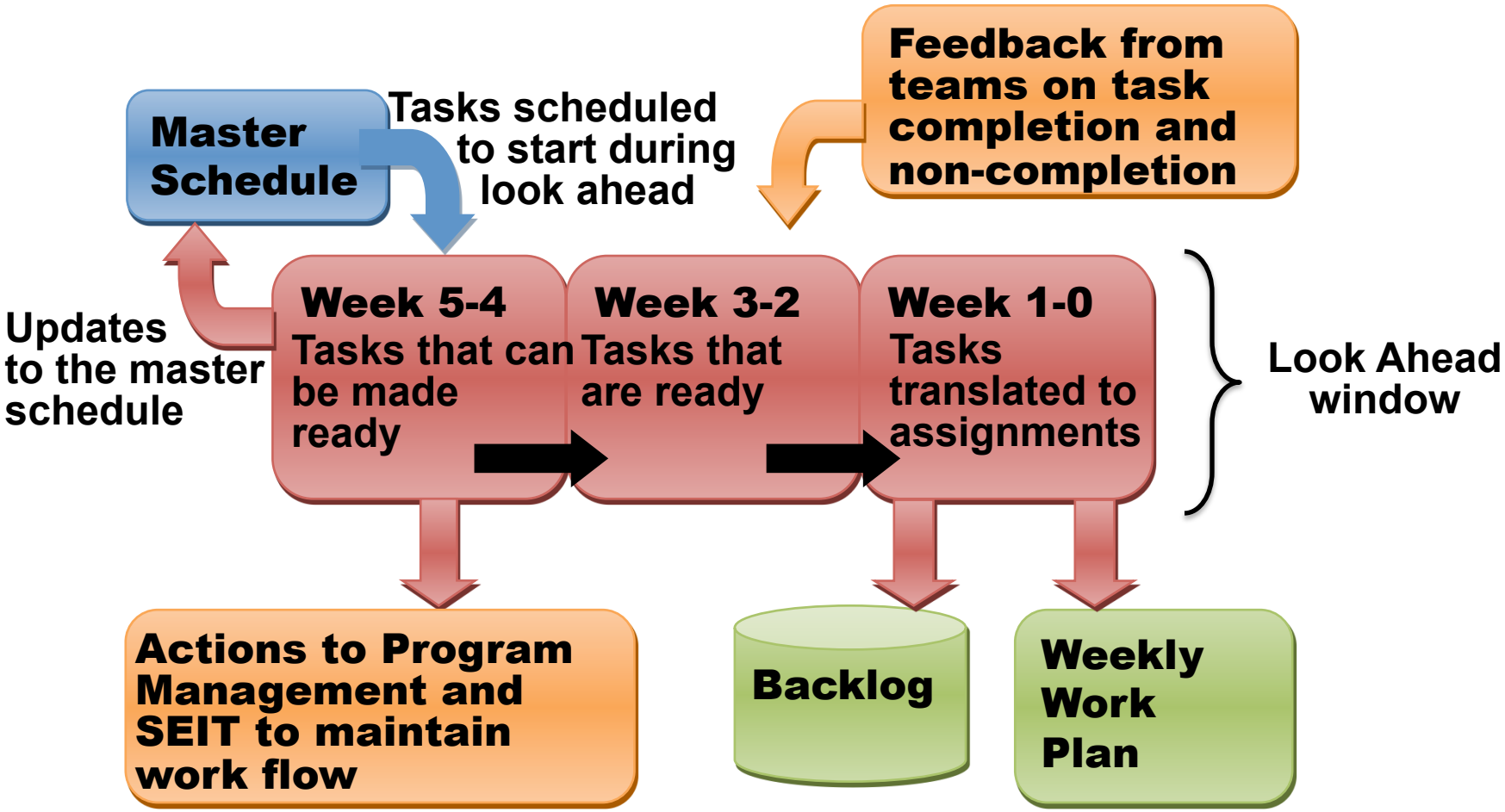
The Last Planner

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**
- **Production Control**
  - **Improving work flow within production teams.**

Variability ≡ Uncertainty

Look Ahead Process



Steps performed weekly

Look Ahead Process

The Look Ahead Process helps the project accomplishes 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**

Look Ahead Process

The Look Ahead Window process consists of seven steps performed on a weekly basis:

- **Step 1 – Analyze project master schedule and identify tasks planned for completion in the next 6 weeks.**
- **Step 2 – (1-2 weeks out) Move "ready tasks" to commitment plans based on quality criteria**
- **Step 3 – (3-4 weeks out) Identify tasks that cannot be "made ready" when scheduled; attempt to pull ready work forward; identify actions needed to make work ready for all tasking in the week 3-4 look ahead window.**
- **Step 4 – (5 weeks out) Identify those tasks in the master scheduled planned to either start or complete in the Week-5 look ahead window, and screen out those tasks that will meet schedule based on current status.**

Hidden presentation slide – put here for the published record

Look Ahead Process (continued)

- Step 5 - Translate Week 1 tasks into the language of production assignments, identifying highly interdependent assignments that should be planned as a whole and tasks that must be jointly planned between multiple production units, teams or crews.
- Step 6 - Calculate the earned value or labor hours in the Week 1 commitment plan and compare to the work rate required to maintain schedule. If the planned effort is below that needed to maintain schedule, pull ready work forward from the week 2-4 look ahead windows as allowed by sequencing and readiness or adjust resources.
- Step 7- Review all action items needed to make work in the lookahead window ready, track and report status until actions are closed and tasks are ready to work. Report the impact of tasks that fail to achieve ready to work status when schedule.

Hidden presentation slide – put here for the published record

Managing Workflow vs. Tasks

TFV View of Project Management

- **Transformation View**
  - ❑ Identifies tasks & transformation of inputs to outputs.
  - ❑ Hierarchical decomposition and control.
- **Flow View**
  - ❑ Movement of work and materials between resources.
  - ❑ Elimination of waste from the flow process.
- **Value Generation View**
  - ❑ Achieving best possible value for the customer.

Transformation View

The key weakness:

- **Decompose project into smaller tasks, each minimized for cost and schedule.**
- **Ignores everything else.**
- **Task model may not be complete, accurate or up to date representation.**

Creates an environment where:

- **Interaction of project management & execution group looks like contract management.**
- **The plan becomes the agreement.**
- **How the job gets done is "their business", as long as they meet budget & schedule.**

Transformation model conceals what needs to be revealed

Work Flow View

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.**

Flow model gives visibility with lookahead process

Production Control

Is production planning, material coordination, work load control & order release, and production unit control.

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

In contrast,
the most common approach in construction flexibility is:

- **mobilizing resources by reacting to whatever work, tasking or lack of work flows to the production unit,**
- **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, maximizing efficiency of the production crews.

It measures the productions unit's ability to perform to plan.

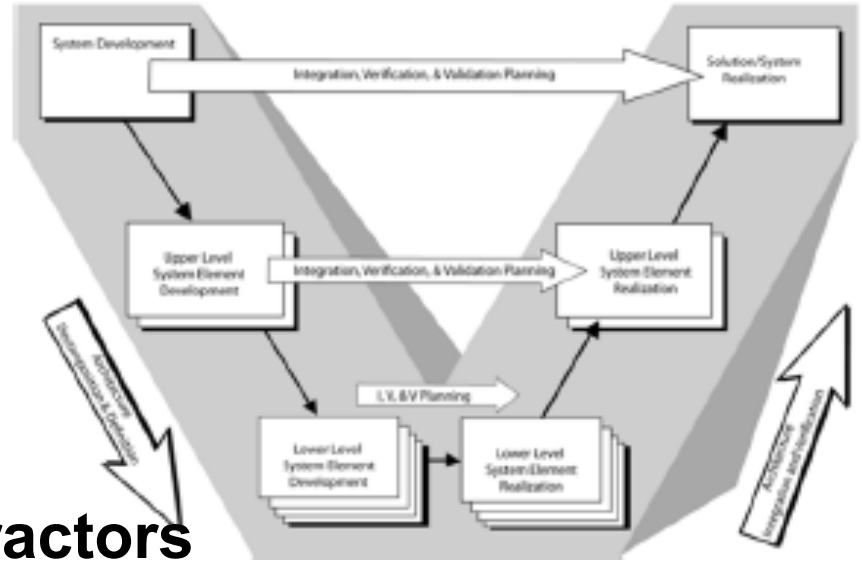
PPC is reported and the metrics are used for root cause analysis to improve work flow

Application in the SE Lifecycle

- Any workflow in the SE lifecycle where personnel, material, predecessor tasks, data, or other elements are a condition to task success.
- Any project element where performing to cost and schedule is paramount.

Can be expanded or focused on:

- 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…

- **Direct result of the management model and so are systemic, viewed as "normal features of the business"**

"Can Do" culture…

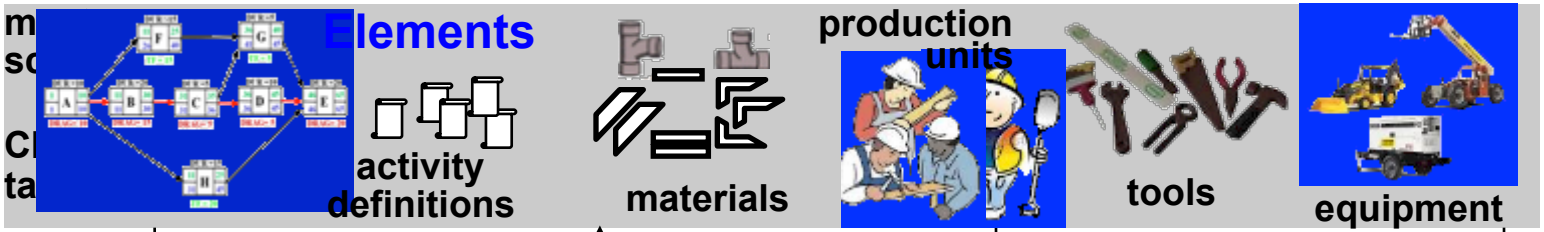
- **Difficult for subordinate team to refuse poor assignments**
- **Fostered by the "hero culture" and "crisis junkies"**

Planning is hard work…

- **Often 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**

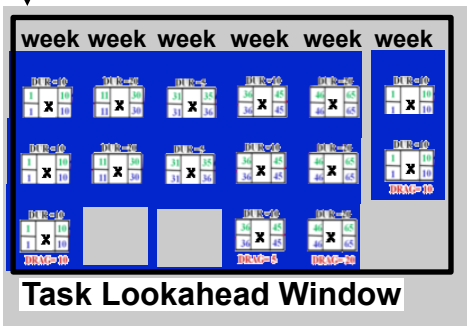
Last Planner Work Flow Management

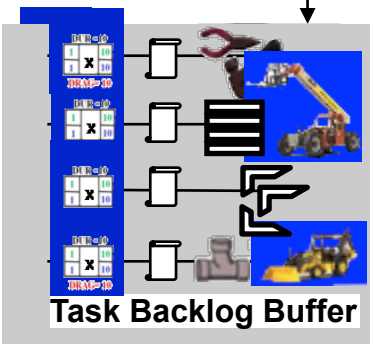
Active management of the anticipated schedule and work flow to ensure there is always a buffer of "quality" jobs ready to work on and matched with resources.

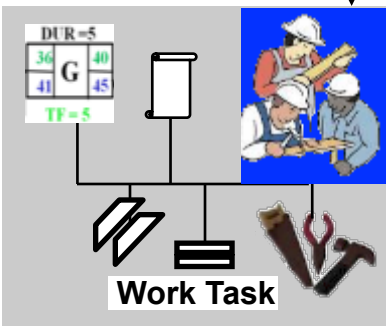


Task prep: Supes/Foremen/Expediters

Task status: Supes/Foreman







Tasks enter look ahead window 6 weeks in advance of execution schedule, advancing only according to readiness, with action on prep for execution.

Tasks enter backlog whenever all necessary elements are ready for execution.

Weekly work tasks are drawn from readiness backlog, keeping crews fully employed.

Last Planner Agile Project Management