

PROCESS VERSUS OPERATIONS WORKFLOW – MAKING THE CASE FOR CONTINUOUS MONITORING OF CONSTRUCTION OPERATIONS

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Outline

- Process vs. Operations Flow Definition
- Construction Focus on Process Flow
- Lean Manufacturing Prioritized Monitoring and Controls
- Model Continuous Monitoring of Craft Labor Operations & Instantiation Results
- Questions and Answers

Process vs. Operations Flow

- The flow of processes and the flow of operations coexist in any production system (Shingo and Dillon 1988)
- On the one hand, process flow represents how the flow of work on a product moves through workstations or tasks
 - Ideal production aims at meeting customer's demand rate with a steady process flow or takt time
- On the other hand, operations flow represents the flow of work within a unit of production such as a worker or workstation
 - In this regard, the optimization of individual production units does not necessarily result in an optimal production system.
- Sacks (2016) observed in the construction literature a convoluted understanding of these two expressions of flow, even though Koskela (2000) and Koskela et al. (2007) had previously noted them. Sacks argues that such confusion results from the batch type of production in construction -as opposed to continuous production in manufacturing and assembly lines.

Lean Axiom of Transformation–Flow–Value

- Lean thinkers claim that efficient and effective production must satisfy the three fundamental axioms of transformation-flow-value (TFV) (Koskela 2000).
- Transformation of outputs based on inputs reflects the traditional management focus on the finished product (Olli Seppänen 2009).
- The value aspect of production aims at optimizing the amount of value delivered to the final customer.
- Finally, the flow aspect of production aims at the minimization of non-value added steps or the simplification of production with the overall objective to eradicate waste.
 - The fluctuation or variability of workflow is an example of waste.

Construction Focus on Process Flow

- In construction, the traditional focus of management has targeted the completed product or project outcome (Grau et al. 2014; Grau and Back 2015; Grau et al. 2016; Grau et al. 2017)
- Management and control techniques have targeted the transformation of outputs from inputs while neglecting the production / operation systems required to achieve those outputs (Howell and Ballard 1996, Koskela 2000)
- The critical path method devises a project as the interrelation of tasks through start and finish type of relationships and thus simplistically assumes a constant flow of work through those tasks. Such project management focus fails to acknowledge other constraints with a likely impact on the flow of work (Koskela 2000)

LPS for Process Flow Stabilization

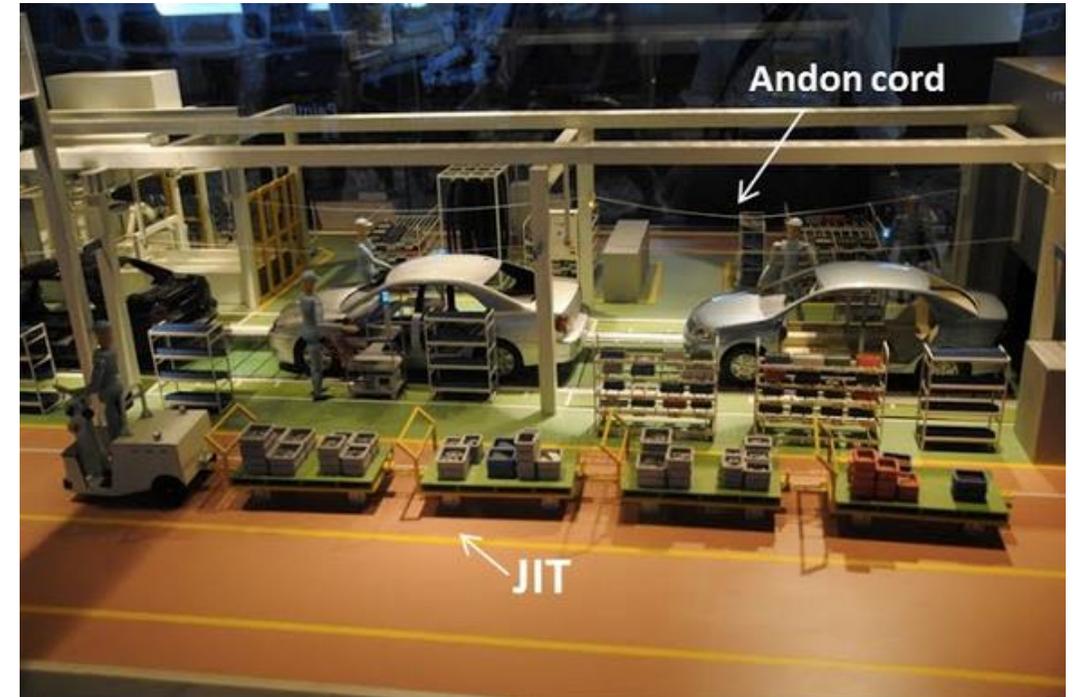
- LPS exemplifies a basic effort to plan tasks with a smooth flow of work between them.
- However, while the planning focus in LPS is process flow, its weekly control informs on the reliability of the planned flow (i.e. PPC) after the weekly transformation cycle, i.e. from the perspective of the transformed work or output
- This shortcoming is understandable since controls in shorter communication cycles could not have been realistically conceived with the state of technology in the early 2000s.
- This lack of attention to operations flow in construction contrasts with the real-time monitoring of operations in lean manufacturing.

Lean Manufacturing Focus on Operations Flow with Prioritized Monitoring and Controls

- Interviews with corporate production and supply corporate managers at car manufacturing organizations
- Two principles on operations flow controls are evident in the automotive manufacturing industry
- *The first principle advocates that a timely prioritization for the communication of information must exist. Such prioritized communication of information aims at enabling informed decisions with timely and accurate knowledge.*
- *The second principle states that a function subject to large variability and with the potential to significantly impact project performance, if such variability is not timely addressed, is be instantaneously monitored*

"Variability is the universal enemy" (Schonberger 1986)

Monitoring of Operations Flow in Lean Manufacturing



[Andon Cord Resuming Operations](https://www.youtube.com/watch?time_continue=4&v=ud1oIIDc5ds)

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Wait a Minute, but is it true that Construction does not Monitor Variability?

- Median turnaround time of information (38 project responses from 11 organizations)

- Safety – nearly immediate

- Quality tests and inspections – 2 days

- Productivity – 7 days

- Change Order Status – 7 days

- Cost – 30 days

- Schedule – 30 days

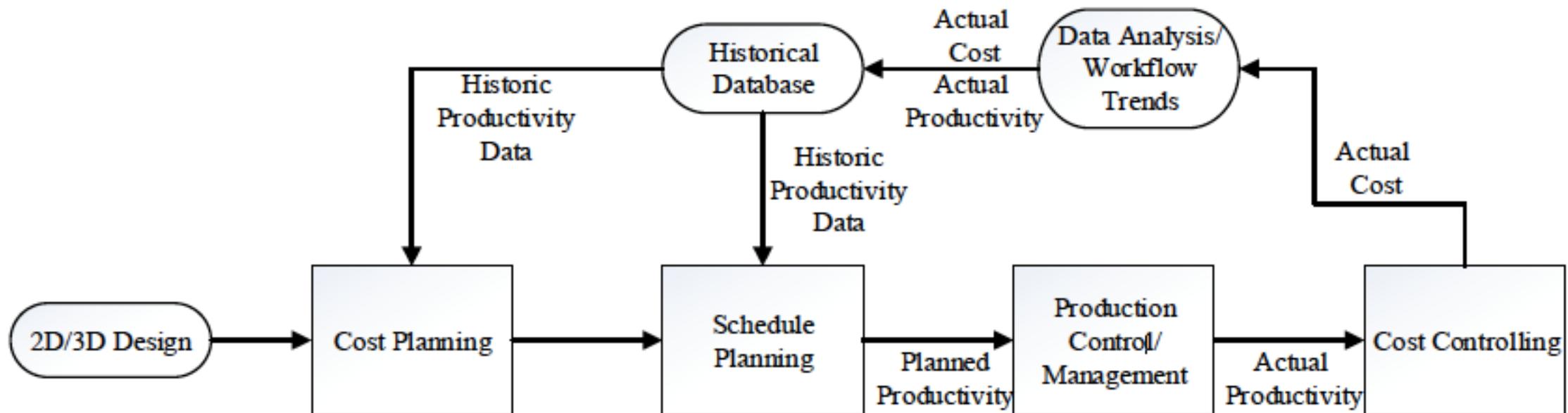
Variability and increased impact with time

Monitoring

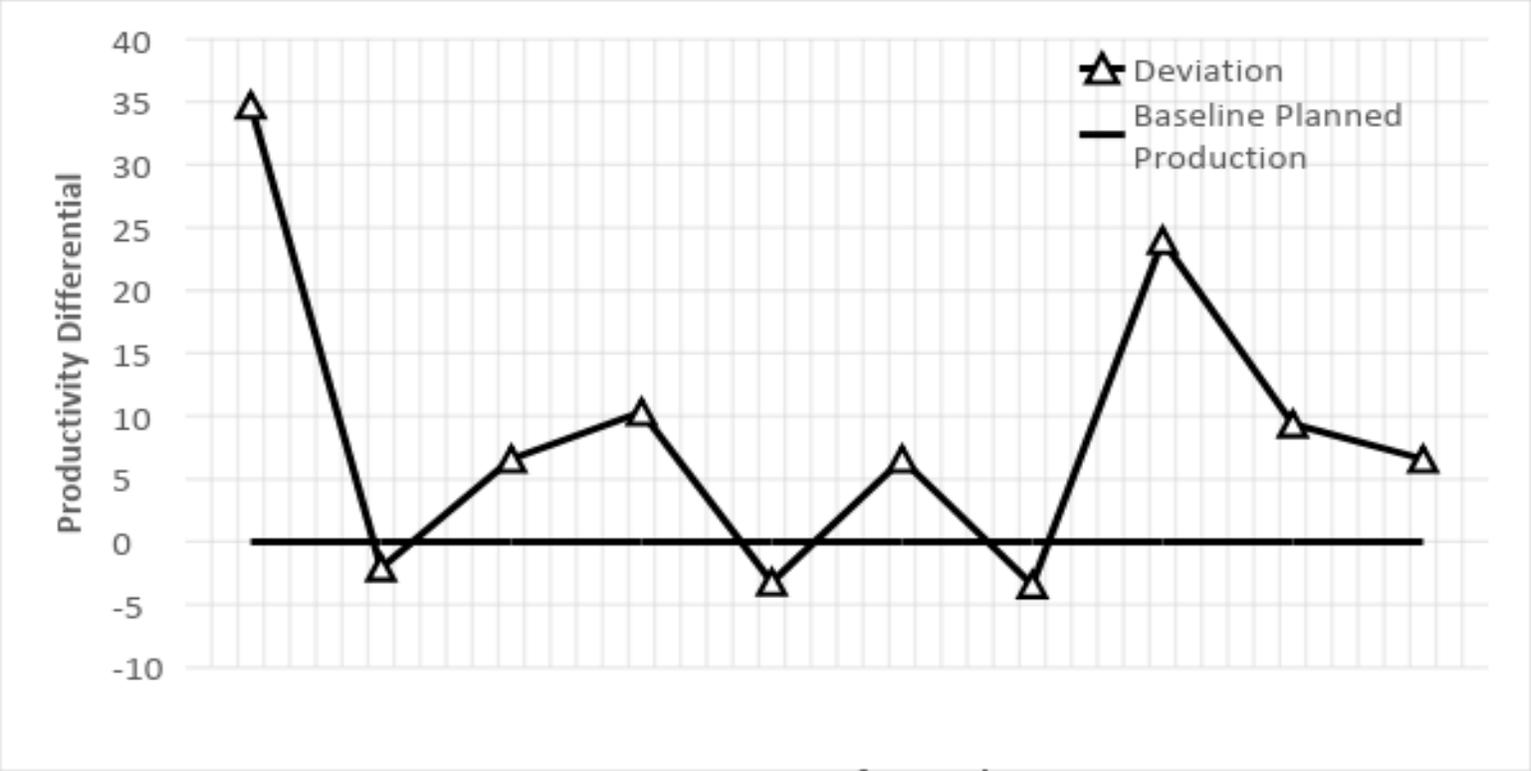
Controls

Model for the Continuous Monitoring of Construction Operations – Drywall Installation

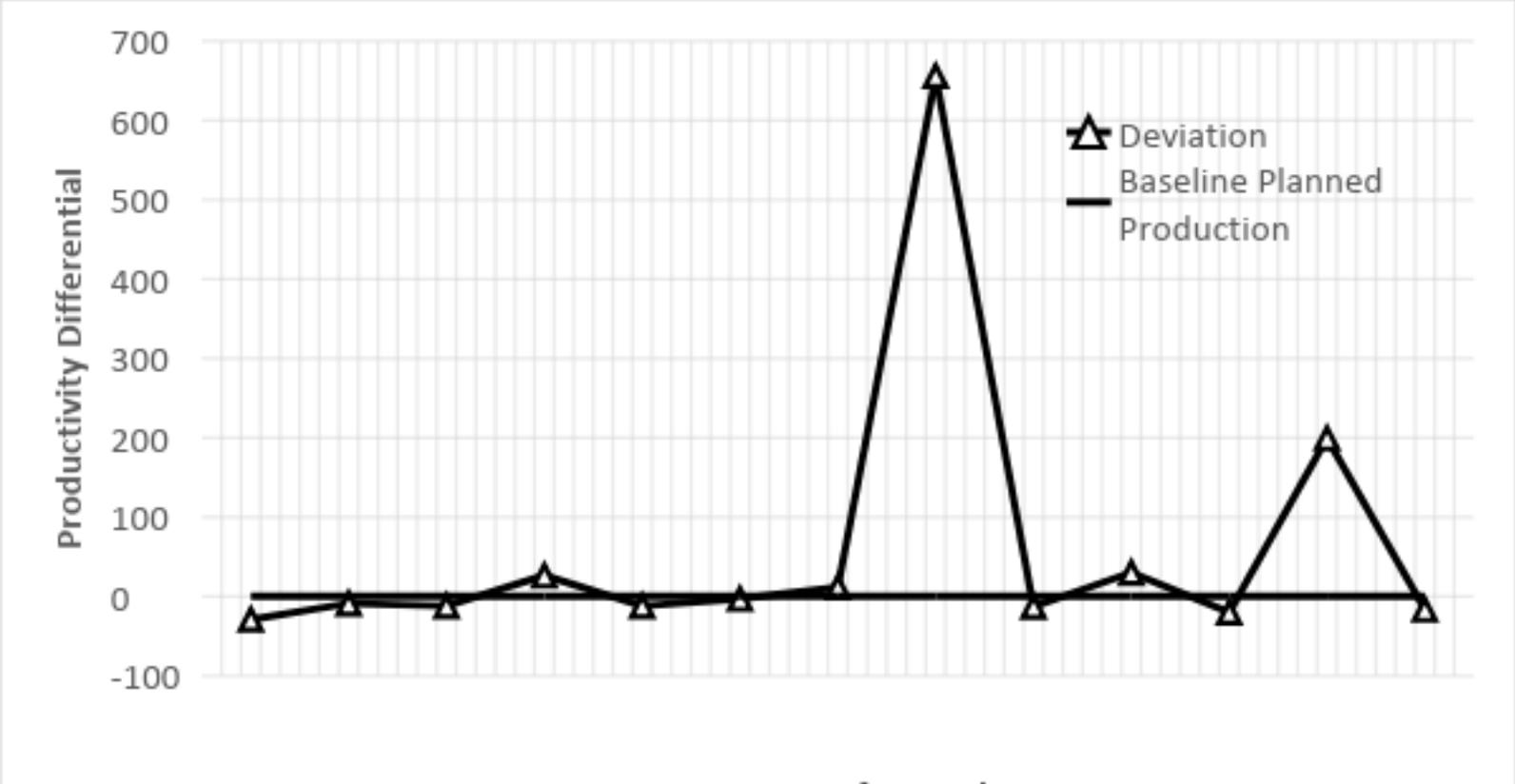
- Craft labor productivity data collection
- Analyze variability/stability vs. planned
- Proactive Management Intervention - correction of deviations



Installation of Top Rack



Hanging of Drywall below Ceiling



Closing Remarks

- How does construction observe production when compared to manufacturing?

| Construction | Lean Manufacturing |
|------------------------|-------------------------------|
| Worker through product | Product through workstations |
| PPC – Batch feed | Continuous data feed |
| Manager (foreman LPS) | Worker |
| Reactive response | Proactive, real-time response |
| Concern / Uncertainty | Ability to Predict |

Questions?

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“We are doomed to failure without a daily destruction of our various preconceptions.” Taichii Ohno



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