Ten Years of Progress in Lean Product Development

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10-15 Years Ago: Questions

- Does Lean apply to Product Development, and its primary processes, Engineering?
- How can we define the “Value” of Product Development?
- How can processes with variation and iteration be mapped and controlled?
- How can uncertainties be handled and even exploited?
- Can “creative” processes be “standardized”?
- Can Engineers practice process discipline?
- Many more….
10-15 Years Ago: Bad Ideas

- Lean is for factories, not “creative” work
- Every product is different and its development is special
- Development should be done “right the first time” and not iterate or follow varying paths
- Analysis and Testing are “Inspection” and are therefore Pure Waste
- Engineers should be made to follow work instructions like factory workers
- Many more....
A great deal of progress
The Problem: Waste in Product Development

- Most tasks are idle most of the time
- When they are in-process, much of the work is NVA
- The 12% VA time is NOT the problem

Survey of aerospace PD process time (2000)

62% job idle  38% job active:

- 12% value-added activities
- 11% necessary NVA activities
- 15% pure waste activities

77% of time is PURE WASTE
Root Causes of Time Wastes

• Resources not available
  • Not in balance with needs of task
  • Unevenness in availability: multitasking, firefighting..

• Institutional/organizational boundaries
  • Unsynchronized operations
  • Slow handoffs

• Legacy processes
  • Over-processing
  • Unnecessary reviews and approvals
Wasteful Processes = Targets for Lean

• Static *Muda* wastes
  • the 7 (or 8 or 10 or 30) wastes applied to the *information* used by engineering/product development processes
  • Information “rots” at around 11% per month (!)

• Even more important to PD processes:
  • *Muri* – Overburden of people or equipment
  • *Mura* – Unevenness or instability in operations or outputs

**Answers to some questions:**
• *Lean should be useful for reducing PD wastes*
• *Lean should allow engineers to do more of what they want to do!*
Five Lean Fundamentals

• Specify *value*: Value is defined by customer in terms of specific products and services

• Identify the *value stream*: Map out all actions, processes and functions necessary for transforming inputs to outputs to identify and eliminate waste

• Make value *flow* continuously: Having eliminated waste, make remaining value-creating steps “flow”

• Let customers *pull* value: Customer’s “pull” cascades throughout the value stream, enabling just-in-time satisfaction of customer needs

• Pursue *perfection*: Pursue continuous process of improvement striving for perfection
Value

• PD creates value by specifying products that users need, buyers can afford, and firms can produce profitably (all reasonably quickly and efficiently)
  • Multiple stakeholders with multiple definitions of value

• All of these change as needs, contexts, and technologies change in unpredictable ways
  • Reducing risk and uncertainty key to creating value

• Not a solved (or solvable) problem
  • Value thinking still key
  • Tools to understand the issues and tradeoffs help
Value-Based Decision Making and Tradespace Exploration

- Exciting new tools for understanding value tradeoffs in complex systems with multiple stakeholders and changing environments

- Link to rapid preliminary design methods for a powerful “front end”
No easy answers - Best practices in an evolving field

• For complex systems, environments, and stakeholder sets, consider new methods
  http://seari.mit.edu

• For dominant users, incorporate their (changing) needs
  • Voice of the customer studies
  • Integrated product team organization (including customers)

• Even for simple cases, consider value of
  • Reduction in risk and uncertainty
  • Speed to market
  • Flexibility to change product as market evolves
Value Stream Mapping
Applied to Product Development

- Same basic techniques apply
- Flows are knowledge and information flows rather than physical products
- Process steps may overlap or involve planned iterations
- Value added steps add or transform knowledge, or reduce uncertainty (role of analysis steps)
- Quantifies key parameters for each activity (cycle time, cost, quality defects, inventory, etc.)
- 2005 document does NOT represent current knowledge; update in progress
Some minor difficulties

- Need expanded symbol set to handle functional silos, overlapping tasks, overarching reviews, interdependent tasks, etc.
- Need expanded analysis methods to understand capacities under unpredictable rework or intentional iteration

**PDVSM works, is useful**

**Difficulties to be addressed in PDVSM 2.0**
Impediments to *Flow* in PD

- Overburden (Muri) due to understaffing, poor allocation of work
- Instability (Mura) due to unpredictability of development work, iterations.
- Lack of work structure (standardization, prioritization, synchronization) and perceived resistance to imposing it
- Organizational and information system barriers to information flow
Intuitive and non-intuitive cases

- “Simple” overburden
  - Find actual capacity accounting for iteration and rework
  - Obtain resources (which may take a while)
  - Adjust workload and/or control “batch sizes” to synchronize

- Variability/instability the harder problem
  - A perfectly balanced, “flow” system will behave very badly if there is instability in either input or process!
Spreadsheet Simulation
Balanced flow system *but* performance modeled by a six-sided die
Queue Time

Based on the equation for queue cycle time,

\[
\text{Time\_in\_Queue} = \text{Activity\_Time} \times \left( \frac{\text{Utilization}}{1 - \text{Utilization}} \right) \times \left( \frac{CV_a^2 + CV_p^2}{2} \right)
\]

- \(CV_a\) is input variation
  - which we may not control
- \(CV_p\) is process variation
  - which we want to minimize
- Utilization rate is Demand/Capacity
  - Note to be "efficient" this should be 1…
Controlling Variability

- Heroic reductions in variability required if utilization is high
- This is the motivation behind the 6-Sigma approach
Controlling Utilization (overburden)

- For any variation level, some level of utilization makes queue time explode
- This is *muri* and *mura* in action
- Often, slight easing makes a dramatic difference
Adapting to variation

- Standardized system for adjusting staffing, resources, or schedule to absorb variation
  - Reserve capacity: for critical projects
  - Flexible staffing: “2-1/2 jobs”
  - Working to a (weekly) pace: “pseudo-Takt”

- Not a solved problem, but plenty of ideas…
Digital tools need flow too

- IT needs to link analytical tools in ways that allow information to flow
Various meanings of *Pull*

- Pull means the organization responds, as a whole, to the needs of the stakeholders

- **Customer pull:**
  - Rapid development, inside the customer’s decision cycle
  - Platformed or mass-customized architectures
  - Concurrent Engineering – delay decisions until customer needs are better known

- **Project pull:**
  - Customization of standard process based on project VS

- **Process pull**
  - Lean Enablers for Systems Engineering tool
Customer Pull

• Note that understanding value, clearing the value steam of waste, and enabling flow are prerequisites!
• Once the process performs, additional tools can enhance the ability of the process to respond to customer needs
• Many TPDS ideas (e.g. concurrent engineering) fall into this category
Project Pull

• Conflict between process standardization and processes flexibility and optimization
• Solved at one LAI member company by allowing project to pull value from standards
• Project goals (value) and VSM of project (as planned) used to customize engineering standards to meet the needs of the specific program
• Done as part of a planning event that goes through the value and value stream steps first
Discipline Pull

- (Aerospace) Systems Engineering having difficulty addressing cost overruns
- Application of Lean Principles to Systems Engineering by pulling from existing body of work
- INCOSE best product 2009
- Shingo research prize 2010
Perfection: Building a Continuous Improvement Culture

- Much of this is learning by doing
- Training and participation plays a role
- Best practices: All employees have familiarization training, participate in event(s) with JIT tool training
- Training should be adapted to local environment/culture
What works?

• LAI / McKinsey study
  • 300 subjects, 28 companies
  • what PD practices correlated with project success?
• High performing companies consistently did better on a variety of metrics
• High performing companies tended to employ a lot of advanced PD practices
• No “silver bullet” practice, but a few correlated particularly strongly with success
The Main Differentiators between Top and Bottom Performers

1. High level of upfront project preparation
   - Scoping of project
   - Staffing of project
   - Handling of “Fuzzy Front End”

2. Focus on project team
   - Emphasize on Project Organization over Line Organization
   - Strong project leadership

3. Keep eyes on the ball
   - Exploration of customer needs at each step of the project
   - Close customer integration, constant feedback loops

These LEAN characteristics correlate with business success

List from Dr. Josef Oehmen
Where to start?

- LAI study of lean practices. Difficulty, impact, interdependencies considered.

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- Process Standardization, Workload leveling suggested as first steps.
Wrapup

• Lean Does Apply to PD/Engineering
• There is no one silver-bullet intervention
• The Value, Value Stream, Flow, Pull, Perfection model works (roughly in order)
• Tools (which are available and plentiful) must be gathered, selected and customized base on your projects’ needs
• There are still areas (e.g. multi-stakeholder value) where research is ongoing

For most of you, there IS enough knowledge to begin your lean journey
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QUESTIONS?