Quantifying the Effects of Waste in a Product Development Process

Presented By
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Product Lifecycle Team
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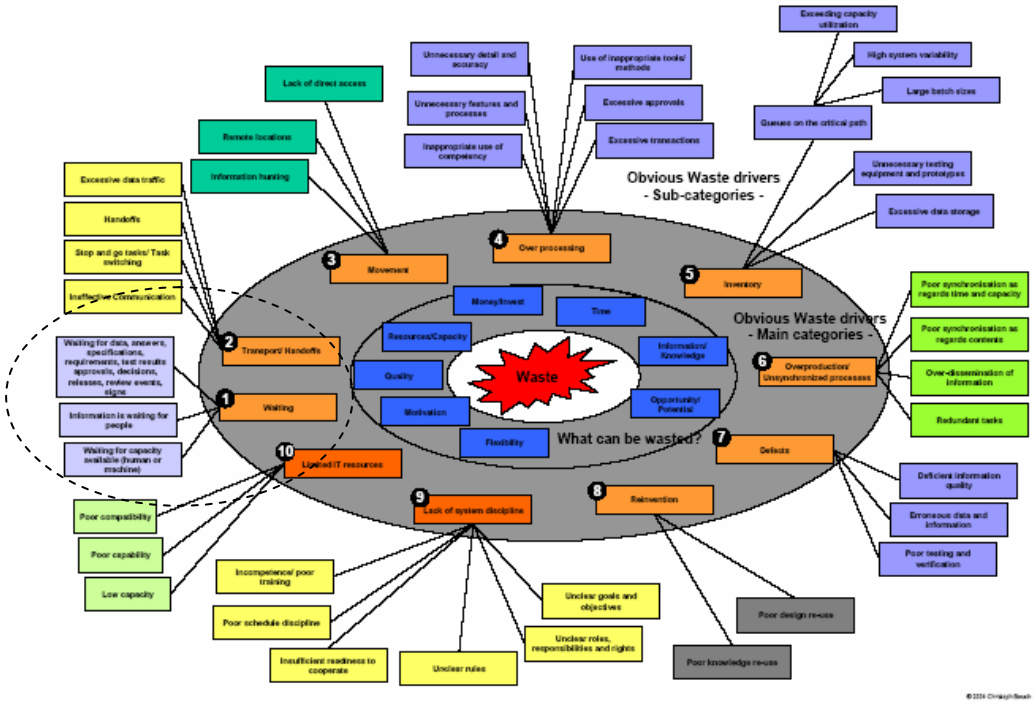
Dan Livengood Biography

- 1st year PhD student in LAI at MIT
- Education:
  - BS and MS in Systems Science and Engineering from Washington University in St. Louis
- Experience:
  - Two summer internships at Lincoln Laboratory
  - Two research assistant roles at Washington University labs

Overview

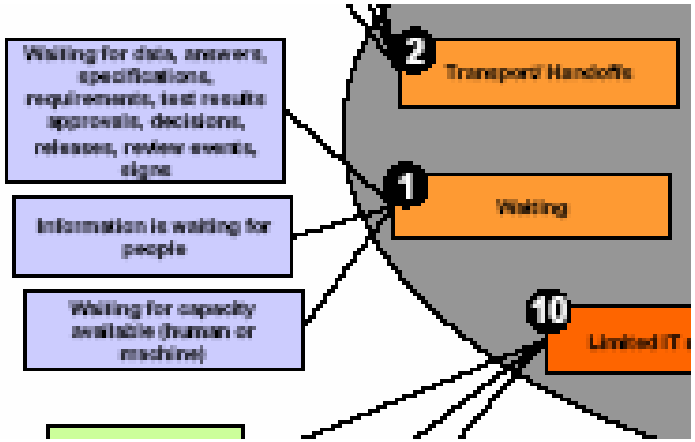
- Setting the stage: Sources of waste in Product Development
- The Main Act: Identifying and measuring waste in typical development processes
- Finale: Solutions and a real-time metric
- Encore: Related research paths could spawn from here within our Product Lifecycle research team

Waste Sources: Waste Analysis Diagram



- **Source: Bauch, Christoph. *Lean Product Development: Making Waste Transparent,* August 2004.**

Main and Sub-categories of Waste: Waiting Example



Sub-categories

Waiting for data, answers, specifications, requirements, test results, approvals, decisions, releases, review events, signatures

Information is waiting for people

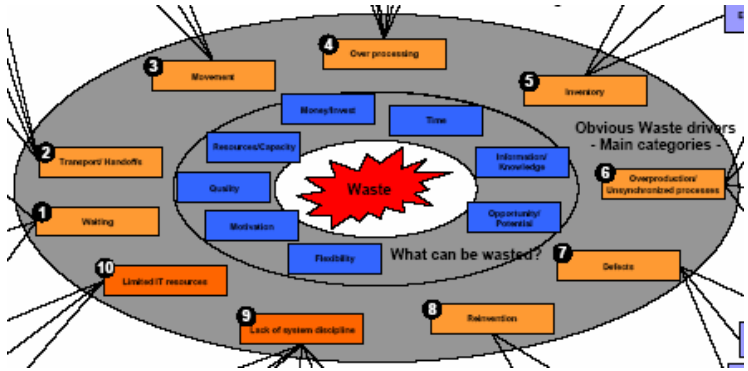
Waiting for capacity to be available (human or machine)

Main Category

Waiting

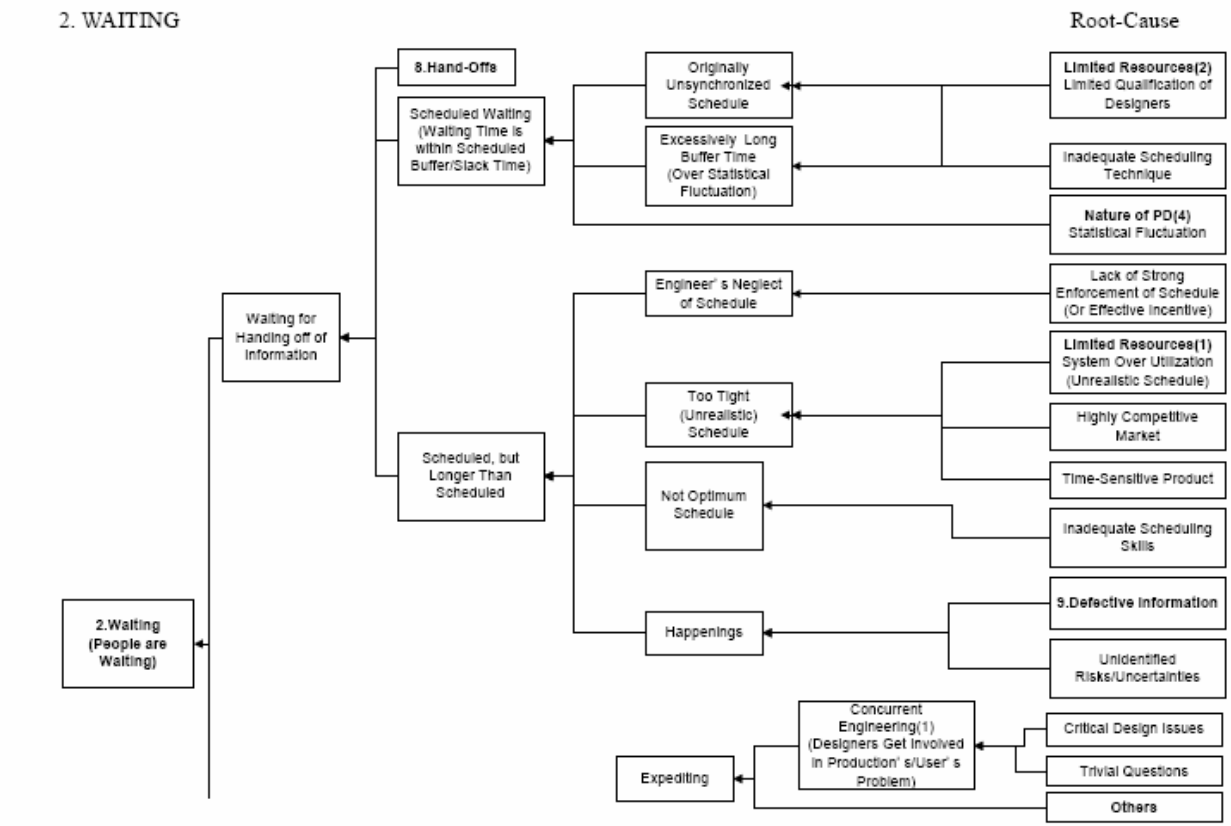
Jin Kato's Nine General Waste Categories

- Defective information
- Hand-offs of information
- Waiting for information
- Re-invention
- Overproduction
- Transportation of information
- Over processing
- Rework
- Motion



- Are these sufficient to categorize all wastes in the product development process?

Sufficiency Tested via Root-Cause Analysis: Waiting Example



- **32 pages of root-cause analysis diagram**

Nine are Sufficient

- From the root cause analysis, Jin concluded that Christoph's nine categories sufficiently categorize waste in product development
- This frames the problem into a manageable set of observable wastes

Focusing on Important Wastes

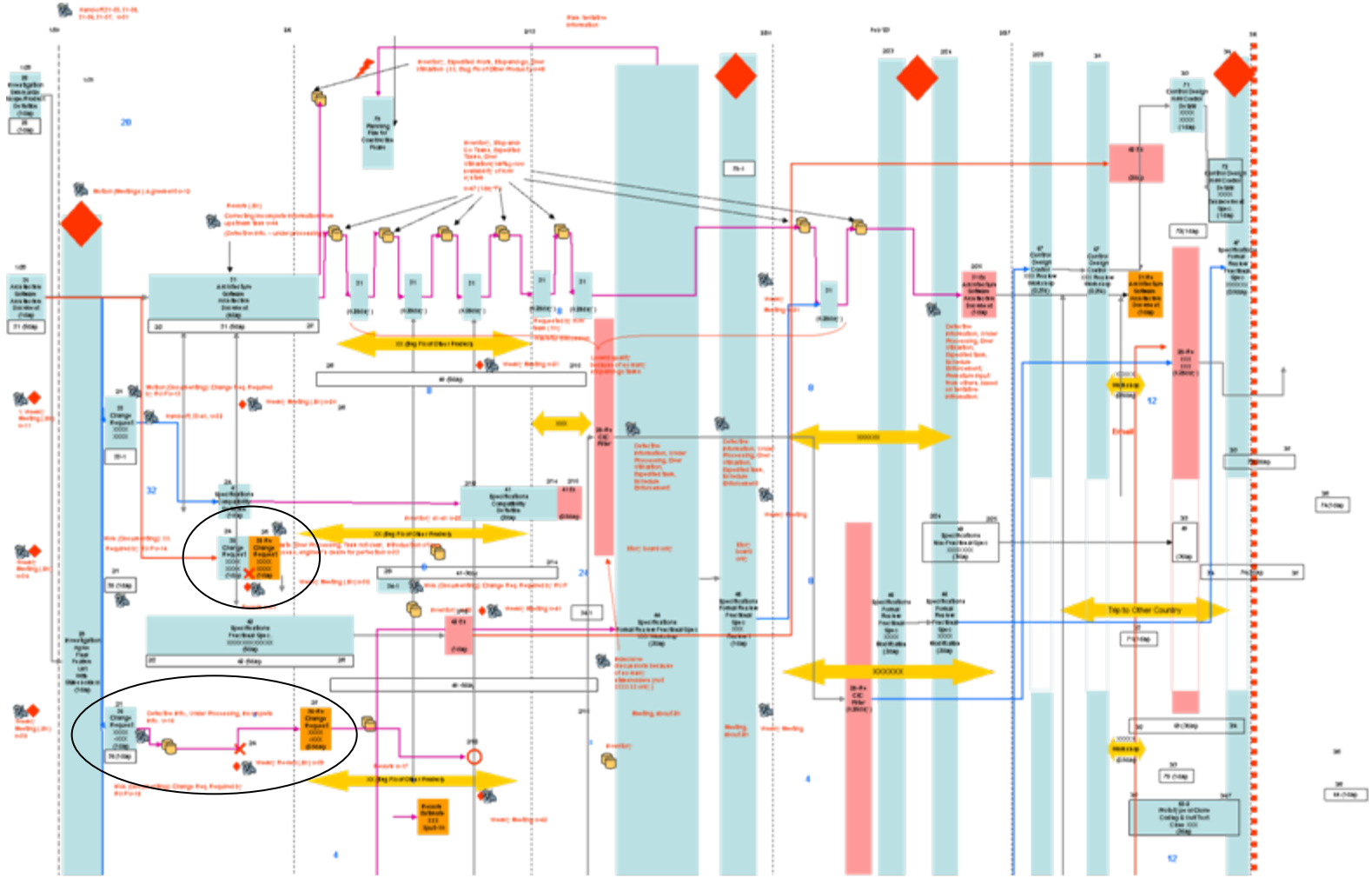
- From our set of nine wastes, how can we determine which are the most important wastes to focus our attention?

- Detailed observation of 3 case studies
- Create a graphical representation
- Analyze the data set

Data Collection Process

- **Three Case Studies**
  - 2 high-tech companies (1 American, 1 Japanese)
  - 3 embedded software projects
  - 11 engineers and managers tracked in detail over the 3 projects
  - 100+ engineers involved at some point in the projects
  - 5 trips to establish the data collection framework
  - Countless emails, phone calls and in-person interviews collecting data over 3 months
  - 50, 17 and 30 weeks of project-related data collected for the 3 projects, respectively
  - Historical data collected by reviewing employee time sheets

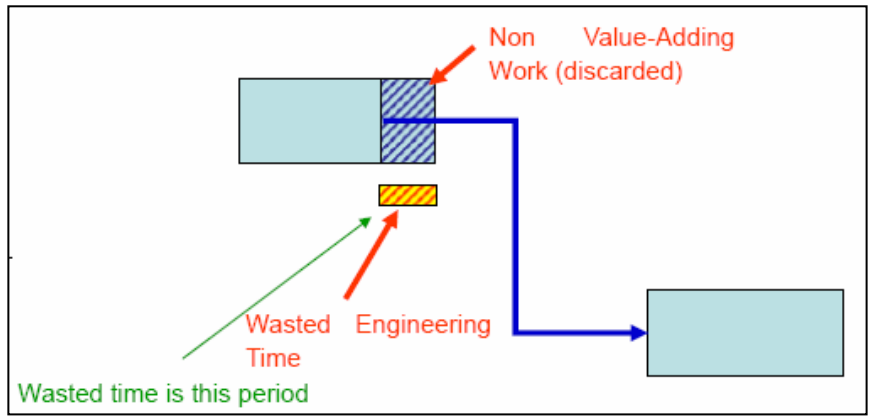
Graphical Representation via VSM

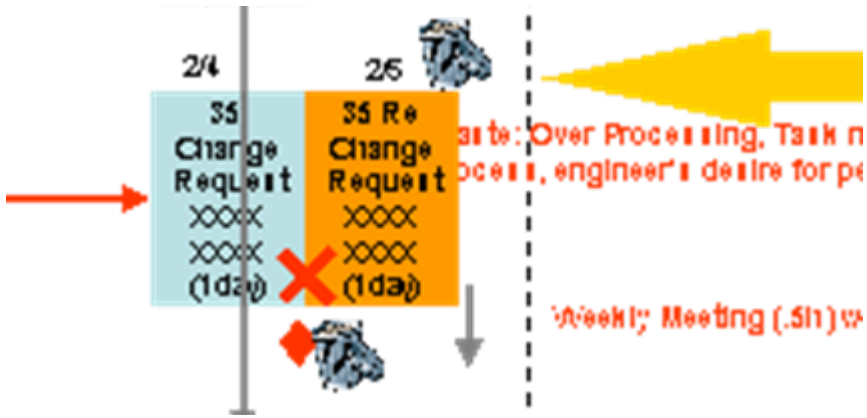


6 weeks

Over Processing

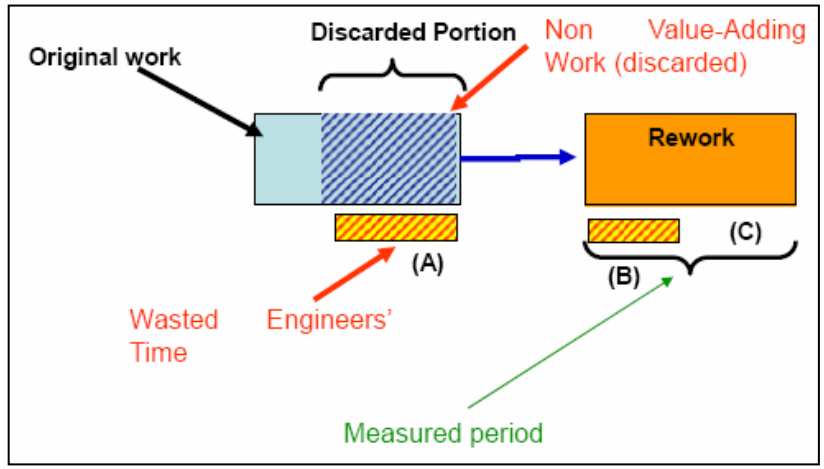
- Some parts of a task may be discarded with no need to replace the original work
- Example: an overzealous worker adds a feature that is dropped from the final product

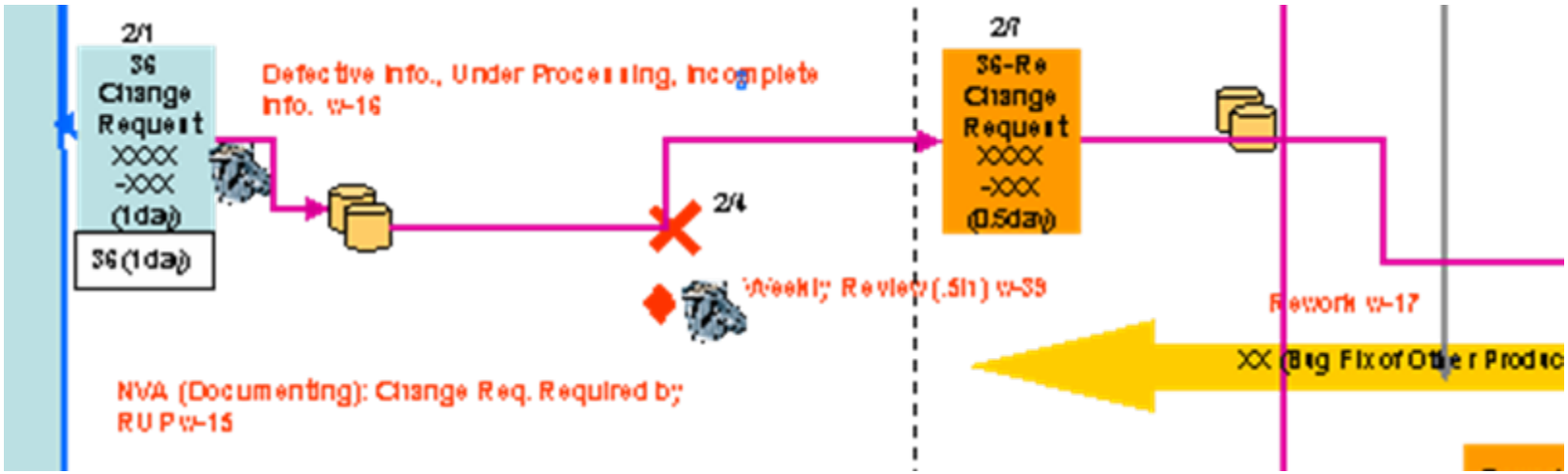




Rework

- Caused by many of the other 9 wastes
- Not a part of the original work plan





Analyze the Data Set: The Top Three Waste Categories

- Three waste sources determined to be the most important to fix:
  - Over processing
  - Rework
  - Defective information
  - Hand-offs of information
  - Waiting for information
  - Transportation of information
  - Re-invention
  - Overproduction
  - Motion

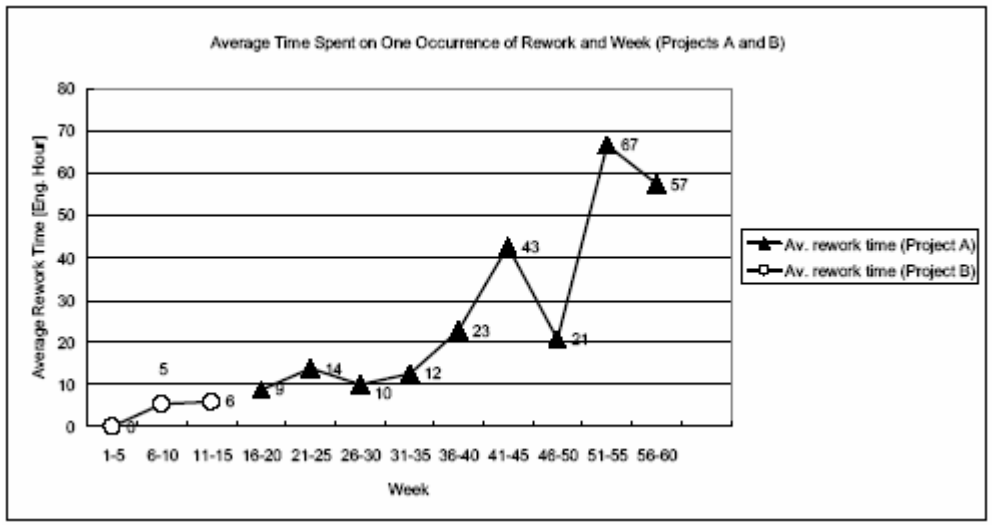
Further Data Analysis

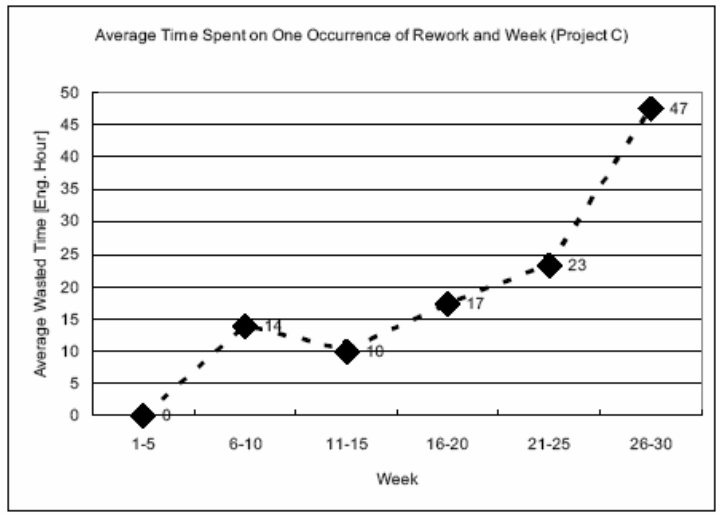
- **Data analysis yielded two numerical conclusions in rework and defective information**

Costs of Rework

- **There is a relationship between the amount of time required to fix mistakes and how far along the team is in the project**

Exponential Increase in Time per Rework Case





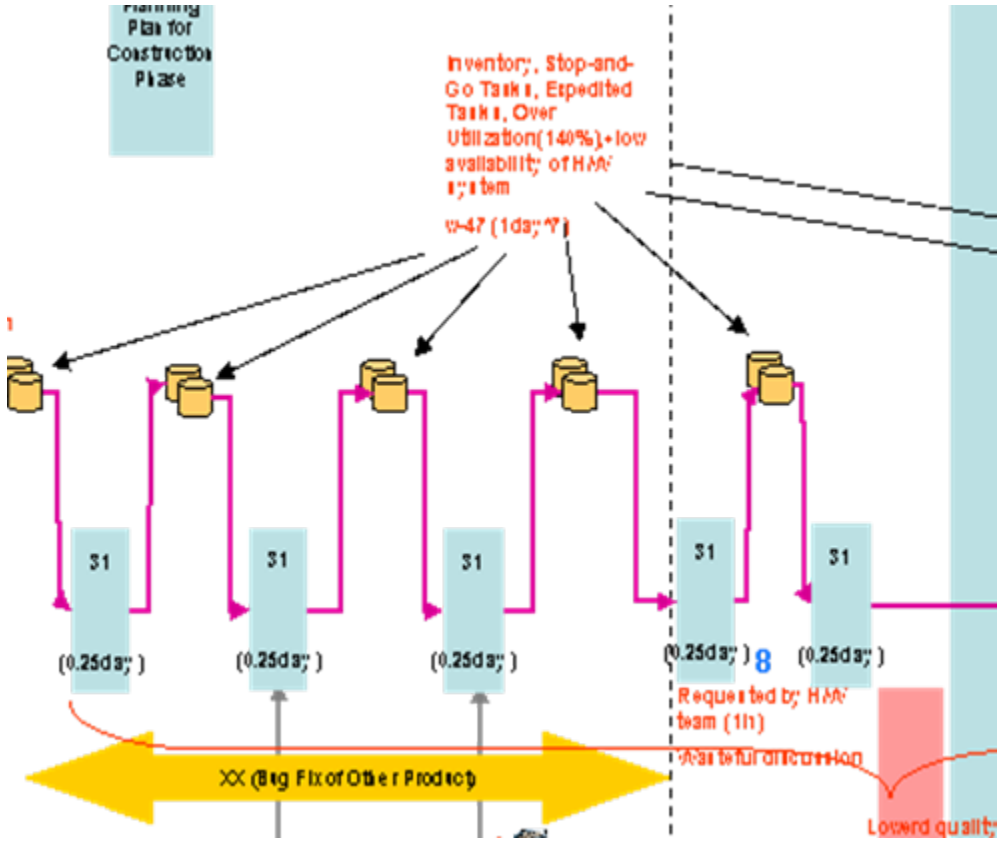
- **Each data point represents the average amount of time spent on each rework task in a given time frame of the project**

Costs of Defective Information

- One major cost of defective information comes from its storage during a project and the decay of the information due to changes in other aspects of the project
- Stored information is termed information in inventory

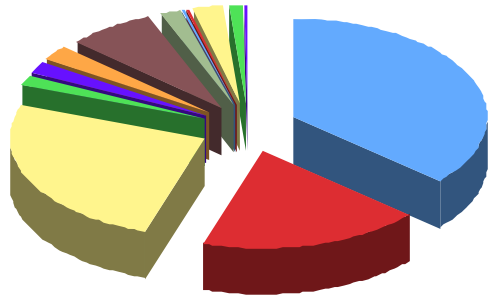
Inventoried Information Represented in VSM

- **Graphically, any arrow that connects two tasks over more than one day has its information enter into inventory**



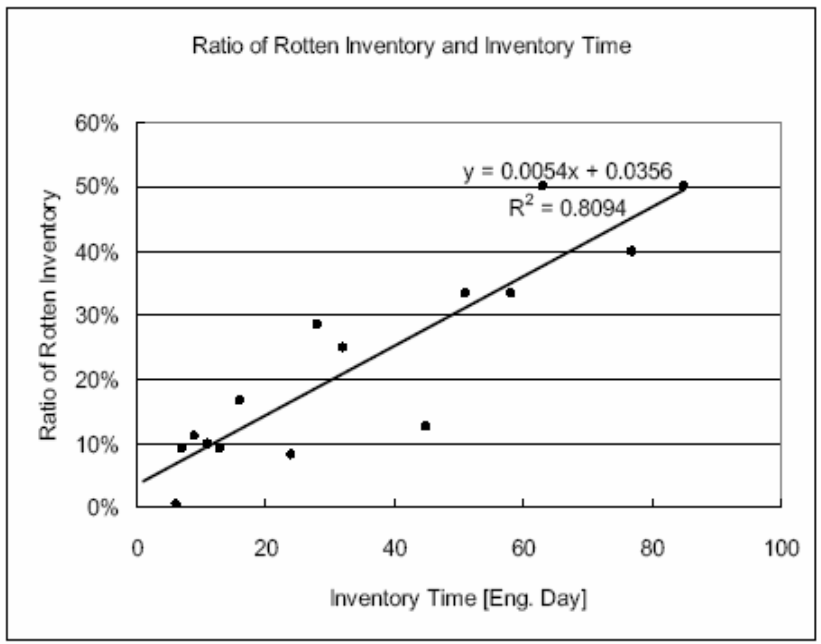
Classification of Information Inventory Types

- Taking care of a more urgent task in the project
- Waiting for information from another task
- Switching to a higher-priority task outside of the project



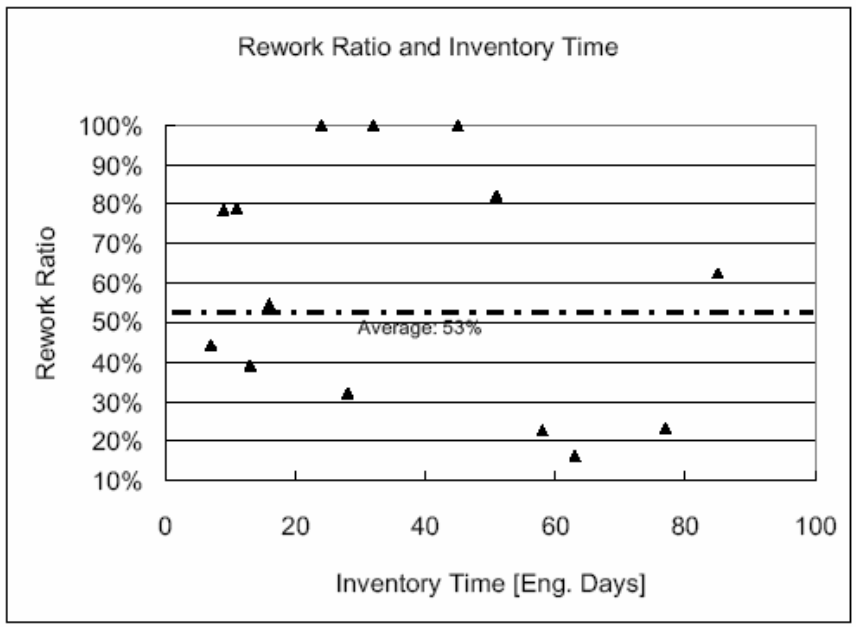
Information in Inventory Decay Rate

- **Information, on average, decays linearly with time:**
  - **Each working day, ½% of stored information decays**
  - **Each working month, 12% of stored information decays**



Cost of Information in Inventory: Rework Ratio

- **Rework Ratio = $\frac{\text{Time spent on rework}}{\text{Time spent on original work}}$**

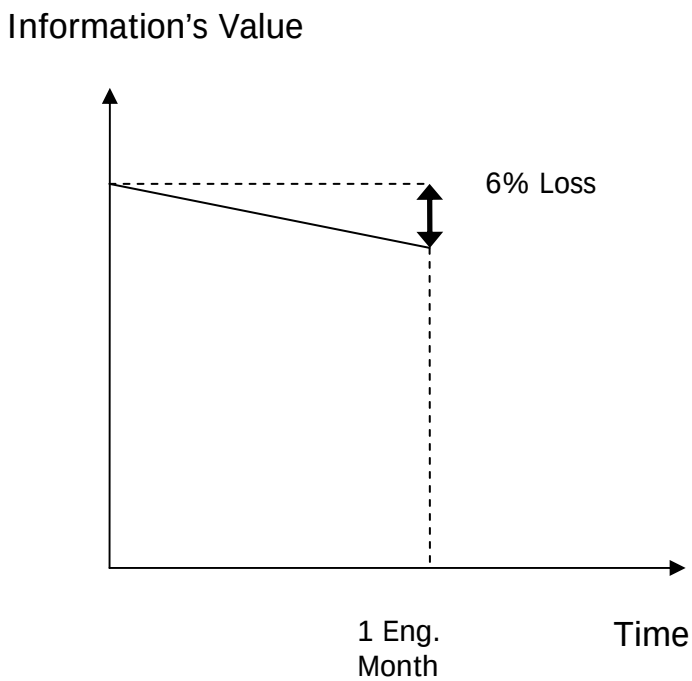


- **Average value of rework ratio ~ 50%**

Cost of Information in Inventory: Monthly Interest Rate

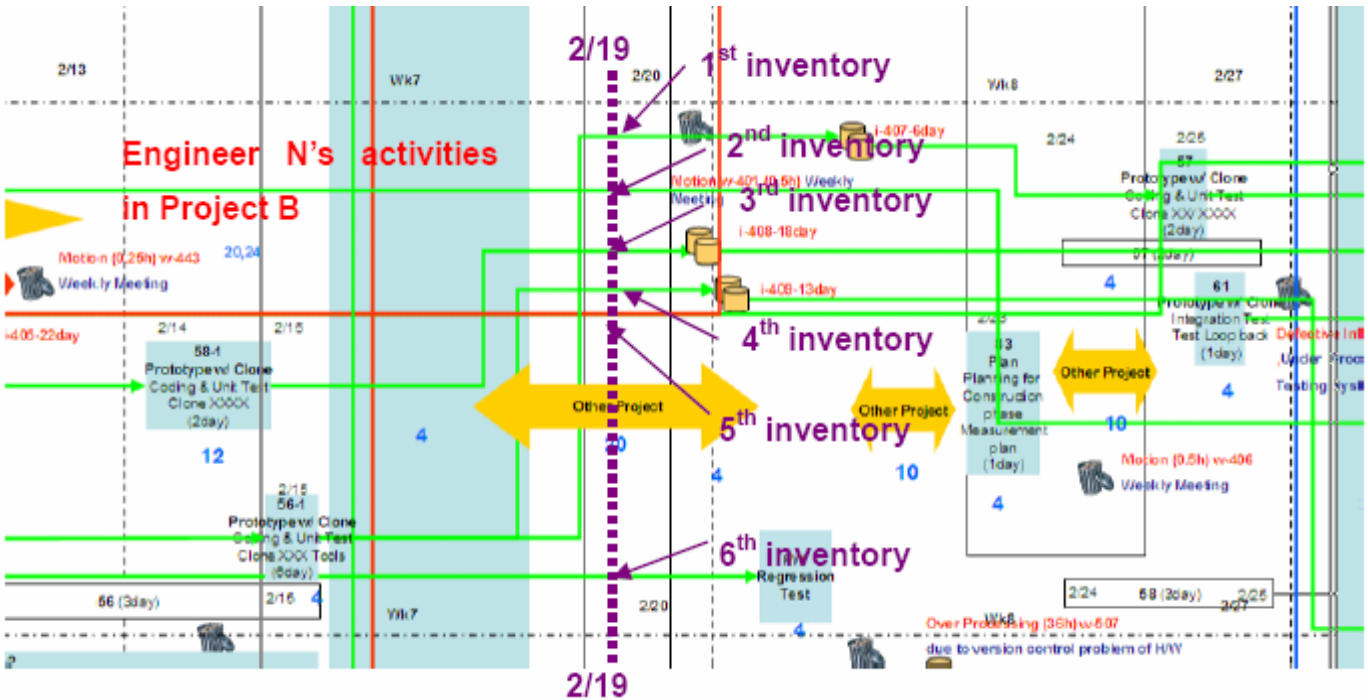
- **Information in inventory's monthly interest rate**
  = 12% /eng. Month * 50% rework ratio
  = 6% /eng. Month

- **For every unit of time originally spent on the information in inventory, you will spend 6% of that time reworking it for every month it is stored in inventory**



Real-Time Metric

- **Once the VSM is created, measure information in inventory by counting the number of lines in a swimlane at a given point in time, i.e. counting the information that is waiting to be used by the next process block**



Possible Solution Ideas Needing Further Development

- Cut out the information 'buffers' (like manufacturing's problem in the 1980s)
- Every decision has an owner at all times, such that it ideally never goes into 'storage'
- One engineer keeps responsibility of maintaining the information's accuracy until the next engineer pulls it along in the process
- Reduce project cycle time and focus on smaller number of projects at a time

Summary

- Nine main waste categories sufficiently categorize waste in PD processes
- Three wastes are most prevalent (rework, over processing, and defective information)
- Average time required for rework tasks increases exponentially with the time spent on the project
- Information in inventory accrues a monthly interest rate of 6%

Master's Theses References

- **Main Source: Kato, Jin. *Development of a Process for Continuous Creation of Lean Value in Product Development Organizations,* June 2005.**
- **Source: Bauch, Christoph. *Lean Product Development: Making Waste Transparent,* August 2004.**

- **More thesis and dissertation conclusions at http://lean.mit.edu > Publications Tab > Publications Link > Theses Link**

Contact Information

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