Introducing Fast Flexible Flow at Hewlett-Packard

Kathy Iberle
Date: 05/01/2012

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Our company

HP is the world's largest provider of information technology infrastructure, software, services, and solutions.

Nearly 350,000 employees in 170 countries

We process over **13.1 billion credit card transactions** annually

We manage more than **100 PB of online data** in **60 countries**

We perform **2.4 billion healthcare transactions** annually

We detect and quarantine more than **3.1 million viruses** annually

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Our department

Who are we?

- A system integration and system test lab
- Serving both Inkjets and LaserJets
- Approximately 100 people
- Spread over 5 U.S. sites plus Asia

HP Officejet

snapfish

HP Photosmart

hp ePrint

HP LaserJet

HP MFP Digital Sending Software

hp Web Jetadmin

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Our story

- Our starting point
- Our application of Lean Management principles and tools:
  - Systems perspective –> optimizing flow of work for maximum profit
  - Visual Management
  - Queuing Theory
  - Interaction between customers and developers
- Where we are today

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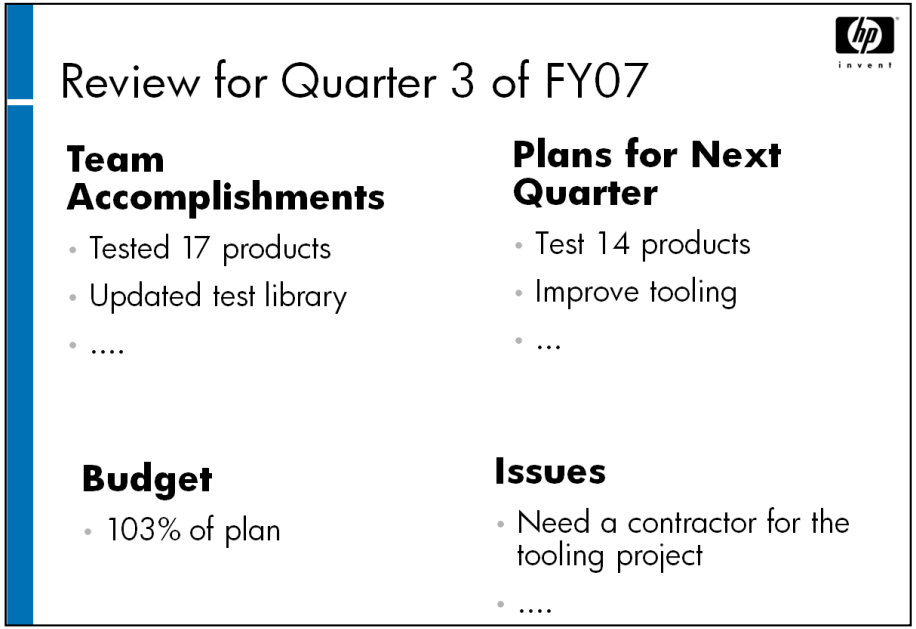
Starting Point

In 2007-2008

We're good at...

- Making plans
- Starting stuff



Focus on activity

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Typical progress

Oct 2007 – yearly planning offsite

The staff agrees on 27 improvement initiatives for the upcoming year

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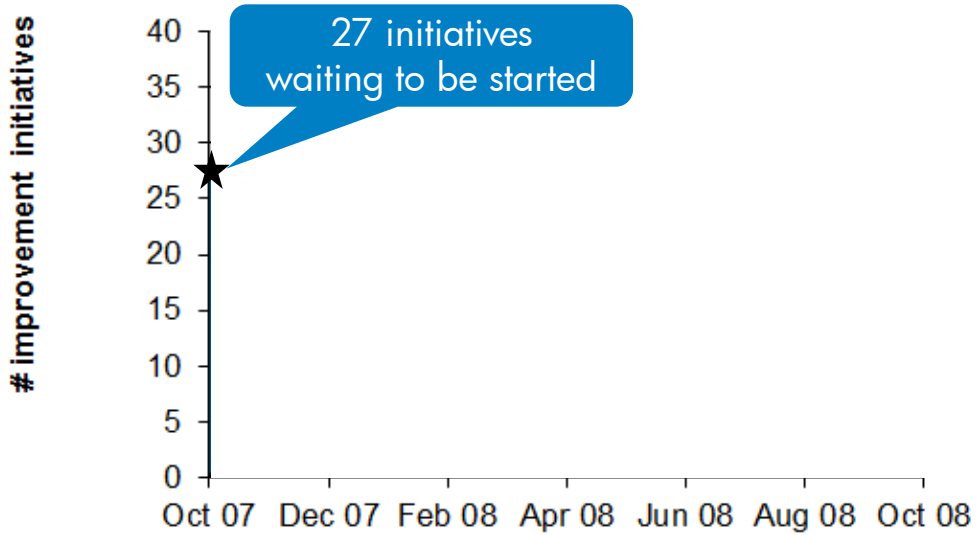
Let's watch the progress over time

Cumulative flow diagram (CFD):

A stacked-line chart
-- number of work items
-- in each state
-- over time

- not started
- started
- done



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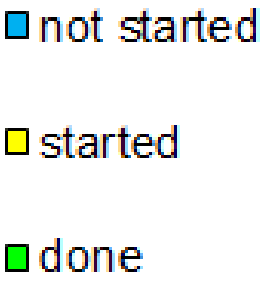
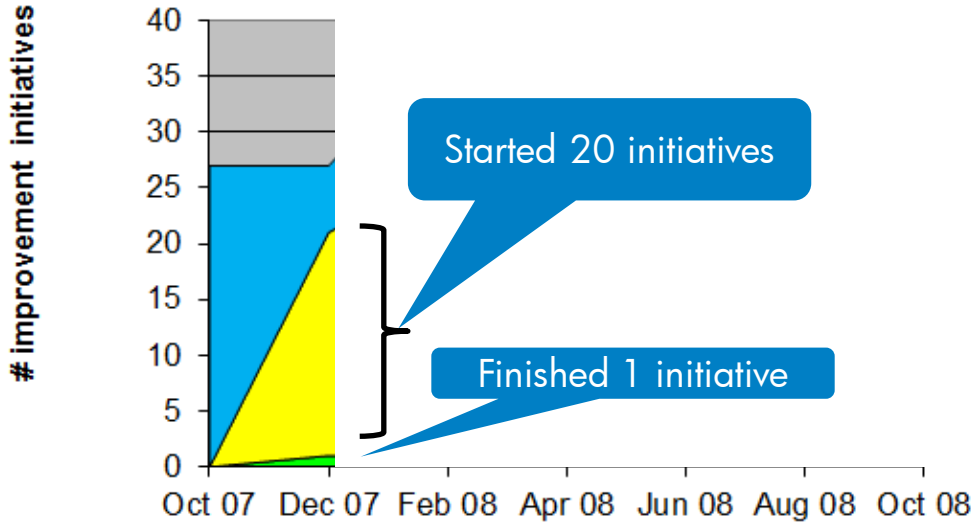
After 2 months of activity…





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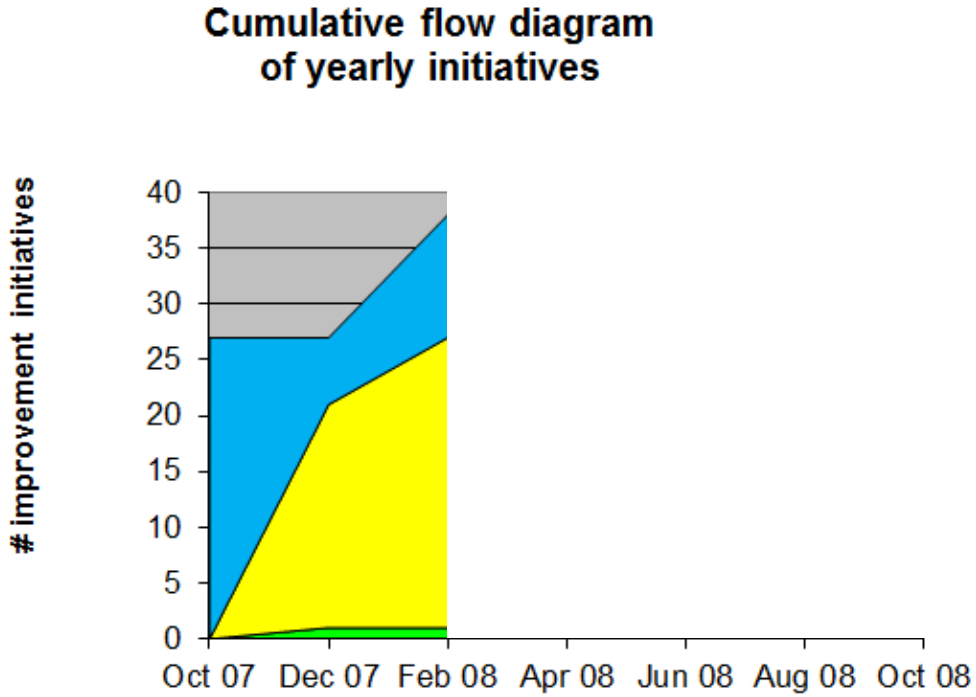
After 4 months of activity...

Only 1 initiative finished



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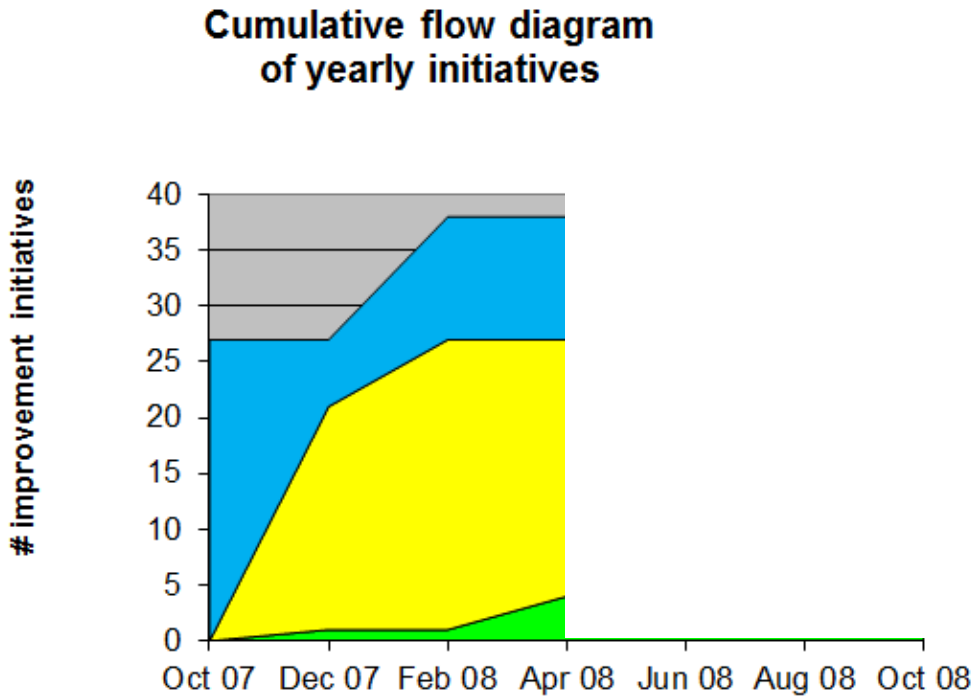
After 6 months of activity...



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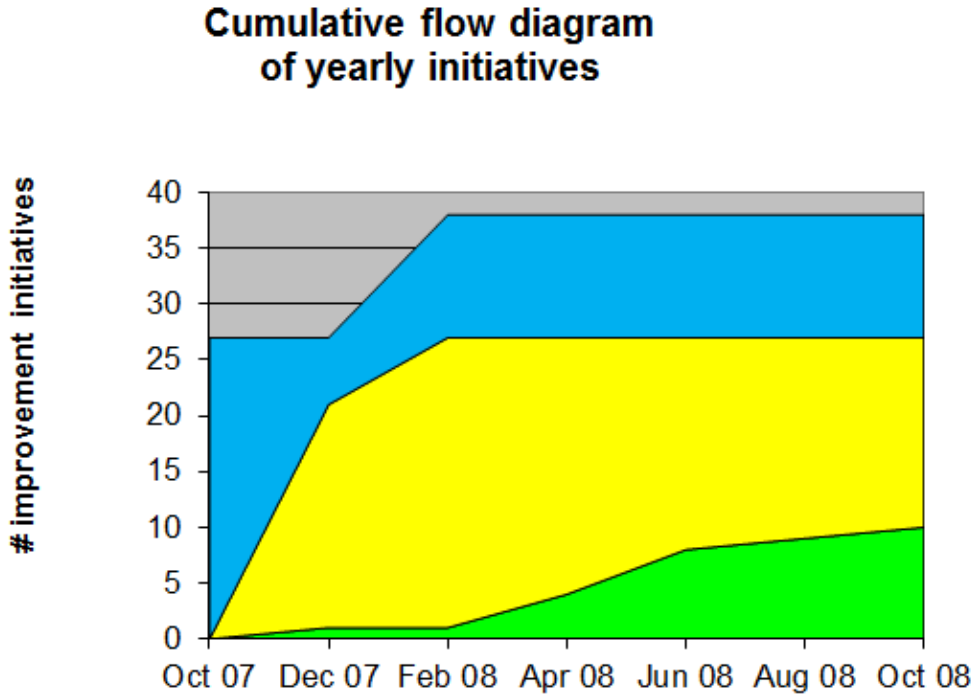
After a year of activity...

10 of 27 initiatives were completed

All the rest were either abandoned or still in progress



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This was considered normal by management

"As we look ahead to FY08, we'll continue to set the bar high and we'll continue to be frustrated with progress. We can see and feel the future and we want it now! "

But … we're not getting the future now, or any time soon …

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2009 – Adopt Lean Management methods

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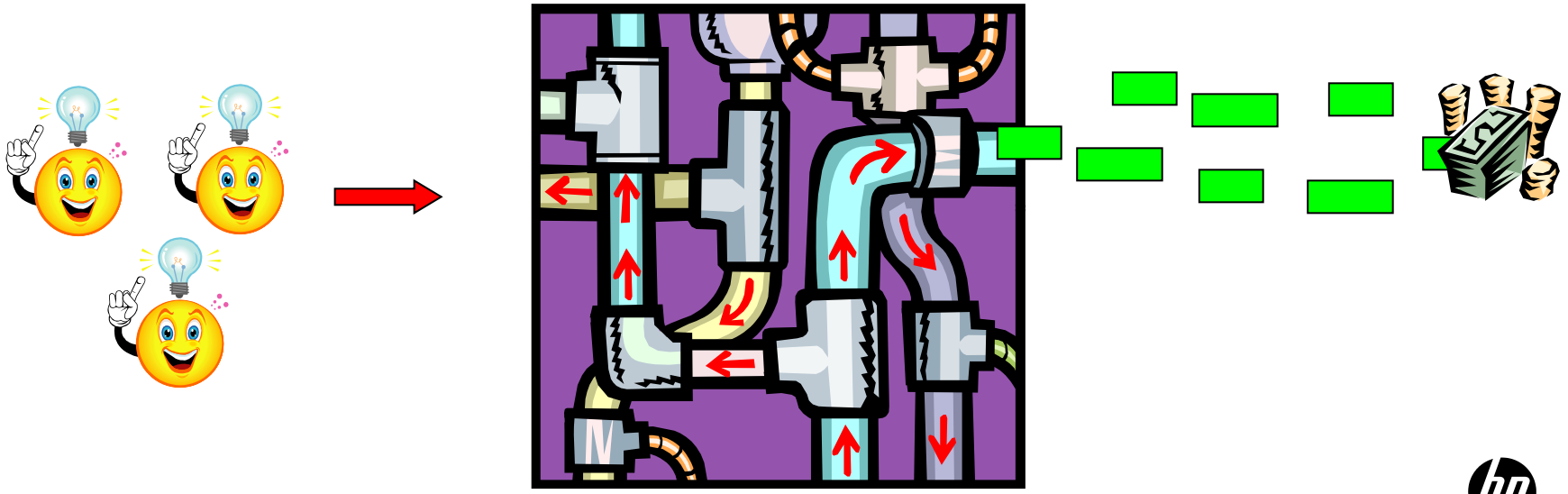
What is Lean Management?

Also called *Fast Flexible Flow* or *2nd-Gen Lean*

Lean management takes a systems view.

Goal: maximize output of valuable stuff over time



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Basics of Lean Management

1) Split work into batches
2) Map the activities in your development system
3) Monitor progress of the batches through the activities
4) When progress is visible, start optimizing flow

We apply “queuing theory” (mathematics of how systems of activities work) to predict the behavior of the system

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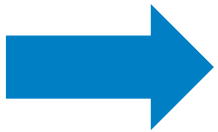
Transformation: Introduction of Lean in May 2009

"Measure and Manage Our Economics"

- First step:
  - Split the work into batches
  - Each batch has clear value
  - Make the batches measurable and visible

- Management directive to our organization:
  - *Capture all work and make it visible on an ongoing basis*



Easy visibility to what has gotten done
and what hasn't

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Making the batches visible

First rollout was a small tools team

- Captured every request for work & defined “how we will know when it is done”

Req ID	Focus A	PR SubStatu	Submitting Orga	Ranking	Name
621	Value Str	3.10 Under D	Common SW	001	Instructions and tooling to handle configuration dependencies of tests with links to req
580	Value Str	2.01 Under St	Common SW	002	Documentation on how to best organize tests in QC to support reuse and linking to req
714	Value Str			003	Duplicate of #651 in Metrics Q: Definition of Standard Test Metrics
521	Value Str	2.01 Under St	Common SW	004	How-to manual for using fields in TM module and RM module for waterfall
537	Value Str	3.10 Under D	Inkjet SW	005	How to documents on using QC to link req and tests in lean/agile, for UMSL and MSL

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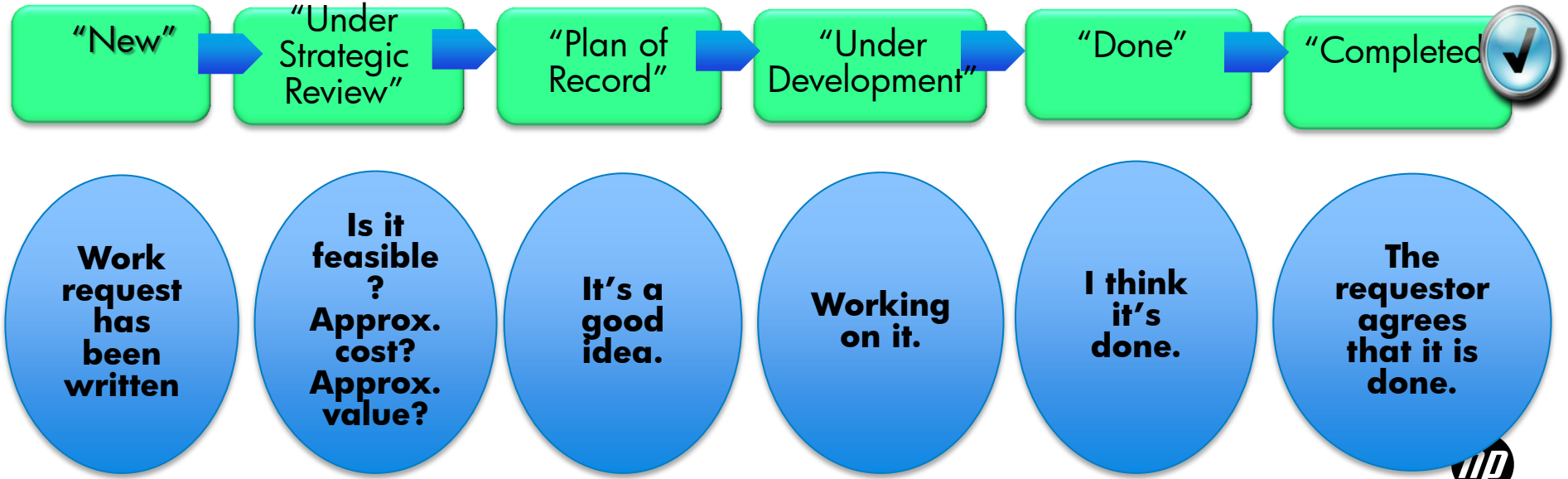
Map activities through which the batches move

Our states created visibility to the top two disputes
-- asking for work vs. agreeing to do the work
-- implementer says it's done, requestor doesn't agree



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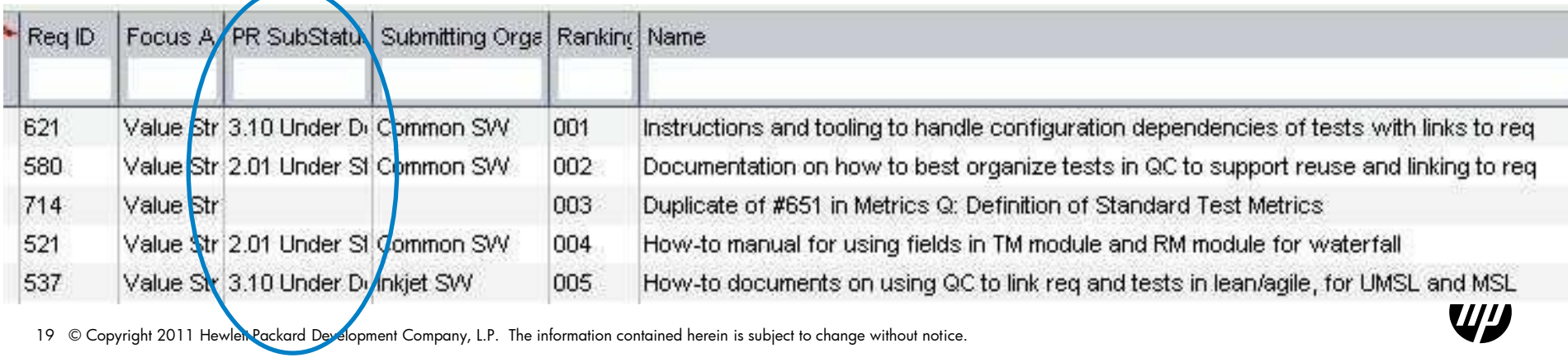
Monitor the progress

Tracked progress and completion in the same tool



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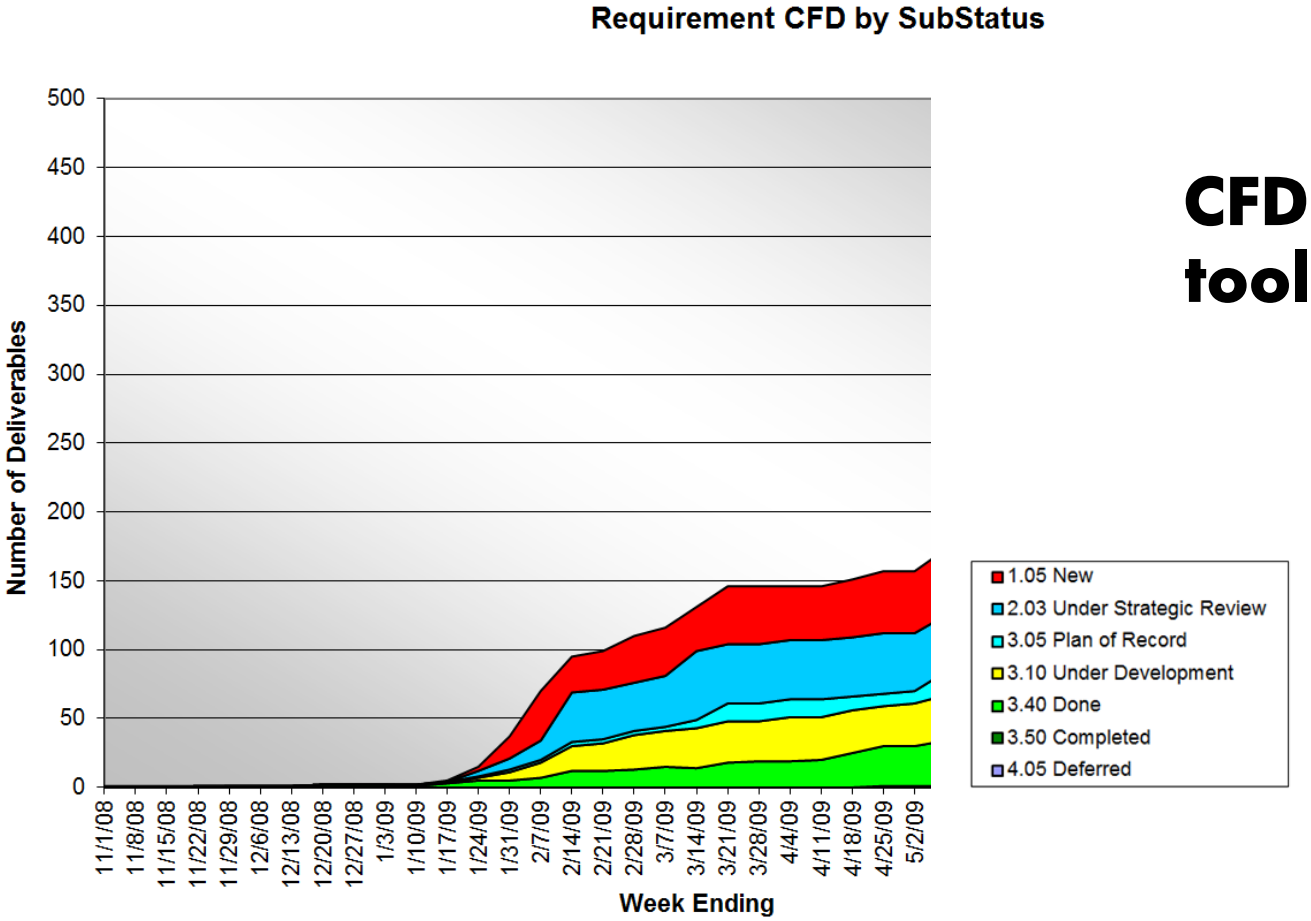
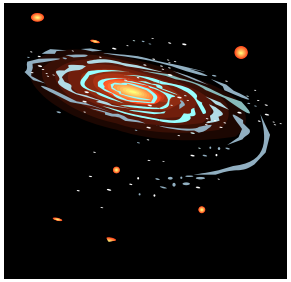
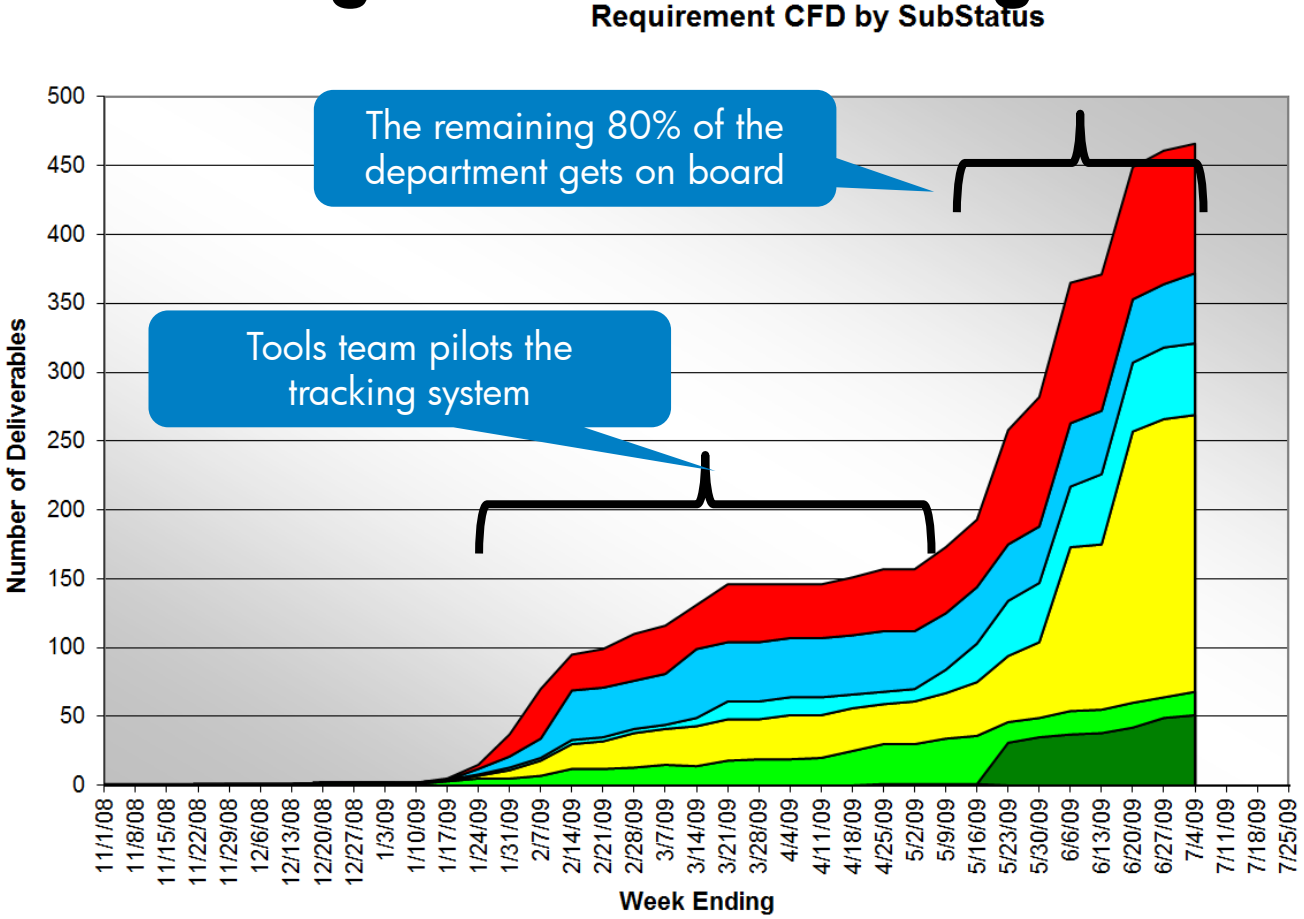
Start monitoring flow of work through activities



CFD for the tools team alone

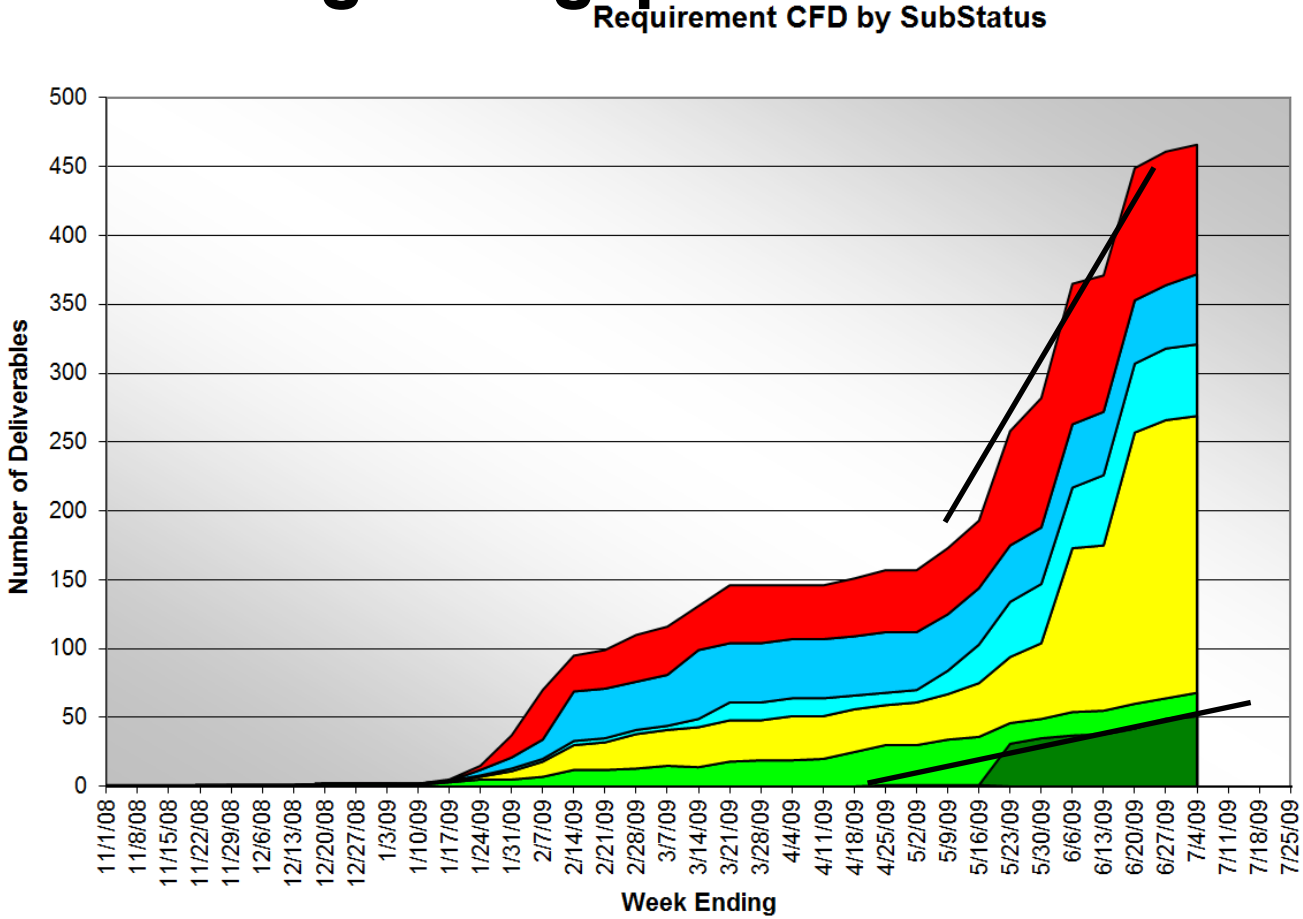
Monitoring flow of work through activities





CFD for entire department

Measuring throughput



Arrival rate = # of batches requested per week

Throughput = # of batches finished per week

Now that the work is visible....

Can we keep up with the demand?
How can we increase ***our*** throughput?

Reduce waste?
Look for bottlenecks?
Reduce Work-in-Progress (WIP) ?

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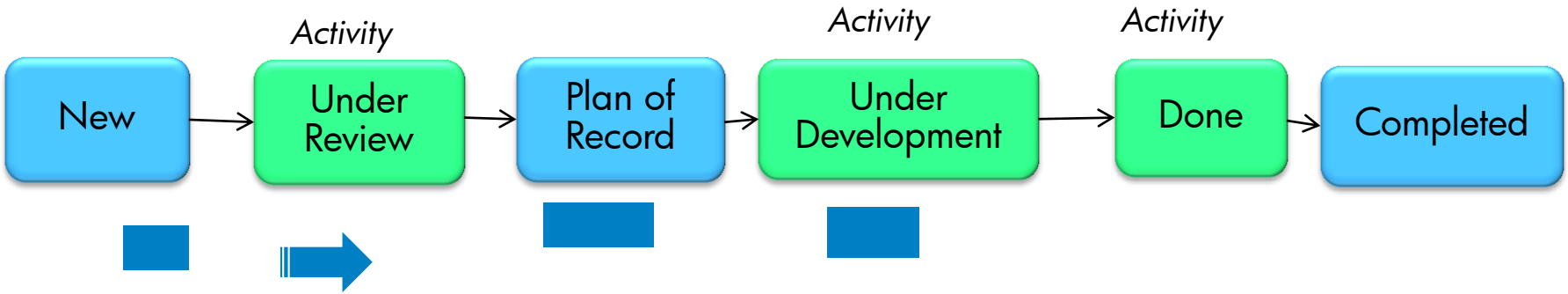
Queuing theory



Queuing theory is a branch of mathematics which describes the behavior of batches of work moving through a system of activities and wait states.

Can calculate: average throughput, cycle time to complete a batch …

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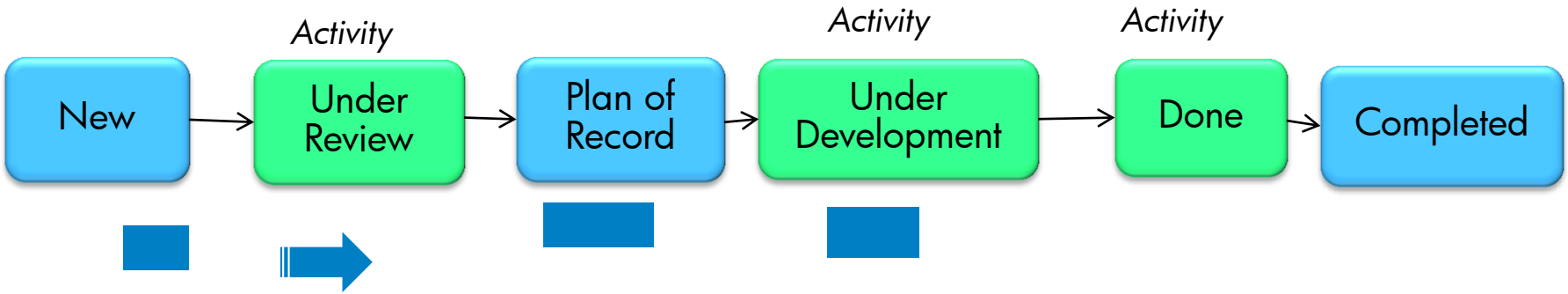
Queuing theory tells us:



System behavior differs radically between systems where:

-- batches are all the same size
-- steady arrival rate
-- batches are physical
-- batches are easily visible

-- batches vary in size
-- variable arrival rate
-- batches are "knowledge"
-- batches are hard to see

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We looked at the theory and examples in books for systems with varying batch sizes and arrival rates

Most likely to cause improvement:

- Work in small batches and finish each batch
- Limit Work-In-Process (WIP) for individuals

Probably less helpful in our current situation

- Look for bottlenecks
- Reduce setup time for each batch so we can run smaller batches

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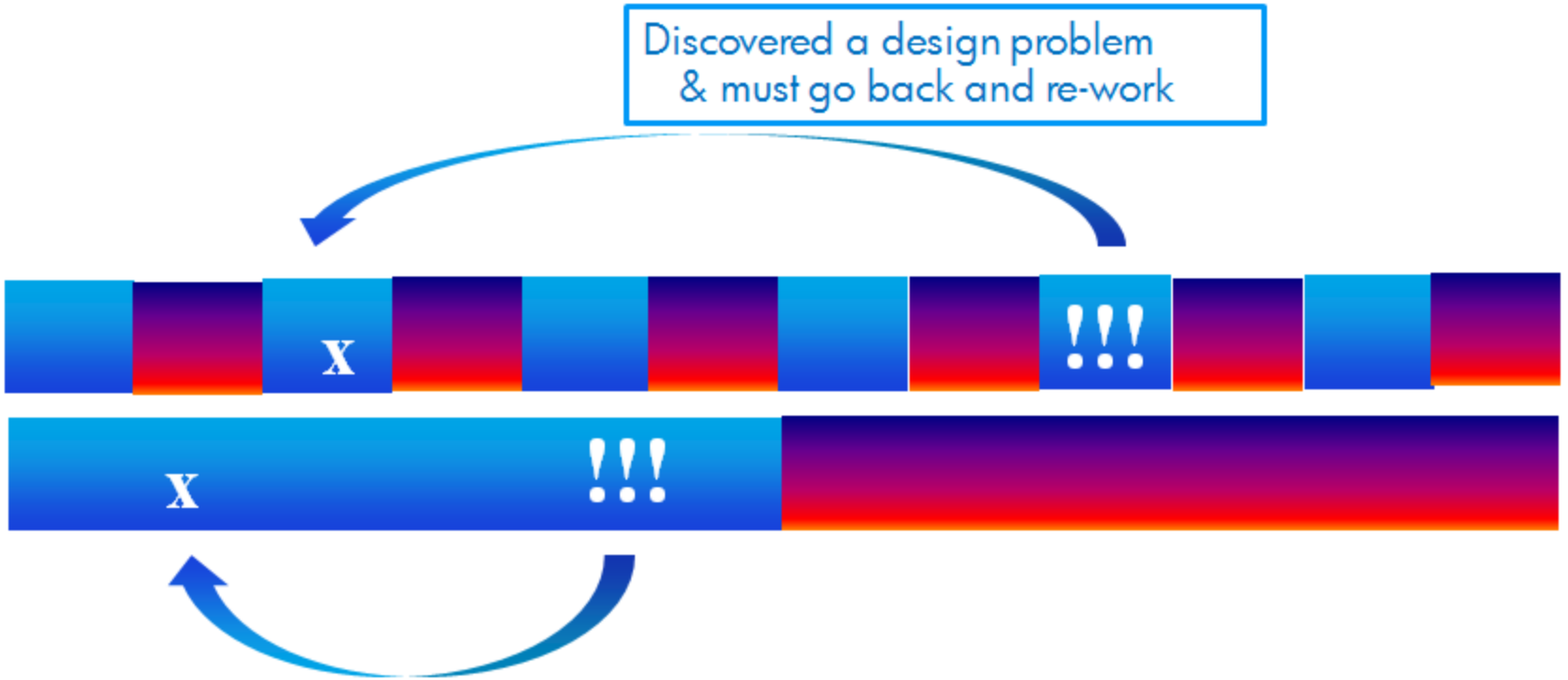
Small batches -> shorter feedback loops -> less work



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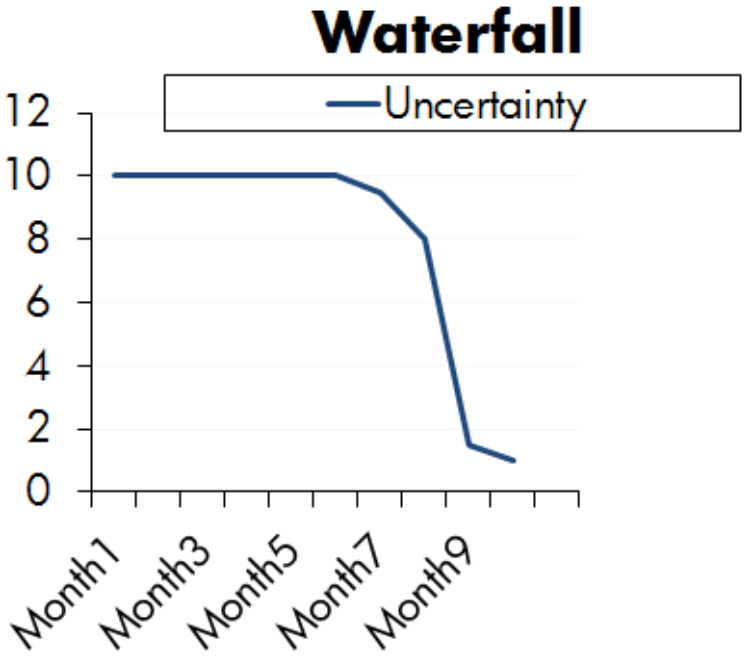
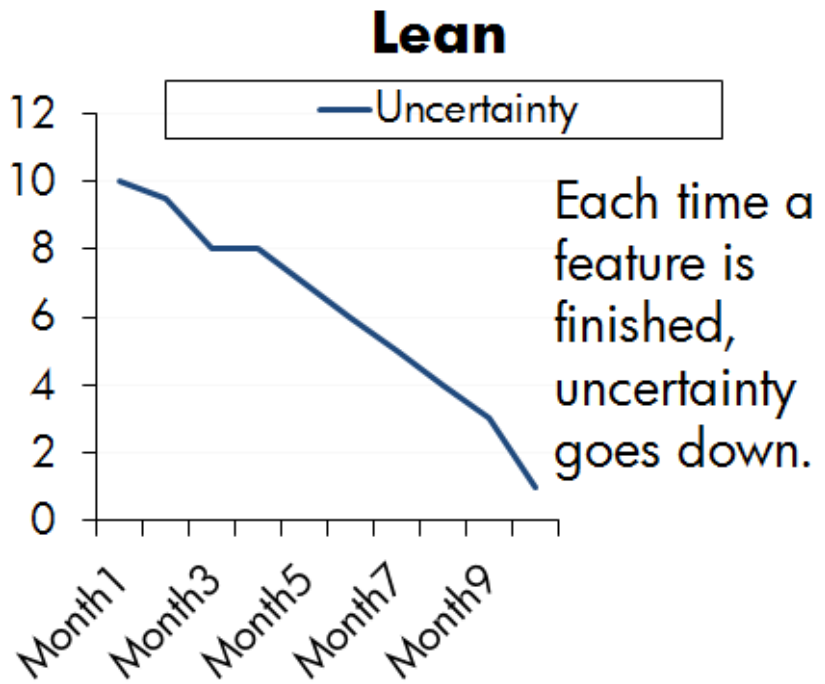
Finishing reduces schedule uncertainty





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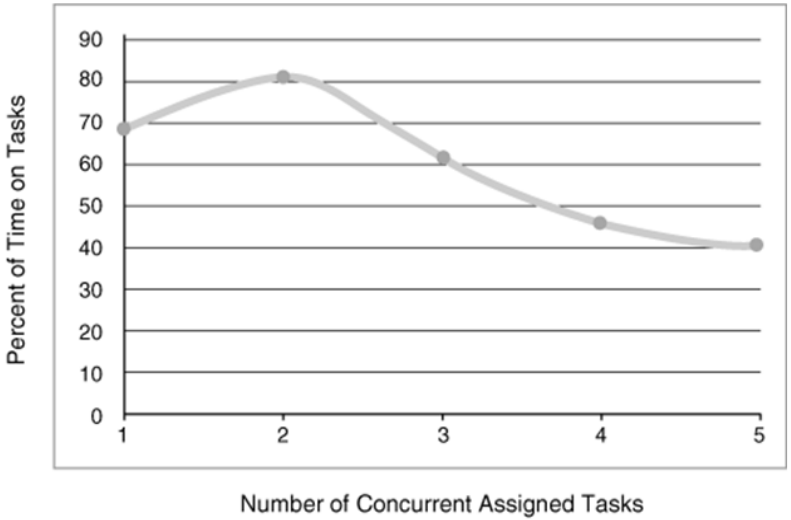
The cost of task-switching in knowledge activities

Psychology studies demonstrate task-switching cost at 10 seconds to 10 minutes, depending on the type of work.

- Engineering work is in the 5-10 minute range.
- Management work often in a smaller range.

Task-switching is usually a huge hidden cost in any "knowledge" activity.

Figure 2.2. Effect of multitasking on productivity.



Cohn, Mike; *Agile Estimating and Planning*; 2006, p.15; Original data from Clark and Wheelwright's *Managing New Product and Process Development: Text and Cases*; 1993

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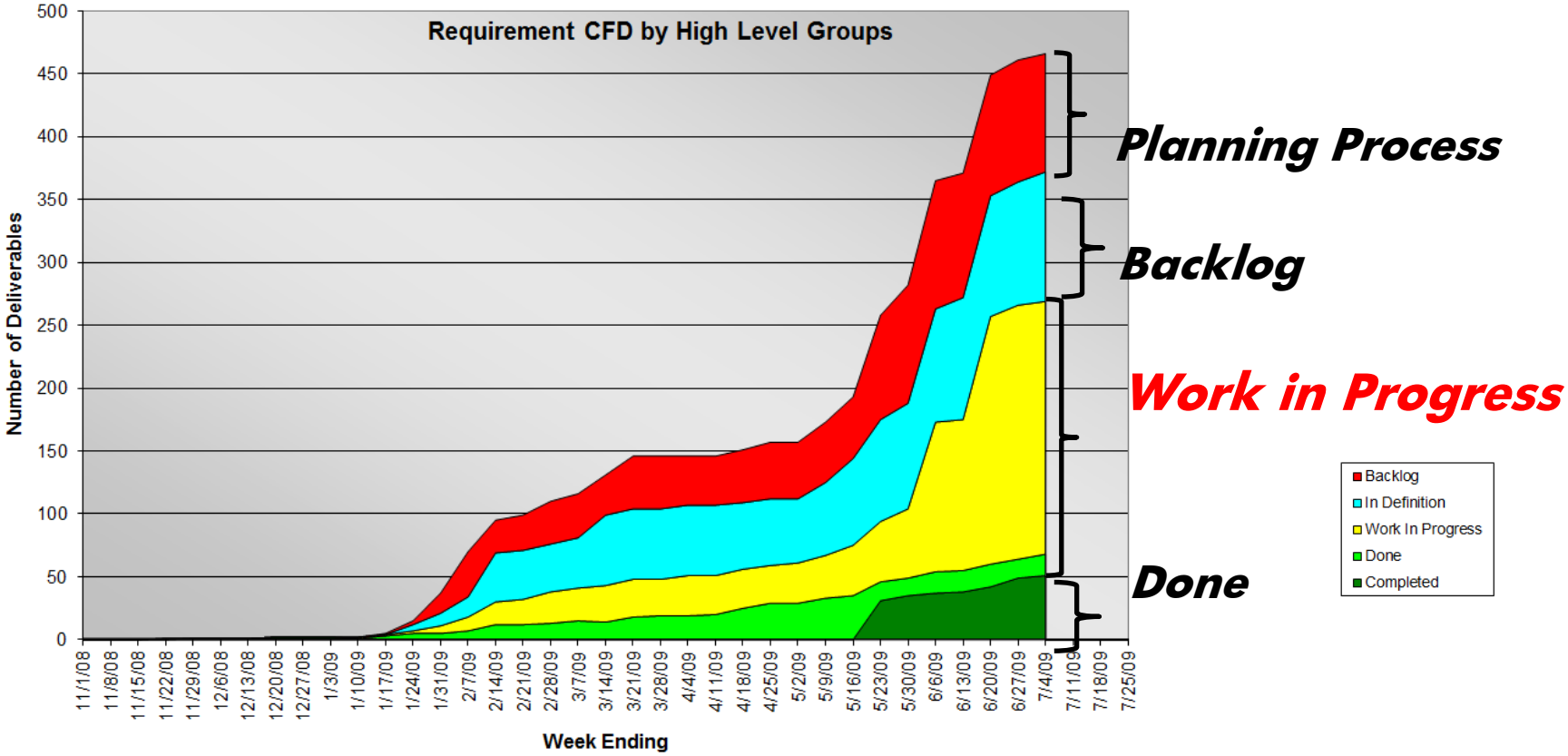
2009: How *is* our overall WIP?



Our New Mantra:

Stop Starting
AND Start Finishing

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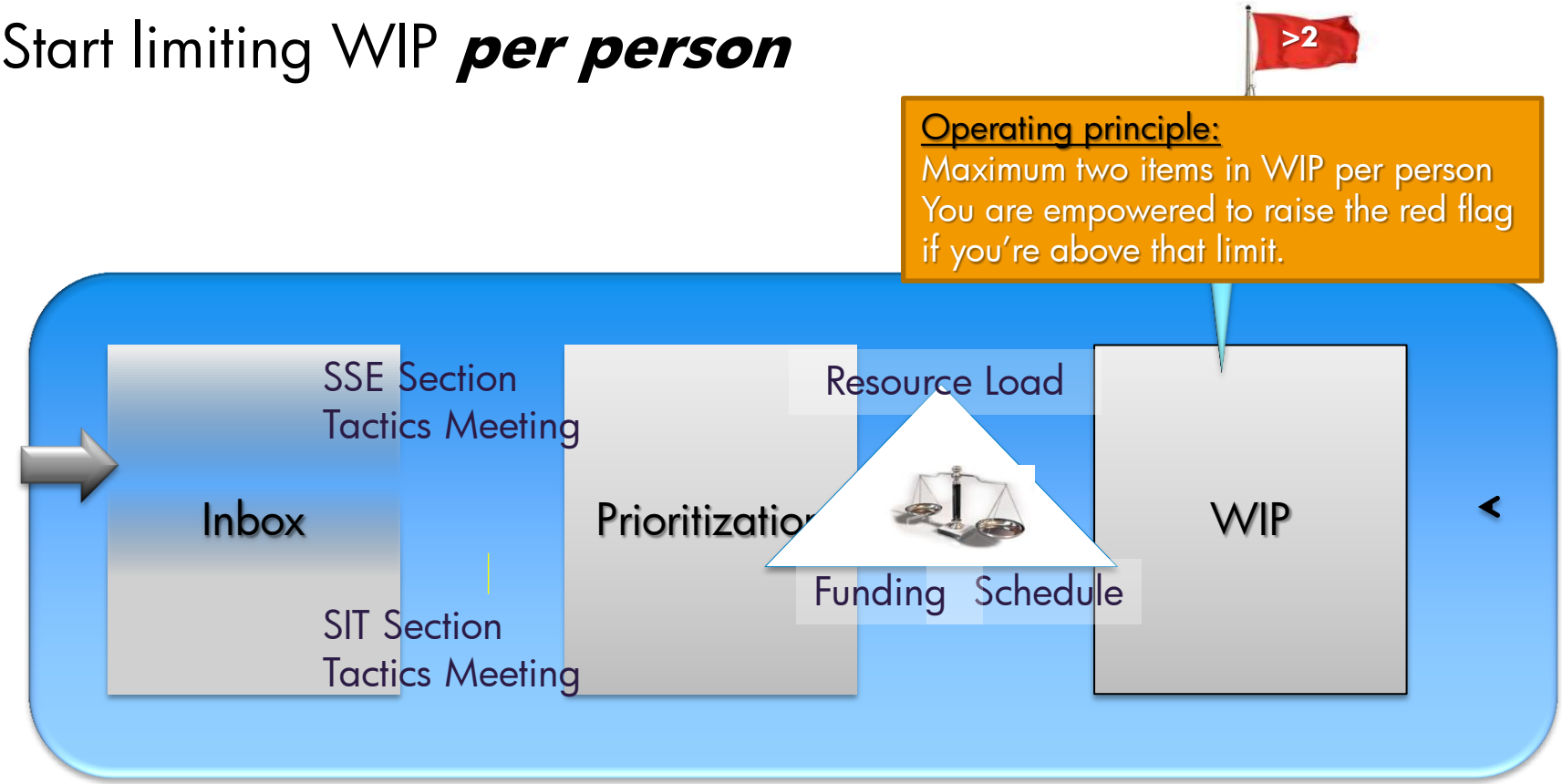
Start limiting WIP ***per person***



"In exchange for low WIP, I expect speed" – lab manager

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With this change…

In 2009, this organization was able to accomplish more “strategic initiatives” than in the previous two years combined:

- Consolidated onto one single test writing and execution tool (and process!)
- Moved most non-system testing “upstream” to other organizations
- Completely re-organized the planning and execution of system test around “getting useful information” – enabled prevention of redundant testing, improved coverage
- Started using CFD and velocity in system test to accurately predict program end dates

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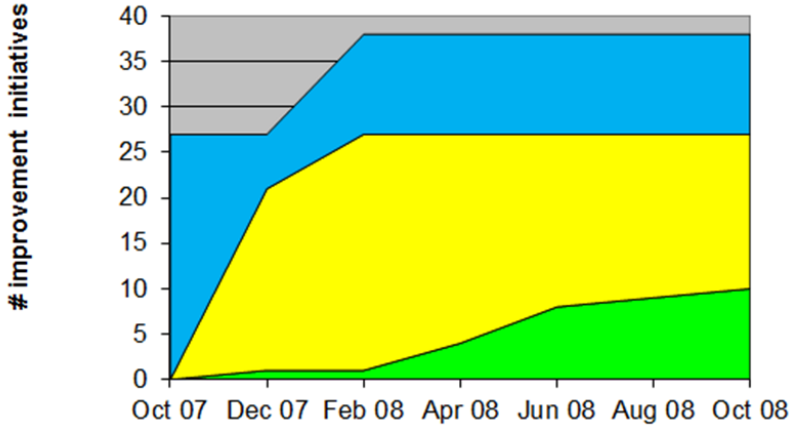
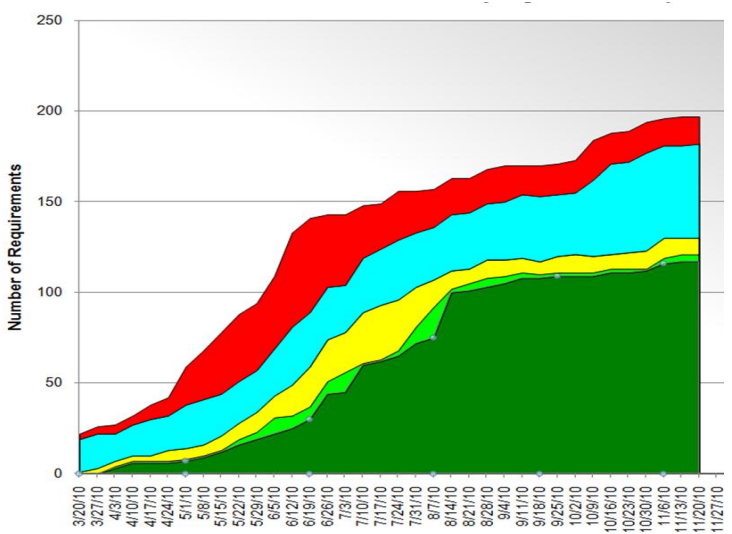
Results: progress on “initiatives” for 2010

FY2008



FY2010



Much earlier delivery of some value
Much more flexibility as business needs change
Much more progress overall

Fast flexible flow!!!

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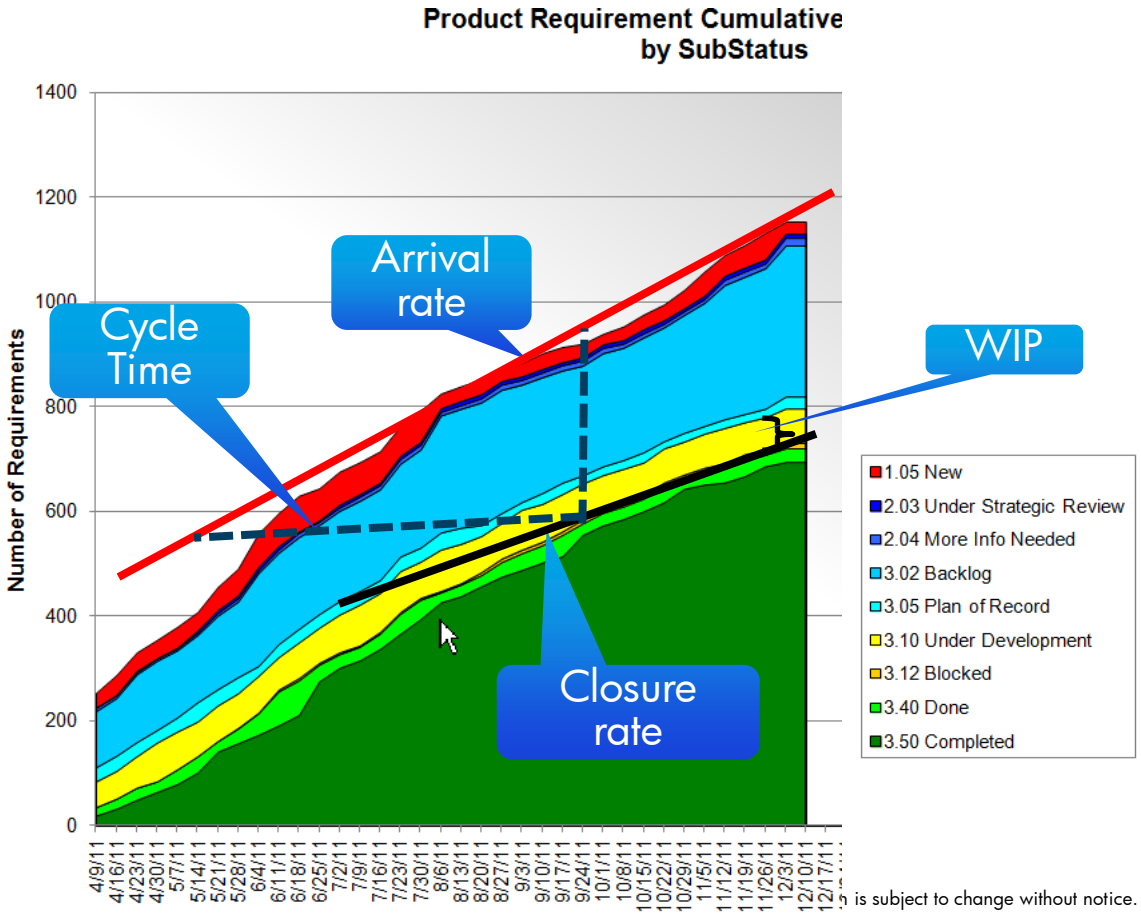
Typical Quarterly Review Now



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- The good
  - Managers have done a great job keeping WIP in control
- The bad
  - Closure rate is still well below incoming rate
- Notables
  - Are we cleaning out the backlog regularly?

287 PR's in Backlog
Submit Dates:
2010 – 19 PR's
11Q1 – 16 PR's
11Q2 – 55 PR's
11Q3 – 66 PR's
11Q4 – 59 PR's
12Q1 – 72 PR's

View from some managers

One of the most significant challenges was to convince the overloaded lab employees that implementing lean was not just another initiative that would start and not finish. L.D.

You can actually ***see*** work moving through the system. L.S.

This is about creating a great work environment that is focused on getting things done. B.D.

The adoption of lean principles enabled me and my team to transition from a traditional testing organization to an effective quality leadership organization. G.S.

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References

- Kanban applied to the work in our system test/integration lab:
  - "Kanban - what is it and why should I care?"; Iberle, Kathy and Reese, Landon. 2011. Proceedings of the Pacific Northwest Software Quality Conference 2011.
- Lean Management applied to development of mixed firmware/software/hardware systems:
  - "Lean System Integration at HP"; Iberle, Kathy; 2010; Proceedings of the Pacific Northwest Software Quality Conference 2010.
- Books with examples of applying queuing theory to systems with variable-sized work items and variable demand
  - See references in "Kanban – what is it and why should I care?"

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Thank you

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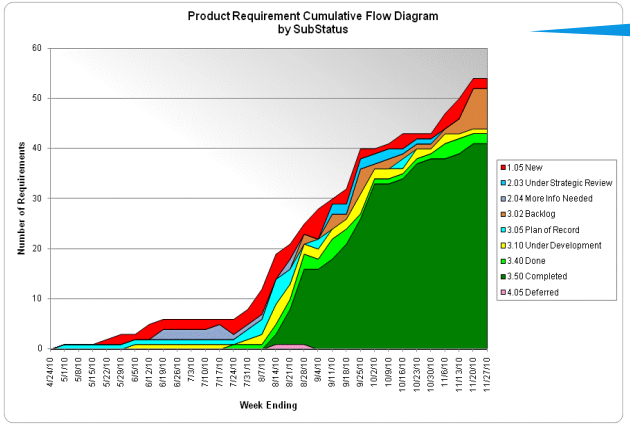
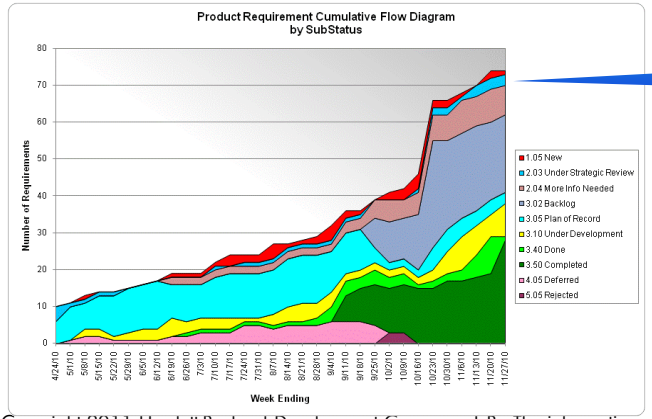
Additional benefits for managers: more tools



Queue #1: Required to keep plane flying

Closure rate > ~3/week



Queue #2: Improvements

Closure rate = ~1/week

- Too much to do?
- Divide work into "required" and "improvements", tagging every work item as one or the other.
- Now you can manage the two queues separately
- We can quickly switch focus to concentrate on one queue or the other

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Consistency across the department (2009)

A Work Request ***IS***…

1. The standard way work is requested, prioritized, planned, tracked, reported, and closed across our department.
2. Prioritized across our whole department
3. The way to view and measure our organization's performance.
4. One day to two weeks in duration.

A Work Request *IS* **NOT**.

1. Optional or tailored to your team.
2. A guarantee that your request will be implemented.
3. To highlight or measure personal performance
4. A measurement of every little piece of work.

What *is* the valuable output of our work?

ein is subject to cha

Challenges in implementing Lean

- The usual suspects:
  - Sponsorship. This method radically changes how a group is managed, so the top management must actively expect and reward the new behavior.
  - Proficiency in the new method. Required research and substantial, repeated training.
  - Buy-in among organization. Advertised repeatedly "What's in it for me".
- Challenges particular to Lean:
  - Deciding on an appropriate batch size and how large a range to allow.
  - Getting the "overhead" for each batch down to a reasonable size.
  - Organizational expectation that commitments are made far in advance and permanently.

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