**Project Flow: Lowering WIP to Increase Productivity & Throughput**

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To achieve Project Flow for the benefit of lowering WIP to increase Productivity and Throughput in a product development system, we must correctly **apply** Lean Principles **AND decouple** Resource Management from Project Management.

The focus of this presentation is on product development systems where a portfolio of projects (typically engineering or manufacturing projects) is being executed by a finite pool of engineering or product development resources. That is to say that the system is capacity constrained.

We observe that typical product development systems have 2 to 3 times more projects than they have the resources to handle them. This tendency to PUSH projects into this capacity constrained system is to create high levels of WIP (work-in-progress). In manufacturing systems, high WIP leads to high inventories on the factory floor, long queues and long cycle times. In product development, we see the same thing. High inventories in manufacturing equates to overloaded “in boxes” in product development.

Long queues and cycle times also exist in product development. High WIP leads to starting projects ASAP which causes resources to multi-task multiple tasks and/or projects. This causes delays and queues during project execution which ultimately leads to long product development cycle times.

This is sometimes called “the vicious cycle”. Its impact or effects are:

- Projects get delayed and require heroic efforts to complete on-time
- Cycle times (intervals) are longer
- Heroic efforts are required to complete a task, only for it to sit in a queue downstream
- Priorities change constantly; forced to pull resources from one task to another
- Lack of support to accomplish task; material, vendor, engineering support not available as needed
- Lack of adequate resources both in skill and quantity
- Time and budget over run
- Managers bogged down in firefighting

The solution to “the vicious cycle” or a project PUSH system is to apply Lean Principles:

- Reduce WIP
- Reduce queues
- Control batch sizes
- Use a PULL system

To create such a PULL system requires us to manage the capacity constraint of the system which is the finite pool of resources that do the work of project execution. Thus, we must seek portfolio achievability by effective resource management through sound capacity planning.

A simple, effective approach to resource management can be based on the immutable laws of supply and demand. Supply is the inventory of resources. It can be identical to your organizational chart, down to the numbers of people, their names, and specific skill sets (e.g. mechanical engineer, software engineer).

Demand is the work that the organization has taken on. In most product development organizations you have feasibility (pre-development) projects, full development projects, projects related to customer or field support, and internal quality or process improvement projects. There may be other categories in your company. Project managers prepare a timeline for each project, allowing for various phases—design, development, testing, and so on. The resource managers (i.e. engineering managers) then input their estimates of how many engineers, and how much of their time, will be assigned to each phase. This is called the “effort forecast.”

Figure 1
Effort Forecast Example

**Effort Forecasts**

Project: Pony Express

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Design | | Development | | | | | Integr | System Test | |
| | | | | | | 1Mar04 | | | | | | | | 1Dec04 | |
| | | | | Column Totals | 22.5 | 0.0 | 0.0 | 1.5 | 1.5 | 2.0 | 2.0 | 2.0 | 2.0 | 3.5 | 4.0 | 4.0 | 0.0 |
| Org1 | Org2 | Org3 | Resource | Project Name | Row Total | Jan 2004 | Feb 2004 | Mar 2004 | Apr 2004 | May 2004 | Jun 2004 | Jul 2004 | Aug 2004 | Sep 2004 | Oct 2004 | Nov 2004 | Dec 2004 |
| Eng | SysTest | | Contractor | Pony Express | 12.00 | | | | | 0.50 | 0.50 | 0.50 | 0.50 | 2.00 | 4.00 | 4.00 | |
| Eng | HW | | Contractor_1 | Pony Express | 7.00 | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | | |
| Eng | HW | Mech | Ann | Pony Express | 3.50 | | | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | | | |

Analysis begins by aggregating the effort forecasts for each project into a composite picture of all the projects in the portfolio. Managers can then begin to identify resources that are overloaded with work. More importantly, this analysis will identify projects that are understaffed and, hence, unachievable as currently planned. Because a typical product development organization has many projects and many resources, this composite picture is most easily painted using a computer software tool.

Figure 2
Portfolio Analysis Example

**Project Analysis**

| Project Name | Prior | Row Totals | Jan 2004 | Feb 2004 | Mar 2004 | Apr 2004 | May 2004 | Jun 2004 | Jul 2004 | Aug 2004 | Sep 2004 | Oct 2004 | Nov 2004 | Dec 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coolidge | | 100% | | | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Hera | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | |
| Monroe | | 95% | | | | | | | | | 94% | 95% | 95% | 95% |
| Orpheus | | 100% | 100% | 100% | 100% | | | | | | | | | |
| Thor | | 98% | | | 97% | 100% | 100% | 94% | | | | | | |
| Wilson | | 100% | | | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Wing Ding | 2 | 98% | | | 100% | 100% | 100% | 88% | 100% | 100% | 100% | 100% | | |
| Athena | 4 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | | | | |
| Medina | 4 | 93% | | | | 100% | 76% | 86% | 100% | 100% | 100% | | | |
| CT 1_SW | 5 | 59% | | 75% | 68% | 94% | 86% | 22% | 17% | 39% | 39% | 39% | 100% | |
| Treasure | 5 | 94% | 100% | 100% | 100% | 100% | 95% | 100% | 84% | 70% | 82% | | | |
| Casablanca | 6 | 92% | 100% | 100% | 70% | 90% | 90% | 85% | 90% | 90% | 91% | 96% | 98% | 100% |
| The African Queen | 7 | 72% | | | 53% | 73% | 64% | 58% | 70% | 71% | 75% | 84% | 90% | 100% |
| Brooklyn | 10 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | | | | | |
| Arruba | 11 | 80% | | 100% | 100% | 100% | 100% | 100% | | | 51% | 83% | 91% | 100% |
| CT 1_NET | 12 | 77% | | 100% | 100% | 67% | 100% | 83% | 83% | 83% | 50% | 50% | 50% | |
| CT 2_SW | 12 | 68% | | 75% | 75% | 41% | 50% | 50% | 50% | 58% | 31% | 69% | 100% | |
| Barina | 20 | 57% | | 67% | 43% | 24% | 53% | 44% | 58% | 58% | 74% | 74% | 89% | 100% |
| CT 3_NET | 20 | 26% | | 67% | 67% | 33% | 57% | 8% | 17% | 17% | 0% | 0% | 0% | |
| Manhattan | 20 | 80% | 100% | 100% | 50% | 50% | 100% | 100% | 100% | | | | | |
| CT 2_NET | 24 | 8% | | 33% | 33% | 17% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | |
| Bahama | 28 | 48% | | 50% | 50% | 65% | 36% | 55% | 34% | 18% | 36% | 65% | 100% | 100% |
| Queens | 30 | 25% | 100% | 0% | 0% | 0% | 50% | 0% | | | | | | |
| Harding | 42 | 69% | | | | | | 22% | 20% | 52% | 68% | 76% | 84% | 100% |
| Hudson | 45 | 42% | | | | | 44% | 42% | 40% | 43% | | | | |
| Jackson | 51 | 82% | | | | | | | 92% | 88% | 81% | 68% | 81% | 86% |
| Mfg Project | 55 | 100% | | | | 100% | 100% | 100% | 100% | 100% | | | | |
| PDW Upgrade | 1000 | 0% | | | | | 0% | 0% | 0% | 0% | | | | |
| CT 3_SW | 9999 | 15% | | 21% | 25% | 4% | 14% | 0% | 6% | 14% | 14% | 14% | 36% | |
| New Project | 9999 | 0% | | 0% | 0% | 0% | 0% | | | | | | | |
| Pony Express | 9999 | 83% | | | 67% | 67% | 100% | 100% | 100% | 100% | 94% | 45% | 88% | |

Decision making is the difficult, but necessary, final step to arrive at an achievable portfolio of projects which does not overload your resources and clog your product development pipeline. According to Peter Heinrich, president of Portfolio DecisionWare Inc., a developer of resource management software based in New York, “You only have four decisions to take to remove the overload in your supply-and-demand picture: cancel projects, reduce projects in scope, postpone projects, or add resources to meet the project demand.”

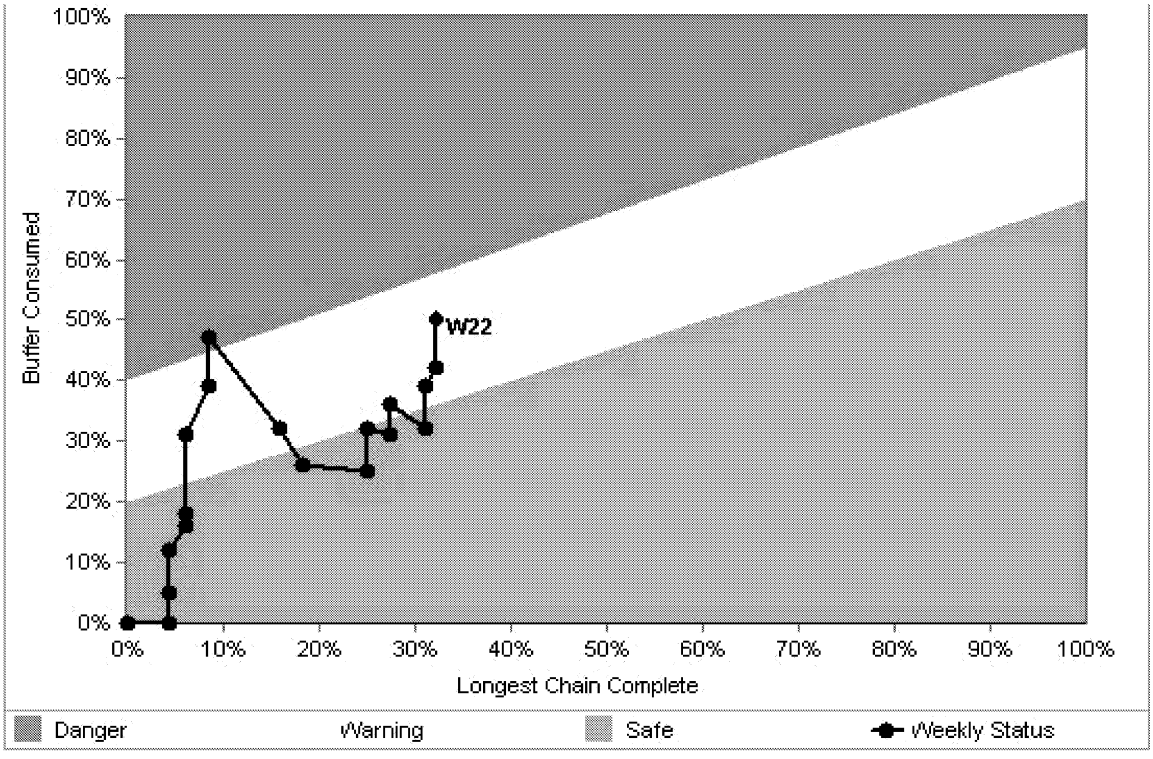
While the above process puts in place a powerfully effective PULL system for improving the Throughput of product development systems, there is another, important phenomena occurring in product development systems that has to be dealt with. That is the phenomena of risk and uncertainty.

Again, we observe that typical product development organizations manage these high risk and uncertainty projects using standard, milestone project management. That is, projects are broken up into a series of milestones that are often managed at a departmental level. Consequently, project management in this paradigm revolves around measuring the performance of each department on meeting their milestones. This causes a conflict for such organizations. Do they provide a short milestone estimate for the good of the project? Or do they provide a longer, padded milestone estimate for the good of satisfying their measurement that may lengthen the project to an unacceptable duration? Furthermore, these milestone measurements almost certainly guarantee that no projects will finish early (since no one wants to admit that they padded their milestone estimates) and many finish late (or cut scope or exceed budget to finish on time).

The solution here is called Buffer Management. Buffer Management is a product of the Critical Chain Method which was first introduced in 1997 by Dr. Eliyahu M. Goldratt. The Critical Chain Method is a proven method to effectively manage the risk and uncertainty that is encountered in product development projects. It essentially seeks to squeeze contingency or safety out of individual tasks in a project plan and aggregate this contingency or safety in strategic locations in the project plan. This aggregated contingency is what is called "buffers". The contingency is, therefore, owned by the project or system and not by the individual task owners.

During project execution, the people doing the work in each project are regularly updating task status in such a way that the consumption of each buffer in the system can be measured. By measuring the percentage of each buffer consumed relative to the percentage of the work completed on the chain of work associated with that buffer, a manager is able to measure the status or health of a project at any given time.

Figure 3
Buffer Management Example




A survey of all the buffers provides a measure of the status or health of all the projects in the product development system.

In conclusion, to achieve Project Flow for the benefit of lowering WIP to increase Productivity and Throughput in a product development system, we must correctly **apply** Lean Principles:

- Use a PULL system
- Reduce waste & queues
- Control batch sizes

The key factor, however, is to **decouple** Resource Management from Project Management:

- To ensure an achievable portfolio, we must perform effective resource management through sound capacity planning.
- To ensure individual project achievability (or success), we must create aggregated time safety or contingency which is called Buffer Management.

Companies using Project Flow have achieved the following:

- Increased Throughput and Productivity by 20-25%
- Achieved Business Growth and Success
- Doubled Throughput in 2 years
- Reduced Stress and Increased Job Satisfaction