Execution Management:
Getting the Most from Product Development Capacity

Under pressure to develop more products while holding their budgets constant, product development organizations are operating under severe time and resource constraints. Little margins for errors remain in executing projects under these conditions.

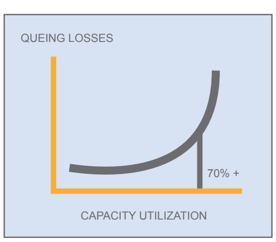
By the same token, developing more products faster can be the key to competitiveness and higher profits. Businesses that can excel in execution will reap substantial rewards.

Over the last many years, product development organizations have had to increase the rate at which they develop new products, while holding resources at the same levels. As a result, product development capacity has become the major limitation today for many businesses. These capacity limitations affect all aspects of product development – from deciding which projects to undertake, creating technology roadmaps, to coordination and control in execution:

I. Portfolio Selection: At the portfolio level, it is no longer possible to accept a project on its own merits. The question one has to answer is: which current or new projects will have to be sacrificed in order to free capacity up for the project being considered, and what is the net effect on business goals of sacrificing those projects?

In addition, lead times for developing new technologies are affected by capacity. Often the best option might be to use an off-the-shelf technology or extend an old platform[1], than wait for capacity to be freed up for leading edge technologies and new platforms.

II. Pipeline Planning: Projects-based operations experience substantial queuing losses (contention for resources, wait times, multitasking etc.) beyond a certain level of capacity utilization. Overload resources by even 10% and the entire pipeline gets clogged … start 10% less projects than what development capacity allows and you sacrifice substantial opportunities. Pipelines have to be carefully loaded and projects properly sequenced to maximize the flow.



III. Pipeline Execution: Most common complaint of project managers during execution is that they do not get resources when needed (even if promised during planning) – somehow required people are always working on other projects. Resources on the other hand complain about conflicting priorities, and about being forced to multitask.

Determining good priorities for resources, and assigning them to the right tasks at the right time can dramatically shorten lead times and increase project completion rates.

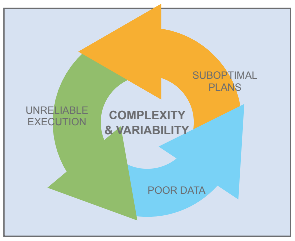
While it is clear that little margins for errors remain today in managing product development capacity, it has hitherto been impossible. The next section explains why.

[1] Platform is a collection of common technical elements that can be used for developing multiple products.

Obstacles to managing execution in product development

While execution management has been successfully applied and integrated into manufacturing management, following factors block us from managing execution in product development:

I. High uncertainties: development tasks cannot be perfectly estimated and delays are inevitable. These delays quickly multiply through activity dependencies and shared resources, preventing management from establishing stable plans and priorities.



II. Poor data: Effects of uncertainties are compounded by poor data. Not having managed their product development capacity in a systematic manner, most organizations have poor data about it. Time and effort required for collecting and refining data becomes an additional obstacle to undertaking capacity management.

Result is a vicious cycle that organizations find difficult to escape from. We need a pragmatic but powerful solution for tackling these obstacles.

Product Development Planning: portfolio selection and project sequencing

Its most limiting resources govern flow of projects through the product development pipeline.

No matter how many activities need to be completed, how complex their interrelationship is, or how many different resources are required, flow of projects through the NPD pipeline is governed by its bottlenecks, i.e., resources that have least capacity compared to the demand placed on them. As corollaries:

- Throughput of the pipeline equals throughput at the bottlenecks.
- Releasing projects in violation of bottlenecks' capacity creates unnecessary WIP.
- Capacity (and operating expense) should support throughput at the bottlenecks.

Following is how we use these inescapable facts to optimize resource allocation during planning:

I. Portfolio Selection: In an unconstrained environment, the rule for selecting projects is very clear. The correct decision is to take a project on if it has positive NPV. But let us assume that there is a finite capacity constraint imposed on the business[2]. How should the NPV rule be modified to consider projects?

As an illustration, Table 1 shows five projects. With no capacity constraints we would accept all five because they all have positive NPV. Now suppose there is a test lab whose capacity is required by these projects for a total of 85 weeks, but only 50 weeks of capacity is actually available.

If we prioritize projects according to their individual NPV, we would accept project 1, skip project 2 (because it needs more than remaining capacity), and accept project 3. Portfolio throughput would be $75,000,000.

But we can increase total throughput to $105,000,000 by accepting projects 5, 2, 4 and 3. These projects have the greatest combined NPV among those combinations of projects that use no more than 50 weeks of test lab capacity.

[2] These are also called constrained capital budgeting problems (reference: "Financial Theory and Corporate Policy", 3rd edition, by Copeland and Weston, Page 55). The constraint could be availability of budgets, or capacity, for example.

The logic leading to correct decision is formalized by prioritizing projects on NPV per unit of constraint's capacity required for each project (constraint-indexed NPV).[3] Using constraint-indexed NPV leads us to first accept project 5, then 2, 4 and finally 3.

Table 1: Illustration of constraints-based portfolio optimization

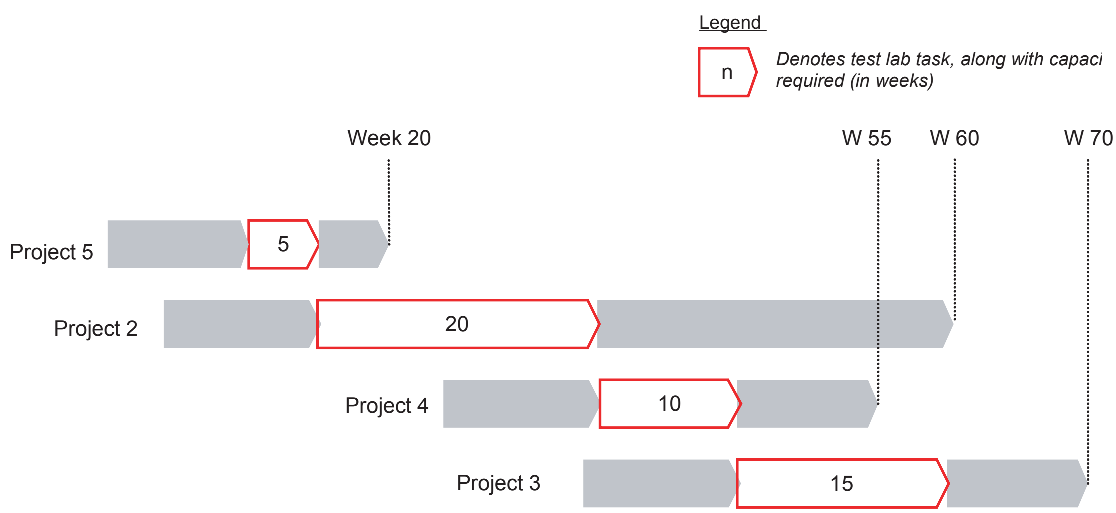
PROJECT	NET PRESENT VALUE (RISK-ADJUSTED)	CAPACITY REQUIRED AT TEST LAB	DECISION WITH SIMPLE NPD	NPV PER UNIT OF TEST LAB CAPACITY	DECISION WITH CONSTRAINT-INDEX NPV
1	$50,000,000	35 WEEKS	SELECT	$1.43 M/ WEEK	DISCARD
2	$45,000,000	20 WEEKS	DISCARD	$2.25 M/ WEEK	2ND CHOICE
3	$25,000,000	15 WEEKS	SELECT	$1.67 M/ WEEK	4TH CHOICE
4	$20,000,000	10 WEEKS	DISCARD	$2.00 M/ WEEK	3RD CHOICE
5	$15,000,000	5 WEEKS	DISCARD	$3.00 M/ WEEK	1ST CHOICE
		PORTFOLIO THROUGHPUT:	**$75,000,000**		**$105,000,000**

II. Pipeline Planning: in an unconstrained environment its critical path dictates lead-time of a project. However in capacity-constrained cases, project schedules and lead times depend on when capacity is available at the constraints.

Continuing with our previous example, once we select Projects 5, 2, 4 and 3, what should be the due-dates of those projects. For simplicity assume that testing lies on the critical path of each project. Table 2 and the accompanying figure show how the test lab is loaded and, then, how project due-dates are established.[4]

Table 2: Illustration of constraints-based due-date quotation

PROJECT	PROJECT LENGTH PRIOR TO TEST	TESTING CAPACITY REQUIRED	TESTING SCHEDULE	PROJECT LENGTH AFTER TEST	PROJECT LEAD TIME
5	10 WEEKS	5 WEEKS	WEEK 11 - 15	5 WEEKS	20 WEEKS
2	10 WEEKS	20 WEEKS	WEEK 16 - 35	25 WEEKS	60 WEEKS
4	10 WEEKS	10 WEEKS	WEEK 36 - 45	10 WEEKS	55 WEEKS
3	10 WEEKS	15 WEEKS	WEEK 46 - 60	10 WEEKS	70 WEEKS



[3] Use of constraint-indexed NPV yields the same results as linear programming optimization. Therefore, not only is using constraint-indexed NPV simple, but also optimal.

If projects are released earlier than when test lab is available, that will only disrupt the existing flow of projects – causing loss of throughput and due-date performance.

Increasing constraint's capacity cuts lead times. In our example, if the company doubled the capacity of the test lab, they can finish projects 4 and 3 in almost half the time![5] Thus, an understanding of the constraints and their capacity also forms the basis of a uniquely valuable piece of information: tradeoff between lead times and capacity.

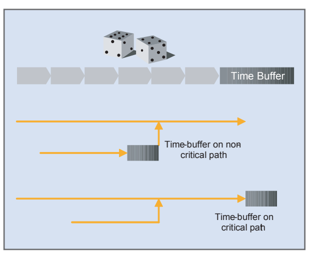
Product Development Execution: coordinating work and resources

Uncertainties limit us from achieving the full throughput potential of constraints.

Uncertainties make local delays inevitable, and due to strong dependencies among tasks those delays tend to propagate rapidly. When delays mount, even non-constraints start experiencing persistent peak loads that interrupt overall pipeline flow. As a result:

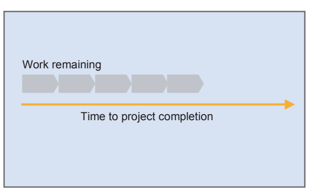
- WIP goes up and project due-dates start slipping, jeopardizing throughput.
- Priorities become unstable – people are shuttled randomly between tasks, reducing their productivity by 20 to 80 percent. (Knowledge workers are not machines that can be switched on, and made to produce full-stream instantly. And if switched off, half-finished work decays rapidly).

If organizations want high project due-date performance and highest possible productivity, they need to contain the effects of uncertainties. Good planning is not enough, and execution tools are required to assure highest level of performance:



I. Time-buffers: these are blocks of time with no scheduled work – typically placed at the end of a set of activities to absorb variability in those activities:

- On non-critical paths, time-buffers **protect integration points**, without increasing project length.
- On the critical path, time-buffers **protect project due-date**

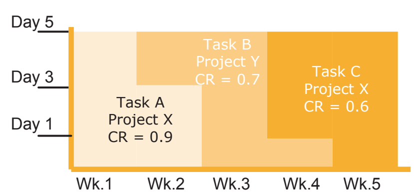


II. Priority setting: even with adequate average capacity, task-time variability during execution can cause peak loads. These peak loads can cause queuing losses in the form of delayed projects and expediting costs. "Just-in-time" resource assignment can be used to contain those losses:

- Since it is difficult to predict actual timing of tasks, they are scheduled when they are actually available to be worked on.
- Critical Ratio is calculated for various tasks in the queue (= work remaining through to project completion / time to project completion.)
- Tasks with highest Critical Ratio are the ones most critical to due-dates of their respective projects, and get first priority. Table 3 and accompanying figure illustrate how to create a just-in-time schedule.

Table 3: Just-in-time queue control using Critical Ratio (CR)

TASK (PROJECT)	WORK REMAINING	TIME TO COMPLETION	CRITICAL RATIO	CAPACITY NEEDED
A (X)	18 WEEKS	20 WEEKS	0.9	8 DAYS
B (Y)	14 WEEKS	20 WEEKS	0.7	8 DAYS
C (X)	9 WEEKS	15 WEEKS	0.6	9 DAYS



[5] Assuming no other resources emerge as new bottlenecks.

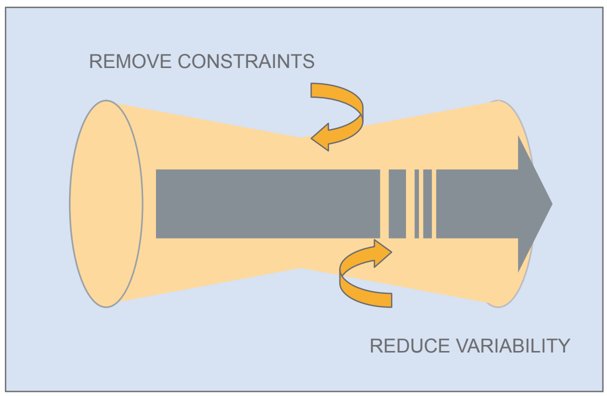
Instituting a process of ongoing improvement

Improvement initiatives should be targeted at the sources of biggest disruptions to flow.

Product development organizations are being tasked not just to make sporadic improvements – but progressively and rapidly improve their performance. This is reflected in growing popularity of concepts such as 6-sigma that focus on process improvements.

Since both the time and resources available to make improvements are finite, managers need to identify areas where local improvement will yield immediate and substantial gains in overall performance. Question is, how to identify high leverage areas?

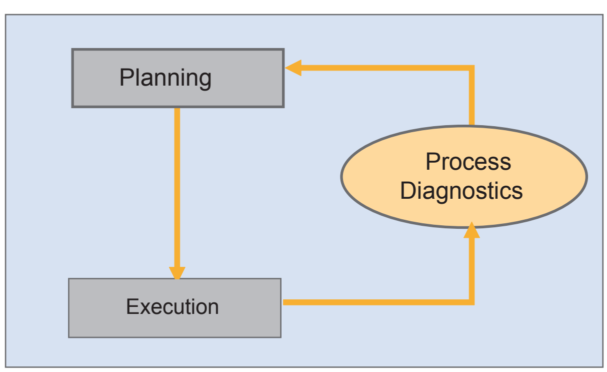
As discussed earlier, constraints establish the upper limit on throughput, and uncertainties limit an organization from achieving that full potential by creating interruptions to flow. Thus, improvement efforts can be directed at **removing constraints** and **reducing uncertainties.**



While constraints are easily identified, difficulty is in selecting areas for reducing uncertainties.

Using buffer performance history to reduce uncertainties
When time-buffers are used to protect schedules, we could also keep a history of which activities actually use up that protection. If we classify those activities (by the type of resources required to perform those activities; type of work they represent; and type of projects they are in), we can have the data to find the biggest sources of interruptions to flow.

Whichever areas consistently consume the highest amount of buffers should be targeted for process improvement - tightening of technical processes, improvement in task estimates, deployment of computer-aided engineering tools, all can be prioritized.



Results from Execution Managment

	BEFORE	AFTER
Next Generation Wireless Technology Product Development Airgo Networks	Cycle time from first silicon to production for 1st generation was 19 months.	Cycle time from first silicon to production for 2nd generation was 8 months.
Automotive Product Development DaimlerChrysler	Cycle time for prototype builds was 10 weeks.	Cycle time for prototype builds is 8 weeks. Delivery date performance increased by 83% with much less fire fighting.
Telecommunications Network Design eircom, Ireland	On-time delivery less than 75%. Average cycle time was 70 days.	Increased on-time delivery to 98+%. Average cycle time dropped to 30 days.
Biotechnology Plant Engineering Genencor	20% projects on time.	87% projects slated to complete on time, with 15% immediate increase in throughput.
Home Appliances New Product Development Hamilton Beach/ Proctor-Silex	34 new products per year. 74% projects on time.	Increased throughput to 52 new products in 1st year, and to 70+ in 2nd year, with no increase in headcount. 88% projects on time.
High Tech New Product Development HP Digital Camera Group	6 cameras launched in 2004. 1 camera launched in the spring window. 1 out of 6 cameras launched on time.	15 cameras launched in 2005, with 25% lower R&D expenses. 7 cameras launched in the spring window. All 15 cameras launched on time.
ASIC Design Technology Development LSI Logic	74% projects on time for small projects; major tool releases were late.	Due-date performance increased to 85% projects on time; major tools released on time for three years in a row.
Telecomm Switches Design, Development and Upgrades Lucent Technologies	Long lead times; poor on-time delivery.	300 to 400 active projects with 30+ deliveries a month. Cycle times are 10 to 25% shorter while throughput per person higher by 45%.
High Tech Medical Product Development Medtronic	1 software release every 6-9 months. Predictability was poor on device programs.	1 software release every two months. Substantial improvement in delivering device programs on time.
Food Preparation and Packaging Oregon Freeze Dry	72 sales projects completed per year.	171 sales projects completed per year. 52% increase in throughput dollars.
Garment Design Skye Group	Product ranges were late to market.	100% due-date performance. 30% reduction in lead times and sampling costs.

Getting Started on Execution Management

Do your customers value fast and reliable deliveries? Do you have limited windows of opportunity to convert ideas and patents into winning products? Is execution efficiency a must in your industry? Do you have production facilities where each extra day of uptime means millions of dollars in revenue? Are you fighting for limited budgets while being asked to do more and more?

Call us. We are Realization, the pioneer in execution management systems.

SCHEDULE AN EXECUTIVE BRIEFING

1.408.271.1712 | BRIEFING@REALIZATION.COM

A SEMINAR ON EXECUTION MANAGEMENT

1.408.271.1719 | SEMINAR@REALIZATION.COM