Integrating Earned Value Management with Critical Chain Execution

Over the past decade, many business and government organizations have benefitted by executing projects using Critical Chain (CC). For example, Realization's customers have reported gains of at least $3.5B by doing projects 20-50% faster.

In parallel, Earned Value Management (EVM) metrics have also become popular. The US government requires that all large projects measure and report status using EVM.

Most people believe that CC and EVM are in conflict and cannot be implemented together. This white paper will debunk this assumption. In fact, it proposes neither CC nor EVM is a complete solution, and they must be integrated to assure projects are on time, on budget and deliver the full scope. It also provides practical instructions for integrating EVM and CC.

Earned Value Management

Consider a simple construction project with three kinds of work (structural, electrical and plumbing). The structural contractor reports that they have poured 50% of concrete while the electrical contractor says they have installed 40% of electrical wiring. Lastly, the plumbing crew says they have installed 70% of the pipes. Such reporting is incomplete because you cannot judge whether the progress is good or bad; it is missing a comparison of progress against the plan and it does not tell you whether the costs are in control or not. EVM provides a way out. During planning, all three contractors estimate the hours of effort required to pour concrete, lay wires, or install the plumbing. During execution, they can report progress based on the planned effort for the scope they have completed.

For example, if the structural contractor estimates it takes 2 hours of effort to pour 10 cubic meters of concrete then pouring 1000 cubic meters equals 200 hours of earned value. The earned hours for all three contractors can be added together and compared to the planned hours for the total project to provide a measure of overall scope completed. Two metrics are commonly used in EVM:

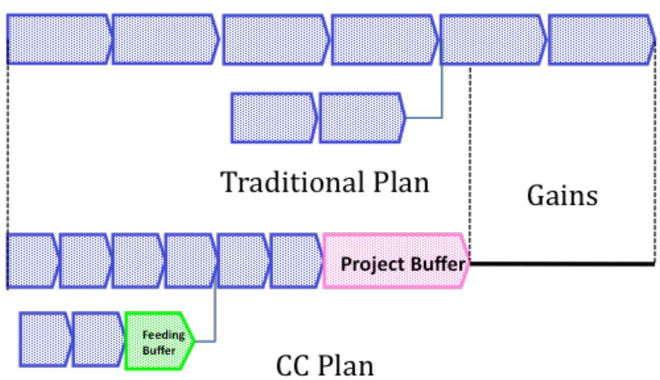
- Cost Performance Index (CPI): This is a comparison of the actual effort spent to the planned effort for a given scope.
- Schedule Performance Index (SPI): This is a comparison of the Earned Value achieved to the Earned Value scheduled.

In addition, these metrics can be broken down by different departments, scope items, etc. to create variance reports that are then used as performance measurements. (Instead of using effort, Earned Value (EV) is sometimes calculated using the budgeted dollars.)

Critical Chain

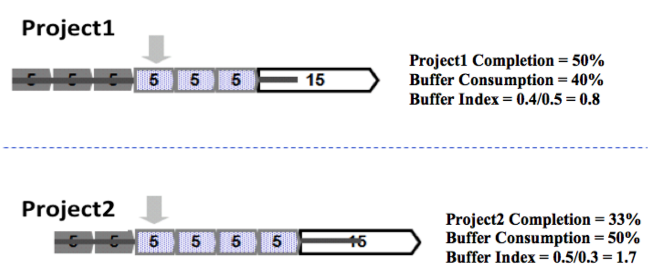
The value of Critical Chain lies in solving root causes of schedule and cost overruns in projects. Significant time and capacity are lost in projects because the required inputs, resources, decisions etc. do not come together at the right time; there is confusion about priorities; and there are bottlenecks and resource conflicts in execution. All these things happen because traditional project schedules become obsolete soon after planning is done. Lacking schedules that can be followed in the execution, people resort to localized ad hoc priorities. These localized priorities lead to lack of synchronization, priority conflicts and bottlenecks. Critical Chain enables Real-Time Synchronization of tasks and resources as ground conditions change in execution.

Critical Chain recognizes that fixed schedules don't work and instead, plans are created with explicit time buffers and flexible task scheduling. In execution, duration updates are gathered and relative priorities are determined by the buffer index (BI) of each task. This way, instead of following a fixed schedule, resources are now synchronized to the same set of real-time priorities.



CC plans have shortened tasks with explicit buffers.

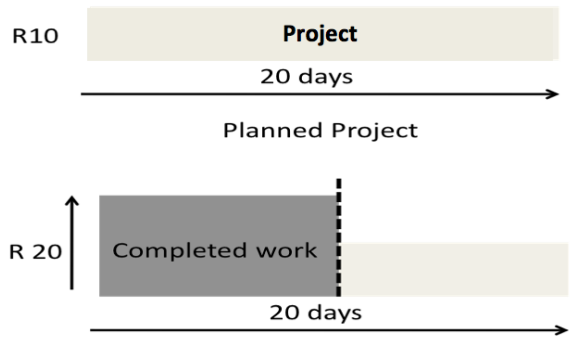
The time saved by using CC is reflected by an overall shorter project.



Buffer Index computes priorities based on the chain remaining and buffer remaining.

EVM and CC Integration: Why needed?

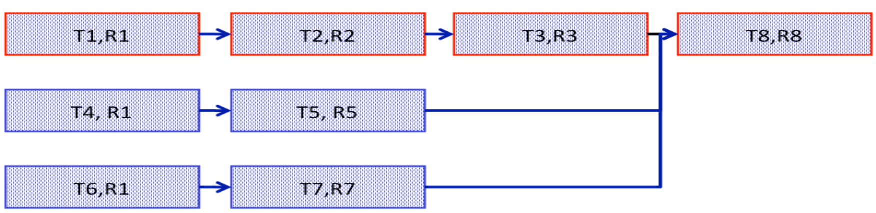
First, some organizations are required by law to use Earned Value Management. If they want the gains associated with Critical Chain, they must integrate. EVM can play an important part in protecting project budgets. Consider the example shown below. The project has been planned with 10 resources over 20 days.



Project in Execution

In execution, consider a scenario where the project buffer is in control but consumes considerably more resources than planned. This situation may arise if the project team has the flexibility to increase resources. The additional resources may be necessary because of an increase in scope or the original estimations were inadequate. It may also be a consequence of poor execution or inadequately trained resources. Whatever the reason may be, it is important that the project manager recognizes the increase in resources. They may be able to reduce resources where they are no longer required or make other budget trade-offs. If nothing else can be done to bring the budget under control, the project manager will have to reset expectations about the project budget. CPI can provide an early warning signal for overruns by capturing the scope accomplished against the budget spent.

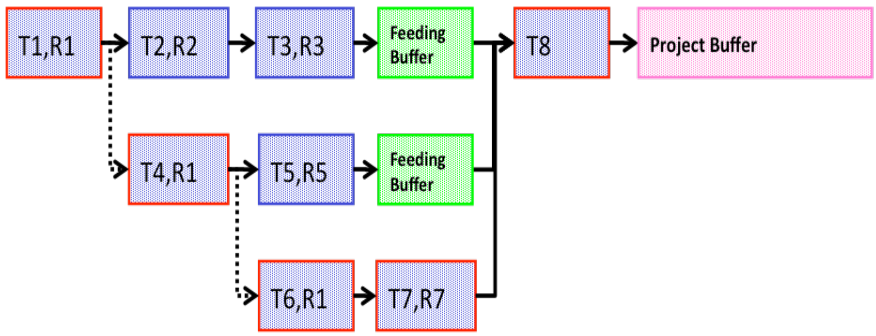
What about SPI? Let's consider another example.



Assume each task in the project takes 10 days and there is only one resource available for each of the resource types (R1, R2, R3, R5, R7, R8). Also, assume that the network accurately captures task dependencies, i.e. task T2 can only be started after task T1 is done. The Critical Path (T1→T2→T3→T8) is highlighted in red. What is not captured in this plan is that T1, T4, T6 all require the same resource (R1). Due to resource dependencies, there is a need to measure both Critical Path completion as well as total of the feeding paths. Insufficient progress on Critical Path or insufficient progress on feeding paths may delay the project. SPI in this case will highlight the problem of insufficient feeding path progress.

Let's make a Critical Chain plan for the above network.

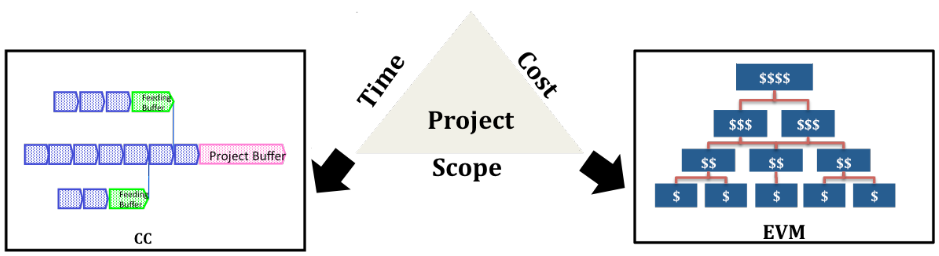
The network will become aggressive with shorter time.
The tasks will be aggressive.
Both task and resource dependencies will be captured in the Critical Chain.
Buffers will be added at the end and at integration points.



The longest chain (known as Critical Chain) of this project has shifted (T1→T4→T6→T7→T8). The Critical Chain is now highlighted in red. Any delays on R1's tasks will immediately impact the overall project buffer. If the project buffer is in control, then SPI performance should also be good. In fact, the project buffer should highlight a possible SPI problem sooner because it is based on the worse chain (original Critical Chain or the Feeding Chains).

If the project buffer is under control and SPI is not good then resource dependencies are missing and should be captured in the plan.

Summary of Integration needs:



Timelines for the given scope managed by CC

Cost for the given scope manage through EVM

EVM and CC Integration: How?

Below are some of key contradictions raised by practitioners on use of CC and EVM together.

CONTRADICTIONS ON USE OF EVM WITH CC	CONTRADICTIONS ON USE OF CC WITH EVM
EVM is cost focused and in order to earn value, it may encourage wrong priorities by: • Not completing a stuck task with low EV remaining • Start more and more tasks without finishing in-progress tasks	CC is single minded on schedule and not cost. Ignores cost completely.
EVM promotes local optima by encouraging more and more granularity in tasks to better capture EV	Tasks are higher level, making it difficult to estimate earned value. Not all work, level of effort (LOE), or resources are captured in CC plan.
	Having buffers in CC plan makes it difficult to: • Define baseline for EVM • Define accountability for buffers

In order to integrate EVM and CC, we need to resolve these contradictions. Therefore, the questions are:

Planning

What is the trade-off between cost and schedule in a project?

How should buffers in CC plans be accounted into the EVM baseline?

CC requires higher level of tasks for better prioritization however EV needs more details to estimate EV. How to define tasks?

Is there a change on how LOE tasks are baselined or progressed?

Execution

How will progress updates happen for CC and EVM?

EV may encourage wrong priorities. How can we counter these behaviors in execution?

Who has accountability of buffers?

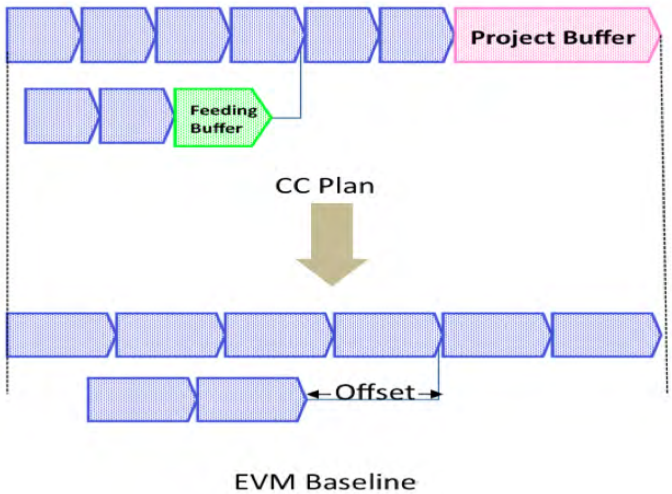
How do we make decisions based on CPI, SPI and Buffer Index?

Planning:

There is no need to make a trade-off between schedule and cost. In fact, both cost and schedule are important for a project. Generally, it is true that faster execution will cost less. However, in order to ensure planned scope is accomplished against planned budget, one must monitor and control cost.

Below are the steps for planning:

Step 1: Create a Critical Chain buffered plan with the right level of task detail. One-third of the project schedule will be buffer and two-third task times. (By definition, if a plan is feasible with the amount of uncertainty in the execution, there is buffer in the plan. This step makes buffers explicit.)



Step 2: Fix start dates of chains based on an offset for integration point. The offset is required to ensure that feeding chain start is not too early for EVM baseline calculation or too late to make project buffer red. The offset for a feeding chain is equal to (feeding chain length/CC chain length)* project buffer size.

Step 3: Expand the task durations by the buffer settings (same timeline, no buffers).

Step 4: Baseline the expanded plan for EVM.

Step 5: Capture the scope associated with each task in a checklist and estimate the earned value for each item. The sum of the earned value for each item is the total earned value for the task. Do not use the resource load from the CC plan as some resources may not be captured at the task level.

Step 6: CC plan should maintain consistency with EVM. When new scope is added in a CC plan, then it needs to be reflected in EVM baseline as well. If tasks are split in CC plan (to better model execution) without change of scope or effort, then it is also recommended to update the EVM baseline for consistency.

Note: Cost accounts should be defined at CC plan tasks or a higher level of the Work Break down Structure (WBS).

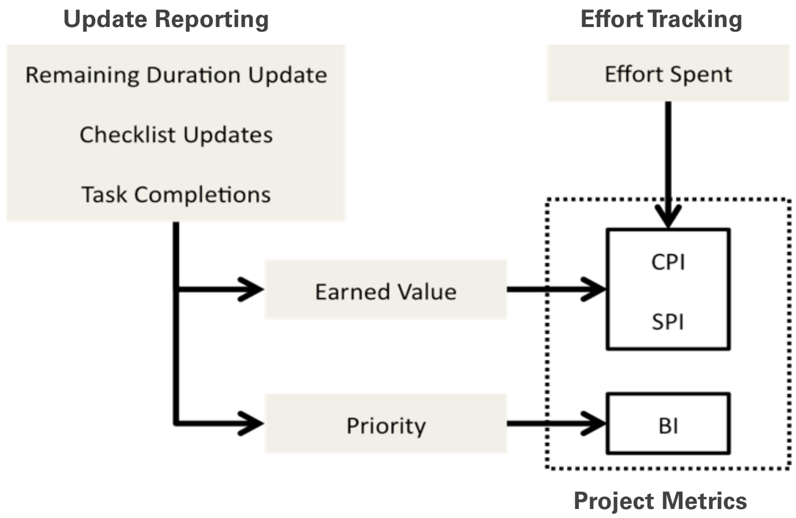
LOE tasks for support and management resources should be maintained outside of CC plans. LOE can be tied to milestones or deliverables in the CC plan and earned on completion. It is not recommended to give automatic credit based on elapsed time.

Execution:

EV for CC tasks is reported based on the checklist completions.

CC requires remaining duration updates. Remaining duration cannot be derived from % complete. It is possible for the last 20% of effort to take 80% of the duration. As a result when working with CC and EVM, EV and remaining duration updates must be made independently.

Continue to maintain actual cost of work performed (ACWP) as done today. An adjustment may be required for charge codes based on cost accounts. Picture below depicts execution integration:



In order to prevent working on wrong priorities, BI priorities must be followed in the execution. When the tasks are not completed or more tasks are opened, BI will immediately flag the issue.

The accountability of buffers is jointly shared by project manager, resources manager and portfolio manager. The reasons for buffer consumption will make it obvious if the responsibility of actions/decisions lies with the project manager, the resource manager, or the portfolio manager.

Matrix for decision making based on CC and EVM metrics:

	BI GOOD	CPI GOOD	SPI GOOD
BI POOR	X	Buffer recovery is required. Check if adding resources will help.	This will happen when the longest chain is behind schedule and feeding chains are executing well. Plan buffer recovery.
CPI POOR	Resources are wasted. Make resource concentration effective for project by: • Cutting resources • Cutting the time lines	X	Resources are wasted. Make resource concentration effective for project by: • Cutting resources • Cutting the time lines
SPI POOR	This can only happen if resource dependencies are missing in CC plan as discussed in the beginning. Fix the CC plan.	In this case BI will be bad too. So, buffer recovery is required. Check if adding resources will help.	X

Conclusions

A good integration of CC and EVM without conflicts is possible and will make a complete solution for the project management. Use CC to manage timelines and EVM to manage cost for the given scope. The guidelines are:

- Use CC plan tasks or higher level in WBS as cost accounts
- Expand the CC plan tasks to get the EVM baseline. Effort is modeled as checklist in CC tasks
- EV is reported by checklist and task completion on CC tasks
- LOE is reported based on milestone or deliverable completions
- Follow BI priorities in execution
- React to the BI, CPI and SPI metrics as discussed

MAINTENANCE, REPAIR AND OVERHAUL RESULTS

	BEFORE	AFTER
ABB, Halle Transformer Repair and Overhaul	42 projects completed in 2007. On-time delivery was 68%.	54 projects completed in 2008. On-time delivery improved to 83%.
Army Fleet Support Helicopter Maintenance, Repair and Overhaul (For Flight Schools)	Maintenance workload increased by 37% and turnaround times were long, leading to helicopter shortages.	32% reduction in CH-47 turnaround time. 52% reduction in UH-60 turnaround time. 8 aircraft returned to customer ($90M in cost avoidance). 18,000 sq ft of hangar space freed up ($2M in cost savings).
Delta Air Lines, Inc. Aircraft Engine Repair and Overhaul	476 engines produced per year. 4-8 weeks piece-part cycle time. 60 days landing gear turnaround time.	586 engines produced per year (23% increase). 30% reduction in engine turnaround time. 15 days piece-part cycle time (70% reduction). 25% increase in throughput. 30 days landing gear turnaround time (50% reduction). $60M monetized in assets from reduced turnaround time. **Ongoing improvement:** 10 days piece-part turnaround time (30% further reduction).
Erickson Air-Crane Helicopter Manufacturing and Maintenance	Only 33% projects completed on time.	On-time delivery increased to 83%.
French Air Force, SIAé Clermont Ferrand Transall Production Line Aircraft Upgrade and Repair	5 aircraft on station. Cycle time of 165 days.	3 aircraft on station, 2 aircraft returned to Air Force, a replacement value of €300 M. 15% cycle time reduction, 15% increase in output with 13% fewer resources; 22% reduction in support shops' cycle time.
US Air Force, Ogden Air Logistics Center 572nd AMXG, C130 Production Line Aircraft Maintenance, Repair and Overhaul	33 aircraft throughput in FY09. 36 aircraft on station.	44 aircraft throughput in FY10 (33% increase). 24 aircraft on station, 12 aircraft returned to Air Force.
US Air Force, Tinker Air Force Base 76th PMXG Aircraft Engine Repair and Overhaul	**Engine piece-part repair:** 137 days backshop cycle time. 260 parts/month backshop throughput. **Engines and Modules:** 45 modules/month throughput. 18 days cycle time.	**Engine piece-part repair:** 42 days backshop cycle time (69% reduction). 434 parts/month throughput (67% increase). **Engines and Modules:** 50 modules/month throughput (10% increase). 8 days cycle time (55% reduction).
US Air Force, Oklahoma City Air Logistics Center B-1 Production Line Aircraft Repair and Overhaul	Turnaround time 162 days. 7 aircraft in repair cycle.	Turnaround time reduced to 115 days. 4 aircraft in repair cycle (3 returned to customer). Production output increased from 185 hours/day to 273. 1 ½ dock spaces freed up (additional revenue potential $35M).
US Air Force, Oklahoma City Air Logistics Center B52 Production Line Aircraft Upgrade and Repair	Produced 11 aircraft a year. Cycle time of 225 days.	Produced 17 aircraft a year. Cycle time of 195 days.
US Air Force, Oklahoma City Air Logistics Center E3 Production Line Aircraft Upgrade and Repair	4 aircraft on base. Cycle time of 183 days.	2.6 aircraft on base on average. Cycle time of 155 days. 11% capacity released for additional workload.
US Air Force, Oklahoma City Air Logistics Center KC135 Production Line Aircraft Maintenance, Repair and Overhaul	Average turnaround time was 327 days.	Average turnaround time reduced to 146 days. 44% increase in throughput from Q4 2008 to Q4 2009.
US Air Force, Warner Robins Air Logistics Center C17 Production Line Aircraft Upgrade and Repair	Throughput of 178 hours per aircraft per day. Turnaround time 46-180 days. Mechanic output was 3.6 hours per day.	25% increase in throughput. Turnaround time reduced to 37-121 days. Mechanic output increased to 4.75 hours per day. 40% reduction in overtime.
US Air Force, Warner Robins Air Logistics Center C5 Production Line Aircraft Repair and Overhaul	Turnaround time 240 days. 13 aircraft in repair cycle.	Turnaround time 160 days. 7 aircraft in repair cycle. 75% fewer defects.
US Army, Corpus Christi Army Depot Helicopter Maintenance, Repair and Overhaul	Throughput of 5.4 aircraft per month. Throughput for Black Hawk was much lower than required. Turnaround times were unacceptable. Work scope per aircraft was increasing.	Throughput increased to 6.3 aircraft per month. Black Hawk throughput increased by 40% in just 6 months. 50% reduction in Apache turnaround time. 15% reduction in CH47 turnaround time. 15% reduction in Pave Hawk turnaround time despite increased scope.
US Marine Corps Logistics Base, Barstow Army Vehicles Maintenance and Repair	Repair cycle time for MK48 was 168 days. Repair cycle time for LAV25 was 180 days. Repair cycle time for MK14 was 152 days. Repair cycle time for LAVAT was 182 days.	Repair cycle time for MK48 reduced to 82 days. Repair cycle time for LAV25 reduced to 124 days. Repair cycle time for MK14 reduced to 59 days. Repair cycle time for LAVAT reduced to 122 days.

MAINTENANCE, REPAIR AND OVERHAUL RESULTS (cont.)

	BEFORE	AFTER
US Naval Aviation Depot, Cherry Point Aircraft Repair and Overhaul	Average turnaround time for H-46 was 225 days. Average turnaround time for H-53 was 310 days. Throughput was 23 aircraft per year.	Reduced H-46 turnaround time to 167 days, while work scope was increasing. Reduced H-53 turnaround time to 180 days. Delivered 23 aircraft in the first 6 months. Throughput increased to 46 aircraft per year.
US Naval Shipyard, Pearl Harbor Submarine Maintenance and Repair	Job completion rate was 94%. On-time delivery was less than 60%. Cost per job was $5,043.	Job completion rate increased to 98%. Increased on-time delivery to 95+%. Reduced cost per job to $3,355, a 33% reduction. Overtime dropped by 49%, a $9M saving in the first year.
US Navy, Fleet Readiness Center Southeast, P-3 Aircraft Maintenance and Upgrades	Produced 6 aircraft in 2008.	Produced 9 aircraft in the first 9 months of 2009.
Votorantim Process Plant Turnaround (Nickel Smelting)	Projects were late and over budget.	Project 1 delivered on time. Project 2 delivered 1 day earlier (with 10% extra scope). Actual cost was 96% of planned budget.

NEW PRODUCT DEVELOPMENT RESULTS

	BEFORE	AFTER
Chrysler Automotive Product Development	Cycle time for prototype builds was 10 weeks.	Cycle time for prototype builds reduced to 8 weeks.
Danisco (Genencor International) Biotechnology Plant Engineering	20% projects on time.	87% projects on time. 15% immediate increase in throughput.
Dr. Reddy's Laboratories Pharmaceutical New Product Development	6 projects completed in the first 12 weeks. 20% projects on time in 12 weeks. 85 global generics and PSAI filings in 2009. 85 product launches in 2009. 915 days cycle time for full development in 2008.	11 projects completed (83% increase). 80% projects on time (60% increase). 110 filings in 2010 (30% increase). 149 launches in 2010 (75% increase). 563 days cycle time for development in 2010 (40% faster).
e2v Semiconductors Semiconductor Design and Manufacturing	Actual cycle time of projects was 38 months; 25% of projects were on time.	Actual cycle time reduced to 23 months; almost all projects are within the committed cycle time of 24 months.
Hamilton Beach Brands, Inc. New Product Development For Home Appliances	34 new products per year. 74% projects on time.	Increased throughput to 52 new products in the 1st year, and to 70+ in the 2nd year, with no increase in head count. 88% projects on time.
Heineken, Spain CPG New Product Development	150 projects per year. 90% on-time delivery.	20% faster time-to-market. 98% on-time delivery. 10% of projects finished ahead of schedule.
HP Digital Camera Group Digital Camera Product Development	6 cameras launched in 2004. 1 camera launched in spring window. 1 out of 6 cameras launched on time.	15 cameras launched in 2005. 7 cameras launched in spring window. All 15 cameras launched on time.
LSI Logic ASIC Design Technology Development	74% projects on time for small projects. Major tool releases were always late.	85% of small projects on time. Major tools released on time for three years in a row.
Marketing Architects Advertising Product Development	Completed 7 projects in 2006.	Completed 7 projects in the first 8 months of 2007.
Medtronic High Tech Medical Product Development	1 software release every 6-9 months. Predictability was poor on device programs.	1 software release every 2 months. Schedule slips on device programs cut by 50%.
Medtronic, Europe High Tech Medical Product Development	Device projects took 18 months on average and were unpredictable.	Development cycle time reduced to 9 months. On-time delivery increased to 90%.
Procter & Gamble Pharmaceuticals Pharmaceutical Product Development	In 2005, completion rate was 5 projects/quarter. 55% of projects delivered on time.	In 2008, completed 12 projects/quarter. 90% on time, with same number of resources.
Skye Group Garment Design	Product ranges were late to market.	100% due-date performance. 30% reduction in lead times and sampling costs.

ENGINEER-TO-ORDER RESULTS

	BEFORE	AFTER
ABB AG, Power Technologies Division Electrical Power Transmission, Engineer-to-Order	Throughput was 300 bays per year.	Throughput increased to 430 bays per year.
ABB Córdoba Power Transformers, Engineer-to-Order	Engineering cycle time was 8 months. On-time delivery was 85%.	Engineering cycle time reduced to 3 months. On-time delivery improved to 95%. 16% increase in manufacturing throughput (revenues).
Alcan Alesa Technologies Material Handling Solutions, Engineer-to-Order	Completed an average of 6.9 projects per year.	Completed 10 projects in first 8 months of 2009. 31% increase in throughput-dollars.
Boeing Space & Intelligence Systems Satellite Design and Assembly	Reflectors were the constraint in Antenna and Satellite delivery. Electronic units were late, delaying Satellite subsystems. Classified Government program was behind schedule and losing money. Operation was losing $200M a quarter.	Doubled Reflectors throughput and reduced cycle time by 28%, alleviating delivery constraint. Increased productivity in Antenna Assembly and Test by 64% and subsequently another 26%. Reduced cycle time for Electronic units, allowing subsystems to finish 30% faster. Stabilized schedule and returned money to Government 4 quarters in a row. Operation turned profitable.
Ismeca Semiconductor Engineer-to-Order	84 days overall cycle time. 24 days production cycle time. 15 machines in 8 months was highest throughput ever.	64 days overall cycle time (25% reduction). 10 days production cycle time (60% reduction). 22 machines in 5 months (47% higher throughput). 22% improvement in EBIT.
LeTourneau Technologies, Inc. Oil & Gas Platform Design & Manufacturing	Design Engineering took 15 months. Production Engineering took 9 months. Fabrication and Assembly took 8 months.	Design Engineering takes 9 months. Production Engineering takes 5 months. Fabrication and Assembly takes 5 months with 22% improvement in labor productivity.
Škoda Power Engineered-to-Order Steam Generators	20 casings per year. 60% on-time delivery.	27 casings per year (30% increase). 90% on-time delivery. 20-30% faster cycle time.
TECNOBIT Defense Products Design and Manufacturing	Long project cycle times with frequent delays. Difficult to synchronize Design and Manufacturing.	Project cycle times reduced by 20%.
ThyssenKrupp (Johann A. Krause, Inc.) Automotive Assembly Systems, Engineer-to-Order	70% of projects were late. High overtime and outsourcing.	Lateness reduced by 50%. 63% gains in productivity. 15% more projects completed.
Valley Cabinet Works Custom Furniture Design and Manufacturing	Struggled to complete 200 projects per year. Revenues were flat, business was just breaking even.	Completed 334 projects in the first 9 months. Revenues increased by 88% and profits by 300%.
Von Ardenne Equipment for Manufacturing Solar Panels, Engineer-to-Order	Revenues of €130 M. Profits of €13 M. Cycle time was 17 weeks. On-time delivery was 80%.	Revenues of €170 M. Profits of €22 M. Cycle time reduced to 14 weeks. On-time delivery improved to 90%.

ENGINEERING, SOFTWARE AND IT RESULTS

	BEFORE	AFTER
Alcatel-Lucent Telecomm Switches Design, Development & Upgrades	300-400 active projects with 30+ deliveries a month. Lead times were long. On-time delivery was poor.	Throughput increased by 45% per person. Lead times shortened by 10-25%. On-time delivery improved to 90+%.
Alna Software Customized Software Development	Growth was stagnating, becoming insufficient to secure market position.	Throughput increased by 14% in the first 6 months. Cycle time reduced by 25% and project completions increased 17% with over 90% on-time delivery.
Airgo Networks (Qualcomm) Next Generation Wireless Technology Product Development	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.

ENGINEERING, SOFTWARE AND IT RESULTS (cont.)

	BEFORE	AFTER
Amdocs Customer Experience Systems Customized SW Development for Telecommunications	Market pressure to reduce cost and cycle time. 8 projects in crisis requiring CEO level attention in 2007.	14% increase in revenue/man-month. 20% reduction in cycle time. 0 projects in crisis in 2008.
C.N. Cofrentes (Iberdrola) Nuclear Power Engineering	Due-date performance was 60%.	Due-date performance increased to 95%. Throughput increased by 30%.
Celsa Group IT Projects	15 SAP functionality projects were completed per month.	SAP functionality project completions increased by 30% to 20 projects a month.
Central Nuclear Almaraz Trillo Nuclear Power Engineering	19 design evaluation and modification projects were being completed per month.	Throughput increased by 25% to 24-30 projects per month.
Oregon Freeze Dry Food Preparation & Packaging	72 sales projects completed per year.	171 sales projects completed per year. 52% increase in throughput-dollars.
Owens-Illinois Process Manufacturing Plant Engineering	6 months cycle time for furnace design. 45 projects/year engineering throughput.	2.5 months cycle time (58% faster). 60 projects/year throughput (33% increase).
Railcare Wolverton, UK Train Maintenance, Repair and Overhaul Engineering	16 months delay in delivery of last order. 1 order executed at a time.	100% on-time delivery on all orders. 3 orders executed in the same timeframe.
Siemens Generator Engineering Electric Generator Engineering	110 projects completed in 11 months. Low overall throughput.	128 projects completed in 11 months. 30% increase in overall throughput. 44% increase in non-project throughput.
Spirit Aerosystems Aircraft Engineering	12 months was best case engineering cycle time.	On track to finish pylon project in 7 months.

CONSTRUCTION AND OTHER RESULTS

	BEFORE	AFTER
Action Park Multiforma Grupo Theme Park Design, Install and Commissioning	121 projects completed in 2004.	142 projects completed in 2005. 153 projects completed in 2006.
BHP Billiton Iron Ore Asset Development Projects	25,800 man-hours of engineering design work had to be completed in 8 months. Historical delays of 2 weeks and man-hour overruns of 20%.	Project finished 3 weeks early. Productivity increased by 25% with only 19,500 man-hours needed.
eircom Telecommunications Network Design & Installation	On-time delivery was less than 75%. Average cycle time was 70 days.	Increased on-time delivery to 98+%. Average cycle time dropped to 30 days.
emcocables Manufacturing Plant Construction	11 months industry standard project duration.	7 months to project completion. (55% additional revenue 4 months earlier).
Emesa TGV Station Construction	6 months left to deliver, and project was 5 months late.	Completed 11 months of work in 6 months. Project on time (€5 M penalty avoided).
Rapid Solutions Group Marketing/Publishing Support	Projects were always late. Lead times were not acceptable.	On-time delivery improved by 30%. Lead times reduced by 25%.
Tata Steel Plant Maintenance and Upgrade	300-500 days for boiler conversion. Routine maintenance took too long. 11 days planned for shutdown. $2M revenue generated per day.	120-160 days completion time (68% faster). 10-33% reduction in 2007 cycle time. 5-33% additional reduction in 2008 cycle time. 8.8 days shutdown achieved. $4M revenue gained. *Set net operating hours industry record (6690 hours per year).*
US Department of Defense Procurement Organization Processing of Purchase Requests	Long delays in processing requests. Long cycle times.	Delays reduced by 40%. 76% reduction in cycle time. 29% increase in throughput.
US Air Force Operational Test & Evaluation Center Warfighter Systems Testing	Long cycle times. Low utilization of resources. Poor visibility of project slips.	30% reduction in cycle time measured over 900 projects. 30% improvement in resource utilization. 88% on-time delivery performance.