USAF Operational Test & Evaluation Center
Boeing Space & Intelligence Systems
Amdocs
Central Nuclear Almaraz Trillo
Hamilton Beach Brands, Inc.
Airgo Networks
LSI Logic
Action Park Multiforma Grupo
Celsa Group
HP Digital Camera Group
USAF Ogden Air Logistics Center
Chrysler
USAF Warner Robins Air Logistics Center
TATA Steel
Danisco (Genencor International)
Alcatel-Lucent
Medtronic
Von Ardenne
US Naval Shipyards, Pearl Harbor
Delta Air Lines, Inc.
Medtronic Europe
US Marine Corps Logistics Base, Barstow
eircom
LeTourneau Technologies, Inc.
Oregon Freeze Dry
Procter & Gamble Pharmaceuticals
Alna Software
Erickson Air-Crane
C.N. Cofrentes (Iberdrola)
Skye Group
Marketing Architects
TECNOBIT
Valley Cabinet Works
US Naval Aviation Depot, Cherry Point
French Air Force, SIAé Clermont Ferrand
Dr. Reddy's Laboratories
e2v Semiconductors
ABB, Halle
USAF Oklahoma City Air Logistics Center
BHP Billiton
ThyssenKrupp (Johann A. Krause, Inc.)
Rapid Solutions Group
ABB AG, Power Technologies Division

Critical Chain

ALL ABOUT EXECUTION, ALL ABOUT RESULTS.

RESULTS AND LESSONS LEARNED

In the past five years, hundreds of managers have attended Realization's Project Flow conferences. From maintenance and repair to high-tech product development, they have implemented Critical Chain Execution Management to increase project speed, throughput and due-date performance.

We thank our clients for sharing their case studies, and have compiled here a summary of their results and lessons learned.

EXECUTION MANAGEMENT RESULTS

	BEFORE	AFTER
Electrical Power Transmission, Engineer-to-Order ABB AG, Power Technologies Division	Throughput was 300 bays per year.	Throughput increased to 430 bays per year.
Transformer Repair and Overhaul ABB, Halle	42 projects completed January-December 2007. On-time delivery of 68%.	54 projects completed January-December 2008. On-time delivery of 83% .
Theme Park Design, Install and Commissioning Action Park Multiforma Grupo	121 projects completed in 2004.	142 projects completed in 2005. 153 projects completed in 2006.
Telecomm Switches Design, Development & Upgrades Alcatel-Lucent	300-400 active projects with 30+ deliveries a month. Lead times were long. On-time delivery was poor.	Throughput was higher by 45% per person. Lead times are 10-25% shorter. 90+% on-time delivery.
Customer Experience Systems – Customized SW Development for Telecommunications Amdocs	8 projects in crisis requiring CEO level attention in 2007. Market pressures to reduce cost and cycle time of projects.	0 projects in crisis in 2008. Project cycle time decreased by 20%. Increase of 14% in revenue/man-month across 4,000 people.
Iron Ore Asset Development Projects BHP Billiton	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.
Satellite Design and Assembly Boeing Space & Intelligence Systems	Antenna Assembly and Test was the constraint in Satellite delivery.	Antenna Assembly and Test was no longer the constraint in Satellite delivery. Productivity increased by 64% on the next Satellite and a further 26% on the subsequent Satellite.
Nuclear Power Engineering Central Nuclear Almaraz Trillo	19 design evaluation and modification projects were completed per month.	Throughput increased by 25% to 24-30 projects per month.
Nuclear Power Engineering C.N. Cofrentes (Iberdrola)	Due date performance was 60%.	Due date performance increased to 95%. Throughput increased by 30%.
Oil & Gas Platform Design & Manufacturing LeTourneau Technologies, Inc.	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.
Advertising Product Development Marketing Architects	Completed 7 projects in 2006.	Completed 7 projects in 8 months of 2007.
Steel Plant Maintenance TATA Steel	Boiler Conversion projects took 300-500 days. Routine maintenance and upgrade took too long.	Boiler Conversion projects took 120-160 days. In 2007, 1st year of Critical Chain, reduced maintenance and upgrade cycle times by 10-33%—saving of $13.4 million. In 2008, achieved a further 5-33% reduction in cycle time.
Defense Products Design and Manufacturing TECNOBIT	Difficult to synchronize Design and Manufacturing. Long project cycle times with frequent delays.	Project cycle times were reduced by 20%.
Automotive Assembly Systems, Engineer-to-Order ThyssenKrupp (Johann A. Krause, Inc.)	70% of projects were late. High overtime and outsourcing.	Lateness reduced by 50%. 63% productivity gain. 15% more projects completed.
Custom Furniture Design and Manufacturing Valley Cabinet Works	Struggled to complete 200 custom furniture projects per year. Revenues were flat, business was just breaking even. A lot of firefighting in execution.	Completed 334 projects in 9 months. Revenues increased 88% and profits increased by 300% in the first year. Firefighting and thrashing eliminated.
Equipment for Manufacturing Solar Panels, Engineer-to-Order Von Ardenne	Revenues of €130 M. Profits of €13 M. Cycle time 17 weeks. On-time delivery of 80%.	Revenues of €170 M. Profits of €22 M. Cycle time 14 weeks. On-time delivery of 90%.

EXECUTION MANAGEMENT RESULTS

	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.
Customized Software Development Alna Software	Growth was stagnating, becoming insufficient to secure market position.	Throughput increased by 14% in first 6 months. Cycle time reduced by 25% and project completions increased 17% with over 90% on-time delivery.
IT Projects Celsa Group	15 SAP functionality projects were completed per month.	SAP functionality project completions increased by 30% to 20 projects a month.
Automotive Product Development Chrysler	Cycle time for prototype builds was 10 weeks.	Cycle time for prototype builds is 8 weeks.
Biotechnology Plant Engineering Danisco (Genencor International)	20% projects on time.	87% projects on time. 15% immediate increase in throughput.
Pharmaceutical Product Development Dr. Reddy's Laboratories	In 12 weeks prior to Critical Chain 6 projects were completed; 20% were on-time.	In 12 weeks since Critical Chain was implemented, 11 projects completed; 80% on-time.
Telecommunications Network Design & Installation eircom	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.
Semiconductor Design and Manufacturing e2v Semiconductors	Actual cycle time of projects 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.
Home Appliances New Product Development Hamilton Beach Brands, Inc.	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 head count. 88% projects on time.
Digital Camera Product Development HP Digital Camera Group	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.
ASIC Design Technology Development LSI Logic	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.
High Tech Medical Product Development Medtronic	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%.
High Tech Medical Product Development Medtronic, Europe	Device projects took 18 months on average and were unpredictable.	Development cycle time reduced to 9 months. On-time delivery increased to 90%.
Food Preparation & Packaging Oregon Freeze Dry	72 sales projects completed per year.	171 sales projects completed per year. 52% increase in throughput dollars.
Pharmaceutical Product Development Procter & Gamble Pharmaceuticals	In 2005 completion rate of 5 projects/Quarter; 55% of projects delivered on time.	In 2008, completing 12 projects/Quarter; 90% of the projects on time, with the same number of resources.
Marketing/Publishing Support Rapid Solutions Group	Projects were always late. Lead times were not acceptable.	On-time delivery improved by 30%. Lead times were reduced by 25%.
Garment Design Skye Group	Product ranges were late to market.	100% due-date performance. 30% reduction in lead times and sampling costs.

EXECUTION MANAGEMENT RESULTS

	BEFORE	AFTER
Engine Repair & Overhaul Delta Air Lines, Inc.	Produced 40 engines per month. 4 weeks piece part cycle time.	Increased production to 50+ engines per month, 16%-26% reduction in engine turnaround time. 2.5 weeks piece part cycle time, 25% increase in piece part throughput.
Helicopter Manufacturing and Maintenance Erickson Air-Crane	Only 33% projects completed on time.	Projects completed on time increased to 83%.
Aircraft Upgrade and Repair French Air Force, SIAé Clermont Ferrand Transall Production Line	5 aircrafts on station; Cycle time of 165 days.	3 aircrafts on station, 2 aircrafts returned to Air Force, replacement value of €300 M. 15% cycle time reduction, 15% increase in output with 13% fewer resources; 22% reduction in support shops' cycle time.
Warfighter Systems Testing US Air Force Operational Test & Evaluation Center	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.
Aircraft Repair & Overhaul US Air Force, Ogden Air Logistics Center, C130 Production Line	21-24 aircrafts on station.	Reduced to 18 aircrafts on station. 25 out of 26 aircrafts delivered on-time or early. (Accumulated 191 days of early delivery in 6 months total).
Aircraft Repair & Overhaul US Air Force, Oklahoma City Air Logistics Center, B-1 Bomber Line	Turnaround time 162 days. 7 aircrafts in repair cycle.	Turnaround time reduced to 115 days. 4 aircrafts in repair cycle (3 returned to customer). Production output increased from 185 hours/day to 273. 1 1/2 dock spaces freed up.
Aircraft Upgrade and Repair US Air Force, Oklahoma City Air Logistics Center, B52 Production Line	Produced 11 aircrafts a year. Cycle time of 225 days.	Produced 17 aircrafts a year. Cycle time of 195 days.
Aircraft Upgrade and Repair US Air Force, Oklahoma City Air Logistics Center, E3 Production Line	4 aircrafts on base. Cycle time of 183 days.	On average 2.6 aircrafts on base. Cycle time of 155 days. 11% capacity released for additional workload.
Aircraft Repair & Overhaul US Air Force, Warner Robins Air Logistics Center, C5 Production Line	Turnaround time 240 days. 13 aircrafts in repair cycle.	Turnaround time 160 days. 7 aircrafts in repair cycle. 75% fewer defects.
Aircraft Upgrade & Repair US Air Force, Warner Robins Air Logistics Center, C17 Production Line	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% overtime reduction.
Army Vehicles Maintenance & Repair US Marine Corps Logistics Base, Barstow	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 is 82 days. Repair cycle time for LAV25 is 124 days. Repair cycle time for MK14 is 59 days. Repair cycle time for LAVAT is 122 days.
Aircraft Repair & Overhaul US Naval Aviation Depot, Cherry Point	Average turnaround time for H-46 aircrafts was 225 days. Average turnaround time for H-53 aircrafts was 310 days. Throughput was 23 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 aircrafts in 6 months. Throughput increased to 46 per year.
Submarine Maintenance & Repair US Naval Shipyard, Pearl Harbor	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 1st year.

LESSONS LEARNED

Managers have described again and again the significant benefits of Critical Chain Execution Management. They have stressed how you can get results within a matter of weeks, and why it is important to forge the new system while the iron is hot. Following are the key lessons from a wide variety of implementations:

LESSON 1: SHORTER CYCLE TIMES DRIVE PERFORMANCE

This is true for both operational and business performance.

Operational Performance

When projects run out of time, you experience more than just delays. There are cost overruns and, all too often, compromises in scope and quality. Consider the following:

- It is well accepted that the longer a project takes, the more resources it will consume.
- Once projects fall behind, expediting costs are often incurred.
- For capital-intensive projects, the longer the project takes, the higher the cost of the tied-up money.
- There is no argument that processes and discipline are essential for ensuring that work gets done with high quality; BUT this goal is easily compromised when projects come under time pressures. Thus, having enough time is vital for processes and discipline.

Business Performance

- In project based businesses, time equals throughput. Simply put, the faster that a project gets completed, the sooner resources become available for the next project.
- The faster the infrastructure projects finish, the faster their benefits start accruing.
- Faster turnaround in aircraft and ship MRO equates to higher fleet availability with a smaller fleet.
- Faster plant maintenance means higher uptime.
- As product life cycles continue to shrink, faster time-to-market translates into higher pricing and larger market shares.

LESSON 2: IMPLEMENT THE THREE RULES, NO MORE NO LESS

All the implementation challenges fall under either achieving buy-in or establishing robust mechanics. It is very easy to waste a lot of energy in those areas by educating everyone thoroughly, tweaking data endlessly, customizing reports etc.

To not get overwhelmed, we must remind ourselves that Critical Chain is about implementing its three rules:

1. **Pipelining:** Reduce WIP. Stagger project starts.
2. **Buffering:** Don't turn estimates into commitments. Shorten project plans, include 50% buffers.
3. **Buffer Management:** Follow task priorities, don't waste buffers.

It is impossible to implement these rules piecemeal. All three have to be implemented from the get-go, without compromise. Any concession will only show up as resistance to change or cumbersome mechanics. For example:

- Organizations doing large projects tend to implement Critical Chain one project at a time. They compromise the PIPELINING rule.

  When projects are not staggered, resource conflicts are bound to arise. Buffers get consumed and commitments are missed. Project Managers do not cut cycle times. Task Managers cannot follow task priorities. Very quickly, faith in the new system is lost.
- Many times organizations initially aim to just deliver projects on time without increasing speed and throughput. They compromise the BUFFERING rule (cycle times are not cut, but buffers are added).

  When cycle times are not cut, PIPELINING rule also has to be compromised because staggering the projects would cause all due-dates to be pushed far out. When projects are not pipelined, BUFFER MANAGEMENT cannot be done. The entire system falls apart.
- Some managers compromise the BUFFER MANAGEMENT rule because they feel it is "micromanagement". In reality, without management, buffers get wasted which creates a feeling that shorter cycle times are unrealistic.

  Sooner or later the organization reverts to its old ways (not staggering project starts; hiding safeties in project plans, and setting priorities *ad hoc* in execution).

Instead of reacting to symptoms when we hit roadblocks, it is better to diagnose which of the rules has been compromised.

LESSON 3: WHY TOP MANAGEMENT SHOULD PLAY AN ACTIVE ROLE AND HOW

Sponsorship is not enough. Even though the top managers' role is to set policies and make planning-time decisions (execution is delegated to middle mangers and frontline managers), in successful implementations the top managers play a more active role for the first 6 to 12 months by:

- **Setting Aggressive Goals:** Only when aggressive goals are set do substantial improvements happen. An organization is more easily galvanized around ambitious goals than incremental improvements.

  For example, though people were overloaded and projects running behind, HP Digital Camera group set an audacious target of going from 6 new cameras in a year to 15. They actually achieved their target, delivering all projects on time with an implementation that went live in six weeks.
- **Creating a Habit of Managing Buffers:** Close oversight by top management is necessary until Buffer Management becomes second nature. For example, the CEO and CFO of Von Ardenne review buffer reports and personally get involved in resolving issues.
- **Not Delegating the Implementation Until Transition is Complete:** Only top management can proactively identify and eliminate policy obstacles. For example, Shalom Passy, Executive VP of Delivery in Admocs is involved in pipelining, buffer diagnostics and even training new managers.