

What Your Lean and Six Sigma People Don't Want You to Know

Achieving Lean In Low Volume Production and Projects

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LEAN RESULTS

While Toyota has achieved remarkable results...

	Toyota	GM
Assembly hours per car	16	31
Assembly defects per car	45	135
Average parts inventory	2 Hrs	2 Wks

...most organizations have struggled

70% of Manufacturing Plants in North America implemented Lean

Out of which only 25% think that they have made significant improvements

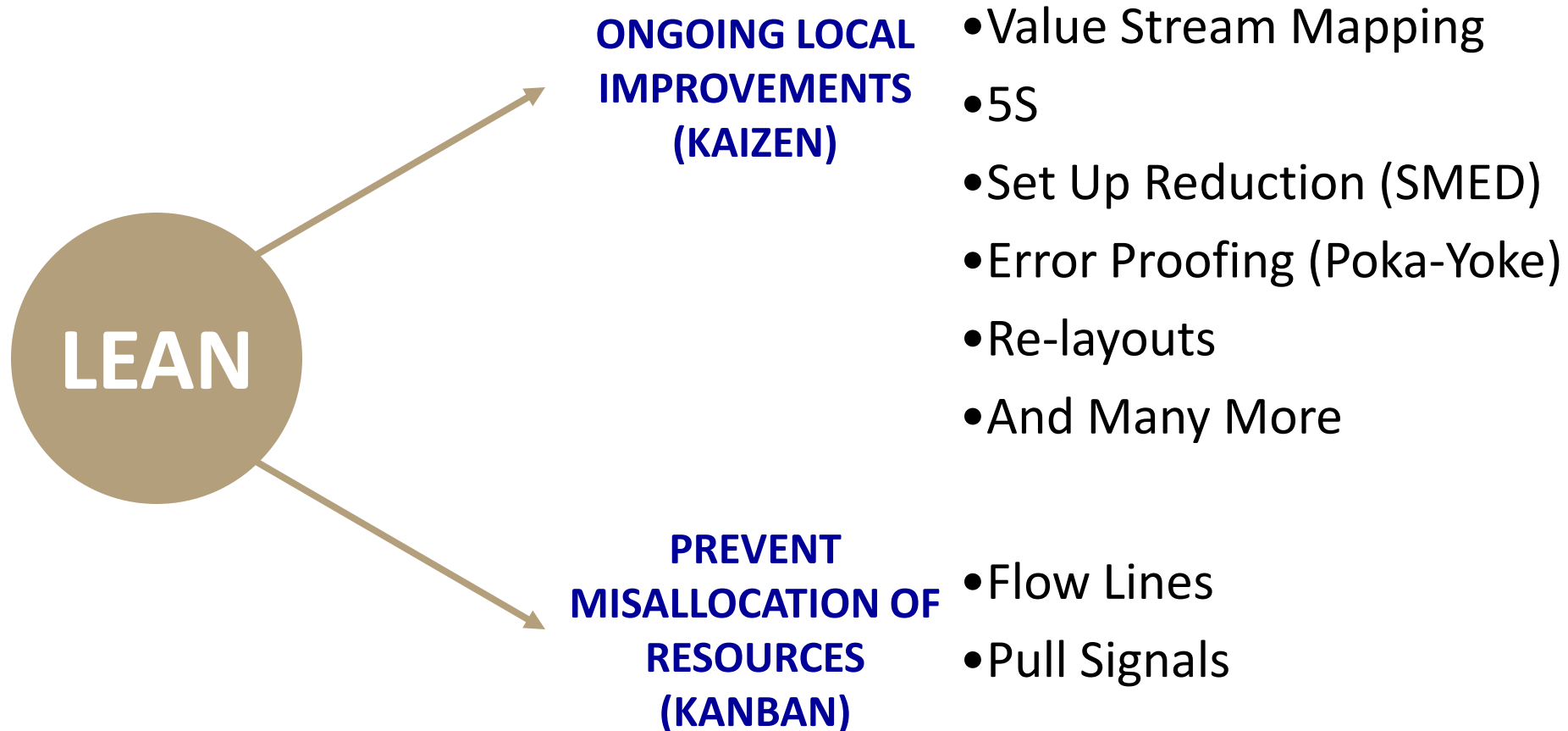
Source: MPI Group 2008 Survey of Manufacturers

What About Lean Really Works

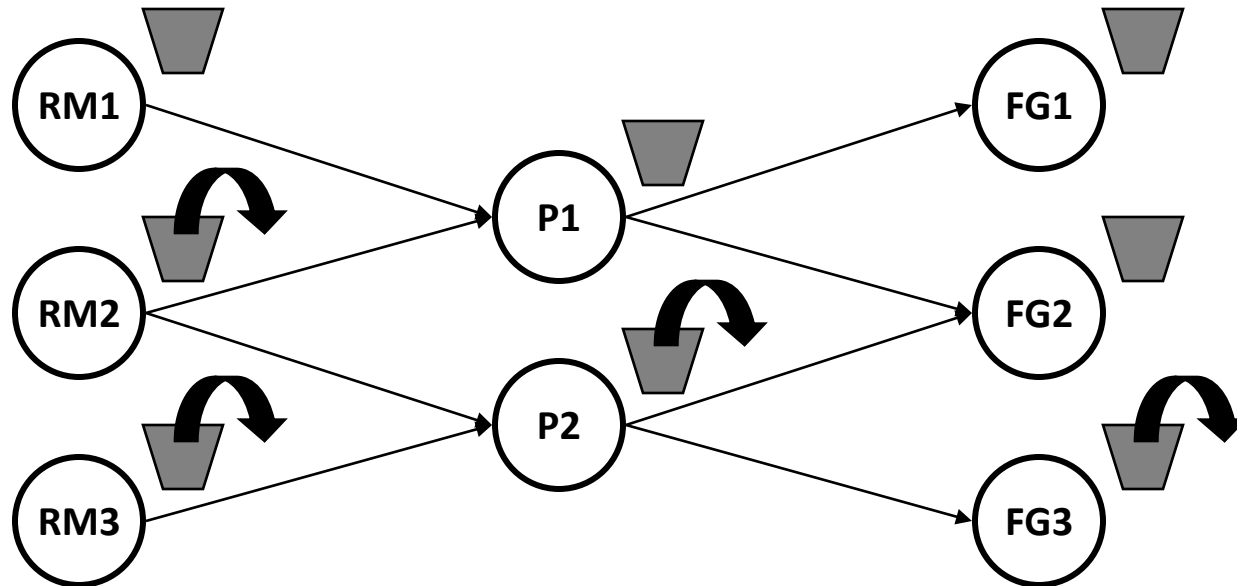
Why Lean Doesn't Work In Projects

How To Achieve Lean Objectives In Projects

RECAP OF LEAN METHODS



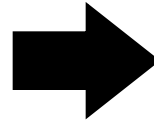
HIGH VOLUME PRODUCTION EXAMPLE



- ❑ Challenge: what products and parts to make and when
- ❑ Complicated scheduling systems don't work
- ❑ Flow Lines and Kanbans provide an elegant solution
 - Including “buffer” against variability

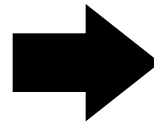
IMPACT OF IMPROVING RESOURCE ALLOCATION

**Less Wait Time
Better Priorities**



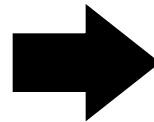
**DELIVERY
(CT, OTD)**

**Higher Utilization
Lower Inventories**



COST

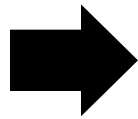
Faster Feedback Loop



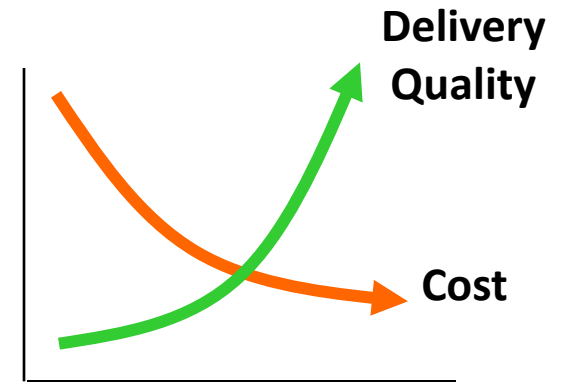
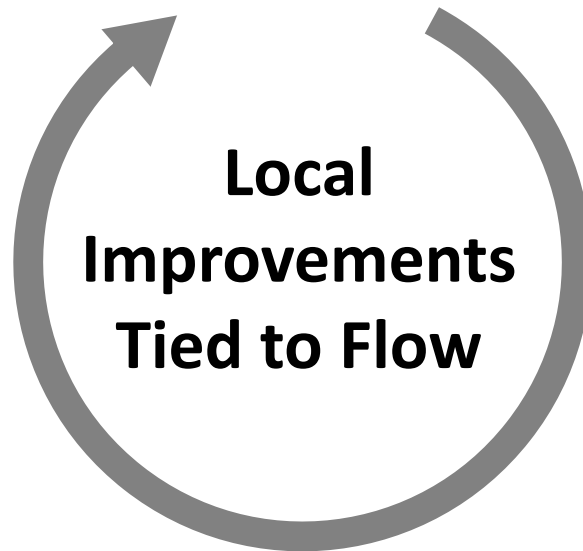
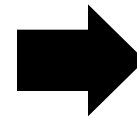
QUALITY

TRUE LEAN

**Abolish Local
Efficiencies**



**Prevent
Misallocation**



WHY FLOW LINES/KANBAN DON'T WORK IN PROJECTS

High Product Variety

High Demand Variability

High Process Variability

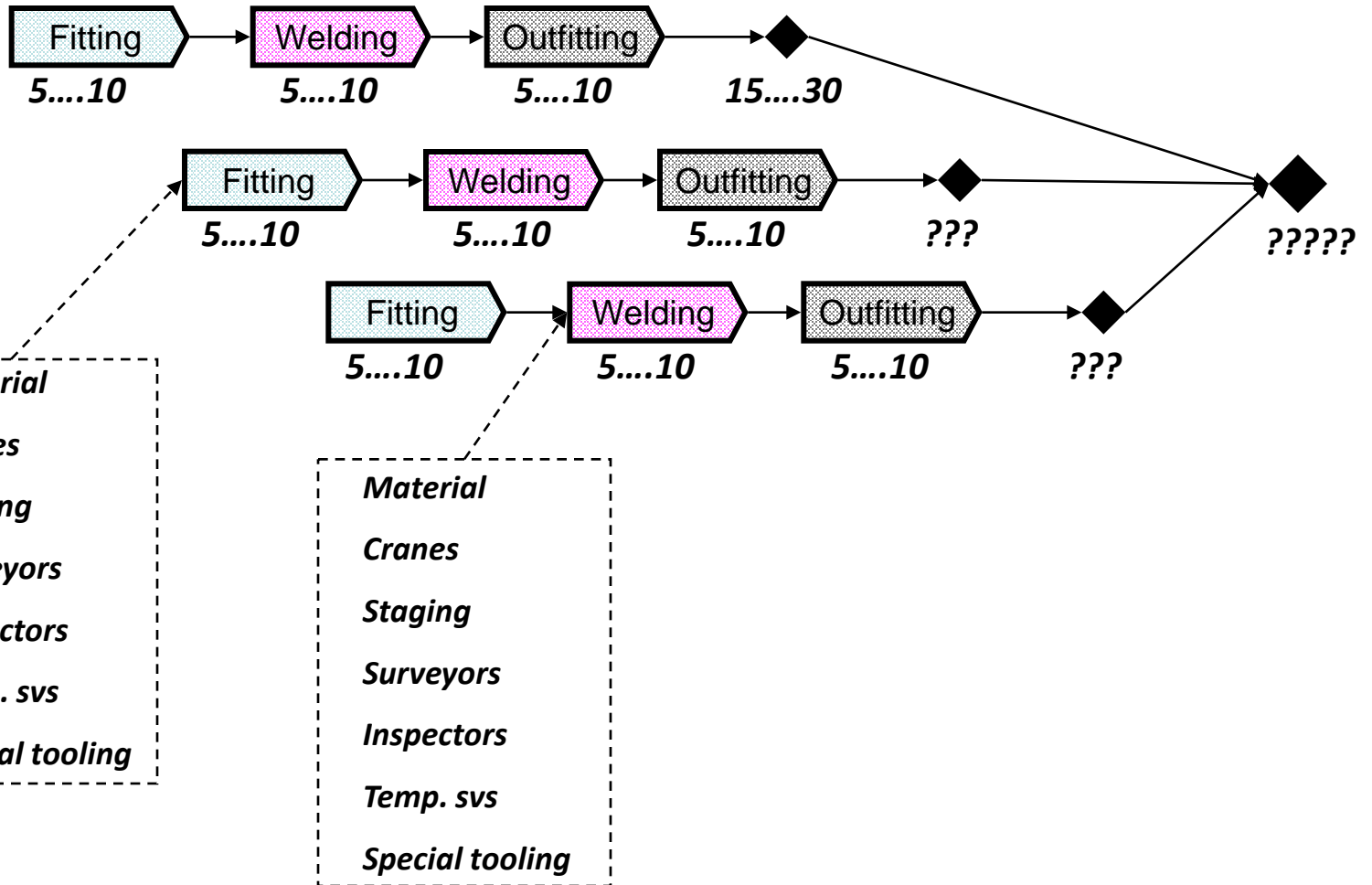
Low Production Volumes

Long Project Cycle Times

Short Demand Horizons

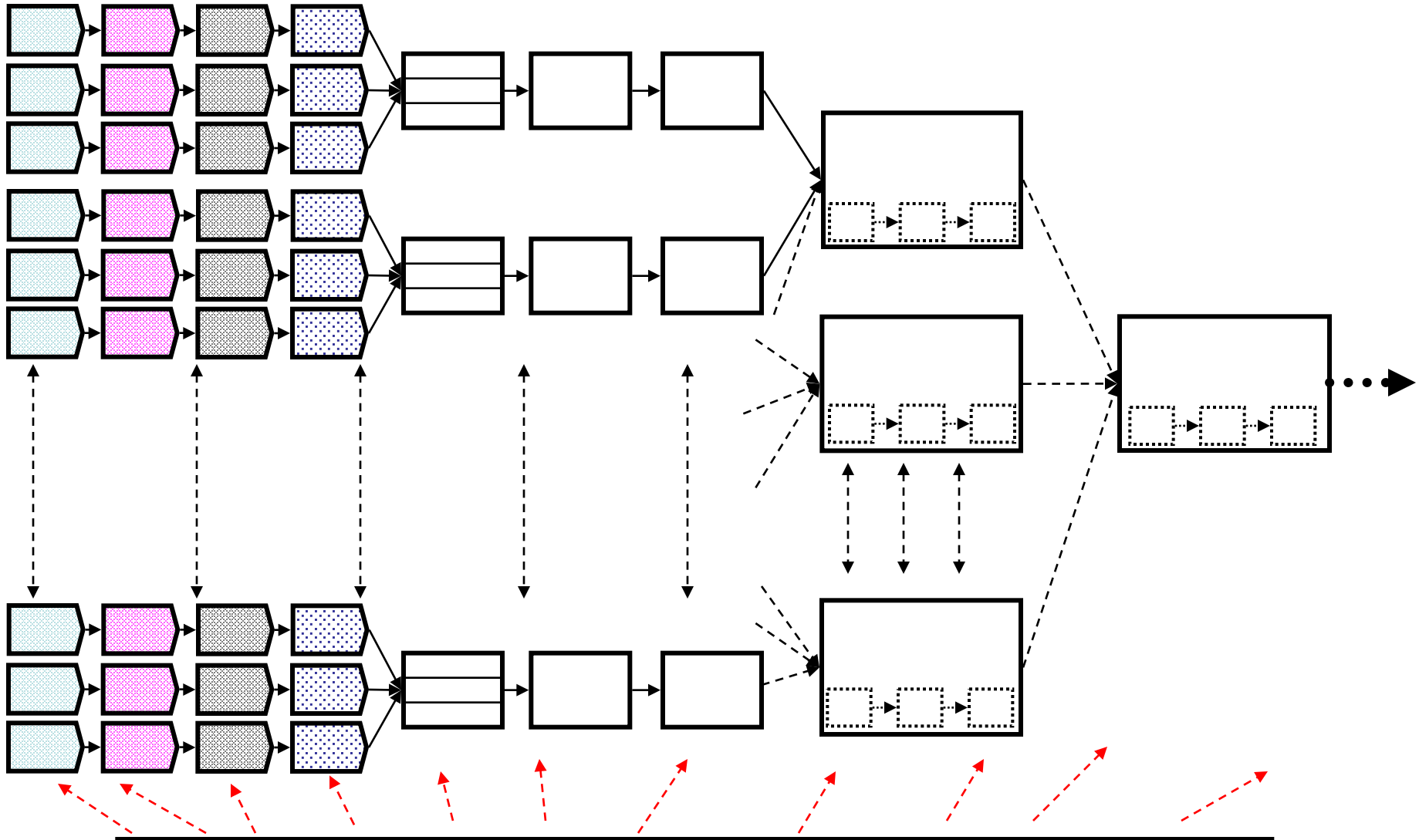
PROBLEM ILLUSTRATION

Uncertainties



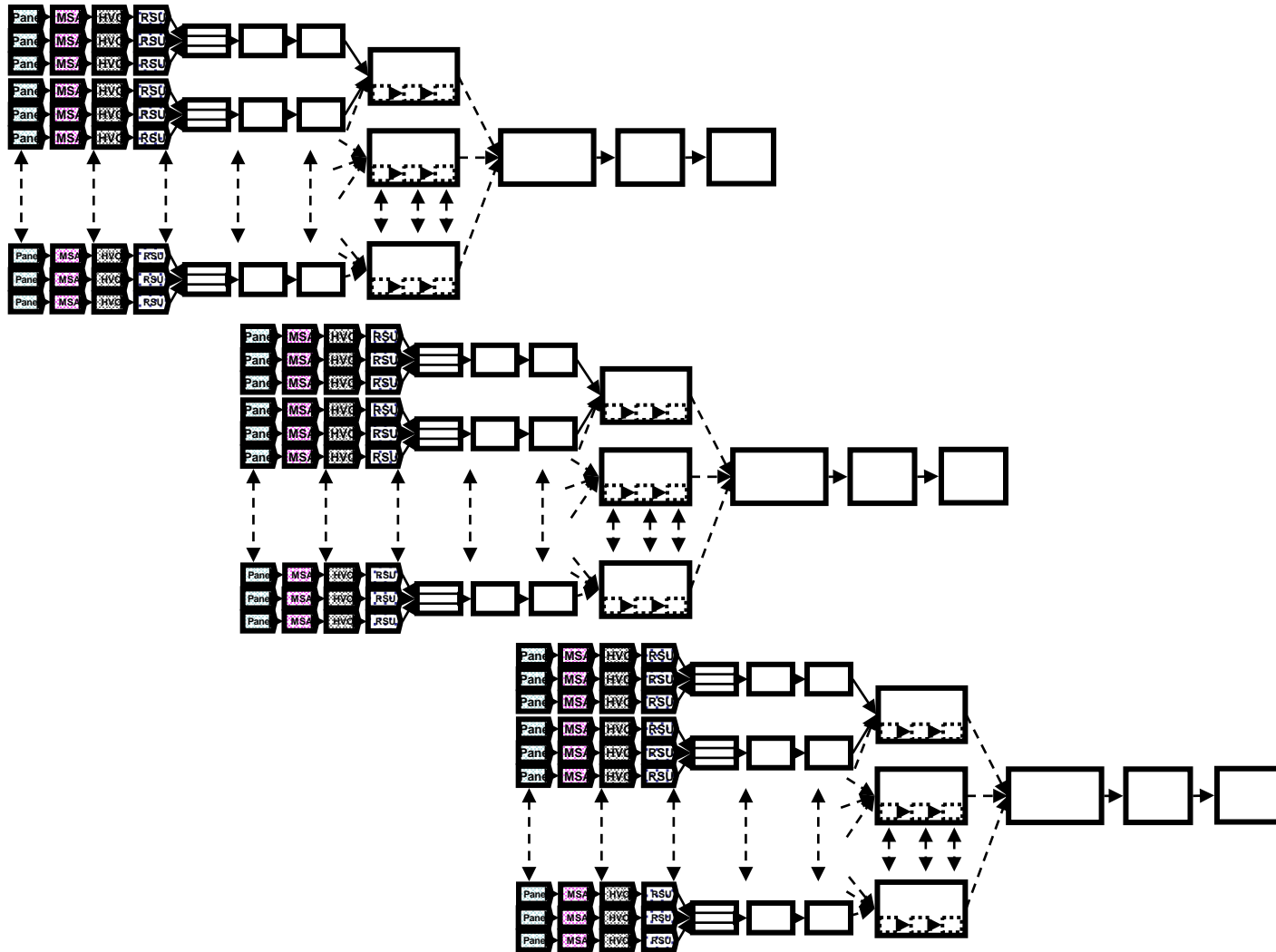
UNCERTAINTIES x SHARED RESOURCES

SHIPBUILDING IS COMPLEX: MANY PARALLEL STREAMS WITH SHARED RESOURCES



Trades, Fab. Shops, Outfitting Shops, Machine Shops, Support Svcs.

MULTI-PROJECT OPERATIONS ARE EVEN MORE COMPLEX

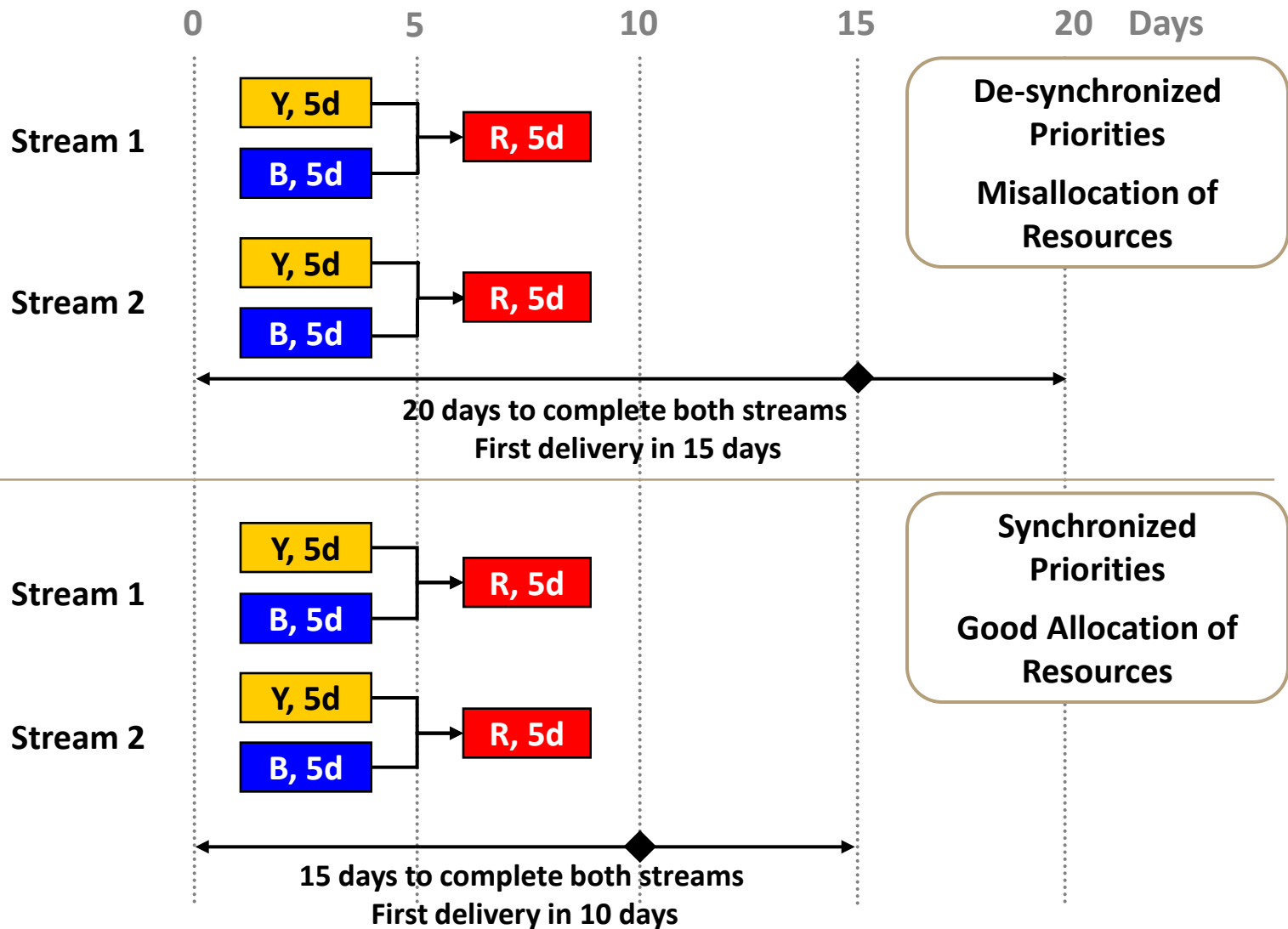


Trades, Fab. Shops, Outfitting Shops, Machine Shops, Support Svcs.

RULES FOR PREVENTING MISALLOCATION IN PROJECTS

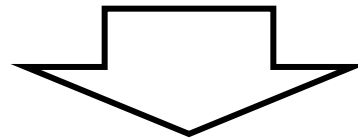
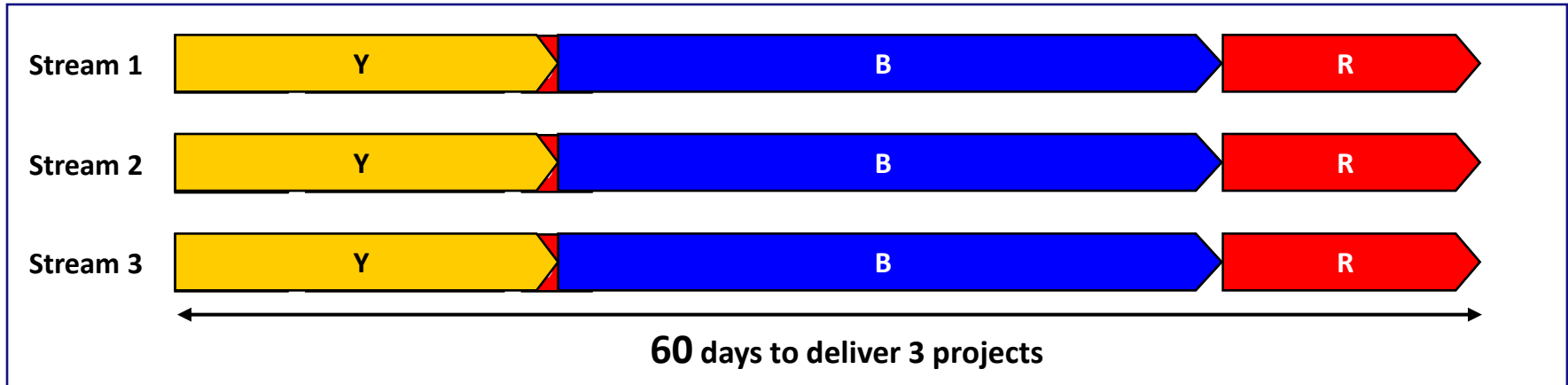
- 1. Limit the number of parallel streams in execution**
- 2. Use time buffers instead of space or inventory**
- 3. Provide task priorities based on buffer consumption**

LOW WIP IMPROVES SYNCHRONIZATION

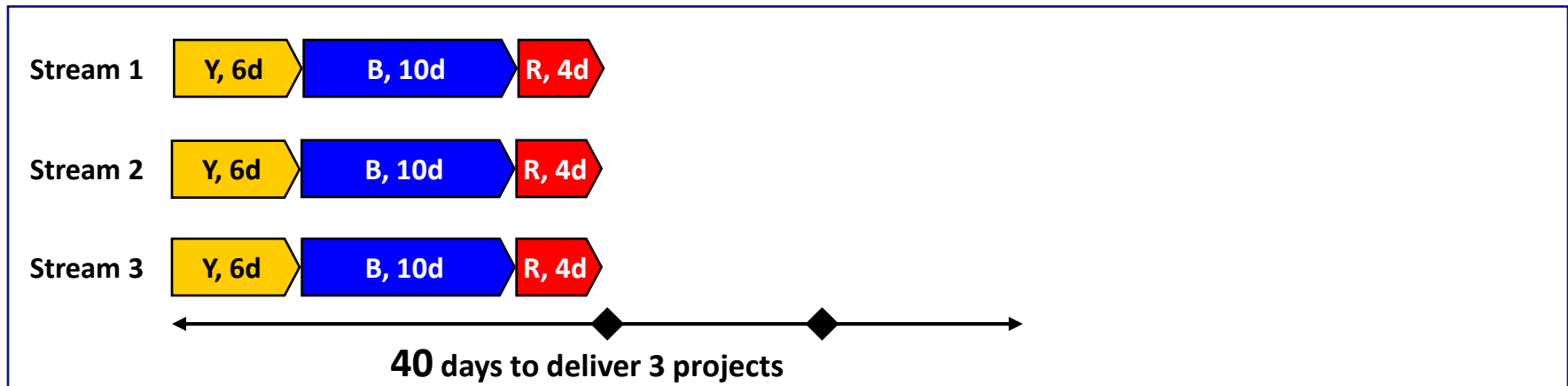


LOW WIP ALSO SHORTENS THE TASK DURATIONS

Three streams in execution at a time

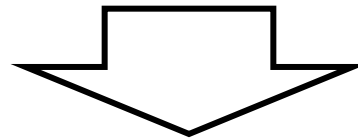
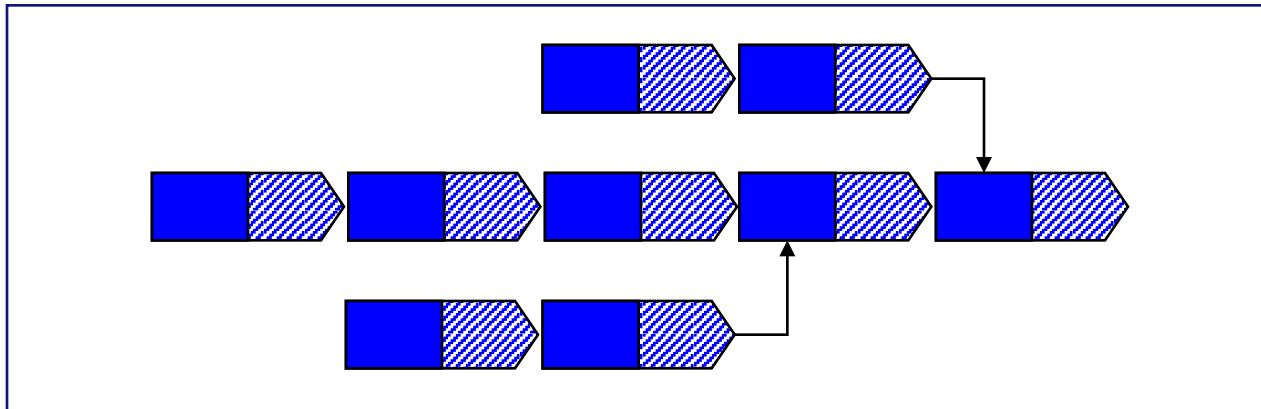


Two streams in execution at a time

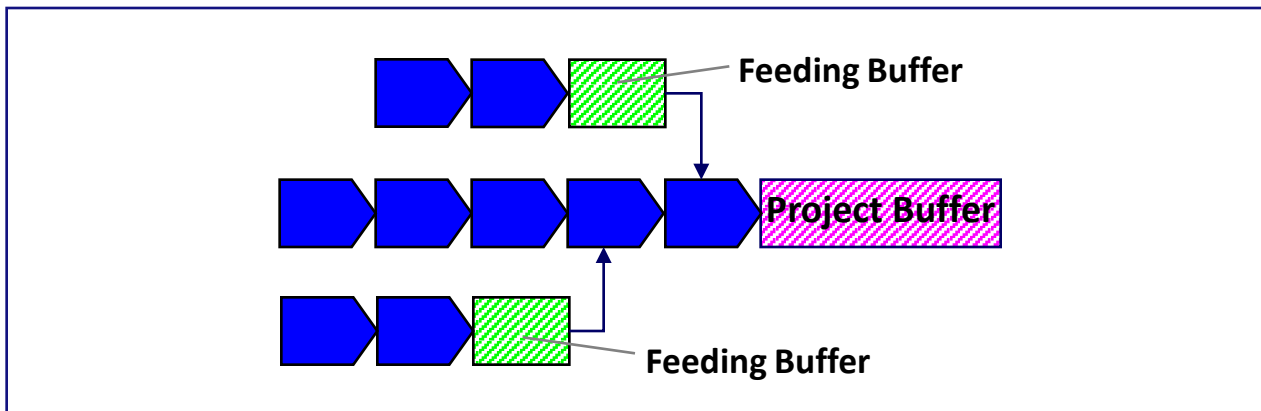


HOW TIME BUFFERS ARE PLACED

Safeties hidden within tasks

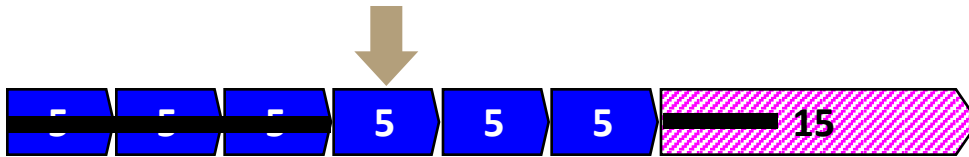


Buffers are explicit and mandatory



HOW TASK PRIORITIES ARE CALCULATED

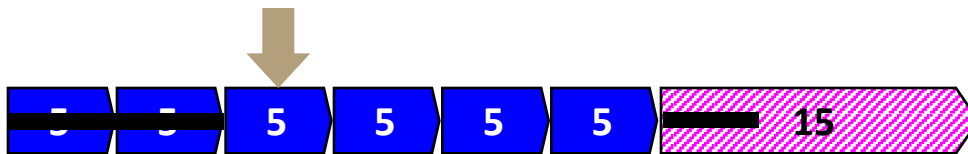
Stream 1



Buffer Consumption = 40%

Project Completion = 50%

Stream 2



Buffer Consumption = 35%

Project Completion = 33%

Task in Stream 2 has higher priority because it is consuming buffer at a faster rate

CRITICAL CHAIN RESULTS

	BEFORE	AFTER
ABB AG, Power Technologies Division Electrical Power Transmission, Engineer-to-Order	Throughput was 300 bays per year.	Increased throughput to 430 bays per year.
ABB, Halle Transformer Repair and Overhaul	42 projects completed in Jan-Dec 2007. On-time delivery of 68%.	Increased throughput to 54 projects in Jan-Dec 2008. Increased on-time delivery to 83%.
Action Park Theme Park Design, Install and Commissioning	121 projects completed in 2004.	Increased throughput to 142 projects in 2005. Increased throughput to 153 projects in 2006.
Airgo Networks Next Generation Wireless Technology Product Development	Cycle Time for 1st generation was 19 months.	Reduced Cycle Time for 2nd generation to 8 months.
Alcatel-Lucent Telecomm Switches Design, Development & Upgrades	300 to 400 active projects, 30+ deliveries a month. Lead times were long. Poor on-time delivery.	Increased throughput per person by 45%. Reduced lead times by 10-25%. Increased on-time delivery to 90%.
Alna Software Customized Software Development	Throughput was stagnating, becoming insufficient to secure market position.	Increased throughput by 14% in first 6 months. Reduced Cycle Time by 25%. Increased project completion by 17% with over 90% on-time delivery.
Amdocs, Israel Customer Experience Systems – Customized SW Development for the Telecommunication Industry	8 projects in crisis requiring CEO attention in 2007. Market pressure to reduce project cost and Cycle Time.	0 projects in crisis in 2008. Reduced project Cycle Time by 20%, increased revenue/man-month across 4,000 people by 14%.
BHP Billiton Iron Ore Asset Development Projects	25,800 man-hours of engineering design work had to be completed in 8 months. Historical 2 week delays and 20% man-hour overruns.	Increased productivity by 25%, using only 19,500 man-hours. Project completed 3 weeks early.
Boeing Space & Intelligence Systems Satellite Design and Assembly	Antenna Assembly and Test was the constraint in Satellite delivery.	Antenna Assembly and Test no longer the constraint in Satellite delivery. Increased productivity by 64% on the first Satellite and a further 26% on the subsequent Satellite.

CRITICAL CHAIN RESULTS

	BEFORE	AFTER
Celsa Group IT Projects	Completed 15 SAP functionality projects per month.	Increased SAP functionality project completions by 30% to 20 projects a month.
Central Nuclear Almaraz Trillo Nuclear Power Engineering	Completed 19 design evaluation and modification projects per month.	Increased throughput by 25% to 24-30 projects per month.
C.N. Cofrentes (Iberdrola) Nuclear Power Engineering	Due-date performance was 60%.	Increased due-date performance to 95%. Increased throughput by 30%.
Chrysler Automotive Product Development	Prototype builds Cycle Time was 10 weeks.	Reduced prototype builds Cycle Time to 8 weeks.
Danisco (Genencor) Biotechnology Plant Engineering	Due-date performance was 20%.	Increased due-date performance to 87%. Increased throughput by 15% immediately.
Dr. Reddy's Laboratories Pharmaceutical Product Development	6 projects completed in 12 weeks before Critical Chain. 20% on-time delivery.	11 projects completed in 12 weeks after Critical Chain. Increased on-time delivery to 80%.
e2v Semiconductors Semiconductor Design and Manufacturing	Cycle Time of projects 38 months. 25% of projects were on-time.	Reduced Cycle Time to 23 months. Increased on-time delivery to 65%.
eircom Telecommunications Network Design & Installation	On-time delivery less than 75%. Average Cycle Time was 70 days.	Increased on-time delivery to 98+%. Reduced average Cycle Time to 30 days.
Hamilton Beach Brands, Inc. Home Appliances, New Product Development	34 new products per year. 74% projects on time.	Increased throughput to 52 new products in 1st year and 70+ in 2nd year, no increase in head count. Increased on-time delivery to 88%.
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.
LeTourneau Technologies, Inc. Oil & Gas Platform Design & Manufacturing	Design Engineering took 15 months. Production Engineering took 9 months. Fabrication and Assembly took 8 months.	Reduced Design Engineering to 9 months. Reduced Production Engineering to 5 months. Reduced Fabrication and Assembly to 5 months, with 22% improvement in labor productivity.

CRITICAL CHAIN RESULTS

	BEFORE	AFTER
LSI Logic ASIC Design Technology Development	74% of small projects on time. Major tool releases were always late.	85% of small projects on time. Major tools released on time for 3 consecutive years.
Marketing Architects Advertising Product Development	Completed 7 projects in 12 months of 2006.	Completed 7 projects in 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. Reduced schedule slips on device programs by 50%.
Medtronic, Europe High Tech Medical Product Development	Development of devices took 18 months on average and were unpredictable.	Reduced development Cycle Time to 9 months. Increased On-time delivery to 90%.
Oregon Freeze Dry Food Preparation & Packaging	72 sales projects completed per year.	171 sales projects completed per year. Increased throughput dollars by 52%.
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% of the projects on time, with the same number of resources.
Rapid Solutions Group Marketing/Publishing Support	Poor delivery performance.	Reduced lead times by 25% with enhanced on-time delivery.
Skye Group Garment Design	Product ranges were late to market.	100% due-date performance. Reduced lead times and sampling cost by 30%.
TATA Steel Steel Plant Maintenance	Boiler Conversion projects took 300-500 days. Routine maintenance and upgrade took too long.	Boiler Conversion projects took 120-160 days. Reduced maintenance and upgrade Cycle Times by 10-33%--savings of \$13.4 million in the first year. Reduced Cycle Time by a further 5-33% the next year.
TECNOBIT Defense Products Design and Manufacturing	Difficult to synchronize Design and Manufacturing. Long project Cycle Times with frequent delays.	Reduced Cycle Time by 20%.
ThyssenKrupp (Johann A. Krause) Automotive Assembly Systems, Engineer-to-Order	70% of projects were late. High overtime and outsourcing.	Reduced lateness by 50%. 63% production gain. Completed 15% more projects.



CRITICAL CHAIN RESULTS

	BEFORE	AFTER
Valley Cabinet Works Custom Furniture Design and Manufacturing	Struggled to complete 200 projects per year. Revenues were flat and profits were low.	Completed 334 projects in 9 months. Increased revenues 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 17 weeks. On-time delivery of 80%.	Increased revenues to €170 M. Increased profits to €22 M. Reduced Cycle Time to 14 weeks. Increased on-time delivery to 90%.
Delta Air Lines, Inc. Engine Repair & Overhaul	Produced 40 engines per month. 4 weeks piece part Cycle Time.	Increased production to 50+ engines per month. Reduced engine turnaround time to 16%-26%. Reduced piece part Cycle Time to 2.5 weeks. Increased piece part throughput by 25%.
Erickson Air-Crane Helicopter Manufacturing and Maintenance	Only 33% projects completed on time.	Increased due-date performance to 83%.
French Air Force, SIAé Clermont Ferrand Transall Production Line Aircraft Upgrade and Repair	5 C-160 aircrafts on station. 150 days planned Cycle Time.	Returned 2 C-160 aircrafts to Air Force, 3 on station --replacement value of approximately €300 M. Reduced planned Cycle Time to 100 days. Increased man-hours by 15% increase with 13% fewer resources.
US Naval Aviation Depot, Cherry Point Aircraft Repair & Overhaul	H-46 aircrafts average turnaround time was 225 days. H-53 aircrafts average turnaround time was 310 days. Throughput was 23 per year.	Reduced H-46 turnaround time to 167 days, while work scope increased. Reduced H-53 turnaround time to 180 days. Delivered 23 aircrafts in 6 months. Increased throughput to 46 per year.
US Naval Shipyard, Pearl Harbor Submarine Maintenance & Repair	Job completion rate was 94%. On-time delivery less than 60%. Cost per job was \$5,043.	Increased job completion rate to 98%. Increased on-time delivery to 95+%. Reduced cost per job to \$3,355, a 33% reduction. Reduced overtime by 49%, a \$9M saving.

CRITICAL CHAIN RESULTS

	BEFORE	AFTER
US Marine Corps Logistics Base, Barstow, CA Army Vehicles Maintenance & 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.	Reduced repair Cycle Time of MK48 to 82 days. Reduced repair Cycle Time of LAV25 to 124 days. Reduced repair Cycle Time of MK14 to 59 days. Reduced repair Cycle Time of LAVAT to 122 days.
USAF, Oklahoma City Air Logistics Center, B-1 Bomber Line Aircraft Repair & Overhaul	Turnaround time 162 days. 7 aircrafts in repair cycle.	Reduced turnaround time to 115 days. Reduced to 4 aircrafts in repair cycle. Increased production from 185 hr/day to 273 hr/day. 1 ½ dock spaces freed up.
USAF, Ogden Air Logistics Center, C130 Production Line Aircraft Repair & Overhaul	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)
USAF, Tinker AFB, Oklahoma City, B52 Line Aircraft Upgrade and Repair	Maintained 11 aircrafts a year. Cycle Time of 225 days.	Increased to 17 aircrafts a year. Reduced Cycle Time to 195 days.
USAF, Tinker AFB, Oklahoma City, E3 Line Aircraft Upgrade and Repair	4 aircrafts on base. Cycle Time of 183 days.	Reduced to 2.6 Aircraft on base. Reduced Cycle Time to 155 days. Released 11% capacity for additional workload.
USAF, Warner Robins Air Logistics Center, C5 Production Line Aircraft Repair & Overhaul	Turnaround time 240 days. 13 aircrafts in repair cycle.	Reduced turnaround time to 160 days. Reduced to 7 aircrafts in repair cycle. Reduced defects by 75%.
USAF, Warner Robins Air Logistics Center, C17 Production Line Aircraft Upgrade & Repair	Throughput of 178 hours per aircraft per day. Turnaround time 46-180 days. Mechanic output 3.6 hours per day.	Increased throughput by 25%. Reduced turnaround time to 37-121 days. Increased mechanic output to 4.75 hr/day. Reduced overtime by 40%.
US Air Force Operational Test & Evaluation Center Warfighter Systems Testing	Long Cycle Times. Low utilization of resources. Poor visibility on project slips.	Reduced Cycle Time by 30% for over 900 projects. Improved resource utilization by 30%. Increased on-time delivery to 88%.

SYNOPSIS OF METHODS THAT WORK

	Flow Lines/ Kanban	Critical Chain
Abolish Local Efficiencies		
Prevent Misallocation	Inventory Buffers Pull Signals	Low WIP Time Buffers Buffer Priorities
Tie Local Improvements to Flow	“Exposing the Rocks”	Buffer Diagnostics

CONTACT INFORMATION

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