



CONTINUOUS PROCESS IMPROVEMENT

S Y M P O S I U M S

 The Airline Industry

 Delta Air Lines, Inc.

 Technical Operations

Engine Maintenance Operations



A Case Study: The Change and Challenge in Engine Maintenance



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The Players....

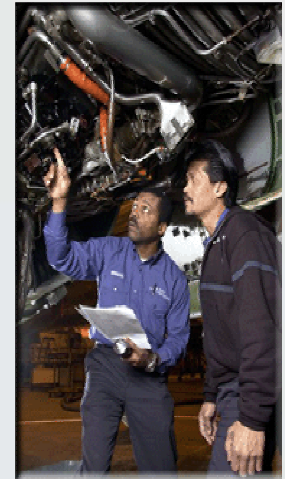
The Airline: Delta Air Lines, Inc.

- Founded as Delta Air Service in 1928
- 8 mainline fleet-types with ~4200 flights daily
- ~50,000 Employees
- \$17B Top Line Revenues



TechOps: Maintenance/Repair/Overhaul Facility

- Grew as necessary to facilitate Delta maintenance
- Line, Airframe, Engine, and Component Maintenance
- 6500 Employees worldwide
- 63 Acres (58 Football Fields) of Facility in Atlanta



Oops, change happens....

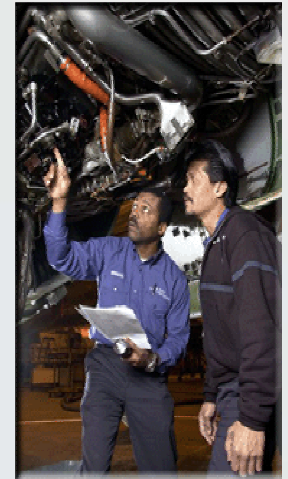
The Airline: Delta Air Lines, Inc.

- Founded as Delta Air Service in 1928
- 13 mainline fleet-types with ~6700 flights daily
- ~75,000 Employees
- \$35B Top Line Revenues



TechOps: Maintenance/Repair/Overhaul Facility

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Large, Complex, Long Standing Entities: Often Slow To Change...

Adapt or ???

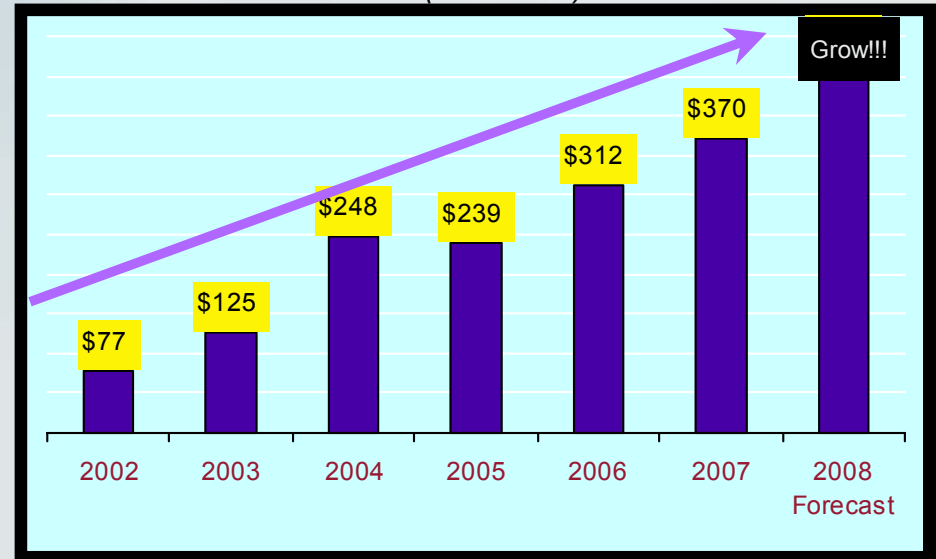
Grow the MRO Aggressively...

Engine Maintenance Operations

- 6 Engine Lines
 - JT8D-219
 - PW2037
 - PW4060
 - CFM56
 - CF34
 - CF6
- Landing Gear, Auxiliary Power Units, Thrust Reverser Overhaul Facilities
- 4 Test Cells
- 20 Total Shared Shops – 1600 Employees
- 600+ Engine Shop Visits Per Year
- Great Capabilities – Great Worldwide Market
- Total Volume Continues Growing YOY

Customer Revenue Growth

(in Millions)



Avg.

Growth Rate: 63% 98% (3%) 31% 19% ???%

Insourcing Growth = 42% CAGR

Mix NOW represents 50% of All Work

Complex Operation Can Be Simplified with TOC, DBR, and CI

Before TOC

How Engines Flowed – Mid 2006:

8 Product Lines– Independently Induct Products Based on Airline NEED



Historical 4 year monthly average production = 38-40 engines/mth
20K open shop orders to support 60 engines in WIP

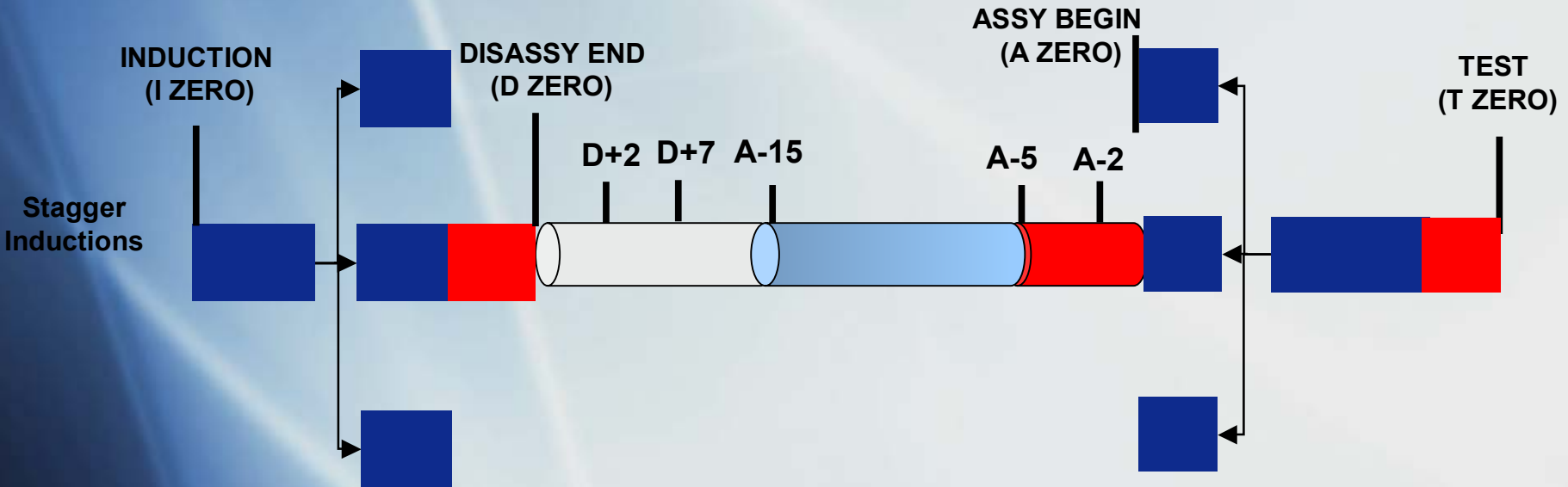
Key Challenges

- All parts are not available when needed (If I just had my %*^# parts)
- Fluctuations in engine demand causes variations in repair processes
- Eight product lines inducted independently based on perceived business need
- Changes to workscope causes delays
- Resources not available when needed
- Delta engines have different parts requirements than insourced engines
- Testing rejects can cause priority changes

Diagnosing the Root Cause



Current Execution Process



DISASSEMBLY

- All exception parts routed
- Complete BOM BY D0
- Ensure all exception parts out by D+2
- D+7, exception parts reach destination and PO assigned

HOLD FOR RELEASE

- Minimizes R&S WIP levels
- Ensures only parts that are needed are in work
- Results include increased throughput and decreased TAT

PARTS REPAIR

- All shops follow RED, FIFO priority in RGM. Expedite tags used only for emergency

ASSEMBLY

- Do not begin until 100% of parts are received
- Use OT only to regain lost buffer

Summary of Changes

1. Create Plans with Buffers

- Developed aggressive project plans with buffers for engine lines
- Setup FIFO/red/expedite priority system for all piece parts

2. Control WIP

- Control the release of engines and parts into work based on WIP levels
- Hold non-exception parts until A-15
- Do not start assembly before A0 and all parts are available for modules

3. Manage Using the Buffers

- Turn parts red 5 days before the start of assembly
- Assign work based on buffer priorities
- Allocate resources to red parts and/or red tasks

4. Exception Management

- Review OSR parts at D+7 and later to ensure on-time delivery
- Review all parts starting A-2 and make decisions if A0 will not be met

Lessons Learned

1. Process Lessons:

- Driven change faster
- Sync Frontline CI/TOC training to better coincide with rollout
- Rolled out Concerto (CC) earlier in the implementation
- Driven a central release area much sooner
- Establish a process to review exception parts list sooner

2. Management Lessons:

- Set up a series of management “offsites” from the beginning
- Ensure metrics were in place faster
- Better anticipated budget pressures to hold back production (cost centered behavior)
- Taken a TOC approach to capital/inventory investment
- Management involvement critical to exception management

Results (Since Mid 2006)

▪ **WIP:**

- Was 20,000 Piece Part WIP → Now 8,000 Piece Part WIP
- Was 60 Engines in WIP → Now: 75-80 Engines in WIP

▪ **TP:**

- 25% increase in piece part repair
- 97+% parts back at A0
- 23% increase in engine production in one year (from 476 to 586) now 600+
- 50+ engines per month produced consistently (63 June 07)

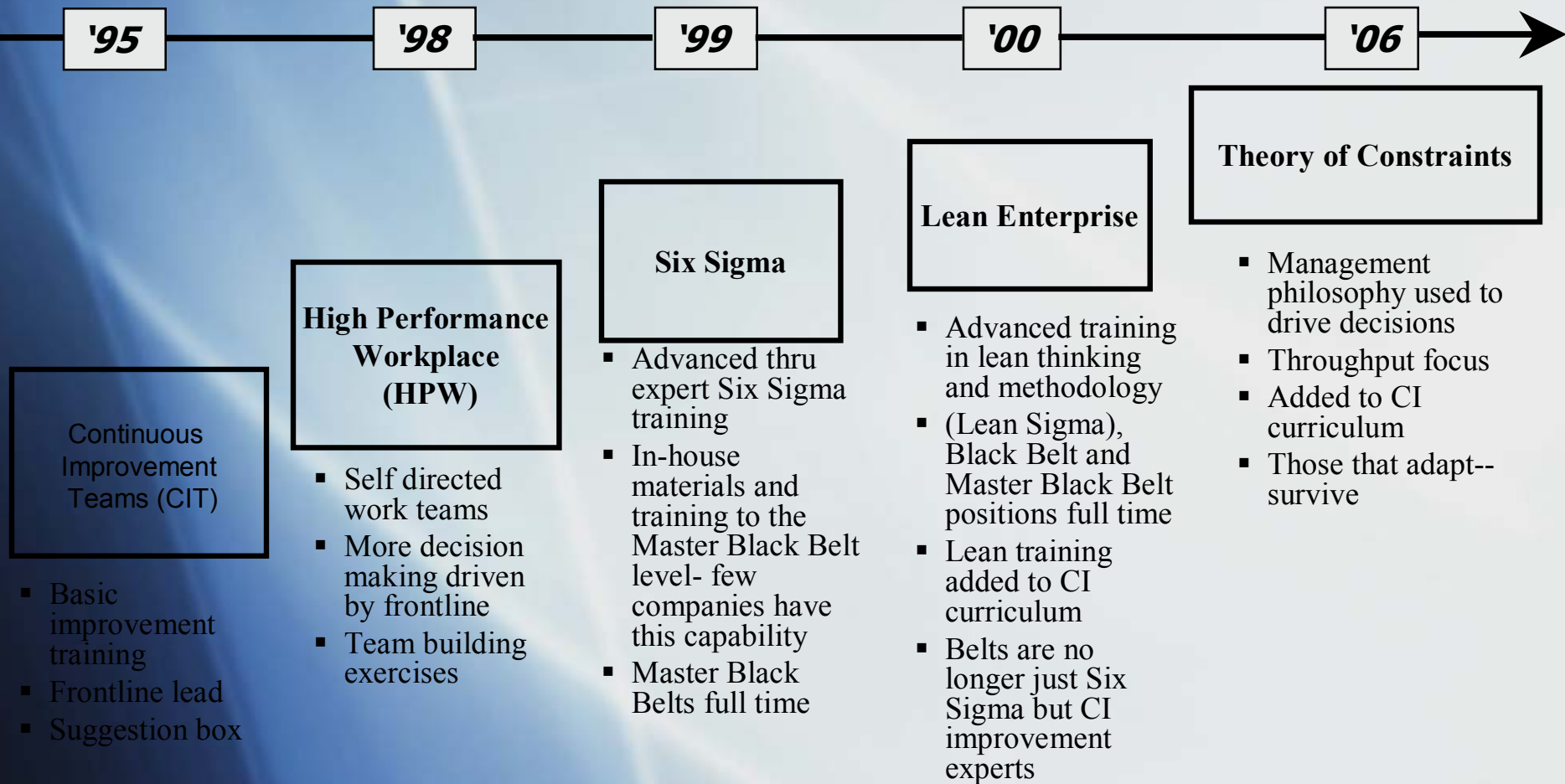
▪ **Turn Time:**

- 50% Reduction in Piece Part TAT
- Engine total TAT reduction – 20% AVG across all product lines
- Engine assembly and disassembly times reduced by 18 to 38%

▪ **Financials:**

- Revenue: 2006: \$312M → 2008 Stretch: Increase 51%
- Budget/Production: 2006: \$484M (548 SV) → 2008: \$514M (~667 SV)

Continuous Improvement History



What would I do if I had it to do over ??????

CI – Methods Integration

- **Six Sigma + Lean + TOC**
- Six Sigma initiated by TechOps 1999 to drive local cost reductions and quality improvements
- Lean initiated 2000 to establish flow of engine disassemble/assemble, point of use, Kanbans, and cell creation. Focused on eliminating waste, understanding flow, and developing a visual workplace
- TOC concepts implemented 2006 to drive focus on constraint(s) and improve overall engine maintenance performance, using CI as a **growth** strategy

TOC concepts has given clear understanding where to apply Six Sigma and Lean methods to achieve true bottom line results

Career Path

- Our culture has evolved to supervisory positions preferring CI training and certification
- Within Delta Tech Ops BB and MBB positions are full time
- Our experience has been that pay for BB and MBB's has to be market driven
- Through our implementation of TOC we have changed the metrics of CI group to be aligned with our business goals

TOC implementation has continued to drive the flywheel faster YOY

Next steps:

1. Focus on outside repair vendors and new material supply processes—In work
2. Attention around exception management—Continuously Improving
3. Expand implementation to include other products that utilize shared shops—Landing Gear
4. Continue to drive inventory reduction
5. Improve sales/production synchronization

THANK YOU FOR....

The Opportunity to Share Our Theories, Facts, and Results Today

Questions?

Continuous
Process
Improvement

May 13, 14, 15
at Weber State
University



S Y M P O S I U M S