The Boeing 737/757 Lean Story

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April 2, 2003

Similarities between...

737-800
Pilot
Bulkheads
Rigid barrier
Keel Beam
Rudder
Doors
Engines
APU
Interiors
Floors
Skin panels
Crew accommodations
Galley
Cargo
Fire protection, Loading
Systems
communication, emergency, lighting, potable water

USNS SHUGART (TAKR 295)
The Boeing 737/757 Lean Story
Our Ship we used to build.....

Toyota Describes TPS With This Balanced House

- Lowest Cost
- Highest Quality
- Shortest Time

Just In Time
Automation & Jidoka
Stability
BOEING PRODUCTION SYSTEM ACADEMY
a.k.a. Lean Academy

OBJECTIVES: Create a cohesive, uniformly trained team centered on an identified Value Stream based on:
  o A common understanding of Lean principles
  o Integrating Lean strategies into a system easily understood at every level.
  o One plan for improvement
  o Top management involvement

DIFFERENCE: The Academy:
  § Integrates a Value Stream TEAM in BPS training and implementation
  § Includes Managers
  § Uses powerful simulations
  § Uses graduates (and ONLY graduates) as instructors and facilitators
  § Gives you an implementation plan for your Value Stream Future State
  § Promotes and enables linkage of Lean activities
  § Culminates in a Value Stream Mapping exercise that will point to where and to what kind of Lean activity to conduct.

737/757 Traditional Factory
1965-2001

- Excess inventory
- Time loss during airplane line moves
- Production and support groups work to different schedules and different priorities
- Tools, parts and drawings not readily available to mechanics
- Production status of factory not visible
- Flow time not correlated to customer demand
9-Step Plan

1. Value stream mapping and analysis
2. Balance the line
3. Standardize work
4. Put visuals in place
5. Point of use staging
6. Establish feeder/supply chain lines
7. Break-through process re-design along main line
8. Convert line to a pulse line
9. Convert to moving line *(continuously flowing or one piece flow line)*

Step 1 – Value Stream Mapping
Before Lean Implementation
Step 1 – Value Stream Mapping
After Lean Implementation

Step 2 – Balancing the Line
Distributing the Work Evenly

By POSITION by DAY by SHIFT
Step 3 — Standardize Work

The fastest way to perform the task at the lowest cost with the highest quality every time the task is performed.

- Support cell next to airplane
- Andon board visible from floor and from support cell
- Andon visual notification
- Audibly - Floor to Support Cell
- Automatic Support Cell paging when line stops

Step 4 — Put Visuals in Place

737-757 Cross Functional Support Teams - Andon System
Step 4 — Put Visuals in Place
Pitch Marks/Color Coding/Kit Queues

Step 5 — Point of Use Staging
737-757 Parts Control Areas (PCAs)

- Kits are replenished in PCA/Tooling work cells, located next to the airplane they support.
Step 5 – Point of Use Staging
737-757 Job Kitting

- All materials needed to complete the job
  - Parts
  - Tools
  - Hazardous material
  - Consumables

Step 6 – Establish Feeder Lines
737-757 Fuel Tubes

**Before:**
- 16 hours on airplane
- FOD
- Over 900 parts
- Ergonomic problem area
- Quality issues

**After:**
- <8 hours on airplane
- Pre-assembled
- <200 parts
- Sorted in 4 bags
- Standard

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Step 7 — Break-Through Process
Re-Design Along Main Line — 737/757 Service-Ready Wings

Eliminated 2 days of flow

In Wing Assembly...
- Trailing edge outboard flaps installed and rigged
- Leading edge slats and slat panels installed and rigged

In Final Assembly...
- 160 fewer labor hours
- 100 fewer parts and assemblies installed
- Tooling and access stands reduction
Step 7 — Break-Through Process
Re-Design Along Main Line—757 Transporter

Transporter

Step 7 — Break-Through Process
Re-Design Along Main Line — 737-757 "Hay Elevator" Seat Loader
Step 8 — Convert Line to a Pulse Line

Step 9 — Convert Line to a Moving Line

737 Final Assembly  
757 Final Assembly
737-757 Final Assembly Lean Production System

Supplier Lean Efforts

- Wichita Division
- Fabrication Division
- Propulsion System Division
- Value stream mapping and analysis
- Aircraft Systems & Interiors
- Yokohama Rubber Company
- Turkish Aerospace Industries
**Lean Global Enterprise**
*Wichita Division Lean Improvements*

### 737 Monolithic Bulkhead Structure
- Weight - 7% Reduction
- Cost - 9% Reduction
- Parts - 49% Reduction
- Simpler Installation

### 757 Section 43, 44 & 46 Floor Beam Assembly Work Transfer to Wichita
- Utilization of existing universal holding fixture eliminate 3 floor gantry’s, assembly jigs, & numerous drill tools
- Utilization of NEOS Robot eliminates the need for current “applied type” tooling used in Renton - Eliminates Auburn Machine Shop routing - Drills all TBS 1, 2 & 3 extruded beams
- Utilization of existing production lines eliminates approx. 4300 sq ft of manufacturing space
Lean Global Enterprise
Fabrication Division Lean Improvements

737 MAIN LANDING GEAR SUPPORT

**Goals:** Substantially reduce product flow days / cycle time, work in process, and unit cost

**Methods:** Develop Lean Manufacturing cell utilizing "right sized" equipment, point of use tooling and Just-In-Time component stores

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Lean Global Enterprise
Propulsion Systems Division Lean Improvements

**737 Engine Build Up Flow Reduction**
- Unit Time flow reduction from 3 days to 1 day
  - 66% inventory reduction per shipset
  - Current cycle time is 4.5 hours per engine

**Before**

**After**

66% Inventory Reduction

3 Flow Days

1 Flow Day
### 737 / 757 Stowage Bin Moving Flow Line

Established in 2001 - Implemented a moving flow line to produce stowage bins Just-In-Time with reduced hrs/part, floor space, and inventory.

**Benefits / Reductions**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hrs/Part</td>
<td>23% (6.9 to 5.3)</td>
<td></td>
</tr>
<tr>
<td>Assembly Stations</td>
<td>20% (5 to 4)</td>
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</tr>
<tr>
<td>Floor Space</td>
<td>1500 Sq. Feet</td>
<td></td>
</tr>
<tr>
<td>Work In Process</td>
<td>66% (12 Bins to 4 Bins)</td>
<td></td>
</tr>
</tbody>
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- Increased predictability of output and adherence to takt time
- Elimination of ergonomic issues associated with manual bin transfer
- All Line stoppages are logged and if possible fixed immediately

### 757 Program Objectives

- Reduce manufacturing lead time by 40%
- Implement moving line

### Results

- **757 Program**
  - Lead time reduction of 40% +
  - New light weight assembly fixture
  - Standard operations/moving line

- **Yokohama Rubber Company**
  - Cycle time reduction of 60%
  - Work in Process reduction of 50%
  - New light weight assembly fixture
  - Standard operations/moving line
### Lean Global Enterprise

**Supplier Management & Procurement Lean Improvements**  
**Turkish Aerospace Industries**

#### 737 Program Objectives
- Increase Volume of Flight Deck Panels by 50%  
  - Assure 100% On Time Delivery  
  - Assure 100% Quality Acceptance

#### Results
- **737 Program**  
  - Volume increase achieved  
  - Achieved On Time Delivery of 99.5%  
  - Achieved Quality Acceptance of 99.0%

- **Turkish Aerospace Industries**  
  - Cycle time reduction of 49%  
  - Point of Use Kitting Sub components  
  - Standard operations established

### Renton Factory Gains Illustration

**WIP At 21 737 airplanes per month**

<table>
<thead>
<tr>
<th>Before...29 airplanes</th>
<th>After...14 airplanes</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Before Image" /></td>
<td><img src="image2" alt="After Image" /></td>
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