Manufacturing Cell Design

History, Design and Principles of Implementation
## The Outline

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Background

The roots of flow

➔ Henry Ford
➔ Mass Production
➔ WW 2
➔ Post WW 2
➔ Lean Thinking
➔ Flow returns
➔ Flexible Cells
Ford Created Manufacturing Flow

Ford was making cars for over 10 years before he hit on the idea of a moving assembly line.

It dramatically changed the economics of the automobile and created the middle class.
## Ford Production Rate

<table>
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<tr>
<th>Frequency</th>
<th>Seconds per day</th>
<th>Cars per day</th>
<th>Cars per year</th>
</tr>
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<tr>
<td>40 sec</td>
<td>86,400</td>
<td>2,160</td>
<td>540,000</td>
</tr>
<tr>
<td>3 shifts</td>
<td></td>
<td></td>
<td>250 days</td>
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Was it a pull or a push?
Pre-World War 2

Most industries had copied the assembly line method.

Frederick Taylor’s methods of scientific management were validated.

General Motors had surpassed Ford and the vertically integrated corporation had been created.

“Work consists mainly of simple, not particularly interesting, tasks. The only way to get people to do them is to incentivize them properly and monitor them carefully.”

– Frederick Winslow Taylor
General Motors 1936
**World War 2**

Every factory in America was converted to war production

William Knudsen was the supply chain genius

TWI was birthed

Everything was produced by flow: cars to guns to ships to bombers

B-24 Bomber: 100,000 parts, one plane every 55 minutes, 80 acre plant, 40,000 workers
Post World War 2

Most factories reverted to peace-time production.

Men returned, TWI was shelved.

US Companies were unrivaled, inefficiency was allowed to grow

A growing economy allowed mass production and flexibility was not needed
The Toyota Effect

Developed system in obscurity

Landed in the US in 1980’s

Turned US manufacturing upside down

Flow is rediscovered in every industry

Boeing’s 2nd epiphany
Boeing

Experimented with a “pulse” line in 1990’s

Started flowing the 737

Building 42 planes per month

Now most planes are made in some type of flow line
## Flow Line Calculations Using Boeing 737

<table>
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<tr>
<th>Planes per month</th>
<th>Work Days</th>
<th>Lead Time</th>
<th>Planes per day</th>
<th>Number of Stages</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>21</td>
<td>9 days</td>
<td>2</td>
<td>18 +</td>
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Design

The Tools and Techniques of designing a flow line

- Process Steps
- Operator Balance Chart
- Matching Takt Time
- Labor Linearity
- Ergonomics
Observation and Documentation

Standard Work Combination Chart
 Lists work steps with times
 Displays relationship and sequence
 Shows manual vs automatic time
 Shows operator motion
Operation Balance Chart

Step time depicted as bars

Displays the balance between steps and the relationship to Takt Time

Shows effective utilization

Lean Standard Work – Work Balancing

Theoretical # of Workers

Total Work Time

\[
= \frac{\text{Total Work Time}}{\text{Takt Time}}
\]

\[
= \frac{18 + 12 + 19 + 12 + 14}{20}
\]

\[
= 3.75 = 4 \text{ Workers}
\]
Ideal Process

Total Work Time = 75 sec

3 operations @ 19 sec

1 operation @ 18 sec
Work Breakdown

How can work be redistributed to create balance.

This will lead to a flow which can eliminate inventory between operations.
Ergonomics
10 Rules of Lean Cell Design

#4 Make it Ergonomic
Chaku Chaku
Simulation

Hands-on Exercise

Trying out the tools
Process Description

Spring Install

Red Resistor

Green Resistor

Diode

LED
Hands On Exercise in Line Balancing
Elements of the Simulation

Assemblers

Observers/Timers

Score-keepers

Analytics

Kaizen Team
Conclusion

Questions and Comments
Additional Videos: Boeing
Additional Videos: Boeing 777 Flow Line