LEAN FLOW TECHNOLOGY

- MODULE LFT106 -

BALANCE AND FLOW
PURPOSE

- Operational Definition.
  - "At, or Below" TAKT Time Targets to create Balance.
- Resolve Imbalances.
- In-Process Kanban.
- Balance and Flexibility.
  - U-Cell Design.
- Physical Implementation.
**BALANCE AND FLOW OVERVIEW**

- **OPERATIONAL DEFINITION.**
  - Optimum Flow is achieved by Grouping Tasks "At, or Below" TAKT Time.
  - When Actual Work Content cannot be Grouped "At or Below" TAKT Time Targets to create Balance = **IMBALANCE**.

- **Resolve Imbalances:**
  1. Eliminate Work Content. – NVA.
  2. Move Work from one Operation to the Next.
  3. Inventory Investment. – IPK's.
  4. Additional Resources. – $$$$$$. 
**BALANCE AND FLOW**

**RESOLVE IMBALANCES**

1 - Eliminate Work Content

2 - Move Work Elements

3 - IPK’s Implementation

4 - Additional Resources
IN-PROCESS KANBAN – IPK's OVERVIEW

- Resolving Imbalance.
- ... **Inventory Investment**.
- Supported with Calculations.
- Visual Signal to Work or Move.
- First In – First Out Management.

#IPK = 1 !...
IN-PROCESS KANBAN FORMULA

\[ \#IPK = \frac{I \times C}{TAKT} \]

I : Imbalance : I = AT - TAKT.
C : Cycle of Imbalance : C = H / AT.
H : Effective Work Time per Shift.
IN-PROCESS KANBAN
A TYPICAL CASE OF ... CALCULATION

TAKT = 2 mn.

AT = 2.0

I = AT - TAKT = 2.2 - 2.0 = 0.2
C = H / AT = 440 / 2.2 = 200

#IPK = \frac{I \times C}{TAKT}

#IPK = \frac{0.2 \times 200}{2} = \frac{400}{2} = 200

#IPK's ? #IPK's ?

#IPK = 20

3.6 (1.8) 3.6

$\text{?}$
IN-PROCESS KANBAN
CALCULATION IN MIXED-MODEL

TAKT = 2 mn.

\[ \#IPK = \frac{I \times C}{TAKT} \]

I = AT - TAKT = 3.8 - 2.0 = 1.8

C = 1 (Mixed-Model)

\[ \#IPK = \frac{1.8 \times 1}{2} = 1 \]

\#IPK = 1
IN-PROCESS KANBAN BETWEEN PROCESSES FORMULA

Between Processes:

A : Shift Difference.
B : $D_c$ per Shift Longer Process.

#IPK = A x B
IN-PROCESS KANBAN
A TYPICAL CASE OF ... CALCULATION

#IPK’s?

<table>
<thead>
<tr>
<th>Process</th>
<th>Cast</th>
<th>Spray</th>
<th>Kiln</th>
<th>Pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dc :</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Shifts :</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Dc per Shift :</td>
<td>150</td>
<td>300</td>
<td>100</td>
<td>150</td>
</tr>
</tbody>
</table>

- Compare Side by Side Processes.
  - **Example between Cast and Spray Processes**:
    - Calculate the Shift Difference between Processes.
      - $2 - 1 = 1$
    - Select the Dc for Process with Greater Number of Shifts.
      - Cast Process : Dc per Shift = 150
    - #IPK's = A (Shift Difference) x B (Dc per Shift Longer Process)
      - #IPK's = 1 x 150 = 150
IN-PROCESS KANBAN
WET LINE

- Additional Work Time to:
  - Preserve a "Wet Line":
    - AFTER EACH PRODUCTION DAY.
  - Hold Production Flow in Balanced.
  - Calculate Additional Resources.
ADDITIONAL WORK AROUND IPK's
A TYPICAL CASE OF ...

AT = 8.8

#IPK = 5

TAKT = 8

Additional Work = #IPK x AT

#IPK : Size of IPK's.
AT : Actual Time.

Additional Work = 5 x 8.8

RESOURCES FOR ADDITIONAL WORK = 44 min.
First Step of Improvement: **U-SHAPED CELLS.**
- Several Operations by Employee.
- Space Floor Saving.
- Create Balance.
- Cells designed for Flexibility.

**Improve:**
- Machine Utilization.
- Labor Productivity.
- Operational Cycle Time.
Wished Flexibility: -20%  
Nominal: 15  
+20%: 12.4

Demand at Capacity - $D_c$: 22  
28  
34

TAKT Time (mn): 19.1  
15  
12.4

Effective Work Time per Shift (mn): 420

Number of Shift(s): 1

Nominal $D_c$: 28  
TAKT Time (mn) = 15

Low $D_c$: 22  
TAKT Time (mn) = 19.1

High $D_c$: 34  
TAKT Time (mn) = 12.4
## BALANCE AND FLEXIBILITY RESOURCES CALCULATION

<table>
<thead>
<tr>
<th>Wished Flexibility</th>
<th>Nominal</th>
<th>+20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand at Capacity - $D_c$</td>
<td>22</td>
<td>28</td>
</tr>
<tr>
<td>TAKT Time (mn)</td>
<td>19.1</td>
<td>15</td>
</tr>
<tr>
<td>#OP – Theoretical</td>
<td>2.84</td>
<td>3.61</td>
</tr>
<tr>
<td>#OP – Effective</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Total Time from SOE's (mn): 54.2

# Operations:

- $\# \text{OP} (D_c) = \frac{54.2}{15} = 3.61$ ???
- $\# \text{OP} (D_c-20\%) = \frac{54.2}{19.1} = 2.84$
- $\# \text{OP} (D_c+20\%) = \frac{54.2}{12.4} = 4.37$
# BALANCE AND FLEXIBILITY
## CORRECTED CAPACITY

<table>
<thead>
<tr>
<th>Wished Flexibility</th>
<th>Nominal</th>
<th>+20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand at Capacity - $D_c$</td>
<td>22</td>
<td>28</td>
</tr>
<tr>
<td>TAKT Time (mn)</td>
<td>19.1</td>
<td>15</td>
</tr>
<tr>
<td>#OP – Theoretical</td>
<td>2.84</td>
<td>3.61</td>
</tr>
<tr>
<td>#OP – Effective</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Corrected Capacity</strong></td>
<td><strong>23</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

Total Time from SOE's (mn) : 54.2

Effective Work Time per Shift (mn) : 420

- #OP – Theoretical : 4: Capacity / Day = 420 x 4 / 54.2 = 30
- #OP – Theoretical : 3: Capacity / Day = 420 x 3 / 54.2 = 23
- #OP – Theoretical : 5: Capacity / Day = 420 x 5 / 54.2 = 38
## BALANCE AND FLEXIBILITY
### CORRECTED FLEXIBILITY

<table>
<thead>
<tr>
<th></th>
<th>Wished Flexibility: -20%</th>
<th>Nominal</th>
<th>+20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand at Capacity - $D_c$</td>
<td>22</td>
<td>28</td>
<td>34</td>
</tr>
<tr>
<td>TAKT Time (mn)</td>
<td>19.1</td>
<td>15</td>
<td>12.4</td>
</tr>
<tr>
<td>#OP – Theoretical</td>
<td>2.84</td>
<td>3.61</td>
<td>4.37</td>
</tr>
<tr>
<td>#OP – Effective</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Corrected Capacity</td>
<td>23</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>Corrected TAKT Time (mn)</td>
<td>18.3</td>
<td>14</td>
<td>11</td>
</tr>
</tbody>
</table>

-23%                        Nominal                        +26%
BALANCE AND FLEXIBILITY
LOW CAPACITY DEFINITION
BALANCE AND FLEXIBILITY

NOMINAL CAPACITY DEFINITION
BALANCE AND FLEXIBILITY
HIGH CAPACITY DEFINITION
# OP based on Customer Demands.
LEAN FLOW TECHNOLOGY
TIMES IN LFT

- TAKT Time.
  - Volume driven Time Targets. – By Process.
- Actual Times. – AT.
  - From the Sequences of Events. – SOE's.
- Operations.
  - Work Grouped within a TAKT Time Target.
- Balance.
  - Between Actual Time at Operation (AT) and TAKT Time, Not Between Operations.
MIXED-MODEL LINE DESIGN
PHYSICAL IMPLEMENTATION

- Demand at Capacity.
- TAKT Time.
- Daily Rate.
- Kanban Sizes.
- Method Sheets.
- Sequence of Events.
- Sequence Lists.
- Operational Definition.
- Staffing.
- Effective Work Hours.
- Number of Shifts.
- Replenishment Intervals.
- IPK's Sizes.

Which Should Change Every Day?
MIXED-MODEL LINE DESIGN
PHYSICAL IMPLEMENTATION

#KB’s =

#IPK’s =
MIXED-MODEL LINE DESIGN
... VISUALIZE THE END RESULT

“Imagination is More Important than Knowledge”

Albert Einstein
MIXED-MODEL LINE DESIGN
WHAT IS THE TRUE FLOW?
SUMMARY

- Operational Definition.
  - "At, or Below" TAKT Time Targets to create Balance.
- Resolve Imbalances.
- In-Process Kanban.
  - Formulae and Calculation.
  - ... Typical Case in Mixed-Model Concept.
  - Additional Work.
- Balance and Flexibility.
  - U-Cell Design.
- Physical Implementation.
LEAN FLOW TECHNOLOGY
QUESTIONS
Lean Flow Technology

COPYRIGHT

- All presentations included in the Lean Flow Technology program are the property of their respective authors.
- The presentations and files, or part thereof, cannot be reproduced, (re)-sold or (re)-distributed without the express written from their authors.
- If you have any questions or comments, please contact us:
  - On the Web site: www.leanflowconsulting.com
  - By Email at: contact@leanflowconsulting.com
- All logos displayed below are registered and are the property of Lean Flow Consulting and/or the authors. You are not permitted to use these logos without the prior written agreement of the authors.