Operational Excellence within a Low Volume High Mix business

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Low Volume-High Mix Production

Characteristics low volume high mix business:

- Volume – max 100 / 200 equipment’s per year per platform type;
- Orders managed by project as:
  - Configured to Order
  - Engineered to Order
- Technology evolution as competitive factor;
- Customer needs adaptation as competitive factor.

The challenges for a low volume high mix, like the one above described, is to drive quality and efficiency continuous improvement while:

- Allowing a competitive time to market on new technology;
- Maintaining a wide portfolio offering
Complete Lines for Beverage Industry

- **BLOWING**
- **COMBI (BLOW & FILL)**
- **FILLING**
  - PET, CAN, GLASS
- **CONVEYING**
  - Air Conveyors, Bottle conveyors, Cap Feeders
- **PACKING & WRAPPING**
  - PET, CAN, GLASS
- **LABELING**
- **SERVICE**
  - Spare Parts
  - Options & Upgrades
  - Technical Training Center

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Complete Lines for Beverage Industry
Lean – Six Sigma - Modularity

A set of methodologies to continuously eliminate Non-Value added tasks, to deliver consistently more Value to Customers while leveraging flexible product platforms tailored for all market needs.

- Lean chases waste (‘Muda’) for simpler and faster processes
- Six Sigma reduces processes variation to enable better quality
- Modularity enables the design of flexible product platform
The Lean and Six Sigma journey

**5S, Std Work, Visual Mgmt., Skill Matrix, TPM, SMED, OEE**

**Lean Office**
- VSM, Voice of Customer

**Lean on Installation**
- 5S, Std Work, Visual Mgmt., Fishbone Diagram, Skill Matrix

**Lean on Assembly**
- Fishbone Diagram, Level Loading, Skill Matrix, One Piece Flow

**Lean on Manufacturing**
- TPM, SMED and OEE

**Lines Efficiency**
- 5S, Std Work, Visual Mgmt., Skill Matrix, TPM, SMED, OEE
Lean Manufacturing
What did we achieve so far with Lean…

Thanks to the strong commitment of our resources to the LEAN methods, we succeeded in:

- Better quality and punctuality of our products
- Faster delivery
- Higher efficiency

…as LEAN is a continuous improvement methodology, we will keep going!
What did we achieve internally…
Never give up these principles…

1) **FLOW THE PRODUCT**
   ... even if it weights 15 to 30 tons

2) **MANAGE BY HOUR**
   ... even if it has 1000 to 5000h of assembly

3) **MAKE IT VISUAL**
   ... to identify the anomalies Vs. the std. and take prompt actions
What did we achieve at the customer sites...

**BASELINE 2009**
- Erection: 19%
- Start-up and comm: 21%
- Closing punch list: 61%
- Baseline LT: 100%

**FINAL 2010**
- Erection: 8%
- Start-up and comm: 24%
- Closing punch list: 19%
- Overall LT: 52%

**ACTUAL 2011**
- Erection: 7%
- Start-up and comm: 25%
- Closing punch list: 13%
- Overall LT: 45%

Data based on similar equipment lines.
Major initiatives at customer sites

**Internal Standard Procedure for installation, to identify the main deviance causes:**

- Importance of a strong installation support team for machine handling and positioning
- Equipment's packaging and handling tools (crane, forklift…) improvement
- Readiness of site: civil works not finished (road, building), lack of power or temporary energies, lighting, poor arrangement of parts storage room (too distant, not lockable…)

**Daily Work Organization:**

- Morning and Evening Meetings led by ISM and involving Team Leader, Customer resources and FSE’s;
- Focus on Hour by Hour Management.

**Seminars with customers focusing on Lean and site activities preparation:**

- Importance of site preparation and readiness;
- Forecast of utilities availability (main impact on the overall lead time).

**Lean team participating to project reviews on regular basis and site visit.**
Six Sigma
New Product Dev. VSM

OPPORTUNITIES:
- Efficiency on LT gained into the modules development loops (31% of total value)
- Efficiency on engineering hours (34% of total value)

KEY ACTIONS:
1 – Tech Standard (TS) for Module Validation
2 – Projects Operating Model (POM)
3 – Field Test @ NPD / Module Incremental
4 – Project Manager / Chief Engineer

LT  PT
71% 81%
13%
12% 15%

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New Product Development Process

Dr = Design Review

Equipment Run-Off

Integration Point

Module Internal Test

Pull Event

Reliability Target Confidence Level

1. If the parts occur issue, have safety risks for operator, have integrity risk for final product, even damage the machine.

2. If the parts occur issue, it would great impact machine running performance, have function or important assembly problems

3. If the parts occur issue, it wouldn’t impact machine running performance, no important impact on assembly, long time to substitute

4. If the parts occur issue, it wouldn’t impact machine running performance, no impact on assembly, short time to substitute

Modules Standard Criticity Levels

TG0

Equipment FMEA

L1 or L2 Module

TG1-2

TG3

Internal Test

Design Of Experiment

CTQs

Module FMEA

L1 or L2 Module

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Classical Approach (Product Design)

Sub-system Development

Sub-system Assembly

Product Test

Product Specs

Continuous Loop-back

Classical Approach

Product Design

Product Test
Set Based Concurrent Design

Sub-system Development

Sub-system Selection

Convergence into Product

Product Concept

Continuous Flow of Knowledge

Alternative 1

Alternative 2

Alternative 3
What is better design with Six Sigma?

From:
- Specifications not well formalized
- Design based on “expert knowledge”
- Trials based on customers field test
- Late redesign loops

To DMAIC applied to critical modules:

Define:
- SIPOC / VSM (Process Mapping)
- KPOV’s (Key Process Output Variables)
  - Definition
- VOC-CTQ’s

Measure:
- Input / Output Analysis
- C&E Matrix – FMEA
- Gauge R&R
- Capability Analysis

Analyze
- Statistical tools matrix (Discrete vs. Variables)
- Hypothesis Testing basic overview

Improve:
- DOE Introduction

Control:
- Protocol & validation
- Control chart
- Std & Docs
How
How did we get organized…

- An internal team of 6 people as a reference for the lean & six sigma practices. They rotate to normal business positions every 2-3 years.

- An internal lean & six sigma academy to train and certify:
  - 8-10 new Lean Specialist per year (more than 30 Lean Specialist certified);
  - 9-12 Green Belt and Black Belt for six sigma.

They are then employed in normal operating roles changing the organization from the inside.

- An internal “service factory”, with a 2 days training module for managers (more than 100 managers trained including CEO and EVP’s up to now).

- Initially, monthly review with CEO and EVP’s on process improvement.

- Lean KPI included in company and personal balance score card for bonuses.
Lean deployment … few tips

- **Lean within low volume and high mix business**
  Several people think that lean methods work only in high flow business…

  **…WRONG!**

  In good companies with high flow business, it’s normally easy to reach a fair level of efficiency…so lean just helps getting to the next level;

  being low volume-high mix business more complex to organize, lean techniques can lead to at least twice the improvement vs. high flow business!

- **Lean & office processes**
  There is no limit to the office processes where you can apply lean: administrative, controlling, engineering, commercial…the pay off at the first shot it’s normally > 30% on Lead Time and Efficiency and it is more relevant than in production.
Lean deployment …few tips

- **Lean competencies external Vs. internal**
  
  External support with consultant it’s normally necessary at the beginning of the lean journey.
  
  To guarantee the success, it is fundamental to develop an internal centre of Lean competencies and deploy Lean experts within the organization, to drive the change and sustain the continuous improvement.

- **Lean & Top Mgmt.**
  
  To successfully foster the continuous improvement mentality, the CEO and the EVP’s have to be fully supportive of the initiative, have a basic understanding of the methodology, review the progress on regular basis plus measure and reward the organization for the success.
Modular Design
Standardization vs. Modularization

STANDARDIZATION

..."ONE SIZE FITS ALL" APPROACH...
...DRIVEN BY MANUFACTURING...
...FROM A JUNGLE OF SOLUTIONS TO A SELECTED AND PRUNED ONE...
...REDUCING OFFERING TO OUR CUSTOMERS!

MODULARIZATION

..."ALL IN ONE" (ARCHITECTURE)!!!
...DRIVEN BY CUSTOMERS NEEDS...
...FROM A JUNGLE OF NEEDS TO THE IDENTIFICATION OF KEY DRIVERS...
...ENLARGING OFFERING TO OUR CUSTOMERS WHILE REDUCING INTERNAL COMPLEXITY!!!
Typical modular architecture goals

**EFFICIENCY**

Reducing Part Number Count (PNC) while increasing offering
Reducing Part Number Introduction (PNI) with strict governance
Increasing configurability
Reducing lead times
Reducing time to market
Reducing warranty cost

A set of defined goals has been identified for each modular architecture project.
Product strategies

Product Leadership
+ Price premium
+ Flexible
- Process change
- Development cost
- Quality risk

Operational Excellence
+ Productivity
+ Even quality
+ Low cost
- Unflexible
- Price pressure

Customer Intimacy
+ Faithful customers
+ Market share
- Unstable processes
- High indirect cost
Modularity = interfaces

Product Leadership
Operational Excellence
Customer Intimacy

Interfaces are isolating the modules in their strategic circle
Define implication of modular set up on Product and Production

<table>
<thead>
<tr>
<th>Business Strategy: Modular Product Structure:</th>
<th>Product Leadership</th>
<th>Operational Superiority</th>
<th>Close to Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-house production</td>
<td>Frequent product changes new technology</td>
<td>Few product changes and high volume</td>
<td>Frequent product changes and low volume</td>
</tr>
<tr>
<td>Close cooperation between development and production</td>
<td>Minimized production cost</td>
<td>Cooperation between development and production</td>
<td></td>
</tr>
</tbody>
</table>

Product Implication
Production Implication
Production Strategy

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Modularity KPIs

\[ M_{\%} = \frac{P_v - M_v}{P_v} \cdot 100 \]

- \( M_v \) = module variants
- \( P_v \) = product variants
- \( \frac{P_v - M_v}{P_v} \) = Modularity

Calculated for every module
Modularity KPIs – PNC and Commonality

Part number count can be assessed:
- **PNC** refers to the total number of unique part numbers required to manufacture all product configurations.

Commonality is the % of part numbers that are common between two or more module variants:
- **%C_n**: % of parts used by at least n variants.
1000 - Valve body - before

21 stainless steel parts

\[ M = 33\% \]
\[ PNC = 83 \]
\[ C = 33\% \]
Only difference between std and Hot Fill is the return hole

M% = 33%
PNC = 64
C% = 61%
# Modular project – commonality comparison

<table>
<thead>
<tr>
<th>Application commonality</th>
<th>Current Portfolio</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. BOM lines (module variant level)</td>
<td>133</td>
<td>123</td>
</tr>
<tr>
<td>N° of common modules</td>
<td>52</td>
<td>74</td>
</tr>
<tr>
<td>WATER vs HF</td>
<td>45%</td>
<td>89%</td>
</tr>
<tr>
<td>Full range commonality</td>
<td>39%</td>
<td>60%</td>
</tr>
</tbody>
</table>
Thank you!