Operational Excellence within a Low Volume High Mix business

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Low Volume-High Mix Production

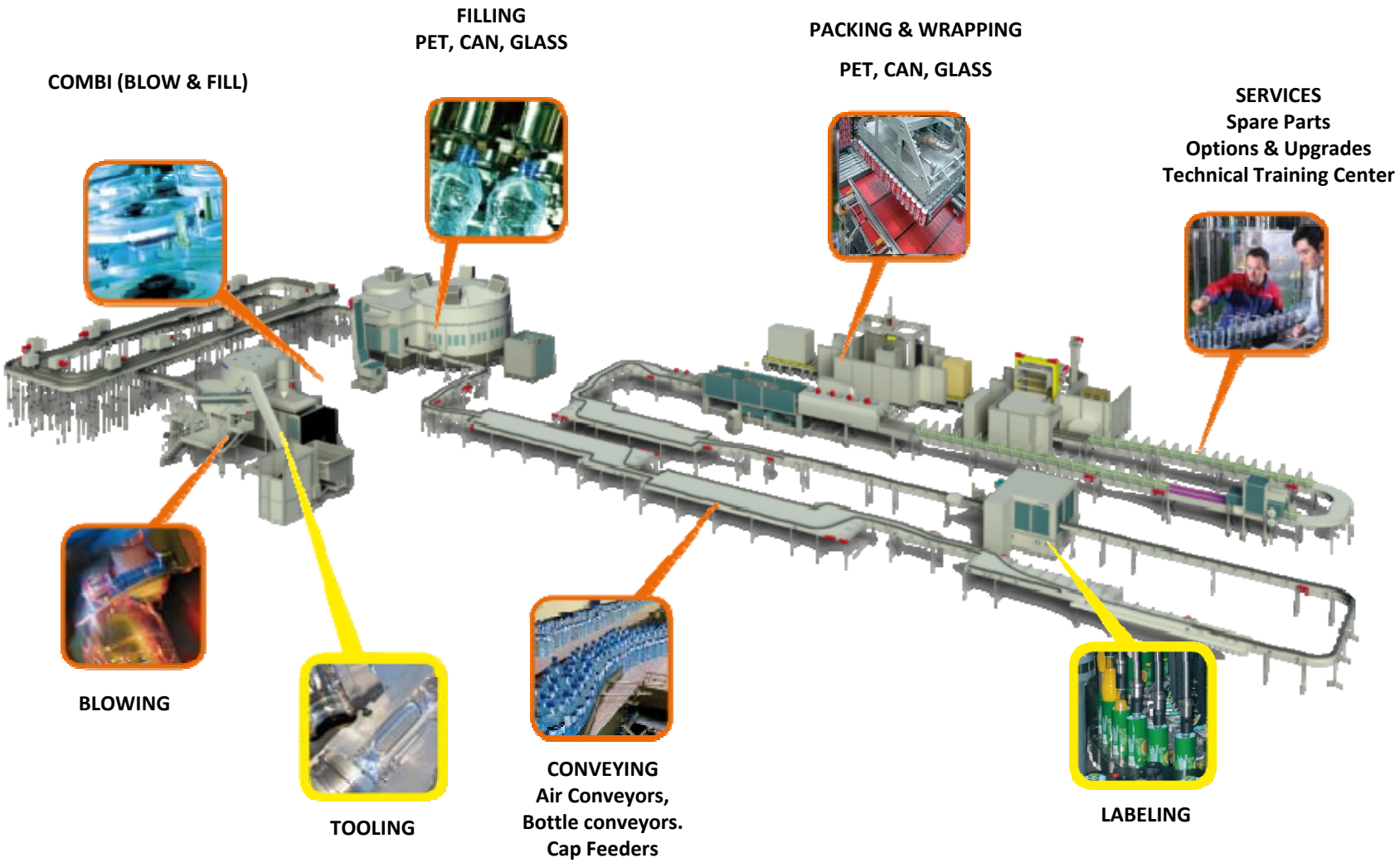
Characteristics low volume high mix business:

- 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

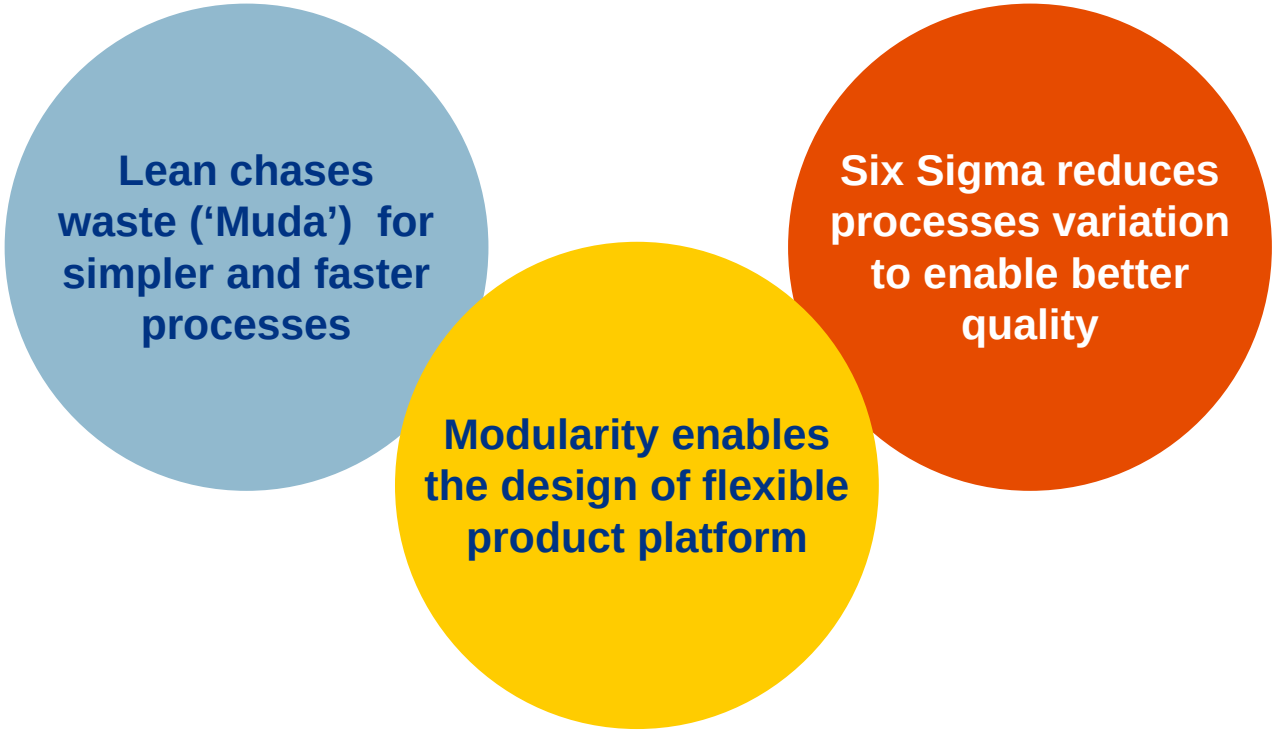
Complete Lines for Beverage Industry



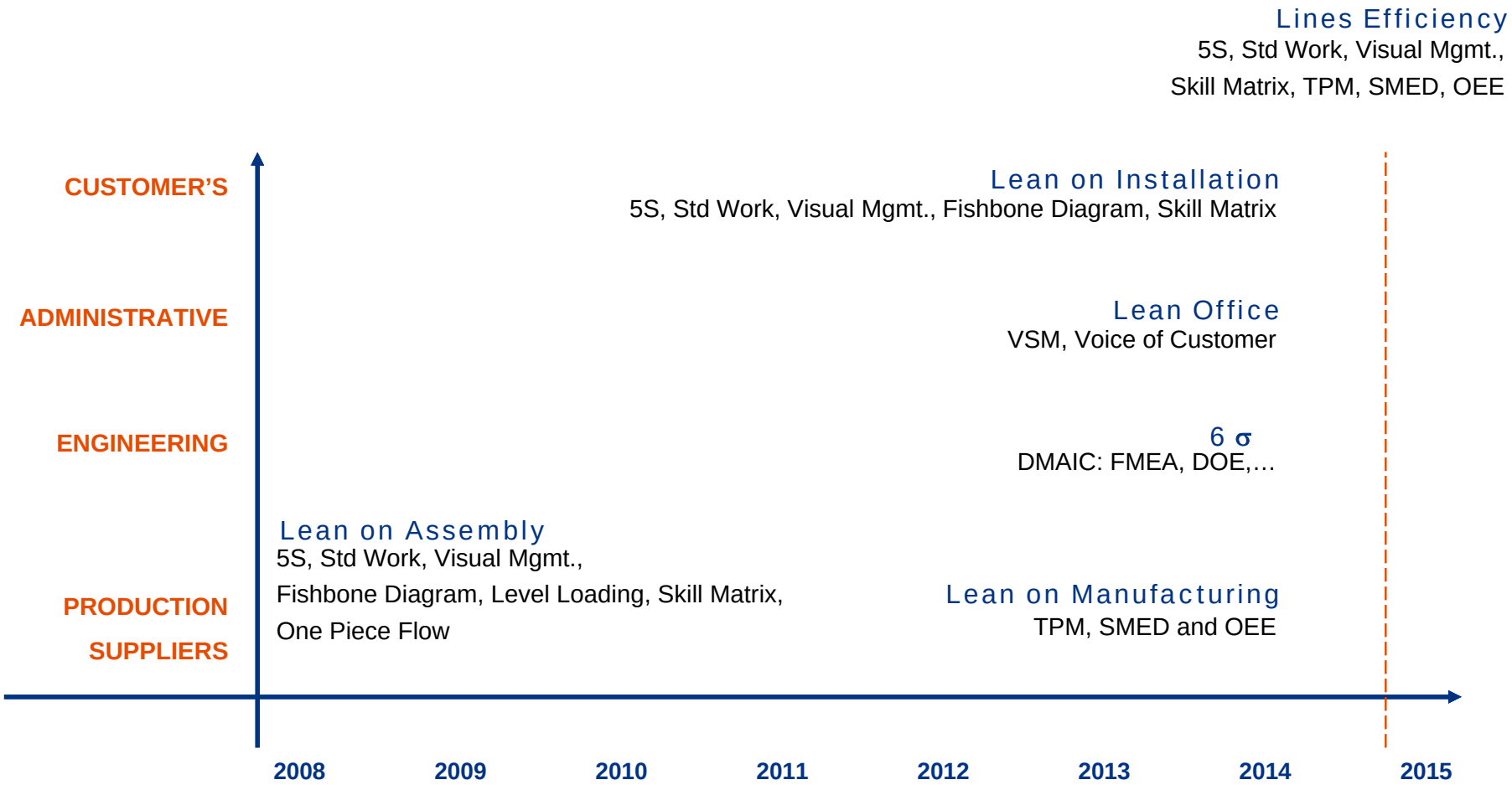
Complete Lines for Beverage Industry

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



The Lean and Six Sigma journey



Lean Manufacturing

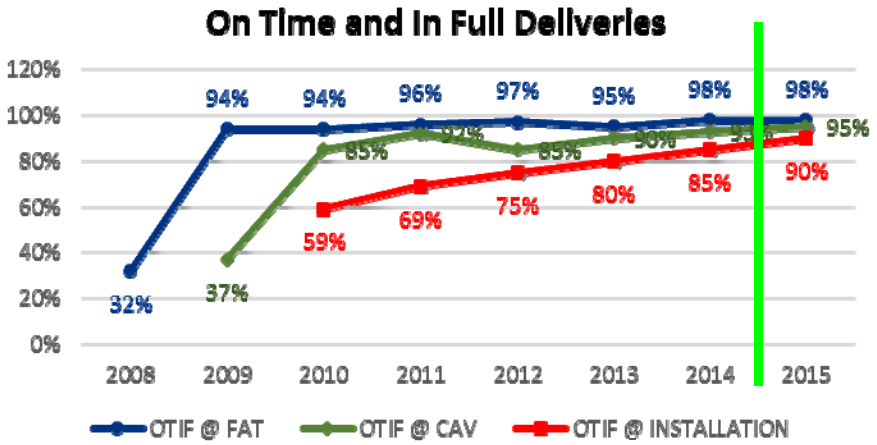
What did we achieve so far with Lean…

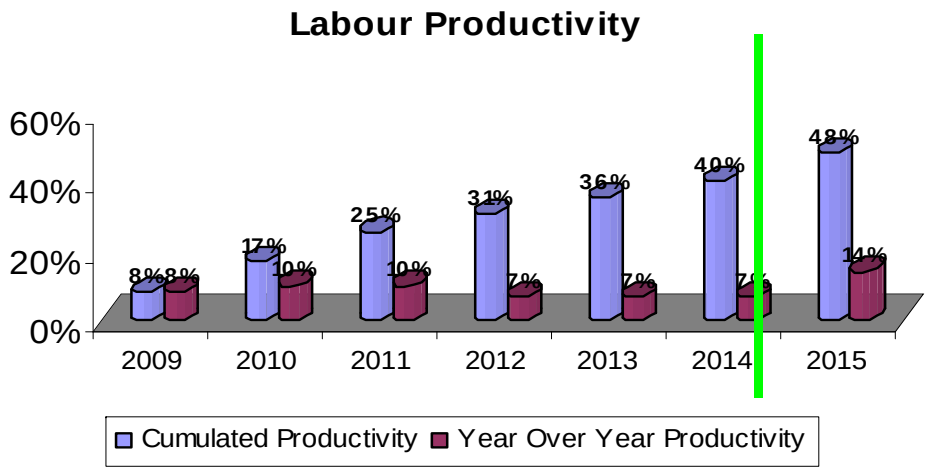
Thanks to the strong **commitment of our resources** to the LEAN methods, we succeeded in:

- 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

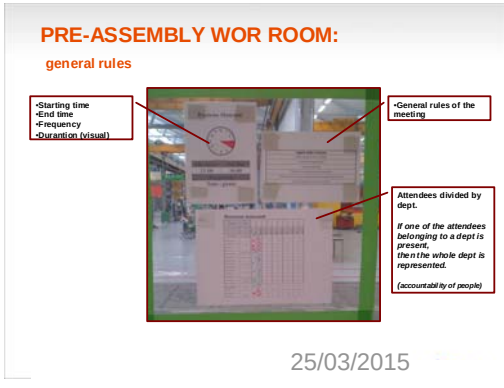
… even if it weights 15 to 30tons

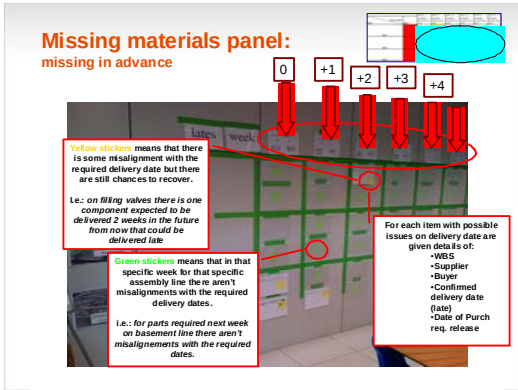
2) MANAGE BY HOUR

… even if it has 1000 to 5000h of assembly

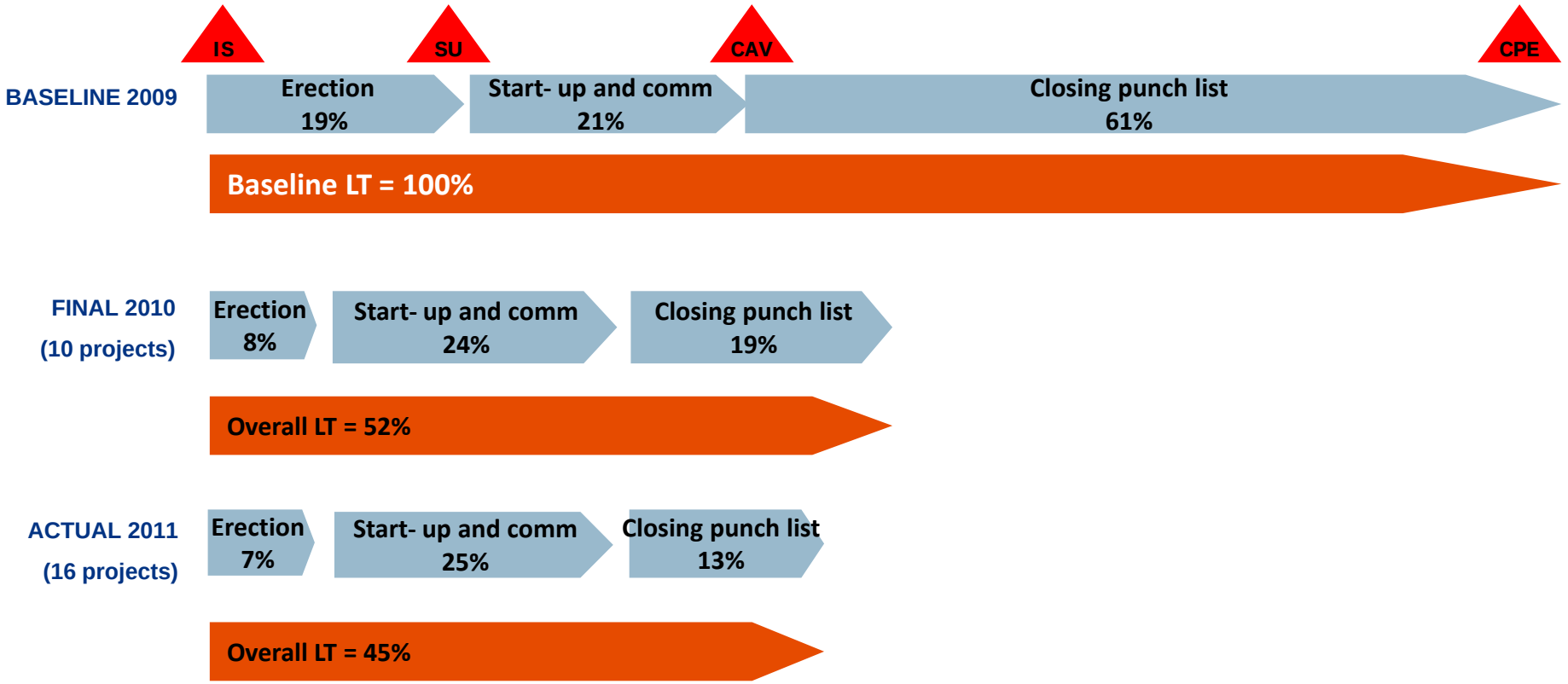
3) MAKE IT VISUAL

…to identify the anomalies Vs. the std. and take prompt actions





What did we achieve at the customer sites…



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:

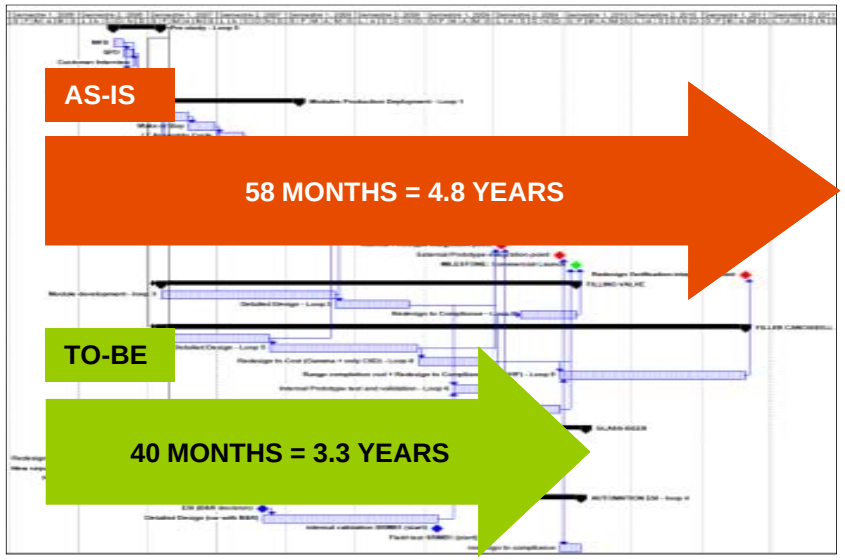
- Importance of site preparation and readiness;
- Forecast of utilities availability (main impact on the overall lead time).

Lean team participating to project reviews on regular basis and site visit.

Six Sigma

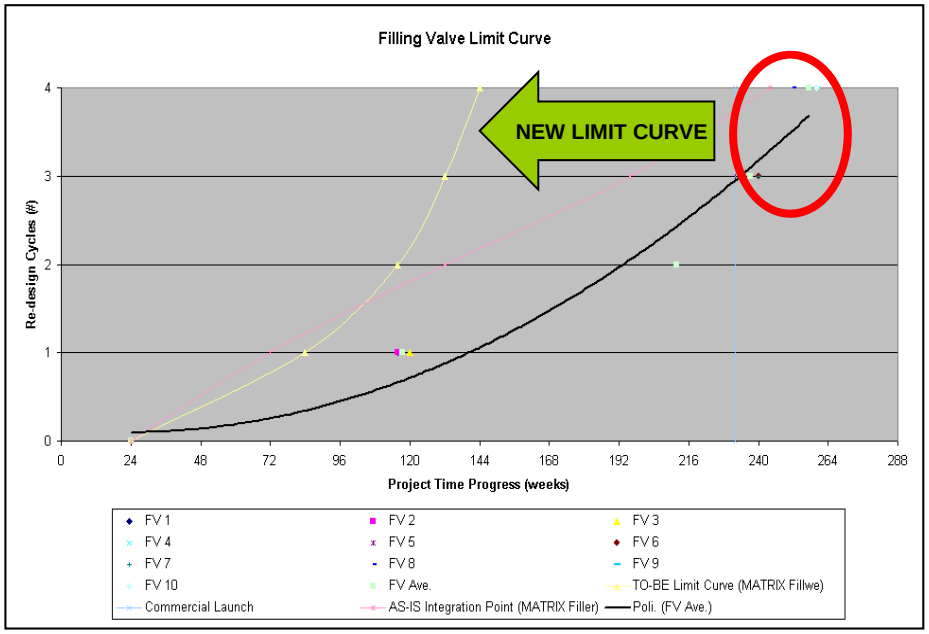
New Product Dev. VSM

VSM	5S	Std work	One piece flow	Visual Mgt	QM	Lean Office	TPM	SMED	Kanban



OPPORTUNITIES:

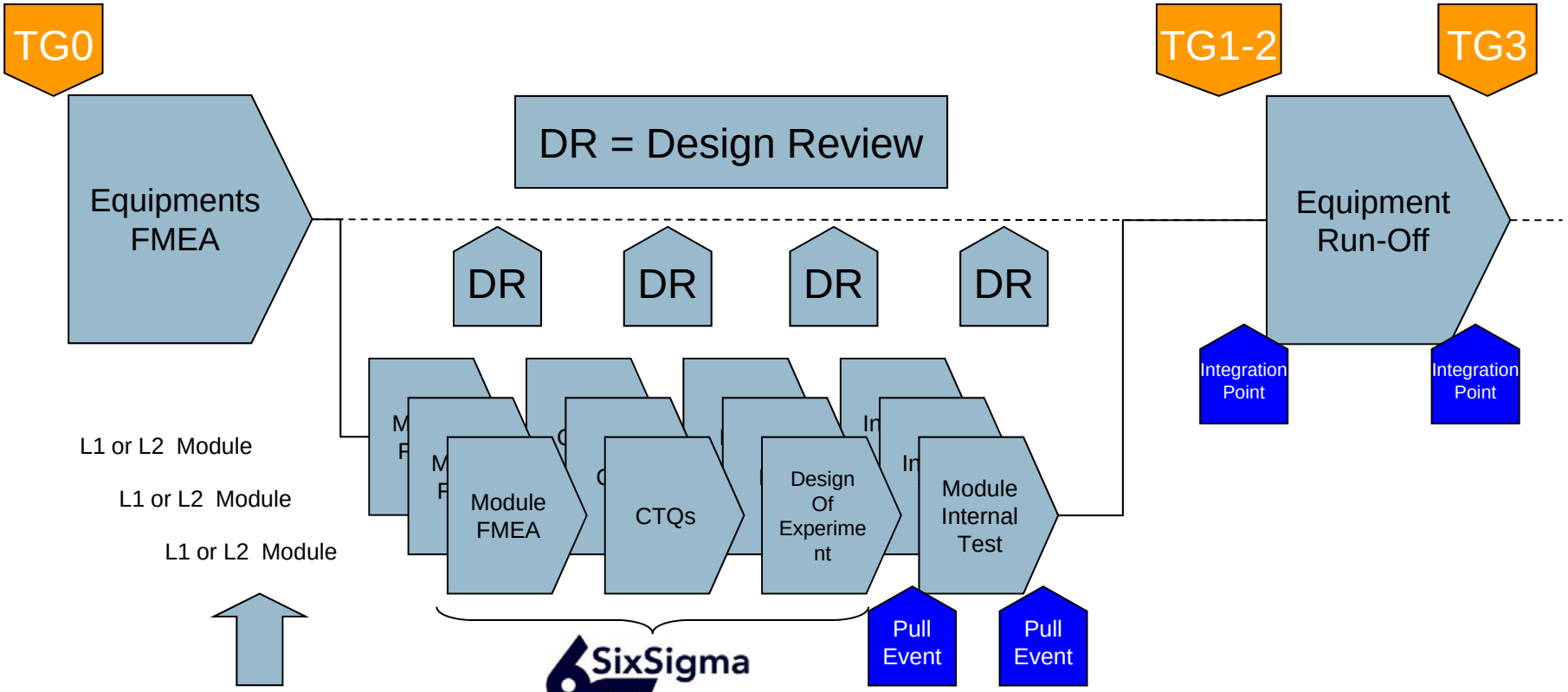
- Efficiency on LT gained into the modules development loops (**31%** of total value)
- Efficiency on engineering hours (**34%** of total value)



KEY ACTIONS:

	LT	PT
1 – Tech Standard (TS) for Module Validation	71%	81%
2 – Projects Operating Model (POM)		
3 – Field Test @ NPD / Module Incremental	13%	
4 – Project Manager / Chief Engineer	12%	15%

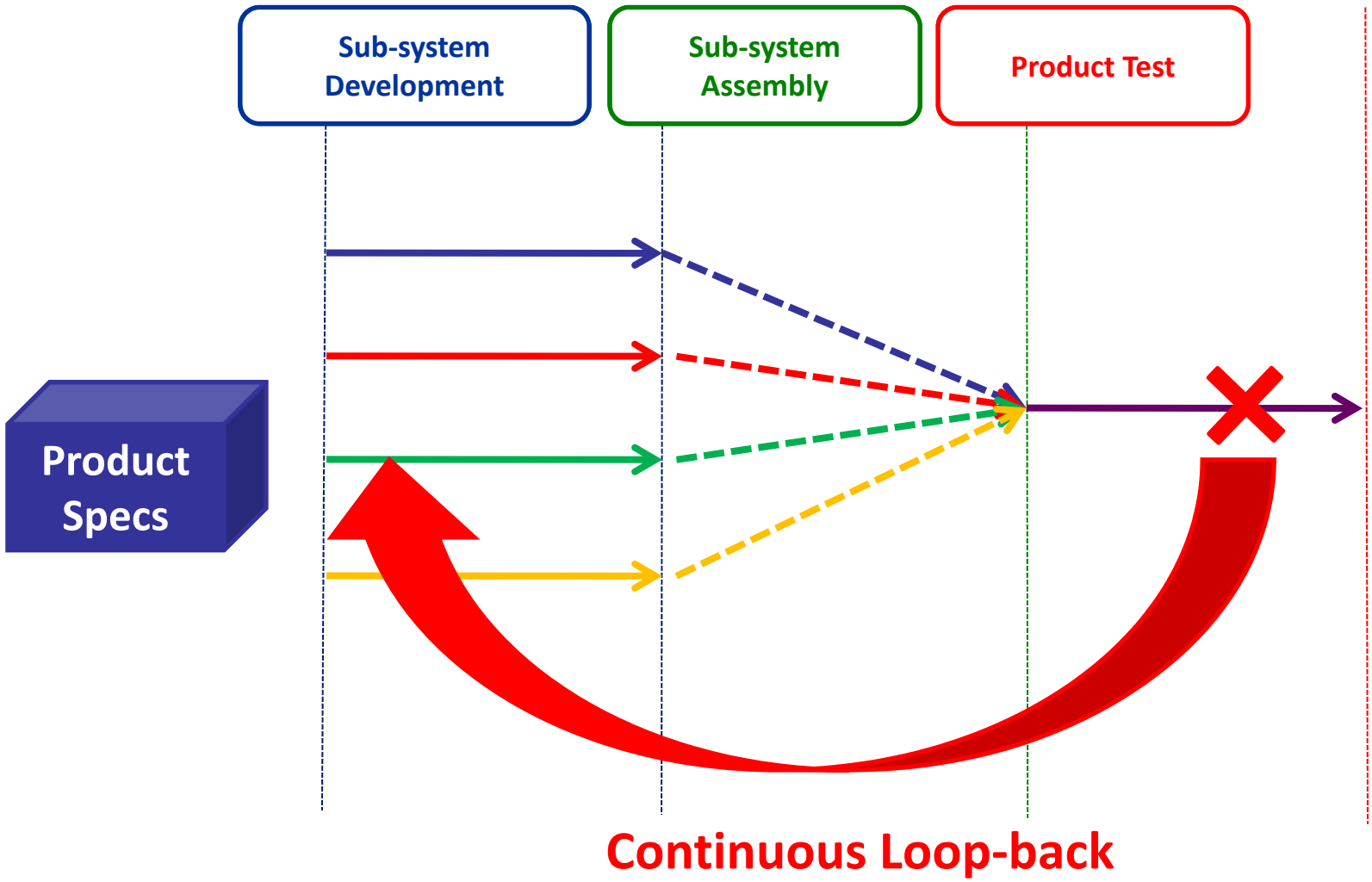
New Product Development Process



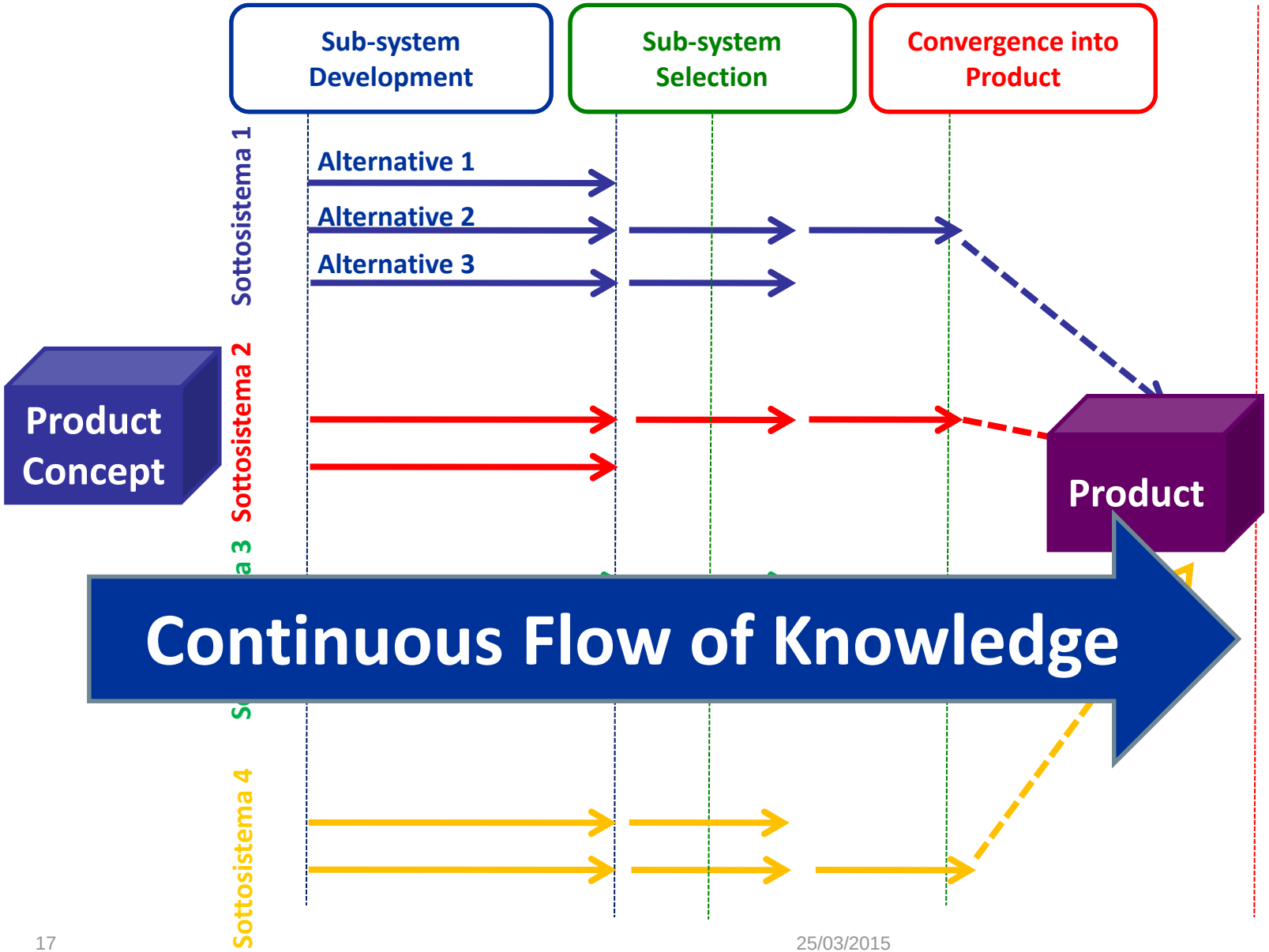
1	If the parts occure issue, have safety risks for operator, have integrity risk for final product, even damage the machine.
2	If the parts occure issue, it would great impact machine runing performance, have function or important assembly problems
3	If the parts occure issue, it wouldn't impact machine running performance, no important impact on assembly, long time to sobstitute
4	If the parts occure issue, it wouldn't impact machine running performance, no impact on assembly, short time to sobstitute

Modules Standard Criticity Levels

Classical Approach (Product Design)



Set Based Concurrent Design



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 than 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 end 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

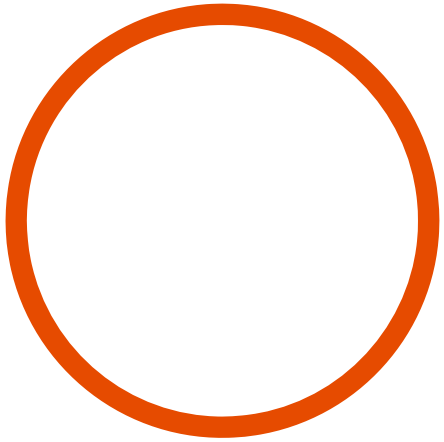
EFFICIENCY

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.

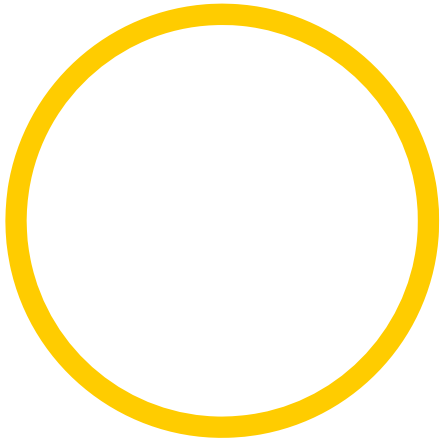
Product strategies

Product Leadership



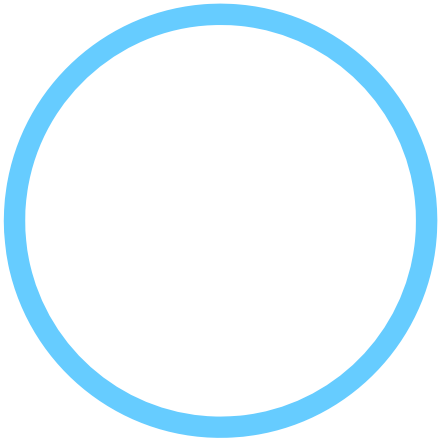
+ Price premium
+ Flexible
- Process change
- Development cost
- Quality risk

Operational Excellence



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

Customer Intimacy



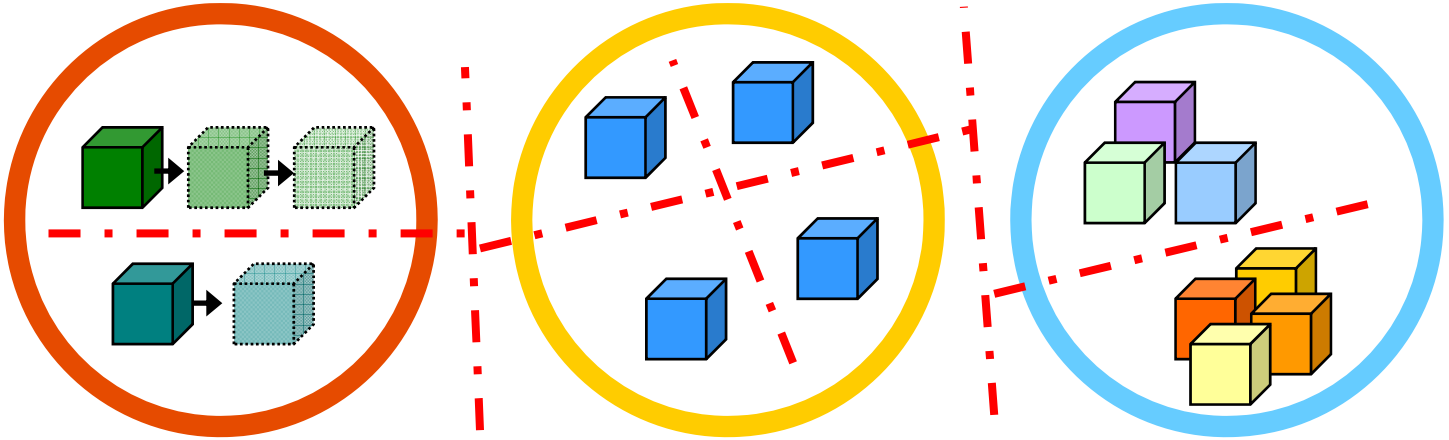
+ Faithful customers
+ Market share
- Unstable processes
- High indirect cost

Modularity = interfaces

Product Leadership

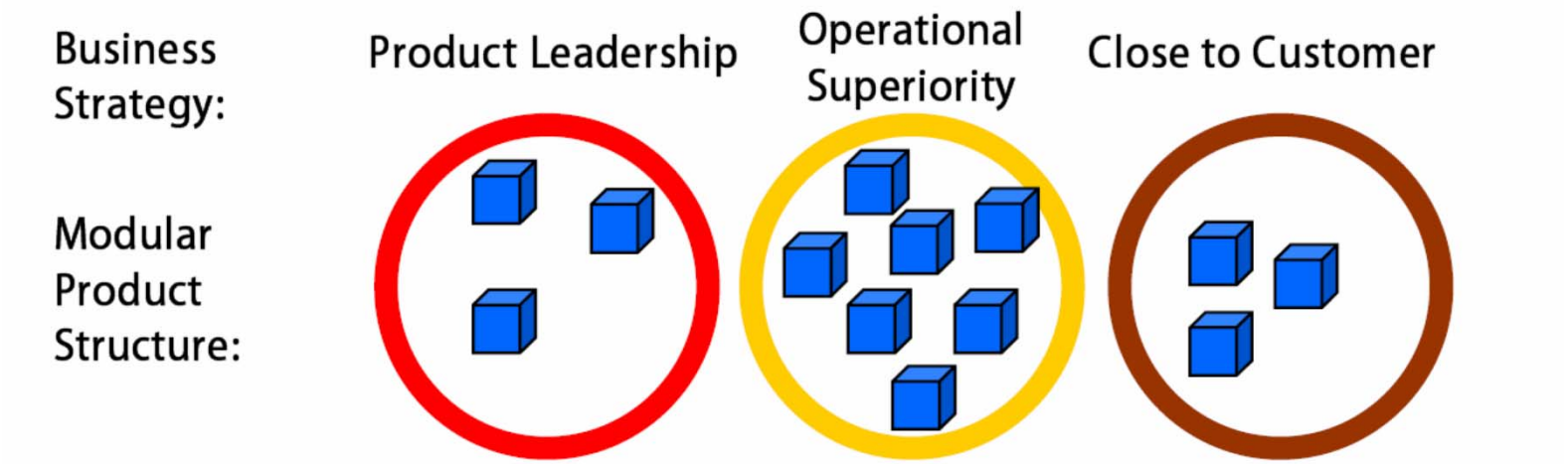
Operational Excellence

Customer Intimacy



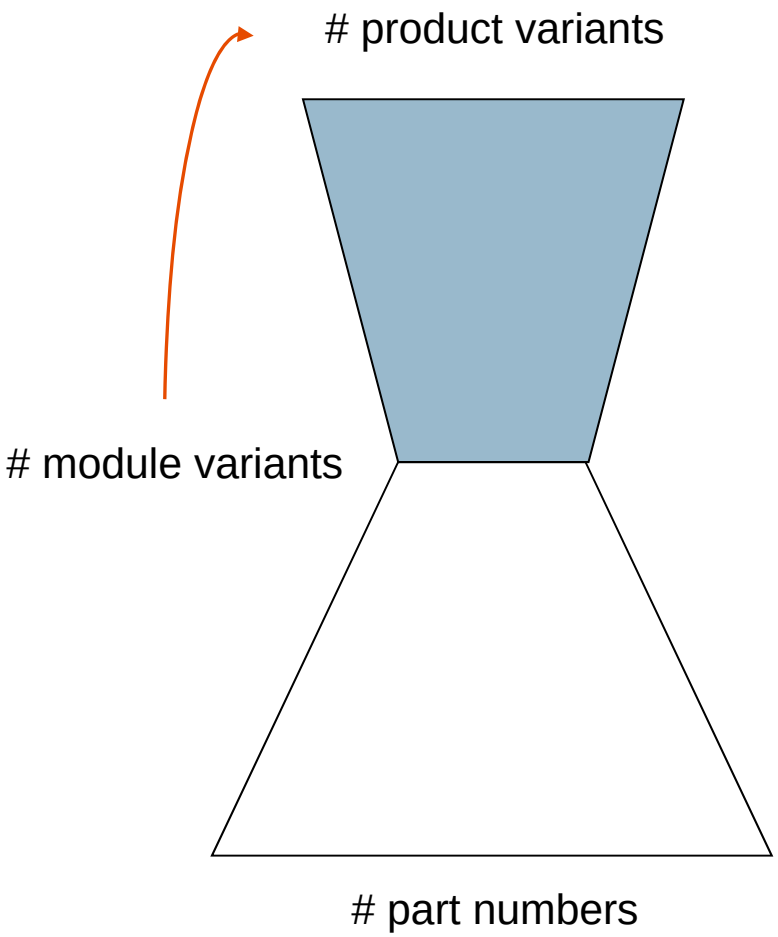
Interfaces are isolating the modules in their strategic circle

Define implication of modular set up on Product and Production



Product Implication	Frequent product changes new technology	Few product changes and high volume	Frequent product changes and low volume
Production Implication	Close cooperation between development and production	Minimized production cost	Cooperation between development and production
Production Strategy	In-house production	Low cost country, lean production	Strategic supplier, agile production

Modularity KPIs



Modularity

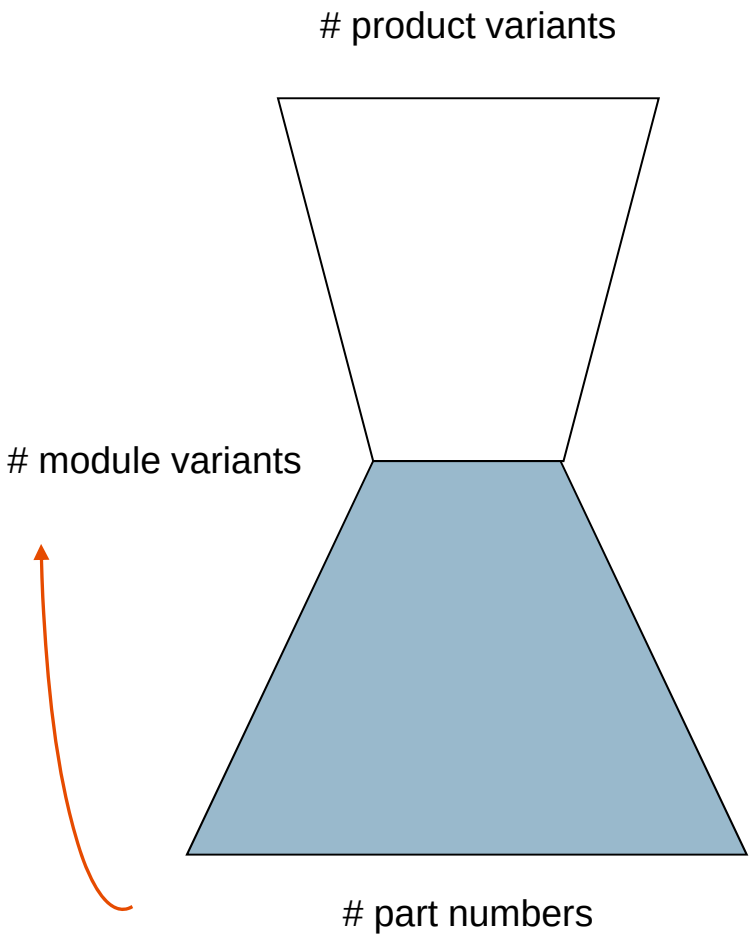
$$M_{\%} = \frac{P_v - M_v}{P_v} \cdot 100$$

M_v = module variants

P_v = product variants

- Calculated for every module

Modularity KPIs – PNC and Commonality



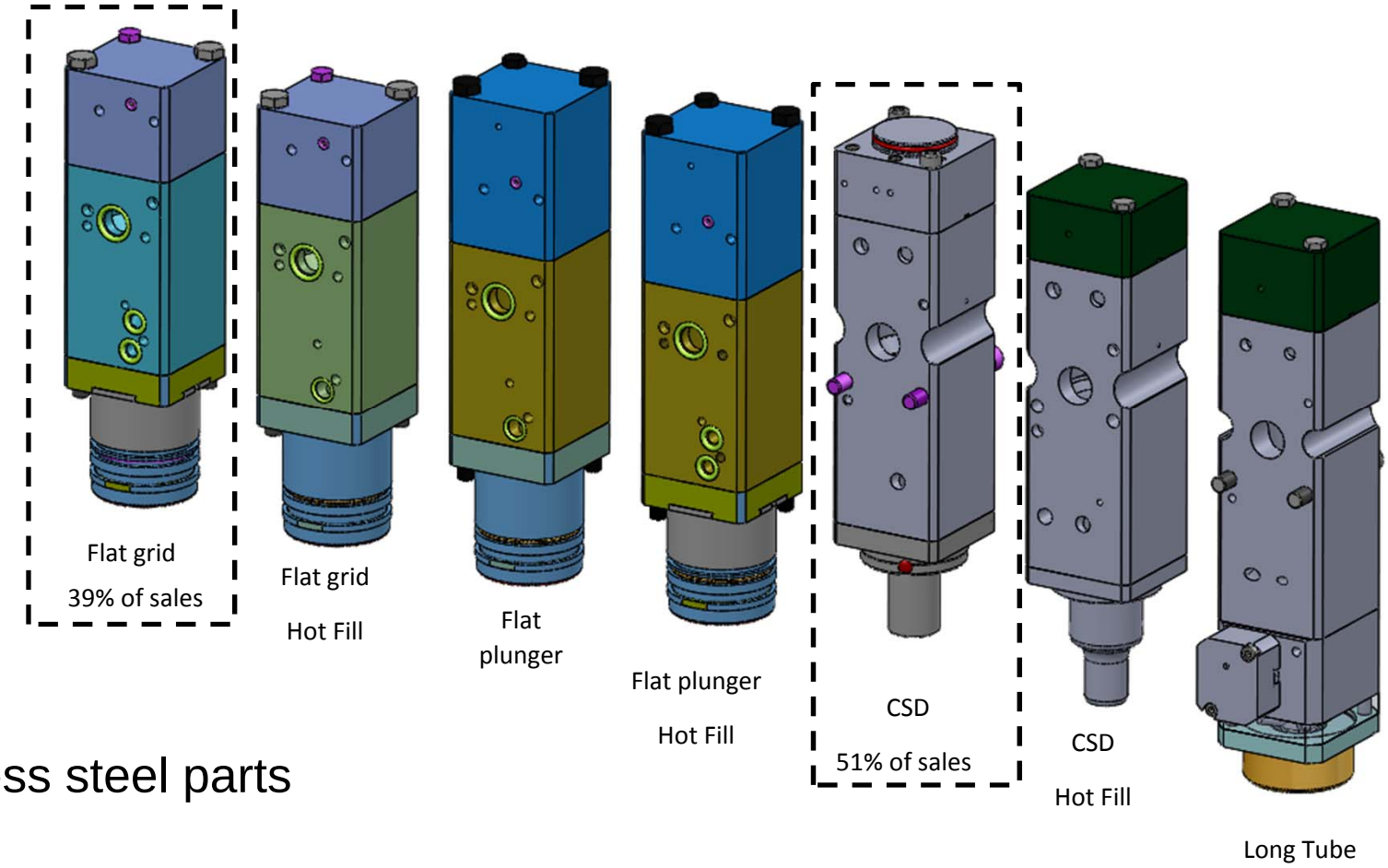
Part number count can be assessed:

- PNC refers to the total number of unique part numbers required to manufacture all product configurations

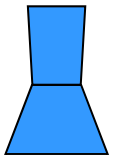
Commonality is the % of part numbers that are common between two or more module variants:

- $\%C_n$: % of parts used by at least n variants

1000 - Valve body - before



21 stainless steel parts



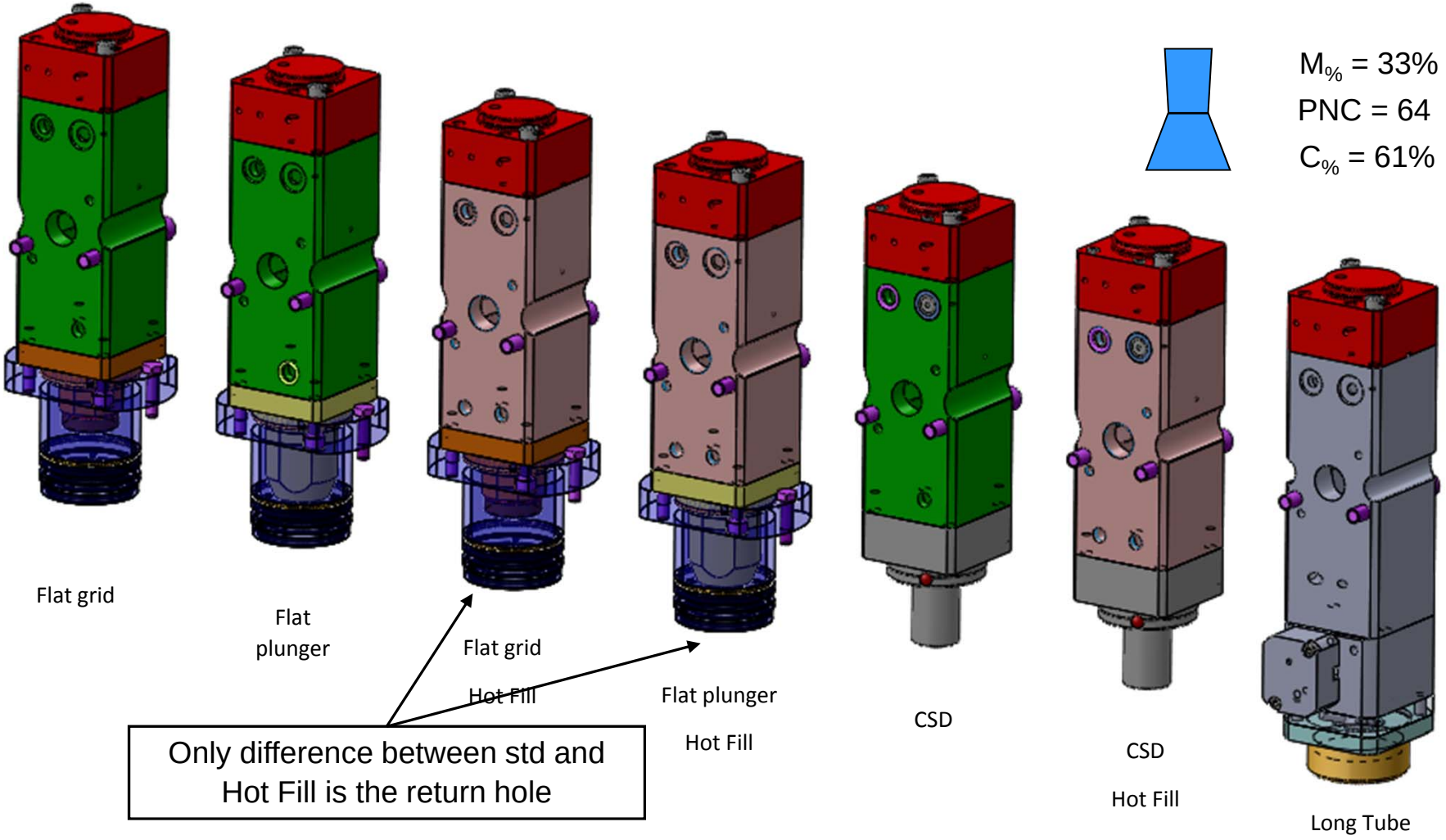
$M_{\%}$ = 33%

PNC = 83

$C_{\%}$ = 33%

1000 - Valve body - after

12 stainless steel parts



Modular project – commonality comparison

Application commonality	Current Portfolio	New	
No. BOM lines (module variant level)	133	123	
N° of common modules	52	74	43%
WATER vs HF	45%	89%	98%
Full range commonality	39%	60%	54%

Thank you!