



Industria 4.0 in BHGE: Caso Nuovo Pignone

**Seminario R2B Siena
14 Giugno 2018**

giugno 24, 2018

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Who we are



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GE Oil & Gas



BAKER HUGHES
a GE company



~65,000 employees

120 countries

The first and only **fullstream** company

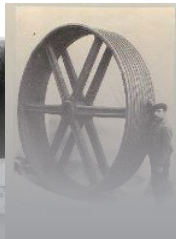
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Nuovo Pignone *More than 160 years of experience*



1842

The Pignone Foundry was founded in Florence.



1900

From a foundry to a mechanical industry



1954

Eni acquires Pignone, that becomes Nuovo Pignone.



1994

GE acquires Nuovo Pignone from Eni.



2011

Nuovo Pignone inaugurates the Avenza yard, reaching 5 plants in Italy. Avenza is the cornerstone of the assembly activities for Industrial Modules



2017

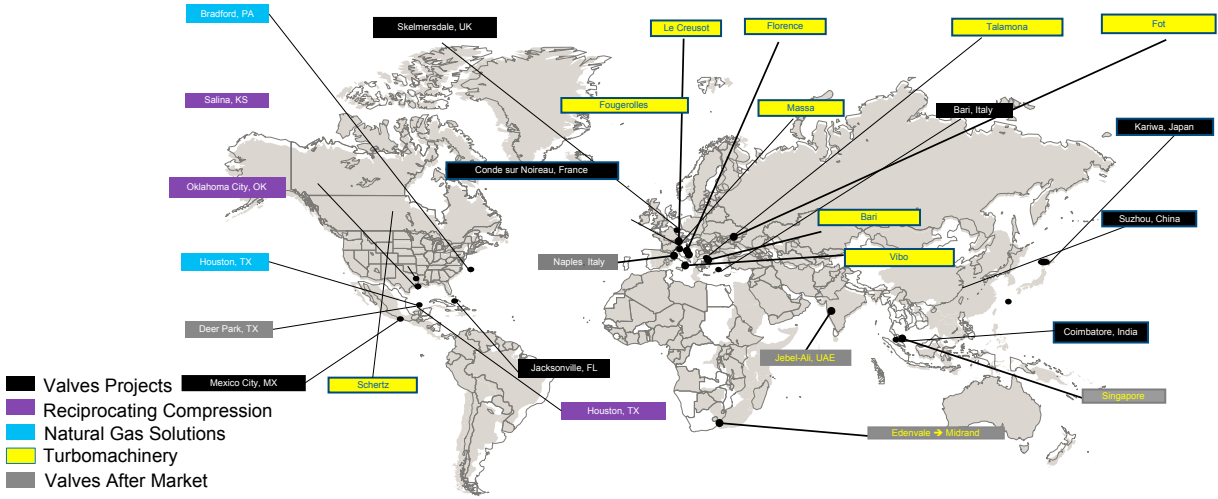
July 2017: Completion of GE Oil & Gas and Baker Hughes Merger. Baker Hughes, a GE company (BHGE) is born



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TPS - Global Manufacturing Footprint



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Smart Operational Excellence: Brilliant Factory

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Leading the manufacturing revolution

THE ORIGINAL INDUSTRIAL REVOLUTION [PAVING THE WAY] 1900

FORD ASSEMBLY LINE 1918
ELECTRICITY + MASS PRODUCTION

TOYOTA PRODUCTION SYSTEM 1985
THE AGE OF DIGITAL ELECTRONICS

GE BRILLIANT FACTORY 2025+
THE INTERNET OF THINGS + ARTIFICIAL INTELLIGENCE

GE BRILLIANT FACTORY

Driving digital maturity, built on lean foundation, with continuous improvement

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Living Lean: On the shop floor

LEAN FACTORY MATURITY FRAMEWORK

BASIC

- Lean getting started
- Customer Focus (L1)
- Engaged & Committed (L2)

BRILLIANT

- Scientifically Improving (L3)
- Inventing New Levels of Success (L4)
- Seeking Perfection (L5)

Improvements starting to have an impact

Continuous improvement a way of life

Mature in all regards – on road to world class performance

Lean Fundamentals

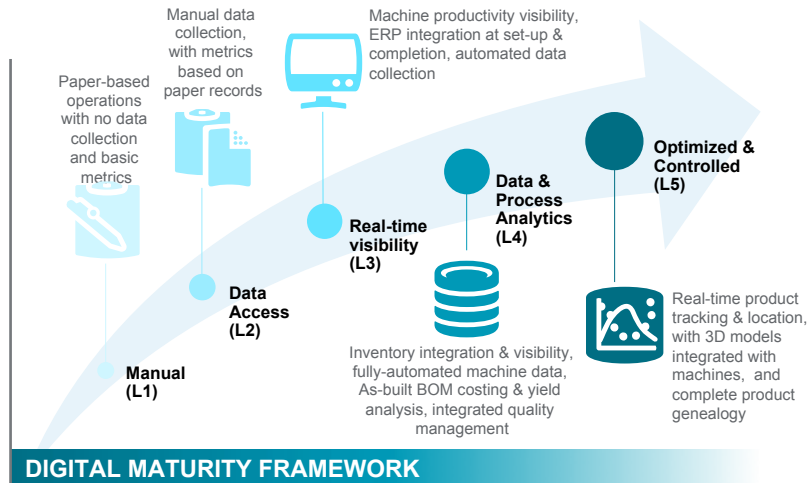
- 5S
- Standard Work
- Value Stream Mapping (VMS)
- Total Productive Maintenance (TPM)
- SMED (Single Minute Exchange of Die)
- Lean Product and Process Design

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Living Digital: On the shop floor



Digital Fundamentals

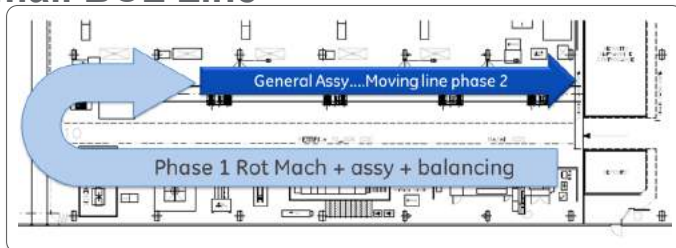
- Quality Management
- Data Collection & Acquisition
- Product Tracking & Genealogy
- Performance Analysis
- Dispatching & Scheduling
- MFG Execution
- Completion & Validation
- Performance Monitoring & Analysis
- Resource Management
- Asset Management & Awareness
- Tool Management & Awareness
- Maintenance Management
- Manufacturing MbE



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Small BCL Line



Line Transformation



Outcomes

- BCL lead time**
↓ 50%
- BCL Inventory**
↓ 39%
- Shop Productivity**
~\$4.5M
- Lean transformation journey underway**

New Dedicated Line



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The digital revolution

	VIRTUAL MANUFACTURING	SENSOR ENABLED	FACTORY + SUPPLY CHAIN OPTIMIZATION
	Bridge information gap between engineering & manufacturing via digital tools	Enable higher uptime & quality at each individual manufacturing machine tool	Increase throughput & inventory turns by enhancing data visibility at factory level
WHY	<p>↓ Cycle</p> <p>↓ Cost</p>	<p>↑ VCP</p> <p>↓ Downtime</p>	<p>↑ OTD</p> <p>↓ Cycle</p>
WHAT	<ul style="list-style-type: none"> ▪ MBE ...Bill of Process & Part Program in PLM/MES ▪ Electronic Work Instruction 	<ul style="list-style-type: none"> ▪ Connect shop machines ▪ KPI Metrics & Analytics ▪ Condition Based Maintenance ▪ Smart Facility Solutions 	<ul style="list-style-type: none"> ▪ Quality management: Statistical Process Control & Digital Gauges ▪ Automation & Additive ▪ Manufacturing Execution System



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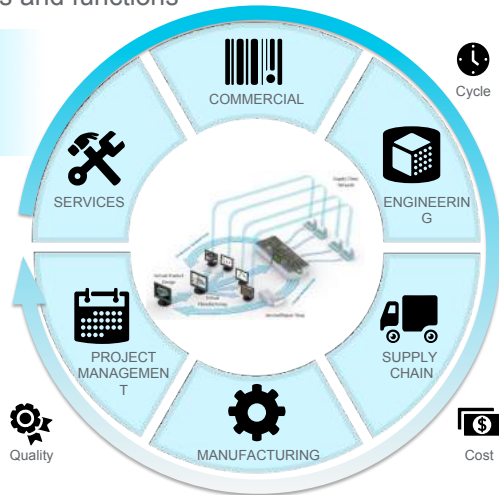
Digital Thread & Model Based Enterprise

Digitizing within and connecting data across all systems and functions

a Digital Thread to improve efficiency, productivity and quality ... remove hidden waste in data manipulation across functions

HOW?

- **Unique** BoM... Engineering & Manufacturing
 - Annotated **3D Models** as the Master of Product Definition ... database for downstream re-use
 - Item **classification**
- ... foundation for the creation of a new Industrial Environment: **Digital Twin** of assets to predict, measure & optimize performance



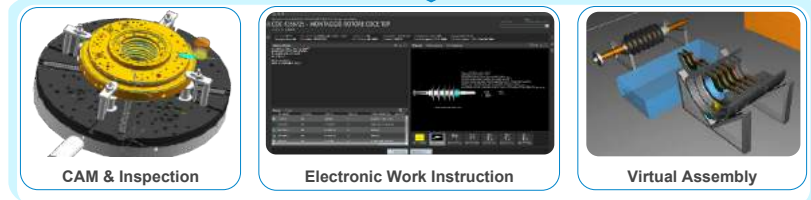
MBE Digital Thread for TPS Brilliant Factory

What is in place in Florence?

From Digital Product Definition ...



... to the Brilliant Factory



- SINGLE SOURCE OF INFORMATION ...
- Searchable
 - Re-usable
 - CAM
 - CMM
 - Inspection Plan
 - Bill of Process
 - Aligned to 3D
 - Multimedia Content
 - Virtual Validation for Machining and Assembly





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Smart Shop Solutions | Intro

A Predix app aimed to monitor shop-floor asset in real time, analyze machining and alarm data and drive productivity.

- Smart Shop Solutions development started in **July '16** and it is **live from Jan '17**
- There are **8 plants connected** across **3 different businesses** (BHGE TPS, BHGE Digital Solutions, Renewables and Avio Aero) and roughly **200 industrial assets**:
 - Milling machines
 - Lathes
 - Ovens
 - EDM
 - Cranes
 - Additive machines
 - Lighting system
- It has an average of **45 visitors per day**
- **+ 500'000 lines of code** written and deployed in Predix platform



It has a **multilanguage UI** (Italian, French, English)





Smart Shop Solutions, powered by Predix™

1 Machine monitoring



- Synoptic view to monitor machine status, MTBF, MTTR, Downtime
- Production monitoring providing Real Time machining data per personas

2 Shop line visualizations



- KPIs – OEE, Availability, Data History, Machine uptime

3 Admin & Diagnostic



- Smart Shop Admin – work calendar & shift management
- Diagnostic in place ... System info, data diagnostic & data storage diagnostic

8 45+ 3K 4.5M 1B+

Connected Plants Daily users Tags Configured Records Stored daily Records Stored ytd



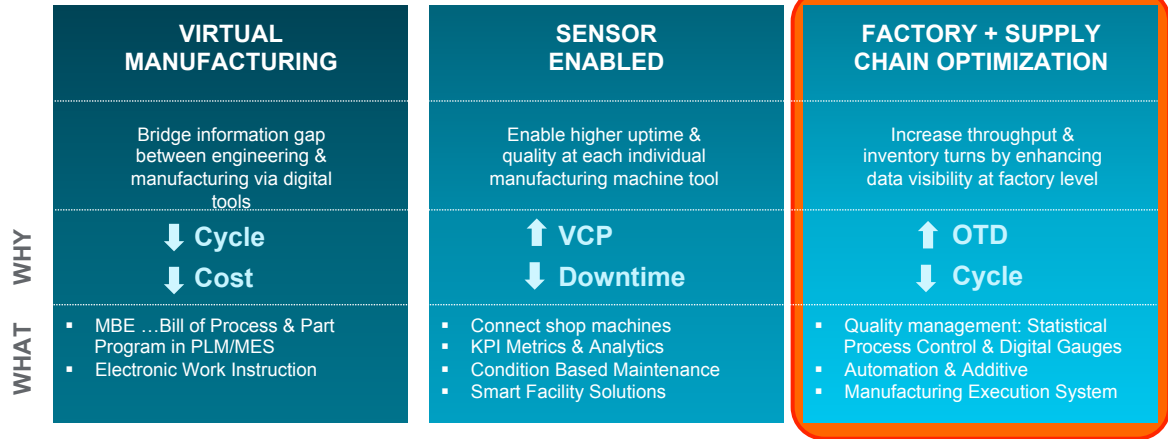
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The digital revolution



Optimizing solutions

Improving performance with GE's Predix™ platform

