Bottero

Glass Technologies

Managing the glass manufacturing process

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Outline

- The Digital Era and Industry 4.0

- Bottero strategic vision

- Pillars from the last decade

- Process view close-loop controls

- Evolutionary roadmap

- Summary and conclusions

The Digital Era and Industry 4.0

Bottero strategic vision

- Ultimate goal: full, **labor-free** automation of the glass manufacturing process

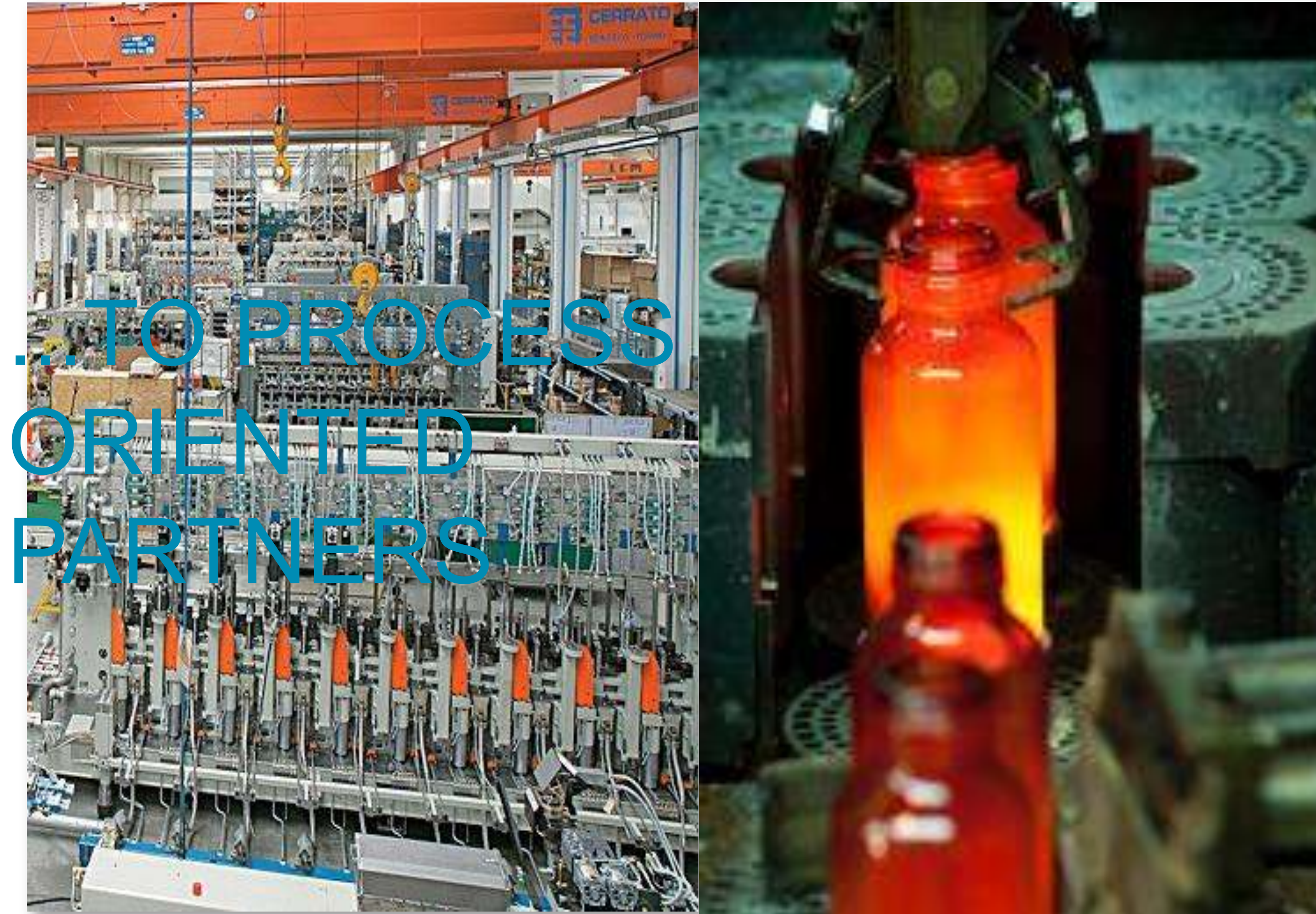- Industry 4.0 identifies a powerful and integrated view, but...

  ...a fully stable process operation is the key to achieve the goal

- Bottero has a deep and consolidated **process knowledge** to pursue this objective

- **BoX** is the first and unique system on the market, conceived and developed to support this vision

Bottero Strategic Vision

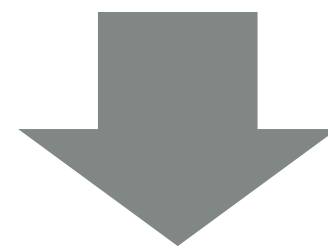...TO PROCESS ORIENTED PARTNERS

Bottero Strategic Vision

Move from equipment supplier to solution provider partnering with the Customers

- Enhance Bottero offer portfolio with new added value products and novel solutions

- Enrich the value proposition including more and more professional services

- Move from an ecosystem of automation products to a fully integrated automation platform

Strategic pillars for the last decade

1. Modelling and Simulation tools and techniques

2. Expertise and competence on the forming process

3. Full control of the production chain through Industrial Automation

Strategic pillars for the last decade

1. Modelling and Simulation tools and techniques

2. *Expertise and competence on the forming process*

3. *Full control of the production chain through Industrial Automation*

Modelling and Simulation

HARDWARE

- 496 CPU fully dedicated
- 1800 GB RAM
- 40,2 TB Hard Disk
- 2 high-duty quadri-processor servers, with 16-core CPUs
- 5,2 teraFLOPS (computer performance indicator)
- 22 calculation servers, in parallel configuration

SOFTWARE

- Abaqus
- Radioss
- Motion Solve
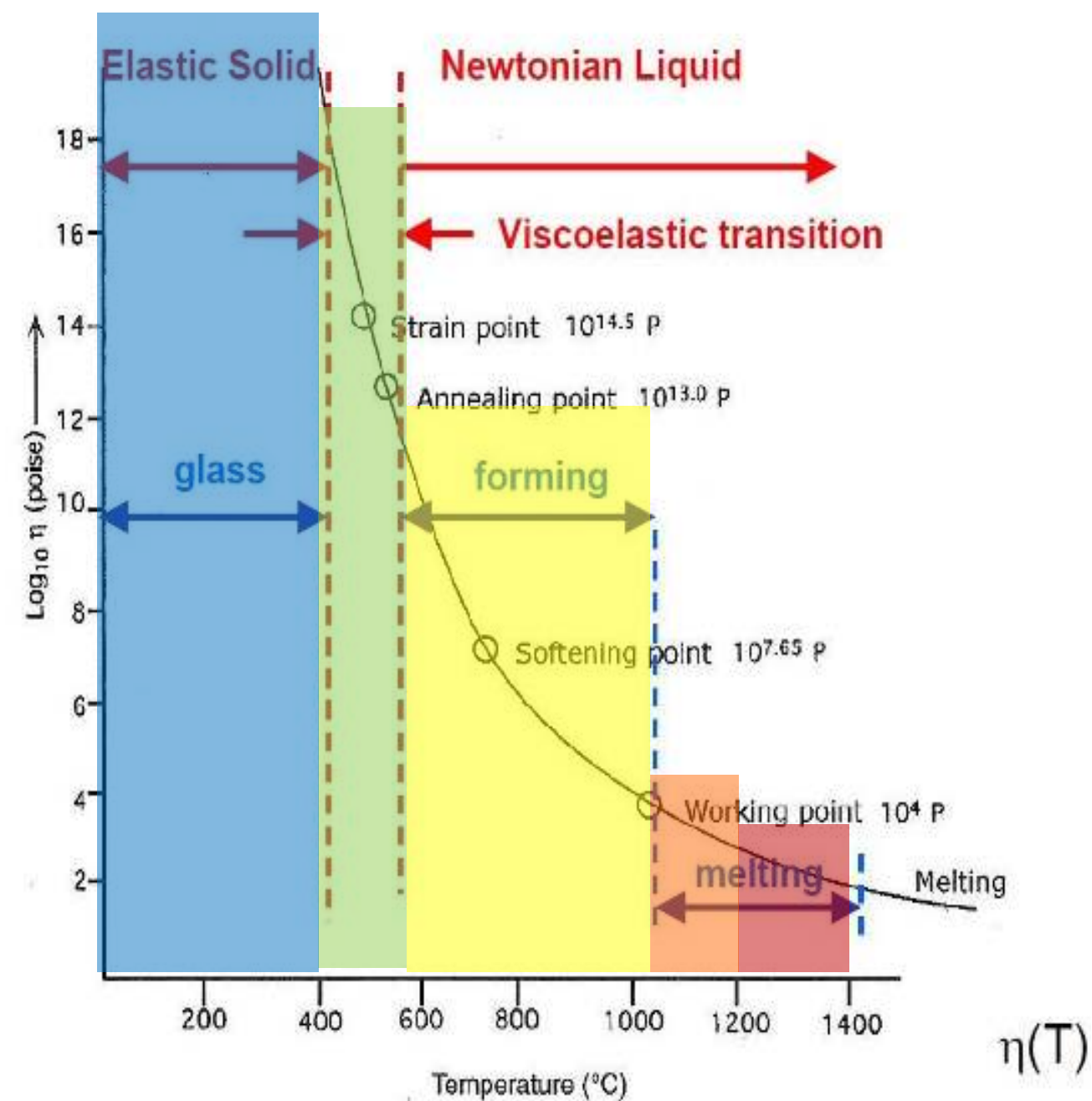- Optistruct
- Star CCM+
- Mode Frontier

HUMANWARE

A team from aerospace and automotive industry

Forming Simulations

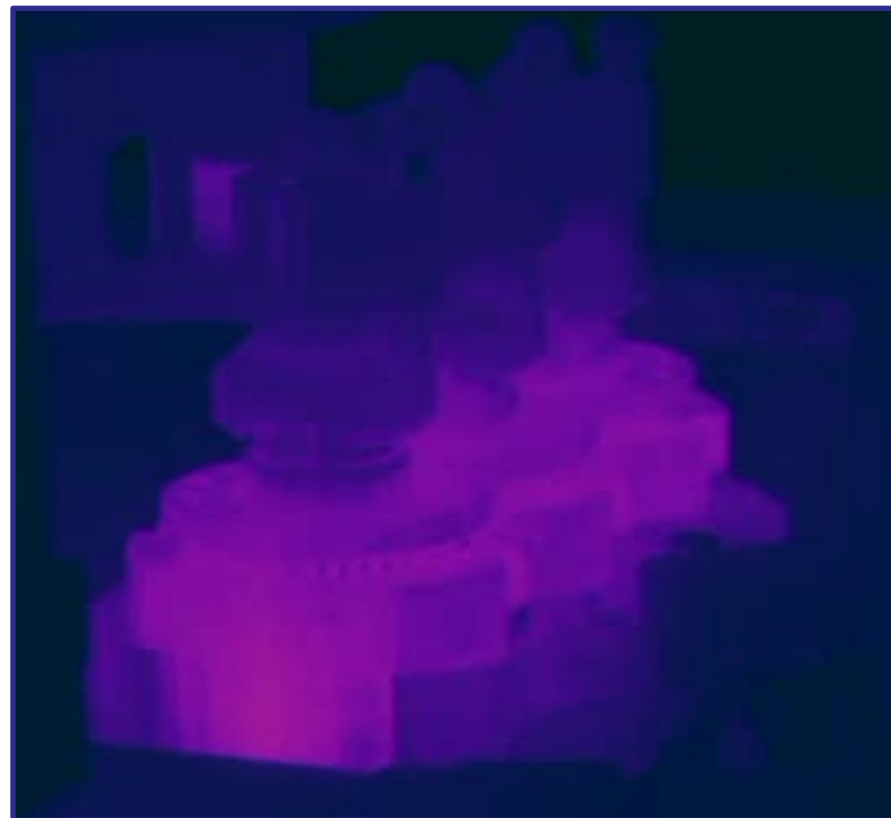Glass viscosity vs. temperature
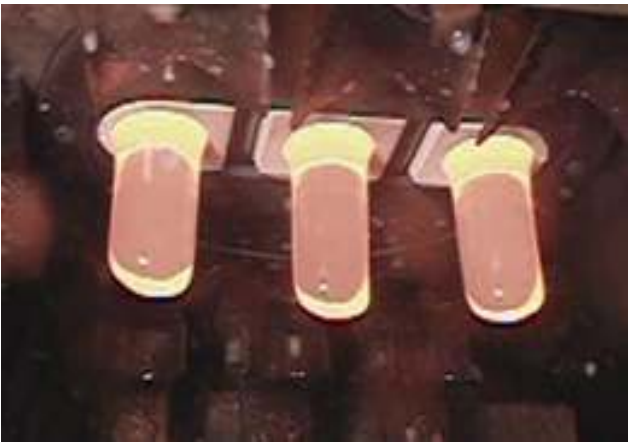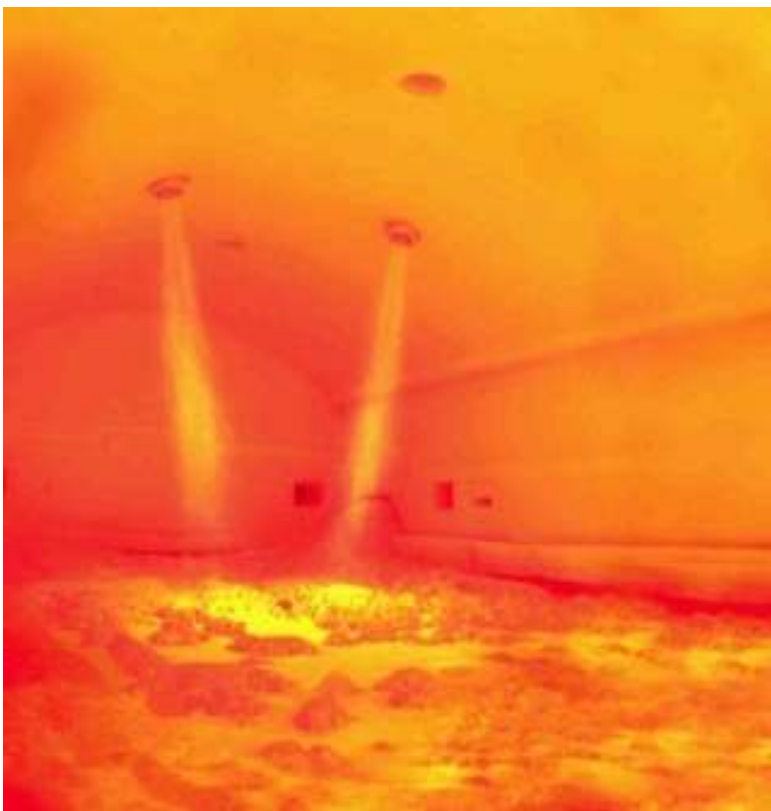
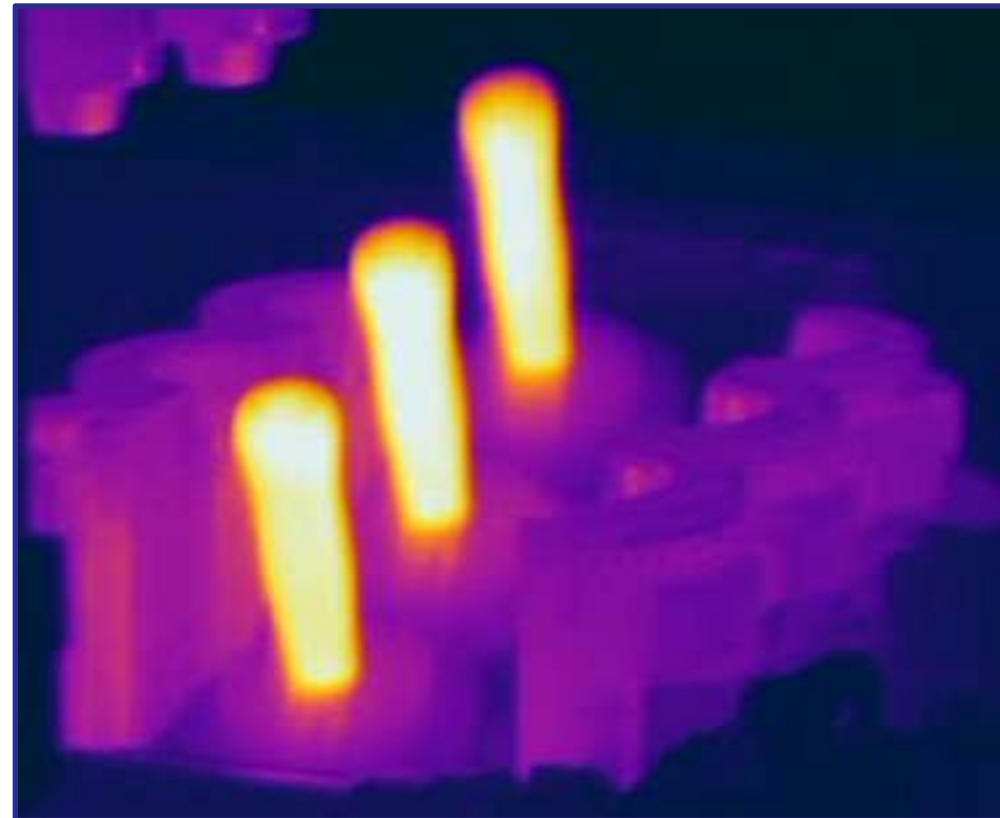# Simulated Forming Process Steps

Step 1
Blank Side
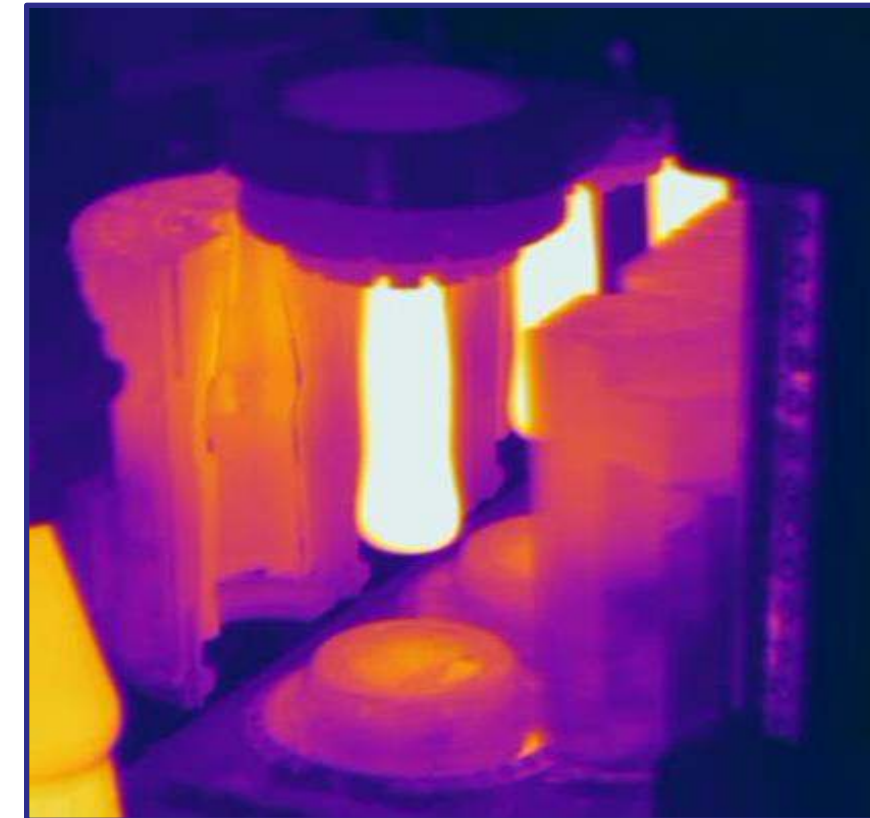
Parison Forming

Step 2
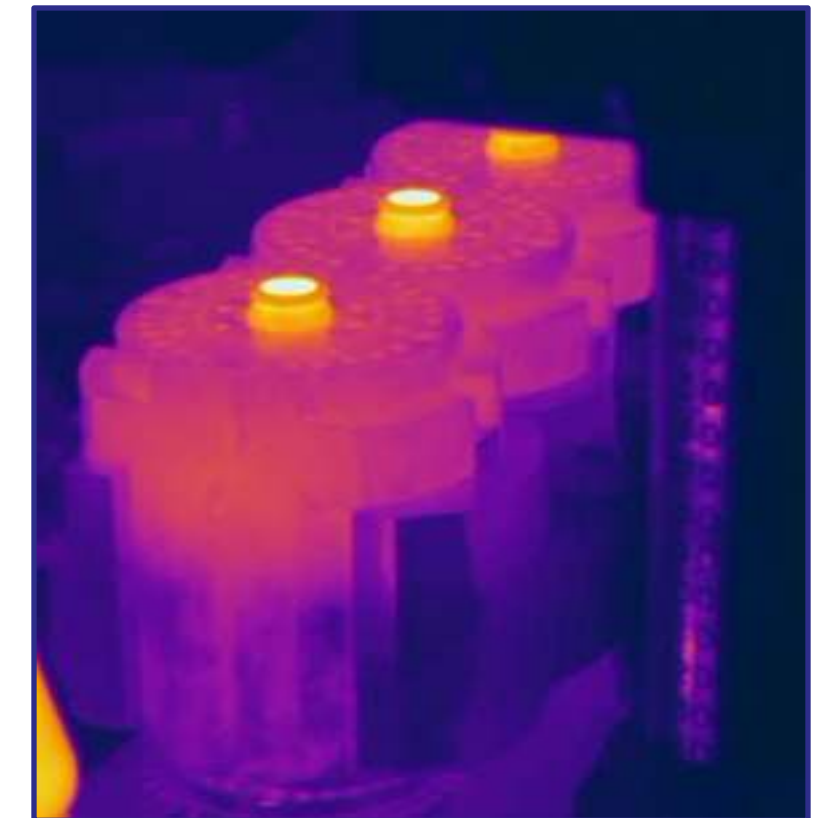**Invert Mechanism**

Reheating

Step 3
Blow Side

Stretching

Step 4
Blow Side

Bottle Forming

Strategic pillars for the last decade

1. Modelling and Simulation tools and techniques

2. Expertise and competence on the forming process

3. Full control of the production chain through Industrial Automation

Forming Engineering

"We believe in glass..."

The forming engineering **FE** department has over ten years experience in granting process support in the different areas of the glass production lines.

The team combines both engineers and production experts that cooperate to support our Customer in reaching the agreed production target.

Forming Engineering

"From conceptual design through training to production..."

Service portfolio

- Cooling design
- Parison and Mold Design
- Support in transition from DG to TG
- Support in transition from B&B to NNPB
- New container design

- Mold Design training
- Production training

- Production support
- Production Support Agreement (PSA)

Strategic pillars for the last decade

1. *Modelling and Simulation tools and techniques*

2. *Expertise and competence on the forming process*

3. Full control of the production chain through Industrial Automation

Benefits of Bottero Automation Platform

- Full standardization of HW components, SW modules and communication interfaces

- Unique, integrated development platform putting together:

  - Supervisory platform with open interface toward external Plant Automation Systems

  - Wide configuration capability of special cycles

- **Tier 1 close-loop** controls (DFS, GWC for BB, Servo Plunger, Prop. Valves 2.0, MWM)

- **Process view close-loop** controls (BoX)

Tier 1 close-loop controls

Dynamic Forming System (DFS)
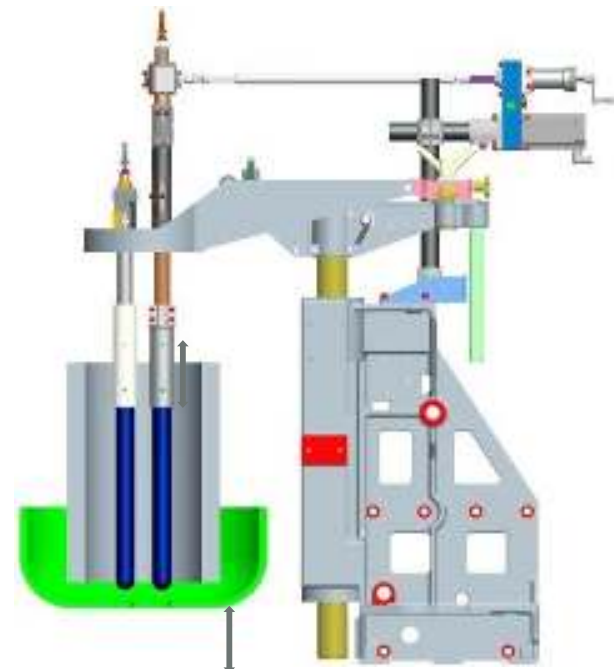
Vertical & Horizontal Plunger Adjustment

Magnetic Position Sensors

- For both **BB** and **NNPB** productions

- Integrated THD (Tube Height Device) and PAC (Plunger Adjustment Control)

- Full stroke plunger motion tracking in **NNPB**

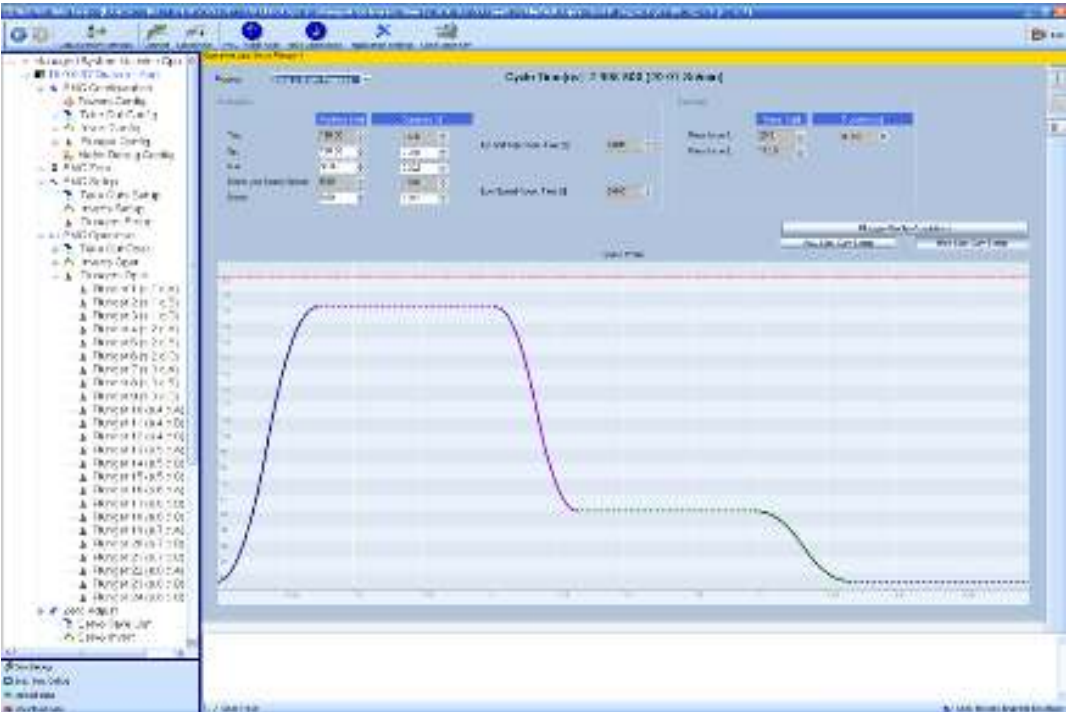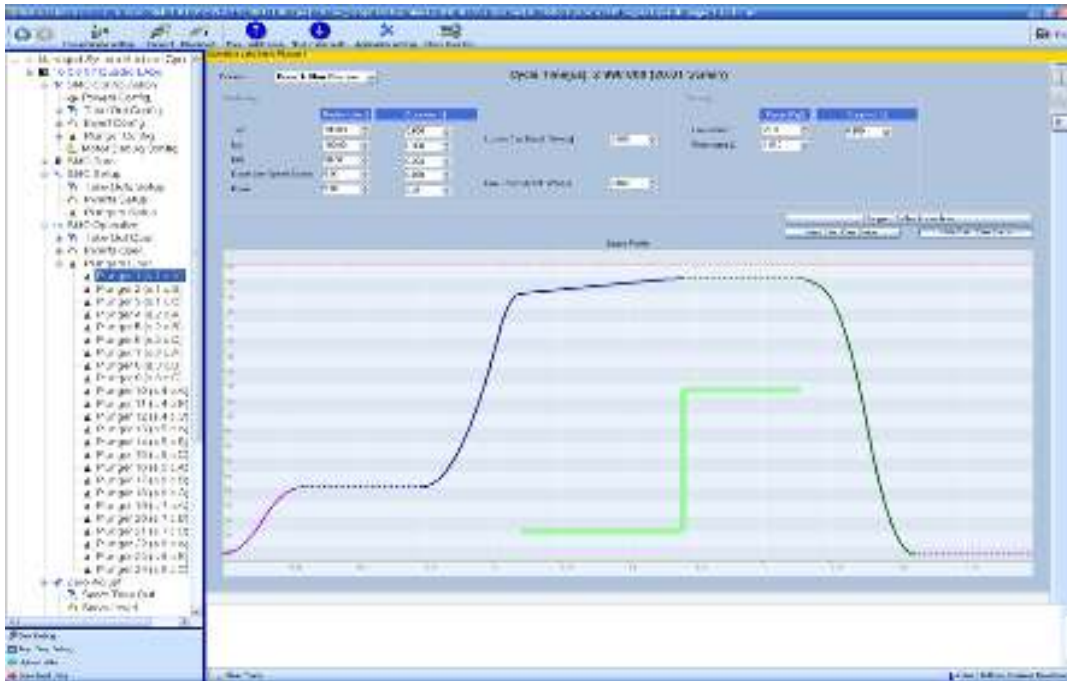- Integrated Weighing Station for **BB**

Weighing Station

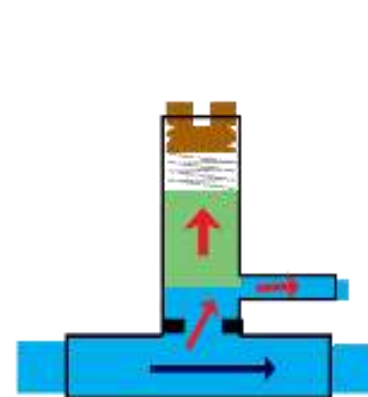Tube Height Control

Servo Plunger integrated with DFS
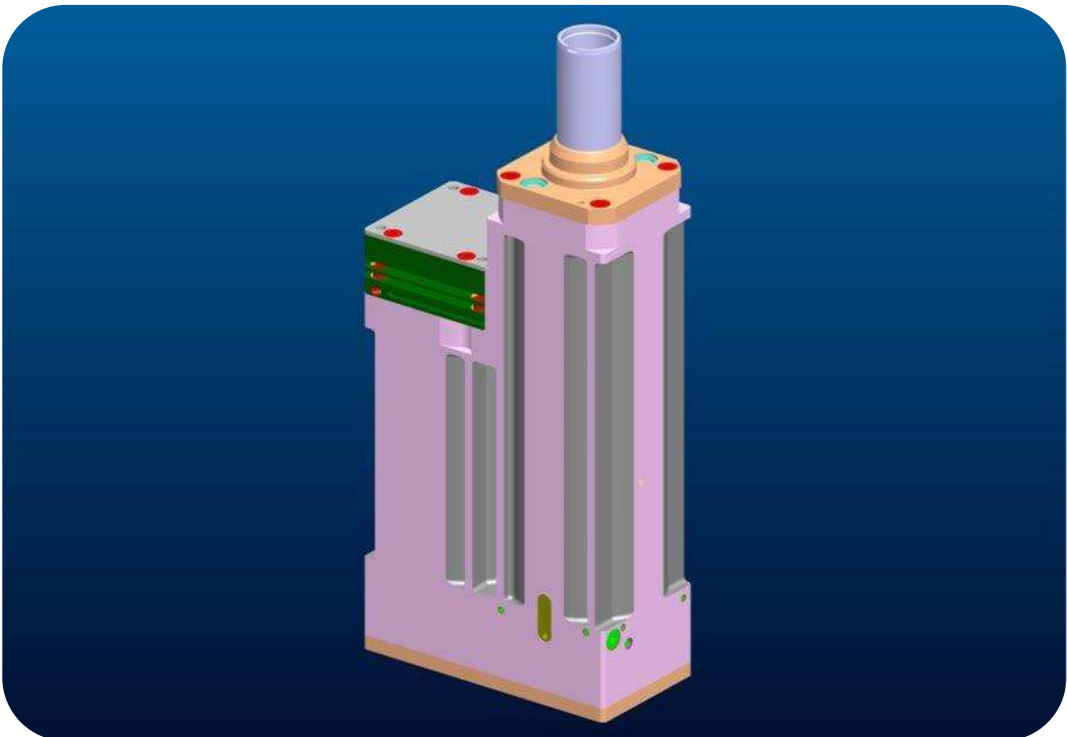
Fully integrated with DFS to implement gob weight control functionalities without the need of position sensors
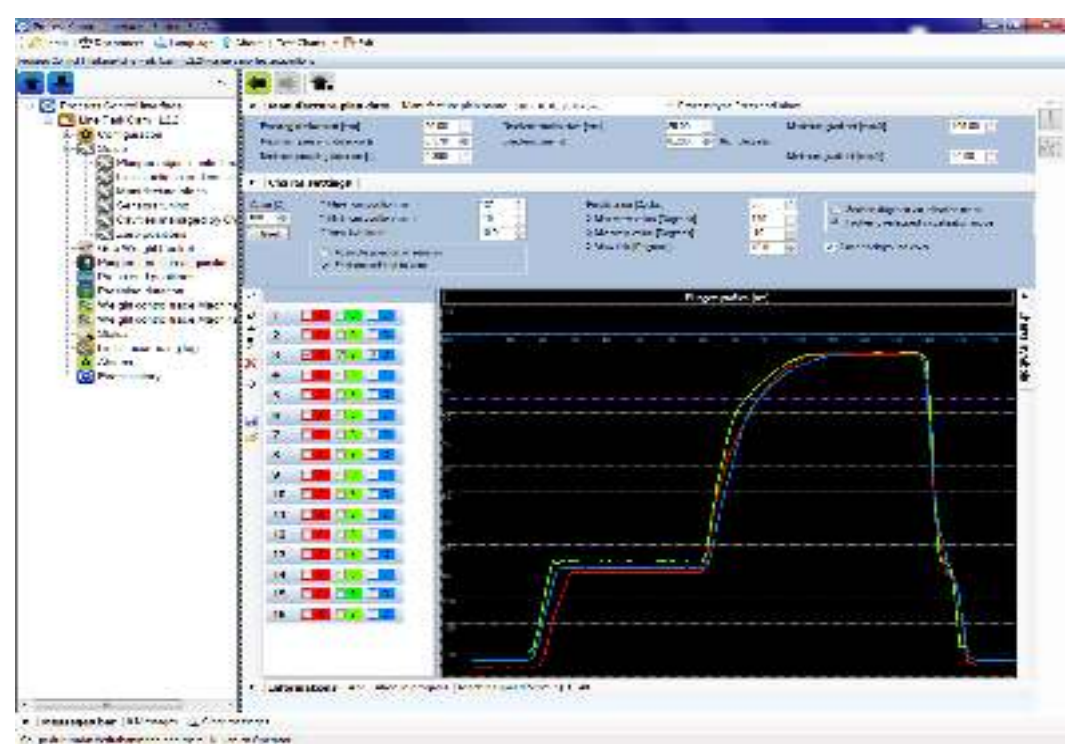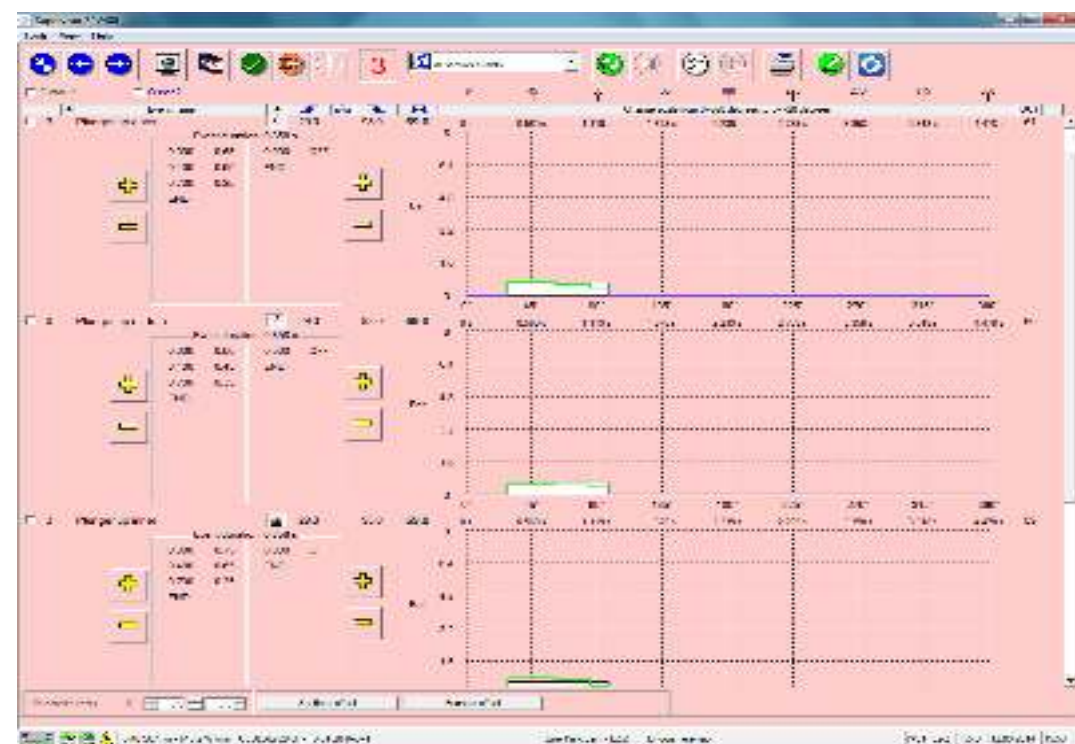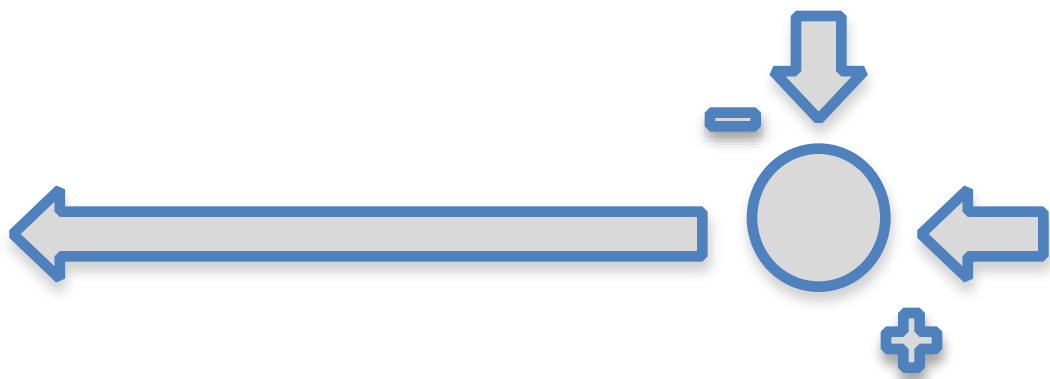
DFS: Plunger Motion Control

Proportional valve for plunger up
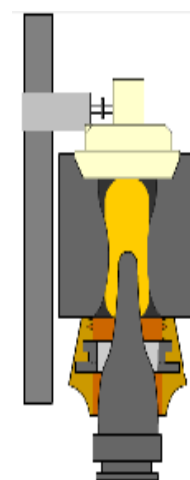
Plunger up motion
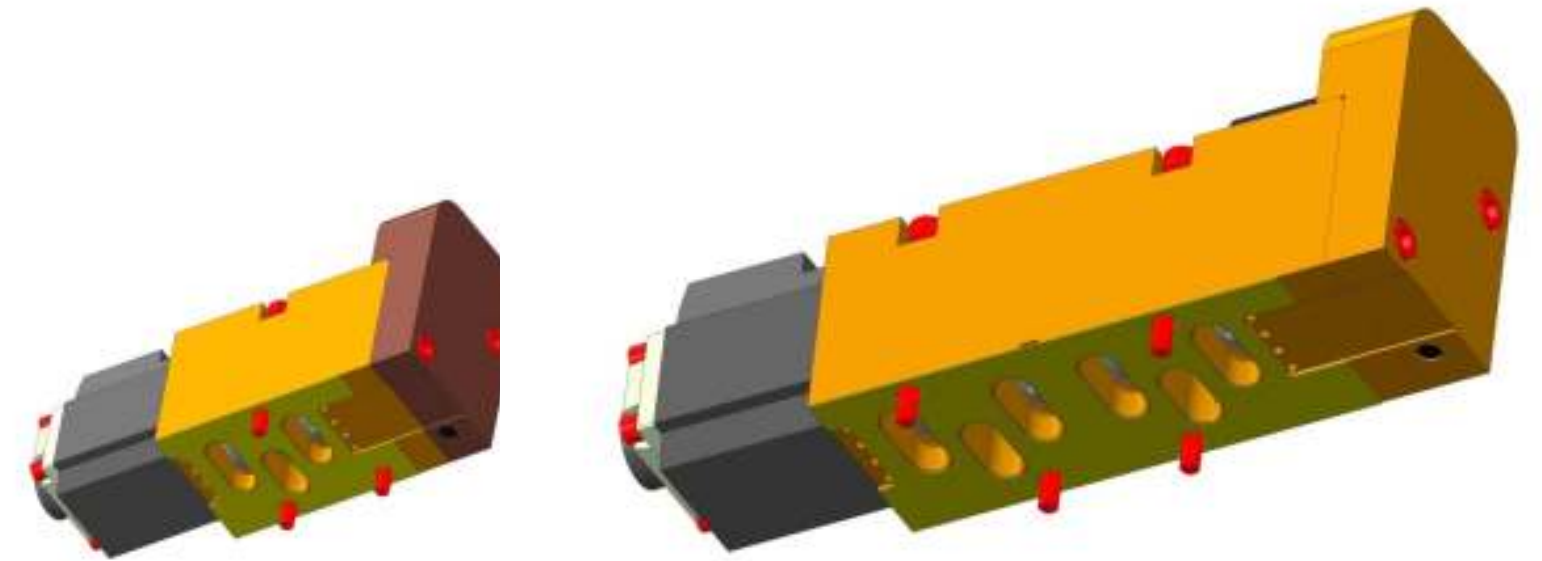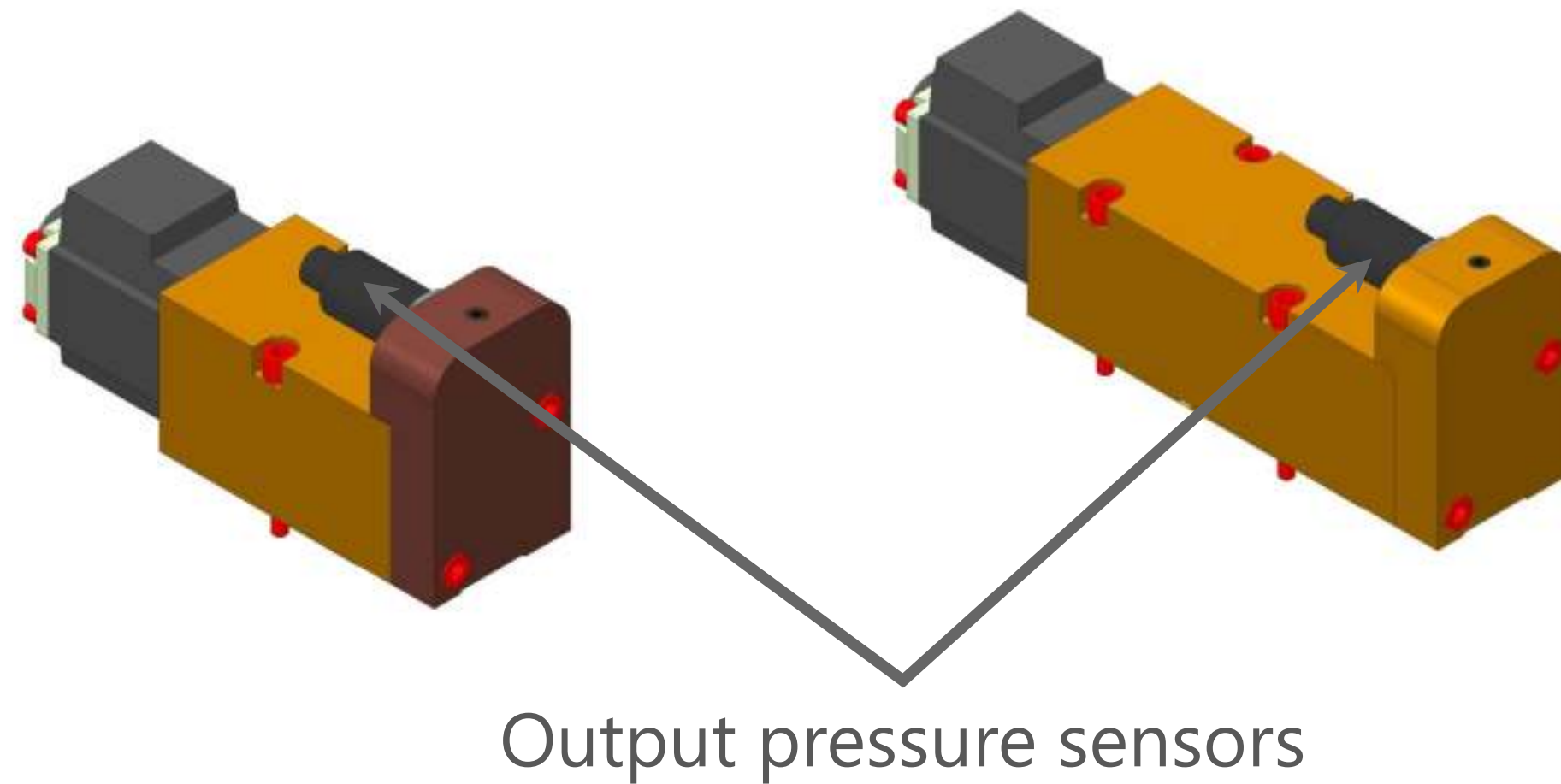
Pressing Time
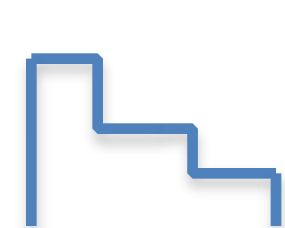
Controller

Pressing Time Set-point

Bottero Proportional Valves 2.0

Close loop on the output pressure based on a dedicated sensor.

- ✓ Response repeatability and precision of the output pressure
- ✓ Response homogeneity among different valves
- ✓ Better precision of the control at low pressure

- • Complete mechanic retrofit with existing bases
- • Same operator interface with control electronic

Output pressure sensors

Multi-Weight Manager

- Tool to support setup and control of productions with multiple weight articles: in principle each section may produce a different weight

- Optional plug-in of Bottero servo feeder (700 series)

- The variable gob weight is achieved regulating the plunger parameters of the servo feeder

- Capability to compensate glass accumulation phenomenon due to the return trajectory of the needles

- Commercial weight scales (e.g. Sartorius) can be optionally integrated for automatic weight acquisition
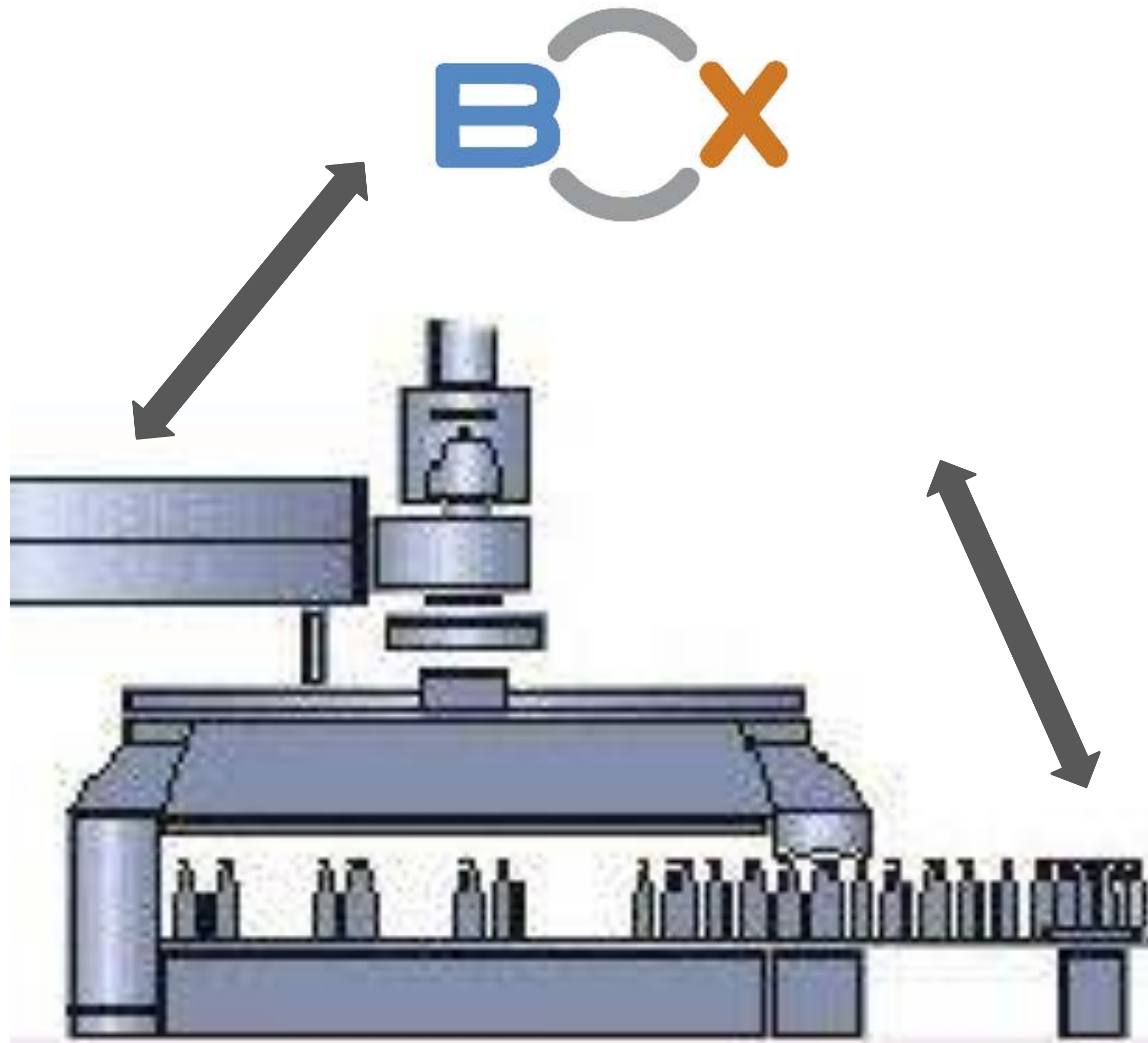
PROCESS VIEW CLOSE-LOOP CONTROLS

BOX :The first and unique tool aiming to control the forming process
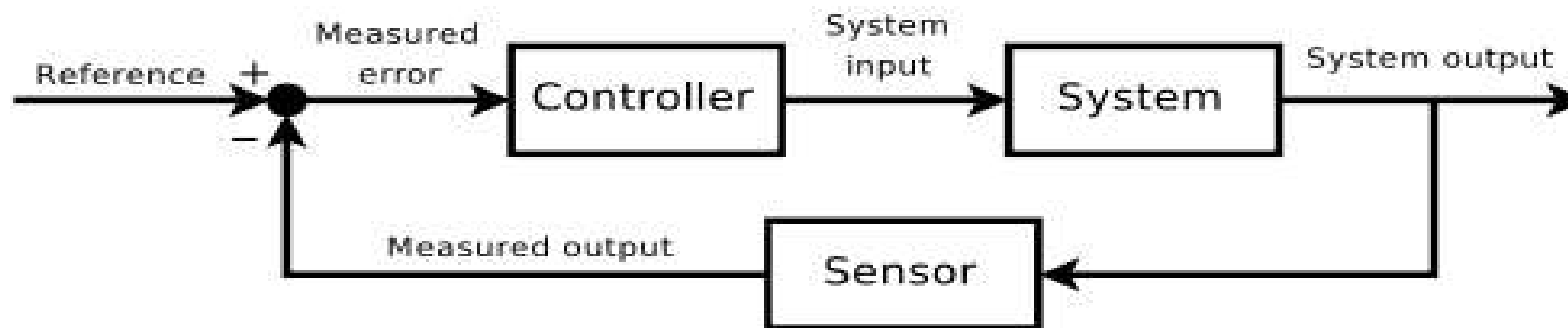
Process View close-loop control
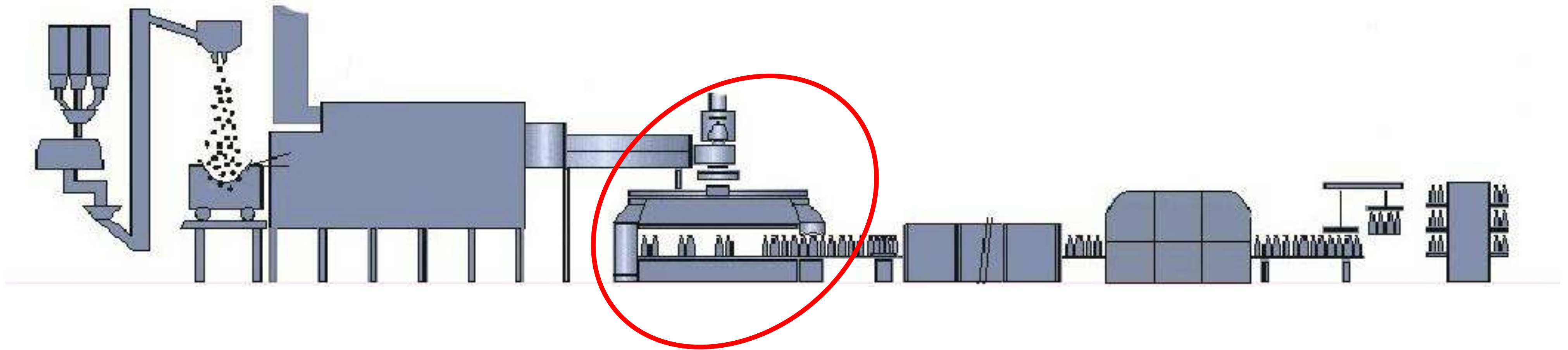
Process View close-loop control

BOX overview

- Automatic control and optimization of ware spacing

- Automatic control and optimization of vertical glass distribution (VGD)

Goals of BoX VGD Control

The BoX controls and maintains the vertical glass distribution under continuously changing operational conditions (due to the environment and to the production process):

- Feeder temperature & pull changes

- Glass conditions changes

- Temperature changes

- Blank heat transfer changes (new Blank)

- Blank swabbing

- Section stop/start
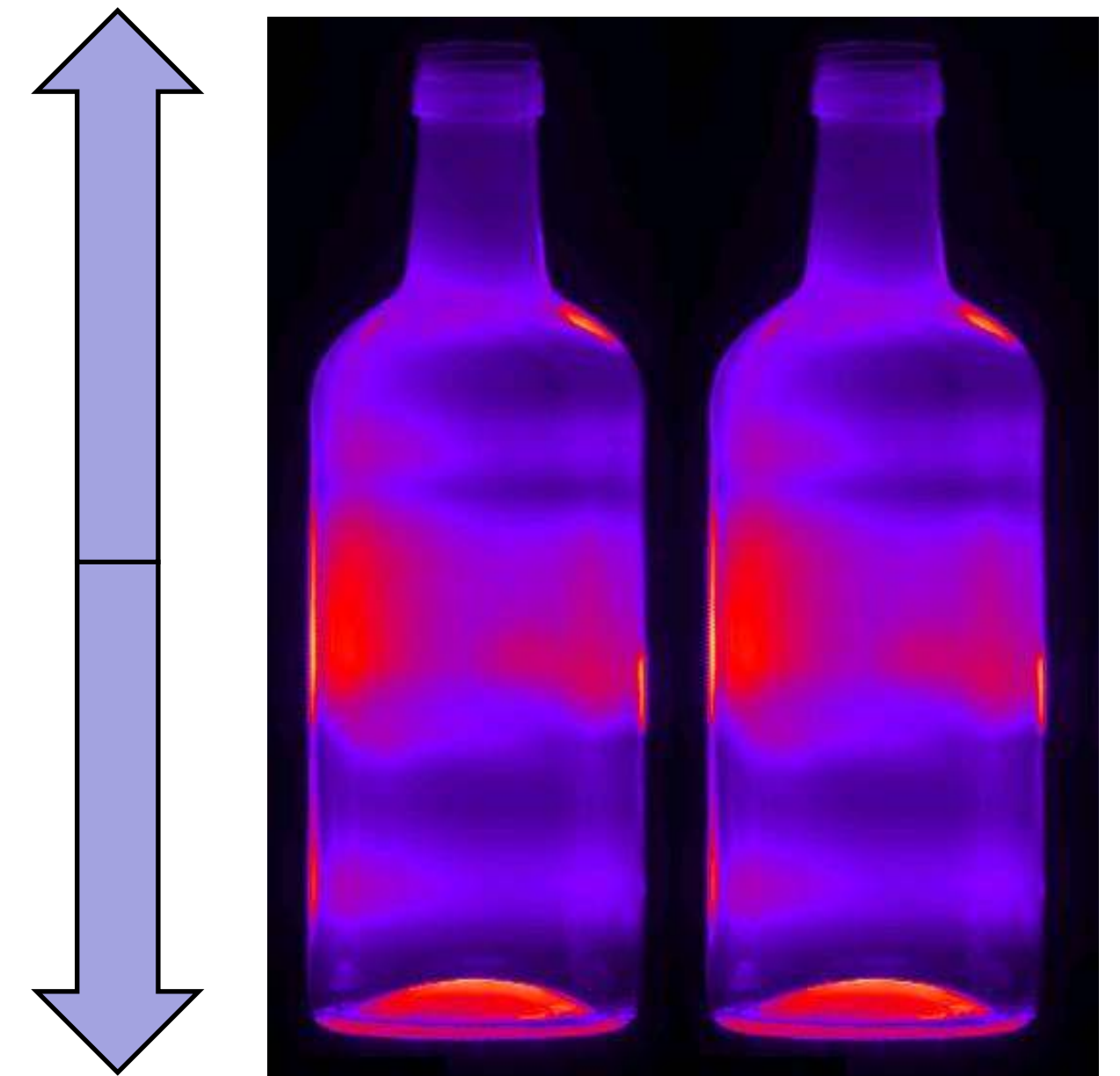
Evolution of the BoX concept

Modelling and Simulation
tools and techniques

Sensors and
measurements

BoX framework

Industrial
Automation

Process
knowledge

**e2e control of the
production process**

The roadmap

1. **Sensors**:

2. **Close-loops**:

3. **Big data storage**:

4. **Big Data Analysis**:

5. **Machine Learning:**

Evolution of the BoX concept

Modelling and Simulation tools and techniques
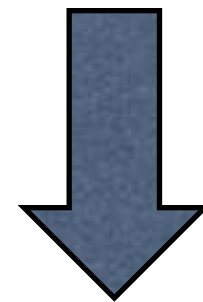
Sensors and measurements

Industrial Automation

BoX framework

Process knowledge

Global control of the production process
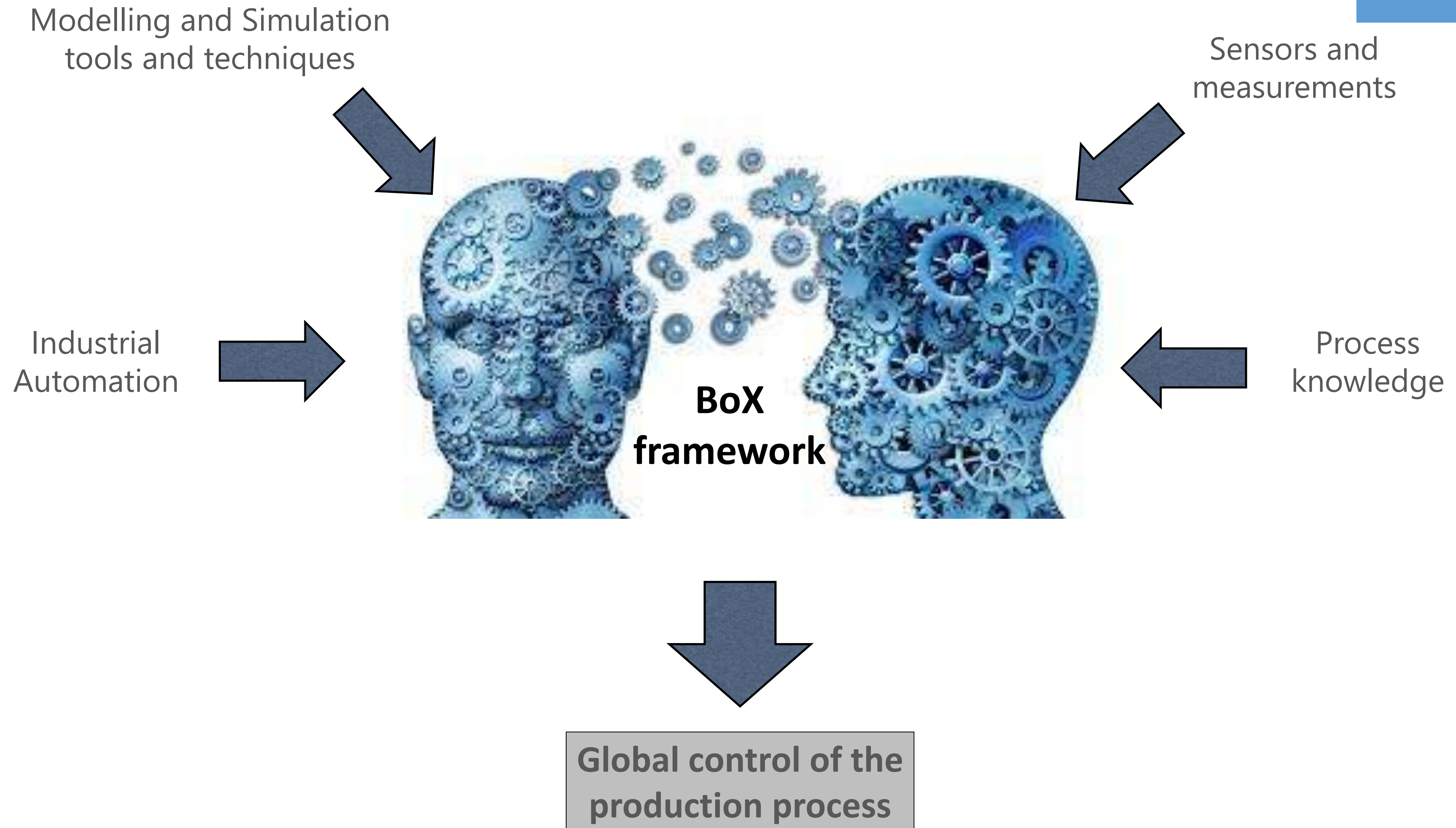
Summary & Conclusions

Bottero strategic view has been presented...

- Ultimate goal: full, **labor-free** automation of the glass manufacturing process

- Industry 4.0 identifies a powerful and integrated view, but...

  ...a fully stable process operation is the key to achieve the goal

- Bottero has a deep and consolidated **process knowledge** to pursue this objective

- **BoX** is the first and unique system on the market, conceived and developed to support this vision

- Starting from the BoX experience, Bottero has defined an evolutionary roadmap aiming at the full process automation

Thank you

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