Container Glass Forming in 2020/2025

The dark factory

Lyon, September 2017

xparvision
heading for perfection

> 20 years track record of innovating the glass production process

- 1994 JD / CTI / RUG / Glass
- 1999 Foundation XPAR Vision
- Focus on container glass industry
- Focus on hot end production process
  - Inspection, process monitoring
  - Sensors, automation, robots → process improvement & quality control

The dark factory

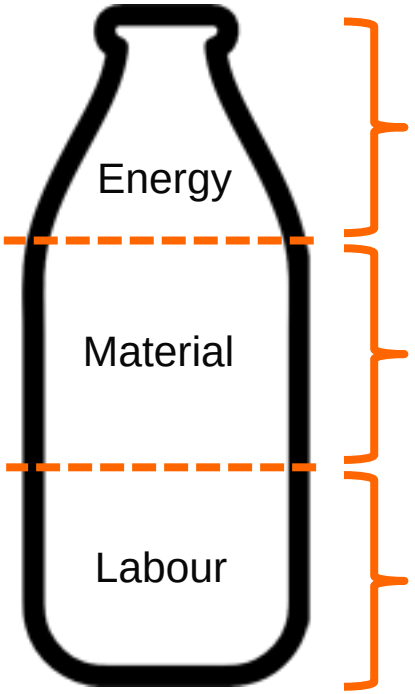
- A dark factory is a fully automated shop floor
- Smart Manufacturing / Industry 4.0

Main drivers: cost, quality, labour

Sustainability

- Environmental (waste/energy/carbon)
- Social (labour conditions)

Cost



Characteristics

- **Efficiency low: 85-90%**
- Quality to customer < 100%
- Many unknown variables
- **No/slow (quality) feedback loop**
- **Forming highly human dependent**
- **Labour is aging**
- **Health/safety is a concern**
- Flexibility is low
- **Containers are too heavy (40%)**
- Speed of production too low

Alternatives

- Plastic, Aluminium, PET
- Cheap, flexible, light

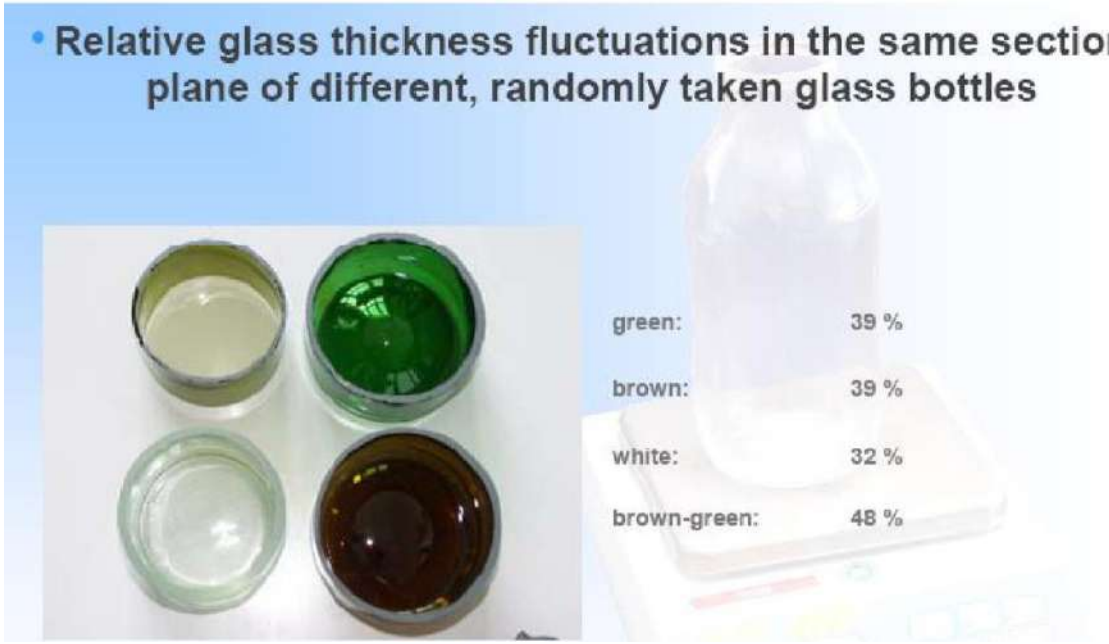
Main drivers: cost, quality, labour

Containers are (designed to be) too heavy

Example:

Beer bottle, customer spec. = min. thickness shoulder/body/heel 1 mm.

Beer bottle, design spec. = 1.8-1.9 mm thickness



Source: Prof. Dr.-Ing. H. Hessenkemper, Glas- und Emailtechnik (TU Bergakademie Freiberg)

The level of (forming) process control is (very) low: efficiency and weight!!

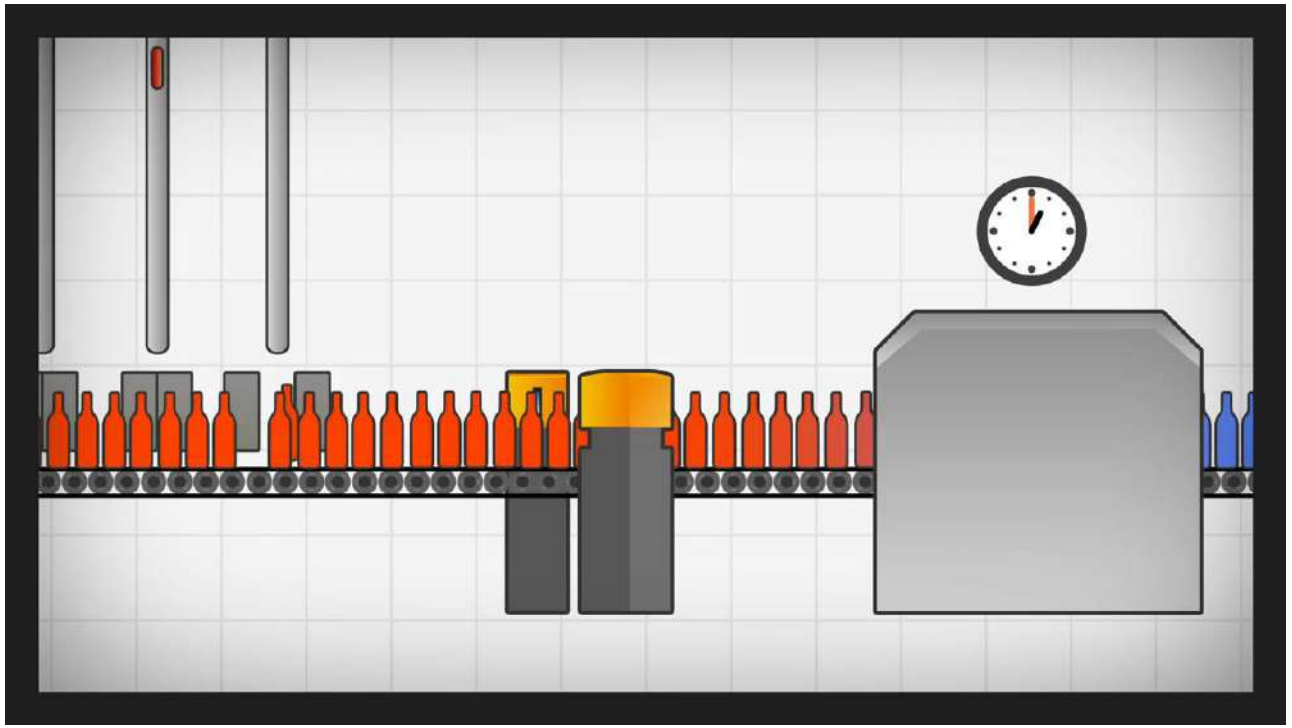
Process stability is the key towards optimization

Process stability is the key

- Cullet
- Batch/homogenity
- Viscosity/temperature /homogenity
- Feeder pull
- Ambient temperature
- **Deterioration/wear**
- Material change
- Operator change
- Stop/start
- Swabbing

- Gob condition (weight/shape/temperature) variation
- Loading variation
- Temperature variation
- Bottle variation/defects

Process stability requires automation (and thus sensors)



1927….2000: No real time factual information on forming process and bottle quality in hot end

More focus on HE pack than on HE quality

Focus on hot end forming

Huge savings potential!

Lighter and stronger containers.....

produced with (almost) zero defects…..

at higher speed….

with minimal human dependency.

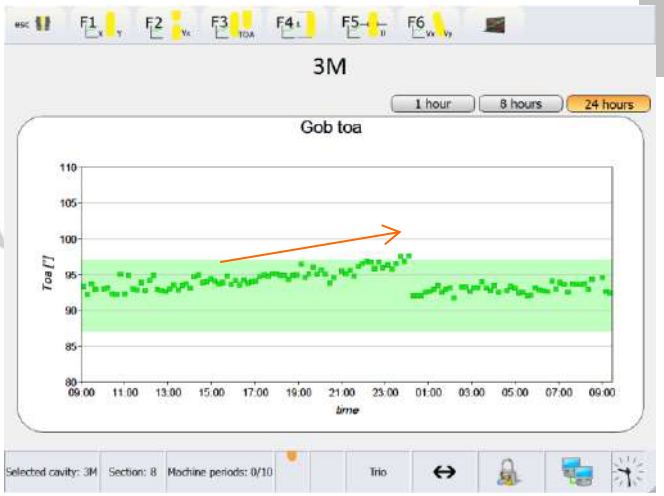
Deflector

- Normally a coating is used in the deflector
- This coating wears out after a while and more and more friction will appear in this area
- When the gob meets more friction it will start to deform:
  - Shorter lenght
  - Increased diameter
  - Shape deviation (from cylindrical)
  - Decreased speed
- More defects are the result

Example process variation: deterioration and wear

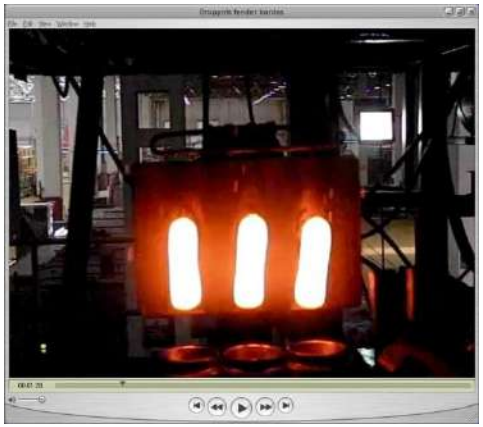
Gob Assist: cavity 3 M, 15-07 00:15

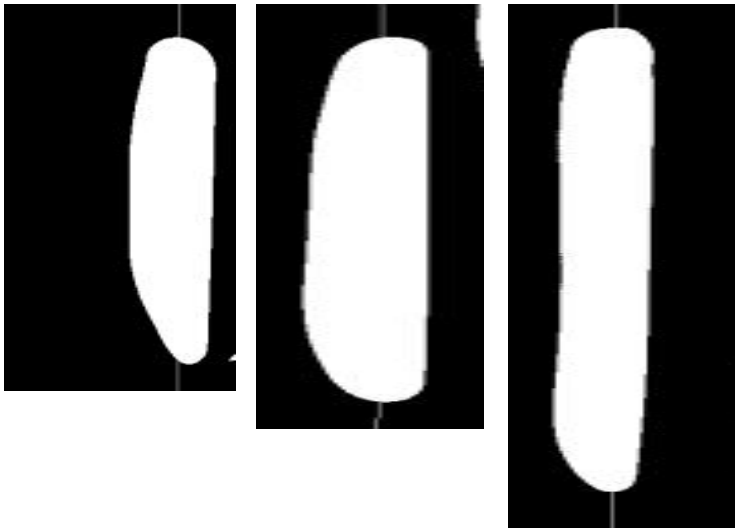
Due to higher friction in delivery



Example process variation: deterioration and wear

Deflector: gob changes



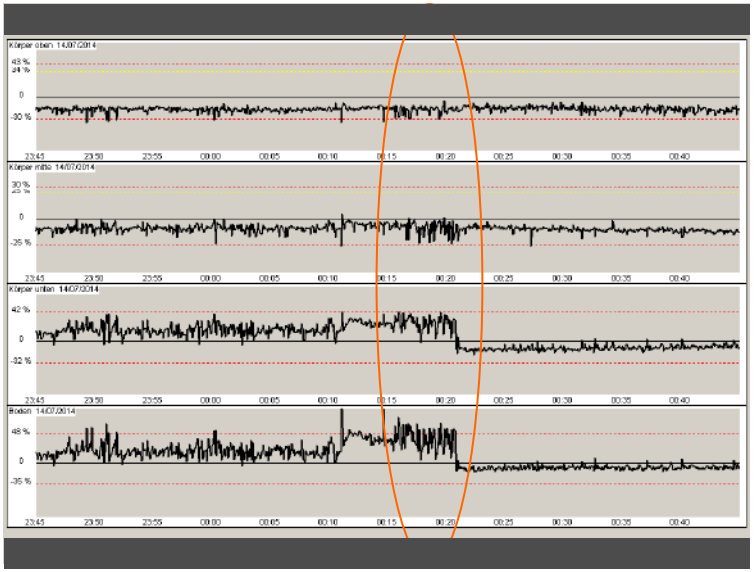


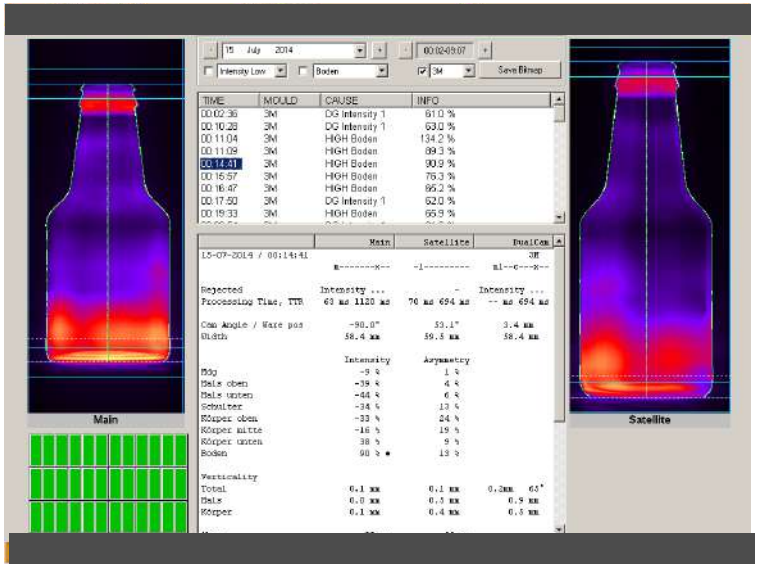
At gob cut shape of gobs might look equal…

…but length, shape and diameter can be different when loading into the blank…

…due to friction in the delivery system

IR-D: cavity 3 M, 15-07 00:15

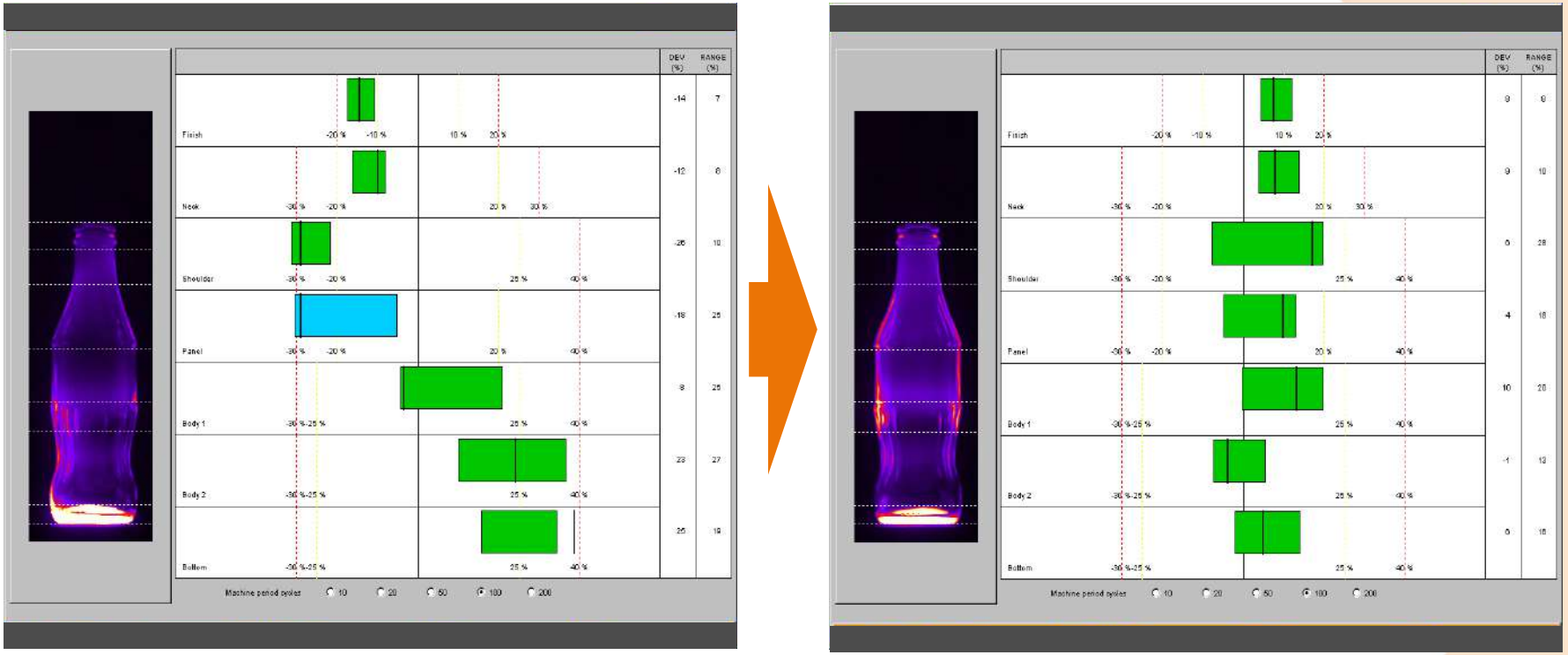




Due to the shorter length the glass distribution changes.

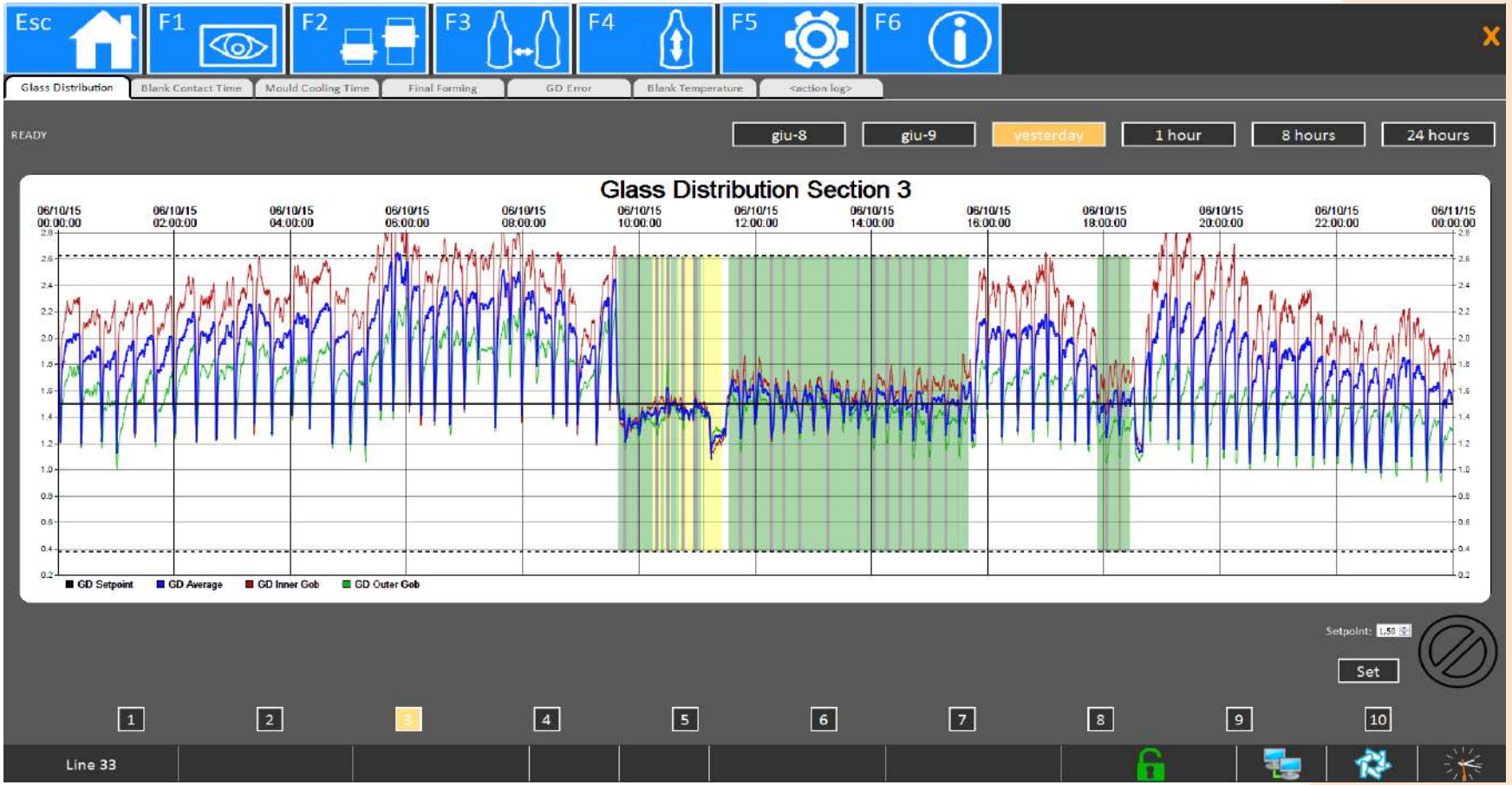
The sensor GA sees the gob condition changing.
An automated lubrication of deflector would prevent this from happening.
More consistency/predictability would be the result.

From uncontrolled to controlled glass distribution

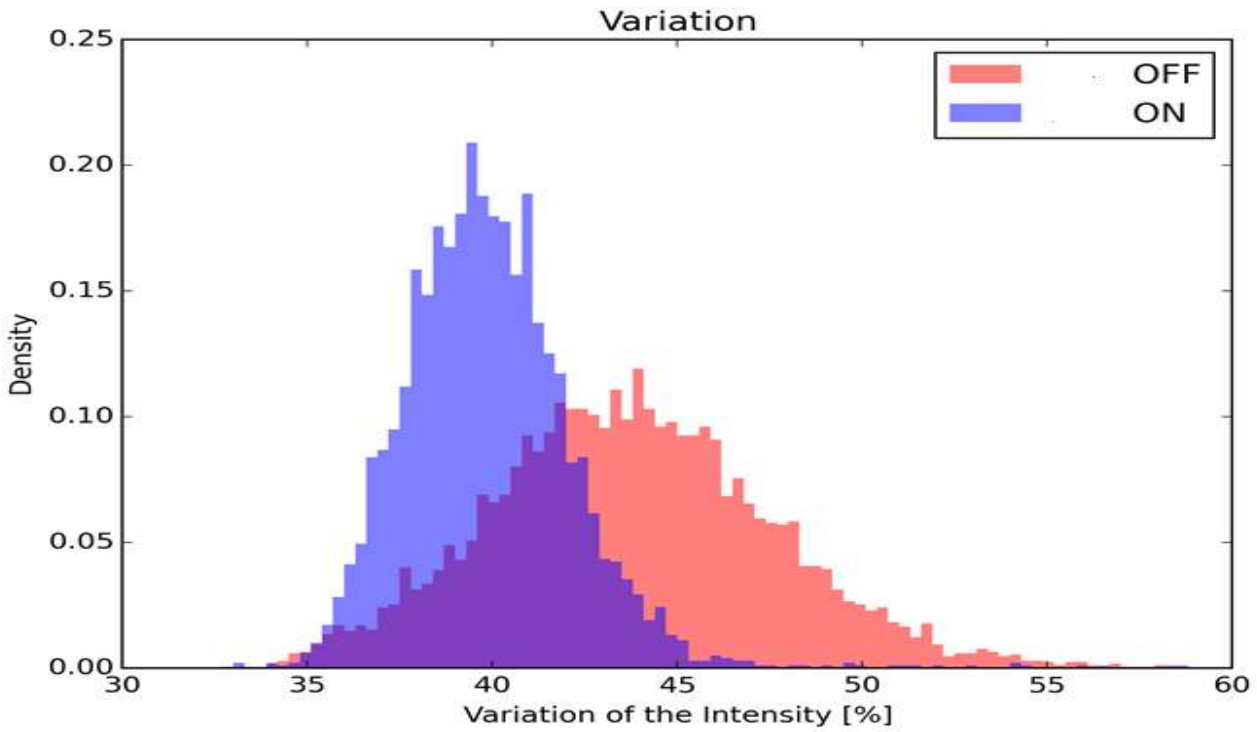


The sensor IR sees the glass distribution changing. Operator will not act upon it as the bottle still within customer specification.
With an automated algorithm it is very easy to optimize/control the glass distribution. The bottle will be stronger and potential for weight decrease is huge.

The impact of automation is huge



The variation of glass thickness (glass distribution) reduces!



Required step to realise weight reduction

What is available today?

Sensors

Bottle/cavity variations
- Inspection
- Container geometry
- Glass distribution
- Position on belt/stuckware/downware

Gob loading variations
- Speed/Lenght
- Time of arrival
- Position
- Orientation/shape/falling angle

Temperature variations
- Mould
- Plunger/neckring
- Parison

Gob Forming
- Temperature/shape
- Weight

Automation

Gob weight control

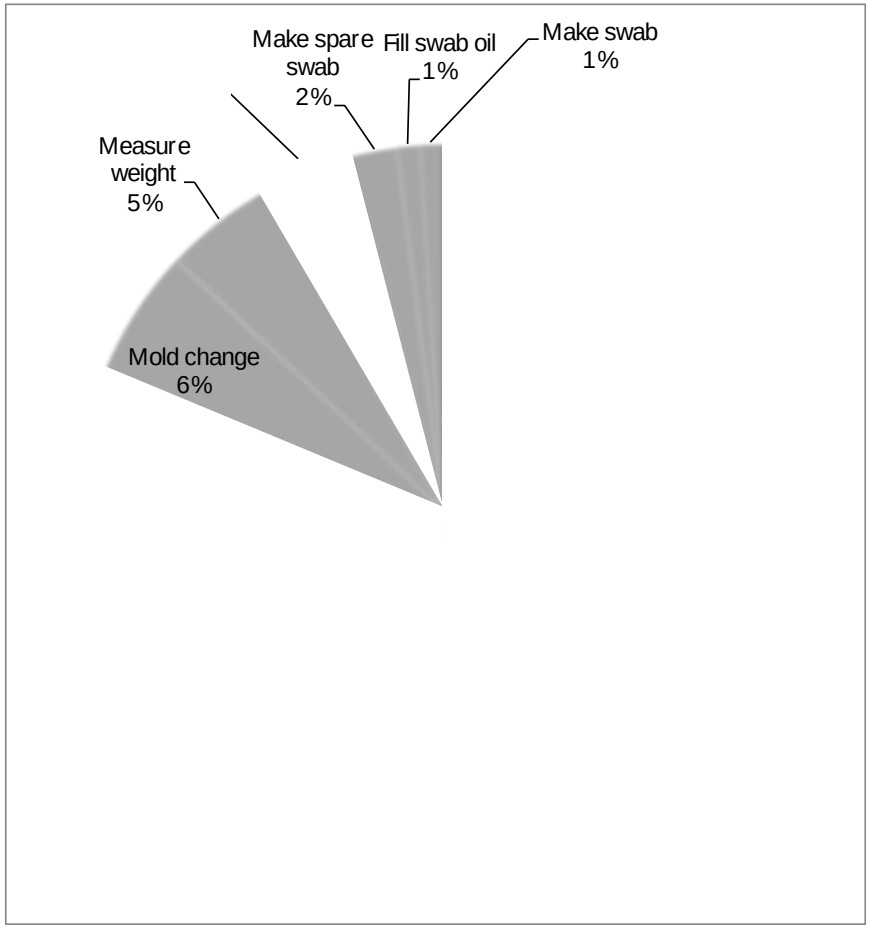
Ware spacing control

Mould temperature control

(Plunger) process control

Vertical glass distribution control

Besides sensors and automation robotics is critical step towards the dark factory



Time distribution tasks hot end operator

- Sensors, automation and robotics will replace (most) functions of the hot end operator
- Leading to much better output
- Reducing the operational costs (TCO)

Focus on hot end forming

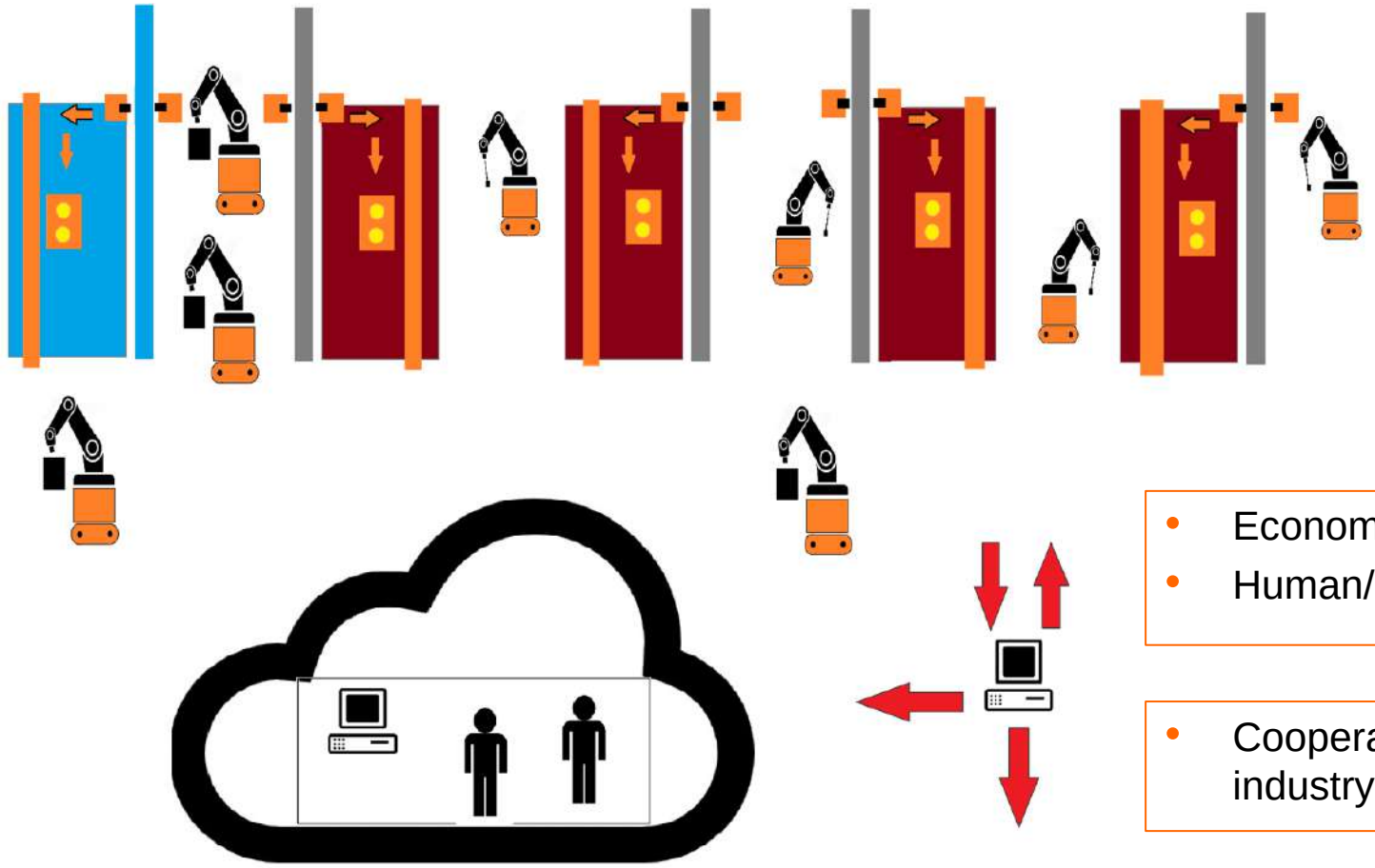
Huge savings potential!

Lighter and stronger containers…..
produced with (almost) zero defects…..
at higher speed…..
with minimal human dependency.

Next steps

- More / better sensors, automated control loops, robot functions
- Integration of systems (=data)
- Smart use of data

The dark factory



- Economical aspects
- Human/labour/safety

- Cooperation within the industry

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