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The future meat plant

FOURTH INDUSTRIAL REVOLUTION – WHAT'S IN IT FOR YOU?

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FOURTH INDUSTRIAL REVOLUTION – WHAT'S IN IT FOR YOU?

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The future meat plant

- The need for handling many small volume product variants is increasing.
- Digitalizing and using data across the value chain to optimize logistics and production processes and exploiting synergies presents critical opportunities. But how do we realize them?
- Is line production still the future slaughterhouse production paradigm?




Industry 4.0 (Wikipedia)

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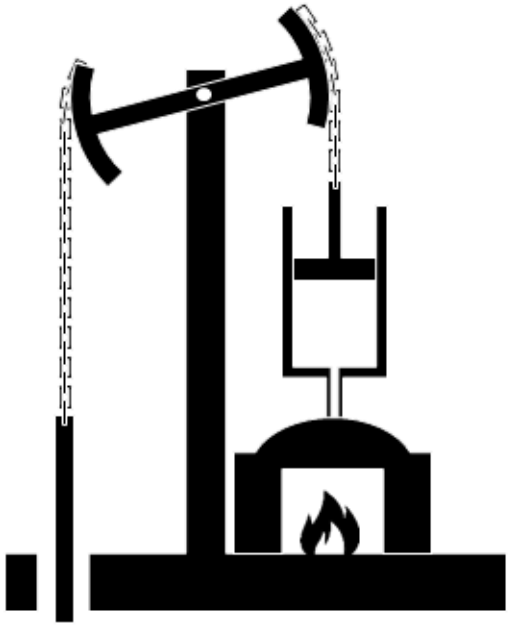
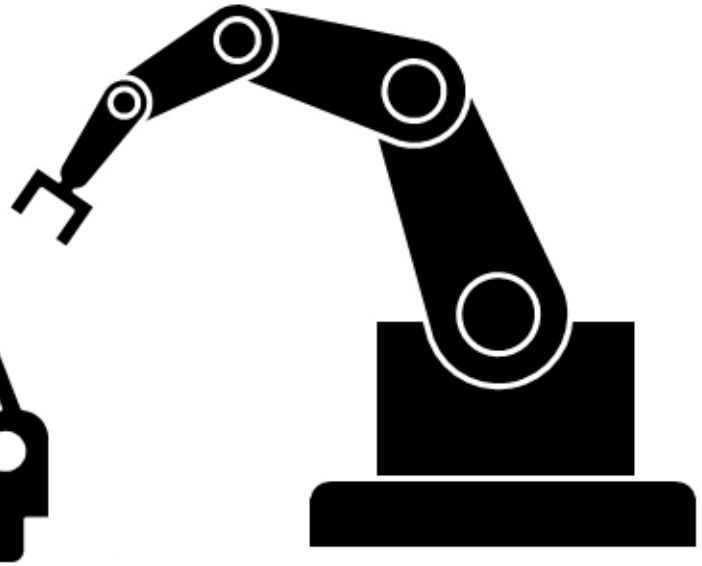
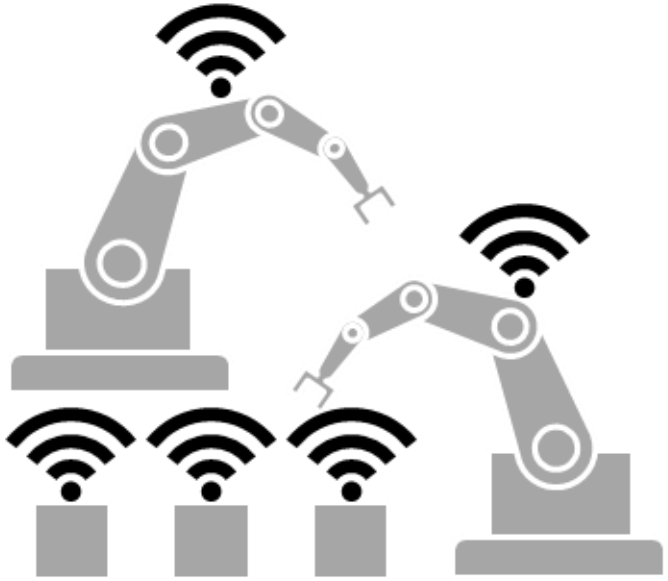






1st	2nd	3rd	4th
Mechanization, water power, steam power	Mass production, assembly line, electricity	Computer and automation	Cyber Physical Systems

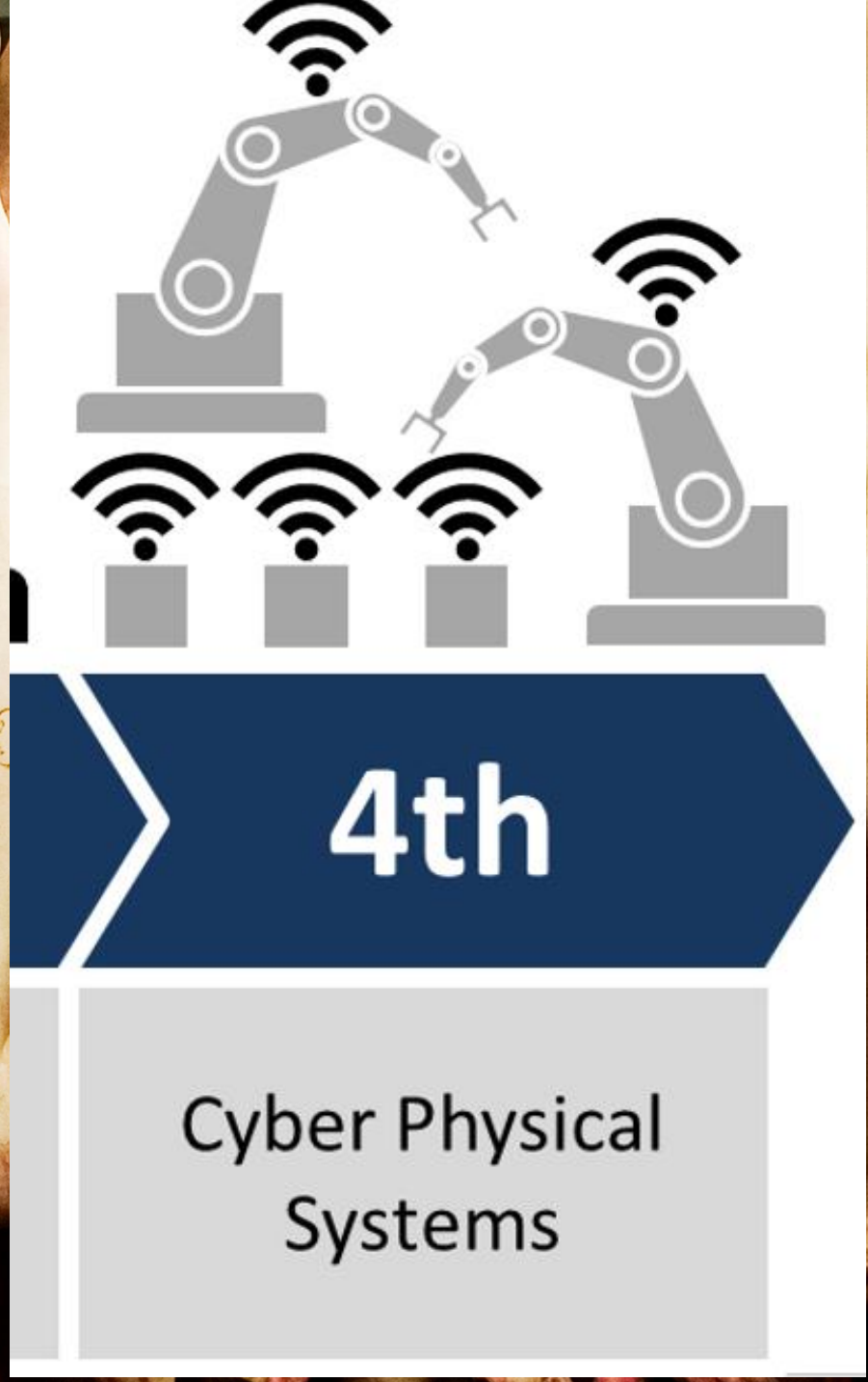
Industry 4.0 (Wikipedia)

A **cyber-physical system** (**CPS**) is a mechanism controlled or monitored by computer-based algorithms, tightly integrated with the internet and its users. In cyber-physical systems, *physical and software components are deeply intertwined, each operating on different spatial and temporal scales, exhibiting multiple and distinct behavioral modalities, and interacting with each other in a myriad of ways that change with context.*[1] Examples of CPS include smart grid, autonomous automobile systems, medical monitoring, process control systems, robotics systems, and automatic pilot avionics.[2]

Are you serious?

Industry 4.0 (for butchers)

- Most information is digitalized and accessible (also along the value chain).
- Machines, raw material and products ”talk” together.
- Access to information about history, present state, and predictions about the future.
- Automation of not just individual processes but also of how to combine and adapt processes (also to small series), i.e. automated/assisted:
  - Production planning.
  - Contingency/error management.
  - Management of variation/small series.



The future meat plant
It’s all about BETTER BUSINESS

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- How can we increase profit?
  - Increase prices
  - Decrease costs
  - Increase volume

Increasing prices
How are we doing?

- Not so well the last 30 years!

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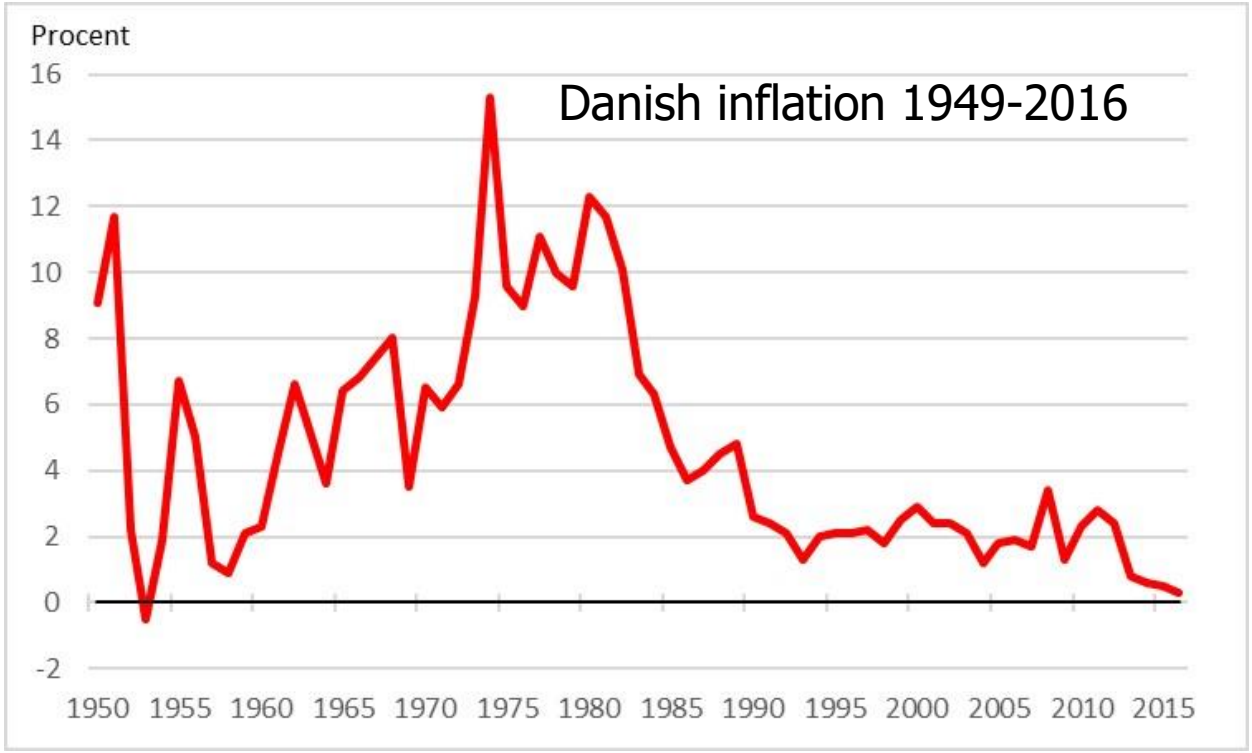
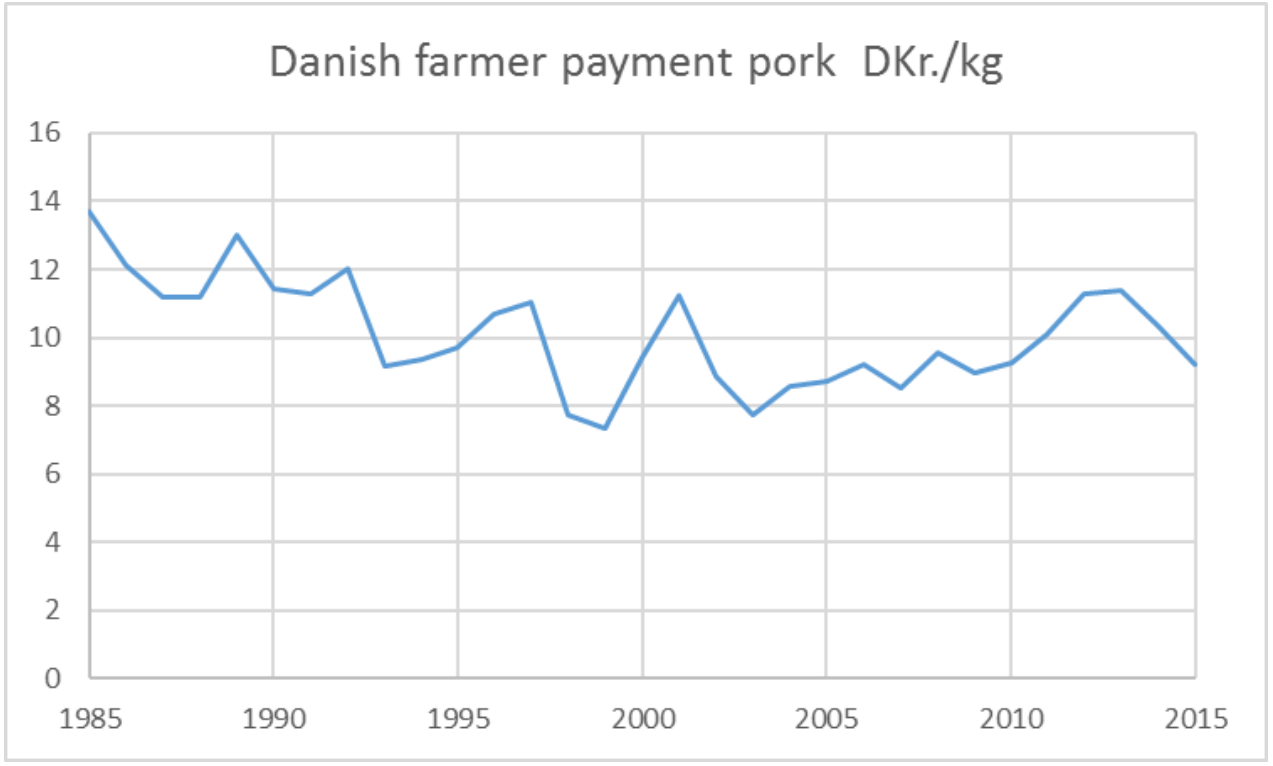
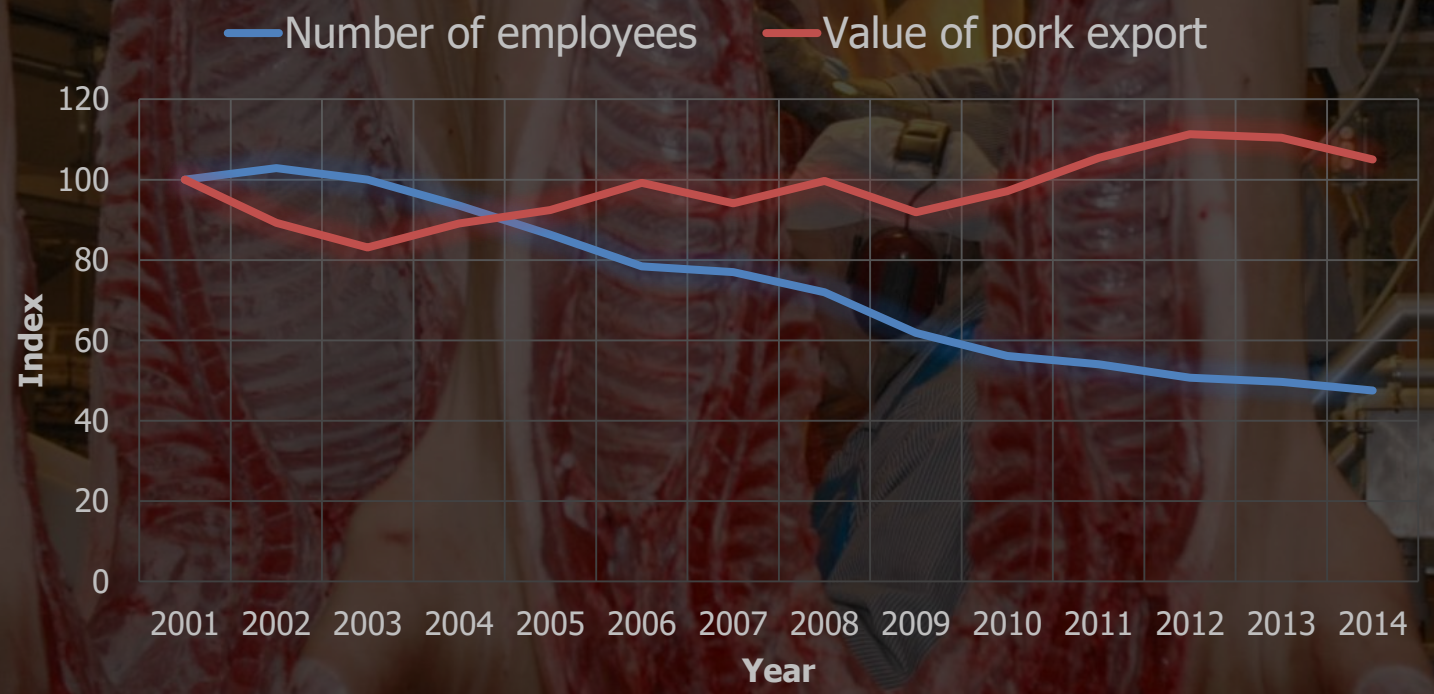


© Danmarks Statistik og Den Store Danske



Data from the Danish Agriculture & Food Council

More than 300 mio € saved every year



Market segmentation

Same same but different

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Enters the ”Craft Beer”

Authenticity, heritage, locality, craftsmanship

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Industrial ”Craft beer”

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Mega trends

Major present and future challenges

How to increase prices?

- **Increasing the perceived value:**
  - **Market segmentation: Let affluent/willing costumers pay according to their value perception.**
  - **Branding & Story telling (the craft beer analogy): Farmer and provenance, animal welfare, food safety, quality, socially sustainable workplace.**

How to increase prices?

- **The challenges. Segmentation, Branding & Story telling require:**
  - **B2C business models (more direct market access/impact, B2B tends to be price driven).**
  - **More complex logistics: More product variants, smaller product series, more detailed distribution.**
  - **Documentation of claims (with a brand comes potential brand damage)**
    - **Traceability.**
    - **Objective an communicative parameters for: Animal welfare, food safety, and quality.**

Industry 4.0 technologies for

- **More complex logistics: More product variants, smaller product series, more detailed distribution**
- **Horizontal integration: Costumer definition of product!**

Industry 4.0 technologies for

- **Documentation of claims (with a brand comes potential brand damage)**
  - **Traceability and documentation (from pig to pack (to consumer)).**
  - **Objective an communicative parameters for: Animal welfare, food safety, and quality.**

Decreasing cost

How are we doing?

- Pretty well historically.
- But is there still room for more efficiency?

Decreasing cost
New paradigms?

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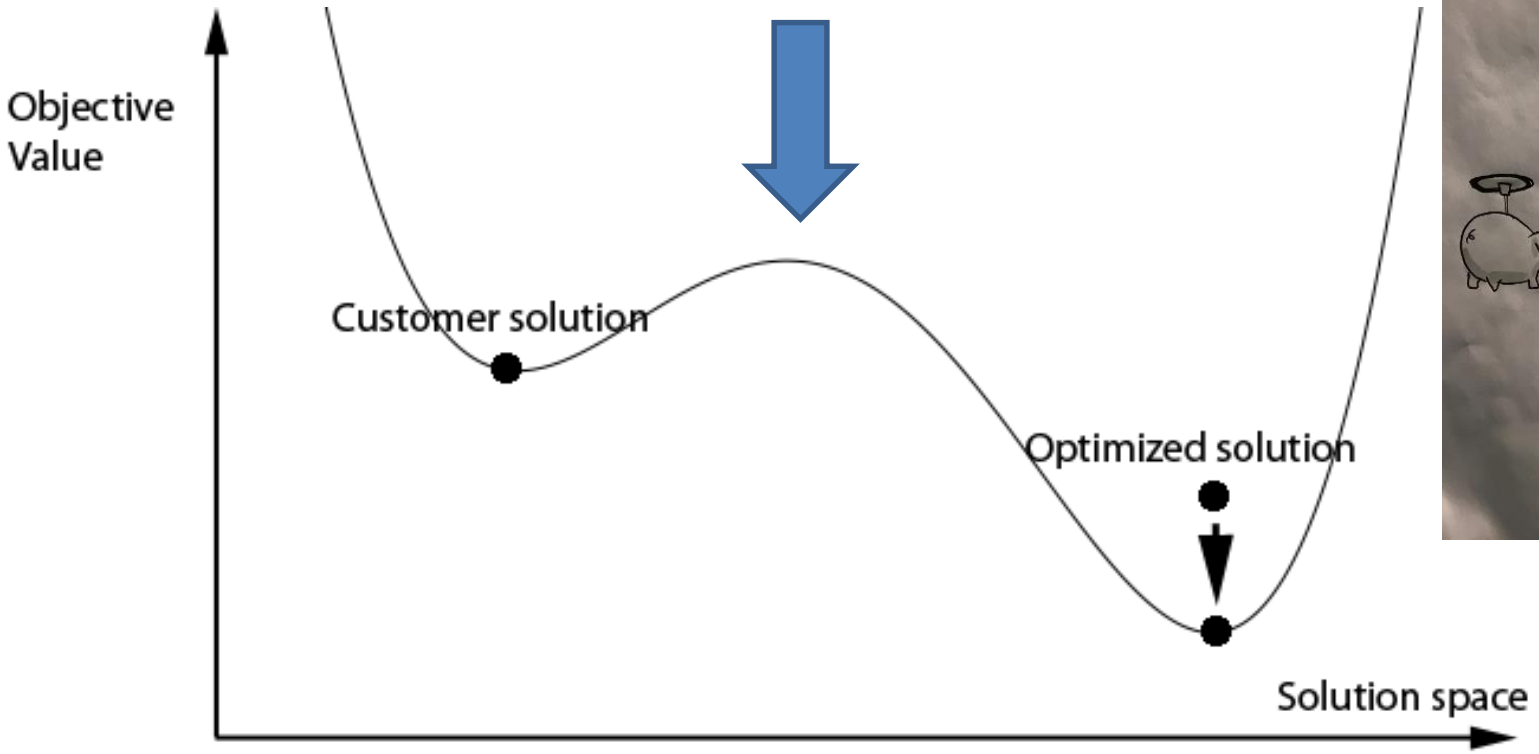

Decreasing cost

Maintain yield (of high value products)!!!

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Raw material 75%

COST INCREMENT	
Administration	1%
Sale + distribution	3%
Depreciation + financial costs	5%
Different indirect costs	6%
Packing material	2%
Labour costs	8%
TOTAL COST INCREMENT	**25%**

Finished products 100%

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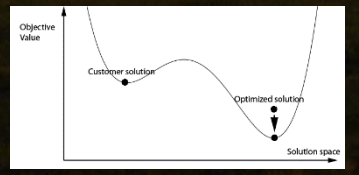
New paradigms?
Fewer but bigger plants running 24/7

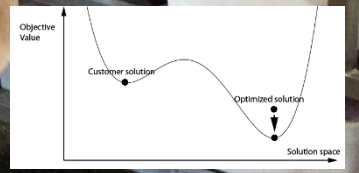
- Why?
  - Less fixed cost
  - Fewer building plots and buildings
  - Better utilization of capital equipment
- Will require (Industry 4.0 technologies for):
  - More automation (labor cost nightshift)
  - Cleaning in Place (CIP) – contained cells
  - Flexibility and redundancy in production
  - Scheduled maintenance



New paradigms?
More streamlined plants

- **Less handling. No buffers. Direct from:**
  - **Truck to stunner.**
  - **FIFO in equalizing chill room.**
  - **Cutting to boning to packaging.**

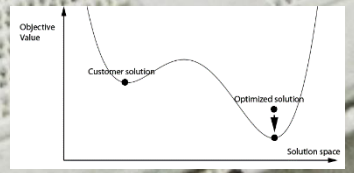
- **But maintaining:**
  - **Optimum usage of carcasses.**
  - **Product/market diversity.**
  - **And even more and smaller product series.**



New paradigms?
More streamlined plants

- **Less handling. No buffers.**
- **But maintaining: Optimum usage of carcasses and Product/market diversity.**

- **Will require Industry 4.0 technologies for**
  - **Measurement**
  - **Traceability**
  - **Automatic sorting**
  - **Flexible smart production (automatic and manual)**



A new production paradigm. What do we need?

Increasing product price:

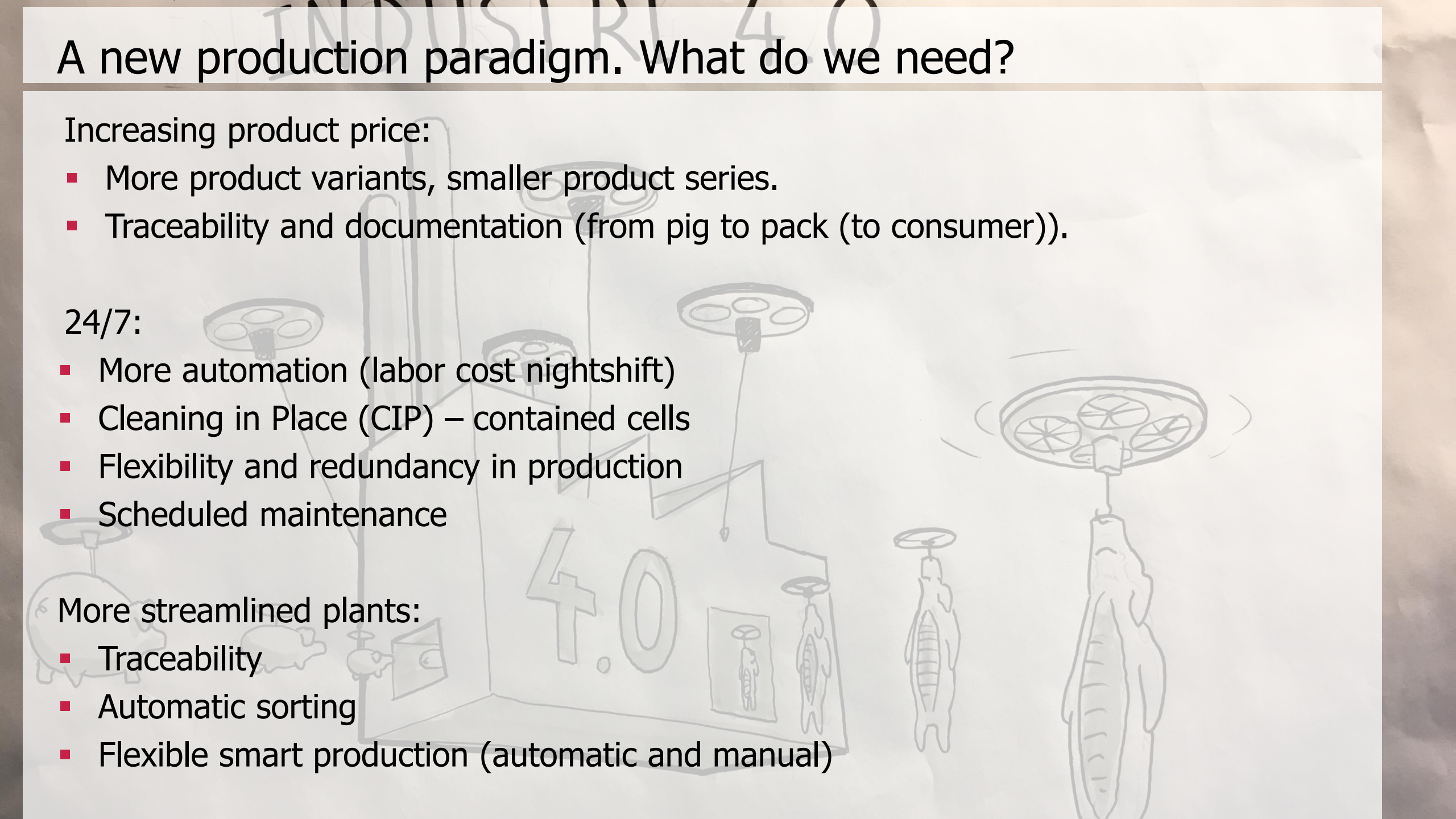
- More product variants, smaller product series.
- Traceability and documentation (from pig to pack (to consumer)).

24/7:

- More automation (labor cost nightshift)
- Cleaning in Place (CIP) – contained cells
- Flexibility and redundancy in production
- Scheduled maintenance

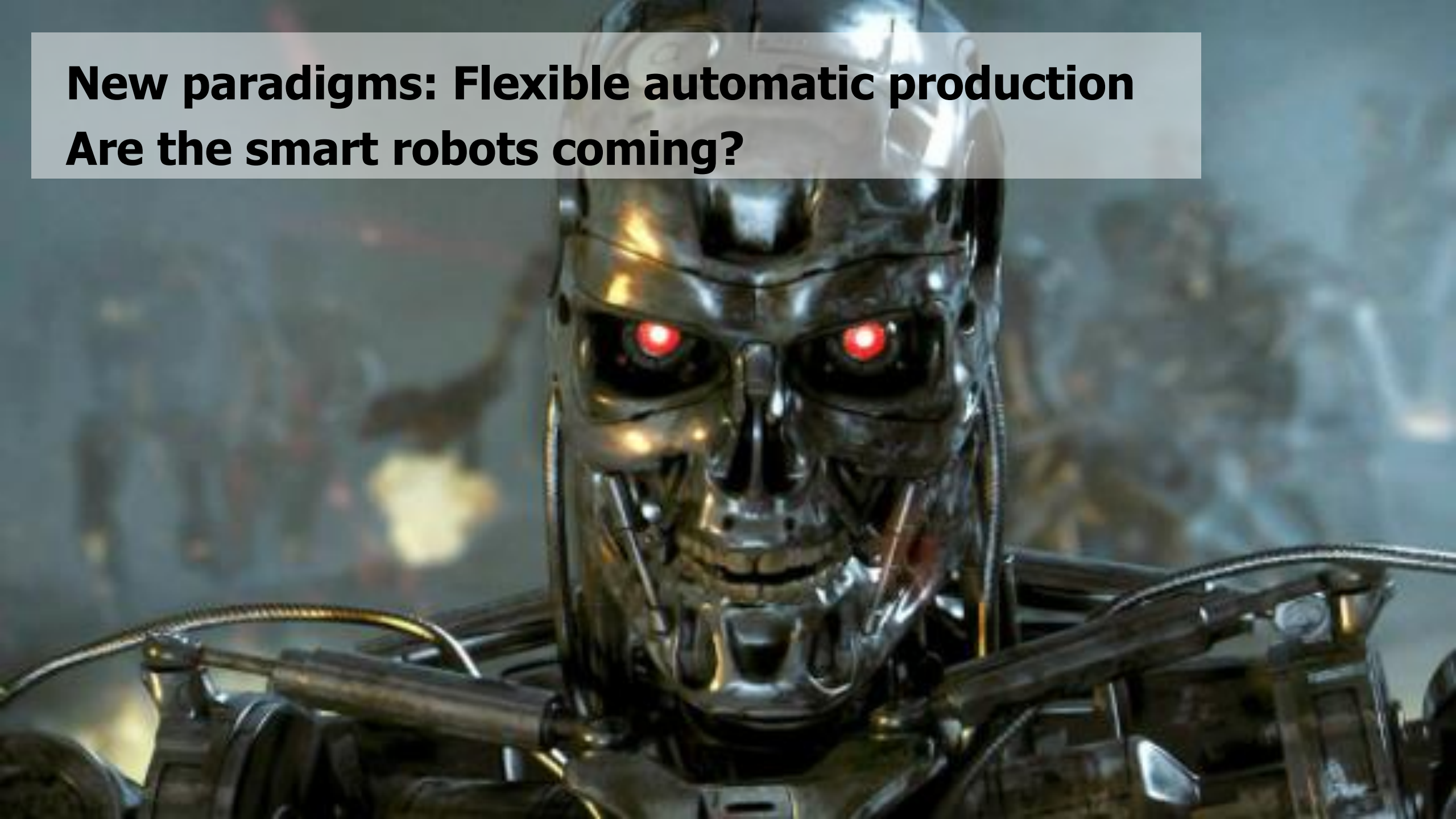
More streamlined plants:

- Traceability
- Automatic sorting
- Flexible smart production (automatic and manual)



New paradigms: Flexible automatic production

Are the smart robots coming?



Potential benefits of Redundant robot cell production paradigm

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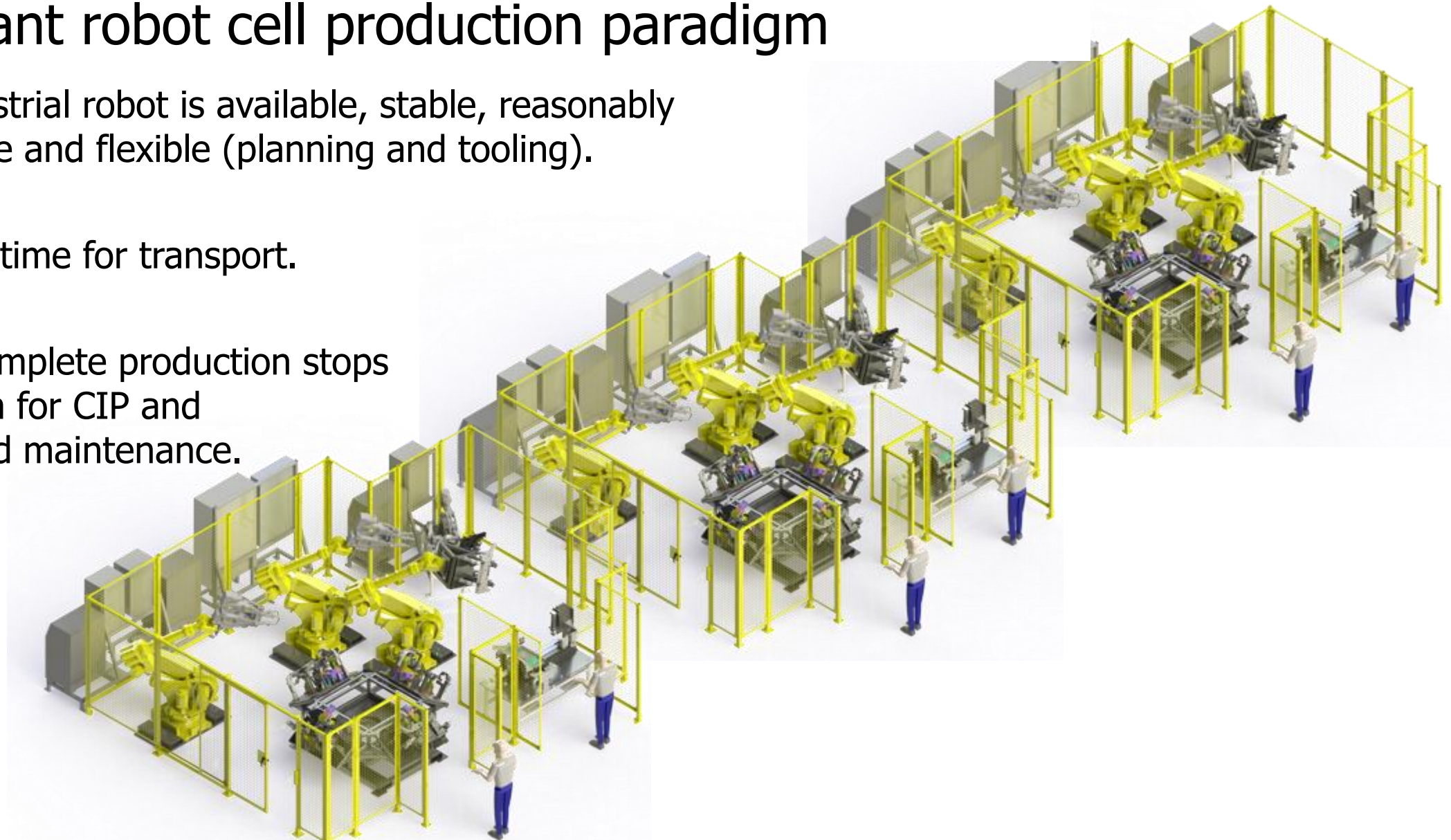
- The industrial robot is available, stable, reasonably affordable and flexible (planning and tooling).
- Reduced time for transport.
- Fewer complete production stops and room for CIP and scheduled maintenance.



Will we save transport time with the robot cell?

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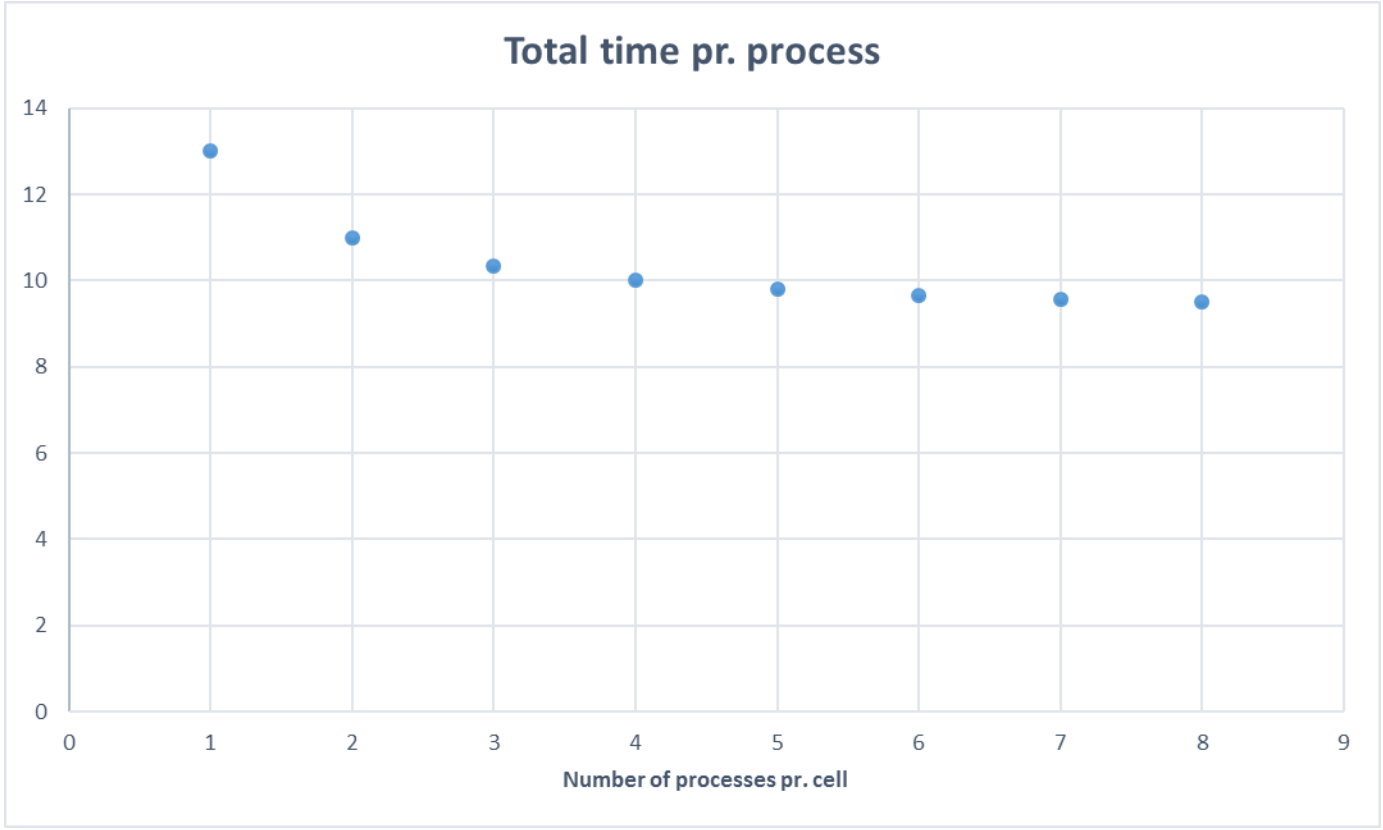
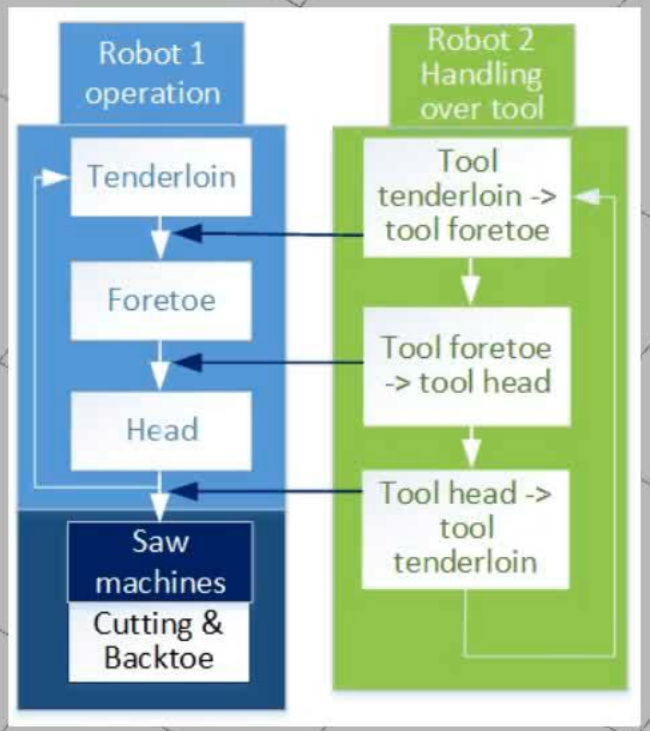
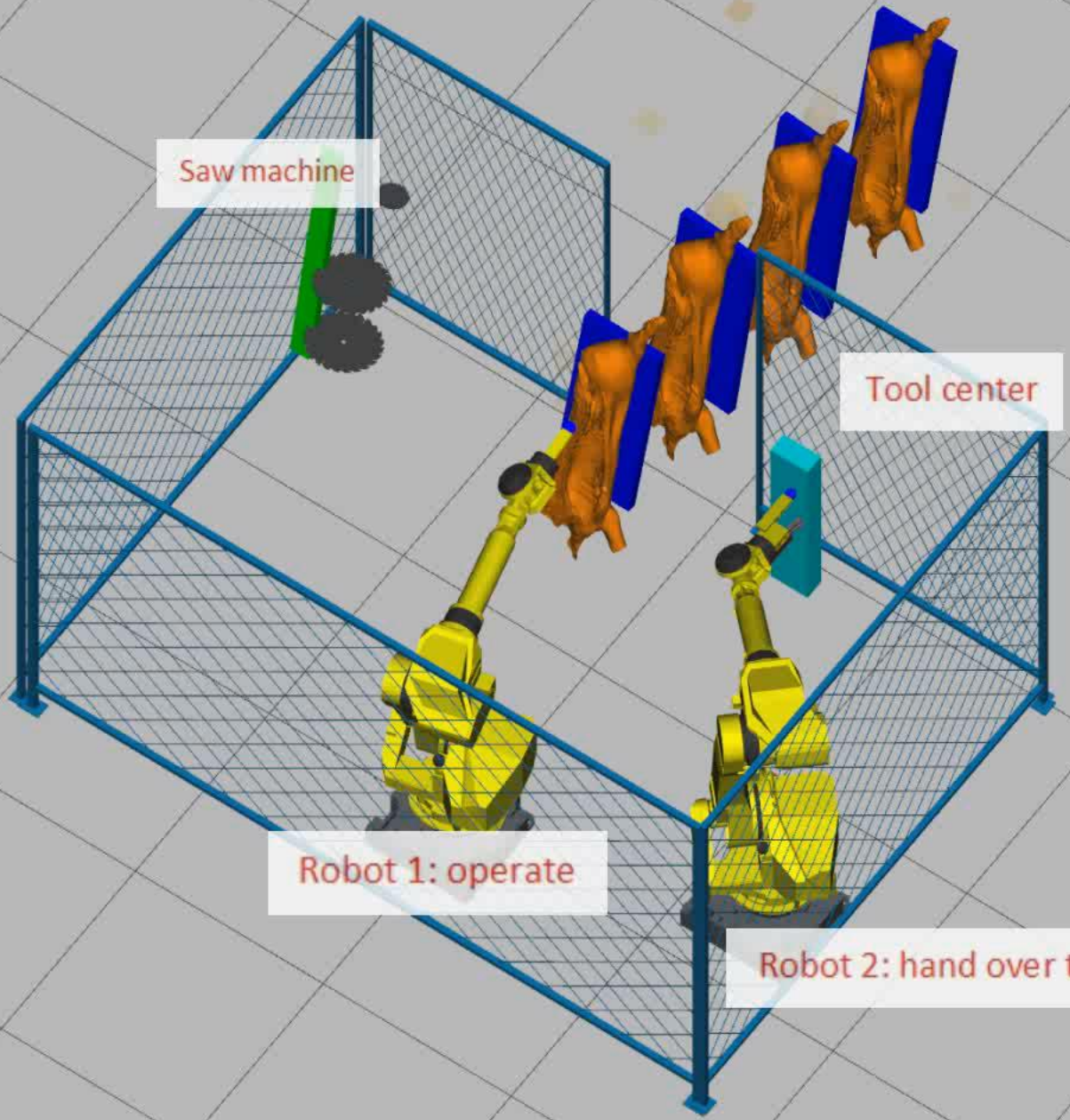
Current draw chain process	Sec.
Process time	6
Transport time	4
Total time pr. process	10

Robot cell	
Process time	6
Tool change time	3
Transport time	4
Number of processes	4
Total time pr. process	10



Robot Cell


Robot 1 operation
Robot 2 Handling over tool
Tenderloin
Foretoe
Head
Saw machines
Cutting & Backtoe
Tool tenderloin -> tool foretoe
Tool foretoe -> tool head
Tool head -> tool tenderloin


Saw machine
Tool center
Robot 1: operate
Robot 2: hand over tools

Robot cell redundancy: Fewer production stops

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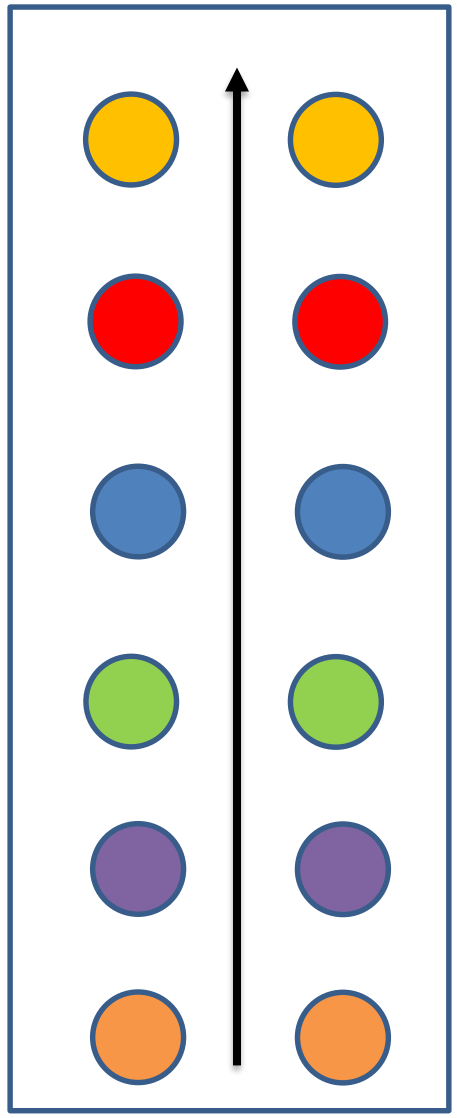
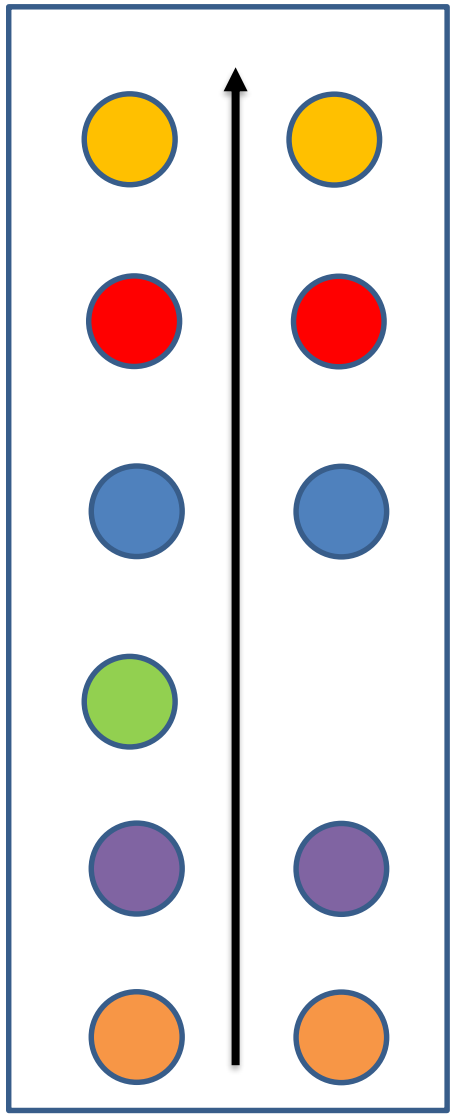


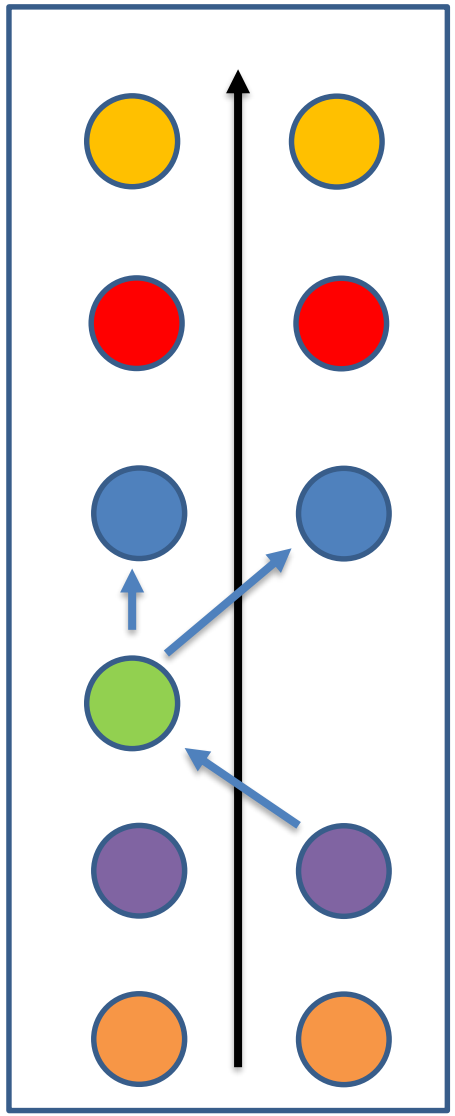
- Two lines equals full capacity (= 1)
- 2 x 6 = 12 cells
- Each circle represent a cell with four processes per cell



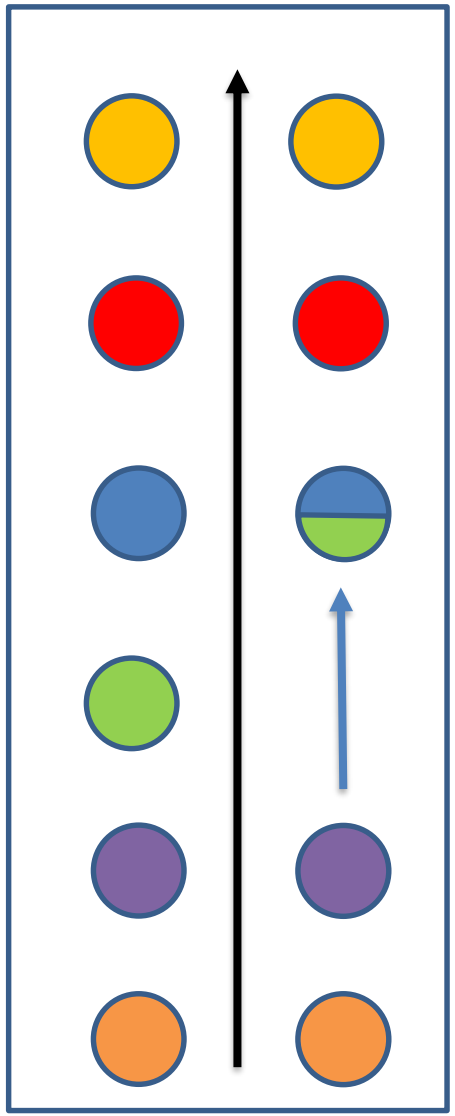
- One cell (the green processes) needs service/cleaning/reparations
- What do we do?

Robot cell redundancy

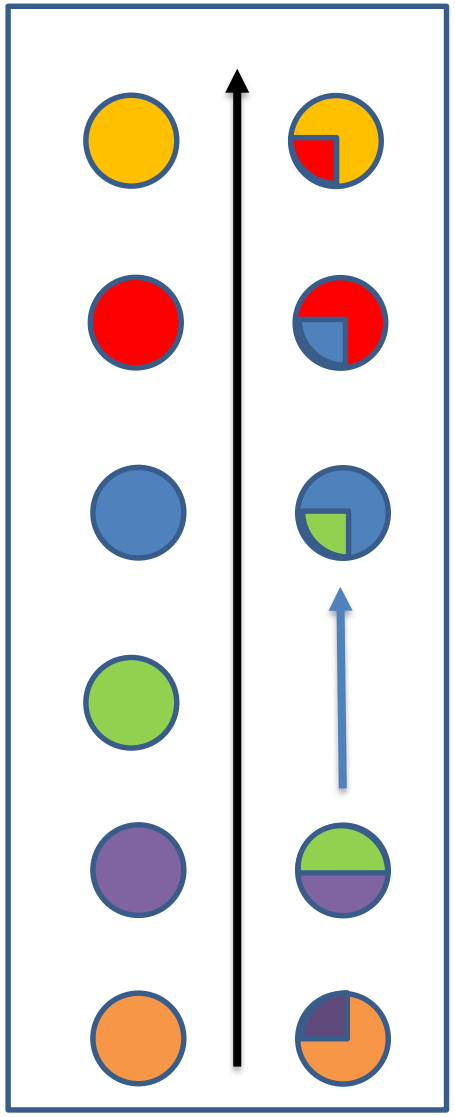
½ capacity



≈ ½ + ½ x ½
= ¾ capacity



≈ ½ + ¾ x ½ = 7/8 capacity
Dynamic allocation: ≈ 11/12



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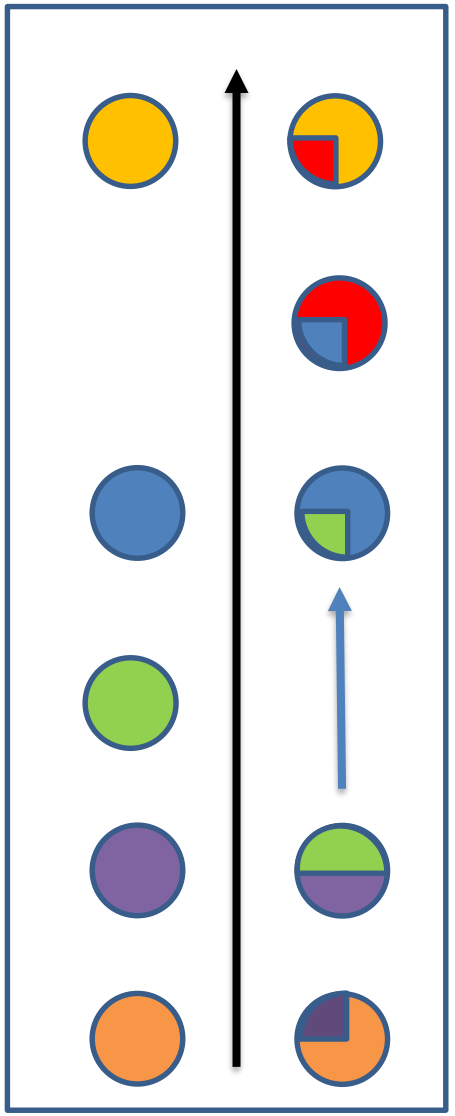
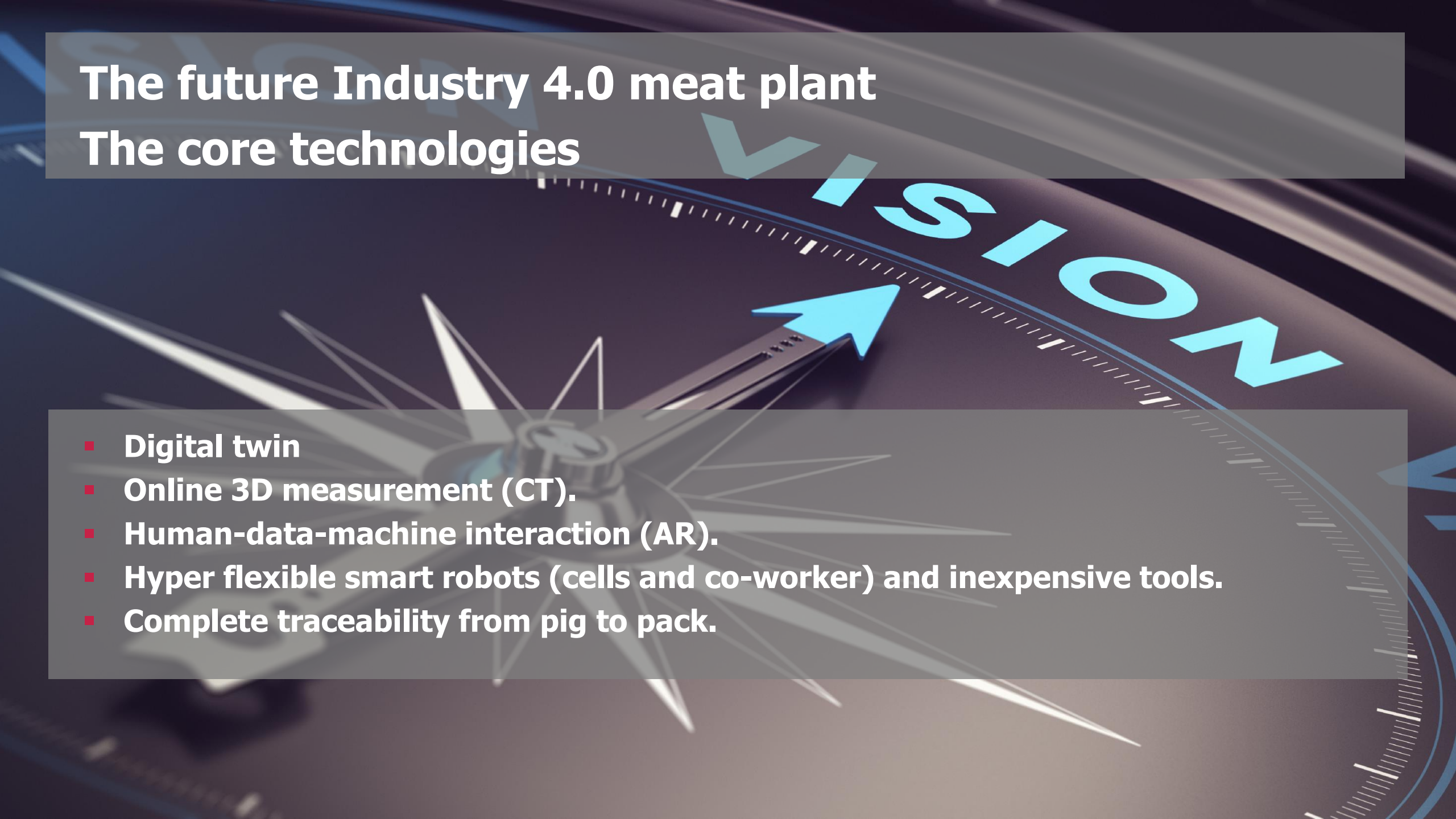
What now?



Challenges for robot cell production paradigm

- Will they be able to do boning?
  - Better yields?
  - New ways to cut and bone?
- The industrial robot is available, stable and affordable. But how about:
  - The tools?
  - The speed?
  - The footprint?
- Reduce time used for transport:
  - Many operations in each cell.
  - Fast tool changing.
  - Fast transit between cells.
- Fewer complete production stops and room for scheduled cleaning and maintenance:
  - More redundancy.
  - Flexibility of cell utilization: Many different tools and fast change of tasks in each cell.
  - Inexpensive tooling (or investment will be too high).
  - Complex planning task, especially in contingency situations: IT planning tools.

The future Industry 4.0 meat plant
The core technologies



- Digital twin
- Online 3D measurement (CT).
- Human-data-machine interaction (AR).
- Hyper flexible smart robots (cells and co-worker) and inexpensive tools.
- Complete traceability from pig to pack.

Digital twin

A real time digital plant equivalent

- Design and commissioning.
- Production planning.
- Forecasting and contingency management.
- Maintenance.

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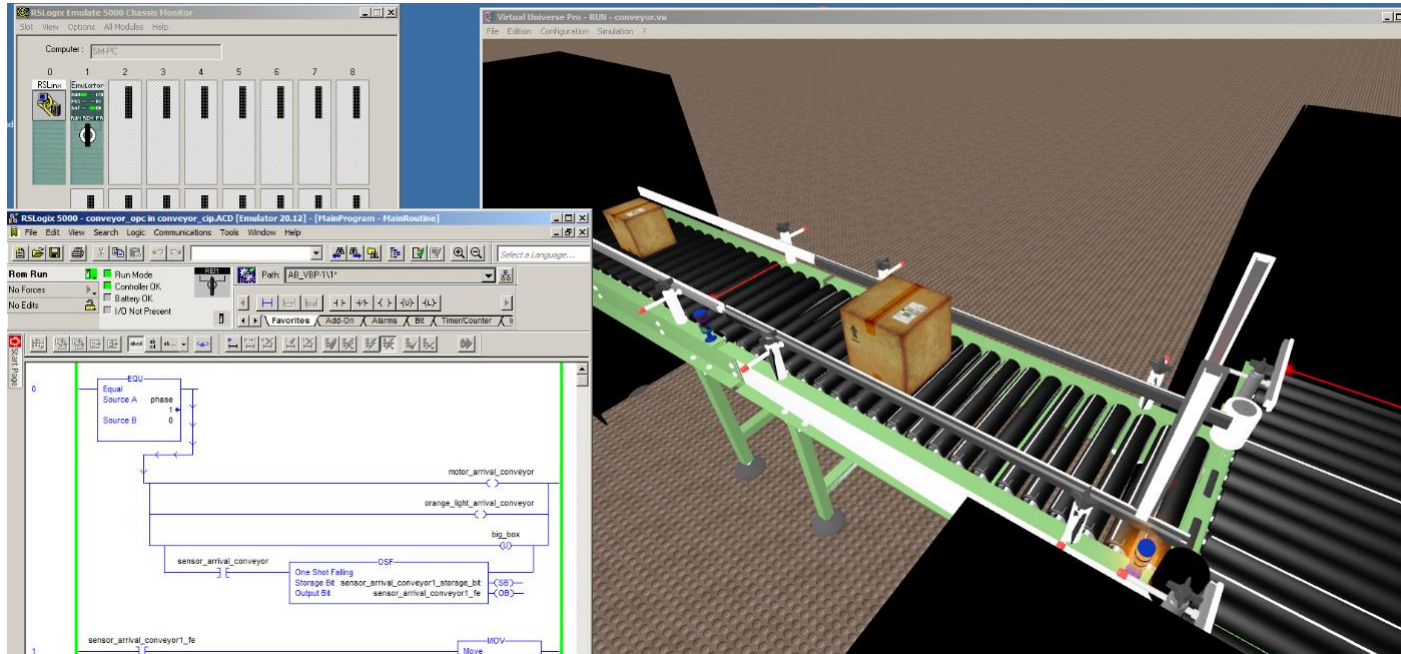

Digital twin

Valid data for optimizing PM

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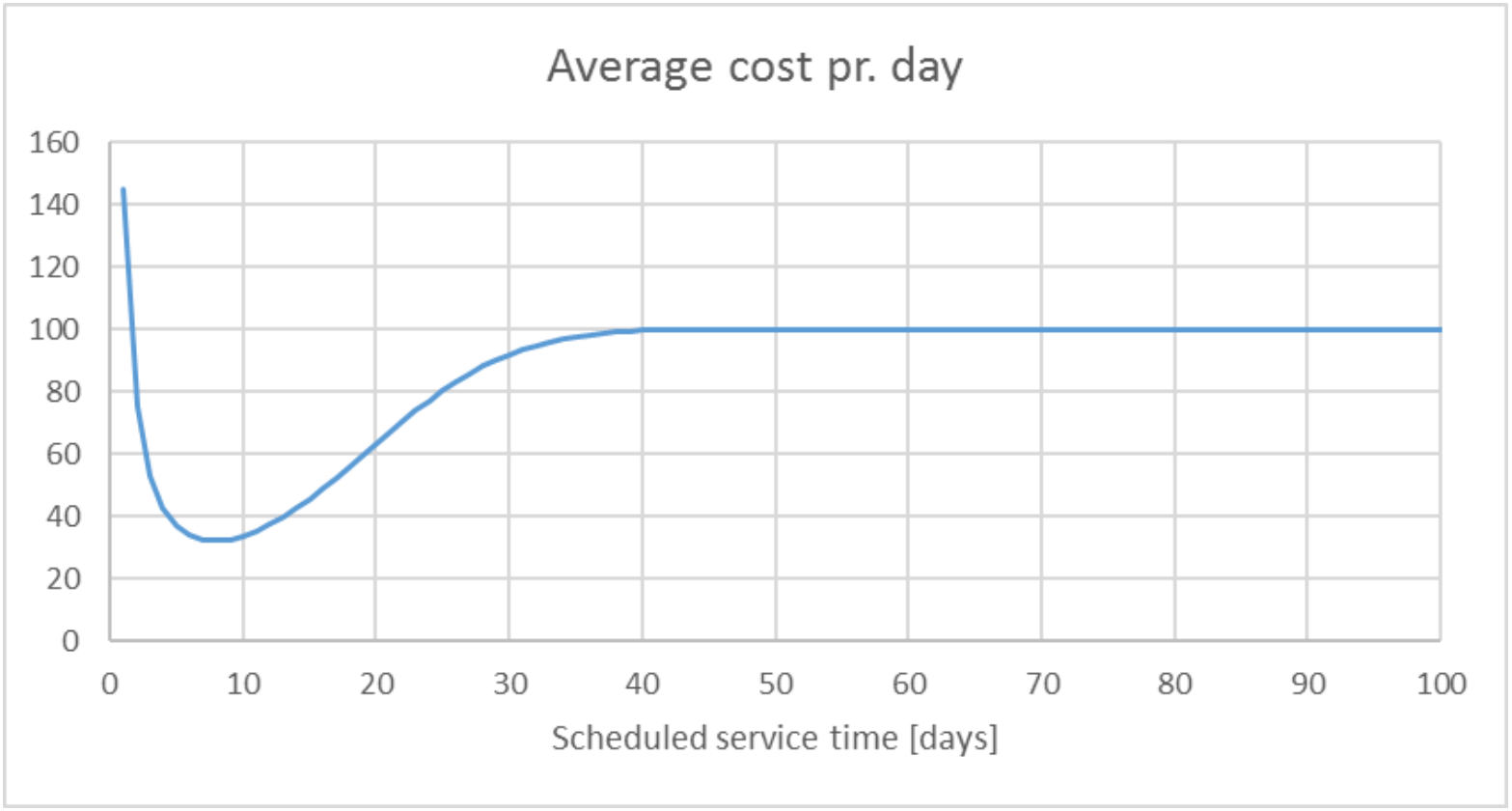

Digital revolution
Digital production - Optimum utilization

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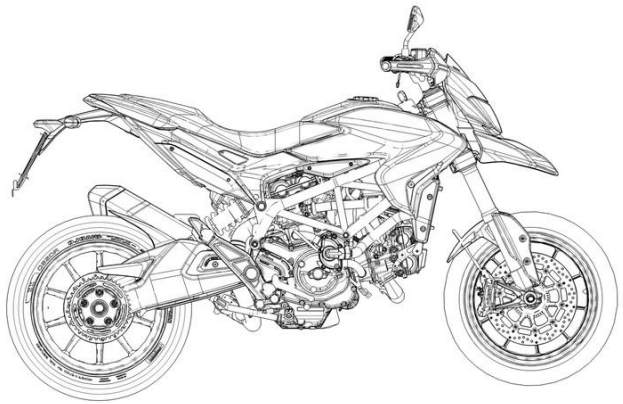

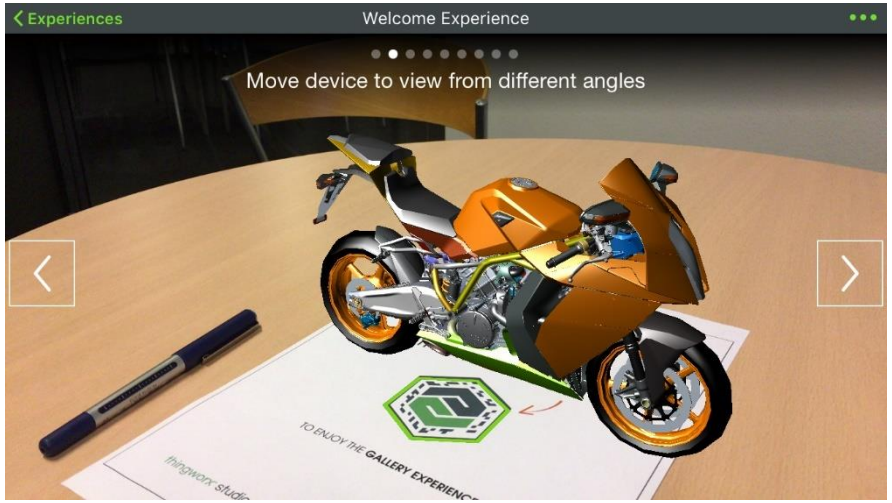

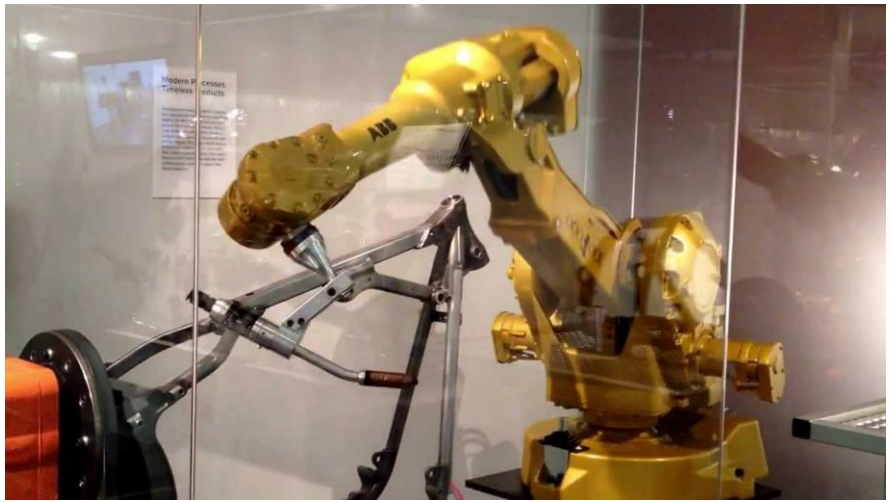

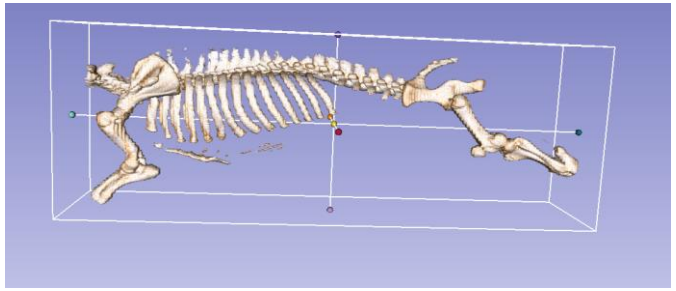

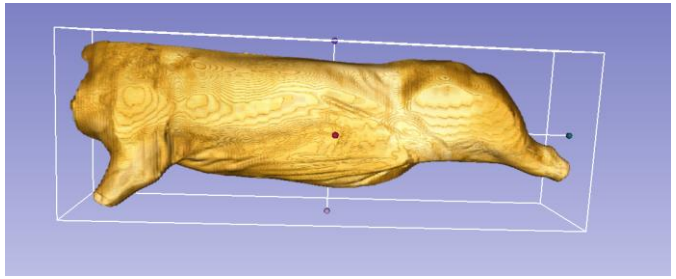

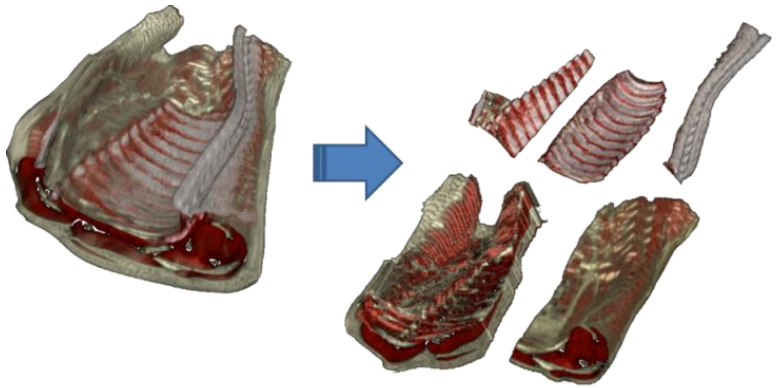

Online 3D measurement (CT)

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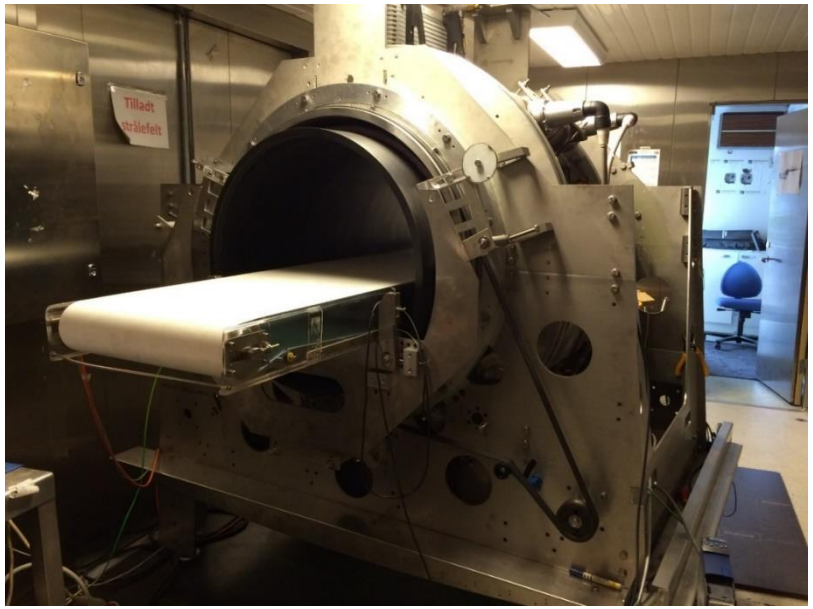

Reconstruction: 4 sec; Picture analysis 2.5 sec; 600 products/hour; 17 slice helix; GPU picture generator

Measure and control

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Augmented Reality (AR)
Communication of 3D information

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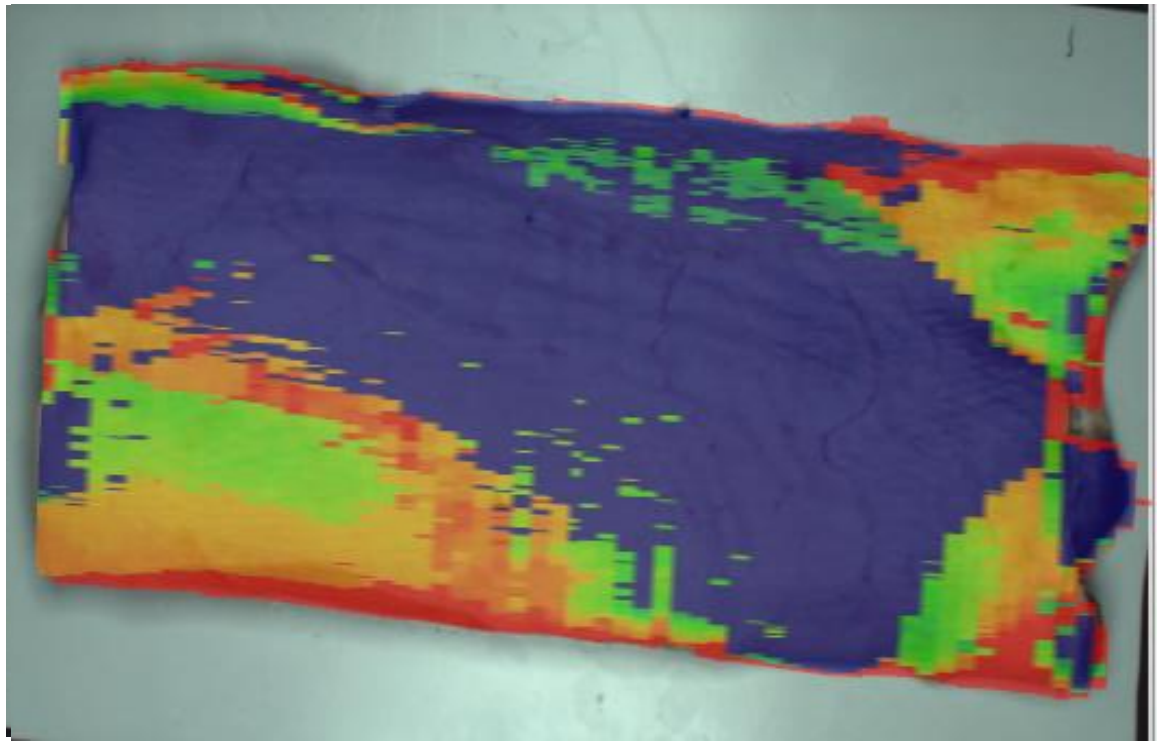

Robots as colleagues

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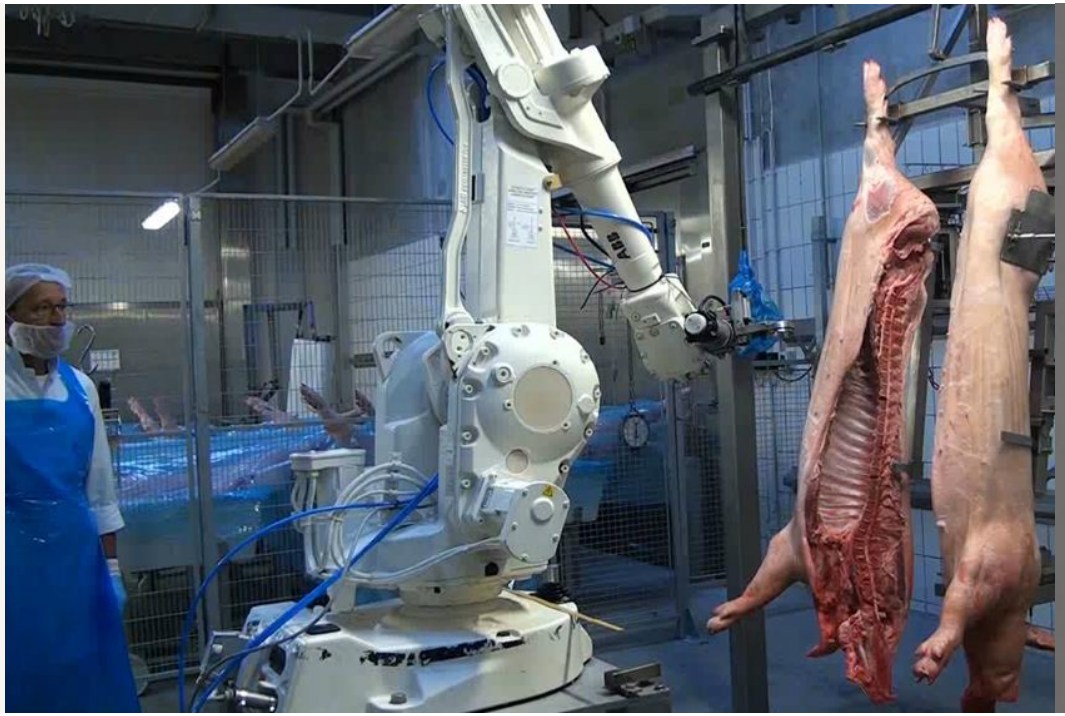
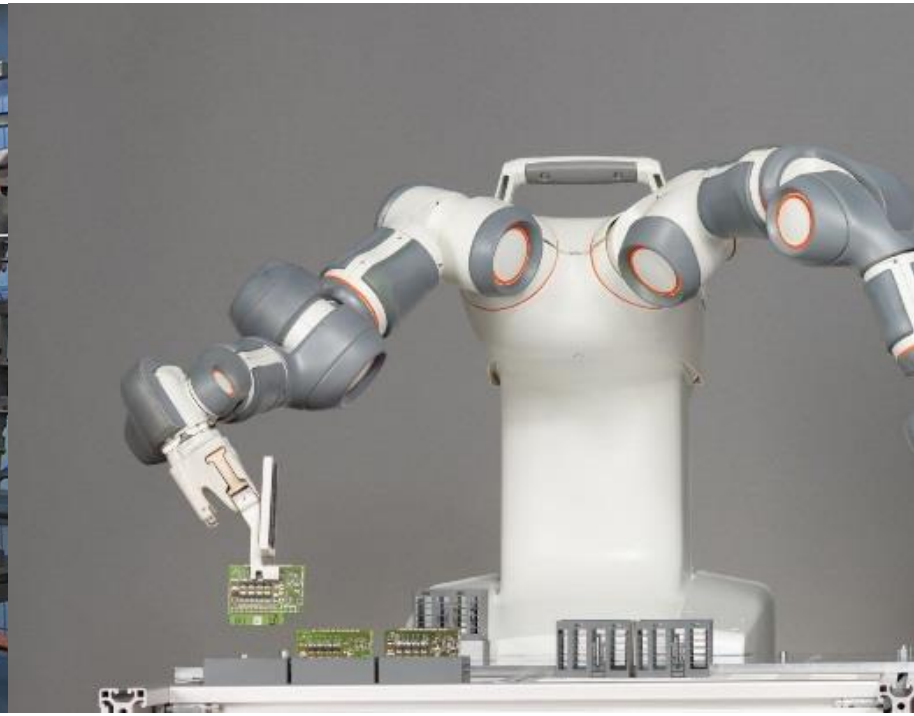
Moving stock around

Supervising the robot

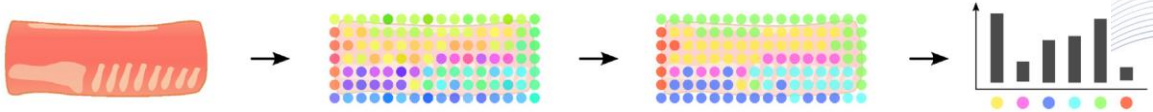


Working together



Complete traceability
From pig to pack

Complete traceability
From pig to pack?



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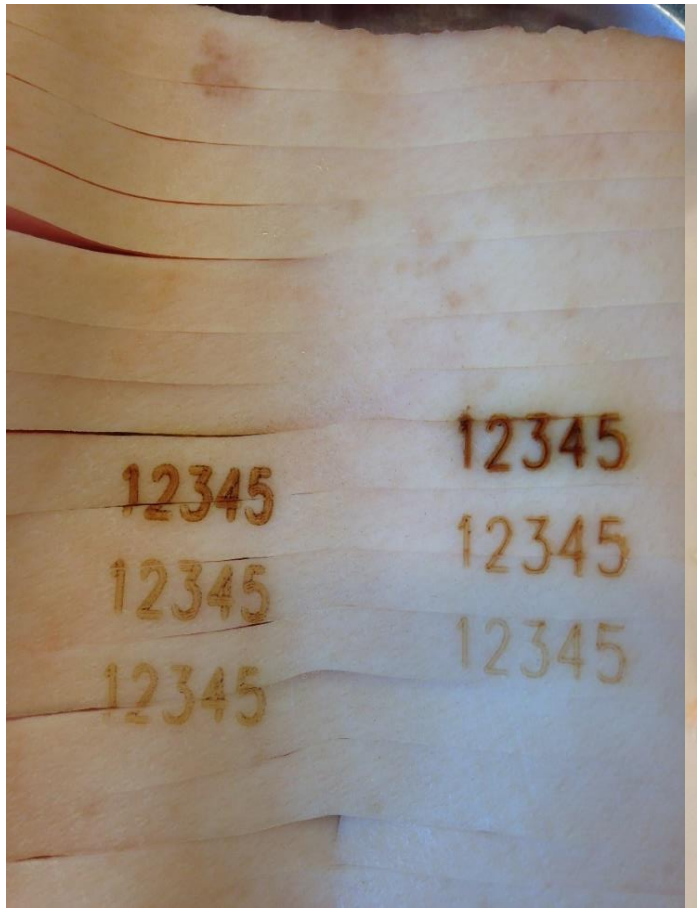

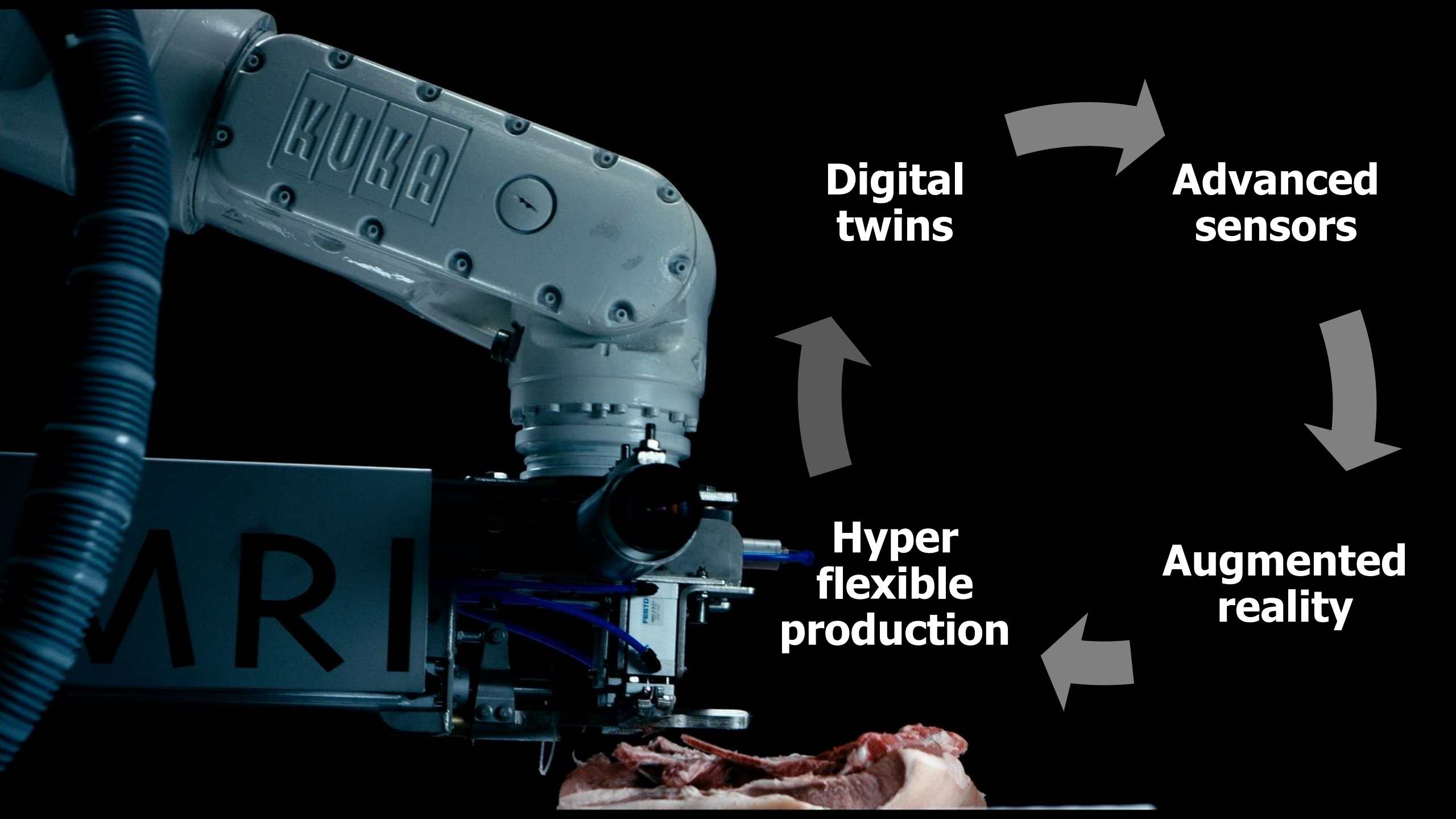
KUKA
Digital twins
Advanced sensors
Augmented reality
Hyper flexible production

Industry 4.0 (for butchers)

- Most information is digitalized and accessible (also along the value chain).
- Machines, raw material and products ”talk” together.
- Access to information about history, present state, and predictions about the future.
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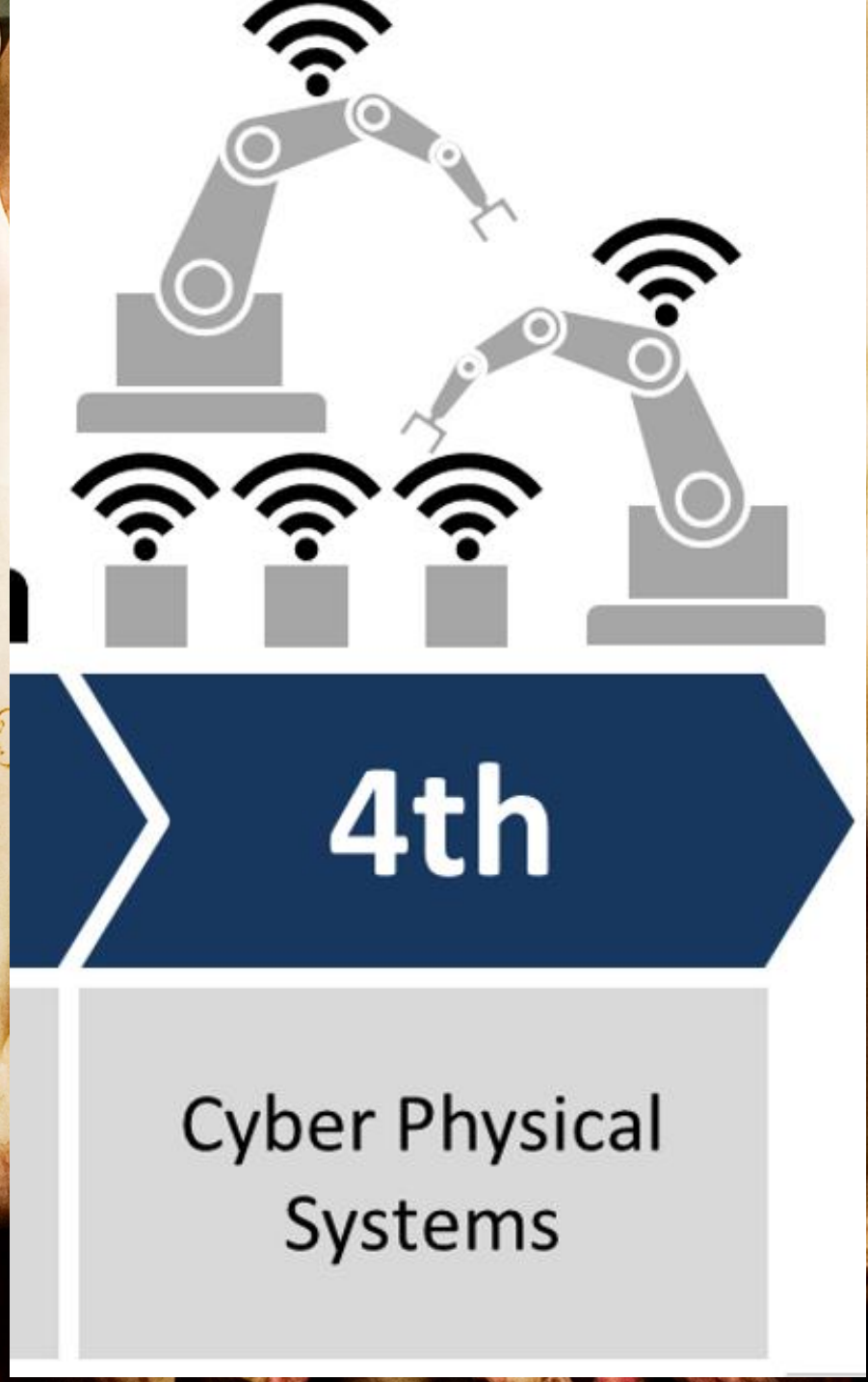

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Thank you for your attention!