Revolutionizing Hospital Sterilization: Harnessing AI, Industrial Insights and Digital Transformation

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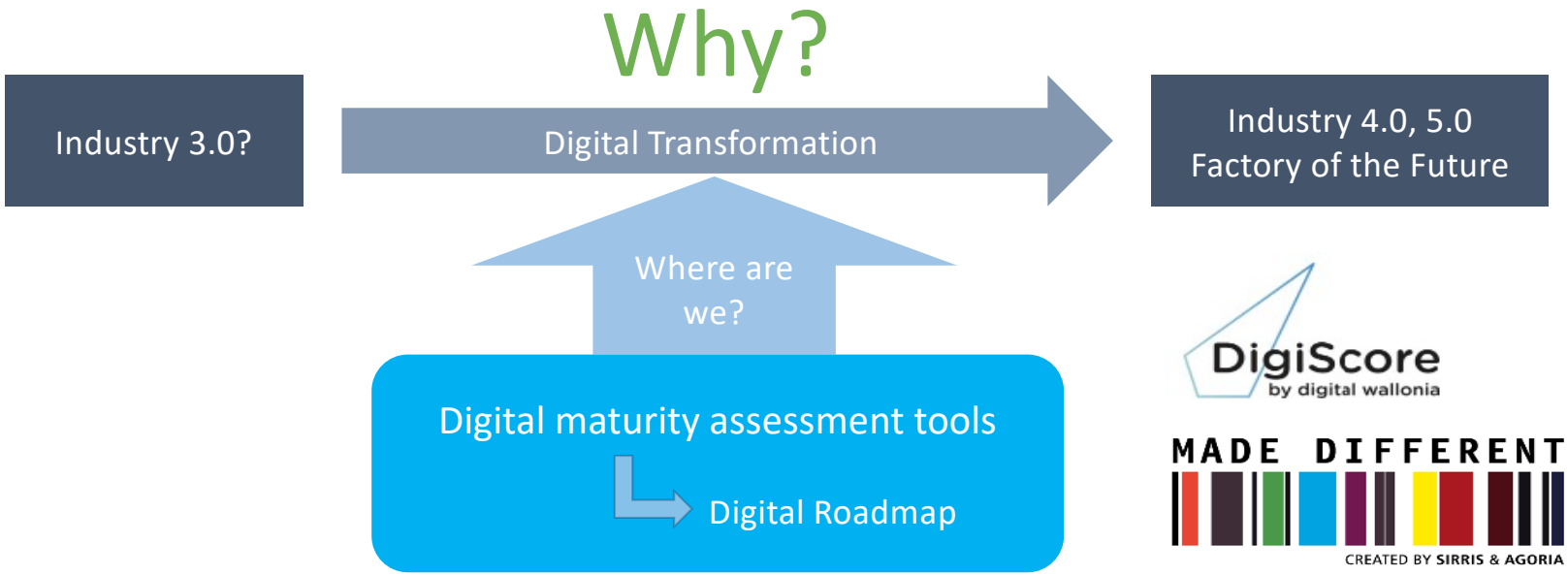
Expert Digital Transformation for « Industrie du Futur » Program

Agenda

- What's Digital Transformation ?
  - Digital maturity assessment tools
  - Benefits
- What's Artificial Intelligence ?
  - Demystifying AI
  - Link with Digital Technologies of the Future
- Use cases in AI for Hospital Sterilization
- Conclusion

Digital Transformation



DigiScore by digital wallonia

MADE DIFFERENT
CREATED BY SIRRIS & AGORIA

DPMM BioPhorum

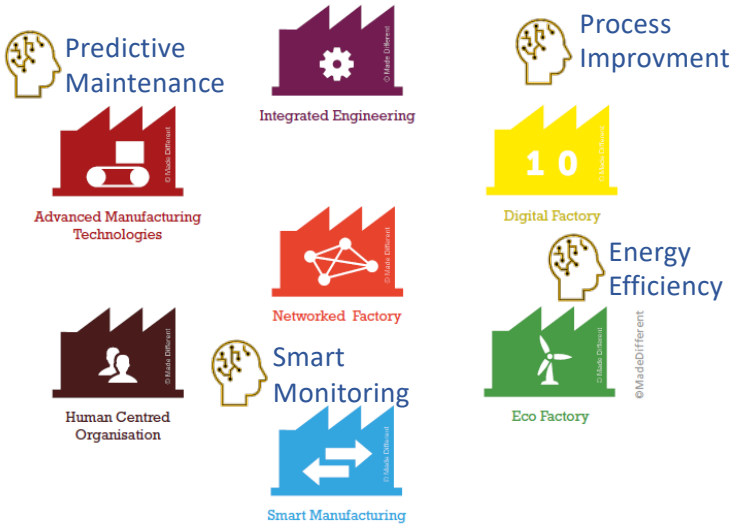
Digital Transformation

- Competitiveness
- Attractiveness of the company
- Advanced Process Automation
- Employee Empowerment
- Cost reduction
- Reduced production cycle time
- Reduced complexity
- Improvement in performance, quality and compliance rate
- Reduction in the arduousness of certain tasks
- Improved reliability, robustness
- Resource saving
- Emissions reduction
- …

Digital Transformation

MADE DIFFERENT

CREATED BY SIRRIS & AGORIA



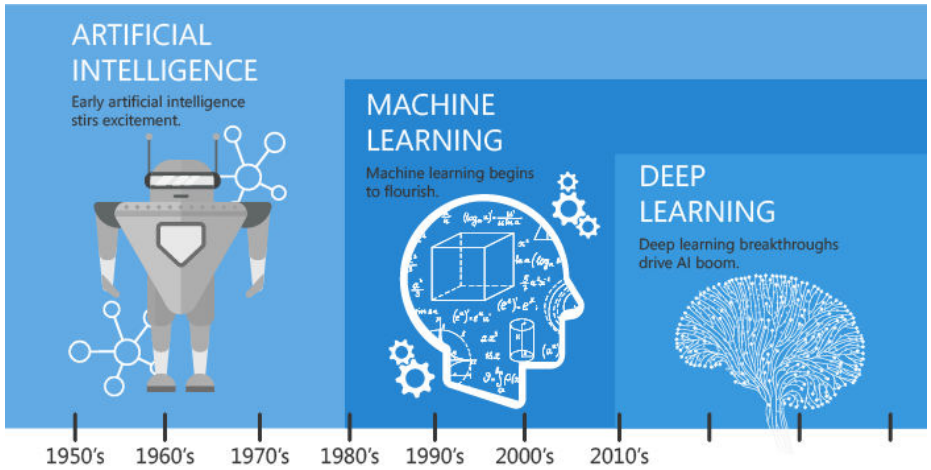
Where AI is introduced?

DPMM BioPhorum

Pre-digital plant → Digital Silos → DATA! Connected Plant → Predictive plant → Adaptative plant

Artificial Intelligence

Demystifying



https://medium.com/datadriveninvestor/artificial-intelligence-vs-machine-learning-vs-deep-learning-vs-data-science-2183ac856368

The theory and development of computer systems able to perform tasks normally requiring human intelligence…

Oxford Reference

AI is a collection of tools, including supervised learning, unsupervised learning, reinforcement learning, and now generative AI. All of these are general-purpose technologies, meaning that — similar to other general-purpose technologies like electricity and the internet — they are useful for many different tasks.

Andrew Ng, DeepLearning.AI

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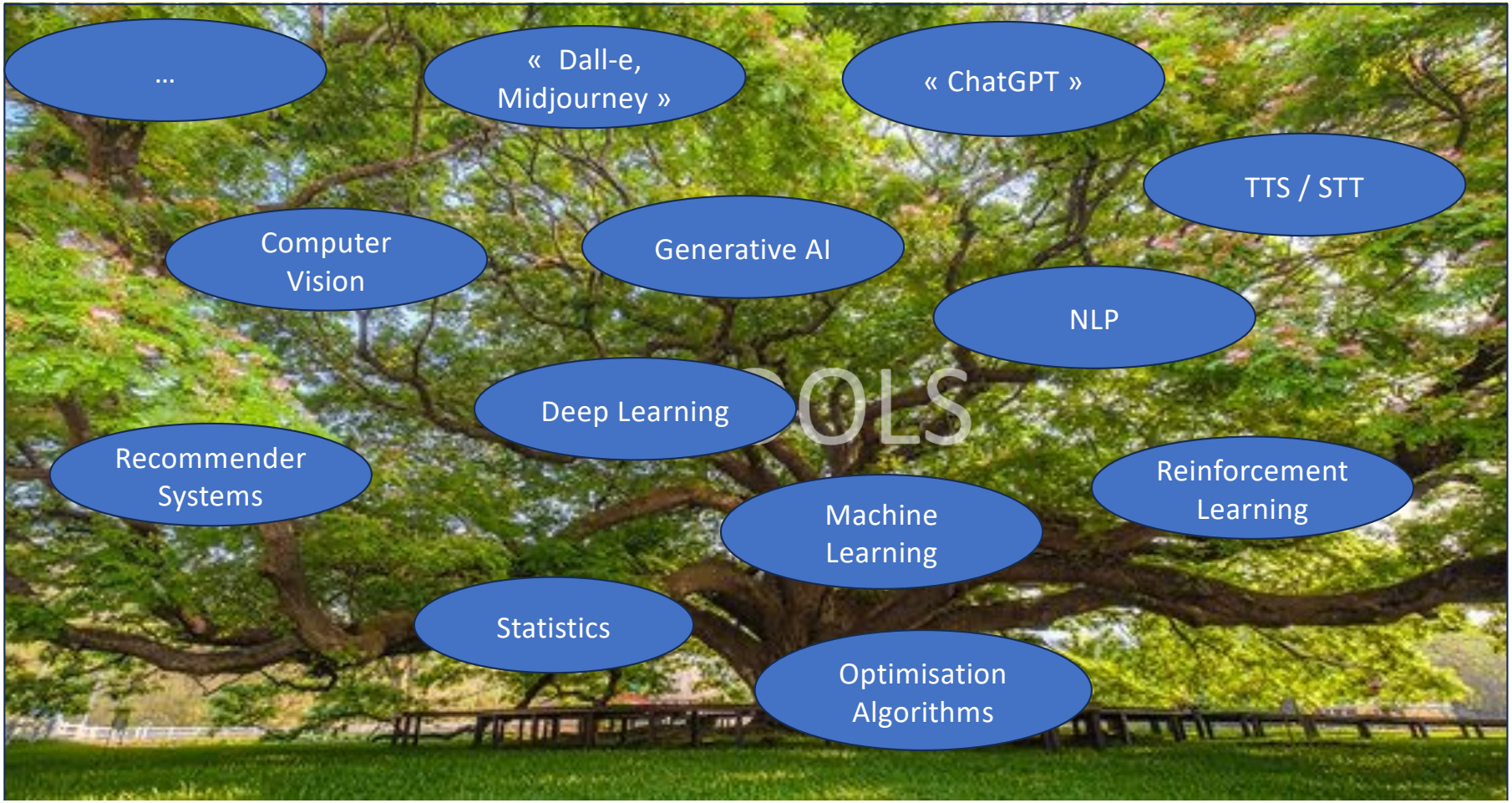
Artificial Intelligence

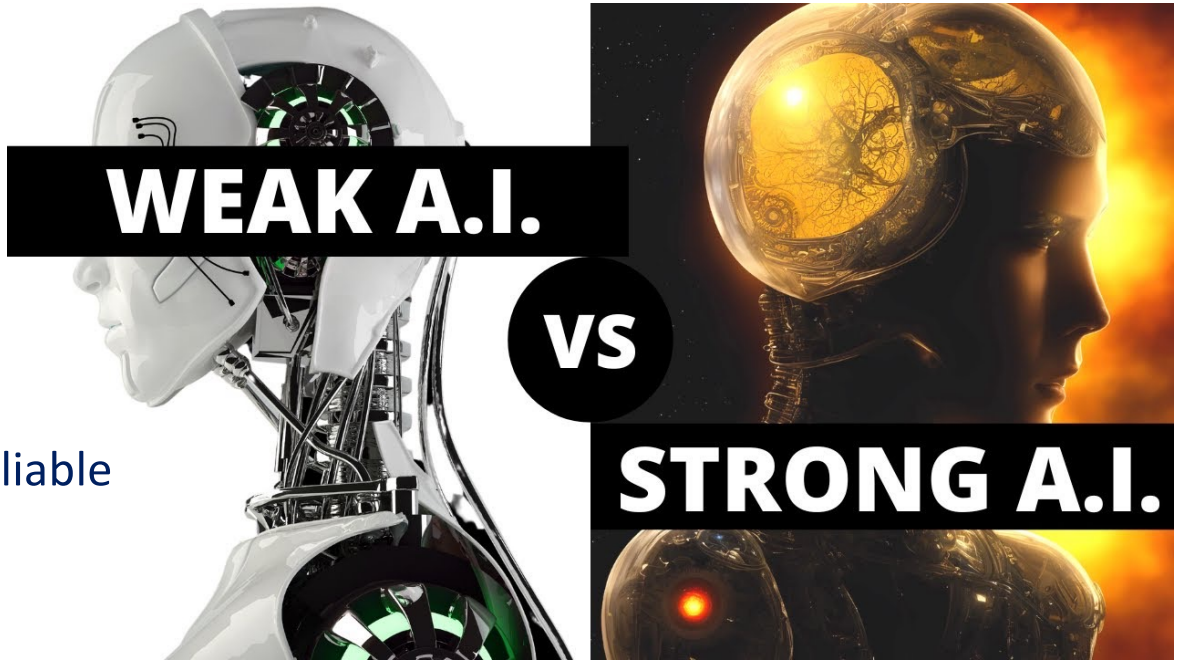
Demystifying

wfhss World Federation for Hospital Sterilisation Sciences



Artificial Intelligence

Demystifying



https://www.youtube.com/watch?app=desktop&v=cnlIK1C_QLQ

Industry expects deterministic, reliable and explainable behaviors !

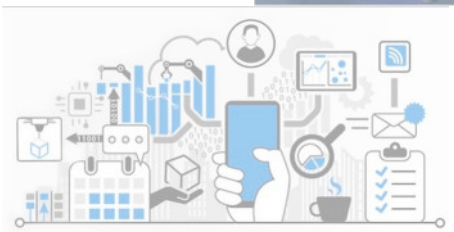
Specific Tasks

Still Science-Fiction

Digital Transformation

Digital Technologies of the Future

- Data Processing and Data & Analytics
- Digital Twin and simulation
- Artificial Intelligence
- High Performance Computing
- Internet of Things (IoT) and sensors
- Electronic and computer components
- Robotics and automation
- 3D printing
- Augmented and Virtual Reality (AR/VR)
- Blockchain
- Advanced Interfacing and Interoperability



https://www.digitalwallonia.be/fr/publications/recherche-industrie-futur/

AI for Hospital Sterilization

Use Cases :

- Digital Twin for Sterilization Process
- Smart Monitoring
- Assessment of AR Solution for Reconditioning
- Predictive Maintenance and Energy Efficiency
- Robot, Cobot and AGV
- Operating Room Schedule Optimizer

AI for Hospital Sterilization

Digital Twin

Process Improvment

How to improve hospital sterilization process?

Sterilization must guarantee the quality of its process and **control the sterilization cycle time** to ensure high availability of instrument sets

Process modelisation,
Simulator,
Digital Twin !!!

CARE-NAM ASBL

[WFHSS 2022 O. Willième
Modeling a Tool for planning a new CSSD]

done by www.cetic.be

Statistics : ~4000 sets from 3 hospitals
from 1 to 100 instruments by set

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AI for Hospital Sterilization

Digital Twin

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Digital Twin of the future sterilization process based on the history of existing facilities

Queue issue
(reinforced by the mass arrival by truck in the new plant)

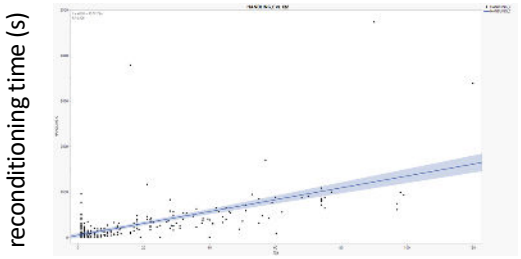
Modeling and simulation by discrete events

OscaR
OPERATIONAL RESEARCH IN SCALA

An event is the change of state of a set following an action.
This change of state makes the next action possible.
Ex: dirty set -> action: manual pre-wash -> set ready for washing machine

Data analysis

- Analysis of incoming sets
- Functional analysis
- Modeling of processing times
- Schedule analysis
- ...



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AI for Hospital Sterilization

Digital Twin

wfhss World Federation for Hospital Sterilisation Sciences

INPUTs related to the sets

Source: Description of the sets exported from the sterilization software
- Name
- Number of instruments
- Size: STU
- Low temperature or steam.

INPUTs related to the activity

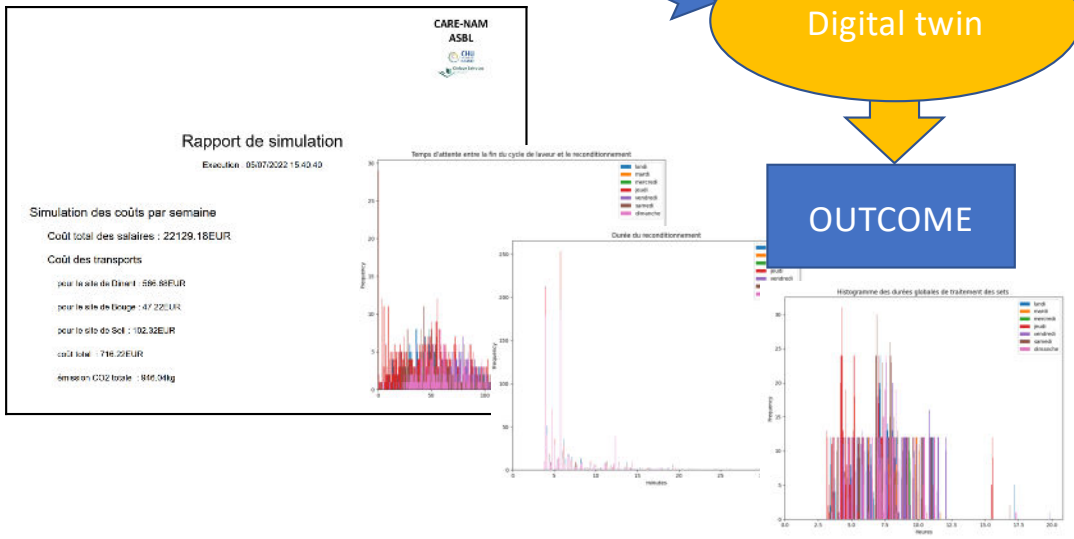
Source: Traceability of the passage of sets within the sterilization department

Simulator VARIABLES

- Number of people/area
- Number of equipment/area
- Volume of equipment
- Time per step (machine/HR)
- Transportation (frequency, time, cost, CO2)

Digital twin

OUTCOME



Taux d'occupation

Taux d'occupation global : 10.01%
Taux d'occupation global Zone Sale : 18.34%
Taux d'occupation global Zone Propre : 8.7%
Taux d'occupation global Zone Logistique : 6.24%

jour	Taux d'occupation Zone Sale (%)	Taux d'occupation Zone Propre (%)	Taux d'occupation Zone Logistique (%)
Lundi	6.99	6.11	4.95
Mardi	12.35	5.26	8.11
Mercredi	23.54	12.69	9.2
Jeudi	26.92	11.15	8.09
Vendredi	27.47	11.37	8.95
Samedi	14.29	5.79	3.62
Dimanche	6.87	9.6	3.61

Nb Operateurs Zone Propre Disponibles	Ch	
4	31,85189247	1 heure 46 minutes
4	55,3670578	1 heure 28 minutes
4	51,22023773	1 heure 20 minutes
4	49,89087296	1 heure 12 minutes
4	9,274377823	4 minutes
1	40,43289948	20 minutes
4	65,28431702	1 heure 17 minutes
4	51,83531189	2 heures 12 minutes
4	56,43848801	1 heure 59 minutes

AI for Hospital Sterilization

Digital Twin

What was done :

- Dimensioning of the future process (nbre of washing machines?)
- Planning (nbre of operators on Monday?)
- Logistic study (best time arrival of the truck?)
- Cost study (cost of the chosen strategy?)

What it can do :

- Analyzing intra-hospital CSSD or external CSSD serving X hospitals
- strategic study (new operating room?, new customer hospital?,)
- tactical purposes (weekly planning, planning for vacations or for busy periods)

➡ ~ Production Planner in the Industry

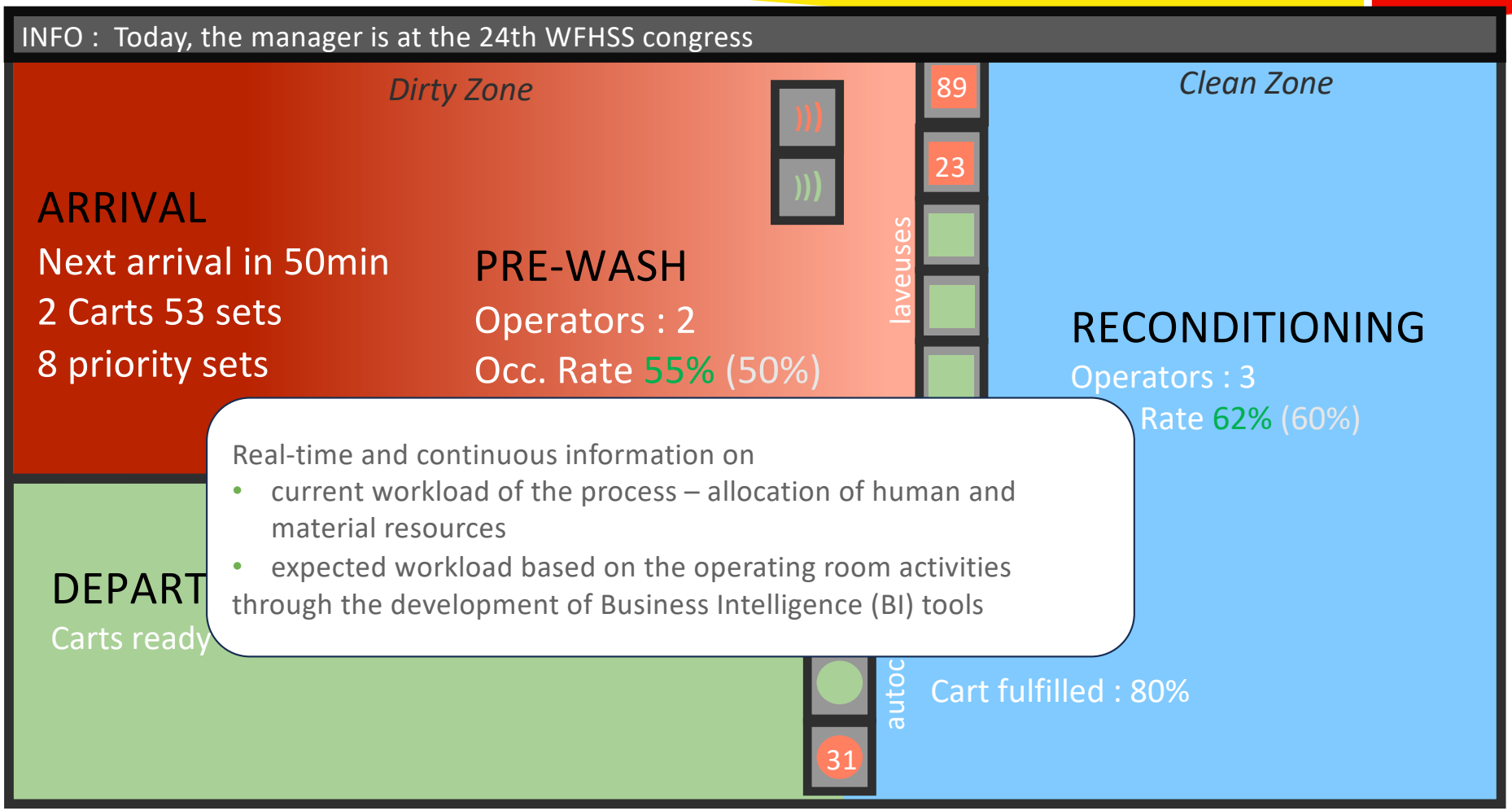
What it could do:

- operational purposes (Business intelligence BI).
- interfacing with the programming tools used in the operating rooms theatre

➡ ~ Manufacturing Execution System (MES) in the Industry

AI for Hospital Sterilization

Smart



AI for Hospital Sterilization

AR for Reconditioning

Process Improvment

How to improve hospital sterilization process?

Sterilization must **guarantee the quality of its process** and control the sterilization cycle time to ensure high availability of nstrument sets

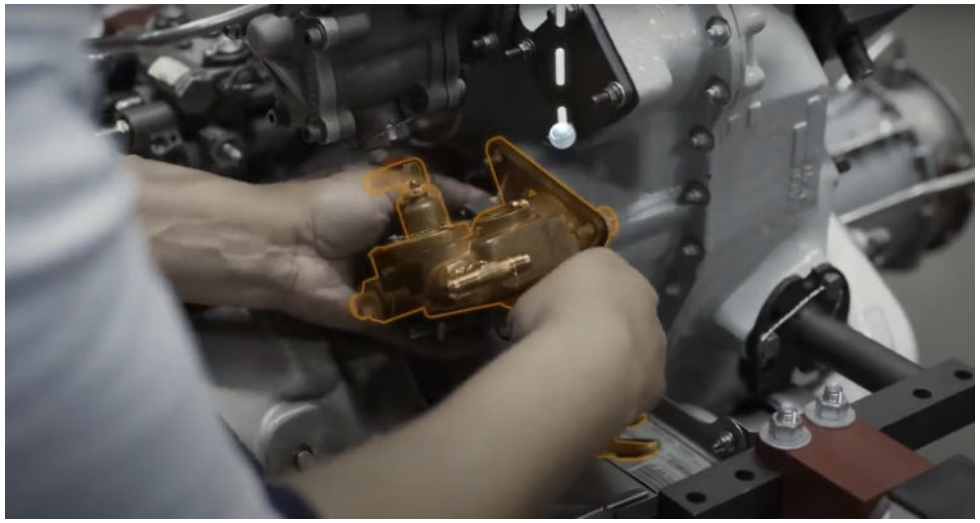
Reconditioning stage
- Tedious and critical stage of the sterilization process
- Need to guarantee a high rate of compliance of the reconstituted sets
- The evolution towards a data matrix system for instruments -> improvement of the compliance rate but potentially (more) slow

=> There is therefore an interest in multiple detection to speed up this step by guaranteeing a good compliance rate.

Augmented Reality : Could this be useful at the reconditioning stage?

AI for Hospital Sterilization

AR for Reconditioning



AR Benefits :

- facilitate learning
- allow role versatility
- reduce the risk of human error
- …
- reduce the space taken up by other interfaces, screen, keyboard, mouse, data matrix reader...

(DREAM for sterilization)

- Could allow multiple detection and auto-filling of the checking list

AI for Hospital Sterilization

AR for Reconditioning

Assessment of AR solution for reconditioning

Results after discussion with specialists (AR, Vision, Sterilization)

- Current use for maintenance cases -> occasionally -> a few machines
- Case of sterilization -> continuous work -> a thousand sets of instruments

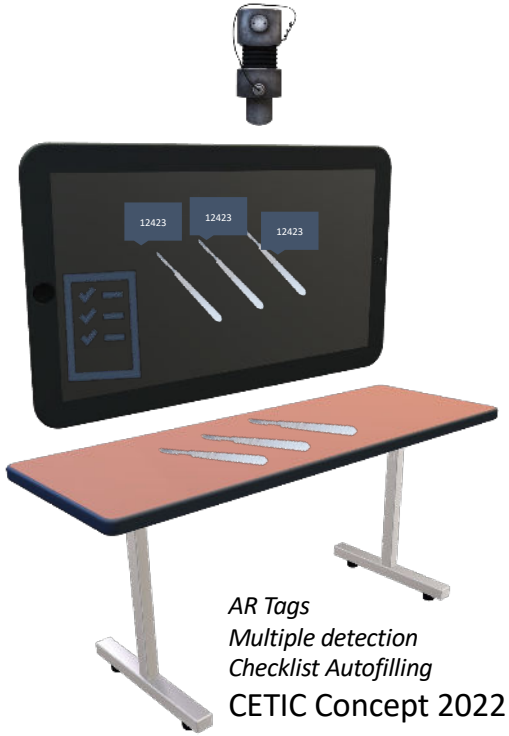
Points of attention

➔ prolonged use of glasses by the operator (Assessment of acceptability by operators)
➔ quantity of interaction (by wink for example)
➔ quantity of instruments-> the examples involve a few pieces of equipment versus a thousand sets of instruments
➔ recognition of instruments -> too much similarity between instruments
➔ data matrix engraving – potentially small (+ discussion on the engraving method)
➔ lighting conditions for reading data matrices on metallic and reflective instruments

AR glasses still too futuristic for the taks

AI for Hospital Sterilization

AR for Reconditioning



AR Tags
Multiple detection
Checklist Autofilling
CETIC Concept 2022

A more in-depth study was carried out for CARE NAM with the company Moviin and a derived prototype is currently being evaluated with initial positive feedback in terms of execution speed.

AI for Hospital Sterilization

Predictive Maintenance
Energy Efficiency

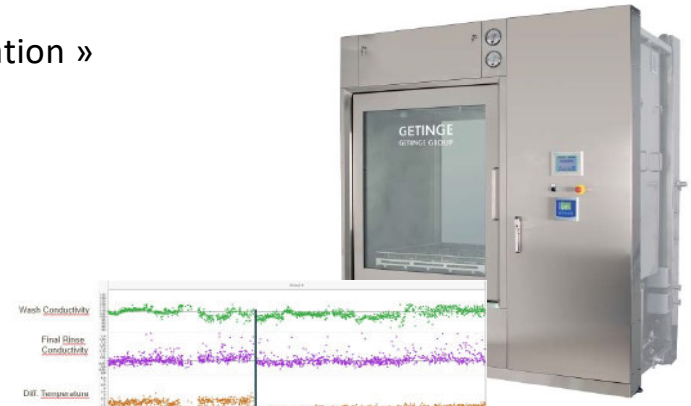
Predictive Maintenance

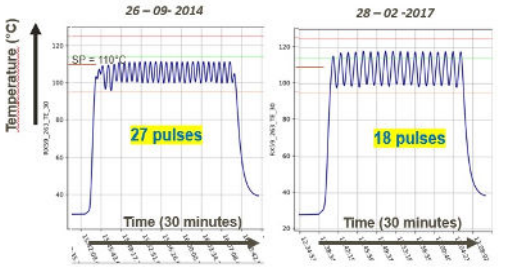
- should be done by the equipment manufacturer -> « Servitization »
  -> advantage - « Holistic view » of their products

- Although efforts can be pooled with Energy Efficiency
  - Detect energy “leakage”
  - Energy monitoring of tasks -> maintenance

Equipements:

- Washing Machine
- Autoclave
- Ultrasound
- HVAC





AI for Hospital Sterilization

Robot, cobot, AGV

ROBOT

https://blog.robotiq.com/a-brief-history-of-robots-in-manufacturing

COBOT

https://natechplastics.com/natech-introduces-cobot-cell/

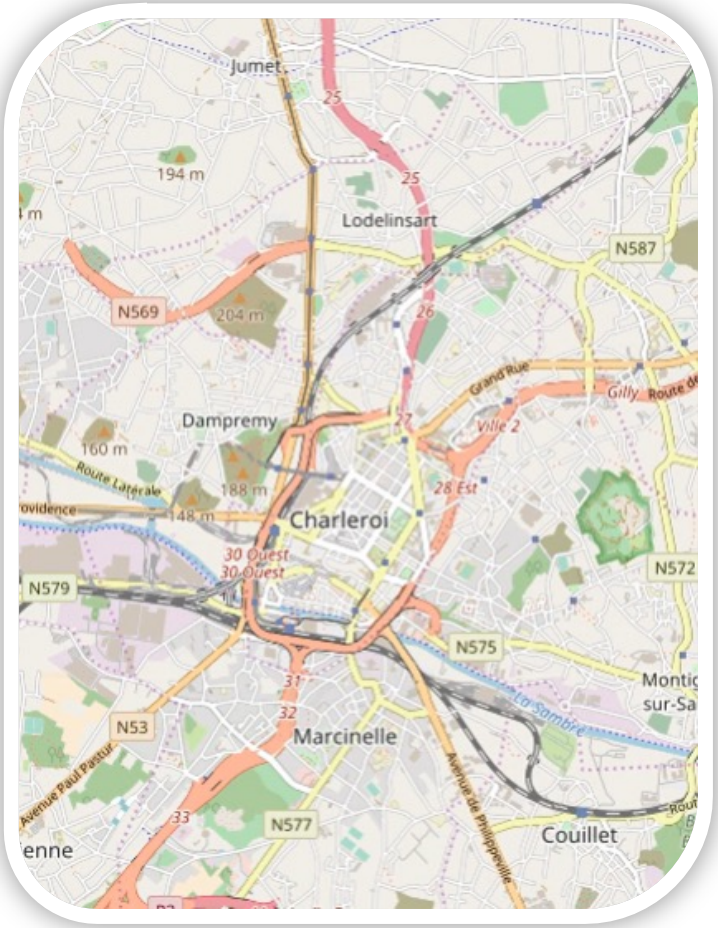
AGV

Automated Guided Hospital Carts (AGV)
Savant Automation, Inc.

AI for Hospital Sterilization

Robot, cobot, AGV

Enhance your AGVs with advanced Routing



Automated Routing Demonstrator

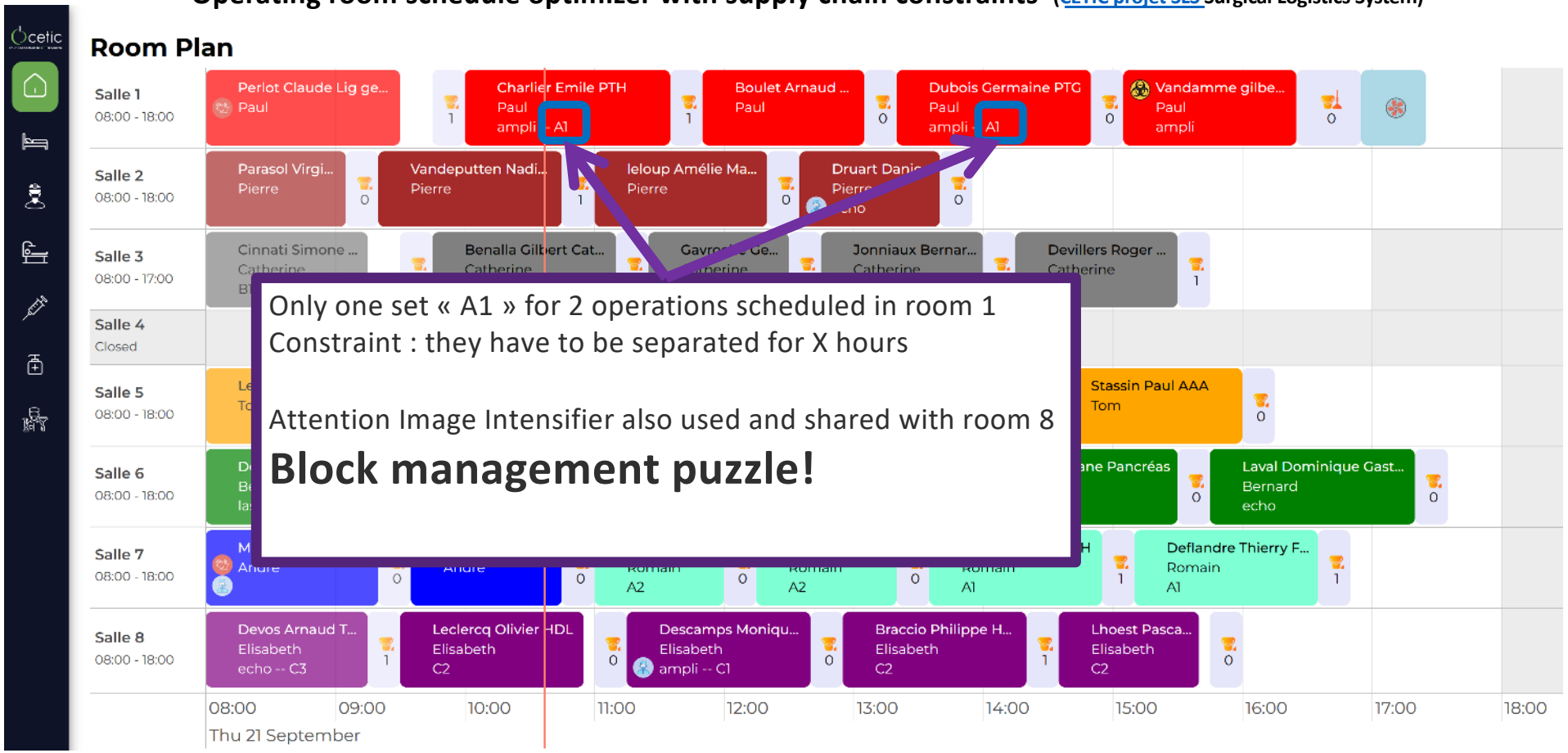
- 15 nurses in car
- 200 patients
- Nurses start from hospital
- Patients are distributed all around (in a rectangle)
- Aim:
  - Minimize time spent on the roads
  - Visit all patients
  - Work = care + parking + journeys
  - limited working time per nurse
- Demonstrator:
  - No traffic jam management
  - Estimated visit Durations
  - No additional constraints

https://www.cetic.be/Demonstrations-of-Oscar-CBLS

AI for Hospital Sterilization

Schedule Optimizer

Operating room schedule optimizer with supply chain constraints (CETIC projet SLS Surgical Logistics System)



Only one set « A1 » for 2 operations scheduled in room 1
Constraint : they have to be separated for X hours

Attention Image Intensifier also used and shared with room 8

Block management puzzle!

Conclusion

- The introduction of AI into the sterilization process must be part of a digital transformation approach
- AI is a toolbox and general-purpose technology that has the potential to augment the capabilities of the tasks to which it is applied
- We showed non-exhaustive examples of AI-driven improvements that can be applied to the hospital sterilization process.

Let's go for the

Sterilization of the Future!

Thank You!

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