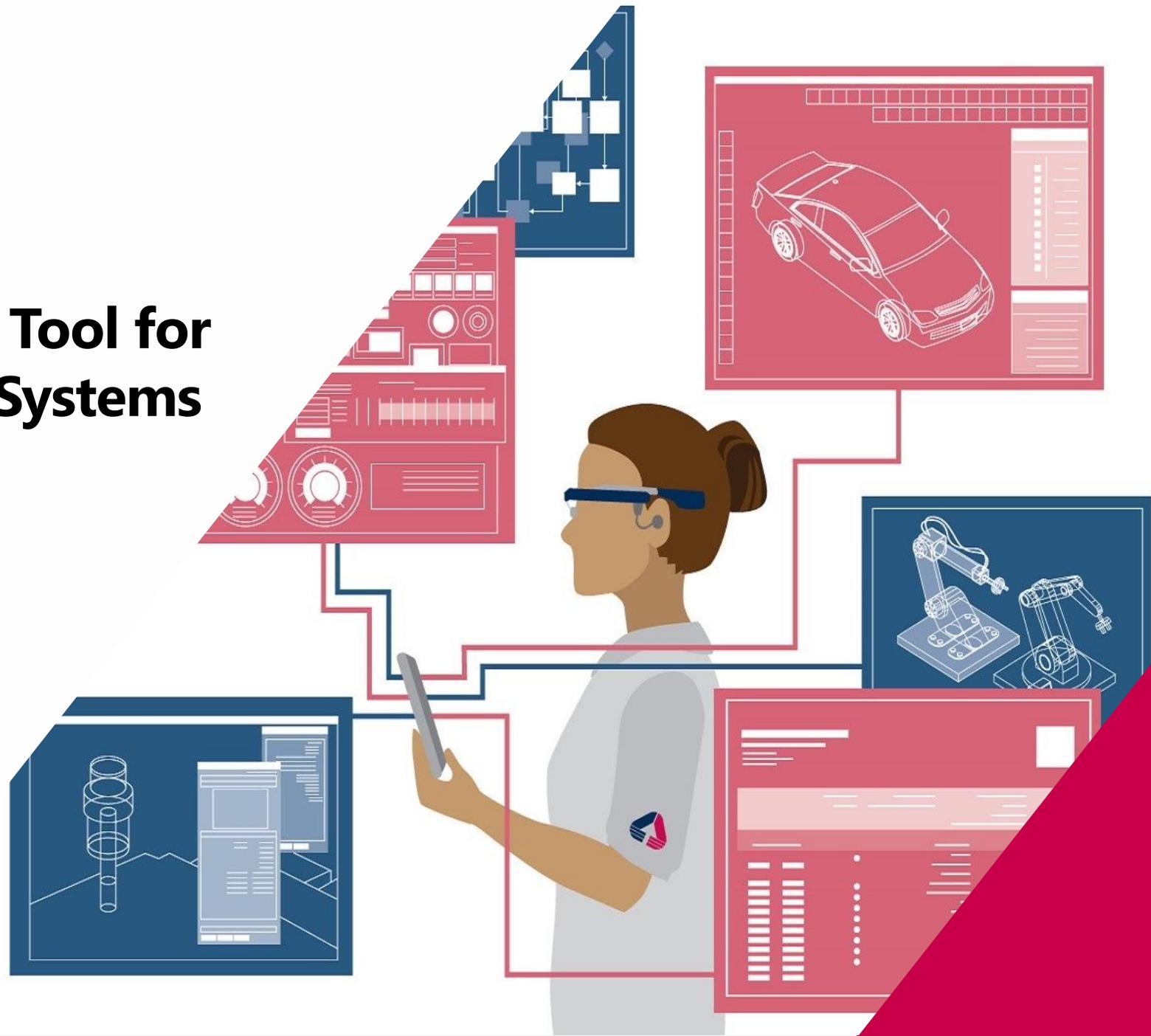


# Performance Evaluation Tool for Flexible Manufacturing Systems

The AnyLogic Conference 2021

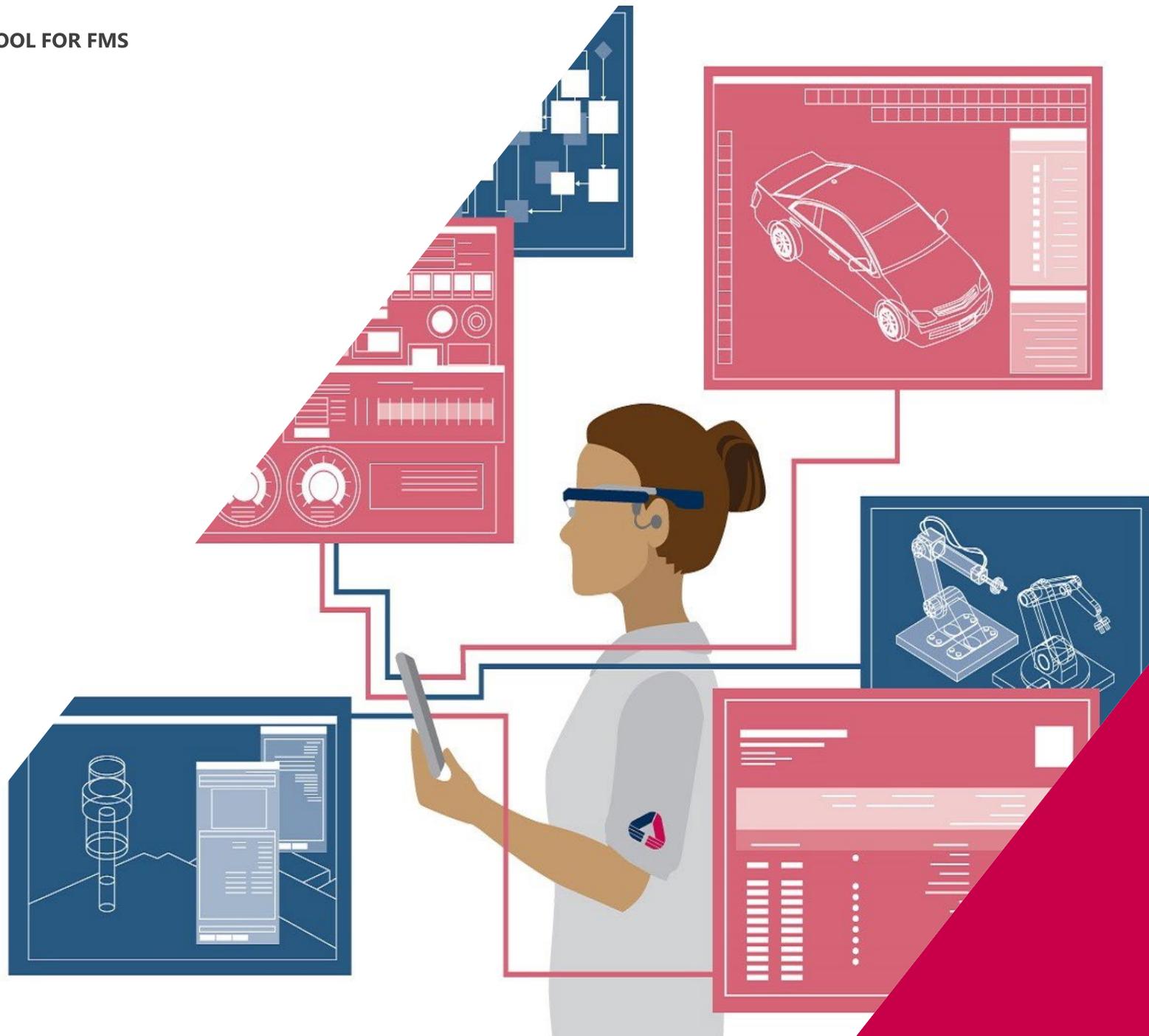
September 23, 2021

3:00 PM UTC+1 / 9:00 AM EST



# Session Agenda

- **About the Speakers**
- **The Engineering Group**
- **MCM**
- **The Problem**
- **The Solution**
- **Achieved & Attainable Results**
- **Q&A**



## About the Speakers



### Giuseppe Fogliazza

Director of Machining Centers  
MCE S.r.l. (division of MCM S.p.A.)

- After receiving his degree in Information Sciences in June 1986, Giuseppe started his work with MCM S.p.A, which specialized in building **machining centers** and **flexible production systems**, with the task of developing their supervision software.
- Since 2014, he has been **Director of Machining Centers** at MCE S.r.l., a software division of MCM S.p.A. He manages 15 software service developers who innovative support manufacturing production and factory integration projects.
- Since 1994, Giuseppe has been responsible for MCM's relations with **academia** and **research** activities.
- Since 1997, he is a member of the **CIRP**. From 2014 to 2018, he has been a member of the **Management and Control Body and of the Scientific Technical Committee** of the national technological consortium **Fabbrica Intelligente**.
- He is also co-author of several articles in the field of **software development** for the control and supervision of flexible production systems.



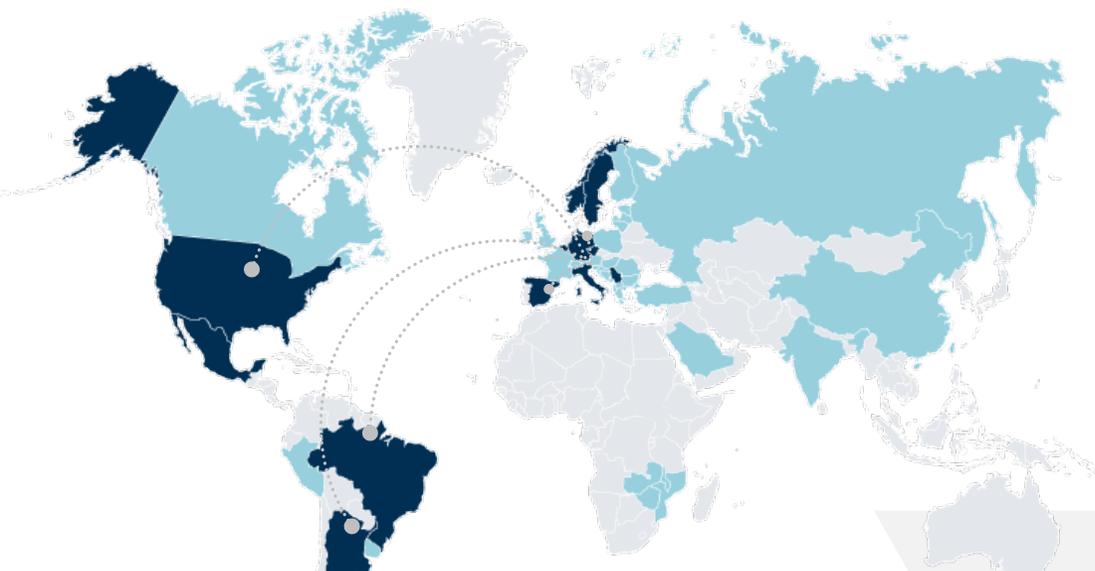
### Roberto Grugni

Simulation Modeling & Digital Twin Expert  
Engineering Group

- Roberto has **10** years of experience in the application of **simulation modeling** to **business consulting**.
- He has successfully led and implemented numerous projects aimed at developing **decision support tools** for Italian and foreign companies operating across various areas and industries.
- His industry experience includes **supply chain, manufacturing, healthcare, pharma, oil & gas** and **transportation**.
- Roberto regularly attends and speaks at conferences, lectures and training courses on the topic of **complexity management through innovative technologies**.



# Engineering Group at a Glance



## A GLOBAL COMPANY

**12.000+**  
Associates

**40+**  
Offices around the world

**Global HQ**  
Rome, Italy

**Worldwide**  
Delivery

**Based in**  
EUROPE  
NORTH AMERICA  
SOUTH AMERICA

## RESEARCH & INNOVATION

**6**  
Development labs

**70+**  
Live Research Projects

**250+**  
Innovators

**40 Mil €**  
Investments

**450+**  
Data Scientists  
& Researchers

## TRAINING

**IT & Management School**  
«Enrico della Valle»  
Our own Academy

**150k**  
Training  
hours

## ASSETS

**20+**

Companies  
within the  
Group

**20+**

Proprietary  
solutions for all  
market sectors

**10+**

Cross-BU  
Competence  
Centers

**16k+**

Projects  
in 2020

**4** Data Centers

**20 petabyte**

Data Handled

**22.000**

Servers managed

**250.000**

Workplaces managed

**Tier IV**

## WHAT WE DO

**€ 1,274 Bn / FY20**    **40+ YEARS** OF CONTINUOUS GROWTH

The World  
**We Live In**

- Smart Energy & Utilities
- Digital Media & Communication
- Augmented City
- Smart Transportation

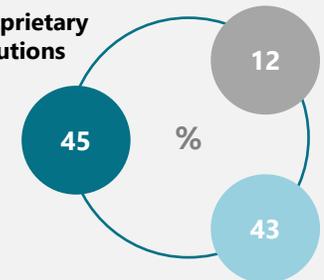
The World  
**We Work In**

- Digital Finance
- Digital Industry
- Digital Retail & Fashion
- Smart Agriculture

The World  
**That Looks After Us**

- Smart Government
- E-Health
- Digital Defense, Aerospace & Homeland Security

**Proprietary Solutions**



**Managed Services**

**Application Management & Transformation**



# Enabling Technologies / Digital Twin



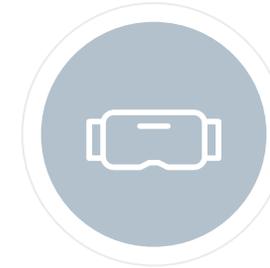
AI & Advanced Analytics



Intelligent Automation (RPA)



Internet of Things



AR / MR / VR



Blockchain



Digital Twin



Cloud



Cybersecurity



## EMERGING TECHNOLOGIES

Drones & Autonomous Vehicles

3D Tech

Advanced Biometrics

Edge Computing

Location Based Services

Virtual Assistant

Wearable Computing

Quantum Computing

5G

...

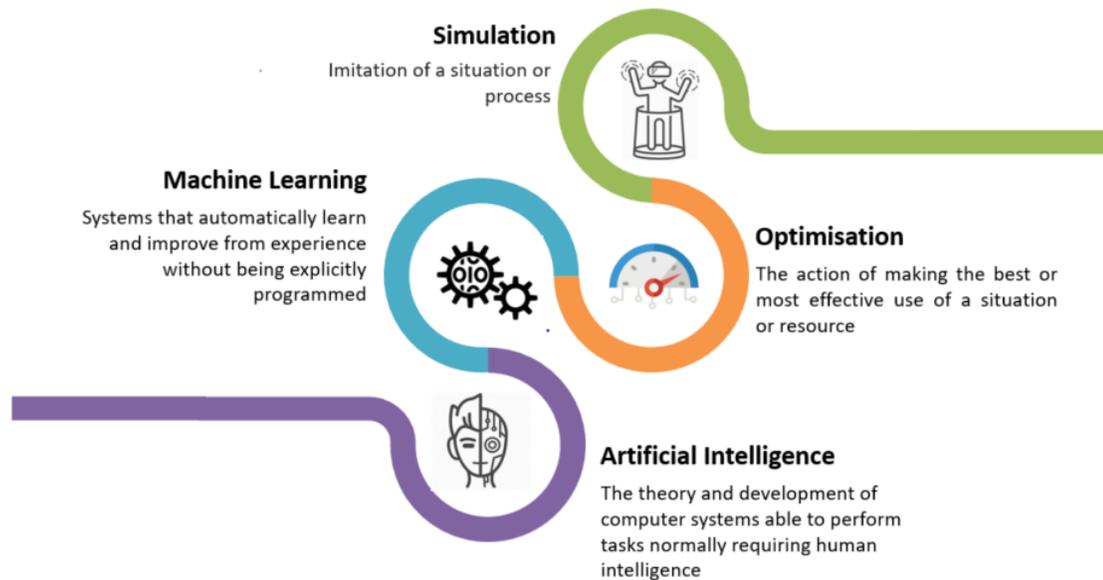


# Simulation & Data Analytics Practice



Our team aims to help customers make more informed decisions and optimize business performance by leveraging a digital copy of their processes or systems.

To reach this aim, our team seamlessly masters and combine **multiple methodologies**, as presented in the picture below.



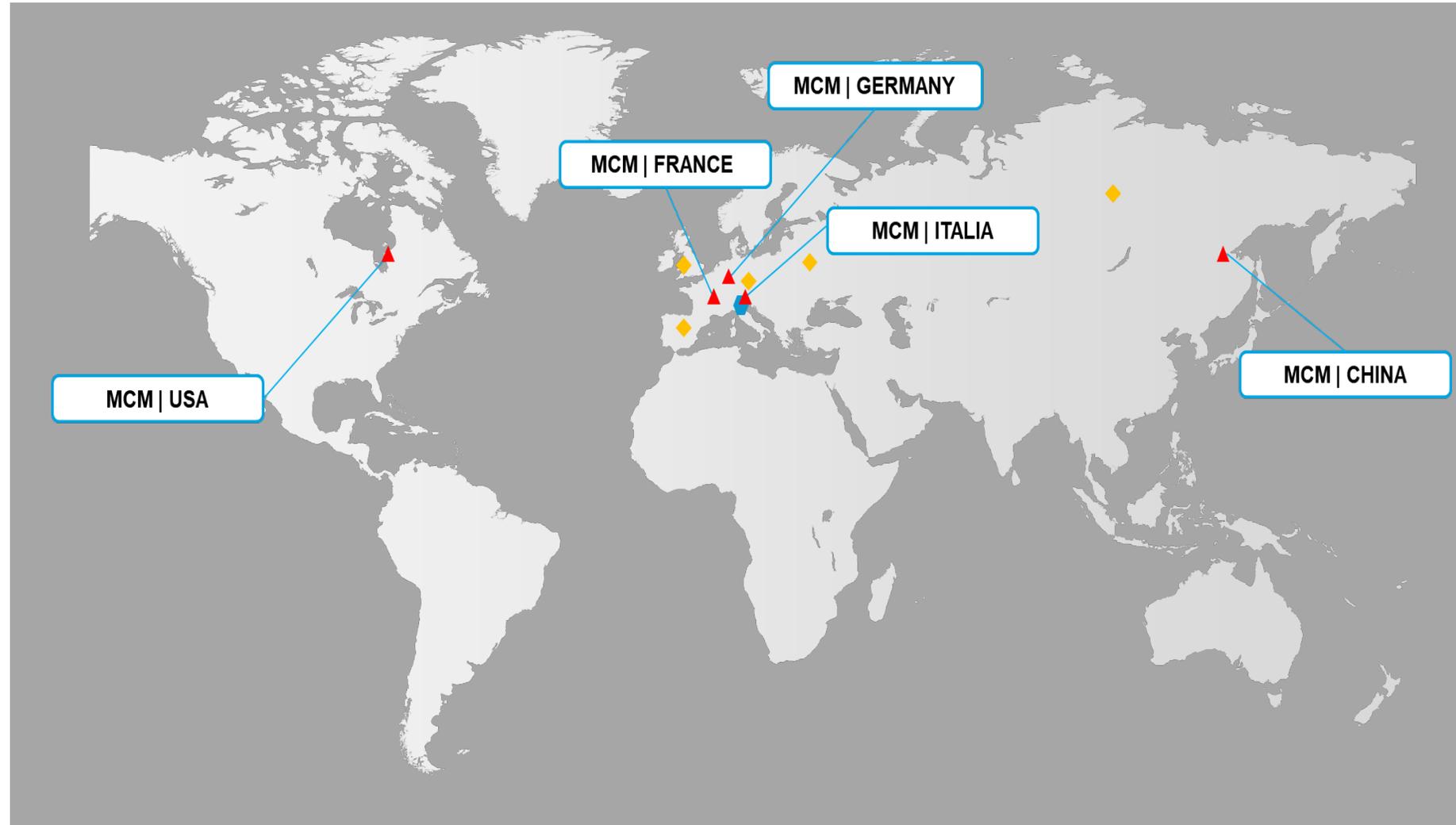
## Some Note-Worthy Customers





# MCM / Corporate Profile

## MCM SPA



MCM operates worldwide with service subsidiaries ▲ located in:  
 ITALY / FRANCE / GERMANY / USA / CHINA

MCM network of local partners ◆ is located in:  
 SPAIN / RUSSIA / UK / POLAND / CZECH REP





# MCM / Production Program

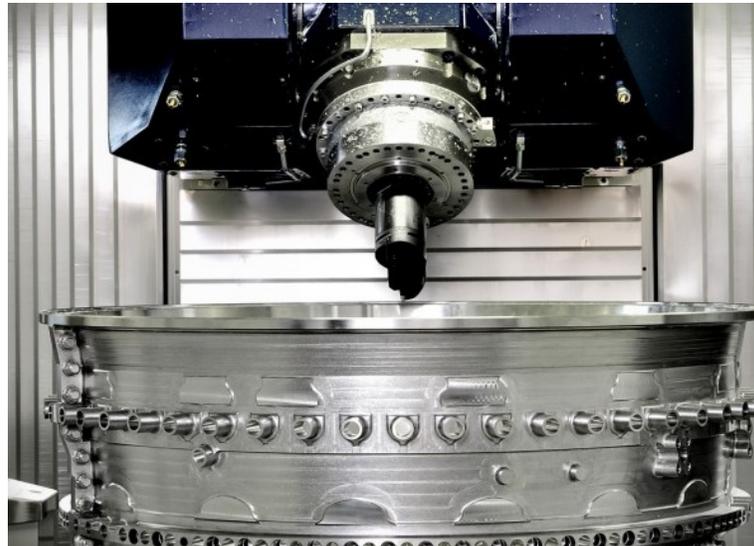
## 4 & 5 AXES MACHINING CENTERS

Milling  
Turning  
Drilling  
Grinding



## INTEGRATED PRODUCTION SYSTEMS

Flexible Machining Systems  
Complementary process integration  
Process automation



## SUPERVISION SOFTWARE

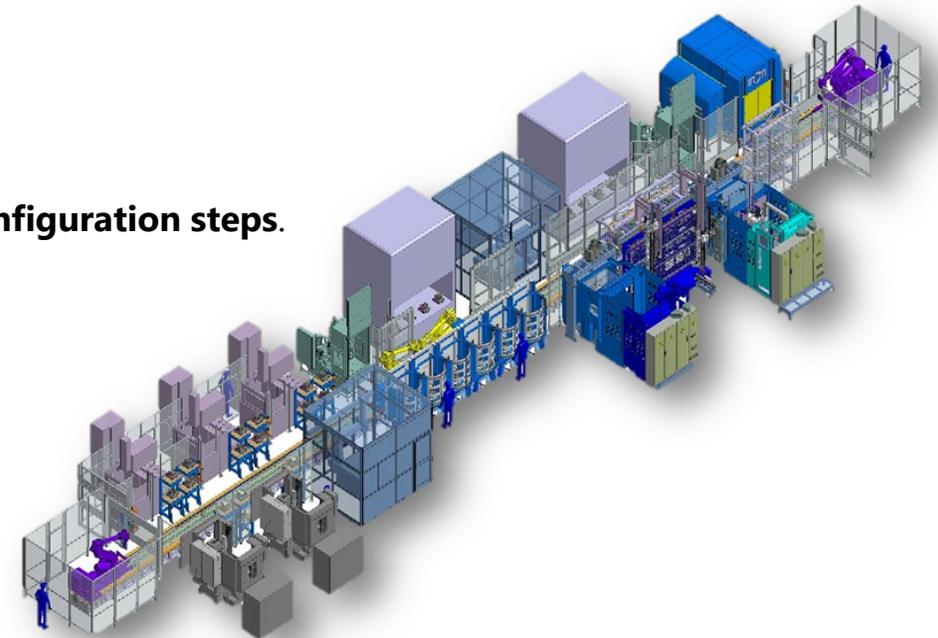
Smart production according to Industry 4.0  
principles  
Production data and statistics  
Cloud and web access





# The Problem

- Modern machining shop floor requires production systems capable of **adapting to the evolution of production problems**.
- For technology reasons, most of the **processes are automated**.
- For economic reasons, flow of material and resources should be automated, enabling **autonomous operation** for long periods of time.
- The resulting systems are complex, **integrating** multiple functionalities with **flexible automation**.
- They require **precise dimensioning** to survive highly competitive bidding process.
- Their real **behaviour is not completely known** after their installation.
- In order to adapt **to the evolution of production** itself, they requires multiple **reconfiguration steps**.
- Control policies should adapt to the evolution of the system as well.



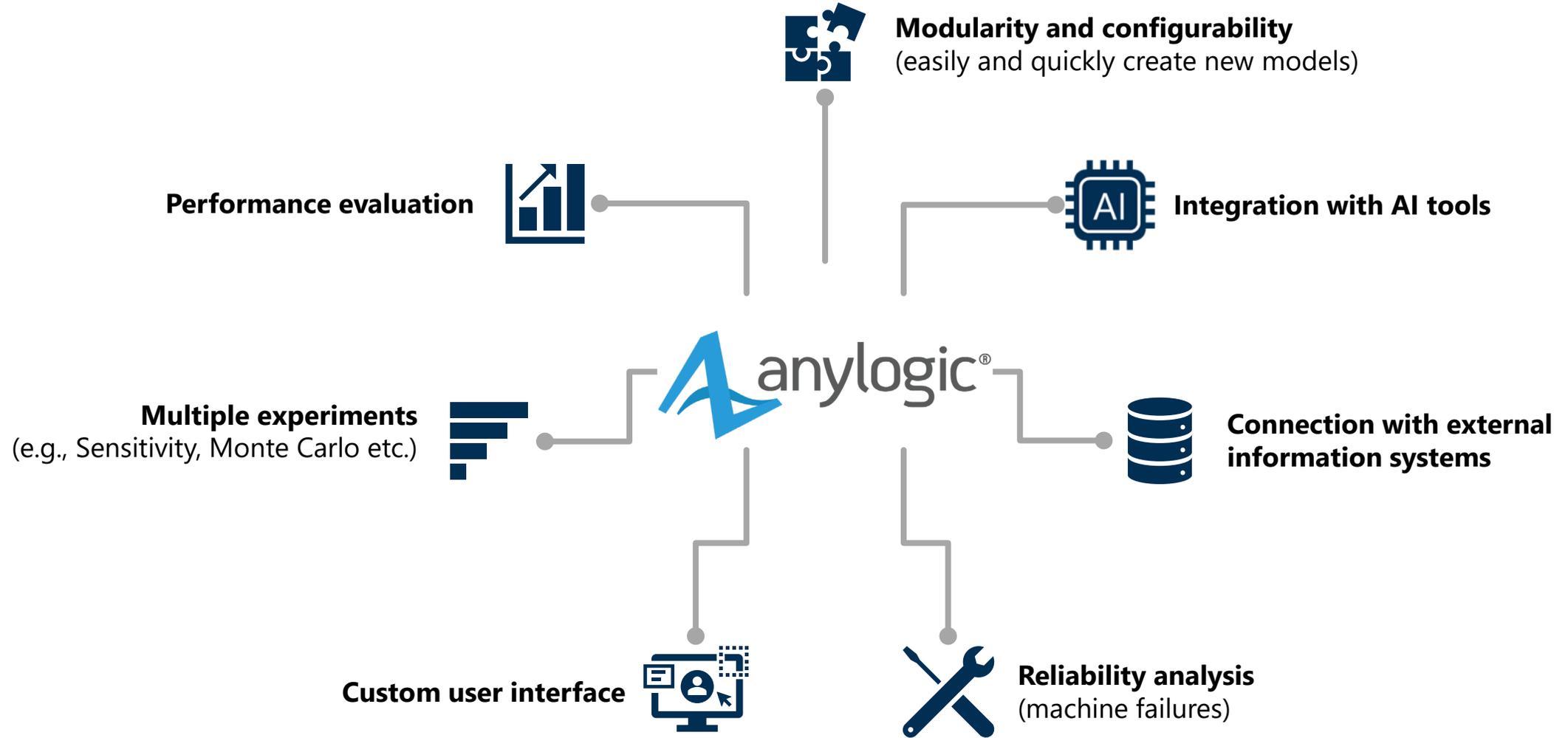


## The Solution

- MCM was interested in developing a **performance evaluation tool** for the FMS plants it designs.
- The tool was expected to **support the initial plant configuration activity** by returning significant KPIs (e.g., throughput, key resource utilization, etc.).
- By leveraging simulation modeling capabilities, MCM is aiming to:
  - ❑ Provide insights about the **automation dimensioning**, considering the impact on system performance.
  - ❑ Provide insights about the **marginal utility** associated with adding/removing an automation component to/from the system.
  - ❑ Enable the **comparison** of several alternative configurations, with respect to the production targets set by the customer.
  - ❑ Access **new business opportunities** related to the provision of advanced services for the use and management of FMS plants.

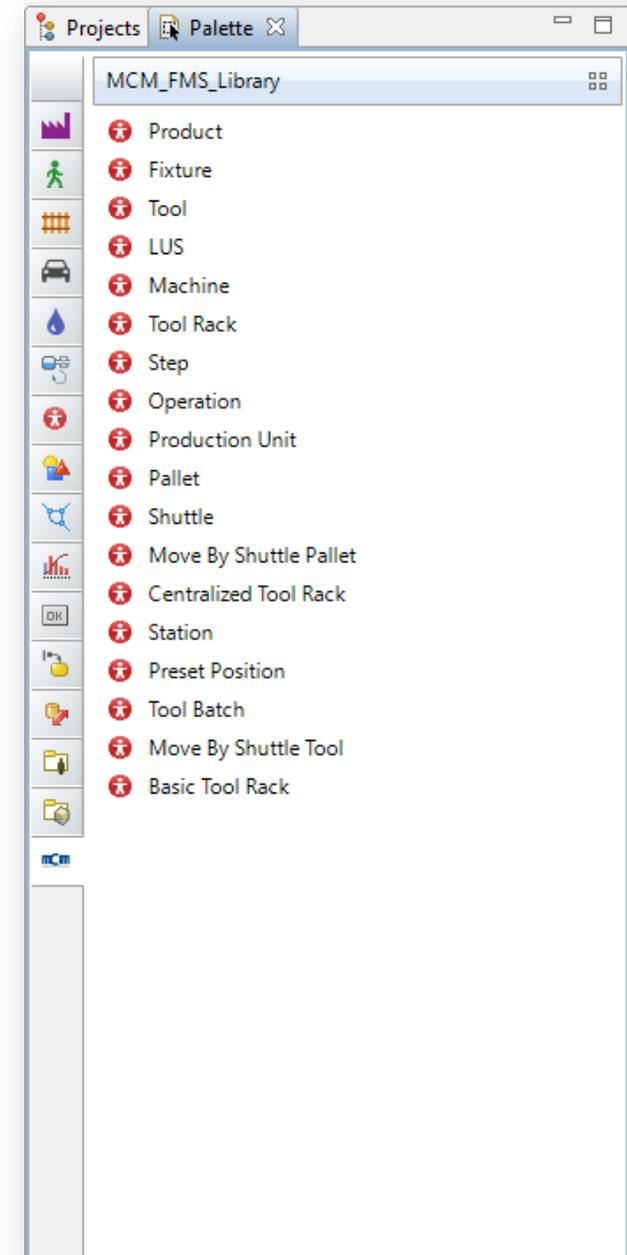


# General Requirements for the Tool



## Tailor-Made FMS-Specific Library

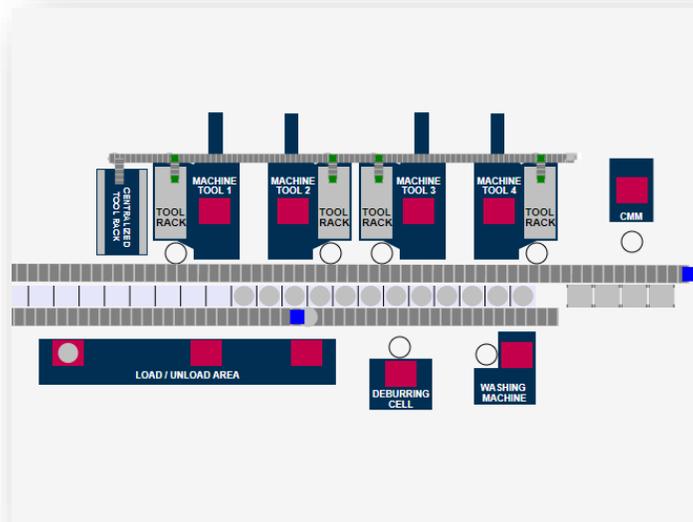
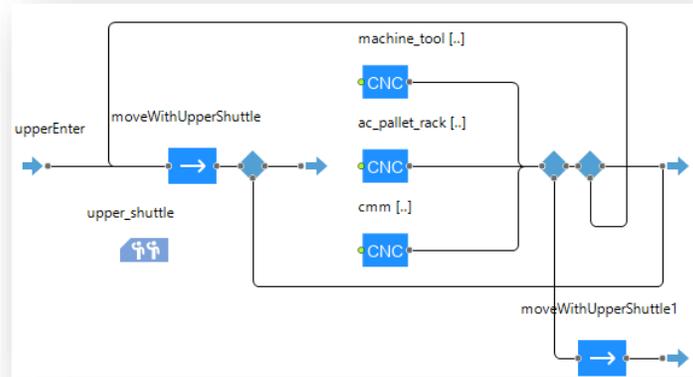
- On behalf of MCM, Engineering Group developed a **tailor-made AnyLogic Library**, i.e., a collection of reusable agents and Java classes developed for FMS applications. These agents are the main components of an FMS system (e.g., production units, machines, pallet and tool racks, shuttles etc.).
- The various library blocks were first designed together with MCM experts, to define the key aspects (list of **user-accessible parameters and functionalities**) to be embedded into each object.
- Then, each library block was developed by leveraging existing AnyLogic libraries (e.g., Process Modeling Library). In this way, our custom library can be **integrated with any other AnyLogic library** and can be opened in the palette view along with the standard ones.





# Library Implementation

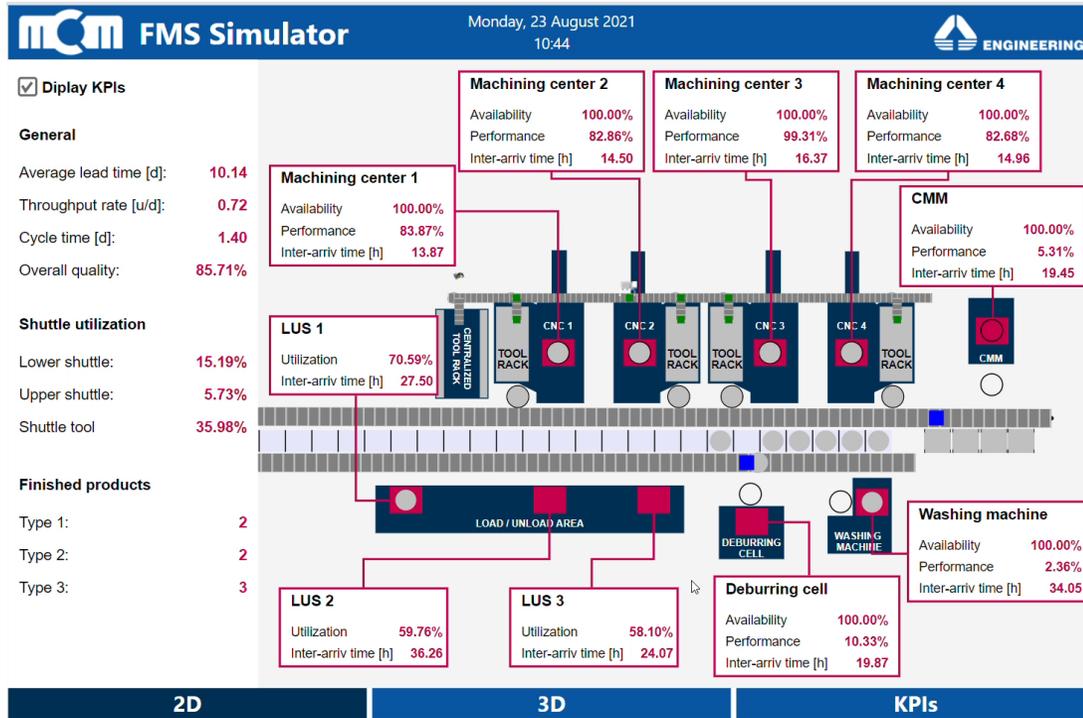
- To test and validate the developed library, we realized a **simulation model of an FMS**.
- To address as many use cases as possible, the systems considers all the main elements of FMS models (e.g. machining centers, loading/unloading stations etc.).
- We developed a pretty-generalized algorithm able to dispatch the products depending on their production sequence (**control policies strictly depend on the plant layout**, so it was not advisable to encapsulate them in the library).
- At the end of each activity, production cells send an alert (message) to a **centralized events collector**, which sorts them according to priority and manages the movements according to a heuristic rule.



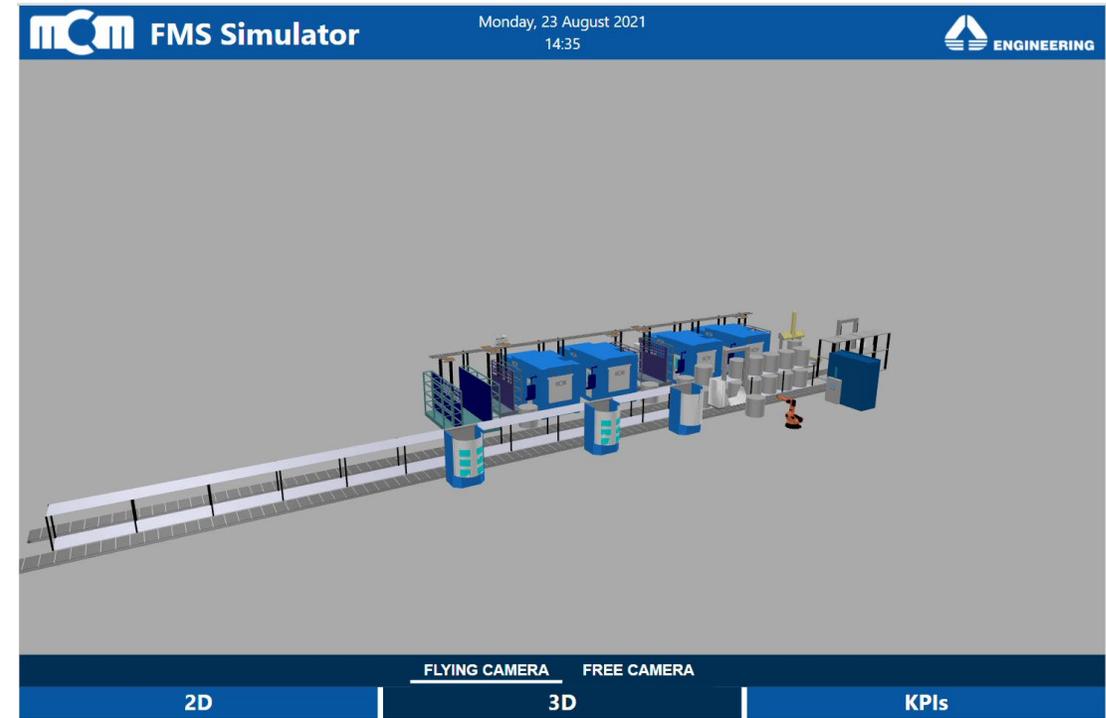


# FMS Simulator / Model Run

## 2D synoptic view with KPIs



## 3D view of the plant





## Achieved & Attainable Results

The provided FMS-specific library can be leveraged for multiple, alternative purpose:

1. **Quickly create simple models of FMS systems.** During the preliminary stages of selling a plant there is usually little information available. The library however allow the modeler to quickly connect the main blocks to run high-level simulations, also useful for showing to the end customer a preview of what the final, real-life solution could be.
2. **Introduce complex control policies.** The various blocks have been designed with “placeholders” for detailing the main system management algorithms. The modeler could even reproduce within the simulation tool the algorithms actually governing each single production cell, thus creating a Digital Twin of the system aiming at:
  - A. Monitoring the real-time status of the plant
  - B. Testing ex-ante all the designed elements and the algorithms governing their automation (**Virtual Commissioning**)
3. **Enabling AI.** The simulation environment could be used to train and/or assess the policies obtained, for example, through the implementation of **Reinforcement Learning** techniques.



# Questions & Answers



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MCE S.r.l. (division of MCM S.p.A.)



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