AI For Manufacturing

-The 12th GIO Roundtable

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CTO – Industry IoT Consortium

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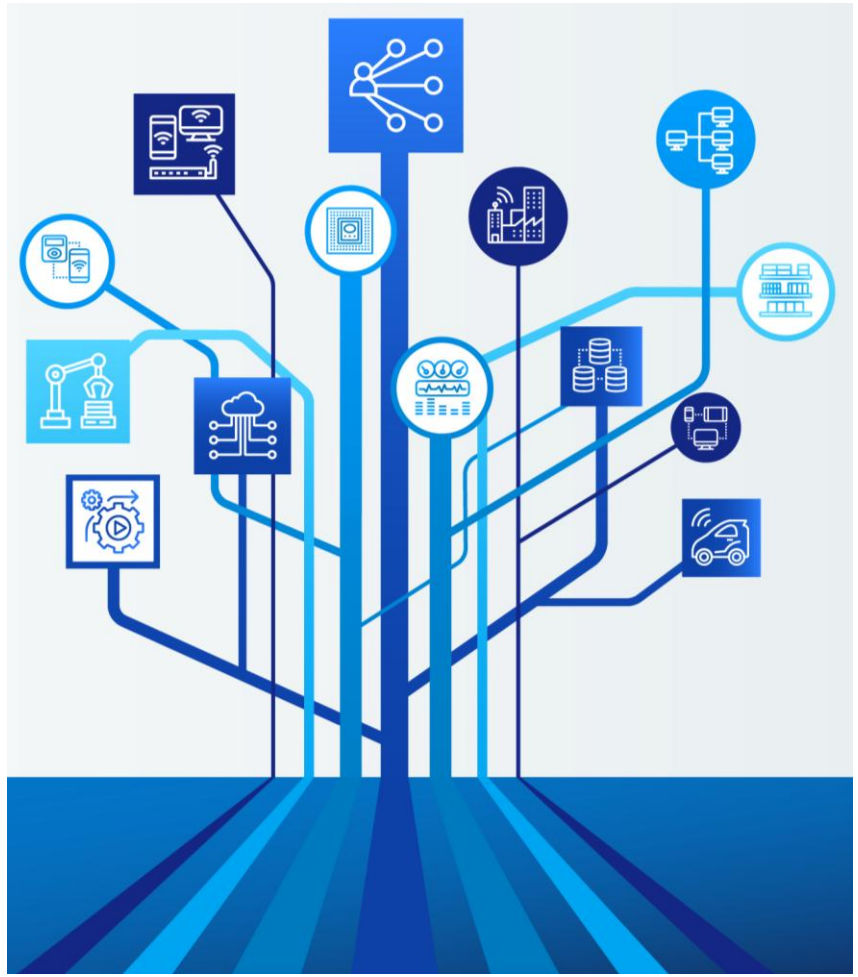
Topics

- Introduction
- Types of AI
- AI Applications in Manufacturing
- Trustworthiness of AI in Manufacturing
- Social and Sustainability Impacts
- OMG Efforts Related to AI
- Conclusions



Greetings From the OMG Family!

Introduction

Artificial Intelligence (AI) will influence most aspects of life

- In manufacturing, it will have deep impact on quality, productivity, cost, efficiency, agility, safety, environmental and labor aspects of factories.
- AI can enable factories to supplement (or in some instances replace) human thought, skill, experience and creativity with software / models.
- Factories that fail to thoughtfully apply AI will be at a disadvantage.
- AI is only as good as the data used to make its models – and that data is often incomplete, obsolete, biased or wrong.

- As with all disruptive technologies, AI has good and bad impacts.

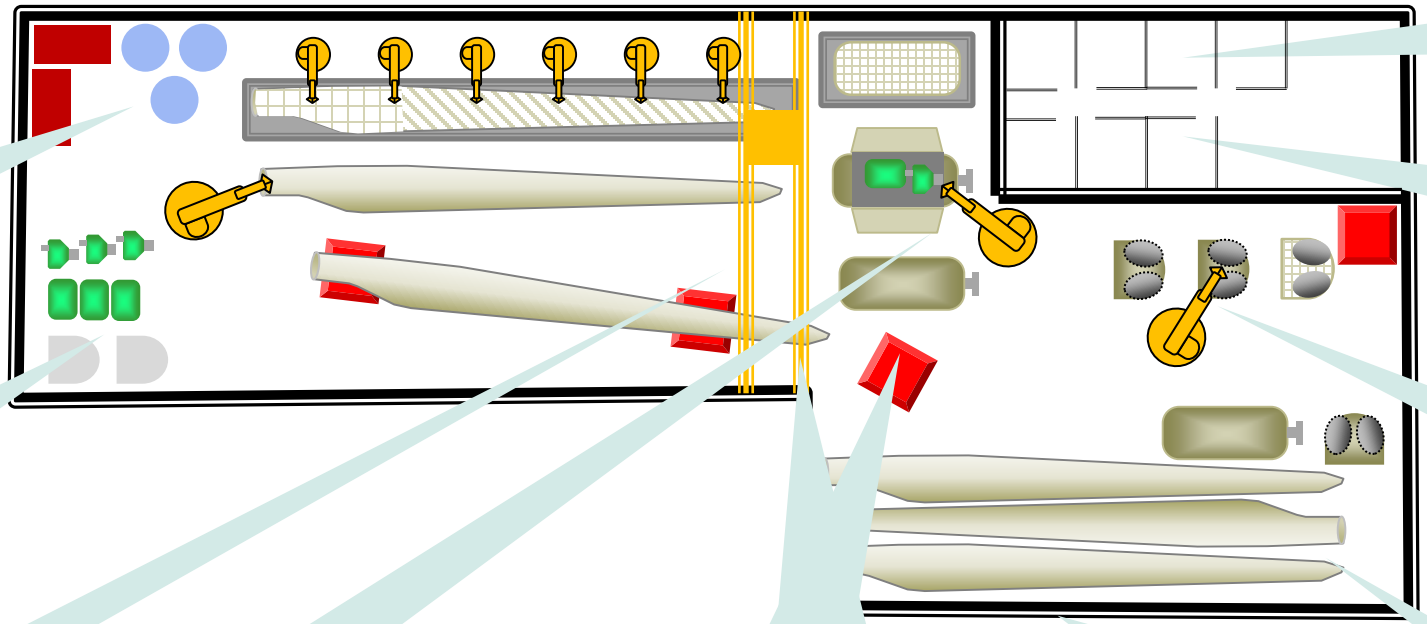
Types of AI

AI for Manufacturing can be split into several categories:

- **Heuristics / Expert Systems:** Pre-programmed responses
- **Recommendation Systems:** Predicted answers based upon past responses
- **Machine Learning / Deep Learning:** Pre-trained neural networks for inference
- **Natural Language Processing:** Speech / text input and output
- **Machine Vision:** Using cameras to monitor / control processes
- **Robotics:** AI techniques to control, coordinate and automate robotic motion
- **Generative / Large Language Models:** Creating original outputs / strategies
- **Explainable AI:** Allowing humans to understand why AIs make choices

AI Applications in Manufacturing

Example 1: AI-Enabled, Highly Automated Factory for Wind Turbines



Raw Materials
- Quality Inspection
- Inventory Planning
- Efficiency Optimization

Subcomponents
- Acceptance Testing
- Supply Chain Control
- Cost Reduction

Blade Production
- Diag. / Troubleshooting
- Process Monitoring
- Cycle Time Reduction

Nacelle Production
- Failure Prediction
- PPE Use Monitoring
- Cobots

AGVs / Cranes
- Safety
- Guidance / Navigation
- Fleet Coordination

Factory Building
- Physical Security
- Energy Optimization
- Comfort / Convenance

Front Office
- Production Planning
- Labor Optimization
- Contract Automation

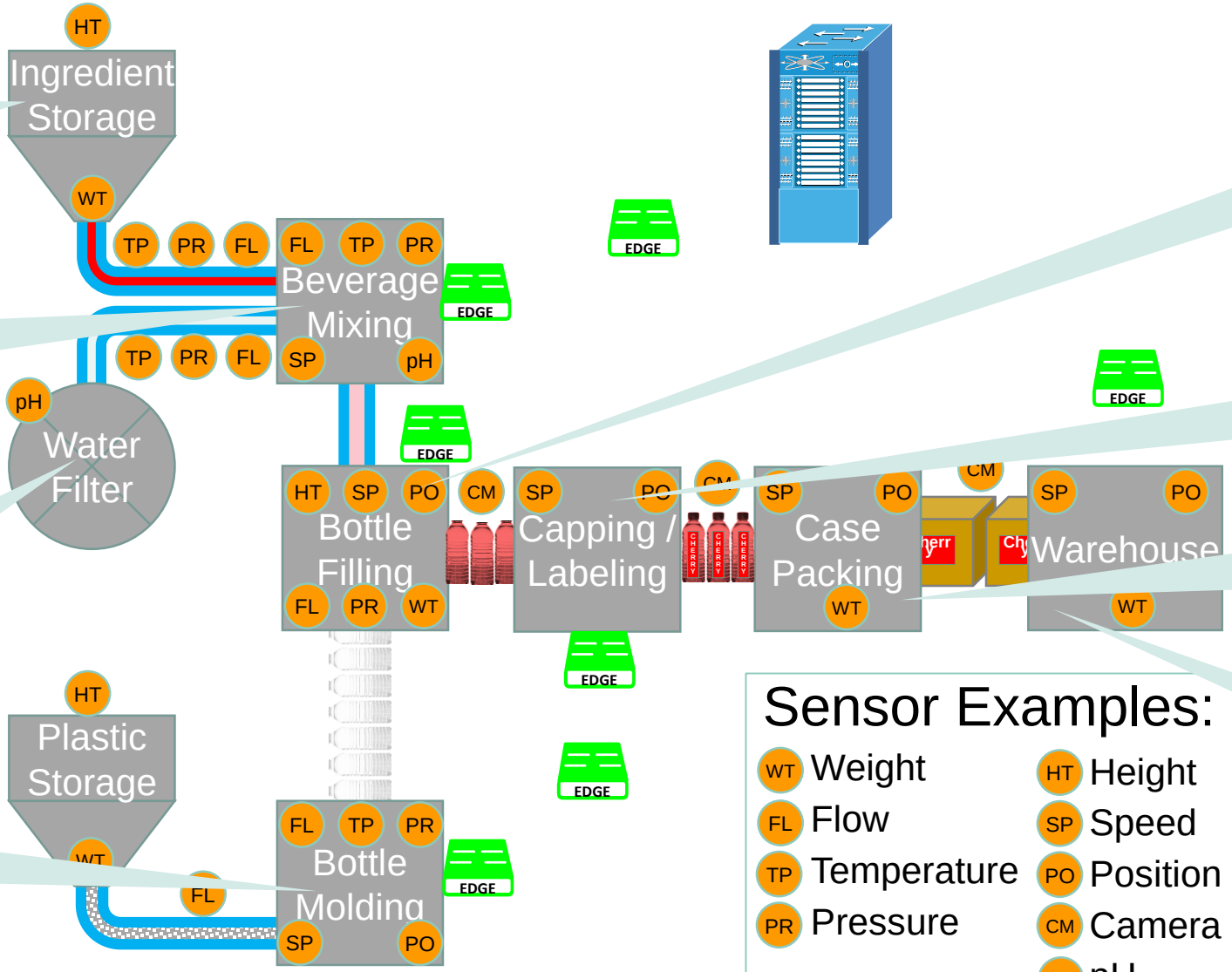
Engineering
- Product Customization
- Code Generation
- Document Creation

Hub Assembly
- Human Interfaces
- Path Planning
- Robot Coordination

Shipping
- Logistics Optimization
- Safety Monitoring
- Sustainability

AI Applications in Manufacturing

Example 2: AI-Enabled Soft Drink Bottling



Raw Materials
- Quality Inspection
- Inventory Planning
- Efficiency Optimization

Process Chemistry
- Sensor Monitoring
- Adaptive Mixing
- Safety

Water
- Use Optimization
- Contaminant Tracing
- Sustainability

Bottle Production
- Diag. / Troubleshooting
- Process Monitoring
- Cycle Time Reduction

High-Speed Filling
- Uptime Improvement
- Predictive Maintenance
- Sanitization

Capping / Labeling
- Sensor Integration
- Quality Inspection
- Print Monitoring

Case Packing
- Robot / Cobot Control
- Custom Logistics
- Just-in-tTme

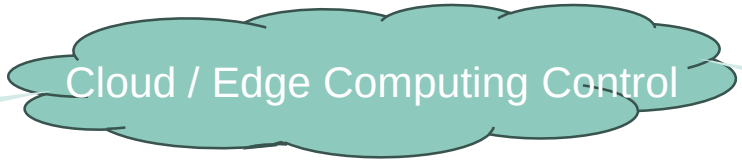
Warehouse
- Inventory Optimization
- Autonomous Vehicles
- PPE Verification

Sensor Examples:

- WT Weight
- FL Flow
- TP Temperature
- PR Pressure
- HT Height
- SP Speed
- PO Position
- CM Camera
- pH pH

AI Applications in Manufacturing

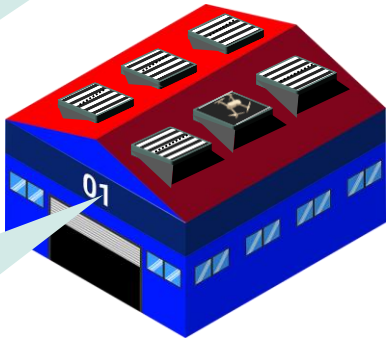
Example 3: Drone Based Logistics Systems

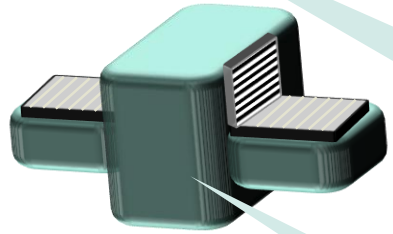


Fleet Coordination
- Demand Forecasting
- Resource Optimization
- Speed Improvements

Air Traffic Control
- Collision Prediction
- Priority Management
- Efficiency Optimization

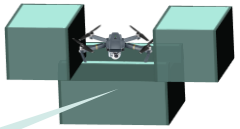
Flight Control
- High-Speed Navigation
- Collision Avoidance
- Precision Landing

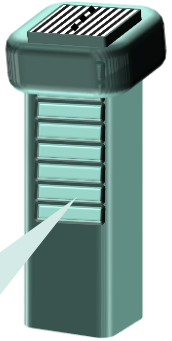




Cargo Management
- Adaptive Retention
- Path Optimization
- Emergency Response

Warehouses
- Autonomous Vehicles
- Smart Security Cameras
- PPE Use Monitoring





TSA-Like Screening
- Hazzard Identification
- Traffic Optimization
- Adaptive Geofence

Drone Dock
- Threat Detection
- Energy Optimization
- Adaptive Security

Robotic Mailbox
- Robotic Control
- User ID Verification
- Storage Optimization

Landing Pad
- Precision Location
- Drone / User Verification
- Loss Prevention

Radios & Sensors
- Radio Spectrum Control
- Weather Prediction
- Rogue Drone Detection

Some Details / Trends on AI Use Cases in Manufacturing

Expert / Recommendation Systems:
- Troubleshooting guides to direct maintenance workers to a quick fix
- Machine performance / efficiency enhancement recommendations
- Warehouse / forklift / conveyer optimization

Machine Learning / Deep Learning:
- Predictive maintenance that watches sensors to detect problems before machines fail
- Optimizing raw material use by laying out patterns on sheet stock, controlling fuel and chemical use
- Identifying authorized / unauthorized devices, users, networks or data

Natural Language Processing:
- Understanding spoken commends of workers - especially "emergency stop"
- Using spoken feedback to workers who need to keep their eyes on the process, such as welders
- Understand and generating text input or output like instant messages or prompts in secondary languages

Machine Vision:
- Quality inspection of welds, surface finishes, subassemblies, final products
- Detection of missing or improperly installed parts
- Gesture detection to allow workers to control cranes, adjust machines or call for help in noisy environments
- "Hand-Eye" coordination for robots
- Safety monitoring for virtual machine guards, vehicle paths, and the correct use of personal protective equipment

Robotics:
- Managing position, speed and acceleration of all motors to keep them safe and efficient
- Autonomous Guided Vehicle (AGV) navigation and path optimization
- Managing safety of people around robots

Generative / Large Language Model AI:
- Modifying designs to customize products for each user
- Rapidly programming PLCs in agile factories as product mixes change
- Writing customized software for factory machines and the products they produce

Trustworthiness of AI in Manufacturing

This is an ongoing focus of IIC / OMG

Components of Trustworthiness:

- **Security** – AI can improve physical / cybersecurity, but can also amplify threats
- **Privacy** – AI can help anonymize personally identifiable information
- **Safety** – AI can monitor for dangerous conditions and prevent accidents
- **Reliability** – AI can detect impending failures and improve machine uptime
- **Resilience** – Supply chains and raw material sourcing can be improved with AI
- **Accuracy** – AI improves precision, repeatability and quality of industrial processes

Overall, the application of AI to manufacturing must be *RESPONSIBLE*

Social and Sustainability Impacts

This is an ongoing focus of the OMG Responsible Computing Consortium

AI is not all good. Potential negative impacts must be addressed:

- Bias, "hallucination", model data accuracy questions
- Most models are not transparent – difficult for humans to understand
- Intellectual Property Rights (IPR) and copyright issues
- Impact on labor – especially automation of many classes of jobs
- Impact on education / training
- Power consumption
- Erosion of cognitive and artistic skills in the population
- Ethics
- Monopoly and power players

Most experts agree some form of government or self-regulation is needed

OMG AI Efforts – Responsible Computing

The Responsible Computing Consortium is interested in ESG aspects of AI
We are working on a major document about many aspects of responsible AI
We produced a webinar on "*Responsible Generative AI*":
https://www.youtube.com/watch?v=AJpYzp25ES8

We are also producing a scholarly paper for the IIC Journal of Innovation:
Title: "*Responsible Generative AI – How could we "tame" this powerful Generative AI Technology?*"
Topics:

- How do we establish and arbitrate the ownership of IP and copyrights?
- How do we tackle the inherent hunger for power of these humongous models and the resulting carbon footprint?
- How do we build trustworthy Generative AI applications with capabilities of explanations and truth verification.
- Will it help humans operate at much higher plains of cognition sooner at an early age?
- How does it impact the desirable behavior skills and cognitive skills like the ability to remember things, ability to analyze situations, conduct within established ethical and moral guidelines of the society, demonstrate conscientiousness, develop individual styles, and the ability to analyze situations?
- Will it reduce the need and societal recognition and respect for formal higher education and specializations?
- What are guidelines, best practices, and guard rails that can be designed and implemented to govern and make responsible use of Generative AI and associated technologies.

OMG AI Efforts: Industry IoT Consortium

The Industry IoT Consortium is interested in IoT / Digital Transformation aspects of AI

Our Industrial AI Task Group published "*Industrial IoT Artificial Intelligence Framework*" document in 2022: https://www.iiconsortium.org/pdf/Industrial-AI-Framework-Final-2022-02-21.pdf

We are working on a new "*Industrial AI Whitepaper*" Topics include:

- Identify applications in IIoT, through example use cases
- Enumerate benefits of using generative AI in IIoT applications
- Identify requirements from an IIoT perspective
- Consider business, usage, implementation, and functional viewpoints
- Consider emerging technology trends
- Examine ethical issues and societal concerns
- Examine the technical concerns and risks
- Provide an update on the industry and standards landscape

OMG AI Efforts: Standards Development

- Artificial Intelligence Task Force "*AI Datasheet*": https://www.omg.org/intro/AIDataSheet.pdf
- Objectives / areas of work for the Task Force:
  - Modeling of AI artifacts
  - Knowledge representations
  - Natural language processing
  - Image and speech recognition and computer vision
  - Robotic systems
  - Virtual and augmented reality
  - Advanced AI applications
  - Machine and deep learning and neural networks
  - Autonomous and autonomic systems and agents
  - Security, privacy, social and other ethical AI impacts
- Artificial Intelligence and OMG Standards White Paper: https://go.omgprograms.org/l/658223/2019-10-03/gvhwl
- Modelling IP / Copyright issues.
- EU Observatory of Standards
- Taxonomy of AI concepts with IEEE P3123

Conclusions

- AI in its various forms is very important to the future of manufacturing
- AI can improve manufacturing quality, productivity, cost, efficiency, safety, etc.
- Potential use cases for AI exist all over typical manufacturing plants
- The trustworthiness of AI systems must be considered at all stages
- Not all impacts of AI are positive, especially related to labor, bias, and energy
- Some guardrails and regulation are needed for AI
- Work in consortia like IIC, DTC, RC, OMG and GIO will be vital to safely apply AI

Thank you!

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Business Transformation.