ARTIFICIAL INTELLIGENCE IN INDUSTRIAL PRODUCTION
Handouts for trainers

Introductory instructions for trainers

We have prepared materials for trainers to follow. They include

- Introduction
- The complete texts as read by the machine voice. The trainer can choose what to say, for example by highlighting certain sentences or concepts.
- Recommendations on where to turn the sound on or off

The presentation can run in two modes

- With audio on
- Without audio on

Presentation with audio on

- In this mode, a machine voice is heard explaining the displayed texts, diagrams and animations.
- This mode is suitable for self-learning.
- The trainer is not recommended to go through the entire content in this way. The trainee's attention may be lost, and the trainee may not focus on what is most important in the content.
- We recommend using this mode no more than 2 times during the presentation.

Presentation with audio off

- If the presenter turns off the sound, they can give the participants an abbreviated version of what the machine voice is saying in the background.
- They can also highlight what is most important about the content being shown.
- The trainer needs to go through the course several times.
- This is because the background machine voice is running all the time, and until the narration is finished, the trainer has no opportunity to move on to the next step in the presentation.

The trainer can either

- do the content switching and scrolling on their own (recommended for online webinars)
- **or** their partner can do it, but it has to be well coordinated with them (recommended for larger audiences)

Link to the course

https://paitool.eu/courses/paitool-course/lessons/content/

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Educational objectives

Each presenter must understand their educational objectives. In the case of AI, participants should gain the following knowledge:

- Understand artificial intelligence as an information system that is capable of learning,
- Know how to identify those processes where it makes sense to use artificial intelligence or machine learning,
- Know the prerequisites for deploying AI in the conditions of a specific company, such as the need for data, the personnel required, etc,
- Recognise the benefits of implementing AI and the risks associated with implementing the project.

Course of training

Introduction

Hello. I would like to show you the ways in which artificial intelligence is transforming the industrial sector and contributing to its continuous growth and improvement. Today's industrial production is no longer just about machines and people, but increasingly links machines and artificial intelligence. These innovations are creating room for more efficient, intelligent and flexible production processes. Artificial intelligence, often referred to as AI, is becoming a key player in a rapidly changing industry. Let’s take a look at some specific examples where AI is finding its application in industrial manufacturing.

I'm going to play you a presentation that gives a voice to artificial intelligence, as a demonstration of one of its capabilities.

START THE PRESENTATION

Slide 1 – introduction

INDUSTRIAL PRODUCTION
Digitization scenario using artificial intelligence

Slide 2 - Introductory examples

Slide 3 - Physical machine and artificial intelligence

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The use of computer-controlled machines is constantly growing in the industry. They are referred to as C.N.C. machines. At the same time, the deployment of the Internet of things, known as IoT, has been proliferating in recent years.
Both create space for the deployment of artificial intelligence directly in production. And indeed, we are seeing more and more practical applications of machine learning and so-called deep learning in industrial production.
The term artificial intelligence is commonly replaced by the acronym A.I.
For more information on what artificial intelligence is used in production, click on the buttons next to each item.

Automated design of production operations. Artificial intelligence tools can help users prepare a production plan for a workpiece, regardless of the machine and how the workpiece is set up. For each device, they can design, for example, workpiece holders, accessories, and coordinates for the correct positions of specific tools.

Programming of computer-controlled facilities. Artificial intelligence can design trajectories for 3-axis and 5-axis turning and optimize the robotic arm's positioning or movement based on data about products and from data collected in the past.

Flexible setting changes. Artificial intelligence can adapt a program for another machine, in the event of a malfunction of any classification, in need to increase production, or transition from prototype to production. It can effectively help with rapid production changes or small series.

Interventions based on continuously collected data. Artificial intelligence can optically recognize the position of the workpiece on the conveyor and identify unwanted anomalies such as vibrations at the device or defects on the workpiece. Based on this, it can control the movement of robots, prevent collisions, stop the process and start the device’s calibration.

Simulation, analysis, and verification. It is possible to create a machine's digital twin or the digital twin of the entire machining environment. One will be able to see the perfect kinematics model of the device, re-evaluate the potential for collisions, axis overshoots, acceleration exceptions, and other conflicts before making a single cut.

Slide 4 - Artificial intelligence and integrated assembly line

Today, most of the devices used by manufacturers send vast amounts of data to the cloud or local storage. Unfortunately, this information is not used very often.
If we start processing data from all devices connected to the Internet of Things, we can get a whole new perspective on our operations. Artificial intelligence can evaluate data in the cloud or locally. By adding artificial intelligence to the ecosystem, we gain new features.

STOP THE SOUND OF THE PRESENTATION

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Optimization of production based on inventory

- Artificial intelligence-driven software analyses inventory in real-time, eliminates downtime, and minimizes relocation

Fault identification and replacement programs running

- When a device fails, the system can automatically run alternate schedules

Load redistribution to different devices

- Artificial intelligence can redistribute work between devices, design parallel processing without the risk of collision, and optimize total times

Operator monitoring

- When facility operators show signs of fatigue, superiors receive alerts from the artificial intelligence

Predictive maintenance

- Artificial intelligence is also essential for predictive maintenance

Quality control

- Artificial intelligence can also monitor the quality of the products

START THE PRESENTATION SOUND

Slide 5 - How artificial intelligence is used in production

- We must first **obtain data** from machines or other sources, bearing in mind that the data will be in different formats and obtained using different protocols.

- Then, we must **prepare the data**. They will need to be aligned in time and the correct order. If the sensors supply data with different frequencies, the data from the slower sensors must be repeated or interpolated to fill the samples expected by the machine learning model.

- Subsequently, we must enter the data into the environment that contains the **machine learning tools** and start creating the model. We use a test sample of data during machine learning to verify whether the artificial intelligence tool continuously generates the correct results.

- Machine-generated models and computer programs that use them or direct control information are **distributed to end devices, operating computers, or operator workstations**. You can easily update any number of end devices, compare different generations of artificial intelligence models, track when they were introduced, and revert to the previous version if problems are found. An embedded AI is a distributed form of artificial intelligence that works on end devices.

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Discussion 1

1. *Have you recently registered, or say since Covid, an increased interest in intelligent solutions directly into the production process??*
2. *If so, what types of companies are involved? Larger or smaller businesses? Can the most active sectors be identified? Does this apply to your business as well?*
3. *To what extent is your company also dealing with the idea of becoming producers as well as consumers? So-called PROSUMERS?*
4. *Do companies have clarity on the topic of energy management? Are they clear about what all Smart Energy solutions encompass?*
5. *Do customers also directly express a demand for the introduction of artificial intelligence? At least indirectly, e.g., by requesting the generation of predictions or the processing of unstructured data or similar?*
6. *How long does it typically take you to negotiate with suppliers from first contact to contract and project start?*

START THE PRESENTATION

Slide 6 Presumptions

Slide 7 Process

The processes with the most significant potential for improving results are selected to optimize production.

If we decide to optimize one process or machine operation, we are talking about partial optimization.

Suppose we want to increase the efficiency of production as a whole. In that case, we are talking about comprehensive optimization. We improve the parameters of several integrated machines and include external factors that directly or indirectly affect production, such as logistics, warehousing, ordering system, or physical location of equipment.

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Prerequisite

- There is a dependence between the process settings and their results

Selection of a suitable process

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- Partial optimization
- Comprehensive optimization

Slide 8 Data

What data is needed

If possible, data that is not collected manually

If an optimization process is already selected, all relevant data that we have available from the factory should enter the solution. It is also appropriate to supplement the additional data related to the process results. It is not advisable to use data entered manually, as they contain errors, and their use usually prevents full automation.

Data from control systems

The most important is the data that describe the process results and performance parameters. The usual data source is the MES system database or the database at the SCADA level and data from supporting processes such as logistics.

Sensor data

Sensor data is an invaluable addition. These can be sensors that measure temperature, pressure, vibration, and other physical parameters. We obtain data on the quality of the resulting products, for example, by measuring the dimensions or minorities of visual systems for visual inspection of products.

Additional data from commercially available databases

In case of insufficient quantity or quality of data, it is appropriate to extend the measured sample with data purchased on the market, for example, from a data bank or anonymized data from a platform service provider.

START THE PRESENTATION SOUND

Slide 9 - Information systems

Information systems are mainly used to provide data.

If artificial intelligence is to provide the information for the decision of the human expert, it is necessary to provide a suitable user interface (charts, tables, traffic lights, etc.).
If the result is to be the automation of decision-making, it is necessary to integrate the solution interface into the control systems of the given process. Here are the most used information systems:

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For more information, click on the four buttons with Information systems shortcuts.

- **MES, Manufacturing Execution System**: a system that allows the collection of actual process data from control systems and technological equipment within the company and use them for real-time management
- **SCADA, Supervisory control and data acquisition**: system for visualization and control of industrial technologies
- **PLM, Product Life Cycle Management**: a system for managing the entire product life cycle, from its inception through construction, design, and production, as well as service and disposal of the product
- **ERP, Enterprise Resource Planning**: enterprise resource planning system, which is used to manage and control all resources, workplaces, and business functions with the support of shared data

Slide 10 - Technical infrastructure

The need for the necessary technical infrastructure is also related to optimizing production. In most cases, it can be divided into three categories:

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The text will be retold by the speaker in their own words:

Data collection - Sensor installation

Different types of sensors must be available for data collection. If they are not part of the supplied machines, the so-called retrofitting of the equipment is deployed. It means adding and installing sensors to the production lines.

Presentation of results - Display devices within the corporate network
Results and additional information are made available through large display panels, computer screens, tablets, or mobile phones.

AI microprocessors - Chips being a part of intelligent devices
When designing the artificial intelligence infrastructure, AI chips, already being a part of the available devices, are also applicable. They are installed in industrial cameras or adaptive controllers.

Information Technology - Cloud infrastructure or edge computer
The computing can be performed remotely in the cloud or locally on edge computers.

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Slide 11 - People

Early involvement of the right personnel on the part of both the client and the supplier is essential for the project's success. **In the case of the client, these are the following profiles:**

Production managers and process engineers work with the contractor's professional consultants to identify problems and goals.

An **operator** who performs support tasks during the AI training and is the first to catch problems and mistakes.

An **IT expert** responsible for the operation of related computer technology and network infrastructure.

The **project sponsor** holds the budget and promotes innovation from the managerial level.

Slide 12 - People

In the case of a supplier, these are the following profiles usually needed:

An **information technology architect** designing the infrastructure needed to support a data platform.

A **professional consultant** who modifies and processes data and performs analytical activities. This role is sometimes referred to as a data scientist.

An **application developer** who implements models into applications to create data-based applications.

An **Information and communication technology specialist** who is responsible for the implementation of the hardware as well as software solutions;

An **Expert in data visualization and interpretation**.

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The text will be retold by the speaker in their own words:

Slide 13 - Organization

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Practical cooperation of the professional teams of the supplier and the contracting authority is essential for the success of the project. Fundamental factors, in this case, are a **project plan** with appropriately set milestones, a **communication model** defining the system of project meetings, but mainly **sufficient allocation of professional teams**, and a **flexible process model** supporting the proactive definition of requirements and timely response to suggestions of the implementation team.

Project plan

- appropriately set milestones and sub-objectives of the project

Communication model

- interaction of professional teams
- regular meetings
- formulation of requirements
- responding to suggestions from the implementation team

Human capacity

- sufficient allocation of the experts
- flexible process model

⏸ *STOP THE PRESENTATION*

Discussion 2

1. *Building an IT environment is a gradual process; it starts with simpler solutions and can progress to artificial intelligence. What does this evolution look like in the cases you have personally encountered?*
2. *In your opinion, is the customer willing to pay for the analysis of their needs as well, or are they trying to take on this role themselves? When you come into contact with supplier companies, to what extent do you have clarity on what you need?*
3. *What problems do you encounter in getting data? Do we mean both technical problems (fragmented and distributed data) and, say, organisational or competency problems?*
4. *How much of your projects are about integrating your solution to third-party systems? How did it work, was it necessary to involve the suppliers of these solutions or did you as a client manage it with your own staff?*
5. *How long does the project probably take?*
6. *Did you experience any problems in getting sufficiently skilled staff? Did you have trouble freeing them up in sufficient numbers for the project?*
7. *What has been your experience supporting management? Are they aware of their role in the project?*
8. *Have you been willing to purchase or upgrade your technical infrastructure in projects if the existing one proved to be inadequate?*

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Slide 14 - Benefits and risks

Slide 15 - Benefits

Projects for deploying artificial intelligence into the production environment have positive qualitative and quantitative benefits.
For more information, click on the four number buttons.

General improvement of results
General improvements, including increased quality, improved product parameters, reduced machine wear, reduced risk of complaints.

Direct resource savings
Direct savings, such as freeing up staff or saving energy.

Completion of data infrastructure
Completion of the data infrastructure creates the possibility of using data in other projects in the Industry 4.0 domain.

Consolidating a culture of achieving measurable results
Data-based decisions lead to a more robust culture of measurable results and the associated additional incentives to develop the production and reduce resistance to innovation.

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The text will be retold by the speaker in their own words:

Slide 16 - What we should be careful about

There are risks associated with the production optimization process that can negatively affect its outcome. **Before proper data analysis, it is possible to determine the expected success of the optimization only roughly**.

Exaggerated expectations before the start of the project
Even simple data analysis by experienced data analysts can relatively well limit the project's expected results, so it is recommended to start with an examination of data and impacts for several projects and then select the project promising the highest benefits.

Inexperience of the team in impact analysis

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The ability to create an impact forecast based on data analysis is the prerogative of truly experienced data analysts. Therefore, it is by no means recommended to leave this project's pivotal point to the junior team.

Lack of communication between the teams of the client and the supplier
During the implementation, the most significant risk is the lack of communication between the teams of the contracting authority and the supplier and the resulting insufficient compliance of the solution with the actual processes and needs of the company. The motivation is often to save experts time and associated costs.

⏸ ***STOP THE PRESENTATION***

Discussion 3

1. *Do you have a solid business plan and payback calculation at the beginning of the project? If so to what extent are these realistic cost-benefit calculations?*
2. *Have you been able to frame the cost of the project in past cases? What might the price be based on?*
3. *What are the most common false expectations that you have registered in your projects?*
4. *How long after project deployment did you contact the contractor for assistance? Did they provide it under warranty, or was it for services beyond warranty?*
5. *Is there an ex-post cost-benefit evaluation after the project is completed in the company?*

⏵ ***START THE PRESENTATION***

Slide 17 - This course was created in collaboration

⏸ ***STOP THE PRESENTATION***

Conclusion:

Artificial intelligence brings a number of benefits to industrial manufacturing. It helps to improve product quality, reduce costs, and bring innovation to traditional manufacturing processes.

At the same time, however, there are risks that must not be underestimated. Exaggerated expectations and a lack of communication between teams can slow down the successful implementation of AI in manufacturing.

It is important to understand that artificial intelligence is not just a trend, but is becoming a reality in the industry. It is a tool that can change the way we make products and manage

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manufacturing processes. With these new developments come opportunities, but also responsibilities, and it is up to us to make the right use of them.

Finally, I would like to thank all the participants for their attention and openness in listening. I hope you were inspired by our presentation and if you have any questions or need more information, we are here to help.

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