PREDICTIVE MAINTENANCE
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/predictive-maintenance/

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,

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- 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,
- Recognize the benefits of implementing AI and the risks associated with implementing the project.

Course of training

Introduction

Hello, today I would like to introduce you to an interesting concept of predictive maintenance and its implementation in a typical production factory. Our session today will include a glimpse into the world of digitalization and artificial intelligence (referred to as AI), which are becoming key tools in improving the efficiency and reliability of operations in the industrial sector. Together, we will look at solutions to common problems in the operation of manufacturing facilities and discover how predictive maintenance can change the way we see and manage production.

Let's start by looking at a simple example that relates to problems in a typical factory, what are the prerequisites for implementing AI into the predictive maintenance process. Finally, we will learn about the potential risks and especially the benefits of AI.

I will now play you a presentation whose voice belongs to AI, as a demonstration of one of its capabilities.

START THE PRESENTATION

Slide 1 - introduction

Digitization scenario using artificial intelligence

Slide 2 - Introductory example

Slide 3 - Common problems of a typical factory

A typical manufacturing plant is a complicated system composed of human activities and running technologies, demanding correct settings and coordination. Shutting down and restarting production is a complex, lengthy, and most importantly, very costly affair.

- Because of this, there is pressure to maximize the **availability of critical equipment** to prevent unplanned production outages and accidents.
- Keeping production facilities in a trouble-free condition requires regular and frequent **preventive inspections.**

Slide 4 - Common problems of a typical factory

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STOP THE SOUND OF THE PRESENTATION

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

Can artificial intelligence help?

Precautionary inspections themselves also harm the continuity of production, as in most cases, they require the machine to be stopped. Therefore, solutions are being sought to reduce the number of these inspections without affecting the risk of failure

1. **Automated data collection:** One solution is automated data collection from the device. The so-called industrial Internet of Things is primarily used for this .
2. **Data processing and evaluation**: However, the data collected needs to be evaluated. To evaluate them, we often need experts who have different qualifications than the staff who perform the routine visual inspection. The evaluation can be inaccurate and the error rate high, as the evaluation of a large amount of data cannot be done intuitively, and the human factor comes into play.

START THE PRESENTATION SOUND

Slide 5 - Problem-solving in production

Artificial intelligence can automatically find patterns in data, much like humans. However, unlike us humans, AI can quickly deal with multidimensional relationships, while it is difficult for ordinary people to imagine even a four-dimensional structure.

STOP THE PRESENTATION

Discussion 1

1. *Are you registering an increased interest in intelligent solutions in the maintenance field, recently or, say, since Covid?*
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?*

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Slide 6 - Prerequisites

Slide 7 - Process

The essential precondition for implementing predictive maintenance is a sufficiently mapped technology on which maintenance is performed. Specifically

1. **Mastered diagnostic methods**: practically mastered diagnostic methods.
2. **Recognized types of disorders**: an overview of the types of failures that occur.
3. **Common causes of device failure**: and mostly, the causes and conditions under which the disorders tend to occur.

Slide 8 - Data

Before running the predictive model, it is necessary to have a sufficient sample of examples, the so-called dataset. It must meet the following parameters. The samples must consist of the measured values of the sensors just before the failure. The dataset must contain data that will then be available in production. The dataset should have at least a few dozen examples. The dataset should be balanced. It should include negative scenarios, that is, failures, and positive scenarios, that is, data from regular operations. It is necessary to create a dataset before running predictive algorithms.

Sufficient sample data

- Examples from the measured values of the sensors just before the failure
- Data that will also be available in running production
- At least a few dozen examples
- Balance - failure and standard operating data
- Creating a dataset before deploying predictive algorithms

Slide 9 - Applications

The operation of manufacturing companies varies from case to case. In each case, the machine can be equipped differently, information systems can also be diverse. M.E.S., P.L.M., and E.R.P. applications are likely to be used for predictive maintenance. The company can have at least a subset of these applications, usually from different manufacturers. This heterogeneity must be considered at the beginning of the project.

STOP THE SOUND OF THE PRESENTATION

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

Commonly used applications:

MES, Manufacturing Execution System

- Allows you to collect operational process data from control systems and technological equipment within the company and use them for real-time management

PLM, Product life cycle management

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- supports the management of 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

- in-house information system, used for administration and management of all sources, workplaces, and business functions with the support of shared data

START THE PRESENTATION SOUND

Slide 10 – Infrastructure

The necessary infrastructure consists of the equipment for data collection and subsequent storage, processing, and analysis. These are usually the following devices:

Typical infrastructure requirements:

- Sensors
- Infrastructure for collecting data from sensors
- Collection centre / Hub
- Data storage
- Analytical server

Much of this infrastructure can also be **operated in the cloud**. In this case, it is necessary to carefully consider **network throughput** and integration into the infrastructure and systems that we **already have deployed locally**.

Slide 11 - People

Competent people, whether on the client's side or the supplier's side, are crucial for the project's success.

STOP THE SOUND OF THE PRESENTATION

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

On the client's side:

Sponsor, the owner of the process, the person who has the resources to finance it

and enough power to push for change

- The top position on the customer side is the project sponsor, who is responsible for its financing and, at the same time, ensures the necessary cooperation or eliminates resistance to change among the employees.

Maintenance expert, expert on the maintenance process provides data samples to the dataset and other necessary inputs

- From a technical point of view, a maintenance expert plays a crucial role. He provides all the detailed information necessary to create a dataset.

Support team, responsibility for partial tasks, mainly artificial intelligence training

- Equally important is the support team, which performs various sub-tasks and oversees artificial intelligence training.

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IT expert, ensures the operation of the infrastructure

- If the automation applications are operated on the client's infrastructure, it is necessary to have an IT specialist in the team which provides operational tasks

Slide 12 – People

On the supplier's side: It is also necessary to have several capable experts available on the supplier's side.

Architect, design of the necessary infrastructure depending on the model of operation, for example, whether the operation will be done in the cloud or directly at the workplace)

- First, the architect ensures the design of the necessary infrastructure, whether it is the infrastructure on the customer's premises or a cloud solution

Consultant, expert in creating datasets and setting predictive algorithms

- A key role is also the consultant, who actively communicates with the expert in maintenance and, according to his instructions, creates a dataset and sets predictive algorithms.

Computer programmer, algorithm processing and programming of the necessary software

- In the case of more complex solutions requiring the creation of unique prediction algorithms, the programmer is also a member of the supplier's team.

Visualization expert, graphical interpretation of data

- Due to the need for graphical interpretation of data, a visualization expert is usually part of the supply team.

START THE PRESENTATION SOUND

Slide 13 - Organization

Practical cooperation of the professional teams of the supplier and the client is crucial for the success of the project. Essential factors, in this case, are the project plan with appropriately set milestones, the communication model defining the system of project meetings, but especially the sufficient allocation of professional teams, and flexible management supporting proactive requirements solving and timely response to suggestions from 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 expert team
- flexible work organization

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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?*

START THE PRESENTATION

Slide 14 - Benefits and risks

Slide 15 - Benefits

The benefits of well-established predictive maintenance are undeniable and significant. They can be labelled as qualitative benefits and quantitative or financial benefits. Qualitative benefits include:

- Reduction of failure rates
- Reduction of unplanned outages
- Increased production
- Reduction of the required number of spare parts
- Extend equipment life
- Extension of maintenance cycles
- Increased security
- Reduced need for service

Slide 16 - Benefits

Quantitative benefits can be defined financially.

This includes savings related to accident prevention, early detection of emerging equipment problems, and expected return on investment. Credible studies confirm that investing in a predictive maintenance system has one of the shortest returns on investment.

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Quantitative benefits:

- Savings
- Return on investment

Slide 17 - What to watch out for

As with any project, we must avoid risks that may harm a successful outcome. Among the most serious are:

The nature of the failure may not allow prediction from the data collected

- An unusual or unique failure may occur. Therefore, its nature does not allow prediction from the prepared dataset.

Too much confidence in the power of machine learning

- Too much confidence in the power of machine learning. Machine learning can only work with the assumptions defined by humans. Predictive maintenance cannot wholly replace preventive care and diagnostics. However, it can reduce its need and extend inspection intervals

Premature termination of the project due to non-fulfilment of expectations

- This may be related to the premature termination of the project due to the non-fulfilment of overly optimistic assumptions

Inexperienced team

- The big problem in this type of project is the lack of specialists with sufficient experience.

Resistance to change

- Any change will naturally be accompanied by resistance. Maintenance workers often feel threatened in these cases. Therefore, it is essential to work with employees and explain the benefits of this solution, especially their future scope of work.

⏸ *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 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?*

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Slide 18 - This course was created in collaboration

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⏸ *STOP THE PRESENTATION*

Conclusion:

In conclusion, I would like to stress that predictive maintenance represents a great potential for manufacturing companies. It reduces the risk of unplanned downtime, increases the efficiency and performance of equipment and leads to significant financial savings. Nevertheless, it is not a miracle, but a tool that requires careful preparation and management. It is important to be aware of the risks and challenges that may arise in the implementation process. To succeed, we need competent people, a well-studied project plan and realistic expectations.

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