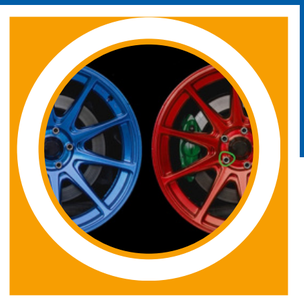
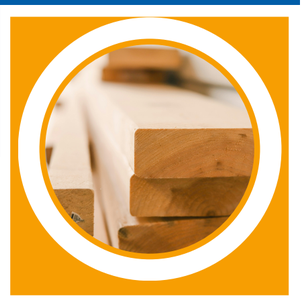
AI FOR MANUFACTURING PROFESSIONALS

AN OVERVIEW GUIDE

Accella AI

TABLE OF CONTENTS



If you are a manufacturing, quality control, or operations professional who wants to evaluate or implement AI solutions on the shop floor in the short- to mid-term and don't know where to start, this eBook is for you.

It provides explanations without jargon and highlights where, how, and why AI can support you from the perspective of experienced practitioners.

AI IS CONFUSING HERE'S WHY

- Too much tech jargon
- Too much information you don't need
- Too little information relevant to you
- Applications and their value in manufacturing are unclear
- Too much hype
- Too little information about implementation

DEFINITIONS OF KEY TERMS

These basic terms are relevant to manufacturers - and many other industries. They are often used somewhat carelessly and interchangeably in the media which leads to confusion. The main insight is that these terms are related and nested like Russian dolls.

ARTIFICIAL INTELLIGENCE (AI)

The ability of machines to perform tasks that typically require human intelligence, e.g. understanding language, recognizing images, making decisions.

MACHINE LEARNING (ML)

Subset of AI that uses algorithms to analyze data, as well as learn to make predictions and decisions without being explicitly programmed.

DEEP LEARNING (DL)

Subset of ML that uses neural networks to mimic the learning process of the human brain. DL needs a larger amount of data but can learn from the environment & past mistakes.

GENERATIVE AI (Gen AI)

A branch of AI and a subset of DL that creates models capable of generating new content, e.g. images, videos, text.

MORE USEFUL TERMS

Implementing AI these terms you are likely to come across

Here are a few additional terms that are important to know when implementing AI in a manufacturing plant.

More useful definitions can be found in our Glossary on the Accella AI webpage

DIGITAL TWIN

A virtual representation of the real-world plant that is continuously updated with data from sensors, devices, and other sources.

Applications:

- Real-time monitoring, analysis, and simulation offering insights into the performance, status, and behavior of the plant.
- Support process optimization, predict maintenance needs and improve overall efficiency

TRAINING DATA

A subset of a dataset that is used to train a machine learning model. During the training process, the model learns patterns, relationships, and features from the training data.

Applications:

- Enable the model to make predictions on new, unseen data.

The representativeness and quality of the training data significantly impact how well the model performs and how generalizable it is.

VALIDATION DATA

A portion of the data that is used to fine-tune and evaluate the performance of an ML.

Applications:

- Serves as an independent dataset to assess how well the model generalizes to unseen data.
- Helps prevent common issues like overfitting by providing a measure of the model's performance on data it hasn't seen before.

UNSUPERVISED LEARNING

In unsupervised learning, an ML model is trained on unlabeled data, meaning there are no predefined output labels.

Applications:

- Uncover patterns, relationships, or structures within the data without explicit guidance on what the model should learn.

SUPERVISED LEARNING

In supervised learning, an ML model is trained on a labeled dataset, which means that each input in the training data is associated with a corresponding target or output.

Applications:

- Learn the relationship between the input data and the desired output by generalizing from the labeled examples.

REFERENCE GUIDE OF AI MODELS

No need to remember these terms, but should you come across them and want to understand what these models do and how they apply to manufacturing, you can find that information here.

Our blog The Role of AI Models in Visual Inspection provides more detail about these models

Convolutional Neural Networks (CNNs)

CCNS are like computerized brains made up of interconnected artificial neurons. “Convolutional” refers to the way the network processes visual data. Instead of looking at the entire image, CNNs break it down into smaller, overlapping pieces. Each piece is analyzed and the information is then combined to understand the whole picture.

Applications

CNNs enable high-accuracy defect detection (> 99.995%) in visual inspection applications. They are also highly adaptable to different manufacturing environments and product types.

Recurrent Neural Networks (RNNs)

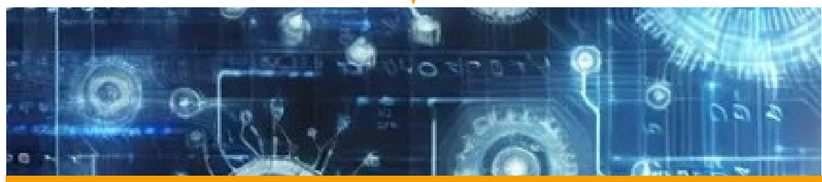
While CNNs excel at image recognition, RNNs specialize in processing sequential data, e.g. visual inspection tasks that involve video streams or time-series data. This makes them valuable tools for tasks where the order of information matters, such as tracking the production process over time.

Applications

RNNs are highly effective for analyzing video streams for continuous inspection and are suitable for applications requiring the analysis of sequential data.

Generative Adversarial Networks (GANs)

A class of AI models known for their ability to generate new or synthetic data that is indistinguishable from real data. GANs augment data for improved model training. They can also simulate various types of defects that might occur in manufacturing processes.



Applications

In visual inspection GANs are used to augment datasets, simulate defects, or generate realistic images for training purposes. This is helpful when not enough data can be collected quickly or rare defects need to be detected.

AI APPLICATIONS IN MANUFACTURING

QUALITY CONTROL

AI excels at defect detection and categorization. Models can be trained to differentiate between OK and NOK products by showing them examples. They then autonomously make a decision for every new product they are shown. They also learn to categorize defects based on examples.

PREDICTIVE MAINTENANCE

AI is a powerful tool to perform predictive maintenance applications because of its ability to quickly analyze large amounts of data and find patterns that indicate emerging issues. Using AI, issues can be detected before they cause unplanned downtime, and tasks like creating maintenance schedules can be streamlined.

PREDICTIVE ANALYTICS

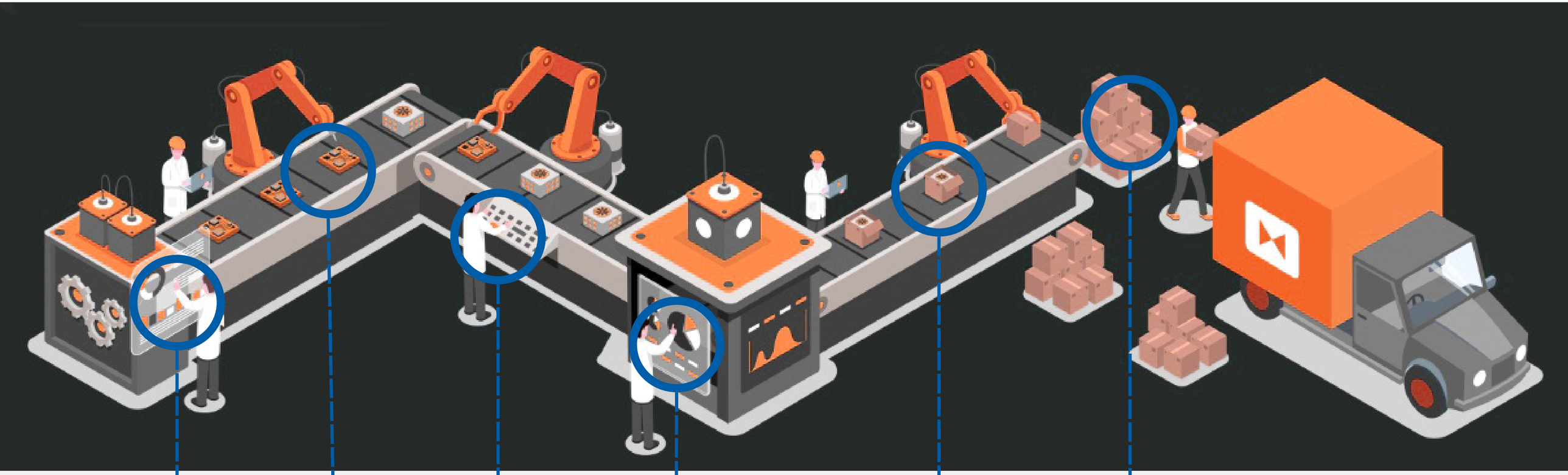
AI can be used to perform predictive analytics, e.g. to predict the physical characteristics of components based on input materials and external factors (e.g. temperature) or for process optimization. Predictive analytics allows the optimization of processes when that was previously not economically feasible.

HMI SIMPLIFICATION

Human-machine interfaces for industrial machinery can be very complex. AI can simplify HMIs by identifying the most critical parameters which can then be used for improved and less complex process control.

> AI in manufacturing is unavoidable; the real question is not whether companies will adopt it, but when. Are they adopting early enough to gain a competitive advantage or will they wait until they have to adopt AI to avoid a competitive disadvantage?
>
> Uli Palli, CEO & Chief Data Scientist, Accella AI

AI ON THE SHOP FLOOR



HMI Simplification
Set-up of complex machinery can be simplified with AI

Quality Control
occurs at critical stages during the production

Predictive maintenance
reduces unplanned downtime and allows the optimization of operations

Predictive analytics helps optimize accuracy and product characteristics

Quality Control
of the final product ensures no defective products are shipped to the customer

Quality Control
packaging, palletizing prior to shipping

USE CASE

VISUAL INSPECTION OF WOOD BOARD SURFACES

Customer: Leading European Construction Company

CUSTOMER NEED

- Detect wooden boards with imperfections, e.g. knots, splits, cracks
- Score quality of boards
- Easily differentiate between boards of A, B and scrap categories

CHALLENGES

The customer needs an automated way of inspecting wooden boards to eliminate ones that might have structural weaknesses. The defects can be hard to spot with traditional machine learning solutions due to the heterogeneity of the wood and challenging illumination conditions in the sawmill.
Additionally, they want to eliminate the time- and resource-consuming manual inspection.

SOLUTION

An ML algorithm is trained to recognize and analyze the wooden boards and to automatically assign a defect score to each board: the higher the score the worse the quality of the board
A cut-off defect score is defined by the customer and boards that do not meet the requirement are used in less demanding applications or discarded.

1. Every board automatically receives a defect score that allows the customer to bin boards into different quality categories
2. Reduces the need for manual quality control as well as scarp
3. Assures only highest quality boards are used for critical applications, e.g. construction of dams

USE CASE

PREDICTIVE MAINTENANCE OF PUMPS

Customer: Leading Manufacturer of Primary Batteries

CUSTOMER NEED

- Develop a holistic understanding of all factors impacting battery quality
- Better control maintenance requirements
- Create a stronger connection between operations and maintenance

CHALLENGES

The customer needs a system that makes pump failure prediction more reliable to avoid unplanned line downtime due to failing pumps. They also want to develop a robust maintenance schedule that optimizes maintenance activities during planned downtime and extend the remaining useful life of the pumps.

SOLUTION

An AI model that links and analyzes data from both quality control and maintenance to generate a holistic picture of pump health that allows the customer to catch emerging issues earlier.

1. Improved maintenance cycles of equipment
2. Less unplanned line downtime
3. Improved overall equipment efficiency

USE CASE

PREDICTIVE ANALYTICS OF SLURRY VISCOSITY

Customer: Leading Manufacturer of Primary Batteries

CUSTOMER NEED

- Predict whether slurry viscosity is within the required range before the start of production
- Adjust process/ product parameters if the viscosity is out of bounds.

CHALLENGES

Traditionally the viscosity of a batch of battery slurry is measured after production. If the viscosity of the slurry did not meet the required specifications, the batch has to be discarded. The customer was looking for a way to determine in advance whether the slurry will meet specs and if not, let AI recommend changes to the process or slurry recipe to compensate.

SOLUTION

An AI model using two dozen production factors was trained on thousands of production batches, Based on that input the model learned to predict slurry viscosity and can now be used to check the slurry characteristics before production of a batch begins.

1. Reduced production of bad batches of batteries leading to less waste
2. Provides actionable recommendations to the operator
3. Reduces cost due to reduced waste

USE CASE

HMI SIMPLIFICATION OF EXTRUDER INTERFACE

Customer: Leading Manufacturer of Extruders

CUSTOMER NEED

- Simplify and shorten setup of a new product on an extruder
- Reduce dependency on a few highly-trained operators

CHALLENGES

The extruder used by the customer is time-consuming and complex to set up and operate taking from 8 to 16 hours. Only highly trained operators were able to perform the task which led to bottlenecks during the night shift. The long setup time also made manufacturing of a new product cost prohibitive especially for short production runs.

SOLUTION

An AI model was trained to assist the operator with the setup: instead of manually adjusting over 100 machine parameters AI, based on an analysis of the product characteristics, proposes suitable values for the machine parameters.

1. Reduces setup time by over 60%.
2. Reduces dependency on a few key staff members
3. Makes short production runs economically feasible

IMPLEMENTATION

Data, people, and technology are the three areas to consider when planning on implementing AI in manufacturing.
Data, change management, and technology challenges associated with AI implementation are real but solvable. The value AI brings to manufacturing is easily provable through a proof-of-concept study. Investing now and gaining an advantage versus playing catch-up later is the smart strategic decision.

DATA QUESTIONS

- Which data do I need for AI?
- Has the data I need been collected?
- If not, how do I collect, curate and archive that data?
- What should my cloud strategy be?

HOW TO PREPARE

No company has all the data they need for AI ready to go.
It is critical to plan ahead, discuss data needs, cloud strategy, and what equipment (cameras, sensors, computers) is needed to acquire the data.
When in doubt, “collect more data and let AI figure out what is important” is a good strategy.

Find out more: AI Implementation: Don’t let these 4 data challenges slow you down

PEOPLE QUESTIONS

- Will we all lose our jobs?
- Is there executive alignment on the goals?
- Are all affected departments informed?
- Is IT/OT ready to support AI implementation?

HOW TO PREPARE

Change management often poses the challenges that are the most difficult to predict and address.
It is important to proactively get a handle on them and, throughout the implementation, keep an eye out for potential new issues and deal with them with the same or greater urgency as technical issues.

Find out more: 4 AI Change Management Challenges to be aware of

TECHNOLOGY QUESTIONS

- How do we integrate AI with other systems?
- Does our infrastructure have sufficient capacity?
- Should we store data in the cloud or on-premise?
- How do we secure our data and systems?

HOW TO PREPARE

To avoid delays when implementing AI it is important to assess the current technology and infrastructure and the changing needs due to AI (e.g AI runs exclusively on Linux).
Addressing infrastructure, integration, storage and security challenges upfront will safe time and expenses during the implementation.

Find out more: 4 Technology Challenges You Need to Address when Implementing AI in Manufacturing

About Accella AI

Founded in 2019, Accella AI provides cutting-edge AI-enabled solutions for manufacturing companies, industrials, and IoT companies that allow them to reduce cost, improve quality, and better utilize existing personnel and equipment.
The Accella AI Bot platform enables companies to implement state-of-the-art AI-based solutions for quality control, predictive maintenance and analytics, and HMI simplification quickly and with existing personnel. Accella AI's solutions lower the barrier to entry, and shield companies from the complexities of model development and life cycle management.
Make Smart Manufacturing a reality with the Accella AI Bot!

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