AI made simple

Turning intelligence into action in the F&B industry

“[Do] not be misled by the name 'artificial intelligence' – there is nothing artificial about it. AI is made by humans, intended to behave like humans, and, ultimately, impact humans' lives and society.”

Dr. Fei-Fei Li, Professor of Computer Science, Stanford

Meeting AI's incredible potential

Artificial intelligence in 2020 may still sound like a science fiction premise but it is today's reality.

The forecasts for the global economic impact of artificial intelligence (AI) suggest a transformative effect across global industry, with a predicted market size of 208.49 billion USD by 2025[1].

As you explore this guide, you will discover practical advice on how to unlock AI's huge potential for a new age of Food and Beverage production.

The gains from AI technology are especially exciting for Food and Beverage (F&B), as they move us ever closer to an autonomous production line, vastly improving efficiencies, saving human labor and ensuring a sustainable future. But in order to maximize AI's potential and mobilize business-wide support, you will have to think strategically.

AI is already playing a vital role in optimizing food quality and safety, ensuring that, in an industry that relies on fresh produce, processes are faster, more streamlined and better at identifying irregularities. And, as the consumer-driven economy demands continual innovation, AI is creating opportunities through new applications and freeing your people from routine tasks so they can think bigger.

The good news does not end there. Though there are significant operational gains to be made today, we have barely scratched the surface of what the partnership between human and machine intelligence can offer.

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The time has come to discover how AI can deliver real value to your business.

[1] Artificial Intelligence Market: Global Size, Trends, Competitive, Historical & Forecast Analysis, 2019- 2025-Increasing application is the key factor driving the Global Artificial Intelligence Market (Brandessence Market Research via COMTEX), 2019

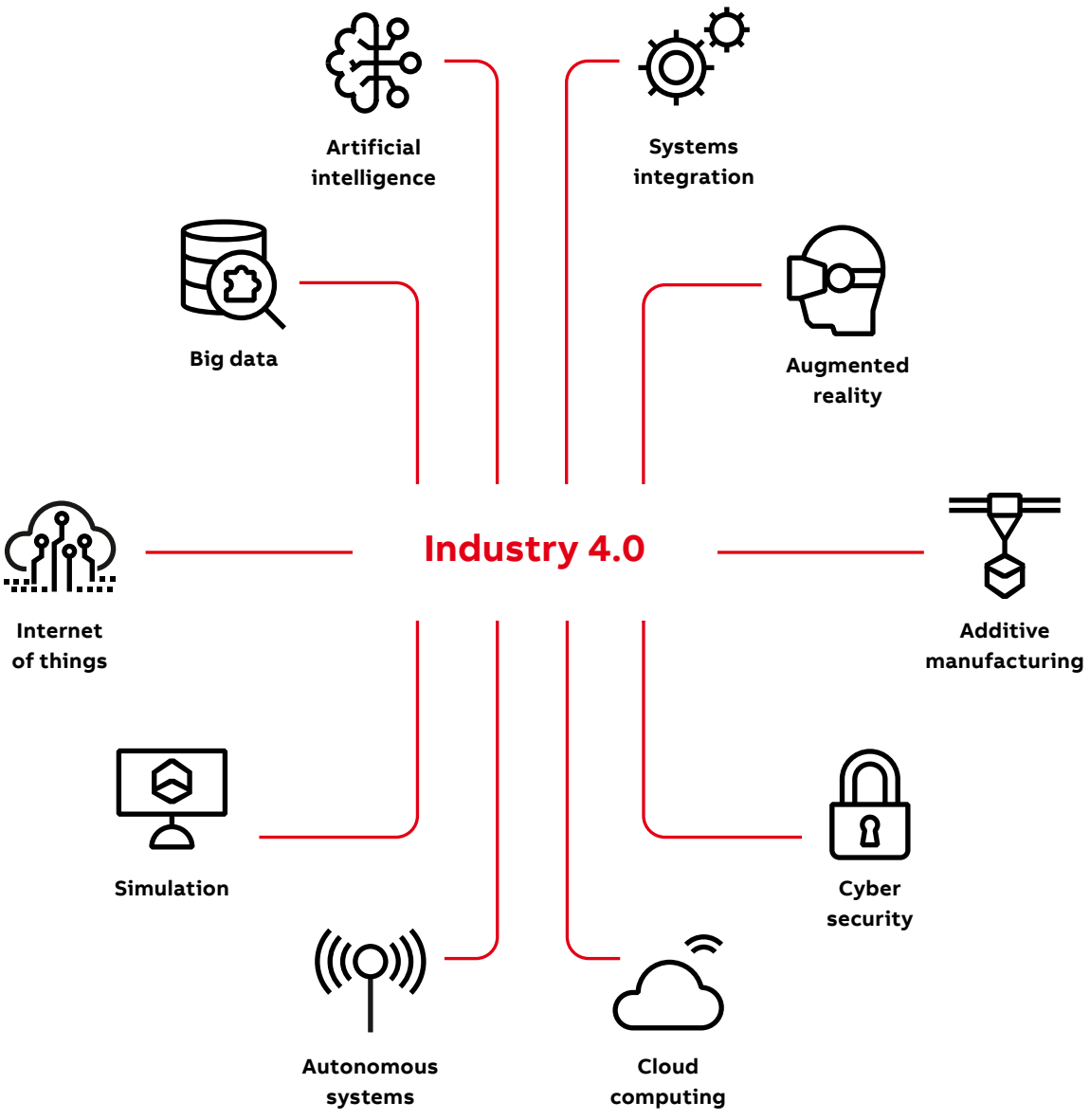
PART ONE: INTRODUCING AI

The building blocks

"The key focus will always be the customer's challenge – AI is just one of the tools to be applied."

Dr Christopher Ganz, Head of Strategic Solutions, ABB Future Labs

AI promises to transform Food and Beverage facilities into Smart Factories, moving towards a highly responsive, adaptive and connected manufacturing model. Smart Factories offer many cost-saving benefits including improved asset use through enhanced connectivity; predictive maintenance and condition monitoring; online quality inspection; automation of manual operations; autonomous systems learning and adaptation to changing situations. As you might have guessed, AI is not solely responsible for every aspect of these improvements. Instead, it is one component in a game-changing suite of Industry 4.0 technology. The end goal is intelligent automation, a holistic approach that integrates human workers, robotics, process automation systems and AI.



The terms you need to know

One of the key challenges of discussing artificial intelligence with multiple departments is how quickly terms and processes bleed into one another. Being able to explain complex technical processes with clarity is key to ensuring internal buy-in and maintaining managers' trust.

Here's a brief rundown of the key AI concepts, uses and processes.

Artificial Intelligence

At the most basic level, AI can be understood in terms of pattern recognition.

AI uses algorithms to recognize patterns in objects or information. From there, it can classify and sort items quickly and accurately. Machines are far more effective and consistent at low-level pattern recognition than humans, but humans retain the advantage in terms of high-level strategic pattern recognition and conceptual thinking that takes factors beyond data into account.

Artificial General Intelligence (AGI)

Much of the excitement and fear generated by AI is due to Artificial General Intelligence, the so-called Broad AI which is comparable in scope to human intelligence.

Whether it is Deep Blue beating Kasparov at chess, or IBM's Watson winning Jeopardy with AI-enhanced trivia, the presence of AI in pop culture has led to a misconception that artificial general intelligence has arrived, it's getting better, and it's overtaking humans. Anxieties surrounding this scenario are misplaced however – the kind of technology that would support superintelligence simply does not yet exist.

Artificial Narrow Intelligence (ANI)

Narrow AI is used in industrial manufacturing. It is highly specialized, focused on a specific domain, and often reliant on large volumes of historical data in order to learn.

Some uses of ANI

- Computer vision (where computers can 'read' and understand an image or photo)
- Product recommendation engines
- Content filters
- Virtual assistants

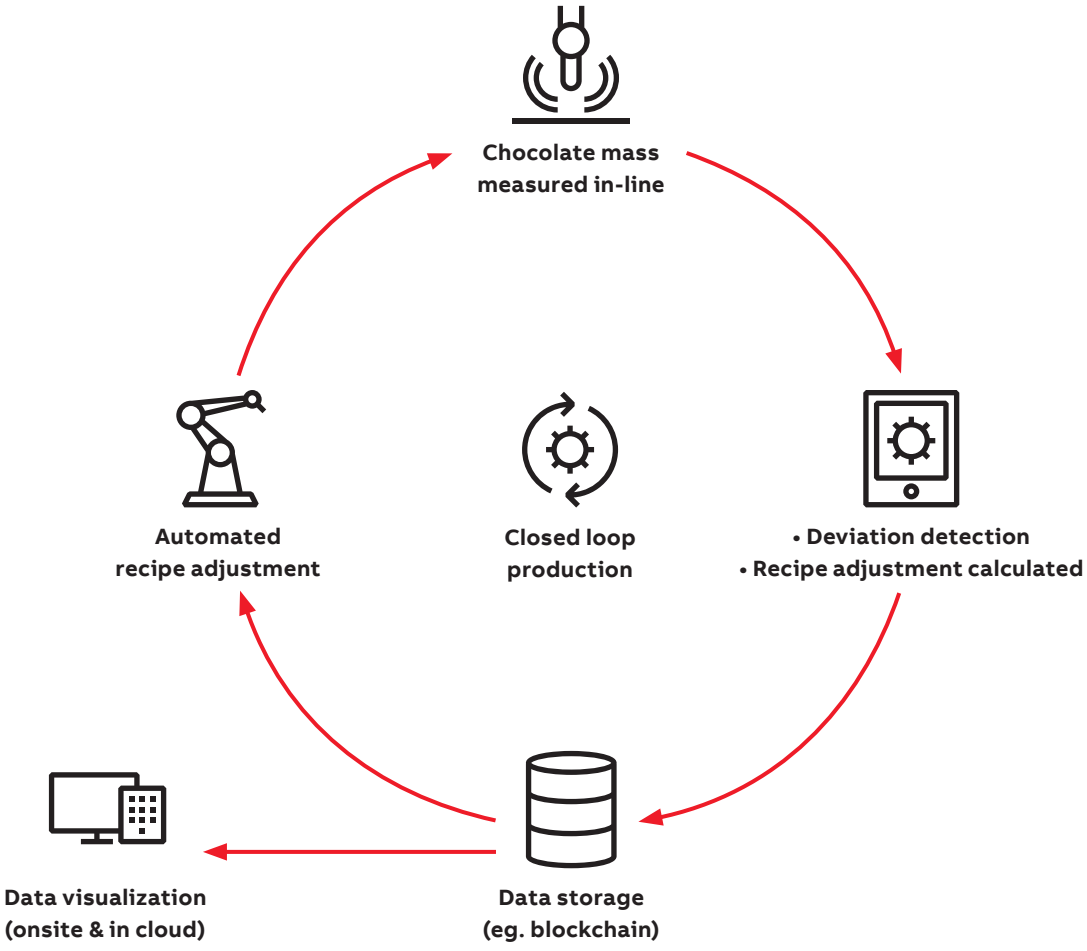
AI & closed loop production

The huge amount of data generated during industrial closed loop processes allow an AI to improve its functionality autonomously.

Chocolate production has evolved to become a fully automated process and takes full advantage of ANI. AI monitors every Value Step in the factory, measuring and analyzing different qualities like texture, weight or temperature at every stage.

If the AI detects any deviation from the norm, it can calculate and store the required adjustments. Then, the altered recipe is sent to the autonomous production line to be implemented and the whole self-improving process begins again.

Closed-loop processes like this are free of human intervention, reduce waste and maintain consistent quality.



Understanding your AI toolkit

"AI is a collection of tools that increase the intelligence of assets. Machine Learning, Deep Learning and Reinforcement Learning are all individual tools within the toolkit"

Shiva Sander-Tavallaey, Principal Scientist, AI Lead, ABB

Machine Learning

Machine Learning (ML) is the principle that a machine can learn without human intervention, developing its own algorithm to improve the performance of a specific task. This is the basis of many of the most widely available consumer applications today.

It requires a huge amount of input to become useful and relies on vast datasets for training purposes.

ML is a large term and can include any of the following:

Neural Networks
A set of algorithms loosely modelled on the way the human brain processes information.

Deep Learning
A sophisticated version of machine learning, used to perform more complex tasks or to produce data needed for decision-making. It uses multi-layer neural networks for a more powerful way to filter and process information.

Reinforcement Learning
A set of goal-oriented algorithms which learn from experience rather than historical data and become progressively better and faster at completing a task.

Natural Language Processing (NLP)
A process that allows computers to process and analyze large volumes of human speech. Applications for NLP include Virtual Assistants and Brand Sentiment Analysis.

Cutting inefficiency
Microsoft and Migros

Leading Swiss meat manufacturer Migros needed to improve the speed and quality of meat categorization without putting additional pressure on their human workforce.

They joined forces with Microsoft's partners to create Custom Vision, an AI application that learned to recognize and sort meat cuts autonomously, using a machine learning algorithm.

The result was a self-optimizing system that freed workers from a repetitive, time-consuming task.

The simplicity challenge

As AI techniques become more sophisticated, new challenges surrounding accuracy and explainability emerge. As machines perceive data in a fundamentally different way to the human brain it can be challenging for anyone but the most highly trained data scientist to interpret the logic behind AI-made decisions.

This is problematic for the Food and Beverage industries where decision makers need to ensure that the business is operating efficiently, ethically and that their AI's recommendations can be trusted.

To address this, Microsoft have pioneered a technique called 'Machine Teaching'. Specialist workers are using their expertise to literally teach machines how to make better, more easily understood decisions by showing them how to break problems into simple steps. They then guide the machine to solve complex tasks faster by using a 'lesson plan' that explains the important information and offers guidance on how to self-monitor for effectiveness.

By teaching machines how to structure their computing methods more like human thought, it becomes easier to understand the reasons for their recommendations. This speaks to the rich potential of digitalization to capture and retain the expertise of skilled senior workers that would otherwise be lost to industry as they head into retirement.

PART TWO: AI IN PRACTICE

Pushing for change

"AI is making possible a new level of competitiveness."

Guido Jouret, Chief Digital Officer, ABB

Far from being a purely industrial proposition, AI has the potential to enhance the entire Food and Beverage ecosystem, from primary production to delivery. The main challenge for F&B business leaders now is how to deliver the greatest amount of value.

If decision makers are to build a robust business case for AI, they must first start with the right questions. These could include: how can AI be integrated with new and existing robotics? How can it improve competitiveness and increase throughput? How does it drive down costs, increase margins or grow revenues?

These practical considerations reflect the need for AI's tight integration with business strategy. For many businesses, the immediate objective will be to use AI to create a predictive analytics model that can limit costly downtime by anticipating potential problems in advance.

The next step after predictive analytics is prescriptive analytics, a more complex AI proposition, that enables intelligent automation, where machines can respond in real time to new and varied inputs.

The good news is that any business that already works with data will have accumulated a suite of skills, tools and resources that will be invaluable in developing AI applications. The diagnostic analytics that are collected after a problem or event on the production line draw on multiple datasets, including both enterprise and operational data. This provides a great starting point for the introduction of AI.

Reeling in the benefits of data

ABB and Norway Royal Salmon

Norway Royal Salmon operates close to the Arctic Circle in some of the harshest conditions on the planet. With wild fisheries unable to satisfy increasing demand for high-quality product, fish farms have become an essential part of the global supply chain. One of the challenges of this farming method centers around keeping fish free of parasites, a problem that costs the industry $600 million USD per year.

ABB and Microsoft are working together with Norway Royal Salmon to bring innovative technologies to every corner of the planet. Their latest breakthrough uses stereoscopic technology and AI to help farm 70,000 tons of salmon using safer methods that support sustainable aquaculture.

In the past, aquaculture workers had to hand-check fish for lice and weight, a practice that often proved a time consuming and physically dangerous. Now AI is used within remote visual detection technology to monitor fish health and optimize the feeding process. The software monitors the fish through underwater cameras, estimating their biomass and releasing the appropriate amount of food. All data captured on site can be viewed through an onshore dashboard, creating both a valuable competitive advantage and a safer, more sustainable process.

How AI is transforming Food and Beverage

The high-profile nature of Food and Beverage means the industry faces pressures that include regulatory compliance, balancing agility and productivity, price squeezing across the value chain and an urgent need to address waste.

Here are some examples of how AI can be used to address each of these issues and create opportunity for business gain across the board.

Safety/quality issues

Without question, AI systems can deliver safer, more accurate production lines results with greater speed and more consistency than humans. AI detection can also be used to scan employees and equipment, identifying potential risks, such as a worker who has forgotten to wear the appropriate safety gear.

Waste reduction

New approaches to measurement and monitoring can have a huge impact on waste reduction. Rather than waiting until the end of a batch or cycle to check the quality of output, AI that uses real-time monitoring can identify anomalies as soon as they occur.

An example of this advanced process control can be found on baking production lines, where AI is used to drastically reduce waste. The algorithm acts as part of a closed loop process, performing real-time in-line measurements to calculate the precise amount of flour needed to prevent dough from sticking to the conveyor belt.

Hygiene

AI also displays great potential for the optimization of the hygiene and cleaning tasks so critical in Food and Beverage facilities. A UK-based partnership between the Martech of Whitwell and the University of Nottingham is working on developing self-optimizing Clean In Place (CIP) systems, where AI-powered multi-sensor system will detect food residue and microbial debris on equipment in order to determine the optimal length of cleaning time, maintaining hygiene standards and boosting efficiency. It is estimated that the system could save the UK food manufacturing sector up to £100 million per year.

Environmental sustainability

AI can play a vital role in optimizing power and water consumption, which creates immediate benefits for operating costs and margins.

For instance, fresh products like fruit and vegetables can vary dramatically in size, shape, color, or texture, adding a layer of complexity to the production line. AI solutions can easily recognize variances, removing contaminants without wasting whole batches and continually adjusting water and energy usage according to requirements. The entire process, including robotics, can be fully automated, running 24-7 and active across production.

AI can also be used to make facility management easier and more sustainable by cutting electricity consumption. Energy Forecasting and Intelligent Alerts, ABB's suite of AI-powered energy management tools, were developed as part of its Open Innovation program to help operatives reduce peak demand charges. The Intelligent Alerts app also utilizes predictive machine learning algorithms to help users identify issues before they become problems, reducing costly downtime.

Production optimization

AI has enormous potential to optimize production and uncover manufacturing facilities' best operating points to meet and even exceed KPIs.

Examples of its application could include faster production changeovers – reducing the amount of time needed to switch from one product to another – and identifying production bottlenecks before they become a problem. Today, an operator is still required to 'tune' the recipe or process but in the future, models will be trained to calibrate production automatically, enhancing output quality and speed.

AI systems will also soon be able to use machine learning algorithms and physical models to predict common failures and self-resolve. Preventive action may also be taken during planned downtime. The ability to predict and prevent unscheduled stops minimizes the risk of production loss, costly repairs and the need for excessive spare part stock. This projected future is not far away – even today, ABB can offer predictive maintenance based on electrical equipment usage data.

Maximizing energy usage is also a key element of production optimization. AI can enhance this process further at plant level, forecasting energy needs, scheduling production to minimize demand peaks and maximizing renewable energy sources by balancing variable rates.

Packaging is another area where AI can play a role. As production batches become smaller, packaging requirements more varied, and distribution more fragmented, AI can play a vital role in optimizing pallets and loads.

For example, an industry-leading dairy produces around 1.5 billion plastic yoghurt containers a year, all of which used to be manually checked for shape, material distribution, wall thickness and weight every 30 minutes. If a fault was detected, the anomaly needed to be removed manually, and, in a worst-case scenario, everything since the last measurement would also be removed from production.

An AI and robotics-powered in-line quality check avoids all of these potential pain points by removing the need for any manual interference, using a faster, fully-automated approach.

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Optimized packing through learned behavior

ABB and Covariant

AI-driven robotics are proving key to meeting the packing and picking demands accelerated by consumers' increasing use of e-commerce. The complex and labor-intensive nature of the process offers unique potential for intelligent automation.

ABB has partnered with Silicon Valley start-up Covariant to supply sophisticated picking robots that work side-by-side with human operatives. Covariant's software combines 3D cameras and reinforcement learning, so robots can learn new tasks independently.

The combination of sophisticated AI and cameras is important as less advanced robots experience difficulties packing simple water bottles. Typical 3D cameras assume that products to be picked are solid and therefore light should not pass through them. A water bottle's transparency allows light through which means certain cameras do not understand what they 'see' and so the robot will ignore it altogether. Covariant's vision system allows the robot to combine footage from the camera with past learned experience. This allows for much more sophisticated trial and error responses, which ultimately result in incredible accuracy that can work at scale.

More than a novelty: AI, invention and creativity

"The closer an industry is to the consumer, the greater the push for change and innovation."

Shiva Sander-Tavallaey, Principal Scientist, AI Lead, ABB

Across the Food and Beverage supply chain, AI is being used to create new brand differentiators and business models. As analytics help to uncover gaps, opportunities and trends, AI enables accelerated innovation and speed to market. This kind of smart industrial process allows for agile experimentation and varied production runs.

From a consumer perspective, AI continues to fascinate and enthrall people across the world. It remains a powerful source of novelty which can be used to differentiate a brand and attract consumer engagement. Potential innovative applications include intelligent robots in retail environments, the promotion of AI-generated recipes, the use of recommendation engines or ever greater personalization.

As vertical integration increases, we can also see AI playing a powerful role in supporting Direct to Consumer business models and in developing new products and varieties. Just as we have become used to recommendation engines on consumer platforms, similar technology may emerge to inform targeted innovation within industry.

There is enormous potential for beverage manufacturers to use AI to put the huge datasets collected in their automated systems to work, analyzing historical data and ingredient parameters. With the support of the right control system, the possibilities become endless: brands can create best-quality flavor profiles and even refine individual steps in the production process such as fermentation or pasteurization.

AI with a spirit for innovation
Microsoft and Mackmyra

Creating new whisky flavor combinations had always been the domain of master blenders. However, in 2019, US distillery, Mackmyra collaborated with ABB partner Microsoft to manufacture and sell AI:01 Intelligens, the first whisky developed by AI.

Intelligens was the result of AI analysing 75 of Mackmyra's award-winning blends, sales data, customer reviews. It is estimated that this dataset alone could generate 70 million recipes based on what was in stock in Mackmyra's warehouse.

Once launched, Intelligens received positive reviews from online whisky aficionados, who were delighted by both the vanilla overtones and novelty factor. It is important to note however that Mackmyra's master blender Angela D'Orazio oversaw the entire creative process to prevent a costly misfire for the brand. In a phrase that underscores the crucial partnership between artificial and 'natural' intelligence, D'Orazio described the process as "AI-generated but human-curated".

PART THREE: GETTING STARTED ON THE JOURNEY

The architecture of success

"The real challenge here is SIMPLICITY. Embedding data smarts in established machines and processes has to be kept open and interoperable… there will be no single source solutions."

Martin Cannell, Global Account Director, ABB USA

Despite the high level of interest and investment in AI across the industry, there seem to be relatively few stories of successful value capture. As many as 70% of companies have reported little or no return on their AI investments to date. However, this is not so much a reflection of the lack of AI's value, but the time and mindset required to deploy AI successfully.

Instead of thinking solely in terms of project-centered goals, decision makers' strategy should be holistic across the business. This means careful consideration of what business transformation means for your organization. It is only through this kind of specific reflection that you can effectively prepare your people and data infrastructure for a new way of working.

Managing cultural change

"Getting the most out of AI requires a team effort. A good rule of thumb is to consider AI to be 10% about algorithms, 20% about technology, and 70% about business process transformation[2]."

Your business's introduction to AI should not be left to the IT department or the CIO alone — integrating the technology demands a whole business commitment.

Your entire AI initiative must have the support of senior business leaders who understand the need to transform business processes to take best advantage of AI's capabilities.

The second aspect of your business transformation should cover AI's impact on the workforce. With more and more routine processes being automated and freeing up the workforce, making the best use of your people's time becomes a key consideration. Roles may need redefining in line with the changing nature of the work. This allows individual workers to take the opportunity to develop new skills as they move away from the more tedious and dangerous tasks now managed through robotics, AI and automation.

Far from being rendered obsolete, human workers will always be a crucial component of the manufacturing process. For instance, although AI can deliver highly nuanced analytical reports, the knowledge and creativity of your people is what can contextualize that data into the most useful insights.

AI's success depends on effective collaboration between

- Humans and machines
- Operating technologies and information technologies
- The board room and the factory floor
- Suppliers, manufacturers and distributors
- Innovation and operations

Addressing skill shortfall

While public attention is heavily focused on the potential employment loss arising from intelligent automation, manufacturers are focused on a different problem: skill shortages. AI will be a significant asset in addressing the lack of skilled workers in the manufacturing industries, which are facing a growth-threatening talent deficit of 7.9 million people by 2030[3].

It is important to note that across the history of industry, there has been a sustained trend toward the removal of dirty, dark, dangerous and dull aspects of work.

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This is especially important from a health and safety perspective, but it also can have a profound impact on reducing costs.

A good example of this new reliance on machine workers can be found in orchards across the world. Many organizations are finding it increasingly difficult to attract seasonal fruit pickers to support their needs. Previously this job could only be filled by humans, who had the fine motor skills required to pick fruit without bruising it. Now we are seeing accelerated developments in robotic capabilities to address the human shortfall and the first models with the delicate touch required are now in operation.

[2] Winning With AI: Pioneers Combine Strategy, Organizational Behavior, and Technology (BCG) 2019
[3] The Global Talent Crunch (Korn Ferry) 2018

Understanding data architecture

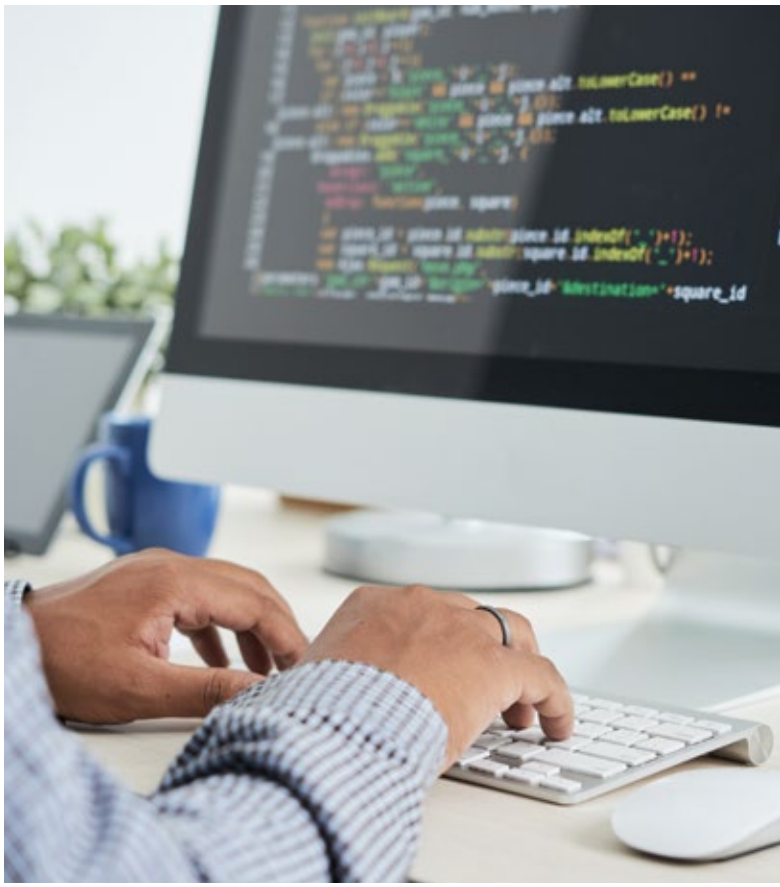
With the Industrial Internet of Things gathering momentum, business leaders must start thinking about their data storage in a completely different way.

One of the most notable facets of industrial data is the sheer volume of information, as it flows from source to processing to final report.

Managing expectations
The essential differences between consumer and industrial AI account for many of the misaligned expectations F&B leaders encounter. Unlike mainstream consumer AI, which can analyze a large range of different datasets because it is usually looking to learn from average consumer behaviors, industrial AI's pattern recognition seeks to learn from differences. Industrial data is sourced from a diverse range of devices and systems, which often have little in common with one another. The outcome of this is that industrial AI requires a much larger dataset than an AI designed for consumer use.

Edge computing and digital twins
Complex models are vital to contextualising and sorting the raw data generated by industrial AI. These models function as a digital twin, acting as a benchmark so any production data that deviates from the norm (usually indicating a problem on the factory floor) can be identified in real time and action taken without the need for human intervention.

The growing scarcity of data centers means that mediated data delivery (a model that converts data into an understandable format) will be increasingly completed in the cloud. Here we see Edge computing playing a critical role. This means that instead of being transmitted to a far-off data center, data is processed in real-time on a local computer, server or even the device that collected it.



Manufacturers are embracing Edge computing as a crucial part of their hybrid data architecture, a way of storing data based on factors like importance, privacy or regulatory requirements.

This is largely because Edge computing vastly reduces latency, lessens the need for data centers and cuts down on costly bandwidth requirements.

The increasing use of faster networking technologies like 5G wireless are helping Edge computing produce even faster results, enabling quicker, localized decision making with less risk to performance and removing the need to store sensitive data outside your organization.

A revolution in small steps

"By thinking big but starting small with manageable projects, the promise and benefits of AI and smart operations can be realized and then quickly scaled."

Tatjana Milenovic, Global Head of Food & Beverage Industry Segment, ABB

Artificial intelligence has the potential to be completely transformational for the Food and Beverage industry. The possibilities are vast and their ability to inspire should not be undersold – this is a time to dream big. But in order to garner support for your AI ambitions, it is also necessary to demonstrate proof of concept. This is why most businesses choose to start their AI project small and roll out their successes.

Less complex, relatively contained applications provide stakeholders with the results, lessons and confidence to support strategy over the longer term. It is a pragmatic approach that avoids the risks of going big from the outset.

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Safety is paramount in the Food and Beverage industries with the cost of any unscheduled downtime easily running into millions of dollars. With this in mind, implementing huge, costly AI projects is rarely a desirable approach.

Another key decision facing businesses is whether to focus on cost reductions or growth applications. In a low margin industry like Food and Beverage, throughput is the vital variable.

Businesses invested in lean production practices will be instinctively attracted to using AI to drive out inefficiencies and waste from the production process. Where lean optimization was once a static, snapshot exercise, it can now be a dynamic and continuous process, addressing issues as they arise.

But the market is changing, and productivity must be balanced with agility and innovation. Optimizing production lines for multiple (short run or small batch) product variants without compromising on quality, safety or productivity is where intelligent automation really comes into its own.

Many businesses today are making large public statements about the value they expect to generate from AI. This needs to be handled with discretion to avoid disappointment and disillusionment. If implementation is not handled carefully it can have a negative effect on future interest and ambitions, to the long-term detriment of the organization.

Avoiding the pitfalls of disappointing AI implementation requires a realistic view of internal capabilities. This could mean seeking out external partnerships or consulting workers on the factory floor alongside gathering input from executives. Looking at operations from every angle, managing expectations and building an everyday infrastructure designed to support AI's capabilities gives businesses a realistic and achievable pathway to success.

Your AI transformation checklist

#1 Integrate AI into your strategy

AI must be properly integrated into your business strategy and overall approach to digitalization. Focus on identifying where AI has the potential to accelerate and enhance business objectives.

#2 Take stock

Successful AI implementation requires an honest appraisal of your internal capabilities and data strategy, governance and quality. This is often summarized as data maturity.

Data quality is key. Without internal confidence in your data, attempts to transform operations and culture will inevitably struggle against cynicism, skepticism and false alarms on the factory floor.

#3 Create a robust data architecture

Build a secure, integrated data architecture that combines operational and information technologies. This process will require engineers with significant experience of industrial facilities, processes and systems.

#4 Manage expectations

Ensure your organization accepts AI's experimental nature. Not every project will succeed and not every algorithm or model will work as expected. This needs to be recognized and understood by all involved.

#5 Leverage existing expertise

AI's outputs should be clearly communicated and easily understood so that current operatives can support its use. This will enable retention of existing experience, knowledge and expertise within your organisation.

#6 Nurture collaboration and partnerships

Establish what external partnerships are required to meet business objectives. Make sure external partners will safeguard your data and intellectual property and understand the complexities and risks involved in the industrial space.

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The true power of AI lies in its ability to support Smart Factories' evolution alongside a changing industry. It's a powerful tool to address shifting customer demand, development of new products or services, and real-time changes to production. It's not about an "end state" but instead an ongoing evolution, a continuous journey.

PART FOUR: LOOKING FORWARD

Into the future with AI

Artificial intelligence is set to define the future of the Food and Beverage industries. Refusing to engage with AI is not an option: 45% of global executives recognize the strategic risk, while 90% believe AI presents opportunities for their business[4].

At the heart of Industry 4.0 is the need for over-arching digital transformation. This means digitalizing the factory floor and creating an integrated architecture across Informational and Operational technologies.

In the immediate short-term, automation will focus on optimizing the quality and safety of produce and operations. But in the future, AI promises to play a key role in developing a vertically integrated system that responds in real time to customer behavior and changing contextual factors. All this will serve to optimize production and delivery at every stage, minimizing waste and maximizing sustainability.

In this guide we have explored the many advantages an optimized AI platform can bring to the F&B industries. Implementing centralized data management can even unlock new solutions that work across traditional siloes. However, it is important to note that AI's most powerful potential can only be realized with a holistic approach.

ABB's approach to digitalization is firmly grounded in our customers' reality. In the current industrial space, a great deal can be achieved by retrofitting capabilities to existing equipment.

Our deep domain expertise coupled with the strength of our robotics proposition means we can work with you to unite systems and assets into a cohesive solution that fits your needs.

So, if you're ready to face a digital future with confidence,

Talk to us.

[4] Winning With AI: Pioneers Combine Strategy, Organizational Behavior, and Technology (BCG) 2019

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