The Path to Industry 5.0

Over time, the Industrial Revolution has introduced new ways of working, new technologies, digitization, and automation to manufacturing. For the past decade specifically, manufacturers have been aligning operations with Industry 4.0, rolling out sophisticated technological innovations to enable smart, connected manufacturing systems. Industry 4.0 revolves around embedded connectivity and smart automation connecting machinery, systems, and products via advanced technologies such as artificial intelligence (AI), IoT, machine-to-machine communication (M2M), and cyber-physical systems (CPS) to create highly efficient smart operations.

What looked like the height of the Industrial revolution with 4.0 is only a prelude to the future. Having built technology and data-driven foundations we have realized the wealth of data available and how this can be stored and intelligently processed for insight-driven integration. The evolution (Industry 5.0) is in taking this infrastructure and data and integrating it with a more human-centric element. AI-enabled collaborative robots (cobots) and smart devices will work together with employees on the factory floor, further leveraging AI, IoT, and big data to make production processes more responsive and hyper customized. This collaboration between the two realities will facilitate faster decision-making, return manpower to factories, and deliver an enhanced customer experience with a heightened focus on sustainability.

In this article, we touch on the fundamental role of AI in enabling Industry 4.0 and 5.0 and considerations for implementing such solutions.
Digitalization was a catalyst in Industry 4.0 and will continue to be as we move into Industry 5.0. AI in particular has enabled radical innovation with companies improving processes, and efficiency, reducing interruptions, increasing customization, and product quality. AI is used in various areas of manufacturing including:

- **Predictive Maintenance** where sensor data is used to analyze and forecast potential failures so maintenance can be scheduled before costly downtime occurs.
- **Industrial Robotics** have automated repetitive tasks through AI such as assembly, welding, painting, and picking and placing.
- **Quality Control** systems use AI to detect deviations from the standard production output by using computer vision. When the final product has different characteristics from what it should, the AI systems raise an alarm.
- **Inventory Management** uses AI to manage stock, demand, and forecasting. AI-powered forecasting capabilities provide very accurate data allowing companies to keep stock at optimal levels and control costs.
- **Process Optimization** relies on AI-based mining software to allow manufacturers to compare performance, costs, and other process-related factors for insight-driven decisions and to streamline processes.

**Technologies Enabling AI in Industrial Automation**

A plethora of technologies enable AI-driven applications. The most common in industrial automation include:

**Computer Vision** enables computers and devices to acquire and decipher information from videos and digital images. Dedicated algorithms automate visual understanding and pattern matching, allowing computers and machines to observe, analyze, and understand visual input to recognize and make distinctions. Computer vision is commonly used in surveillance, quality inspection, robots, and automation.

**Robotics** combines mechanical/electrical engineering and computer science to design, build and operate robots that are commonly used to perform human-like activities or repetitive tasks. AI enables robots to interact with their surroundings autonomously and make decisions based on pre-existing programming. Applications range from domestic vacuum cleaners to mechanical arms and autonomous vehicles.

**Natural Language Processing (NLP):** brings together computer science and AI to program computers to process and analyze human language. NLP involves speech recognition, human language understanding, and generation. NLP is the foundation of technologies such as auto correct, chatbots, search engines, and virtual assistants.
How to Choose Hardware for AI

AI-enabled technologies capable of deep learning and inference need to be built on the right image processing hardware for optimal results. Hence, it’s important to consider the best balance of performance, power consumption, and footprint. Graphics processing units (GPU), field-programmable gate arrays (FPGA), and vision processing units (VPU) are common choices among system builders. These systems offer a comprehensive ecosystem of software, technical resources, and support to aid AI implementation:

- **GPUs** have thousands of processor cores and are designed with a highly parallelable architecture, making them ideal for the acceleration of high-performance computing workloads, deep learning, and inference. NVIDIA is a recognized market leader in GPUs, having heavily invested in developing tools for enabling deep learning and inference processes.

- **FPGAs** are widely deployed in machine vision cameras and frame grabbers. They provide flexibility and repeat programmability for data processing acceleration and various other workloads. FPGAs have a large memory bandwidth, reducing latency and enabling real-time processing of high volumes of data. Intel FPGAs come with an extensive ecosystem of support and tools.

- **VPUs** are chip-type processors developed to acquire and interpret visual information. Designed for mobile devices, VPUs are a compact, efficient, and high-performing solution for on-device inference. Intel's Movidius™ Myriad™ X VPU features a Neural Compute Engine and is specifically designed to power visual intelligence on the edge.

- **Tiny ML-based MCUs**: Tiny Machine Learning (TinyML) for microcontroller units (MCUs), are mini computer-like components requiring low power and little to no bandwidth. Used for ML optimization techniques and inference applications, they are compact, efficient, and affordable. Microcontroller providers like ST Microelectronics and NXP offer solutions that integrate TinyML.

To Build or To Buy

Deciding to build or buy AI-based solutions depends on varying factors. Time-to-market, in-house expertise and the risk/cost of failure are common decisional drivers. Building in-house offers greater customization and flexibility and can be cost-effective for high-volume applications. However, high upfront development costs, maintenance, and future-proofing requirements may not outweigh the benefits for businesses.

In comparison, buying pre-configured systems means vendors generally manage integration and upgrades within existing environments. Although this option limits customization, it accelerates time to market with minimal risk. Vendors have established teams and acquired expertise to ensure systems are always up to date using the latest technology.
Summary

Digitalization and AI-enabled technologies drive industry 4.0 and will serve as the foundation for industry 5.0. Having the right technology and hardware in place is vital to being successful. The major decision lies in hardware/software technology selection and whether to build or buy solutions, either way, it is advisable to discuss your options with a trusted advisor.

Comprehensive solution providers like Arrow offer a wide portfolio of offerings for both build and buy options and can also support with design services to streamline deployment. Arrow has expertise in defining solutions across the entire AI stack and assisting companies in adopting AI/ML technology. Arrow’s proven experience developing distributed architecture and implementing edge-to-cloud solutions also ensure speed to market.

References
- Industry 4.0+: The Next Level of Intelligent and Self-optimizing Factories
- Reference: A Primer on Multiple Intelligences