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GEORGIA'S INNOVATION &
TECHNOLOGY AGENCY

Top 10 Industry 4.0 Trends in 2022

1. Artificial Intelligence

AI and machine learning are driving innovations across industries and functional areas. AI-specific hardware and new algorithms are being developed to optimize the existing systems and tackle new challenges facing manufacturing. **Factories are beginning to integrate AI** across their production systems and processes. Advanced AI makes it possible to conduct predictive maintenance, cognitive computing, swarm intelligence, context-aware computing, smart machines, hardware accelerators, and generative design. All of these technologies propel manufacturing facilities to move towards complete lights-out manufacturing.

2. Human Augmentation & Extended Reality

The physical and cognitive augmentation of humans forms another major industry 4.0 trend. The limitations in humans are being augmented with the help of technologies such as wearables and exoskeletons. Further, industrial mobile devices, natural and intuitive UI, and portable machine control screens enhance the ease of using such technology. XR technologies like **mixed reality (MR)**, **augmented reality (AR)**, and **virtual reality (VR)** are already in use in Industry 4.0 from the research and development (R&D) to full-scale production and post-production processes. This multi-experience paradigm is changing the way industrial manufacturing systems function. The nature of human-machine interaction is aligning more toward machine-enabled workers.

3. Edge, Fog & Cloud Computing

The immense amount of data being generated by the industrial internet of things (IIoT) is **propelling the adoption of edge, fog, and cloud computing** capabilities in Industry 4.0. Custom hardware and software solutions like connected clouds, distributed clouds, distributed compute and storage, hybrid computing, low code development platforms, microservices, mobile computing, and multi-access edge computing are shaping up this industry 4.0 trend.

4. Network & Connectivity

Network and connectivity are among the main driving forces in enabling Industry 4.0. A number of technology developments such as edge-to-cloud, gigabit ethernet time-sensitive networks, low-power wide-area network (LPWAN), **5G**, machine-to-machine communication (M2M), real-time deterministic ethernet, time-sensitive networking (TSN), ubiquitous radio access, unified IoT framework, and zero-touch networks nudge factories to implement IIoT to transform into Industry 4.0 facilities. These technologies constantly improve machine-machine and human-machine communication, as well as data transmission. As a result, innovations in this area increase speed, improve security and efficiency, and reduce the cost of network connectivity.

5. Advanced Robotics

Advancements in robotics make the processes in industry 4.0 faster, efficient, and safer. The most prominent robotic technologies impacting manufacturing include autonomous robots, collaborative robots (cobots), collaborative autonomous mobile robots, humanoid, mobile robots, cloud robotics, APIs, pick and place robots, and robot swarms. The use of robots offers higher precision and agility while improving the capability of rapidly developing customizable robots. Robots also free up time for the human workforce to focus on other non-repetitive or high-value tasks.

6. Internet of Everything

The **machine-machine**, **human-machine**, and human-human real-time connectedness together comprise the internet of everything in manufacturing. It includes **IIoT**, internet of skills, internet of services, internet of systems, and shop floor IoT. The internet of everything combines together real-time data, machine intelligence, and human skills, resulting in faster, efficient, and cost-effective manufacturing processes. Interoperability and a unified internet of things framework are crucial for the smooth implementation of industry 4.0 facilities.

7. Big Data & Analytics

The scale of industrial data collection eventually enables factories to make the transition into industry 4.0 facilities. Big data is complex and is valuable only when it is captured, stored, and analyzed in a quick and cost-effective manner. Advancements to utilize data for gaining valuable insights into the manufacturing systems, along with the availability of immediate and real-time data, **open up opportunities for prescriptive and predictive analytics** at different levels of a company's manufacturing facilities.

8. Additive Manufacturing

Manufacturers constantly search for new technologies to cater to all aspects of the growing market demand. Additive manufacturing, which started out as a prototyping technique, is

revolutionizing and decentralizing production. Hybrid manufacturing aims to integrate both additive manufacturing and subtractive manufacturing. The advancement in material science and techniques such as **stereolithography** and metal 3D printing enables a simple fabrication of intricate structures and complex components. **Additive manufacturing** is making highly-customizable and sustainable cloud-based production a reality.

9. Cybersecurity, Transparency & Privacy

The flow of information due to the connectedness in Industry 4.0 is raising concerns about security, transparency, and privacy. As the manufacturing practices are increasingly becoming personal and customizable, the data management practices done outside and within the shop floor will hugely influence the appeal of the company. The transmission and processing of sensitive industrial data need to be done securely to avoid cyberattacks on critical industrial facilities. Digital ethics and privacy, privacy-enhancing technologies, self-adaptive security, zero-trust security, end-to-end communication security, DevSecOps, blockchain are some of the new developments in this field. The focus on **cybersecurity needs to be balanced with transparency** and privacy.

10. Digital Twin

Digital twin technology creates virtual models of industrial assets by combining dynamic real-time sensing and visualization data. Some of the promising use cases of digital twins include model-driven design, virtual prototyping, virtual system validation, throughput optimization, and evolutionary design. The use of digital twins is propelling industry 4.0 manufacturing towards hyper-automation. **Digital twins provide valuable insights** into all steps of the manufacturing process.