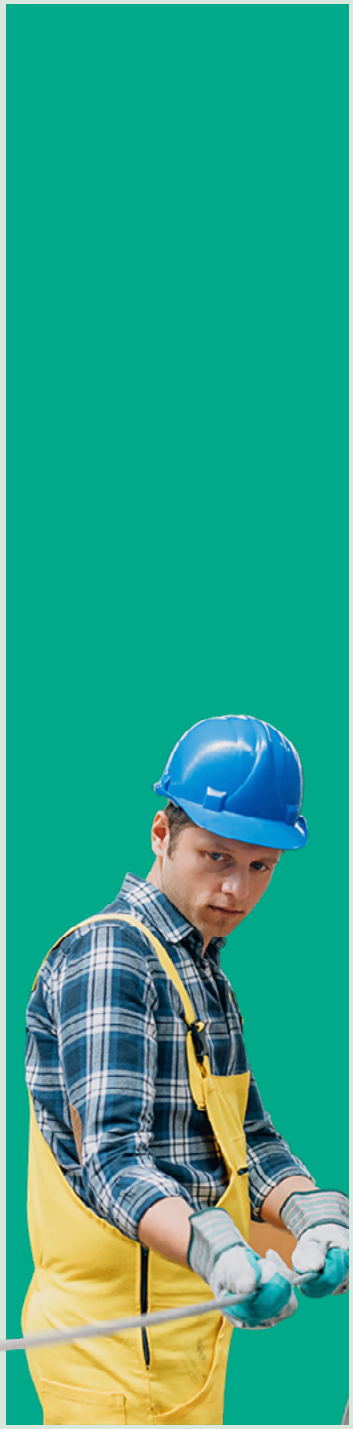
WHITE PAPER

REDEFINING SMART MANUFACTURING THROUGH EMERGING HUMAN-CENTRIC TECHNOLOGIES



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Preface

In the rapidly evolving landscape of smart manufacturing, integration and adoption of technology have transformed traditional production processes. Unfortunately, the adoption of technology across various factory segments is not uniform and poses a significant issue in the collaborative functioning of the end-to-end system. There are user personas who have a high exposure to advanced technology versus certain blue-collar workers who are minimally exposed to such evolving technologies and hence cannot reap benefits to contribute toward accelerated production and overall process efficiency improvement. The table below depicts the various roles and personas in the factory, which are grouped based on their extent of exposure to technology.

Factory personas	ICT Technology Usage	Illustrative ICT applications
Sales, Marketing, Data Analyst	High	CRM, ERPs, Business Intelligence Tools, SAS, SQL, Data Processing, etc.
Factory Designers, Production Supervisor, Quality Inspector, Maintenance Technician	Medium	Production Management Software, Digital Dashboards, Digital Inspection Tools, Diagnostic Tool and Spreadsheets
Assembly Line Worker, Packaging Operator, Material Handler	Low	Tools used has zero or minimal digital interaction and assistance, hence often are dangerous and poses risk at workplace

The disparity in technology exposure arises from several factors, including organizational investment priorities, infrastructure and technology maturity, training and skill development programs, and the complexity and risk associated with certain tools, which also hinders adoption. To bridge this technology adoption gap, industries are looking towards human centric innovations powered by Industry 5.0 such that work force on ground is powered with safe, easy to learn, effective and collaborative technologies that help them amplify their production output and quality seamlessly.

Progressing From Industry 4.0 (Automation) To Industry 5.0 (Collaboration)

Transitioning from Industry 4.0 to Industry 5.0 isn't about starting from scratch.[1] The idea revolves around leveraging the technological mileage achieved as part of Industry 4.0 and adding a human-centric, sustainable, and resilient approach.[2]

Industry 5.0 governs a mindset shift as how humans and machines interact. Industry 5.0 envisions humans focusing on creative tasks, problem-solving, and strategic decision-making, while machines handle repetitive, dangerous, and physically demanding tasks.

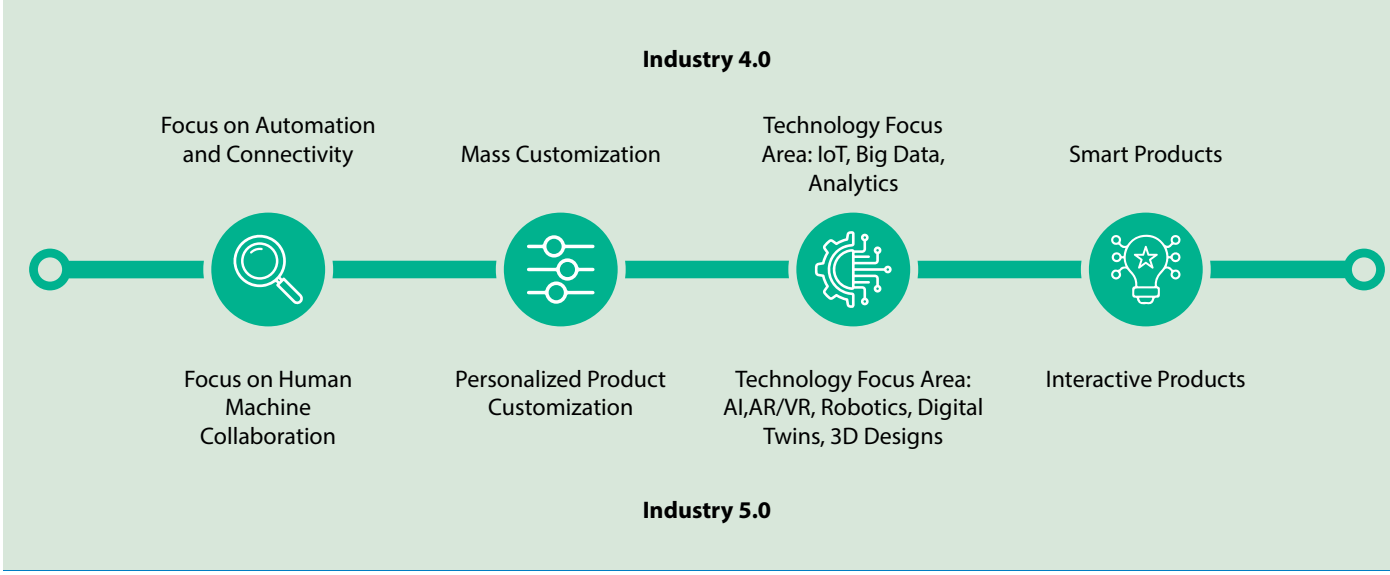


Figure 1: Transitioning from Industry 4.0 to Industry 5.0

Strategic steps involved to accomplish this transition are:

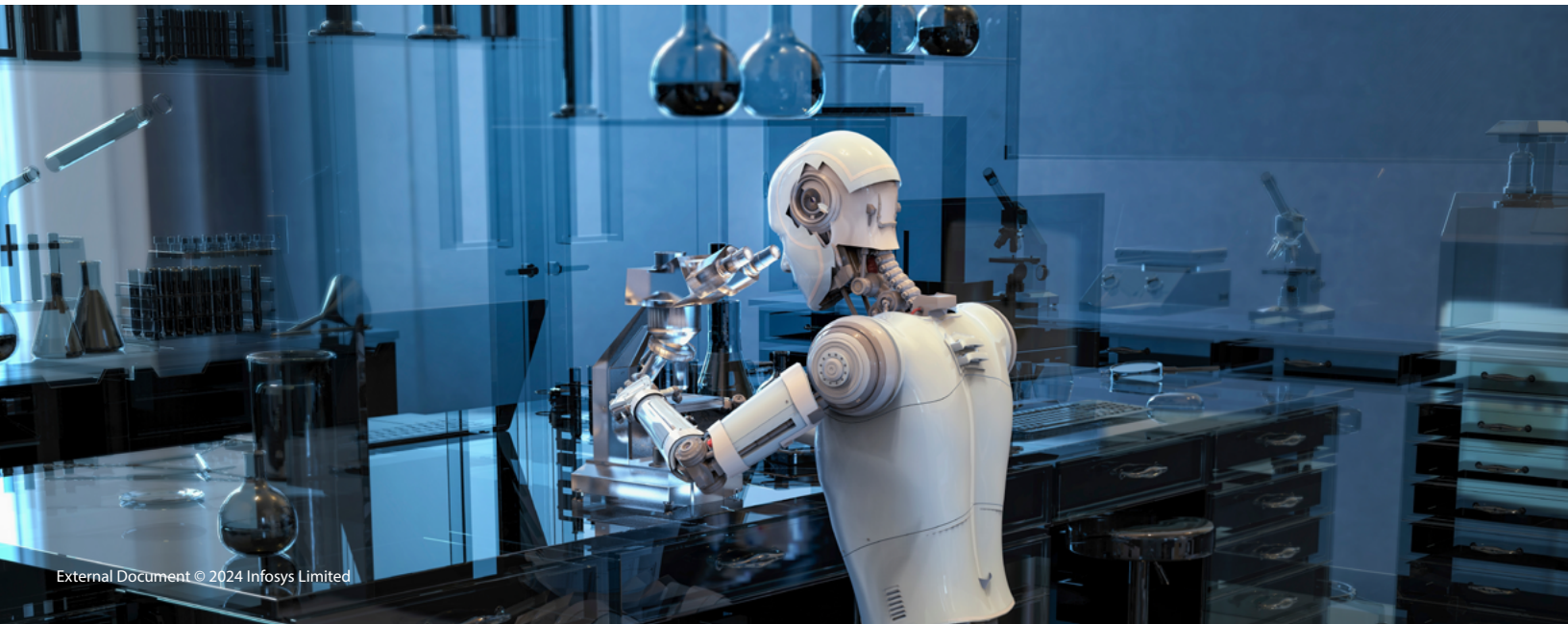
- **Upskilling the Workforce:** Equip your employees with the skills needed to collaborate effectively with advanced technologies. This might involve training programs on AI, robotics, and data analysis.
- **Investing in Human-Centered Design:** Rethink your workspaces and processes to optimize human-machine collaboration. This might involve creating user-friendly interfaces for robots, designing ergonomic workstations, and fostering a culture of open communication between humans and AI.
- **Embracing Sustainable Practices:** Focus on environmental responsibility throughout your supply chain. Explore renewable energy sources, implement eco-friendly materials, and minimize waste generation.
- **Data Transparency and Security:** As data becomes even more critical in Industry 5.0, ensure robust data security practices and transparency in how data is collected, used, and shared.

Technological Integration:

The incorporation of emerging technologies such as extended reality, digital twins, artificial intelligence and robotics have transformed traditional production processes. Industry 4.0 has brought about unprecedented levels of automation and efficiency. However, as we transition towards Industry 5.0, there is a growing recognition of the need to place human workers at the center of these technological advancements.

- **Collaborative Robots (Cobots):** Unlike traditional industrial robots that operate in isolated environments, Cobots are designed to work safely alongside human workers. They are equipped with sensors and safety features to detect human presence and avoid collisions. Cobots can assist with tasks such as assembly, packaging, and quality inspection, enhancing productivity and reducing the physical strain on workers.
- **Extended Reality (XR):** Utilize Augmented reality and Virtual reality levers for training, maintenance, and remote assistance, enhancing human capabilities. They create immersive training environments where workers can practice tasks in a virtual setting before performing them on the factory floor. This reduces the risk of errors and accidents during the initial learning phase. AR overlays digital information onto physical equipment, guiding technicians through maintenance procedures with real-time instructions and visual aids. VR can enable remote experts to assist on-site workers by providing real-time guidance and troubleshooting support.
- **Digital Twins:** Create digital replicas of physical processes and products to simulate and optimize assembly line layouts and performance in a virtual environment before implementing changes in the real world. This can help identify potential issues, optimize processes, and improve product design. By continuously monitoring the digital twin of a machine, manufacturers can predict when maintenance is needed, preventing unexpected breakdowns and extending the lifespan of equipment.
- **Advancement in AI and Machine Learning:** Leverage AI and machine learning for personalized product customization, dynamic decision-making and forecasting use cases. Telemetry data captured by field sensors are being heavily used to predict equipment failure probabilities. This allows factories to adapt proactive strategies which in turn aids towards reduced downtime and overall cost. AI/ML tools can optimize production schedules, manage supply chains, and improve quality control by identifying patterns and anomalies that human operators might miss.

By integrating these advanced technologies, manufacturers can create a more efficient, flexible, and human-centric production environment. This not only enhances productivity and quality but also improves worker safety and job satisfaction.



Industry 5.0 – Core Values

Industry 5.0 centers around three interconnected core values [3]

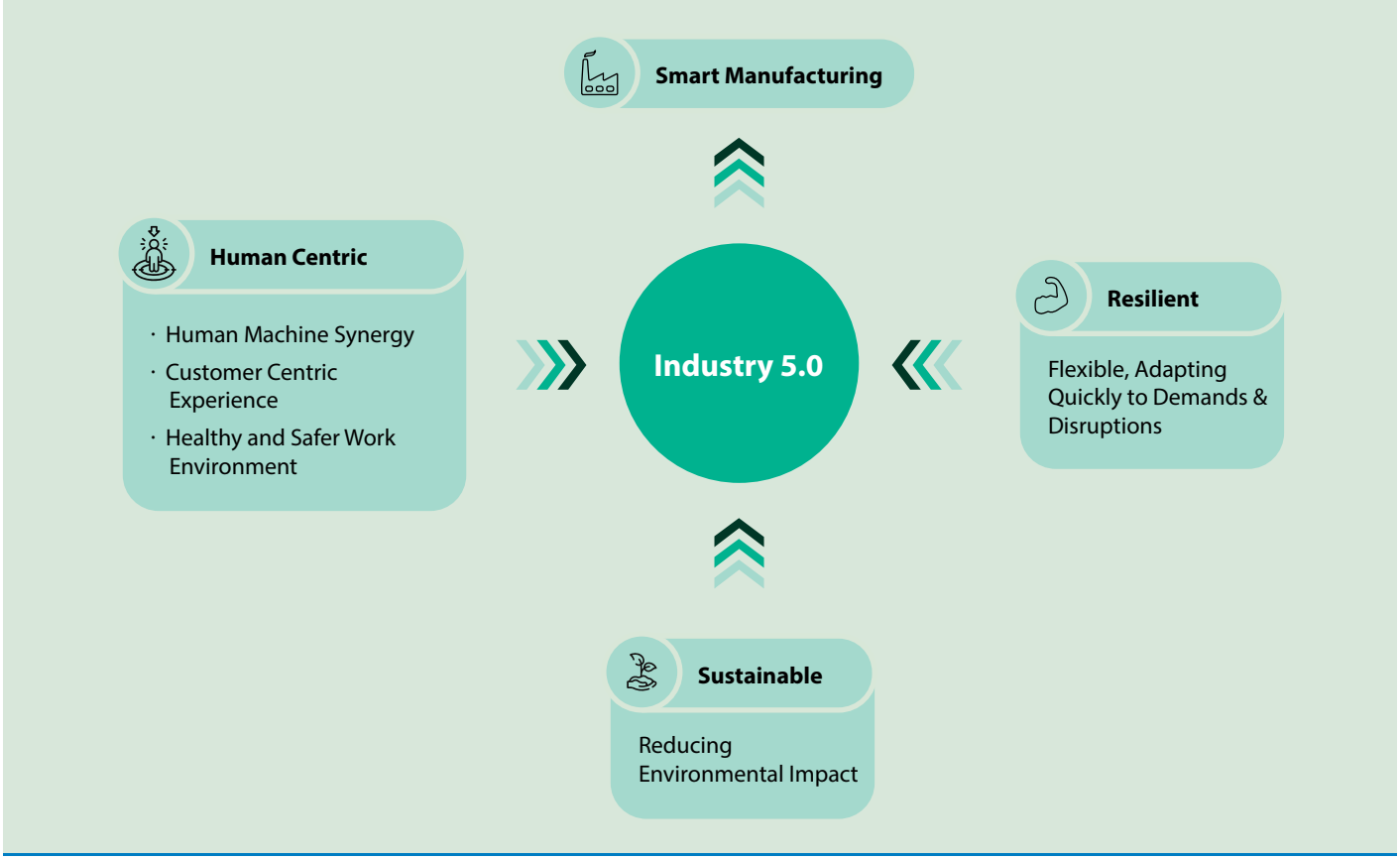


Figure 2: Industry5.0 - Core Values

- **Human-Centricity:** This core value places the human worker at the center. It emphasizes collaboration between humans and machines, ensuring that technology empowers people rather than replacing them. Industry 5.0 strives to create a work environment that is optimized for both efficiency and human well-being.
- **Sustainability:** Industry 5.0 recognizes the need for environmentally responsible manufacturing practices. This value focuses on reducing waste, minimizing environmental impact, and adopting renewable energy sources. It also promotes circular economy principles where resources are kept in use for as long as possible.
- **Resilience:** This core value emphasizes the ability of industrial systems to adapt to disruptions and challenges. Industry 5.0 aims to create flexible, adaptable, and decentralized automated manufacturing processes that can recover from unexpected events and continue to function effectively.

Why Human Centricity Is Crucial for Smart Factory Evolution

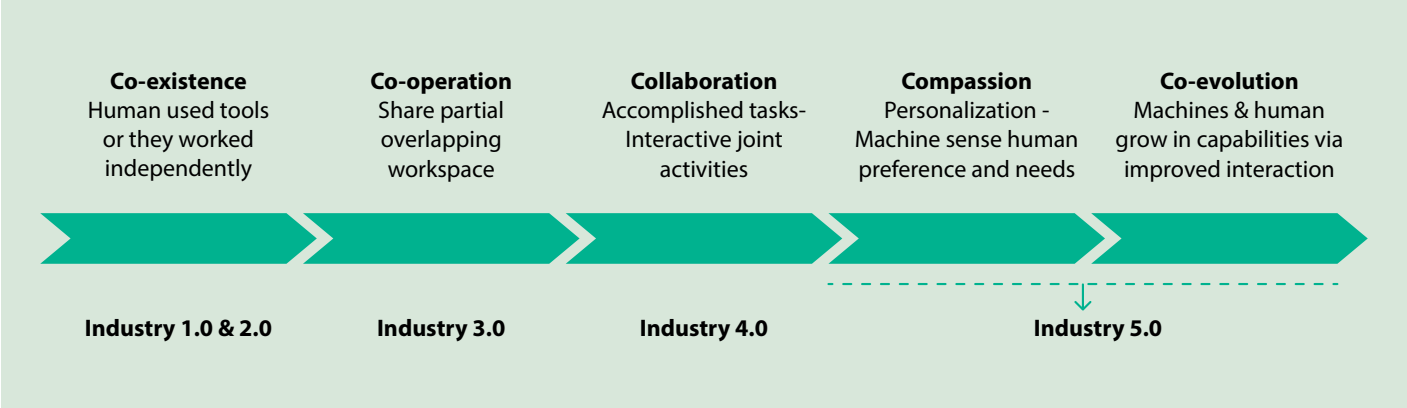
Human-centricity in smart manufacturing emphasizes the importance of collaboration between humans and machines. Rather than viewing technology as a replacement for human labor, Industry 5.0 envisions a symbiotic relationship where technology enhances human capabilities and well-being. This approach not only aims to improve productivity and efficiency but also seeks to create a more sustainable and resilient manufacturing ecosystem.

By prioritizing human-centric values, smart manufacturing can address critical challenges such as workforce displacement, environmental sustainability, and the need for adaptable and resilient production systems. This perspective highlights the belief that the true potential of smart factories can only be realized when human workers are empowered, and their well-being and safety is prioritized.

The driving factors for human centric innovation are centered around:

- **Machine Takes Over the Mundane:** Manufacturing should make jobs better. Workers shouldn't have to do dull, dirty, or dangerous tasks. Machines should be used to take over these tasks.
- **Focus on Creativity and Innovation:** By freeing up human potential, smart factories allow workers to tap into their creativity and problem-solving skills, transitioning from a blue-collar role to white collar.
- **Prioritizing Worker Wellbeing:** Human-centric design ensures a safe and comfortable work environment. Ergonomically designed workplaces, proper lighting, and access to data on their own performance empower workers and promote well-being.
- **People-Focused Digital Transformation:** New technologies should be used to improve what people can do, not replace them.
- **Connected Workforce:** Embracement of digitalization in factories in a way that augments workers' performance to deliver shop floor speed, flexibility, and visibility empowers a connected workforce.

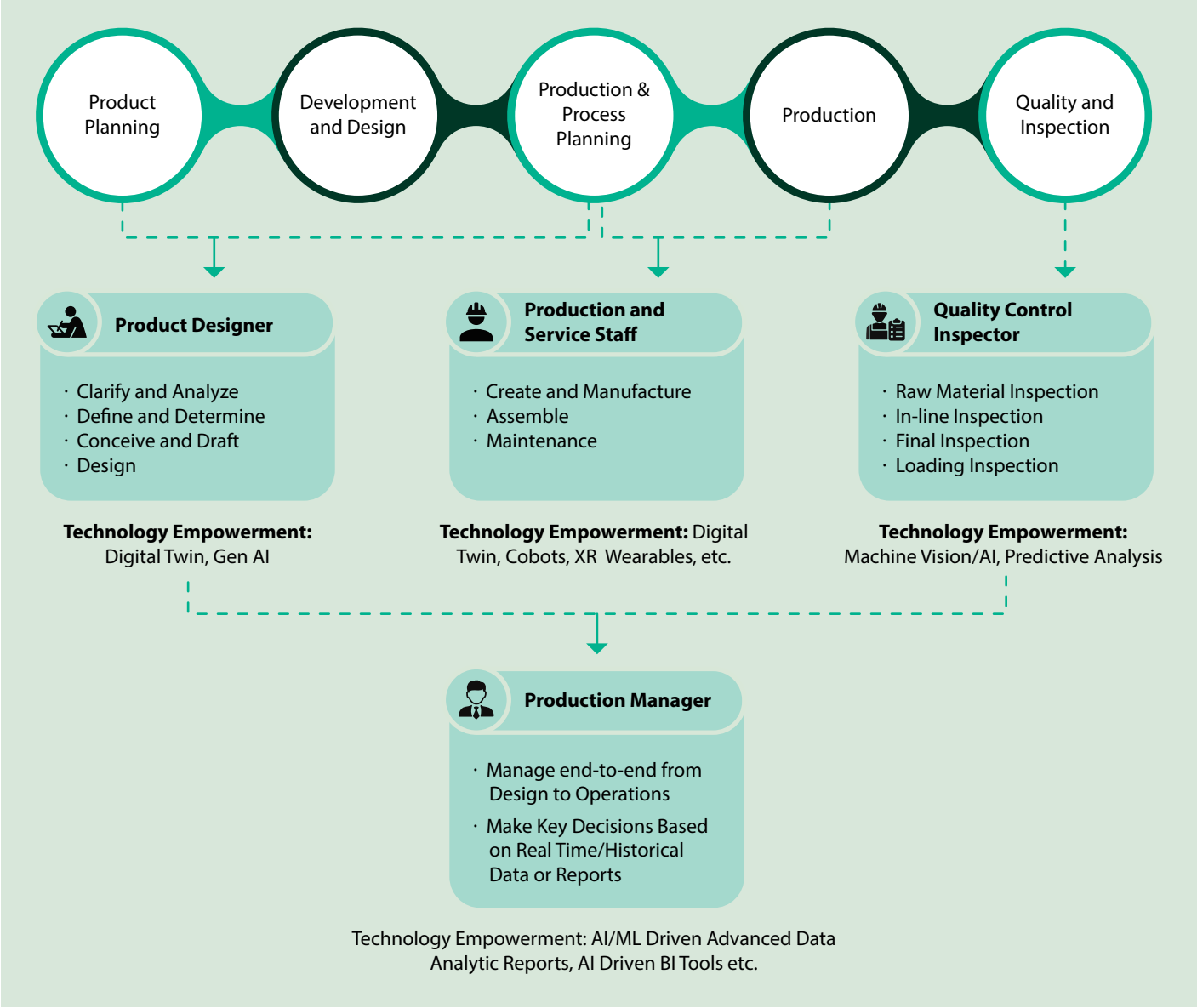
The 5C journey describes the evolving relationship between humans and machines throughout history, particularly within the context of manufacturing. [4]



These stages, however, are not strictly linear. Coexistence may still occur in certain settings even as we move towards collaboration and beyond. The future of human-machine relationships hinges on navigating the ethical and social challenges alongside the exciting possibilities of coevolution.

Worker Empowerment In The Electronic Manufacturing Industry – An illustration

This illustration depicts a transformed electronic manufacturing shop floor, showcasing how human-centric design empowers workers through technology at every stage that aids improvement in efficiency, accuracy and boost overall productivity. [5]



Smart Factory - Multi Dimensional Improvement

A "three-dimensional improvement" refers to enhancing efficiency, quality, and flexibility across all aspects of production. This encompasses processes, technology, and workforce engagement. Improving smart factories across factory structure, factory digitization, and operational excellence is crucial for staying competitive in the ever-evolving manufacturing landscape.(6) Potential use cases across the factory segments are enlisted below.

Factory Structure

- Layout simulation and optimization to enhance production: **Digital Twins**
- Modular and reconfigurable assembly line setup: **Cobots / IoT**
- Sustainable production: **Green Sourcing, Reusability and Energy Optimization**

Factory Digitization

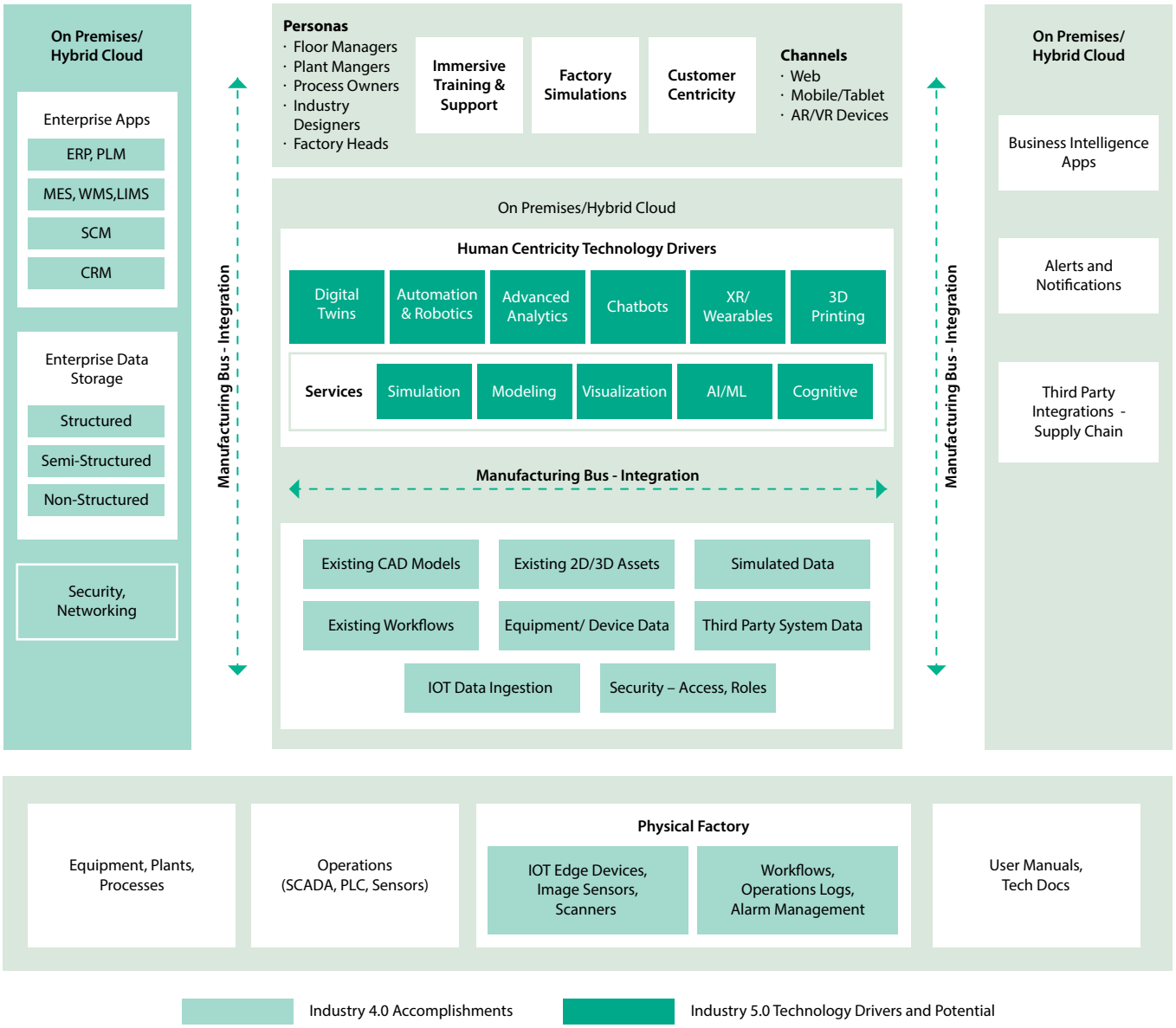
- Assembly maintenance and logistics (order picking , transport): **Wearables/ Smart Glasses**
- Boost productivity, quality and material handling: **HRC, Cobots**
- Additive manufacturing: **3D Printing**
- Immersive training and troubleshooting/repair sessions: **AR/VR/MR, Robotics**
- Predictive maintenance: **AI/ML, Data Analytics**

Operation Excellance

Lean management: **Tech Driven Automation**

- Customer centricity - deeper understanding of customer needs, last minute order modifications: **Big data Analytics to Derive Insights**
- Customer Interaction and delight: **AI Powered Chatbots, NLP**
- EHS : Worker Safety - **AI/Automation/ Vision Computing**
- ESG: Carbon footprint mitigation - **AI/Advanced Analytics**

Reference Architecture



Conclusion

By focusing on human-centric innovation, smart factories are not only enhancing productivity and efficiency but also opening opportunities for blue-collar workers to acquire new skills and transition into white-collar roles. This transformation is essential for building a more skilled, adaptable, and satisfied workforce. The various human centric roles and responsibilities in smart factories can be further boosted and empowered by integrating some of the below technologies.

Factory Personas	ICT Technology Usage	Technologies Boosting Human-Centric Adoption and Collaboration
Sales, Marketing, Data Analyst	High	AI Powered Chatbots, Generative AI Based Content / Report Generation, AI/ML Driven Insights and BI Tools
Factory Designers, Production Supervisor, Quality Inspector, Maintenance Technician	Medium	Digital Twins, XR Technologies, 3D Scanning and Machine Vision-Based Inspection
Assembly Line Worker, Packaging Operator, Material Handler	Low	Digital Twins, Collaborative Robots, Smart Wearables and Headgears

We have developed intellectual property and assets in several of the aforementioned areas, which can serve as accelerators for delivering human-centric applications more rapidly within a smart factory setting. Key IPs that can be utilized include the Infosys XR platform, Infosys AI Conversational Suite, Infosys AI Chatbot, Infosys Cortex, and Infosys Personalized Smart Video (PSV), among others. Additionally, our Centers of Excellence (CoEs) at iCETS are staffed with trained and skilled professionals capable of delivering solutions on industry-leading AI suite and hyperscalers such as AWS, Azure, and Google, NVIDIA Omniverse, and others.

References

1. https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/industry-50-towards-more-sustainable-resilient-and-human-centric-industry-2021-01-07_en
2. https://hgs.cx/blog/industry-5-0-connecting-humans-and-technology-for-sustainable-growth/
3. https://www.forbes.com/sites/jeroenkraaijenbrink/2022/05/24/what-is-industry-50-and-how-it-will-radically-change-your-business-strategy/
4. https://www.ericsson.com/en/about-us/new-world-of-possibilities/imagine-possible-perspectives/industry5-0-human-centric-manufacturing/
5. https://blogs.sw.siemens.com/jt-open/xr-virtual-augmented-mixed-reality-in-product-creation/
6. https://www.bcg.com/publications/2023/designing-factories-built-for-the-future
7. https://www.infotech.com/research/ss/bring-your-factory-to-life-with-smart-manufacturing-5-0
8. https://techwireasia.com/2019/12/frost-how-industry-4-0-pioneers-can-evolve-to-the-industry-5-0-model/

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