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Revaluation of Industry 5.0: The Human Focused Solutions for Sustainable Growth and Development

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Abstract: Industry 5.0 is an effort to address the human impacts of the fourth Industrial Revolution. It starts from the belief that businesses want to do more than just maximize profit and provides pathways for integrating social and environmental concerns into technological innovation. This ar- ticle is dedicated to the theoretical definition of the topic of the fifth industrial revolution. It de- scribes the differences between the last two industrial revolutions and defines three basic elements that are crucial for Industry 5.0. In the end, the scientific output is devoted to the description of specific ways in which simulation can help in the transition to Industry 5.0 and at the very end a summary, the challenges and requirements that Industry 5.0 brings.

Keywords: Industry 5.0, Human-Centricity, Sustainability, Resilience

1.Introduction

The manufacturing industry has been going through its fourth major transition since artisans gave way to workshops and factories. The first of these revolutions was mecha- nization and the use of steam power, which later succeeded by the adoption of electricity. Then came computerization, and today that's being followed by the arrival of cyber-phys-ical systems and advanced analytics, otherwise known as Industry 4.0.
Industry 5.0 however is not a typical succession to 4.0. Neither is it a marketing

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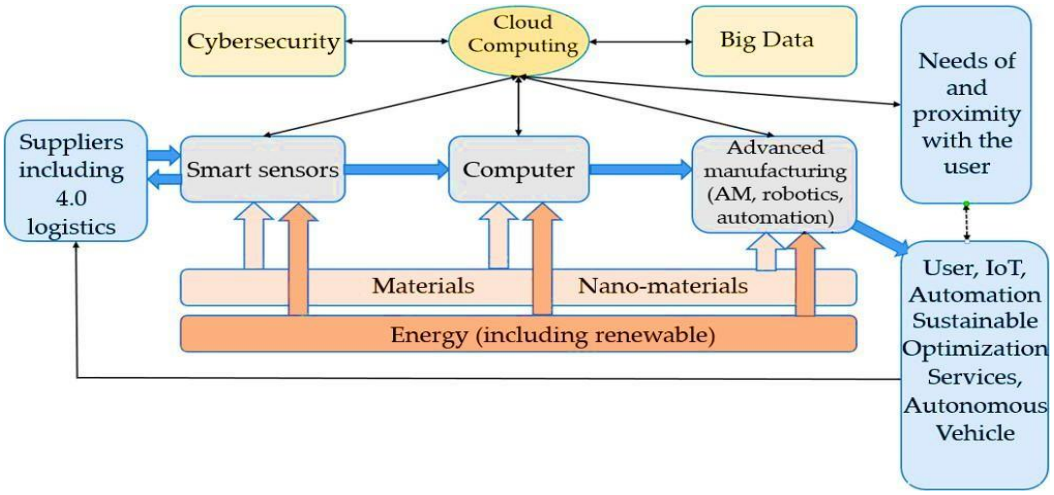

Fig-1: Computer and its wings

term conceived by an overworked advertising agency. Industry 5.0 refers to the human side of 4.0 and seeks to address the issues raised by 4.0 adoption. Industry 5.0 is a framework for re-imagining the future of energy, manufacturing, mobility, and supply chains that build upon and complement the meaningful groundwork paved by the vision of Industry 4.0.

Industry 5.0 uses collaborative robots and artificial intelligence to bring a human touch to the concept of digital transformation. Promoted by the European commission and other governmental bodies, Industry 5.0 emphasizes a triple-bottom-line of eco- nomic, environmental, and societal impact, bringing ESG (Environment, Social and Gov- ernance) perspective and balance to what have often been technology-led and economic- driven choices [1].

2.Understanding Industry 5.0

Industry 4.0 -- a phenomenon since the industrial revolution – deals with the integra- tion of innovation and new technologies into the manufacturing production process. Though Industry 4.0 has delivered industrial automation and other significant positive impacts, it sometimes has replaced humans in the workflow process. Industry 5.0 seeks to correct that imbalance, using the concepts of cognitive computing, cyber-phyisical sys- tems, and artificial intelligence to.

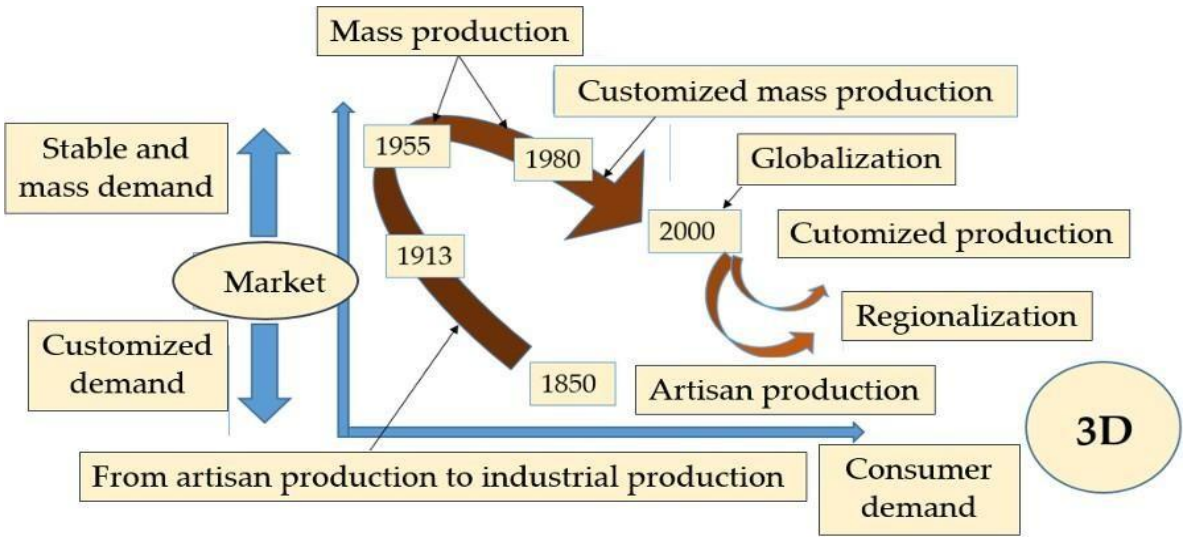

Fig 2: Layout Industry 5.0

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Industry 4.0 is a technological revolution that will have far-reaching human impacts. In manufacturing, increasing automation means that many many workers may get dis- placed, not only on the factory floor but in administrative and even professional functions. Meanwhile, very little has been done to address some of the biggest challenges facing manufacturers, like where to find the next generation of workers, how to move towards a circular economy, and how to become more resilient in the face of unexpected change and supply chain disruption. Championed by the European Union, Industry 5.0 is an effort to address the human impacts of the fourth Industrial Revolution. It starts from the belief that businesses want to do more than just maximize profit and provides pathways for integrating social and environmental concerns into technological innovation [2].

Altruism plays a part in this, but there's also a strong element of self-interest. Young people want to work for socially aware organizations and people want to buy from com- panies that behave responsibly. So, by adopting Industry 5.0 principles, organizations wish to safeguard their futures. One of Industry 5.0 challenges is to make processes more human-centric. Part of the motivation is to mitigate the concerns and resistance to auto- mation from labor unions and politicians concerned that Industry 4.0, in theory, could create crises of technological unemployment. From the start of the cycle of innovation during the industrial revolution, the goal of manufacturers has been to enable technolo- gies that would make the production process more efficient. From a practical perspective, this benchmark has been achieved – highly automated processes can deliver highly con- sistent and repeatable outputs. But this does not address the need to provide increasingly customized or personalized products (as customer expectations become increasingly so- phisticated). Human-machine collaboration is the key to unlocking these benefits [3].

2.1 Sustainable Development & Environmental Issues in India

Achieving economic development is crucial for any country. But is it worth it if it comes at the cost of environmental degradation? We were made aware of the ill-effects of environmental degradation in our high schools. But what about the economic implications of such issues? Or the benefit that sustainable development can offer to any economy?

This article will break down the meaning & function of 'environment', the various environmental issues & concerns India is facing at the moment; and assess the alternative that sustainable development offers.

2.2 Environment: Meaning & Function

The term 'environment' refers to the natural setting in which we live, which is bestowed to us by our ancestors. It encompasses the interaction between biotic (the living components, including plants, animals, birds, etc.) and abiotic components (land, air, water, etc.) that co-exist to form this natural-setting.

The four major functions served by the environment are: supply of resources, sustenance of life, providing aesthetic value, and assimilation of waste generated by various production & consumption activities.

2.3 Environmental Issues in India

In India, factors like rapid growth of population, urbanization, industrialization, and poverty, among others are responsible for harming the environment. Some of the severe environmental issues prevalent in India are

1. Degrading Air Quality Index
2. Rampant Environmental Degradation
3. Loss of Biodiversity
4. Urbanization in the Himalayas

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5. Loss of Resilience in Ecosystems
6. Lack of Waste Management
7. Depletion of Resources (land, air, water)
8. Growing Water Scarcity

There are many more such issues that need to be addressed to maintain a sustainable environment so as to ensure consistent economic development.

2.4 Governmental Initiatives to Tackle Environmental Degradation

While the cooperation of every citizen of the country is essential for safeguarding the environment, governments have a huge role to play in helping find solutions to the problems. The government of India has taken various steps to safeguard the environment. Some of them are listed below:

1. Swachh Bharat Mission
2. Green Skill Development Programme
3. Namami Gange Programme
4. Compensatory Afforestation Fund Act (CAMPA)
5. National Mission for Green India
6. National River Conservation Programme
7. Conservation of Natural Resources & Eco-systems

2.5 Sustainable Development: Meaning & Features

"Sustainable Development is the development that meets the needs of the present generation without compromising with the needs of future generations." This definition was put forward by the Brundtland Commission in its report "Our Common Future" in 1987. It calls for a concerted effort to build an inclusive, sustainable, and resilient ecosystem for the people and the planet.

The main features of sustainable development include

1. Increase in per capita income
2. Judicious use of natural resources
3. Preserving the resources for future generations

3.Elements of Industry 5.0

Perhaps the most important distinction of Industry 5.0 is the reintroduction of the human element into the manufacturing process. In one sense, the human element brings the soul back to manufacturing by enabling collaborative production – the imagination and flexibility of the human worker become empowered and advanced with the ability to harness cyber-physical systems like collaborative robots (or cobots). The combination of smart machines, cognitive computing, cloud computing, and savvy humans will allow for true "mass personalization" and more nimble production.

3.1Human-Centricity

Industry 5.0 seeks to restore a human-centric approach to business that some would say was lacking with an Industry 4.0 approach. The symbiosis of humans and machines is essential to creating more jobs, leveraging productivity and efficiency, and attracting and retaining talent. Particularly to technology-centred organizations, human capital is the most strategic asset and businesses will need to accommodate the growing cohort of Gen-Z and Millennials' changing needs. For younger generations of workers, the commit- ment to environmental and social factors becomes increasingly important in their choice of employer, and this may include a commitment to community initiatives, flex working arrangements, and the cultivation of historically underrepresented minorities in leader- ship roles. The human-centric vision also critically involves re-thinking how workers and machines collaborate. Traditionally static manufacturing processes can be updated with digital twins, and new collaborative robotics (cobots) with line workers empowered to exercise greater

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flexibility in production. A healthy and happy workforce with opportu- nities for creative personal and professional advancement is likely to create lasting value for the business [4].
This proposes that workers be viewed as investments and not costs. Thus, rather than seeking to drive down labor costs, manufacturers should look at how to maximize the return from their employees. This leads to the view that processes should be adapted to

suit workers, and workers should be given the tools to help them do their jobs better. Some of the key components that support the human-centric approach are:

- Exoskeletons
- Augmented reality
- Virtual reality
- Wearables
- Cobots
- Analytics

Furthermore, to maximize the benefits of these new technologies, which include higher productivity, less waste, and lower accidents, workers should be included in their design and deployment. As part of this, it's believed that there is a clear need for up- skilling and reskilling [5].

3.2 Sustainability

Industry 5.0 seeks to create a manufacturing environment that is both sustainable and resilient, while also being human-centric. With the growing regulatory and investor emphasis on reducing carbon emissions and environmental impact, businesses need to evaluate their resource footprint that supports their manufacturing process. This may in- volve analyzing the source of raw materials, the proportion of waste generated, along with an evaluation of the environmental impact, the energy efficiency of processes, as well as the sources of energy.
Businesses want to reduce their environmental impact by using alternative energy sources to minimize their footprint. At the same time, it is important to lower the opera- tional costs but also attract young talents. Businesses are realizing that it is the right thing to do and they are adding sustainability plans to their strategy. One reason is to lower operating costs by cutting resource consumption and waste. Another is because it's what employees and younger recruits want to see. And a third reason is that it's the right thing to do. Many firms have committed to specific reductions of fossil fuels and clean energy generation sources. Additionally, the adoption of new materials and composites (away from petroleum-based for instance) can reduce environmental impact while increasing smart manufacturing practices, such as recycling and repurposing materials, to achieve objectives for socio-ecological sustainability [6].
Industry 5.0 addresses how manufacturers and others can move towards a circular economy where recycling is integral to production and consumption. With an emphasis on this, plus re-use and repurposing, Industry 5.0 encourages adopting artificial intelli- gence (AI) and additive manufacturing to avoid resource depletion and environmental degradation [7].

3.3 Resilience

In the Industry 4.0 paradigm, businesses have been forced to cope with increased uncertainties and adapt to cope with change. That's why Industry 5.0 bolsters resilience for companies looking to balance man and machine. It's important for organizations to engage in planning exercises that account for potential disruptions across the value chain, from the factory floor to the supplier network, to transportation channels, to regulatory and geopolitical changes that can promote the achievement of societal goals.
Digital technologies and methodologies (simulations and AI-enhanced modeling) can help identify optimal alternative paths in the event of a disruption, weighing different factors such as cost, substitution, quality, and logistical concerns into the mix. Start with identifying the greatest points of vulnerability (whether in process or supply chain), iso- late the key inputs, and then formulate contingency planning for any disruptions [8].
Some tools and capabilities that will play a part in this are:
Deployment of modular factories
New materials (and the ability to transition seamlessly between sources)

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Remotely operated factories
Real-time risk monitoring
Enhanced cybersecurity
Any perception that Industry 5.0, (and also Industry 4.0,) is only for deep-pocketed global manufacturers is incorrect. Small and medium enterprises (SMEs) are just as ca- pable of adopting these new technologies and perspectives as their larger brethren, and perhaps more so [9]. For many of the trends and technologies discussed above, implemen- tation is as dependent on open minds and a willingness to change as on financial re- sources, and these are areas where SMEs often excel [3].

4.Industry 5.0 Transition Support

Factories and manufacturing processes are becoming smarter, and competitors never stop looking for an "edge." Against this background, it's more important than ever to keep changing and improving, but also to do it faster and to avoid mistakes.
Manufacturing simulation plays a key role in all three elements of Industry 5.0. By modeling existing or proposed manufacturing systems, it provides a so-called "virtual sandbox" that enables risk-free exploration of ideas and alternatives. It's used to gain a deeper understanding of complex operations and relationships, to identify potential prob- lems or conflicts, and to identify opportunities and solve current problems [10]. Specific ways in which simulation supports an Industry 5.0 transition include:

- Creation of digital twins
- Virtual commissioning
- Modeling supply chain disruptions
- Travel avoidance
- Risk-free experimentation
- Upskilling

A digital twin is a complete and accurate representation of part or all of the produc- tion process. Most importantly, by connecting it to sensors installed on the physical sys- tem, it maintains fidelity to real-world conditions. With this, it's possible to evaluate changes and the impact of disruptions and come up with alternative production sched- ules. It also helps with debugging problems and can avoid the need for technicians to travel to work sites or factories. Virtual commissioning uses a digital twin to accelerate the implementation of new equipment and processes [11].

5.Conclusions

The essential Industry 5.0 strategy is designed to ensure a framework for industry that combines competitiveness and sustainability, allowing industry to realize its poten- tial as one of the pillars of transformation. It is a strategy focused on emphasizing the impact of alternative modes of (technology) governance for sustainability and resilience. An effective Industry 5.0 strategy empowers workers using digital devices, endorsing a human-centric approach to technology; builds transition pathways towards environmen- tally sustainable uses of technology; expands the remit of corporation's responsibility to their whole value chains; and, finally, introduces indicators that show, for each industrial ecosystem, the progress achieved on the path to well-being, resilience, and overall sus- tainability.
Preparing for Industry 5.0 is not inconsequential, but there are multiple forces array- ing to compel businesses to adopt the core principles of human-centricity, resilience, and sustainability. It's far better to take the opportunity to prepare ahead of time, rather than react to an unanticipated shock to the system. Beyond better, cheaper, and faster, the tech- nology-enhanced mantra Industry 5.0 promises to lead the next generation into a balance of decisions that support smarter, cleaner, and more resilient industries. Realizing the up- dated vision for Industry 5.0 will require new economic priorities to measure industry performance, new structure and design of business models, value chains and supply

chains, updated objectives for digital transformation, innovative approaches to policy- making that better align the interests with business and industry, new ways to drive in- novation and research capabilities, while better aligning the interests of businesses with broader society, government, and environment. The lessons learned from the pandemic underscore the compelling need to build resilience across value chains while securing jobs and economic security.

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