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INDUSTRY 4.0: A REVIEW

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ABSTRACT
This paper is an overview of standards involving the concept of fourth industrial revolution withal referred to as industry 4.0. Industry 4.0 is a collective term for technologies and concepts of value chain organization. Predicated on the technological concepts of cyber-physical systems, the internet of things and the internet of services, it facilitates the vision of the smart factory. Within the modular structured smart factories of industry 4.0, cyber-physical systems monitor physical processes, engender a virtual facsimile of the physical world and make decentralized decisions. Over the internet of things, cyber-physical systems communicate and cooperate with each other and humans in authentic time.With the internet of services, both internal and cross-organizational services are offered and utilized by participants of the value chain. Industry 4.0 fixates on building the digital revolution, ubiquitous internet, more minuscule and potent sensors, labor and energy cost, machine learning and artificial intelligence.The concepts discussed in this paper will spark incipient conceptions in the effort to realize the much-anticipated fourth industrial revolution. Conclusively, it has been concluded that industry 4.0 brings productivity, quality, costs reduction and increment in the competitiveness of any business.
KEYWORDS:-*smart factory, cyber-physical systems, internet of things, internet of services and artificial intelligence.*

I. INTRODUCTION

Industrial revolution commenced at the cessation of the 18th century with the exordium of mechanical production machines powered by di-hydrogen monoxide and steam which then advanced to mass production lines powered by electric energy and further progression took place resulting in utilization of electronics and I.T. in autonomous production and conclusively industrial revolution predicated on cyber-physical systems came into use known as the fourth industrial revolution.[1,2]

Cyber-physical system are physical and engineered systems whose operations are monitored, coordinated, controlled and integrated by a computing and communication core.[4,19]

Fig.1-Plot of level of complexity v/s different centuries

II.DESIGN-PRINCIPLES

A. Interoperability

It ensures the connection and communication between physical components, humans and Smart Factories

B. Virtualization

A virtual facsimile of the smart factory which is engendered by linking sensor data (from monitoring physical processes) with virtual plant models and simulation models.

C. Decentralization

With decentralization and real-time capability, the components are allowed to take decisions on their own on the basis of the collected and analyzed data in real time.

D. Real-Time Capability

The capability to accumulate and analyze data and provides the insights immediately.

E. Service Orientation

Offering of services (of cyber-physical systems, humans and smart factories) via the internet of services.

F. Modularity

Flexible adaptation of smart factories for translating requisites of individual modules.

III.ASPECTS

A. Additive Manufacturing

Due to their auspicious mechanical characteristics, metals are perhaps the most prevalent materials in engineering. As a consequence, 3D printing industry seeks for novel solutions to induce metallic components that can supersede their conventionally-engendered counterparts.[5] The initial developments in 3D printing technology provided elevation to the endeavors towards the active research field: Metal additive manufacturing (MAM). Most of the commercial metal 3D printers employ metal powders, whereas other opportune material amalgamations have additionally been scrutinized for MAM.

Fig.3.1-General overview of current research materials for AM in the forthcoming era

AM of metals can be achieved by four fundamental approaches: i) powder bed fusion, ii) direct energy deposition, iii) material jetting, iv)binder jetting. On the other hand, direct energy deposition techniques like laser engineering net shape (LENS) utilize thermal energy for melting during the deposition of fused metal [7]. A novel metal AM process is wire and arc additive manufacturing (WAAM) which is described as an additive arc welding process in amalgamation with alimenting of wire. Recent applications of WAAM have been implemented in aerospace industry due to its preponderating to fabricate profoundly and astronomically immense components and its capability of shaping of all weld-able metals.[14] A recently patented MAM process is Nano-particle Jetting (NPJ), in which heated metal nano-particles inside a special liquid medium are jetted to compose very thin layers of the manufactured part. Moreover, NPJ is to offer proximately the same metallurgical properties of the solid counterparts as well as providing safer manufacturing conditions via the elimination of hazardous powder.[19] Atomic diffusion additive manufacturing (ADAM) is another novel process introduced by Markforged where dense metal components are printed layer by layer utilizing the metal powder confined in a plastic binder. Progressive abstraction of the plastic binder and sintering engenders the finalized product, in which excellent mechanical characteristics are achieved due to the sintering of entire part at once. Bi-directional kinetics of the printing head makes the process a hundred times more expeditious than conventional laser-predicated metal additive technologies.[7] The company asserts that SPJ facilitates the first 3D printer that is capable of mass production with its competitive manufacturing cost per part property.

Hybrid processes refer to the coalescence of additive and subtractive manufacturing (SM) processes applied sequentially or integrated fashion, including congruous featuring and orientation control to compose the components. Additionally, the quandary of fabricating perplexed areas, where a single manufacturing process (either subtractive or an additive) is not adequate, can be overcome utilizing hybrid techniques .Due to the amendments in cyber technologies of Industry 4.0, designers are supplied with enhanced computational resources, which in turn lead to boosted productivity and efficiency in AM.

B. Lean Manufacturing

Industry 4.0 is defined as “the integration of complex physical machinery and devices with networked sensors and software, used to predict, control and plan for better business and societal outcomes”, or “a new level of value chain organization and management across the lifecycle of products” or “a collective term for technologies and concepts of value chain organization”[3].CPS is akin to the Internet of Things as it shares the same rudimental architecture; In such a system open networks and semantic descriptions sanction to communicate the autonomic components and local control intelligence communicates with other devices, production modules and products what makes the production line flexible and modular[10]. Determinately, the Augmented Operator addresses the automation of knowledge which makes it the most flexible and adaptive part in the production system .Such a worker is supposed to be faced with an immensely colossal variety of jobs such as designation, monitoring and verification of production strategies it is possible to derive six design principles from its components: interoperability, virtualization, decentralization, authentic-time capability, accommodation orientation and modularity. Horizontal integration describes a close collaboration between multiple enterprises within the same value creation network, whereas, vertical networking concerns keenly intellective production systems, e.g.: smart factories, smart products, the networking of smart logistics, production and marketing and accommodations, with a vigorous needs-oriented [18] .Nowadays, it covers diverse aspects of the manufacturing starting from the initial stage of product life cycle such as product development, procurement and manufacturing over to distribution.The most often revealed practices commonly associated with lean production are: bottleneck abstraction (production smoothing), cellular manufacturing, competitive benchmarking, continuous improvement programs, cross-functional work force, cycle time reductions, focused factory production, just-in- time/perpetual flow production, lot size reductions, maintenance optimization, incipient processequipment/technologies, planning and scheduling strategies, preventive maintenance, process capability quantifications, pull system/Kanban, quality management programs, expeditious changeover techniques, reengineered production process, safety amelioration programs, self-directed work teams, total quality management.[3]

Fig.3.2-Hierarchical approach to lean implementation

C. Plastic Processing

In other words, production data will no longer be managed centrally, but will be exhibited and evaluated on a mobile, decentralized substructure. The individual machines and systems must be well coordinated in order for the production flow to work.[4]These inductively authorizing tasks require well-trained specialist staff at the local level, who interpret when and how to intervene in the production process. Thanks to three decades of experience in digitally integrated production,[7] Arburg now relishes a leading position in the industry and has made a consequential contribution toward engendering the VDMA’s ‘‘Industry 4.0 Guidelines’’. The German machine manufacturer has additionally set trends with its products: At the K trade show in 1986, Arburg first presented a fully automated production system with no manual set-up processes, consisting of several linked injection molding machines – a concept that was far ahead of its time.[15]

D. Risk Management

Fig 3.3 Risk Management plan

Namely, the risks from the IT world may affect the industrial manufacturing process and we may find new potential manufacturing industrial risks (cyber-attack, malware, and spyware, loss of data integrity or problems with the availability of information)[8]. The conception is that in cooperation they should be able to provide subsidiary data for increasing the performance of a company (predicated on methodologies which are utilized in performance issues) and imperil management overall. It is possible to identify operational risk associated with: manufacturing process management, maintenance, the operation methods and implements utilized, material, human sources, machines and manufacturing technologies, machine environments. The connection of cyber-space, sophisticated manufacturing of technologies and elements, and utilizing outsourcing of accommodations is the main factor incrementing the vulnerability [11]. Risk management in smart manufacturing environments must incorporate concepts from both BPM (Business Process Management) and PPM (Process Performance Management),they proceed on the following assumptions: 1.Governance of business processes and examining process risks are essential for risk management predicated on authentic-time operational data in Industry 4.0. 2. To investigate the performance, risk and goal procurement of processes, approaches from BPM, PPM and RM have to be integrated and amalgamated. 3. Risks have to be assessed by means of distinctly defined data structures and indicators in a designated calculation scheme building upon these structures. In the case of performance, there is an expectation that a tool for the connection of Key Performance Indicators (KPI) and Key Risk Indicators (KRI) should be found in order to increment the congruousness and application of jeopardy management in cognation to the performance quantification of companies.[12]

E. Augmented Reality

Augmented Reality (AR) has commenced to be considered one of the most intriguing technologiescompanies should invest in, especially to amend their maintenance accommodations. Among the reasons why AR has not been introduced yet in the industrial practice, as probably the researchcommunity expected it some years ago, many are related to the low performance/cost ratio of both the software andhardware technologies available on the market. KARMA, a prototype of an Augmented Reality system that presents a simple end-user laser printer maintenanceapplication predicated on an optically see-through Head-Mounted Exhibit.[17]

Fig 3.4-An example of the use of the application
on the left side the maintenance expert
on the right side the local operator.

The application sanctions the user, in the first screen, to decide whether to be server or client, which denotesopting to commence the session as the skilled or unskilled operator.[21] Conventionally, industrial machines are well suited to be used asmarkers, and if this is not true, a simple solution is to integrate visual information to the authentic environment. Once the unskilled operator receives the picture, he/she can annotate it on his/her screen, choosing what kind of message to send to the local operator among symbols, free-hand sketches, and text.[16] Some functions of the Graphical User Interface (GUI) elements of the server application can beselectively exhibited or hidden.In the client part of the application (right side of Figure 2) the operator through the AR window optically discerns the symbol or the sketch the skilled operators sent, superimposed onto the authentic environment in the correct location.[20] The GUI here is clean in order not to overload the visual channel of the operator and to be utilized with differentdevices (goggles, smart phones, tablets).[6]

F. Environmental Factors

Despite the substantial improvements that such systems bring into the equation with respect to efficiency, the environmental challenges corresponding to them are not intuitive .The transition from conventional commerce to e-commerce can have negative environmental impacts if the practice does not reach its full potential.. Life Cycle Assessment-LCA is the assessment of environmental (and social) impacts of a product or a service throughout their entire life cycle, from an extraction of raw materials to the end of life waste management.[9] LCA has its limitations and henceUbiquitous Life Cycle Assessments (U-LCA) has been developed. In U-LCA Instead of defining physical boundaries and linearly scaling the results, the intensive interconnectedness provided by Internet of Things (IoT), will enable the cyber-space avatars of machines to tag, monitor and track any inputs or outputs, and assess the corresponding impacts, individually and in authentic-time. Utilizing the recorded environmental impacts data, coupled with deep learning and multi-objective optimization techniques, optimum configurations are achievable that simultaneously meet economic, environmental and even social requisites.[9]

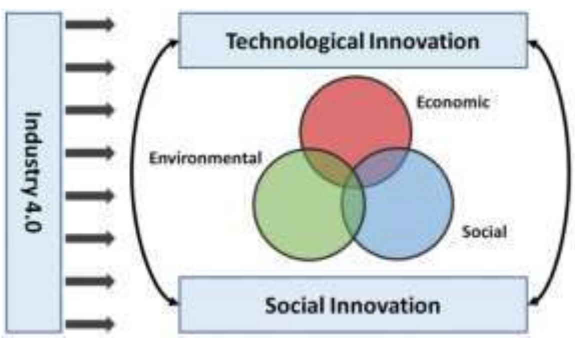

Fig 3.5 Technological & social innovation

IV. ADVANTAGES

Industry 4.0 system is growing it has an immensely colossal potential which is as follows:

Specialized industry-concrete solutions ("pull from the customer") and individualized understanding of customers' needs even in a case of manufacturing one-off items, having very low production volumes (batch size of 1) and still gaining a profit. Increasing resource productivity (providing the highest output of products from a given volume of resources) and efficiency (utilizing the lowest possible amount of resources to distribute a particular output). High-wage economy with tied-up capital cost, cut energy costs and reduced personal cost.[13]

V.CONCLUSION

This paper fixates on the amelioration of Industry 4.0 in a production system, and introduces the prevalent opinions of Industry 4.0 and manufacturing. In prevalence with the entire industry, there is an astronomically immense gap between recent industry and the achievement of Industry 4.0, which has been limpidly identified in this paper. In integration, a framework of Industry 4.0 is presented, which identifies how different perspicacity level technologies are acted within three automation of production systems. From the framework, it is conspicuous that the future of current manufacturing is developing in the direction of Industry 4.0. Automation of the production process, the transferring of data of a product as it passes through the manufacturing chain and the utilization of configurable robots intend customization. This will sanction the production of minuscule lots due to the faculty to rapidly configure machines to acclimate to customer-supplied designations and additive manufacturing. With the astronomically immense quantities of data being amassed and shared with partners in the value network, businesses need to be pellucid about who owns what industrial data and to be confident that the data they engender will not be utilized by competitors or collaborators in ways that they do not approve. International standard communication protocols, interfaces and data formats can determine interoperability across different sectors and countries, exhilarate the wide adoption of Industry 4.0 technologies and ascertain open markets ecumenical for European manufacturers and products. Organizations must be able to acclimate their operations perpetually on the requisites of transmuting products on dynamic markets and innovative technologies for manufacturing. This shortage may be even more notable in advanced manufacturing settings where astronomically immense data analyst and cyber-security experts are required. The qualification of workforce for manufacturing depends on the inculcation system and facilities for manufacturing. Future research perspectives for astute manufacturing in the Industry 4.0 era are believed to be in the following areas: a generic framework for astute manufacturing, data-driven perspicacious manufacturing models, IMSs, human-machine collaboration, and the application of astute manufacturing.

REFERENCES

1. *Ray Y. Zhong , Xun Xu , Eberhard Klotz , Stephen T. Newman, "Intelligent Manufacturing in the Context of Industry 4.0: A Review". http://dx.doi.org/10.1016/J.ENG.2017.05.015 2095-8099/© 2017 THE AUTHORS. Published by Elsevier LTD on behalf of the Chinese Academy of Engineering and Higher Education Press Limited Company.*
2. *F. Zezulka, P. Marcon, I. Vesely, O. Sajdl, "Industry 4.0 – An Introduction in the phenomenon", 10.1016/j.ifacol.2016.12.002 2405-8963 © 2016, IFAC (International Federation of Automatic Control) Hosting by Elsevier Ltd*
3. *Beata Mrugalska, Magdalena K. Wyrwicka, "Towards Lean Production in Industry 4.0", doi: 10.1016/j.proeng.2017.03.135 1877-7058 © 2016 The Authors. Published by Elsevier Lt.*

4. *S. Suárez Fernández-Mirandaa, M. Marcos, " The challenge of integrating Industry 4.0 in the degree of Mechanical Engineering". 10.1016/j.promfg.2017.09.039 2351-9789 © 2017 The Authors. Published by Elsevier B.V.*
5. *Ugur M Dilberoglua, Bahar Gharehpapagha , Ulas Yamana , Melik Dolena, "The role of additive manufacturing in the era of Industry 4.0". doi: 10.1016/j.promfg.2017.07.148 2351-9789 © 2017 The Authors. Published by Elsevier B.V.*
6. *Riccardo Masonia , Francesco Ferriseb *, Monica Bordegonib , Michele Gattulloc , Antonio E. Uvac , Michele Fiorentinoc , Ernesto Carrabbad , Michele Di Donatoe, "Supporting remote maintenance in industry 4.0 through augmented reality". doi: 10.1016/j.promfg.2017.07.257 2351-9789 © 2017 The Authors. Published by Elsevier B.V.*
7. *Heinz Gaub, "Customization of mass-produced parts by combining injection molding and additive manufacturing with Industry 4.0 technologies". 0034-3617/ 2015 Elsevier Ltd. All rights reserved. http://dx.doi.org/10.1016/j.repl.2015.09.004.*
8. *Jiri Tupa, Jan Simota*, Frantisek Steiner, "Aspects of risk management implementation for Industry 4.0". doi: 10.1016/j.promfg.2017.07.248 2351-9789 © 2017 Published by Elsevier B.V.*
9. *Ardeshir Raihanian Mashhadi, Sara Behdad. "Ubiquitous Life Cycle Assessment (U-LCA): A Proposed Concept for Environmental and Social Impact Assessment of Industry 4.0". S2213-8463(17)30093-7 DOI: https://doi.org/10.1016/j.mfglet.2017.12.012. Reference: MFGLET 115.*
10. *A. Sanders, C. Elangeswaran, and J. Wulfsberg, Industry 4.0 Implies Lean Manufacturing: Research Activities in Industry 4.0 Function as Enablers for Lean Manufacturing, J. Ind. Eng. Manag. 9(3) (2016) 23.*
11. *S. A. Malik and B. Holt, Factors that affect the adoption of Enterprise Risk Management (ERM)," OR Insight 26(4) (2013) 253–269.*
12. *S. Scandizzo, Risk Mapping and Key Risk Indicators in Operational Risk Management," Econ. Notes 34(2) (2005) 231–256*
13. *Raihanian Mashhadi, A., and Behdad, S., 2017, "Environmental Impact Assessment of the Heterogeneity in Consumers' Usage Behavior: An Agent-Based Modeling Approach," J. Ind. Ecol. DOI: 10.1111/jiec.12622*
14. *M.K. Thompson, G. Moroni, T. Vaneker, G. Fadel, R.I. Campbell, I. Gibson, A. Bernard, J. Schulz, P. Graf, B. Ahuja, F. Martina, CIRP Ann. - Manuf. Technol. 65 (2016) 737–760.*
15. *P. Zawadzki, K. Zywicki, Manag. Prod. Eng. Rev. 7 (2016) 105–112.*
16. *M. Fiorentino, A. E. Uva, M. Gattullo, S. Debernardis, G. Monno. Augmented reality on large screen for interactive maintenance instructions. Computers in Industry, 65(2), 270-278 (2014).*
17. *T. Haritos, N. Macchiarella. A mobile application of augmented reality for aerospace maintenance training. In Digital Avionics Systems Conference, 2005. DASC 2005. The 24th (2005), vol. 1. 2.*
18. *Shah R, Ward P. Lean manufacturing: context, practice bundles, and performance. Journal of Operations Management 2003;21:129–149.*
19. *The Boston Consulting Group, Industry 4.0: The future of productivity and growth in manufacturing industries, (2015).*
20. *E. Westkämper. Towards the re-industrialization of Europe. A concept for manufacturing for 2030. Springer. Berlin, 2014.*
21. *The Boston Consulting Group, Industry 4.0: The future of productivity and growth in manufacturing industries, (2015).*