

Research on Industry 4.0- Human Factor, Technology and Materials

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Abstract:

The fourth industrial revolution is a most important part of the development of the world as it changes the role of human in operation systems. Industry 4.0 are becoming more prevalent in the production and logistics. Industrial revolution growth has to be increased but regarding the perspective of economics, environmental and social sustainability. We studied how to adoption of different industry 4.0 technologies is associated with the expected for product, operation and side-effect aspects.

Here review paper on industrial revolution with impact of material and by discussing the real expectation on the future performance of the industry when implementing new technologies as well as the paper concludes with the future research direction on human factor in industry 4.0.

Introduction:

In 18th century, in the worldwide industrial growth started. [1] Industrial revolution are often framed in a technological perspective: The 1st industrial revolution relating to steam powered systems, 2nd revolution to the use of electrically powered systems and the 3rd to the adoption of information technology and automation. 4th evolution refers to the digitalization and integration of information technologies including application such as Internet of Things(IoT).[2-9]

1. Fourth industrial evolution (industry 4.0): Industry 4.0 is started in 21st century in developed countries, where the revolution of industry already mature regarding ICT usage and automation, the two concepts of the 3rd revolution that converge in the industry 4.0. industry 4.0 connects with IoT, Cloud computing, Big data, Simulation, Augmented reality, Automonus robot and Cyber security.[2-9]

2. Materials impact on industry 4.0:

Materials are major impact of the industrial revolution, as per the industry 1.0 iron is obtained by melting ores. Properties of iron are a transition metal. In textile industry, cotton materials make a transition.[fig1]

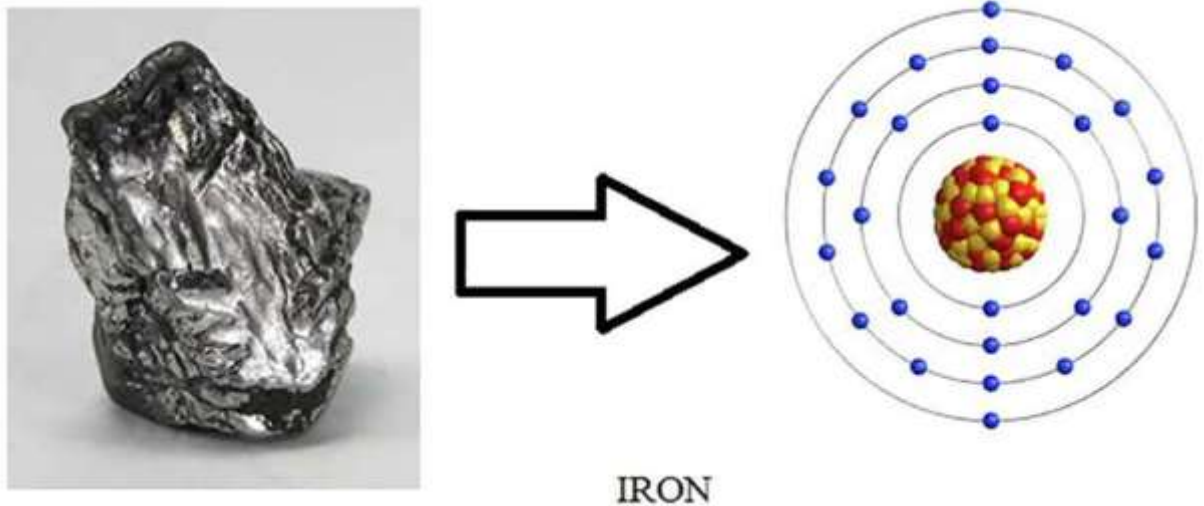


Figure 1. Iron and Iron atomic structure

In Industry 2.0 transition impact by Electrical Power Generation. Electrical Power Generation, Transmission and consumption are copper and Aluminium is important material on Industry 2.0 revolution. Copper atomic structure is shown in Fig. 2.

Copper is a transition metal. Copper atomic weight is 63.56, melting point is 108.62 °C, 1357.77 K, boiling point is 2560 °C, the number of electrons and protons is 29 and neutrons are 34.[¹⁰]

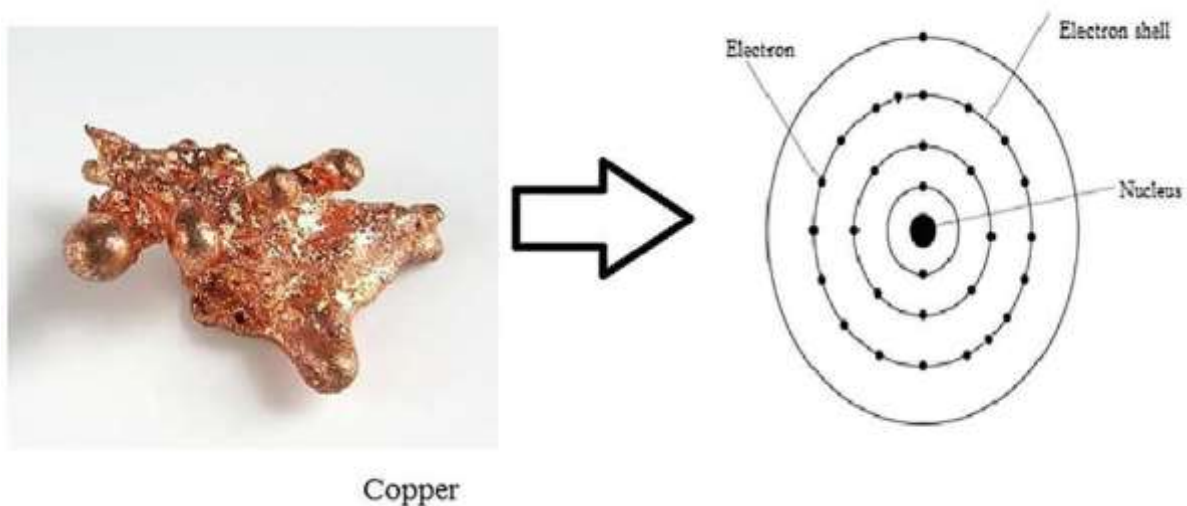


Figure 2. Copper and atomic structure

In Industry 3.0 transition technology is Programmable Integrated Circuit. The integrated circuit is manufacture by Semiconductor material [fig.3]. The semiconductor material is a partial conductor. Silicon and germanium is an example of semiconductor material.[¹¹]

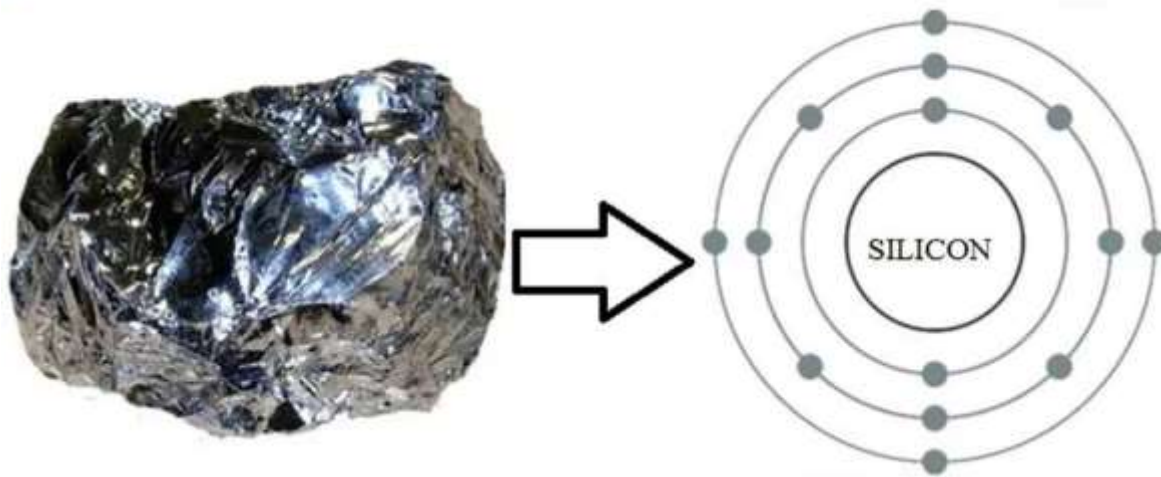


Figure 3. silicon and atomic structure

In industry 4.0 the nanomaterials are the transition materials. Nanomaterials have extremely small size which has at least one dimension 100nm or less [fig.4][¹¹]

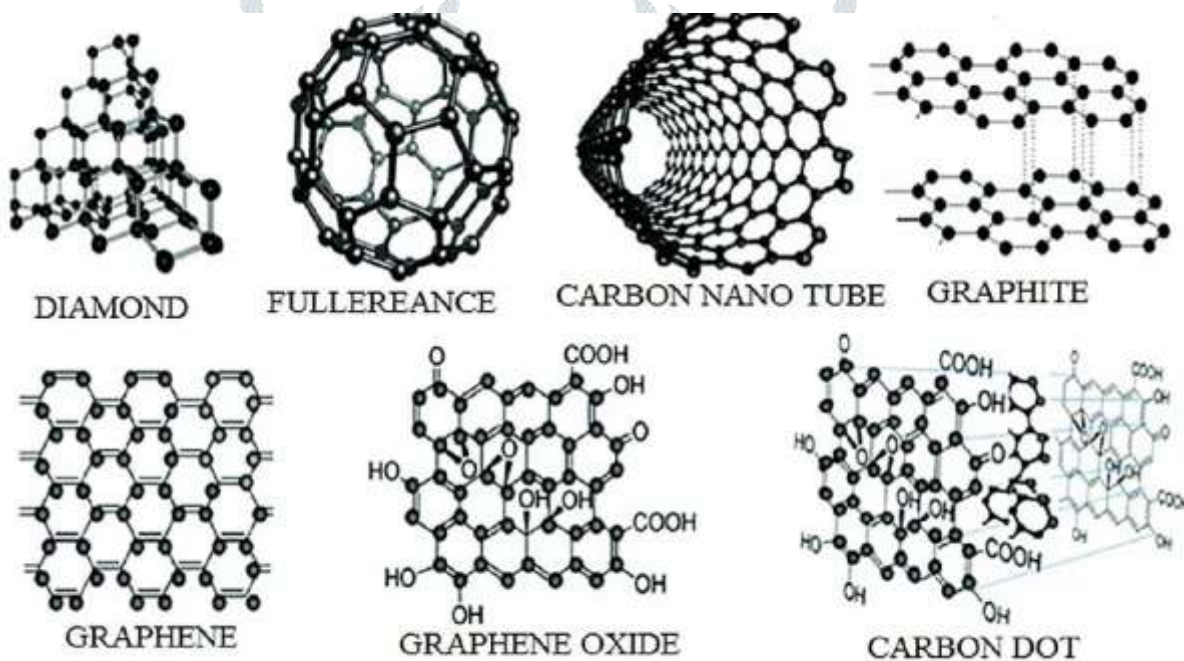


Figure 4. types of nanomaterials

3. **Technologies and expected benefits:**

The technologies of Industry 4.0 adopted by the industrial sector and benefits expected by industrial sector that are applying these technologies as shown in [table1]. the Industry 4.0 technologies are represented by 9 technologies and the expected benefits by 14 main benefits aligned with those highlighted in the literature.^[12] the percentage of companies in each industrial sector that indicated the adoption of a specific technology and the expectation for a specific benefit. Therefore, our study considers the analysis at the industrial sector level. Besides these variables, we also included two dummies as potential control variables in order to represent the three levels of technology intensity of the 27 industrial sectors under analysis (low, medium and high).

Technologies and expected benefits considered in the research model:

Technologies (Independent Variables)	Expected benefits (Dependent variables)
Computer-Aided Design integrated with Computer-Aided Manufacturing [CAD/CAM] Integrated engineering systems [ENG_SYS] Digital automation with sensors [SENSORING] Flexible manufacturing lines [FLEXIBLE] MES and SCADA systems [MES/SCADA] Big data [BIG_DATA] Digital Product-Services [DIGITAL_SERV] Additive manufacturing [ADDITIVE] Cloud services [CLOUD]	Y1: Improvement of product customization Y2: Optimize automation processes Y3: Increase energy efficiency Y4: Improvement of product quality Y5: Improve decision-making process Y6: Reduction of operational costs Y7: Increase productivity Y8: Increase worker safety Y9: Create new business models Y10: Reduction of product launch time Y11: Improving of sustainability Y12: Increase of processes visualization and control Y13: Reduce of labor claims Y14: Compensate for the lack of a skilled worker

4. Human factor- A system framework:

Industry 4.0 and technological change are rapidly transforming virtually all areas of human life, work, and interaction. These changes are acutely apparent in the way human work is organized and performed. However, it is still not fully clear to many in both industry and research what fully realised I4.0 applications might look like or how they might operate. For most practitioners, the digital transformation and its implications on operations processes remain a big black box. The transformation of production due to both technological and paradigmatic drivers leads to fundamental changes of organizations and processes and finally also of human work. Within this context, attention to human factors (HF) has been particularly sparse, despite the evident centrality of HF in four of the eight I4.0 developmental priorities (i.e. managing complex systems, safety and security, work organization and design, and training and professional development) laid out in the seminal I4.0-report by Kagermann et al.

Human Factors

Mental- learn, knowledge, training, capabilities, skill/s, experience/s, education, behavior(al), teaching, cognitive/cognition, talent, competencies, hmi, human-machine, mental, qualification, creativity, psychology/psychological, human-centered, confusion/ing/ed, human-robot, e-learning, human-computer, forget/ting, human-technology, memory, reasoning
Physical- physical, safety, manual, ergonomic/s, fatigue / fatiguing, posture, well-being, gesture, musculoskeletal disorder
Psychosocial- involve*, culture / cultural, feedback, motivation, stress/ful/ing, teamwork, fairness, work_design, psychosocial, job satisfaction, job demand, job control, support
Perceptual- read/ing, perception/ual, information processing

5. Conclusion:

In this paper in Industrial revolution are Materials is the key factor of Industrial growth. In each new material are used to satisfy the customer needs and profit in production side. Artificial intelligence are developing Expert industrial systems are explored all industrial challenges. This article aimed at identifying which HF aspects have been considered to what extent in the scientific literature on Industry 4.0 and at providing a systematic approach that supports corporate Industry 4.0-system development. the benefits of Industry 4.0 related- technologies for three industrial performance metrics: product, operational and side-effects. Our results showed that some of these technologies are positively associated to the expected industrial benefits while others are still at a very early stage of adoption and, thus, without clear expected benefits. We discussed reasons for the lack of expectation of benefits for some of the promising technologies of the Industry 4.0 in this specific emerging industry.

Reference:

1. S. K. Babey, J. E. McFee, C. D. Anger, A. Moise, and S.B.Achal. Feasibility of optical detection of landmine tripwires. In A. C. Dubey et al., editors, Detection and Remediation Technologies for Mines and Minelike Targets V, pages 220–231, Seattle, WA, 2000. International Society for Optical Engineering..
2. Lu, Y., 2017. Industry 4.0: A Survey on Technologies, Applications and Open Research Issues. Journal of Industrial Information Integration, 6, 1-10.
3. Antonio Grieco, Pierpaolo Caricato, Doriana Gianfreda, Matteo Pesce, Valeria Rigon, Luca Tregnaghi, Adriano Voglino, An industry 4.0 case study in fashion manufacturing, Procedia Manuf. 11 (2017) 871–877,

<https://doi.org/10.1016/j.promfg.2017.07.190>.

4. B. Motyl, G. Baronio, S. Uberti, D. Speranza, S. Filippi, How will change the future Engineer's skills in the industry 4.0 framework? A questionnaire survey, *Procedia Manuf.* (2017) 11.
5. S. Weyer, M. Schmitt, M. Ohmer, D. Gorecky, Towards Industry 4.0 – Standardization as the crucial challenge for highly modular, multi-vendor production systems, *IFAC-PapersOnLine* 48 (3) (2015).
6. Margherita Peruzzini, Fabio Grandi, Marcello Pellicciari, Benchmarking of tools for user experience analysis in industry 4.0, *Procedia Manuf.* 11 (2017) 806– 813, <https://doi.org/10.1016/j.promfg.2017.07.182>.
7. C. Leyh, S. Martin, T. Schäffer, Industry 4.0 and Lean Production – A Matching Relationship? An analysis of selected Industry 4.0 models, 2017 Federal Conference on Computer Science and Informatics Systems (2017).
8. F. Baena, A. Guarin, J. Mora, J. Sauza, S. Retat Learning Factory: The Path to Industry 4.0 *Procedia Manufacturing* 9 2017.
9. J. Tupa, J. Simota, F. Steiner, Aspects of Risk Management Implementation for Industry 4.0, *Procedia Manuf.* 11 (2017).[8] Horn, Jeff; Rosenband, Leonard; Smith, Merritt (2010). *Reconceptualizing the Industrial Revolution*. Cambridge MA, London: MIT Press. ISBN 978-0-262-51562-7.
10. Juris Meija et al., Atomic weights of the elements 2013 (IUPAC Technical Report), *Pure Appl. Chem.* 88 (3) (2016) 265–291, <https://doi.org/10.1515/pac-2015-0305>.
11. Buzea, Cristina; Pacheco, Ivan; Robbie, Kevin (2007). “Nanomaterials and Nanoparticles: Sources and Toxicity”. *Biointerphases*. 2 (4): MR17–MR71. arXiv:0801.3280.
12. CNI - Confederação Nacional da Indústria, 2016. Industry 4.0: a New Challenge for Brazilian Industry. Available at: https://bucket-gw-cni-static-cms-si.s3.amazonaws.com/media/filer_public/54/02/54021e9b-ed9e-4d87-a7e5_3b37399a9030/challenges_for_industry_40_in_brazil.pdf.