A REVIEW ON THE INDUSTRIAL REVOLUTION 5.0: THE IMPACT OF VALUE SENSITIVE DESIGN

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ABSTRACT

Present-day, we are in the industrial revolution 4.0: computerizing manufacturing through artificial intelligence (AI), machine learning, 3D printing, large amounts of analytics, and cloud technology (use of information through computing services). Society is transitioning into the industrial revolution 5.0 as human cognition improves and humans becoming smarter. The 5th industrial revolution is about making an economic improvement through a balanced society between humans and technology. Connecting the physical space and cyberspace can lead to AI surpassing human capabilities of retrieving, comprehending, and utilizing information in the same manner as human cognition. This revolution is in the process with an objective to improve efficiency and time management of human productivity in the workspace through technology like Value Sensitive Design (VSD) and network interoperability.

Keywords: 5th Industrial Revolution, Human Cognition, Artificial Intelligence, Value Sensitive Design, Network Interoperability, Neural Networks, ACT-R.

I.   INTRODUCTION

Since the first industrial revolution in the 1760s, industrialization has developed tremendously [8]: first revolution, which helped (spinning jenny, steam engine, and banking) [3]; second revolution (railroad systems, international bartering, and household goods being standardized) [4]; third revolution (personal and mainframe computing, and semiconductors) [5]; and the fourth revolution, which we are currently in, (3D printers and genetic engineering, also referred to as genetic modification [6]) [7].

Table 1: Leading attributes of each industrial revolution

Time Period	Transition Period	Key Energy Resource	Notable Technical Achievement	Developed Industries	Forms of Transportation
1760-1900	1860-1900	Coal	Steam engine	Steel, Textile	Train
1900-1960	1940-1960	Oil, Electricity	Internal Combustion Engine	Auto, Machine Building, Metallurgy	Car, Train
1960-2000	1980-2000	Natural Gas, Nuclear Energy	Robots, Computers	Chemistry, Auto	Plane, Car
2000-Present	2000-2010	Green Energy	3D Printers, Internet, Genetic Engineering	Tech Industries	Bullet Trains, Electric Cars

Meanwhile, the industrial revolution 5.0 is the concept of humans and robots working simultaneously to increase productivity in the workspace [1]. As the world is starting to revolve around technology, predominantly machine learning, AI, cloud technology, and more, many companies are trying to reap the benefits. This is supported by this research as pairing humans and machines to advance the use of human creativity and brainpower to improve efficiency in the workspace. This is also what makes the difference between the fourth industrial revolution and the fifth industrial revolution: 4.0 is focused on automation, while 5.0 is the cooperation between automation and humans. There is immense amount of data being generated [36] in healthcare areas where there are various hardware-based innovations such as disinfecting robots [37] and

software-based innovations in the areas of stuttering [38] and autism [39] which collects immense amounts of data and store it on a cloud platform. Once it gets stored on a cloud platform there are lot of machines learning driven technologies [40] which helps to analyze the data and draw some predictions from them. The industrial revolution 5.0 works as cyberspace (computer networks that facilitate online communication [26]) accumulates large amounts of information from sensors, which is then analyzed and assessed by AI. After AI gets it results, it would be sent to the physical space, otherwise considered as humans [2]. This data needs to secure in a way [41] which helps to protect the day. This step-by-step method of retrieving information differs from industrial revolution 4.0 as people would have to go to a search engine to search, analyze, and retrieve information. The industrial revolution 5.0 would do all the hard work of searching, analyzing, and retrieving the various information sources in the world and return only the relevant data.

Human cognition is the process of obtaining and comprehending the information retrieved through the human senses and experiences. While someone might struggle with storing and using information from the environment, cognition simplifies the information to its foundation [27].

AI plays a very important role in medical imaging and interventions. Starting from use cases in radiology [42], dermatology [43] and orthopedics [44], AI has expanded it's potential to design and develop decision making systems for physicians which assists them to further take decisions. This kind of a technological approach helps the medical fraternity in saving time, making detection methods more efficient and economical and focus more on patient care.

Human cognition is a major factor of the 5th industrial revolution. The proposed research supports this as AI is proof that humans are trying to develop machines that perform brain-like activities [28]. Soon, AI can be believed as human intelligence being simulated through information processing systems [29]. This can be done by determining the main cognitive processes that are used in AI [28]. AI developed human cognitive features like learning and planning, emotion or speech recognition, reasoning and problem-solving occurred through deep learning. Deep learning is a multi-layered neural network (reflects the human brain's behavior, which allows computer programs to solve problems and determine patterns relating to deep learning [31]) that focuses on imitating human behavior [30]. Robots can perform unrestricted tasks without human assistance through a precise processing system that allows robots to learn and adjust to different situations. To achieve knowledge acquisition, there will need to be a large amount of prediction systems like neural networks [29].

Finance is one of the integral part when we talk about Industrial Revolution 5.0. There are lot of frameworks which includes deployment of blockchain [45] through high end graphical processing units. There is a lot of literature search which exists on decentralized finance protocols [46] which assists the in decision-making process.

One method to determine the main cognitive processes is through ACT-R (adaptive character of thought-rational [32]). Psychological theories support that human tasks are performed through a combination of distinct operations. ACT-R is a method that specifies ways that a human brain is organized for cognition output [33]. ACT-R has been used to capture how people solve algebraic questions. Methodology is that the cognitive architecture is required to download the codes of ACT-R and upload it in a CL (common lisp) distribution for an interpreter to access. It would then produce a simulation of the human behavior in an ACT-R script [34].

II.   LITERATURE REVIEW

Some people believe that the advancements of technology in the workspace will lead to an increase in unemployment rates. However, it is the opposite as technology offers many advantages like opening more job opportunities in certain fields and many more as listed in table 2.

Table 2: Advantages

Economic Advancements	Social Problem Resolutions
Energy's demand is increasing	Greenhouse gases (GHG) emissions are decreasing
Foodstuffs demand is increasing	Production increased and foodstuffs are being less wasted
Aging society is advancing, and the lifespan is	Costs being mitigated relating to the aging society

lasting longer	
International competition is becoming harsher	Industrialization can be reasonably sustainable
Wealth inequality is growing	Promotion of wealth equality

Caption: Balancing the economic advancements with resolutions of social problems

One method can be through developing technology so different programs and networks can cooperate without any supplementary interfaces or tools [9]. This is also known as network interoperability. The research states that a benefit of network interoperability is that it helps achieve quicker analyses and provides customizable processes [10]. Network interoperability is when management software allows consumers to customize their software to adapt to their circumstance. This can be done through making a network of sensors consisting of low processing power and low-level intelligence, which can allow for data to be locally preprocessed [11]. Preprocessing data is when the cluster of data is transformed into a more efficient format to be interpreted and prevent overload and network latencies, or the time it takes for information to travel from one point to another [12, 13]. Then the data that is easily formatted to allow new possibilities for extraordinary customization in the manufacturing processing in businesses.

Another method that can be useful in the 5th industrial revolution is the Value Sensitive Design (VSD). This is mainly to take account of technologies in society and its impacts. It also provides methods and theories for human values to hold account of in a systematic and principled format all through the design process [18]. VSD has been one of the most chosen approaches in the last 20 years to guide the design for the future of factories. This is because it helps build the framework methodologically, (set of principles and methods used for an activity [15]) and theoretically (relating to theories and ideas over actions [16]). Relating to the 5th industrial revolution, VSD is beneficial because of its versatility – since VSD can be applied across many different design fields – and its focus and introspection of stakeholders, direct and indirectly, for the philosophical analysis and design process of the implicated values, which was an unexpected combination for a basic process for approaching designs [14].

Tying this into the 5th industrial revolution, VSD plans to work at a meta-level, which is the evolutionary strategy of a reflective model [17], over targeting a set of values to avoid VSD from being grouped as a single use framework. A large range of dynamic variables like technologies, values, stakeholder groups, and social contexts is the main aim for VSD. The methodology for VSD is to interact with stakeholders interested in the 5th industrial revolution to assist in the development of technology at an early stage and repeatedly improve itself during the design process as the values change. This three-part structure illustrated in Figure 1 demonstrates the process behind VSD's constant improvisations [14].
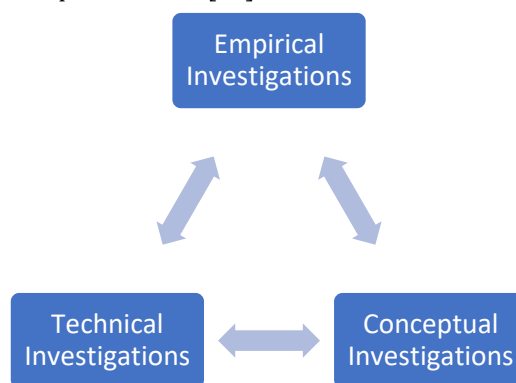

Figure 1: The three investigations of VSD's methodology

A. Conceptual Investigations: The proposed research states that VSD's main purpose is to set stakeholder's values in the design process to help guide the technology to map the important values. The values used in the investigation are preferred to be in sets over individual values. To start a conceptual investigation, it is needed to first look at any information that is in context, whether it will be used or not. It is recommended to use value systems for the starting point of this analysis. The proposed research has used these three [14]: PVQ (Portrait Values Questionnaire) [19], WVI (Work Values Inventory) [20], and WIS (Work Importance Study) [21].

B. Technical Investigations: This is used after conceptual investigations to regulate/decide the technical aspects of VSD's technology. The study supports that VSD's main function is to determine the general technologies' position based off their attributes [14]. In other words, VSD moves values of the specific design's requirements through the definition of set-norm. A norm is the midpoint between a technology's values and design requirements. They are known to be the classifications of the values or design objectives of the project. Norms of the values are decided through the context of the technology: norms can be used for broad or narrow design requirements [22]. This can be used to figure out a technology's proposed solution was composed for.
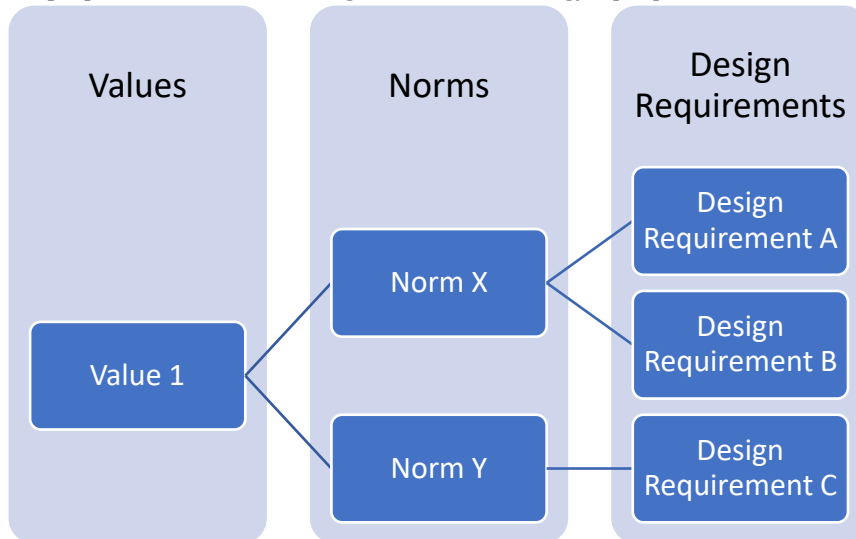

Figure 2: Value-norm-design requirement system

C. Empirical Investigations: Empirical investigations concludes the VSD cycle by admitting stakeholders to understand their role with the technology and the function behind the values mapping on the designs [23]. A limitation of VSD is the ethical issues that might come up from not committing to a single ethical theory [22]. This can be resolved with the research technique known as reporter's questions (who, what, when, where, why, and how) and a bottom-up approach (retrieving information through the human senses to build an image) [24, 25].

Table 3: Limitations of the Value Sensitive Design (VSD)

Limitations of VSD	
	Need to compare data across multiple nations or cultures to find similarities/differences
	Value system is heavily influenced by production activites, work world, and the socio-cultural factors all constantly changing
	Can only be referenced to businesses with similar features
	The process, (investigating, determining, and translating the values into the requirements), is demanding and laborious
	VSD works against the art of striving for perfection, so it can suite innovation hubs that do not have too much time or resources, but can also work against the businesses that have the requirements

III.   CONCLUSION

Human cognition is a crucial part of the 5th industrial revolution as humans need to understand how the cognitive side of the human brain works. This can then be used to further the development of artificial intelligence. Study of the cognitive brain can be done through technology like ACT-R, which shows how the human brain is organized when cognition output is occurring [34]. Human cognition can make a big difference in how the 5th industrial revolution transpires. The goal is for humans and machines to work alongside each other as artificial intelligence and machine learning leads the way for machines and humans to think alike.

As society is transitioning into the industrial revolution 5.0 era, there are many benefits to consider. One can be that it can raise employment rates as there will need to be people to monitor and manage the technology. Another is an increase in the productivity of human cognition as technology can handle the extensive search of data through the Internet, which leads to humans being able to use the information to make decisions. This is done through connecting the physical space and cyberspace to work alongside each other to increase efficiency in the manufacturing and production processes.

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