

DOI: 10.7596/taksad.v11i1.3182

Citation: Xaba, S., Fang, X., Shah, D., & Mugerwa, I. (2022). The Impact of 4IR technologies in Visual Art. *Journal of History Culture and Art Research*, 11(1), 41-56. doi: <http://dx.doi.org/10.7596/taksad.v11i1.3182>

The Impact of 4IR technologies in Visual Art

Siyanda Xaba¹, Xing Fang², Dhaneshwar Shah³, Ibrahim Mugerwa⁴

Abstract

The Fourth Industrial Revolution (4IR) will have a great impact on society with technologies that are said to revolutionize industries. Research tells us that technologies such as Artificial Intelligence (AI), Internet of Things (IoT), Cyber-Physical Systems (CPS), robotics, and 3D printing will change the workplace, allowing greater performance and productivity. Extensive research in this discipline including manufacturing, employment, education, ICT, healthcare, and smart factories investigated the attitude of employees on the adoption of new technologies to simplify certain work professions and the results indicate that these technologies are capable of improving the way of living. There is a dearth of research that looks into the impact of 4IR in Visual Art. We have been told that the creative sector will be at forefront of the 4IR, however, we have no idea what technologies will be used in Visual Art in the 4IR. Therefore, the study aims to bridge this gap by discussing the impact of 4IR technologies in Visual Art. The study uses a practice-led method, focusing on the creative process of digital art technologies such as Autodesk Sketchbook, Deep Dream Generator, and Rhinoceros.

Keywords: 4IR, 4IR technologies, digital art, visual art

¹ School of Art and Design, Wuhan University of Technology, Wuhan, China. Email: master.xaba@gmail.com

² School of Art and Design, Wuhan University of Technology, Wuhan, China. Email: 428037@qq.com

³ School of Art and Design, Wuhan University of Technology, Wuhan, China. Email: dhaneshwar005@yahoo.co.in

⁴ School of Art and Design, Wuhan University of Technology, Wuhan, China. Email: ibraton@gmail.com

Introduction

Historically, we see the industrial revolutions having an impact in Visual Art as a result of the type of technologies that emerged. The First Industrial Revolution and the Scientific Revolution contributed to the type of art that emerged as art shifted from the Enlightenment principles of order, balance, logic, reason, and rational, to art that portrayed technological innovation of the Scientific Revolution and the depiction of the working class in factories brought by the industrial age. The Second Industrial Revolution brought technologies that pushed Visual Art into evolving in art expression and this is evident with the introduction of the camera. The camera could capture real life scenes and events, something that had been done by visual artists throughout the Enlightenment. This meant that artists could no longer produce realistic depiction of scenes and had to look into other innovative ways of producing art. The period of Modernism saw artists producing expressive and vivid art that broke away from Enlightenment canons. The Third Industrial Revolution transformed Visual Art in terms of the materials of art production. Visual artists shifted from traditional mediums such as drawing, painting, and sculpture and started exploring media such as video, sound, computer, installation and technologies that came with the Third Industrial Revolution. The Fourth Industrial Revolution is around the corner and we already see other sectors preparing for it. Technologies such as AI, robotics, IoT, CPS, 3D printing will be operational in many industries, allowing greater performance and productivity. Extensive research in this discipline include (manufacturing, employment, education, ICT, healthcare, smart factories) investigated the attitude of employees on the adoption of new technologies to simplify certain work professions and the results indicate that these technologies are capable of improving the way of living. There is dearth of research that looks into the impact of 4IR in Visual Art and therefore, the study aims to bridge this gap by discussing the impact of 4IR technologies in Visual Art.

Challenges in integrating 4IR technologies in Visual Art

Research tells us that the creative sector will be the driving force in the 4IR as a result of creativity and critical thinking in the 4IR. Not much has been written that looks to what technologies will be used in Visual Art in the 4IR era. This is of concern considering that there are expectations for the creative sector to be at the forefront of this new revolution. We do know that creative industries such as industrial design and product design are more equipped in adopting to the technological changes that will be brought by the 4IR since these industries specialize in innovation and technological advancement. The Visual Arts seem to be lagging behind as a result of slow integration of 4IR technologies in tertiary art institutions as well as visual art practice. Some traditional creatives are unsure of how to integrate digital technology and are hesitant to see coding and other tech skills as artistic practices, (Faramarzi, 2019). Artmaking skills largely revolve around traditional mediums with

little application of new innovative ways of producing art. This is not to say that visual artists are not applying any new innovative ways of creating art, it is to say that there's been a slow integration and application of these 4IR technologies in art practice. There is a negative perception evoked by traditional creatives towards the use of digital art technologies in art practice. This trend of thought was also persistent in the Renaissance period where the camera obscura was used to produce realistic paintings. Traditional artists tend to view artists that use these technologies as cheating the creative process and lacking in skills. This kind of perception needs to be debunked because the most important aspect in a work of art is the message that an artwork evokes. Of course, it's also important to have natural talent and basic understanding of traditional mediums, however, in the contemporary art world, the message behind a work of art is most important. For the creative sector to be at the forefront of this new revolution, the Visual Arts need to integrate 4IR technologies in the creative process

Fourth Industrial Revolution and Contemporary Art

The Fourth Industrial Revolution appeared for the first time in 2011 because of German effort (Douaioui et al. 2018: 128). The Fourth Industrial Revolution is known as a digital revolution and we see Visual Artists using digital mediums such as computer-generated art, three-dimensional printing (3D), Artificial Intelligence (AI) as their form of artistic expression. The Fourth Industrial Revolution builds on the Third, the digital revolution has been occurring since the middle of the last century (Schwab 2015: 1). Technologies that emerged in the Third Industrial Revolution such as computers, and AI are developing in the 4IR at an extraordinary rate. Contemporary art is widely known as a distinct genre since the early 2000s and is known to be extremely eclectic (Leduc 2019: 257). Contemporary artists are using new tools to reform commercial art such as photography, television, music, and film (Rani 2018: 62). We also see contemporary artists using technologies such as AI, 3D printing, digital art, and digital platforms for promoting art. Contemporary art is the most recent art that is still in process of being historicized. Furthermore, Contemporary artists address a variety of themes, and it is often marked by wilful obscurity that makes the work more puzzling and difficult to categorize. Some of the earliest forms of digital art can be traced back to 1950 with visual artists using programming and technology to create art (Wands and Emeritus 2017: 1). In its inception, it was not viewed as part of Contemporary Art because many artists were not using this type of art, and galleries and museums were finding it hard to archive this type of art (Wands and Emeritus 2017: 2). Digital art gained much international attention in the 1960s, however, the 1970s saw traditional institutions and artists shying away from digital art. The 1980s saw very few digital art curators and in the 1990s the art community started embracing it. In this day and age, digital artists use iPads, computers to produce digital drawings. Some digital artists use powerful apple devices for design drawings such as Autodesk

Sketchbook, Procreate, Adobe Creative Suite 6 Master Collection, CAD, Rhinoceros, 3D printing, and CorelDRAW.

AI and Art

AI (Artificial Intelligence) is part of the Fourth Industrial Revolution and has also integrated itself into Visual Art. AI-generated artworks are artworks created with the assistance of artificial intelligence. This refers to an algorithm that has been programmed into a computer-generated piece of art. Initially, artificial intelligence was used in art as an impersonator rather than a creator. The 1960s and the end of the 20th century was the infant stage of AiArt which produced computer art (Chen et al. 2020: 48). At this stage, AiArt could achieve human-computer communication and interaction through receiving information from the surrounding environment, and then using text, voice, motion, and other information media and sensor systems to output feedback to users (Cho and Lee 2013). The 21st century in AiArt is regarded as the popularization of AiArt which is also referred to as the stage of intelligence art (Chen et al. 2020: 49). Artists use cognitive intelligence to learn specific aesthetic rules by analyzing thousands of images and then trying to create new images that fit their aesthetic characteristics (Chen et al 2020: 49). In this stage, computer programs have the capability of creating artworks without the aid of human effort (Elgammal et al. 2017: 2). Gey (2021) argues that some people believe that this new type of technology will replace humans in society, leading to no human-based art and some believe that it is just a tool that visual artists could use in their creative process. AI is merely a sophisticated tool with additional capabilities and features. Overall, it all comes down to learning how to code AI algorithms and then creating your unique artwork based on whatever art style and machine learning you prefer.

3D printing

The first invention of 3D printing dates back to 1984 and was invented by Charles W. Hull from 3D Systems Corp (Pirjan and Petrosanu 2013: 1). Interestingly, it's only recently that visual artists are using this technology in their work (Hansen 2020). 3D printing is a rapid prototype of new technologies (Xichang and Sheng 2016: 94). Furthermore, 3D printing technology is different from traditional "cut-oriented manufacturing", which is performed in the raw material cutting, etching, grinding to remove excess detail to give the parts, and combine to form a complete product (Xichang and Sheng 2016: 94). 3D printing has been used in art creation, particularly in sculpture design (Xichang and Sheng 2016: 94). Traditional sculpture design is said to include many aspects of labour costs and is very complex in production whereas 3D printing technology uses a computer and high precision 3D printer. Computer-Aided Design (CAD) is software used in animation and 3D printing for printing designs (Ho 2019). CAD is digital software that allows artists to create the sculptural design digitally and later print it using 3D

printing technology. 3D printing allows the liberty of creating complex structures that would be almost impossible to make and extremely time-consuming (Asherian 2019). Traditional sculpture requires a level of genius and precision that only a few have, fortunately, 3D printing compensates with that since the printing does the work. The only requirement that the visual artist need is to learn how to operate CAD software to digitally create a work of art that is intended to be 3D printed.

Digital platforms

The introduction of computer and online platforms have replaced the need for physical interactions between artists and objects (Warren 2005). This trend is evident throughout the world with artists using digital platforms such as Instagram, Facebook, and Online art gallery to showcase their works. Digital media has become instrumental in the documentation and conservation of Contemporary Art (Lughi 2014: 45). Furthermore, museums and institutions produce and store large amounts of digital material and they make the content available to the public through the net (Lughi 2014: 45). Digital media is freeing artistic practices from conventional archaic customs in production, exhibition, and curation. Instagram allows artists to reach a wider audience with the help of hashtags, promotions, Instagram stories. Another interesting feature is the Instagram insight which is an analytic tool that allows the artist to know the right time to post art to have a greater audience reach. The 21st century came with technologies that influenced the millennial to be technologically driven. The younger generation is fascinated with technology and this is because they grew up being exposed to it. The difference between old and new art is the difference in the use of media (McLuhan 2000). The media not only determines the way and form of artistic expression but also has a huge impact on the nature and beauty of artistic works that leads to the change in creative thinking and concepts (Chen et al. 2020: 50).

Research Method

The study uses a qualitative approach. Creswell (2013: 23) states that qualitative methods include the process of collecting, analyzing, interpreting, and writing the result of the study. For this study, we use secondary data for literature and we also applied the practice-led method. Candy (2006: 3) states that practice-led research is concerned with the nature of practice and leads to new knowledge that has operational significance for that practice or to advance knowledge within practice. Skains (2018: 85) states that practice-led research methodology is applicable in four key areas and these include theoretical, conceptual, dialectical, and contextual. In this study, we look at practice-led research from a theoretical aspect. Skains (2018: 85) explains the theoretical aspect as when a researcher is exploring research issues and problems. The study examines the creative process of artists using digital art

software, namely, Autodesk Sketchbook, Deep Dream Generator, and Rhinoceros software. The study looks at the work produced by Siyanda Xaba, Dhaneshwar Shah, and Ibrahim Mugerwa.

The creative process behind the work

This section focuses on the creative process behind digital artwork and looks at how artists have utilized these technologies. In this study, we used Autodesk Sketchbook, Deep Dream Generator, and Rhinoceros software to investigate how artists operate these technologies and also identify certain characteristics that can be associated with 4IR technology. We focused on these technologies because we have experience in using them and we firmly believe visual artists can be able to use them since we come from a background of traditional art.

Autodesk Sketchbook

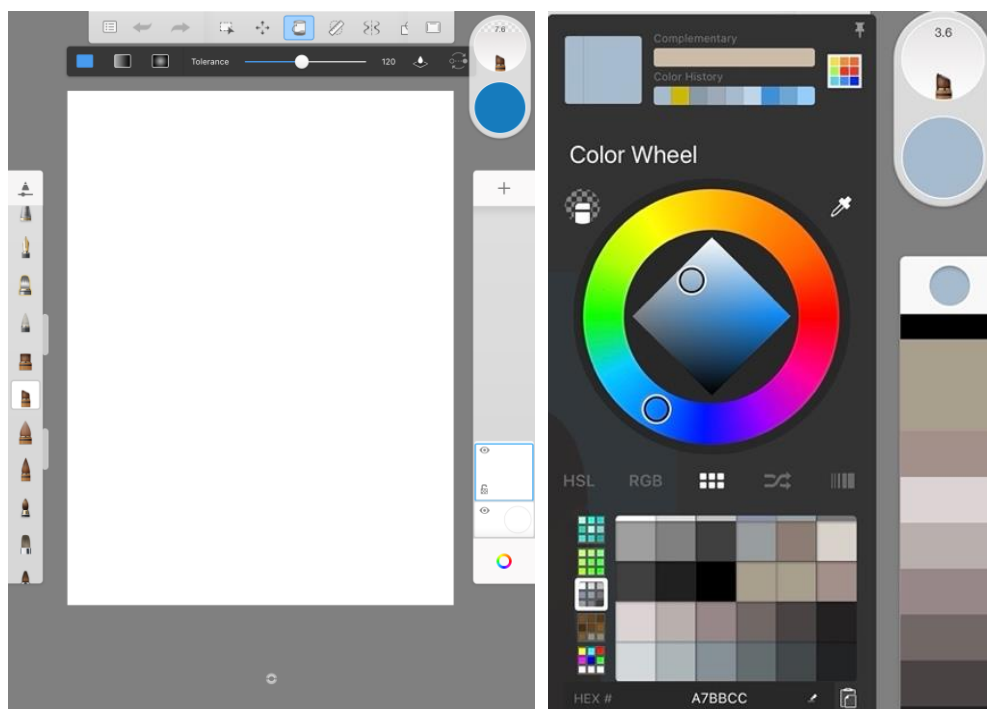


Figure 1

Siyanda Xaba, Autodesk Sketchbook, 2021 (photograph by the author)

Figure 1 is an illustration of the Autodesk Sketchbook software that is used to produce a work of art digitally. Artists can use an iPad device that has the software; however, visual artists can install this software on their laptop devices. Autodesk Sketchbook allows artists to have a variety of functions to operate to contribute to the creative process of the work. This includes the colour pallet, variety of drawing tools that have different textures. The first picture in figure 1 illustrates the interface of the software and the different tools that can be used to produce a work of art. The second picture in figure 1 illustrates the colour pallet that can be used to insert background colour and apply a variety of shades of colour. The software allows visual artists liberty to explore various ways of assembling the artwork.

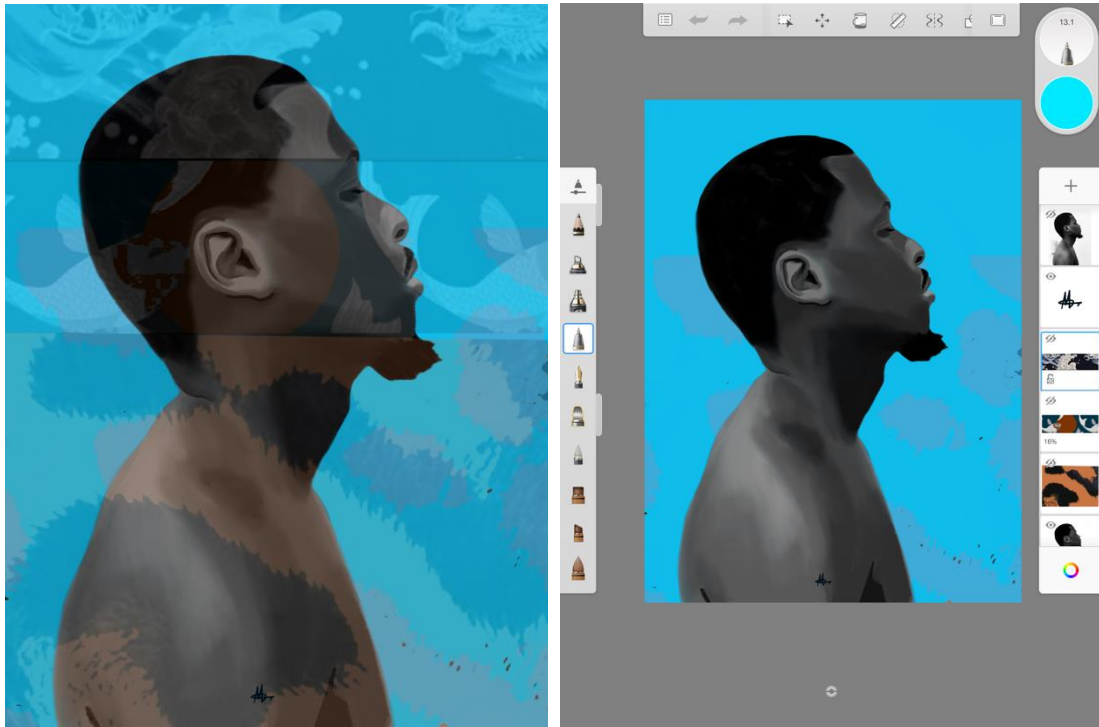


Figure 2 Siyanda Xaba, *Self-portrait*, 2021, digital art, (photograph by the author)

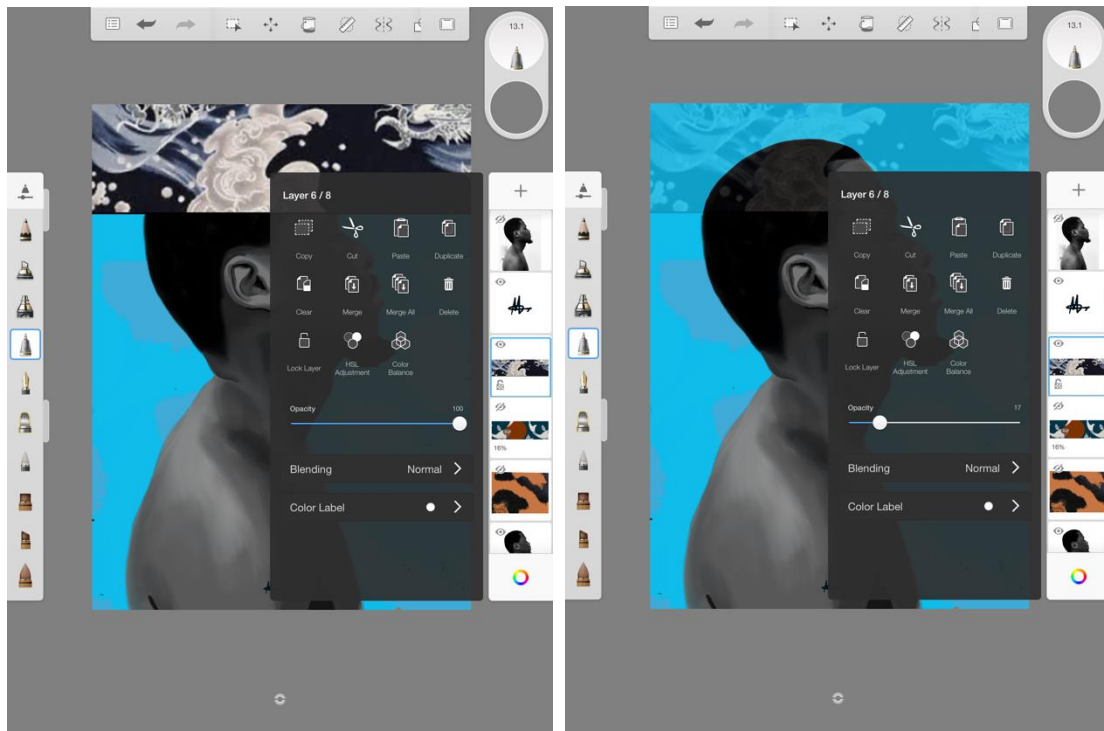


Figure 3

Siyanda Xaba, *Inserting designs*, 2021, digital art (photograph by the author)

The work in figure 2 was produced by Siyanda Xaba using Autodesk Sketchbook which is a digital art software that is used for producing art digitally and is mostly used by product designers. The work in figure 2 shows the complete work with design work elements included and the second picture shows the creative process behind the work. The artists first drew the portrait and then later included some design elements which are illustrated in figure 3. This was done by inserting images in the drawing and then reducing the opacity of the image from 100 percent to 17 percent. The reduction of opacity led to the transparent finish that is integrated into the drawing. This whole process was repeated three times with different images that were superimposed in the drawing. Siyanda Xaba is a visual artist who has a background in traditional drawing and painting and he finds it interesting to use the software as it eliminates a lot of effort that goes through in creating a work of art. One of the characteristics of the Fourth Industrial Revolution is the ability to use less human effort and we see this with Autodesk Sketchbook as it uses less human effort to operate. Traditional media such as painting and sculpture require time and effort to produce a work of art whereas, with this software, little effort and time are needed to produce a work of art. Of course, the artist still draws but the software allows users to accurately capture objects and figures with the option to trace the outline of the reference picture. Visual artists that specialize in commissions can take advantage of digital art software by using the tracing tool just like how Renaissance artists used the camera obscura to produce realistic paintings. Visual artists can insert the background colour or design at a click of a button whereas painting requires the artist to use human effort to apply layers of paint to produce good quality background colour and design.



Figure 4

Siyanda Xaba, Commission work, 2021, digital art, (photograph by the author)

Artists can use this software to produce artworks for clients and this is evident in the work illustrated in figure 4. Autodesk Sketchbook was used to create the artwork and after completing the work, it was then saved in a picture format. The work was printed on A1 paper and was later framed and shipped to the client’s location. The Fourth Industrial Revolution has had a huge impact on Visual Art as artists no longer need to spend money on buying paint, spend days painting and toil in trying to produce good quality work. Digital art software can cut production costs and allow the artist to produce work of high standard in a short space of time.

Deep Dream Generator

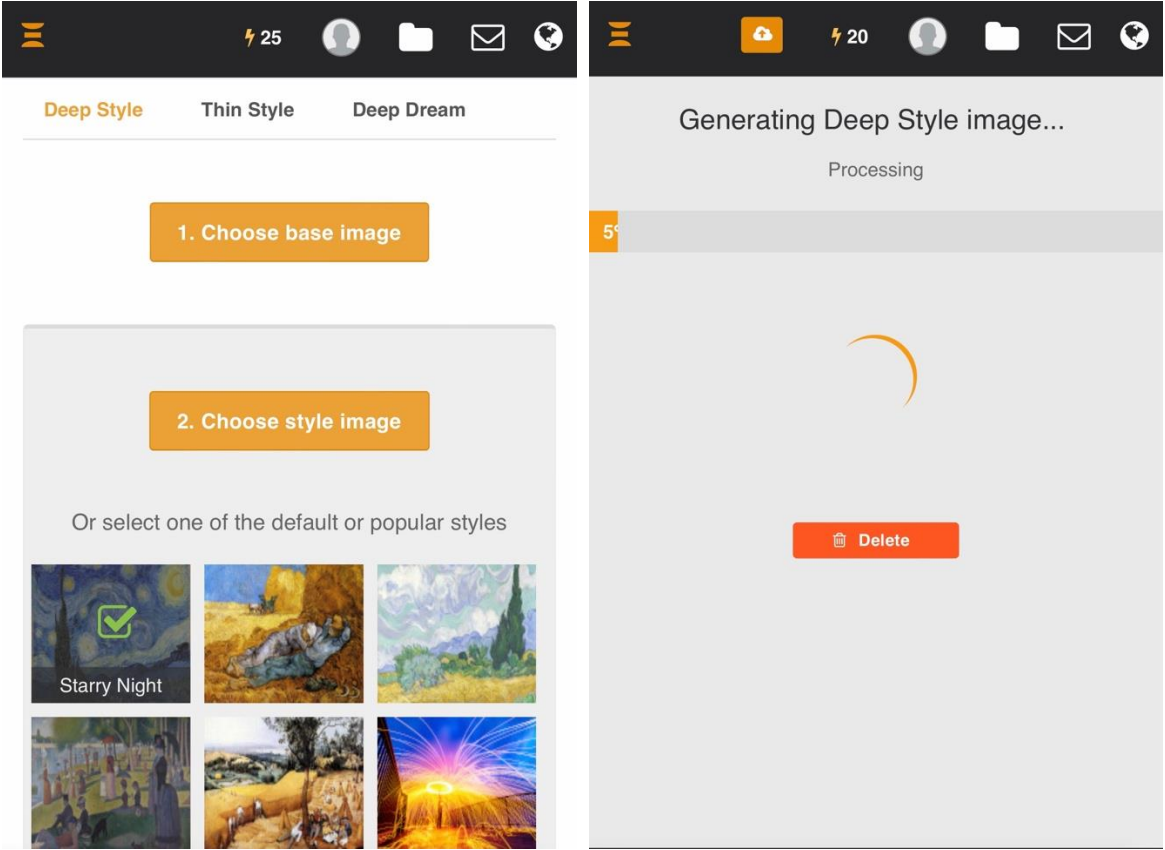


Figure 5
Deep Dream Generator screenshot (retrieved from public domain
<https://deepdreamgenerator.com>)



Figure 5

Dhaneshwar Shah's artworks, 2021, (photograph by the author)

When we talk about AI-generated art, we usually mean one of two things: Neural Style Transfer or Generative Adversarial Networks. The term "Neural Style Transfer" refers to a group of algorithms that apply the style of existing images to new images. To produce a new piece of art, the artist must first choose an input image (the bird) and a style image (Vincent van Gogh's *The Starry Night*). The final image will be a unique, random combination of the first and second images after the algorithm command. Deep dream generator is a computer version platform that allows users to insert images in the software and transform them through an artificial intelligence algorithm. Artists have taken advantage of this software by transforming their work of art into something new. Dhaneshwar Shah is a contemporary artist in the area of painting. He explored this software by inserting both the artworks in figure 5 and forming a new work of art. Figure 4 illustrates this process where the artist inserts the base image of the rabbit and then inserts another image of the painting as the style image.

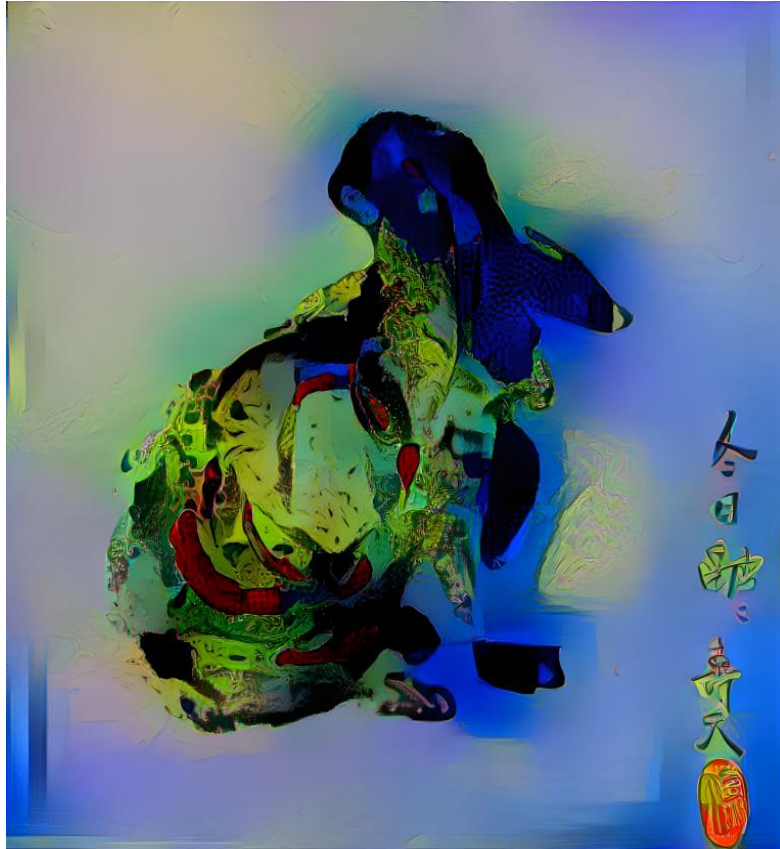


Figure 6
Dhaneshwar Shah, AI generated artwork, 2021 (photograph by the author)

The work in figure 6 illustrates the new work that was formed as a result of the combination of images. Deep Dream is a free and simple-to-use application. It has three features that allow you to transform any photo you upload. Deep Style, Thin Style, and Deep Dream are the three options. AI is assisting artists in a variety of ways, including helping them imitate the styles of famous painters from the past. This ability to imitate and replicate can be valuable in both the creation and restoration of a work. In three ways, AI may be used to generate new ideas: through generating innovative combinations, exploring the potential of conceptual spaces, and transforming data. New breakthroughs in AI and machine learning technologies are being used in new breakthroughs to give computers more autonomy in image creation. Not only is AI evaluating and estimating the worth of an artwork, but it is also assisting in the forecasting of the value of the next piece of art. With AI's help, an artist can devote more time to developing new creative concepts.

Rhinoceros Software

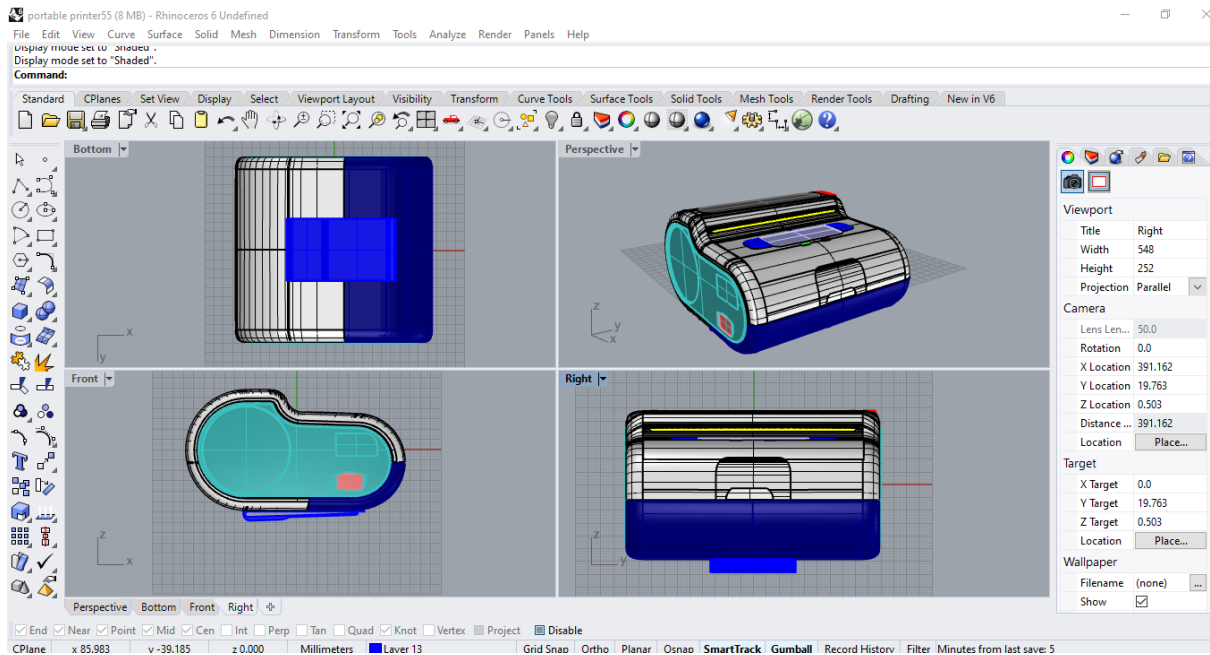


Figure 7

Ibrahim Mugerwa, Rhinoceros software 3D model, 2021 (photograph by the author)

The work in figure 7 is an illustration of the Rhinoceros software that contains tools and functions needed to design a product. Rhinoceros Software is a 3d software that is used mostly by Industrial designers (Product designers). It's an interesting software where a designer can make 3d model in more than 4 views. Top, bottom, Right, Left, front. From these views, the designer will be able to come up with a solid work of rhino. Rhino is unique in that the designer uses line and curves to create a surface. Surfaces will be created like tools like Loft, Sweep rail 1 and 2, Revolve, curve network, etc. Curves will be created with keys like Line, polyline, circle, etc. In Rhino still, the designer can be able to make simple renderings of his 3d model. During the creative process, artists use the software to produce designs and after that process, the artists then produce a prototype by using 3D printing technology. If the product is approved, it is then manufactured as a complete usable product. Artists who specialize in sculpture can utilize this software to produce sculptural pieces digitally and then print them using 3D printing technology.



Figure 8

Ibrahim Mugerwa, 2021, Portable Printer, (photograph by the author)

The work in figure 8 illustrates a product rendering of a portable printer done by Ibrahim. It's a Bluetooth portable printer design that supports android, iOS, and windows convenient to print receipts from dive wirelessly designed to be used by Express delivery companies. It's a simple printer which measures Size: 12x7.5x5cm (Product), 17x13x7cm. The printer uses a USB cable charger, Bluetooth, digital display. The material for the printer is hard plastic.

Ibrahim has a background in Industrial and Fine Art where he studied graphic design, painting, and drawing. Ibrahim started using Rhinoceros software in China when he joined a product design class. He had to teach himself how to use the English version of the software since all of his Chinese classmates were using a Chinese version of the software. As time went on, he was able to learn how to use the software through trial and error. In his experience, the fascinating aspect about the software is that each user can use it in his/her way, using different tools to come up with a complete product.

Analysis of the 4IR technologies

Innovation

In all of the digital software used in this study, there's an element of innovation that cannot be easily achieved using traditional mediums. Autodesk Sketchbook not only allows the artist to draw digitally

but also allows the artist the ability to play with images as illustrated in figure 3 by superimposing design elements in the drawing. Deep Dream Generator allows artists to generate new innovative artworks with a click of a button by combining images to generate new ones. This is best captured in the work of Dhaneshwar Shah as he was able to combine both his artworks to form a new one. According to Ibrahim, Rhinoceros allows artists to produce a work of art in their way with different tools available. Furthermore, artists can produce a prototype of their design using 3D printing technology.

Time

Traditional drawing, painting, and sculpture often consume time as a result of errors and the process of creating a complete artwork. Autodesk Sketchbook reduces time and helps to quickly capture the accurate proportion of the drawing with the use of the tracing tool in the software. In a situation where errors occur during the creating process, artists can use the back arrow button to remove the mistake with a click of a button. Deep Dream Generator allows new works of art to be quickly produced within seconds. After inserting images, the software automatically generates a new work of art. The software uses less human effort as it automatically generates new art at a click of a button. Rhinoceros also reduces the production time and effort needed to produce a work of art. Producing a traditional sculpture is usually a long process that requires time and effort, however, with Rhinoceros, the artist can digitally produce a 3D model of an artwork and then print it using 3D printing. This process reduces the human effort that is often needed when producing a sculptural piece.

Creativity and Critical thinking

Creativity and critical thinking is an essential part of 4IR, and Visual Art consists of these skills. Literature also tells us that the creative industry will be the driving force in the 4IR and that investing in creative occupations will facilitate problem-solving and design thinking that emerges from technology supported by imagination. Looking at Autodesk Sketchbook, Deep Dream Generator, and Rhinoceros, there's an element of creativity and critical thinking that exist within the software. In Autodesk Sketchbook, Siyanda Xaba was able to solve complex problems that require precision and accuracy by playing around with the tools that exist in the software. This is evident when the artist was able to incorporate design elements in the drawing and being able to capture the accurate proportions of the portrait drawing. In Deep Dream Generator, Dhaneshwar Shah used less human effort to create a new work of art. The software did all the hard work by producing a new form of art as a result of combinations of artworks. However, it is important to note that for the software to generate a new work of art, the artist needs to be involved in the creation and the conceptualization of the work since the artist chooses is the one that inserts the images in the software. Rhinoceros allowed Ibrahim

Mugerwa the ability to create a 3D piece. The software allows innovation, creativity, and critical thinking and is capable of solving complex problems that are needed in producing a product. For visual artists in the field of sculpture, this is a game-changer as it would eliminate the rigorous process needed for creating a sculptural piece.

Conclusion

In literature, we see the relationship between the Industrial Revolutions and Visual Art, and this is evident from the First Industrial Revolution to the Third Industrial Revolution. The study identified two issues that exist in the literature regarding the 4IR in Visual Art. This includes the lack of novel insight regarding the 4IR technologies in Visual Art and the lack of knowledge regarding technologies needed in Visual Art to operate in the 4IR. The study addresses these issues by first establishing through literature an understanding of what we consider as 4IR technologies. Technologies such as AI, 3D printing, and digital platforms are identified in the study as technologies that artists are using in their art practice. We then conducted a practice-led study, focusing on digital art technologies such as Autodesk Sketchbook, Deep Dream Generator, and Rhinoceros. We noted that these technologies allow innovation, creativity, and critical thinking, and reduce production time. These are some of the skills that the World Economic Forum considers as the third most important skill needed to survive and thrive in the 4IR. The study does not attempt to discredit traditional art but only aims to offer novel insight on technological innovation and progress in Visual Art. Limitations exist in this study as there were no interviews conducted that look into visual artists that use 4IR technologies. Future studies can look at the role that visual artists will play in the 4IR and could also look at whether the advancement of technology has eliminated the need for the artist to produce a work of art.

References

- Asherian, N. (2019). 3D Printed in Art: How 3D Printing Makes Its Way into Art. <https://all3dp.com/2/3d-printed-art-how-3d-printing-makes-way-into-creativity/>
- Candy, L. (2006). Practice Based Research: A Guide. CCS Report, 1-19.
- Chen, W., Shidujaman, M., & Xuelin, T. (2020). AiArt: Towards Artificial Intelligence Art. *MMEDIA 2020: The Twelfth International Conference on Advances in Multimedia*, 47-52.
- Cho, O, H., & Lee, W, H. (2013). "Application of Reinforcement Learning System to Interactive Digital Art". *Journal of Internet Technology*, 14, 99-106. <http://dx.doi.org/10.6138%2fJIT.2013.14.1.10>
- Creswell, J.W. (2013). Research Design [B]. United Kingdom: Sage Publications Inc, 1-342.

- Douaioui, K., Fri, M., Mabrouk, C., & Semma, E. A. (2018). The interaction between industry 4.0 and smart logistics: concepts and perspectives, *International Conference on Logistics*, 128-132. <https://doi.org/10.1109/LOGISTIQUA.2018.8428300>
- Elgammal, A., Liu, B., Elhoseiny, M., & Mazzone, M. (2017). "CAN: Creative Adversarial Networks Generating 'Art' by Learning About Styles and Deviating from Style Norms". *The Eighth International Conference on Computational Creativity (ICCC)*, 1-22. <https://arxiv.org/abs/1706.07068>
- Faramarzi, S. (2019). Art Schools of the Future Need to Teach Students to Understand Technology. How Will That Change the Future of Art? <https://news.artnet.com/art-world/art-school-tech-adapt-1742802>
- Gey, T. (2021). The Role of AI in Art Creation. <https://towardsdatascience.com/the-role-of-ai-in-art-creation-a53dbd562cdb>
- Ho, C. Y. (2019). Building The Essential Skills of Creativity of the Fourth Industrial Revolution#4IR#FutureofEmployment. <https://www.fenews.co.uk/exclusive/26846-building-the-essential-skills-of-creativity-for-the-fourth-industrial-revolution-4ir-futureofemployment/>
- Mcluhan, H. M. (2000). *Understanding the Media: An Extension of the Man*, Beijing: Commercial Press, 46-326.
- Leduc, M. (2019). Defining contemporary art: what the Kunstkompass Top 100 lists can tell us about contemporary art. *Journal of Visual Art Practice*. Routledge, 18(3), 257-274. <https://doi.org/10.1080/14702029.2019.1654204>
- Lughi, G. (2014). Digital Media and Contemporary Art. *Mimesis Journal*, 3(2), 43-52. <https://doi.org/10.4000/mimesis.686>
- Pirjan, A., & Petrosanu, D. M. (2016). The Impact of 3D Printing Technology on The Society and Economy, 1-11.
- Rani, A. (2018). Digital Technology: It's Role in Art Creativity. *Journal of Commerce & Trade*, 13(2), 61-65. <https://doi.org/10.26703/JCT.v13i2-9>
- Schwab, K. (2015). The Fourth Industrial Revolution. *SNAPSHOT*, 1-9.
- Skains, R. L. (2018). Creative Practice as Research: Discourse on Methodology. *Media Practice and Education*, 19(1), 82-97. <https://doi.org/10.1080/14682753.2017.1362175>
- Wands, B., & Emeritus, C. (2017). The Engagement of Digital Art with Contemporary Art. BCS Learning and Development Ltd, 340-344.
- Warren, N. A. (2005). "Internet and globalization." *Economics of Globalization*, 192-193.
- Xichang, W., & Sheng, L. (2016). The Land Sculpture Design and Manufacturing Research Based on Parametric Design and 3D Printing. *2016 International Conference on Smart City and System Engineering*, 94-96. <https://doi.org/10.1109/ICSCSE.2016.0035>