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The future is now: opportunities and challenges of integrated technology in graphic communications for Industry 5.0: a Systematic mapping of the literature

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Short abstract

This study provides a holistic overview of Integrated Technologies, such as Automation, Artificial Intelligence (AI), the Internet of Things (IoT), Big Data, Machine Learning (ML), and Augmented Reality (AR), and their applications within the Graphic Communications Industry. By leveraging a systematic literature review utilizing both quantitative and qualitative publications, this study aims to answer the following question, *"In the Graphic Communications Industry, do the implementations of Integrated Technologies have an impact on the quality of performance of organizations and the users who have adopted them in the previous 10 years?"*. Identified publications were selected in order to contain a variety of different perspectives from a myriad of authors to make it abundantly clear that new approaches containing unprecedented use of integrated technologies are bringing continuous development and change, both positive and negative. They will reshape our current approach to technology in the Graphic Communications Industry and will therefore transform the way lives are lived. A pilot study was conducted by Syeda and El Asaleh in 2022 about the integrated technology available in the graphic communication industry. This study expands on previous existing research, including a more in-depth analysis to continue to shed light on existing implementation. These new opportunities and existing limitations will aid in determining the path the future of the Graphic Communications Industry will take in the Industry 5.0 revolution. This paper is part of ongoing research at The Creative School of Toronto Metropolitan University (Formerly known as Ryerson), 2022, and will serve as a basis on which further research will be conducted, as it's a neglected research topic and one that's lacking within the field of Graphic Communications.

Keywords: artificial intelligence, automation, integrated technology, graphic communication, Industry 5.0

1. Introduction and background

Automation, Artificial Intelligence (AI), the Internet of Things (IoT), Big Data (BD), Machine Learning (ML), Virtual Reality (VR), and Augmented Reality (AR), are more than modern terms, these technologies have created new potential innovations within the workplace, and it has been ruling many aspects of our daily life. Essentially, automation substitutes mundane or physically difficult labor by limiting human involvement. This technological-industrial integration has been, once again, revolutionizing our means of production, increasing productivity as never before. Businesses and economies worldwide can benefit from this technological-industrial integration into their workplaces. The results will not be immediate, but the long-term benefits are significant for companies. McKinsey (2019) stated that "the automation of activities can enable businesses to improve performance by reducing errors, improving quality and speed, and in some cases achieving outcomes that go beyond human capabilities". For instance, VIZIT, as a packaging mockup tool, provides a practical demonstration for consumers looking for a front-back-end automated solution. By delivering virtual prototypes for packaging design visualizations, VIZIT enables users to customize, personalize and view their mockup in real time.

Industry 4.0 is here and it's growing, however, it also brings certain concerns for the general population. The substitution of workplace labor by machines has unshackled workers to focus on higher-value tasks or

establish new ones, which leaves an uncertain future scenario for the availability of work. Many employees fear that there will not be enough jobs with the increasing integration of automation and artificial intelligence in the workplace or that some jobs will become obsolete. Seeking this, many individuals are already looking forward to the Fifth Industrial Revolution. Nahavandi (2019) defines it as "where robots are intertwined with the human brain and work as collaborators instead of competitors". Increased efficiency and intelligence systems are combined with human labor, which comes back to the fold 10 times over, to create revolutionary machinery in Industry 5.0. This research study will go deeper into the transition between Industry 4.0 and Industry 5.0, examining the challenges and opportunities that these technologies present to businesses in the Graphic Communications Industry, and will more specifically, discuss whether industry 5.0 will see a balance of cobots, and the impact of them.

This Paper will showcase background information about promising technologies that are already taking place in the industry nowadays and discuss their use within Industry 5.0, a new production model that emerges as a favorable alternative for the future of our society. A systematic literature review will be employed in order to construct a base from different authors and perspectives and draw conclusions based on the evidence presented. The paper employs a systematic review to critically evaluate relevant literature and focus on contemporary applications in various Graphic Communication Industry Sectors such as Graphic Arts, Graphic Design, Packaging, Printing, and others. This information will benefit those within the Graphic Communications Industries and those who are considering the implementation of integrated technologies within their respective businesses. It will explore the numerous benefits and drawbacks associated with the usage of Integrated Technologies, as well as their impact within the Graphic Communications Industry, focusing on performance quality and customer experience.

Given the scarcity of previous research on the subject, this study is especially important because it expands on previous research that's the first of its nature, thereby contributing to further research in this field. It provides a systematic review with clear definitions of emerging technologies such as Automation, AI, IoT, ML, VR, AR, and BD, as well as a holistic approach to discussing the implementation of Integrated Technologies in the Graphic Communications Industries, thereby making available evidence more accessible and advancing the Graphic Communications Industry forward.

1.1 Back-end and Front-end interrelation

Technologies in the current industry are diverse, from AI to IoT, and they all connect to each other in the automated production process, as seen in Figure 1. In many cases, they are not all employed at the same time, yet this whole process and information flow are leveraged by automation as it improves over time. Artificial intelligence enables the workflow to evolve as long as it learns, depending less on humans and manual programming to perform daily tasks in the production process. As technology continues to evolve rapidly, the merger of robotics and the human mind is causing huge breakthroughs in artificial intelligence, which will play a machine-independent role in Industry 5.0 allowing for a collective synergy between humans and autonomous machines.

Figure 1: Information process of back-end & front-end integrated technologies

2. Materials and methods

A systematic literature review was conducted based on PICO guidelines to showcase background information and current implementations of promising integrated technologies already taking place in the indus-

try and discuss their use and challenges within Industry 5.0. The study was considered to showcase the benefits and drawbacks of the implementation of relevant integrated technologies, such as Automation, AI, IoT, VR, AR, BD, and ML. The current challenges faced, barriers, and the road to Industry 5.0 are also discussed.

The study pulls over 463 academic papers, from thesis' to conference publications, to research reports. The available literature was gathered from unique sources, such as the Toronto Metropolitan University Library, Web of Science, ScienceDirect, Communication & Mass Media, Google Scholar, and the OpenDOAR database. The team took five main steps as we aimed to gather all empirical data that fit our pre-specified criteria to answer the research question posed.

The first step was to identify and frame the research question using the PICO method to strategize the Population, Intervention, Comparison, and Outcome. The second step was to define the inclusion and exclusion criteria, allowing the team to focus on the keywords that would be used throughout the literature search. The third step was to manually filter and extract data from the aforementioned resources, after which the fourth step was to select studies that fit our inclusion criteria. Using the keyword database created, the team used the Boolean logic technique of using both and/or to track down literature. The secondary screening was followed for final inclusion in the review, determining if the studies met the pre-determined criteria, and thereby limiting any biases. The final step was data extraction from the selected studies to report findings and conclusions. Any disagreements were discussed openly allowing the team to assess and compromise.

While this approach is not a unique research method, the singularity of this study is that it's one of the only available studies that cover the wide scope of sectors in the Graphic Communications field and hence bridges a research gap that was previously present. The findings that have been analyzed will benefit those within the Graphic Communications industries as well as those who may be thinking about integrating these technologies within their businesses and are focused on performance quality and customer interactions. The exploration of benefits and drawbacks associated with the implementation of integrated technologies within a workplace setting allows a basis for industry professionals to consider the use of these technologies, and how it may impact process optimization, quality control, decision making, user satisfaction, creativity, production, and management.

3. Results and discussion

Worries that emerged with Industry 4.0 and past industrial revolutions are embraced by Industry 5.0 solutions. Unfortunately, and inevitably, others remain and new ones appear. Industry 5.0 certainly has good premises, but it's important to understand its limitations and all the parts involved in the process to make it what it's expected to be in the future. Tech companies, technology fair access, and ethical questions are examples of important subjects to be addressed in order to prepare a safe path to the next industrial revolution.

A question that was already brought up by the Fourth Industrial Revolution: who would benefit the most from industrial technology innovations? The answer seems easy: larger companies have always been ahead when it comes to new technologies employment, with more structured data and access to resources. Even though these are expected to become more accessible through time and development, they must be guaranteed to keep a fair market share among different businesses. Industry tech owners must keep an effort to provide solutions for small firms. There are already semi-automated systems (in contrast to the larger full ones) available in the market that could be adopted by small-scale businesses. According to Moore's

Law, electronic devices tend to get smaller over time, which could contribute to the growth of new tech employment by small-scale firms.

New technologies should also be seen through the ethics lens, in order to identify the implications that come along. AI bias, for example, is one major problem that has been drawing a lot of attention recently, resulting in many studies by researchers and technologists. Therefore, AI bias must be taken into consideration to ensure that algorithms work in favor of all humans in all conditions, promoting the harmonic collaborative workforce expected. Generative AI can be difficult to accept as it provides a limited explanation when formulating a result. As long as these integrated technologies like Tilia Labs' Phoenix AI, CHILI publish, and Adobe Sensei are fed ethical data and correct criteria, companies can generate respectable outputs.

The most important question is: would machines replace humans, would the increased adaptation and integration to those emerging technologies replace the human factor and expertise? Several studies were focused on exploring human-machine interactions (Abbass, 2019; Albrecht, 2018; Nahavandi, 2019), while others concluded that while using emerging technologies would provide real-time solutions and enhance the decision-making process, the need to have human involvement and expertise is an asset (Verganti, Vendraminelli and Iansiti, 2020; Doehling; 2019; Krafft, Sajtos and Haenlein, 2020). With programming tools like Adobe Firefly, Tilia Labs, and CHILI publish, there is a tendency in society to associate these technologies in the workplace with negative consequences. The fear and uncertainty of these technologies have led to a reluctance to learn about the potential these mechanisms can offer to the workplace. Understanding that industries driven by creativity, such as the Graphic Communication sector, are subjective and dependent on catering to the needs of a consumer, human involvement remains a necessity. AI's role is not to substitute human labor but rather to foster opportunities for human participation to engage in higher-order thinking activities, such as supervising and project managing client expectations to deliver the most effective creative solutions.

The final question is: will there be smart enough technologies available in the next future? Cobots and the idea of a perfect collaborative synergy between machines and humans will require a high level of automation and advancements never seen before. Industry 5.0 intentions are achievable, however, they rely on technological progress that requires time and investment. At the present moment, technology has been providing contributions to industrial automation, this ultra-connected environment is a significant step toward integrating humans with machines. AI, IoT, VR, AR, BD and many others are the beginning of the future for the Next Industrial Revolution.

3.1 Findings

To study how integrated technology impacted organizations and users who adopted them, articles were sorted into 3 categories reflecting the graphic communications workflow: ideation, production, and customer satisfaction. These categories covered process optimization, quality control, decision-making, and user satisfaction in graphic arts.

3.1.1 Creativity

The Graphics Arts industry relies heavily on creativity, which involves various processes and workflows. However, with the emergence of immersive technologies like AI, IoT, VR, AR, and BD is transforming traditional creative professions. This subcategory of articles explores how integrated technologies reinvent and optimize processes, leading to new outputs and results. Adopting technology for creative purposes involves various tasks and procedures, including generating and preparing materials, simplifying projects, making decisions, and solving problems. However, limitations and technical challenges arise when tech-

nology leads the creative process, leading to copyright infringement and protection concerns. Adopting intelligent algorithms could transform the design industry, but creative-based firms may require a cautious implementation to preserve their human capital. Larger organizations could strategically leverage these technologies to streamline processes and boost efficiency in areas where the creative process has a lower impact on the final output.

3.1.2 Production management

Creating successful customer experiences and interactions requires the implementation of robust production and management practices. This subcategory delves into how immersive technologies like AI, IoT, VR, AR, and BD transform organizations' production and management processes. By incorporating intelligent algorithms, companies can optimize their operations for human and machine inputs, enhancing efficiency, quality, and cost-effectiveness. For example, Kodak PRINERGY Workflow, Esko Automation Engine, and HP PrintOS are AI-driven software that provides practical production management to help administrate files and eliminate redundant and tedious mundane tasks. However, digitizing processes also pose challenges such as job security, investments, and training. The articles also explore the impact of these technologies on employee relationships and management practices, focusing on safety, well-being, health, and training procedures. Ethical and moral judgments are crucial in evaluating the adoption of integrated technology, with deep learning employed to manage these protocols. While these technologies have brought significant benefits, they raise concerns about ethical implications, governance, privacy, and politics.

3.1.3 Customer interaction/experience

Selected papers focused on a customer-centric approach and output, particularly in the User Satisfaction, customer interaction, and experience subcategories. Companies must decide how their integrated technology benefits frequent consumer desires to improve their product, process, or organization. Consumer decision-making and evaluations of whether to adopt or not are based on the technology's benefits, experience, and final product results. ML has been utilized to enhance customer experiences in various settings, such as retail markets, creative environments, and learning environments. However, customers also have technological anxieties and may distrust integrated technologies, such as VR glasses, leading to negative attitudes and perceptions related to ethical and robotic relationships.

4. Conclusions

The main aim of this study is to provide a snapshot of the existing technologies in the last decade and how that impacted human perspectives and engagement with these technologies. It explores the pros and cons as well as challenges and future improvements. Overall, studies showed the positive impact of integrating various technologies in enhancing workflow automation, decision-making, consumer design, and engagement with products or services from AI art, prepared packaging compositions, and preflight software. On the other hand, certain articles discuss challenges such as recognizing the hesitancy and fear from the older generation in engaging with cutting-edge technology such as VR, AR, ChatGPT, and other AI-related technologies due to various factors such as the fear of the unknown. Along with the rise of automation and the adaptation of novel AI technologies such as Generative AI applications, the question of ethical consumption and the legal source of the training data used in various ML algorithms fed by those applications was also elaborated on in other articles. A successful adaptation must be accompanied by a substantial change management policy to ensure the sustainability of the service provided. Now we live in a competitive era where an organization's awareness of available technologies is recognized as significant to keep up with IT infrastructure and technology to stay on top of the mind of consumers. If you miss the wave, you miss the younger generation's profit.

As ongoing and current research at the Toronto Metropolitan University's (TMU) (formerly known as Ryerson), The Creative School, 2023, this paper will serve as the basis on which further research will be conducted to cover broader sectors in the Graphic Communications and the Creative Industries that were not addressed in this current research, as well as contribute to providing clear and accessible evidence of a neglected research topic and one that's severely under-addressed within the field of Graphic Communications. In addition, this study would benefit from identifying gaps in the available literature and implementing keyword co-occurrence and cross-fertilization of selected field analysis techniques. For example, some machine learning technologies were used to enhance overall performance optimization which lead to better decision-making. Analysis such as these would aid in the holistic approach considered in this paper to advance the Graphic Communications industry even further.

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