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ASPT2024

THE 14TH ASIAN SYMPOSIUM ON PRINTING TECHNOLOGY

VIETNAM

DECEMBER 19TH

THE 14TH ASIAN SYMPOSIUM ON PRINTING TECHNOLOGY (ASPT 2024)
December 19th and 20th, 2024

Artificial Intelligence and Sustainable Printing Trends and Challenges

HCMC UNIVERSITY OF TECHNOLOGY AND EDUCATION
FACULTY OF GRAPHIC ARTS AND MEDIA
THU DUC CITY, HO CHI MINH CITY, VIETNAM

The 14th Asian Symposium on Printing Technology (ASPT 2024)

Artificial Intelligence and Sustainable Printing: Trends and Challenges

Host

Faculty of Graphic Arts and Media, Ho Chi Minh City University of Technology and Education

Co-hosts

The Japanese Society of Printing Science and Technology (JSPST)

Chiba University

University of Tsukuba

Department of Engineering, Tokyo Polytechnic University

Department of Imaging and Printing Technology, Chulalongkorn University

December 19th and 20th, 2024

Ho Chi Minh City University of Technology and Education

Thu Duc City, Ho Chi Minh City, Vietnam

The 14th ASIAN SYMPOSIUM ON PRINTING TECHNOLOGY (ASPT 2024)

We are pleased to inform you that the 14th Asian Symposium on Printing Technology (ASPT 2024) for the first time since the successful 4th 2013 Asian Symposium (ASPT 2013), and the second time since 12th 2022 (ASPT 2022) on Printing Technology in Vietnam. This symposium was supported by JSPS Core-to-Core Program (grant number: JPJSCCB20220006). ASPT 2024, with the main topic AI and Sustainable Printing: Trends and Challenges, will be held on December 19th and 20th, 2024, at Ho Chi Minh City University of Technology and Education. The representative topics in this year related to printing engineering technology are listed as follows:

- Environmentally friendly printing materials
- Sustainable development
- Digital transformation in the printing industry
- Application of AI (Artificial Intelligence) in graphic design and packaging design
- Functional and security printings
- Printed electronic devices
- Digital printing technology
- Prepress, media, and image processing
- Color management
- Print quality assessment

The results of the studies from researchers in the field will be presented at the conference. To accomplish this symposium, we cordially invite researchers and experts active in related fields of printing, packaging, and graphic design, as well as keynote speakers to enhance fruitful international exchange. In addition, this conference will include oral and poster presentations in the sessions, which will provide more technical information and allow for interactive discussion.

We look forward to welcoming many international attendees, particularly from Asian countries, to this technical symposium.

Host: Ho Chi Minh City University of Technology and Education, Printing Association of Ho Chi Minh City, and Vietnam Printing Association.

Conference: The 14th Asian Symposium on Printing Technology (ASPT 2024)
"Artificial Intelligence and Sustainable Printing: Trends and Challenges"

Date and Venue:

Date: 19th and 20th, December, 2024

Venue: Ho Chi Minh City University of Technology and Education, Vietnam

Add: No 1 Vo Van Ngan Street, Linh Chieu Ward, Thu Duc City, Ho Chi Minh City

Contact: ASTP2024@hcmute.edu.vn
giangnl@hcmute.edu.vn (Chair)
phuongnt@hcmute.edu.vn (Secretary)

Co-hosts: The Japanese Society of Printing Science and Technology (JSPST)
Faculty of Life and Environmental Sciences, University of Tsukuba
Department of Engineering, Tokyo Polytechnic University
Department of Imaging and Printing Technology, Chulalongkorn University

Homepage: http://www.aspt2024.hcmute.edu.vn

Committee:

A. Organizing Committee

Le Hieu Giang (HCMC University of Technology and Education)	Rector of UTE
Yoshihiko Azuma (Tokyo Polytechnic University)	President of JSPST
Nguyen Long Giang (HCMC University of Technology and Education)	Symposium Chair
Aran Hansuebsai (Chulalongkorn University)	Co-Chair
Suda Kiatkamjornwong (Chulalongkorn University)	Co-chair
Toshiharu Enomae (University of Tsukuba)	Co-chair
Toshifumi Satoh (Tokyo Polytechnic University)	Co-chair
Nguyen Thanh Phuong (HCMC University of Technology and Education)	Secretary
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B. Program Advisory Committee

• Domestic members

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• Asian Members (Invited Keynote speakers in the past ASPTs)

Adisorn Tuantranont (TOPIC, Thailand)

Guangxue Chen (South China University of Technology, P.R. China)

Tan Jit Khoon (Winson Press, Singapore)

Hirokazu Shimizu (Shimizu printing, Japan)

Chinmay Bhattacharya (Indian Statistical Institute, Kolkata, India)

Hamidin Abdullah (University of Technology MARA, Malaysia)

Rolando F. Rocha (Philippine Center for Print Excellence Foundation, Inc., Philippines)

Taufan Hidayat (Center for Pulp and Paper, Indonesia)

ADORA S. PILI (Technological University of the Philippines, Philippines)

Muhammad Yusuf Bin Masod (Universiti Teknologi MARA, Malaysia)

Tohru Sugiyama (Dai Nippon Printing Co., Ltd. Japan)

Michinari Kohri (Chiba University, Japan)

Tsuyoshi Hotta (Dai Nippon Printing Co., Ltd., Japan)

Komkrit Sajja-Anantakul (Haydale Technologies, Thailand Co., Ltd), Thailand)

Krairop Charoensopa (Suan Sunandha Rajabhat University, Thailand)

Tae-Wook Kim (Jeonbuk National University, Korea)

Youngshin Kwak (Ulsan national institute of science and engineering, Korea)

Aran Hansuebsai (Chulalongkorn University)

Registration for attendees

Registration fee

- Speakers: Free of charge.
- Overseas participants: VND 1.000.000 / US$ 50.
- Overseas students, including residents in Vietnam: Free of charge
- Vietnamese academics/students: Free of charge.

How to register

- Everyone who is attending the symposium should register, including speakers.
- Register online at Email: aspt2024@hcmute.edu.vn

The 14th Asian Symposium on Printing Technology (ASPT 2024)

(December 19th and 20th, 2024)

"Artificial Intelligence and Sustainable Printing: Trends and Challenges"

At Faculty of Graphic Arts & Media, Ho Chi Minh City University of Technology and Education, Vietnam

Important Dates:

- Abstract submission (Oral and poster presentations) deadline: **10th November 2024.**
- Full proceedings paper submission deadline: **10th December 2024**
- Letter of invitation delivery: **12th – 30th, November 2024**
- Web registration (Presentations and Banquet): http: aspt2024.hcmute.edu.vn
- Abstract submission should be prepared with up to 200 words in a word. The ASPT 2024 word template is available at Email: aspt2024@hcmute.edu.vn

Submit abstract online:

- Email: aspt2024@hcmute.edu.vn

See more:

- Template: ASPT2024 Word Template

Best Regards,

ASPT 2024 – Conference Secretariat

The 14th Asian Symposium on Printing Technology (ASPT 2024)

(December 19th and 20th, 2024)

"Artificial Intelligence and Sustainable Printing: Trends and Challenges"

At Faculty of Graphic Arts & Media, Ho Chi Minh City University of Technology and Education, Vietnam

PROGRAM

19th December 2024

No	Date/Time	Schedule	Note
1	8.00 – 8.30	**Welcome Reception, Registration.**	Organizing Committee
	8.45 – 9.00	**Welcome Performance**	
2	9.30 – 10.15	Discussion with Representatives from Various Countries	
		Introducing the Delegates	Host (MC)
		– Opening Speech – Discussion from representatives of participating countries	– President of HCMUTE – President of JSPST – Dean of Garphic Arts and Media
3	10.15 – 11.00	– Speeches by Sponsors - Scholarship Awards for Students	
	11.00 – 11.05	– Speech by Dean of Faculty of Graphic Arts and Media	
3	11.05 – 11.15	**Tea Break**	

No	Date/Time	Schedule	Note
4	11.15 – 12.25	**Poster Section**	
4.1	11.15 – 11.25	***Development of print quality monitor system using artificial intelligence*** **Kolyuth Hansoad**, Banchar Arnonkijpanich and Chawan Koopipat Department of Imaging and Printing Technology, Faculty of Science, Chulalongkorn University, Bangkok, Thailand.	
4.2	11.25 – 11.35	***Polypyrrole-ZrO2 hybrid synthesis and adaptability to the olfactory sensor*** **Kaiki Noma**, Yukihiro Tsugita, Yasuo Kato, Shuichi Maeda Tokai University, 4-1-1 Kitakaname, Hiratsuka-shi, Kanagawa, 259-1292, Japan	
4.3	11.35 – 11.45	***Report on optimizing the method of calculating the necessary amount of component inks for offset printing mixing based on the database from the previous research project*** **Nguyen Tran Phuong Duy** Cty Modelleisenbahn VietNam, KCN VSIP2, VietNam.	
4.4	11.45 – 11.55	***Protein-based Biopolymer for Sealable Packaging Film: Preparation and Characterization*** **Prof. Shuichi Maeda** Degree Programs in Life and Earth Sciences, University of Tsukuba, Tsukuba, Japan	
4.5	11.55 – 12.05	***Transforming Waste Papers into Value: A Study on Papercrete Applications*** **Ms. Krissawan Korkiate**, Thanakorn Wasanapiarnpong and Aran Hansuebsai Dept. of Imaging and Printing Technology, Faculty of Science, Chulalongkorn University, Bangkok 10330 Thailand	

No	Date/Time	Schedule	Note
4.6	12.05 – 12.15	***Reduce color deviation by using ai to calculate color values based on images from cameras*** ***Nguyen Van Nhat**, Bui Ha Duc, Nguyen long Giang* ***Faculty of Graphic Arts and Media, HCMC University of Technology and Education***	
4.7	12.15 – 12.25	***Marine Biomass Utilization: Exploring Laminaria japonica Cellulose for Nanofiber Production*** ***Muhammad Nur Fauzan[1]**, Toshiharu Enomae[2]* *[1]Degree Program in Agricultural Sciences, University of Tsukuba, Japan* *[2]Faculty of Life and Environmental Sciences, University of Tsukuba, Japan*	
5	12.30 – 3.30	**Plenary Section**	
		Meeting Room 3 **(Printing Technology – Presented in English)**	**Meeting Room 2** **(Graphic Design & Printing Technology – Presented in Vietnamese)**
5.1	12.30 – 1.00	***Enhancing the surface properties of activated carbon derived from waste papers in printing houses through H_3PO_4 activation*** Krairop Charoensopa, Thanakorn Wasanapiarnpong Takaaki Wajima, and **Prof. Aran Hansuebsai** Chulalongkorn University, Suan Sunandha Rajabhat University	***Tự động hóa và số hóa chuỗi bao bì bền vững*** **Ông. Nguyễn Liên Minh** Tổng giám đốc Công ty CP Nhựa bao bì Liên Minh (Aplas)

No	Date/Time	Schedule	Note
5.2	1.00 – 1.30	***Research on the application of intelligent ink supply system in printing Color Control*** **Prof. Linlin Liu**, Dao Thi Thanh Van, Qingwei Wang, Jinrui Han Xi'an University of Technology, No 5, Jinhua Road, Xi'an City, Shaanxi Province, China.	***Smart Growth with AI Optimize Processes, Reduce Costs, and Maximize Profits*** **Mr. Trương Hoàng Thọ** Founder, CEO of Alipo Creative. Co-Founder, Chief Creative Officer of Dizim. Vice President of the Vietnam AIID Alliance
5.3	1.30 – 2.00	***Mineral oil – free antibacterial ink makes printing safer*** **Prof. Ma Zhang Ming** Suzhou kingswood education technology co.Ltd	**Mr. Scott Mackie** Giám đốc Phòng Đồ họa truyền thông, khu vực Châu Á Thái Bình Dương.
5.4	2.00 – 2.30	***Innovative Use of Waste Papers from Printing Houses in Molded Pulp Products: Enhancing Quality, Reducing Carbon Footprint, and Advancing Sustainable Materials*** **Ms. Yolravee Kittiboongate**, Sarita Pornputtkul, Chi Hong Liao, Takehiro Ishihara and Aran Hansuebsai. E.Molding International co.,ltd, Bangplee, Samutprakarn 10540, Thailand	***Development of colorimetry and its application in offset printing quality control*** **Mr. Cao Xuan Vu** Faculty of Graphic Arts and Media, Ho Chi Minh University of Technology and Education, VN 01 Vo Van Ngan street, Linh Chieu ward, Thu Duc city, Ho Chi Minh city, Vietnam.

No	Date/Time	Schedule	Note
5.5	2.30 – 3.00	***Synthesis of ZnO nanoparticles-based fluorescent ink for information encryption and security applications*** **Dr. Nguyen Thanh Phuong** Printing Material Lab, Faculty of Graphic Arts and Media, HCMC University of Technology and Education, No. 1 Vo Van Ngan Street, Linh Chieu Ward, Thu Duc District, Ho Chi Minh City, 70000, Viet Nam.	***Application of Artificial Intelligence (AI) in Vietnamese food packaging design - Trends and challenges*** **Ms. Le Thi Bich Loan**[1] Prof. Cung Duong Hang[2] [1]Digital Fine Arts, FPT University - Ho Chi Minh City [2]Department of Applied Arts, Ho Chi Minh City University of Fine Arts
5.6	3.00 – 3.30	***Printing and Packaging Industry Facing Energy and Environmental Challenges: Trends Toward a Sustainable Approach*** **Dr. Nguyen Trung Hieu** Faculty of Applied Chemical Materials, Hanoi University of Science & Technology, Hanoi, Vietnam.	***The role of color and printing technology in spring newspaper covers in Southern Vietnam before 1975*** **Ms. Nguyen Thi Thu Trang** Lecturer of Digital Art & Design, FPT University – Ho Chi Minh city
6	3.30 – 3.40	**Closing remark**	
7	3.40 – 5.30	**Banquet**	

20th December 2024

8.00 – 11.00: Visiting local printing company

21st December 2024

7.00 – 17.00: Conference tour.

DETAILED PROGRAM THURSDAY, Dec 19th, 2024			
Printing technology Meeting Room 3 (Printing Technology – Presented in English)			
No	**Authors**	**Topic**	**Presentation type**
1	Linlin Liu, Dao Thi Thanh Van, Qingwei Wang, Jinrui Han	**Research on the application of intelligent ink supply system in printing Color Control** Prof. Linlin Liu, Dao Thi Thanh Van, Qingwei Wang, Jinrui Han Xi'an University of Technology, No 5, Jinhua Road, Xi'an City, Shaanxi Province, China. **Abstract** Against the backdrop of the rapid development of the printing industry towards digitalization and intelligence nowadays, numerous drawbacks of the traditional ink control systems of offset printing machines have become increasingly prominent. However, the new intelligent ink supply devices and the accompanying printing color control systems have significantly enhanced the reliability, efficiency, and consistency of printing color control in offset printing production at a relatively low cost. This paper elaborates in detail on the working principles, key technologies, testing experiments, and application results of this system. Specifically, it includes aspects such as realizing digital and intelligent color control, precise ink supply, and expanding the color gamut. Meanwhile, it also introduces the specific application situations, challenges faced, and future development trends of the relevant intelligent printing systems in the industry. Its purpose is to provide references with both theoretical value and practical significance for the further development of printing color control technologies, which will contribute to promoting the technological upgrading, renovation, and replacement of ink control equipment for offset printing, and realizing the digitalization and intelligence of printing production.	Oral

		Key words: Intelligent ink supply device, color control, color management	
2	Ma Zhang Ming	**Mineral oil – free antibacterial ink makes printing safer** Prof. Ma Zhang Ming Suzhou kingswood education technology co.Ltd	Oral
3	Krairop Charoensopa, Thanakorn Wasanapiarnpong Takaaki Wajima, and Aran Hansuebsai	**Enhancing the surface properties of activated carbon derived from waste papers in printing houses through H3PO4 activation** Krairop Charoensopa, Thanakorn Wasanapiarnpong Takaaki Wajima, and Aran Hansuebsai Chulalongkorn University, Suan Sunandha Rajabhat University	Oral
4	Nguyen Thanh Phuong	**Synthesis of ZnO nanoparticles-based fluorescent ink for information encryption and security applications** Nguyen Thanh Phuong Printing Material Lab, Faculty of Graphic Arts and Media, HCMC University of Technology and Education, No. 1 Vo Van Ngan Street, Linh Chieu Ward, Thu Duc District, Ho Chi Minh City, 70000, Viet Nam **Abstract** Luminescent ZnO nano pigments with a hexagonal structure were successfully synthesized using the hydrothermal method. The color fluorescent emission of ink can be tuned by hydrothermal conditions in the synthesis of pigment or by adjusting the pH values of the ink formulation. The ink formula based on luminescent ZnO nano pigments with a concentration of 15 % (w/w) was dispersed and homogenized in the vehicle, including water, PVA, and ethylene glycol. The stable ZnO nano ink formula has the zeta potential value of $\xi = -24.8$ mV at pH = 7.2, and ZnO pigments have an average particle size of about 500	Oral

		nm in length and 90 nm in width. The logo samples printed on graphic paper and Couche paper with luminescent ink using a screen printing method show a bright yellow fluorescence at 565 nm under UV irradiation 365 nm and are invisible under normal light. The QR code on paper is readable by a smartphone under UV light. The ZnO nano ink is suitable for information encryption and anti-counterfeiting applications. **Keywords:** ZnO nanoparticles, Luminescence printing, Counterfeiting, Luminescent ink, Encryption	
5	Yolravee Kittiboongate, Sarita Pornputtkul, Chi Hong Liao , Takehiro Ishihara and Aran Hansuebsai	**Innovative Use of Waste Papers from Printing Houses in Molded Pulp Products: Enhancing Quality, Reducing Carbon Footprint, and Advancing Sustainable Materials** Yolravee KITTIBOONGATE, Sarita PORNPUTTKUL, Chi Hong Liao , Takehiro ISHIHARA and Aran Hansuebsai E.Molding International co.,ltd, Bangplee, Samutprakarn 10540, Thailand	Oral
6	Nguyen Trung Hieu	**Printing and Packaging Industry Facing Energy and Environmental Challenges: Trends Toward a Sustainable Approach** Nguyen Trung Hieu Faculty of Applied Chemical Materials, Hanoi University of Science & Technology, Hanoi, Vietnam	Oral
7	Kolyuth Hansoad, Banchar Arnonkijpanich and Chawan Koopipat	**Development of print quality monitor system using artificial intelligence** Kolyuth Hansoad, Banchar Arnonkijpanich and Chawan Koopipat Department of Imaging and Printing Technology, Faculty of Science, Chulalongkorn University, Bangkok, Thailand **Abstract**	Poster

		This research aims to use AI to detect problems in four-color offset printing processes. To minimize paper size by limiting it to the printing area, quality control strips (color bars) cannot be added. Consequently, print quality monitoring during the printing run relies on the skills and experience of the print operator. Common quality-check parameters include registration, color consistency, and color accuracy, which may vary due to human error. A print monitoring system based on artificial intelligence (AI) has been developed. It consists of imaging equipment, a lighting system, color charts, and image analysis algorithms. The AI compares and analyzes images captured from printed sheets to reference proof sheets. By applying principal component analysis (PCA), the AI can quickly identify discrepancies and various defects in printing. Test results show that the proposed system can effectively detect print defects such as scumming, ink spots, hickeys, color deviations, pattern distortions, and missing or excessive content. This system helps reduce costs, improve consistency, and deliver print quality that meets client requirements.	
8	Kaiki Noma, Yukihiro Tsugita, Yasuo Kato, Shuichi Maeda	***Polypyrrole-ZrO2 hybrid synthesis and adaptability to the olfactory sensor*** Kaiki Noma, Yukihiro Tsugita, Yasuo Kato, Shuichi Maeda Tokai University, 4-1-1 Kitakaname, Hiratsuka-shi, Kanagawa, 259-1292, Japan **Abstract** We have prepared organic conducting particles which utilize polypyrrole as conducting parts and small ZrO2 particles as dispersants. The polypyrrole-ZrO2 nano ink successfully achieved stable colloidal dispersion of polypyrrole in water, which usually aggregate in aqueous liquids. The polypyrrole-ZrO2 exhibited up to a conductivity of 2.3 S/cm. Applying the polypyrrole-ZrO2 to an olfactory receptor chip, we measured the resistance during ammonia injection as an odorant, in order to explore its potential as an olfactory sensor.	Poster

9	Nguyen Tran Phuong Duy, Nguyen Long Giang	***Report on optimizing the method of calculating the necessary amount of component inks for offset printing mixing based on the database from the previous research project*** Nguyen Tran Phuong Duy[1], Nguyen Long Giang[2] [1]Modelleisenbahn VietNam Co., KCN VSIP2, VietNam. [2]Faculty of Graphic Arts and Media, HCMC University of Technology and Education, No. 1 Vo Van Ngan Street, Linh Chieu Ward, Thu Duc District, Ho Chi Minh City, 70000, Vietnam. **Abstract** In Machine Learning, linear regression is a supervised algorithm in which the relation between input and output is described by a linear function. This algorithm is also known as linear fitting or linear least square(I). This report discusses the application of linear regression problems in calculating colour mixing based on L, a, b values. In addition, a comparison is indicated to test the effectiveness of this algorithm compared to the previously studied algorithm(II).	Poster
10	Zulfikar A, Enomae T	**Protein-based Biopolymer for Sealable Packaging Film: Preparation and Characterization** Zulfikar A, Enomae T Degree Programs in Life and Earth Sciences, University of Tsukuba, Tsukuba, Japan **Abstract** Today, the production of plastic materials, particularly food packaging, is primarily based on plastics that originate from fossil resources such as petroleum, and therefore do not constitute a renewable source. In this context, proteins are a good candidate for sustainable food packaging since they create strong barriers and possess multifunctional attributes. This work focuses on the blending of gelatin and zein to enhance the	Poster

		functional properties of protein-based films for food packaging application. Glycerol was used as a plasticizer while 60% acetic acid was used as a solvent in the preparation of varying zein concentration (0%, 20%, 40%, 60%, 80% and 100%) film-forming solutions (FFS). The FFS was sonicated, coated on petri dishes, and allowed to dry for 24 hours before peeling off. The films obtained displayed very good heat seal ability, while increasing the concentration of zein produced a stronger seal. As the zein concentration increased, tensile strength also increased but film elongational properties became lower. The optical characteristics of the films made with zein also changed because of zein inclusion, with the films becoming darker and yellower as zein concentration increased. UV-Vis analysis did however show that the incorporation of zein improved the UV absorbing ability of the films, which is ideal for food sensitive to UV irradiation. It can be concluded that it is feasible to develop a protein-based packaging film by blending gelatin with zein that has very good UV blocking capacity and heat sealable properties ideally suited for food packaging applications.	
11	Krissawan Korkiate, Thanakorn Wasanapiarnpong and Aran Hansuebsai	**Transforming Waste Papers into Value: A Study on Papercrete Applications** Krissawan Korkiate, Thanakorn Wasanapiarnpong and Aran Hansuebsai Dept. of Imaging and Printing Technology, Faculty of Science, Chulalongkorn University, Bangkok 10330 THAILAND	Poster
12	Muhammad Nur Fauzan, Toshiharu Enomae	**Marine Biomass Utilization: Exploring *Laminaria japonica* Cellulose for Nanofiber Production** Muhammad Nur Fauzan[1], Toshiharu Enomae[2] 1. Degree Program in Agricultural Sciences, University of Tsukuba, Japan 2. Faculty of Life and Environmental Sciences, University of Tsukuba, Japan	Poster

		Abstract Kelp (*Laminaria japonica*), a valuable marine resource, holds immense potential for extracting bioactive components such as alginate, minerals, proteins, and cellulose. Residues remaining after alginate extraction still contain significant amounts of minerals, proteins, and cellulose, enabling efficient biomass utilization and minimizing waste generation. This study investigated alginate extraction at varying temperatures (70–100°C), revealing that the process did not significantly affect cellulose yields, which ranged from 8.71% to 8.87%. Subsequent bleaching with different H_2O_2 concentrations produced cellulose yields ranging from 16.94% to 8.73%. Scanning Electron Microscopy (SEM) analysis indicated that ultrasonication-assisted acid hydrolysis, performed with varying acid concentrations, yielded cellulose with widths of 20.9–22.0 nm and lengths extending to several micrometers. The resulting cellulose exhibited diverse structural morphologies, including filaments and web-like formations. To advance green nanotechnology, this research explored the preparation of cellulose nanofibers (CNFs) from *Laminaria japonica* using ultrasonication-assisted acid hydrolysis, a greener and more sustainable approach. This research highlights the potential of marine-derived cellulose as a renewable resource for developing innovative nanomaterials, emphasizing its role in advancing green and sustainable technologies. The findings provide a foundation for future exploration and applications of seaweed-based CNFs in diverse fields including printing applications.	
13	Nguyen Van Nhat, Bui Ha Duc, Nguyen long Giang	**Eeduce color deviation by using ai to calculate color values based on images from cameras** Nguyen Van Nhat*, Bui Ha Duc, Nguyen Long Giang Printing Material Lab, Faculty of Graphic Arts and Media, HCMC University of Technology and Education	

		No. 1, Vo Van Ngan, Thu Duc City, Ho Chi Minh City, Viet Nam. **Abstract** This poster presents a method to improve color deviation by using machine learning to calculate color values based on images from cameras. Unlike traditional approaches from previous projects, which relied solely on manual or formula-based calculations, this study leverages AI to enhance accuracy and consistency . A dataset of Lab color values and images captured by cameras and smartphones was used to train machine learning models, including Linear Regression, XGBoost, and CNN. This work establishes a new framework for training AI models to achieve better color accuracy and adapt to real-world applications.	Poster
DETAILED PROGRAM THURSDAY, Dec 19th, 2024 Meeting Room 2 (Graphic Design & Printing Technology – Presented in Vietnamese)			
No	**Authors**	**Topic**	**Presentation type**
1	Le Thi Bich Loan, Cung Duong Hang	**Application of Artificial Intelligence (AI) in Vietnamese food packaging design - Trends and challenges** Digital Fine Arts, FPT University - Ho Chi Minh City Department of Applied Arts, Ho Chi Minh City University of Fine Arts **Abstract** Since the Fourth Industrial Revolution, the food packaging design industry in Vietnam has witnessed significant advancements thanks to the integration of modern technology, especially Artificial Intelligence (AI). This study focuses on analyzing the trends, impacts, and challenges of applying AI in packaging design, aiming to enhance user experience and increase the smart interactivity of products. The research aims to explore the potential of AI in enhancing aesthetic value, asserting differentiation, and promoting the positioning of Vietnamese packaging brands in the international market. To achieve this goal, a multidisciplinary approach,	Oral

		including document analysis, case studies, and SWOT analysis, is applied to comprehensively assess the benefits and capabilities that AI brings in meeting the increasingly stringent market demands. **Key words:** *AI packaging, artificial intelligence, food packaging, packaging design*	
2	Nguyen Thi Thu Trang	**The role of color and printing technology in spring newspaper covers in Southern Vietnam before 1975** Lecturer of Digital Art & Design, FPT University – Ho Chi Minh city trangntt101@fe.edu.vn **Abstract** Preserving traditional values through period-specific cultural products has become a pressing concern in the digital age. This study analyzes the use of color and printing technology on spring newspaper covers in Southern Vietnam, aiming to identify distinctive color characteristics and their meanings in the context of traditional Tet culture. Colors such as red, yellow, and green are not only expressive elements in the design but also optimize the conveyed message, enhance aesthetic appeal, and preserve cultural and historical values. The research employs fine arts methodologies with an interdisciplinary approach, including document analysis, case studies, and SPSS analysis, to identify patterns and methods of color usage. The findings contribute to the body of research on preserving traditional cultural values while applying these insights to modern design practices. **Key words**: symbolic color, Tet magazine covers, print media design, Vietnamese traditional values.	Oral
3	Nguyen Thanh Phuong, Nguyen Long Giang	**Investigation on conformance of sheet-fed offset ink to ISO 2846-1 standard** Nguyen Thanh Phuong, Nguyen Long Giang, Le Cong Danh, Nguyen Thi Ngoc Nhung, Nguyen Le Phuong Trinh Printing Material Lab, Faculty of Graphic Arts and Media, HCMC University of Technology and	Oral

		Education, No. 1 Vo Van Ngan Street, Linh Chieu Ward, Thu Duc District, Ho Chi Minh City, 70000, Vietnam. ***Abstract*** As we know, ink is one of the most critical input materials in printing processes, affecting the quality of printed products. Besides the quality of paper and other factors, uniformity and color reproduction depend on ink performance. As a result, the experiments test and verify the input ink quality based on the ISO 2846-1 international standard. Five sets of CMYK offset printing inks from five manufacturers were collected and tested. The names of the ink manufacturers will not be mentioned in this study, and the ink sets will be identified as ink set 1 to ink set 5. The results show that the ink set 1 conforms to ISO 2846-1, and the remaining ink sets have some satisfactory parameters and some unsatisfactory parameters. The results also show that the ink sets conformed with the ISO 2846-1 standard, which satisfies ISO 12647-2. This research result is very useful for evaluating and comparing the quality of various printing inks.	
4	Cao Xuan Vu, Che Quoc Long	**Development of colorimetry and its application in offset printing quality control** Cao Xuan Vu, Che Quoc Long Faculty of Graphic Arts and Media, Ho Chi Minh University of Technology and Education, VN 01 Vo Van Ngan street, Linh Chieu ward, Thu Duc city, Ho Chi Minh city, Vietnam ***Abstract*** In this study, the research team designed and manufactured a tristimulus colorimeter. The measuring head and optical system models were designed and simulated on a 3D platform for easy observation and adjustment before manufacturing. The processing unit was designed with a PIC32MX460F512L microprocessor. Color measurements were performed under standard light source D65 from Nichia - Japan and a color sensor from TAOS. The research focused on	Oral

		processing and applying results to the quality management of printed products.	
5	Nguyen Thi Ngoc Chau	**Impact of cultural factors on packaging design process** Nguyen Thi Ngoc Chau Faculty of Graphic Arts and Media, HCMC University of Technology and Education, No. 1 Vo Van Ngan Street, Linh Chieu Ward, Thu Duc District, Ho Chi Minh City ***Abstract*** In the context of globalization integration, all areas of social life are changing rapidly and traditional cultural values are increasingly being promoted and valued. The development of national cultural identity into graphic design products contribute to promote Vietnamese culture to be more advanced and imbued with national identity, especially when there are many foreign elements appearing in many places. The system of cultural transmission has been corrupted and lost. On the other hand, application design products in general and packaging products in particular are also an effective communication channel in preserving and promoting the cultural values of the ethnic community to consumers and today. The more famous the image of the people and country of Vietnam in the eyes of foreigners. Cultural factors in packaging products become a bridge connecting the contributions that create the values of a brand, containing the characteristics and soul of the nation to consumers in all countries around the world. Thence, it not only contributes to improving trade efficiency, increasing sales but also creating influence and enhancing the country's position in the international community. ***Keywords:*** Design, Application design, Packaging products, Product design.	Oral

6	Nguyen Cung Dan	**Application of visual principles in products graphic design** Dan Nguyen Cung Faculty of Graphic and Material, Ho Chi Minh City University of Technology and Education 01 Vo Van Ngan Street, Linh Chieu Ward, Thu Duc City, HCMC, Vietnam. ***Abstract*** In graphic design, visual principles play an important role in creating intuitive, understandable and attractive products. These principles not only help organize design elements in a logical way but also enhance the user experience, from easy access to information to the perception of the product's aesthetics. The correct application of principles such as contrast, emphasis, proximity or alignment not only makes the product stand out but also effectively reflects the brand's message and values.	Oral
7	Tran Thanh Ha	**Sustainable development: challenges and solutions for designing and prepress of folding box production** Ths. Trần Thanh Hà Faculty of Graphic Arts and Media, Ho Chi Minh University of Technology and Education, VN 01 Vo Van Ngan street, Linh Chieu ward, Thu Duc city, Ho Chi Minh city, Vietnam ***Tóm tắt*** Trong bối cảnh thế giới phát triển nhanh chóng không chỉ về kỹ thuật, công nghệ sản xuất, mà còn có sự xuất hiện của trí tuệ nhân tạo… thì mọi lãnh vực cần có sự thay đổi phù hợp. Với mục tiêu phát triển bền vững cho toàn cầu thì ngành in nói chung và việc thiết kế, chế bản cho bao bì hộp giấy cũng đã và đang có những thay đổi mạnh mẽ để không chỉ theo kịp xu hướng mà còn nhằm cắt giảm giá thành và tăng hiệu quả sản xuất. Bài viết dưới đây giới thiệu chi tiết về những nội dung bắt buộc phải có cũng như các kỹ thuật và phần mềm phụ trợ cho sự phát triển bền vững trong thiết kế và chế bản cho sản xuất bao bì hộp giấy.	Oral

		Các điểm chính của bài viết: Các mục tiêu phát triển bền vững liên quan đến ngành công nghiệp in và bao bì; Công nghệ thiết kế và sản xuất bao bì hộp giấy; Nội dung chính của phát triển bền vững trong thiết kế và chế bản; Các nguyên tắc thiết kế bền vững trong thiết kế; Các giải pháp bền vững trong thiết kế cấu trúc-thiết kế bề mặt – Chế bản; Mức độ ứng dụng các giải pháp phát triển bền vững tại các nhà in bao bì hộp giấy tại Việt Nam.	
8	Vu Thi Thuy	**Tổng quan về Pháp lam Huế - Dấu ấn từ lịch sử đến hiện tại** Vũ Thị Thúy Khoa In và Truyền thông Trường Đại học Sư Phạm Kỹ Thuật Thành phố Hồ Chí Minh Số 1 Võ Văn Ngân, Phường Linh Chiểu, Thành phố Thủ Đức, Thành phố Hồ Chí Minh. ***Tóm tắt*** Pháp lam là một sản phẩm mỹ thuật có cốt làm bằng đồng, bên ngoài được vẽ bằng một hay nhiều lớp men màu được đem nung mà thành. Do cách thức tạo ra sản phẩm đặc biệt nên pháp lam không chỉ đẹp về mặt hình thức mà còn có độ bền rất cao vì vậy mà có khả năng chống chịu cao trước sự va đập, hoặc sự ăn mòn của môi trường và khí hậu. Pháp lam Huế cũng trải qua cũng dấu mốc thăng trầm, phát triển mạnh nhất vào thời vua Minh Mạng (1820 – 1841) rồi sa sút và mất hẳn vào thời vua đồng Khánh (1885 – 1889). Tuy vậy nhưng trải qua hàng trăm năm lịch sử, Pháp lam Huế vẫn là một điểm nhấn vàng son trong trang sử vàng văn hóa nghệ thuật Việt Nam. Trong thời đại mà chúng ta khao khát muốn tìm về và phục dựng lại những giá trị nguồn cội, thì Pháp lam Huế có thể được nhắc đến bởi sự cầu kì , tinh xảo, trang nhã và vô cùng đẹp mắt. Tuy nhiên hiện nay, Pháp lam vẫn còn là một sản phẩm khá xa lạ đối với nhiều người, thậm chí là trong giới nghệ thuật. Vì vậy mà trong bài nghiên cứu “Tổng quan về Pháp lam Huế - dấu ấn từ lịch sử đến hiện tại” sẽ mang đến một cái nhìn tổng quan về Pháp lam Huế cũng như vì sao chúng ta cần phải bảo tồn nét văn hóa truyền thống này.	Oral

Artificial Intelligence and Sustainable Printing: Trends and Challenges

Dr. Nguyen Long Giang

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We are delighted to invite you to the ASPT 2024 conference, entitled "Artificial Intelligence and Sustainable Printing: Trends and Challenges." This gathering will provide an in-depth exploration of the convergence of Artificial Intelligence (AI) and its transformative potential within the printing industry, with a specific focus on promoting sustainability. The conference will delve into the multifaceted applications of AI in driving efficiencies, reducing waste, and enabling more environmentally responsible practices within the printing sector. We will also address the emerging trends and challenges that accompany this digital transformation. Prior to the commencement of our discussions, it is imperative to dispel certain misconceptions surrounding AI.

Misconceptions about AI

A prevalent misconception regarding artificial intelligence (AI) is the notion that it will result in widespread job displacement. While AI undoubtedly automates numerous processes, its true efficacy lies in augmenting human capabilities rather than supplanting them. In the printing industry, AI can serve as an invaluable tool for operators, facilitating more informed decision-making, enhancing productivity, and elevating overall print quality. It empowers us to minimize waste and energy consumption, essential elements in achieving sustainability within the printing sector.

Another misconception is that AI is a panacea for all challenges. In reality, the applications of AI in printing and graphic design are highly specialized and diverse. AI can assist in optimizing processes tailored to the specific needs of the industry, whether it is enhancing the efficiency of printers or providing design solutions for environmentally conscious products.

Sustainable printing extends beyond mere paper reduction, encompassing a comprehensive approach to minimize the environmental impact of printing activities. This involves utilizing eco-friendly materials, reducing energy consumption, decreasing waste, and ensuring that production methods adhere to sustainability principles.

In the realm of graphic design, sustainability entails designing for longevity and recyclability. This involves selecting materials that are less harmful to the environment and creating designs that are energy-efficient. The ultimate objective is to reduce the environmental footprint across all stages of production, encompassing the concept from conception to delivery.

How Artificial Intelligence (AI) Contributes to Sustainable Printing

Artificial Intelligence (AI) holds the potential to revolutionize the printing industry by facilitating sustainable practices. Through optimization of the printing process, AI can minimize waste, reduce energy consumption, and enhance overall efficiency. AI-driven systems can monitor print jobs in real-time, identifying potential inefficiencies and implementing adjustments to minimize material waste and prevent errors.

For instance, AI-powered predictive maintenance ensures that printing equipment operates at optimal levels, reducing downtime and extending the lifespan of machinery. In graphic design, AI tools automate repetitive tasks, such as layout adjustments and color optimization, allowing designers to concentrate on creative endeavors while prioritizing sustainability.

AI in Printing and Graphic Design: Key Data

To better illustrate the impact of AI on the printing and design sectors, here are some key figures:

- According to Napco Research
    - The percentage of printing service providers using AI has increased from 24.7% in September 2023 to 40.0% in March 2024.
    - The percentage of companies that do not plan to adopt AI in the next year has decreased from 48.4% to 32.8%, indicating a growing trend toward AI integration in the industry.

- Current AI Applications in the Printing Industry**

The most prevalent current AI applications in the printing industry encompass:

- Content creation (29.0%).
- Marketing (16.1%).
- Sales (15.3%).

In the forthcoming year, the domains where AI investment is anticipated to experience the most significant growth are:

- Operations (37.9%).
- Customer analysis (27.4%).
- Market analysis (25.8%).

A report by Adobe underscores the widespread adoption of AI-based tools by designers, with over 60% currently utilizing such tools to streamline their workflows. This integration highlights the growing significance of AI in the graphic design domain.

Furthermore, AI-driven printing technologies have demonstrated the potential to reduce material waste by up to 30%, making them an indispensable component of sustainable printing practices.

Trends in AI and Sustainable Printing

Artificial Intelligence (AI) and sustainable printing are intertwined with several defining trends in the contemporary printing industry. One of the most prominent trends is the advent of smart automation, where AI is seamlessly integrated into the production process, thereby enhancing efficiency and minimizing resource consumption. Concurrently, the printing industry is witnessing a surge in the adoption of sustainable materials, such as biodegradable inks and recyclable paper, which are effectively managed through AI-enabled quality control systems.

Moreover, we are witnessing the emergence of the circular economy within the printing sector. AI plays a pivotal role in optimizing supply chains, recycling processes, and material management, ensuring that resources are reused efficiently and waste is minimized throughout the production lifecycle.

Current Status of the Printing Industry in Vietnam

The printing industry in Vietnam is experiencing substantial growth, particularly in the packaging sector. The total packaging output reached $6 billion in 2020 and is projected to surpass $6.5 billion by 2024. Within this segment, exports and exports-related packaging accounted for $2.3 billion in 2020, exhibiting a growth rate of over 6.8% to reach $2.7 billion in 2021 and an estimated $3.3 billion by 2024.

Regarding investments in Vietnam's printing industry, as of 2023, the total number of imported printing machines amounted to 69,079 units, with a value of VND 7,067 billion. Among these, 926 industrial printing machines, valued at VND 4.14 billion, encompassed various types of offset, flexo, gravure, and letterpress printing machines. These figures underscore the substantial investment in machinery and technology, which is pivotal for enhancing productivity and sustainability within the sector.

Action Plan for Educators and Experts in the Printing Industry

As educators and experts in the printing industry, we bear a pivotal responsibility in cultivating an environment that embraces both innovation and sustainability. Here are several key action steps that we can undertake:

1. Promote Awareness and Education: As the printing industry undergoes transformation, it is imperative that we equip the next generation of print professionals with the knowledge of how artificial intelligence (AI) can be harnessed to enhance sustainability. This entails offering programs and workshops on AI, automation, and green printing technologies.
2. Encourage Industry Collaboration: Sustainability in the printing sector cannot be achieved through isolated efforts. Collaboration between technology developers, print manufacturers, material suppliers, and environmental experts is paramount. We must foster a collaborative spirit and share best practices to achieve collective success.
3. Adopt and Experiment with AI Tools: It is not sufficient to merely discuss AI; we must demonstrate its practical application. Printing companies, regardless of their size, can initiate the integration of AI tools into their

operations. Educators can guide students in conducting practical experiments with these technologies to gain firsthand experience of the challenges and opportunities they present.

4. Advocate for Industry Standards: There is a pressing need for the establishment of common sustainability standards within the printing industry, particularly with regard to AI-driven solutions. By contributing to the development of such standards, we can ensure that the industry adopts responsible and impactful practices.
5. Continuous Research and Innovation: The printing industry is undergoing rapid transformation, and so is the landscape of artificial intelligence (AI). To remain at the forefront of sustainable practices and technological advancements, we must commit to continuous learning, research, and experimentation.

Conclusion

In conclusion, artificial intelligence (AI) transcends its role as a mere efficiency tool; rather, it serves as a catalyst for transformative change within the printing industry. By integrating AI with sustainable development objectives, we possess the potential to revolutionize our production, design, and printing processes, thereby mitigating environmental impact and fostering a circular economy.

As we embark on today's sessions, I strongly encourage all participants to engage in substantive discussions, share their expertise, and collaborate on the identification of innovative solutions that will propel the future of AI-driven, sustainable printing.

Once again, I extend my gratitude for your presence, and I eagerly anticipate the invaluable insights that will be shared throughout this conference. With that, let us commence the conference proceedings.

Research on the Application of Intelligent Ink Supply System in Printing Color Control

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Abstract

In the context of the rapid development of digitalization and intelligence in the printing industry, the numerous drawbacks of traditional offset press ink control systems have become increasingly prominent. The new intelligent ink supply device and its corresponding printing color control system have significantly enhanced the reliability, efficiency, and consistency of printing color control in offset printing production at a relatively low cost. This paper elaborates on the working principle, key technologies, testing experiments, and application results of this system, including aspects such as achieving digital and intelligent color control, precise ink supply, and expanding the color gamut. Additionally, it presents the specific application scenarios, challenges, and future trends of relevant intelligent printing systems in the industry. The aim is to provide a reference with both theoretical and practical value for the further advancement of printing color control technology, facilitating the technological upgrading and renewal of offset printing ink control equipment and realizing the digitalization and intelligence of printing production.

Keywords: Intelligent Ink Supply Device; Color Control; Color Management

1. Introduction

The color quality of printed products is of utmost importance for printing production. As the mainstream printing method, offset printing is significantly influenced by the ink supply amount in terms of color control. Traditional offset printing color control involves the operator making a preliminary judgment on the ink supply amount of the printing press based on the observation of the plate image and their production experience before printing, manually adjusting the ink keys color by color and one by one. After printing commences, the ink keys are repeatedly adjusted color by color and one by one according to the color changes of the actual sample sheets until the color matching is achieved. The entire process is cumbersome, lacking automation and data support, resulting in long printing preparation times, low printing efficiency, difficulty in ensuring color quality, high consumption of ink and paper during the color matching process, excessive reliance on the operator's experience, and increased difficulty in color control for batch printing due to personalized operations during the production process.

In recent years, intelligent ink supply systems developed based on digital technology have provided a new approach to solving the problem of offset printing color control, and related research and applications have been continuously evolving. The intelligent ink supply device can be installed as an independent module on traditional offset presses, demonstrating wide adaptability. The accompanying printing color control system can automate the color adjustment process of the printing press, putting an end to the non-standardized and non-data-driven history of determining the printing process control and printing quality solely by human experience for many years. This has significantly improved printing production efficiency, enhanced printing quality, reduced the labor intensity of operators, and saved production costs.

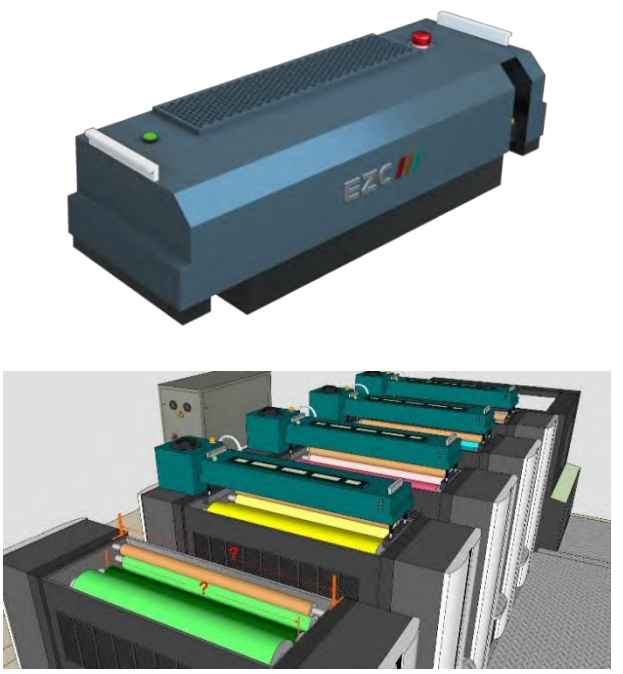

Figure 1. Intelligent ink supply device

2. Working Principle

To make the "actual ink amount required for printing colors" as close as possible to the "ideal ink amount", the traditional method is to utilize the measurement results of a colorimeter scanner for closed-loop color control of the printing press. The printing color control software reads the printed graphic area information and, based on a large number of color standard and printability tests corresponding to printing consumables conducted on the printing press, converts the read printed graphic area information into the ink amount value required by the printing press. This method has achieved certain results in the dataization of color control. Compared with color judgment by the human eye, it has enhanced the reliability of printing color control, optimized the printing color control process, and improved printing production efficiency. However, due to the influence of traditional electric ink fountains, although the software obtains the ink amount data required for the corresponding printed graphic area through the reading and analysis of the printed graphic area and the color standard sampling of the printing press, it cannot measure the volume or mass of the ink supplied by the electric ink fountain and thus cannot evaluate whether the electric ink fountain has supplied ink according to the ink amount calculated by the software. The dataization problem of traditional electric ink fountains has become a major challenge in color control for offset printing production.

The new printing color control system proposed in this paper breaks through the structure of traditional electric ink fountains and adopts a high-precision digital ink supply device to replace the traditional non-data-driven electric ink fountain. On this basis, a supporting printing color control software is developed. Through a large number of printing tests on mainstream printing consumables and printing press brands, a substantial amount of color data is collected, establishing a data model capable of accurately calculating the chromaticity value of ink and the corresponding relationship between the ink amount required to achieve this chromaticity value, ultimately realizing intelligent color control in the offset printing production process.

The high-precision digital ink supply device focuses on solving two core issues: accurately calculating the ink amount required for the printed sheet and supplying ink precisely. The ink amount required for the printed sheet can be divided into two parts: the base ink for the rubber rollers and the working ink for printing. Among them, the base ink for the rubber rollers is a new concept related to the arrangement structure, total circumference, and diameter of the rubber rollers of the printing press. Theoretically, the transfer of ink between the rubber rollers in the ink path follows the dichotomy. Through this ideal data model and by incorporating various influencing factors such as ink fluidity, paper, plate, and blanket, the base ink amount for the rubber rollers is calculated using a mathematical model. Additionally, according to the CIP3 file output before printing, the graphic area is corrected through a professional algorithm to precisely match the working ink amount required for each ink channel of the printing press. In this way, the total ink amount required for each printed sheet to reach the standard density can be accurately calculated. The core hardware of the digital ink supply system, with an ink supply unit having a precision of up to 5 μm, can directly and accurately supply ink to the rubber rollers without transfer errors, automatically loading the ink amount that meets the standard for the printing unit.

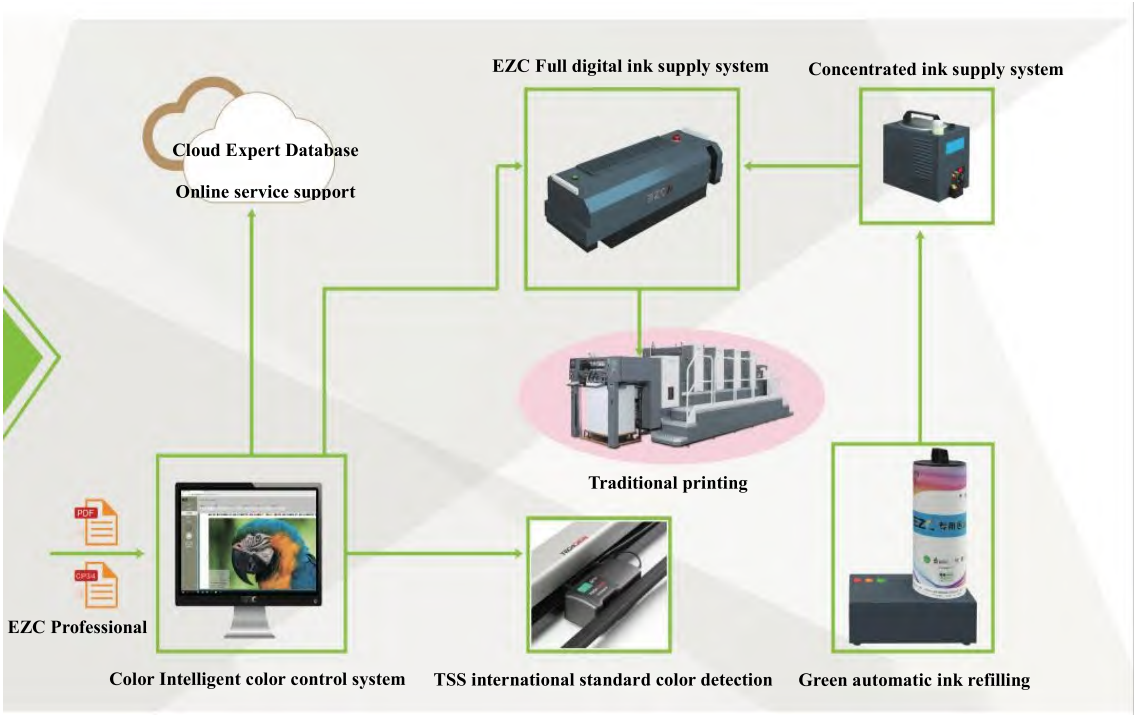

Figure 2. Printing color control system of intelligent ink supply device

3. Key Technologies

3.1 Digital Precise Ink Supply for Printing Press

In the traditional electric ink fountain system, the ink supply is controlled by two factors: the ink keys and the ink fountain roller. Typically, the adjustment range of the ink keys of a printing press is between the zero position (closed state) and 10 thou (divided into 100 equal parts), forming the adjustable value of the opening degree of the ink keys; the rotation angle range of the ink fountain roller is 0 - 180 degrees. The operator changes the opening degree of the ink keys driven by the motor and the ink transfer speed of the ink fountain roller by setting or adjusting the values of the ink keys and the rotation angle of the ink fountain roller, thereby realizing the control of the ink supply amount. This control method belongs to intermittent analog ink supply. Due to the influence of the combined control of the opening degree of the ink keys and the rotation angle of the ink fountain roller, it is difficult to assess which parameter needs to be adjusted to obtain the target ink supply amount. Moreover, due to the wear of the steel or polyester sheets at the ink outlet, the zero position cannot be ensured to return to zero, resulting in non-linear ink supply of the ink supply device and adversely affecting the uniformity of printing colors.

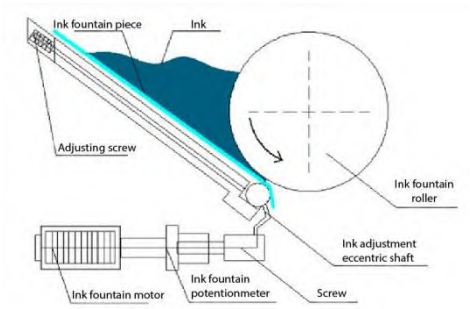

Figure 4. Traditional electric ink fountain

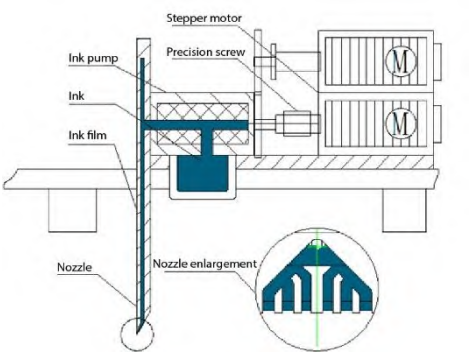

Figure 5. Metering ink delivery units

The new system replaces the ink keys on traditional printing presses by developing metering ink delivery units. Each metering ink delivery unit directly delivers ink to the corresponding ink zone, using volume and mass as measurement bases to achieve quantitative ink supply for each ink zone. In the working state, the ink supply flow rate of each metering ink delivery unit is calculated based on the ink consumption of its corresponding color plate and ink zone in a single sheet and the running speed of the printing press, and the ink supply flow rate of each metering ink delivery unit is calculated and adjusted in real-time as the running speed of the printing press changes. The research results can adjust the ink supply amount precisely and in real-time, possess a high degree of automation and digitalization, have a wide adjustable ink supply amount range, and can achieve unidirectional ink transmission, avoiding ink backflow.

3.2 Printing Color Control of Intelligent Ink Supply Device

The new system consists of a color process management module, a communication network, and an ink supply device. The ink supply device is installed in each single-color printing unit of the printing press, replacing the traditional electric ink fountain of the printing press; the color process management module is set on the control terminal and exchanges data with and controls the ink supply device through the communication network.

The color process management module reads the plate image data, calculates the ink consumption of each corresponding ink zone of each color plate in a single sheet, and then transmits the ink consumption to the ink supply device through the communication network. The ink supply device acquires the running data of the printing press through signal collection, uses a controller to set the ink supply flow rate for the metering ink delivery units in the ink supply device, and adjusts it with the running speed of the printing press, realizing the quantitative delivery of ink during the actual printing process.

3.3 Realization of Metering Ink Delivery by Single-Tube Dual-Chamber Injection Pump Structure (Dual Motors)

The new system employs a single-tube dual-chamber injection pump, a steering motor, a screw motor, a transmission device, a sensing device, and a control device. The transmission device includes a transmission bracket and two gears meshing with each other inside the transmission bracket. The screw of the single-tube dual-chamber injection pump penetrates the screw motor and is connected to one of the gears in the transmission device; the output shaft of the steering motor is also connected to one of the gears in the transmission device. A sensing device is installed on the transmission device. The single-tube dual-chamber injection pump in this research result is specially designed. When the screw motor pulls the injection shaft to move, one medium chamber injects the medium towards the outlet end while the other medium chamber sucks in the medium from the inlet end. Through reciprocating motion and the exchange of the corresponding relationship between the grooves and the inlet and outlet during steering, this structure can maintain the ability to continuously output the medium in a single direction.

4. Application Effects

This research has achieved the organic combination of

traditional offset printing and digital ink supply device technology, successfully solving the problem of non-data-driven color control in traditional offset printing production. After five years of research and development and application testing, the research results of the printing color control system based on the intelligent ink supply device have been commercialized and have obtained good applications in the market.

4.1 Realization of Digitalization and Intelligence in Offset Printing Color Control Process

The expert database in the printing color control system can accurately and intelligently calculate the working ink amount corresponding to each printed product required for printing based on different inks, blankets, plates, papers, and selected printing color standards. Intelligent printing color control not only improves printing production efficiency but also enhances printing quality and saves production costs.

4.2 Fully Enclosed Digital Precise Ink Supply Expands Printing Color Gamut Range

The intelligent ink supply device adopts a fully enclosed ink supply technology, eliminating the ink supply transfer error of traditional electric ink fountains and controlling the ink supply accuracy error within 1%. Thus, it can expand the color gamut range of printing, making printed products more saturated in color, richer in color expression levels, and capable of simulating more spot colors.

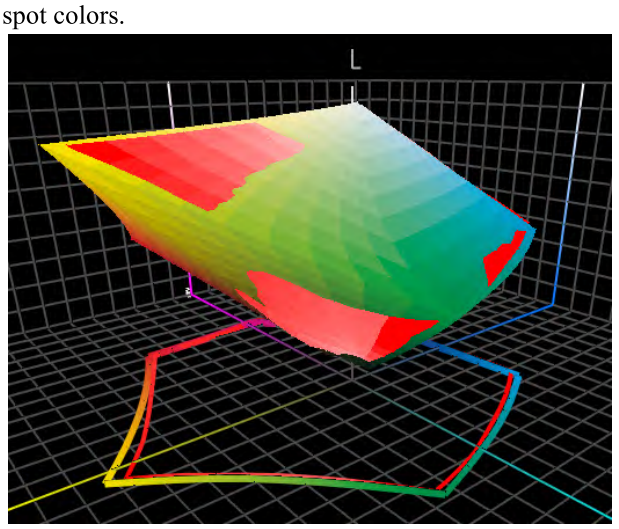

Figure 6. Printing color gamut contrast

4.3 High-Quality Color Reproduction and Consistency

The intelligent ink supply device operates based on a standard color management environment and can automatically match the color properties of different inks and papers during the printing process without the need for cumbersome manual intervention and closed-loop control to realize the printing process.

4.4 High-Efficiency Fully Integrated Automatic Printing

The printing color control system integrates the prepress digital workflow, CTP plate-making system, and intelligent ink supply device of the printing press. It can automatically convert the file format of standard printing job files, automatically correct errors, and automatically impose plates. The imposed large plate file will automatically enter the CTP plate-making process, and the printing ink preset file ppf will be sent to the intelligent ink supply device, driving the printing press to achieve intelligent operation without manual adjustment of ink keys.

4.5 Printing Adaptability Tests and Evaluations of Various Consumables

The minimum control ink supply amount unit of the printing color control system based on the intelligent ink supply device reaches the micrometer level, enabling precise control of color during the printing test process. Through a large number of printing test results, accurate ink consumption data for printing can be collected. Taking the test of a certain brand of ink as an example.

The printing color control system based on the intelligent ink supply device can accurately test the ink drying compensation amount. When the printing press is in a stopped state, the ink on the rubber rollers contacts the air and oxidizes, resulting in drying and solidification, which will cause an insufficient ink amount when printing resumes. However, by supplementing a quantitative ink, the standard state can be quickly reached when the machine starts again. In this process, the ink layer thickness compensated per unit time area is defined as the ink drying compensation amount (μm/h). By detecting the ink drying compensation amount parameter, the ink amount can be accurately controlled when printing resumes after a shutdown, helping to improve printing efficiency and color accuracy. After verification by a large number of printing tests, the ink drying compensation amount data of a certain brand of ink is collected as follows.

Table1. Drying compensation amount of a brand of ink

Item	C	M	Y	K
Printing Ink Consumption	**0.78**	**0.75**	**0.86**	**0.91**
Ink drying compensation amount	**0.04**	**0.04**	**0.03**	**0.2**

5. Conclusions

This research has developed a single-tube dual-chamber injection pump structure (dual motors), successfully realizing metering ink delivery. By developing metering ink delivery units to replace the ink keys on traditional printing presses, the problem of precise ink transmission has been effectively solved. The research results have been verified in practice, significantly improving the reliability, efficiency, and consistency of printing color control in offset printing production while reducing costs. This research result has achieved automatic control of the color adjustment process of the printing press, ending the non-standardized and non-data-driven history of determining the printing process control and printing quality solely by human experience for many years. It has not only improved printing production efficiency and enhanced printing quality but also reduced the labor intensity of operators and saved production costs.

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Investigation on conformance of sheet-fed offset ink to ISO 2846-1 standard

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Abstract

As we know, ink is one of the most critical input materials in printing processes, affecting the quality of printed products. Besides the quality of paper and other factors, uniformity and color reproduction depend on ink performance. As a result, the experiments test and verify the input ink quality based on the ISO 2846-1 international standard. Five sets of CMYK offset printing inks from five manufacturers were collected and tested. The names of the ink manufacturers will not be mentioned in this study, and the ink sets will be identified as ink set 1 to ink set 5. The results show that the ink set 1 conforms to ISO 2846-1, and the remaining ink sets have some satisfactory parameters and some unsatisfactory parameters. The results also show that the ink sets conformed with the ISO 2846-1 standard, which satisfies ISO 12647-2. This research result is very useful for evaluating and comparing the quality of various printing inks.

Introduction

Ink and paper are critical bulk raw materials for printing companies' daily use. Product diversification and color complexity have brought substantial economic benefits and broad prospects for market development and provided a solid guarantee for the rapid growth of Vietnam's printing industries. However, standard terminology remains blank for the domestic ink industry. Therefore, print product quality is not guaranteed, which results in color reproduction difficulties and a lack of repeatability in printing production activities.

Additionally, ISO 2846 standards [1] were developed to define a standard European inks, and it was shown that this standard should include inks from North America and Japan as well. The standard consists of 2846-1 for heat set or oxidative set offset (magazine) inks, 2846-2 for cold set offset (newsprint) inks, 2846-3 for publication gravure inks, 2846-4 for screen printing inks, and 2846-5 for flexo graphic inks, respectively. Moreover, the United States, Japan, China, and other developed countries have rapidly expanded their ink color and ink color system certification standards [2, 3], which affect the development of the ink industries in our country. For example, Japan color ink and Japan paper type 1 for sheetfed offset printing are displayed in Tables 1 and 2.

Table 1. *CIE LAB values for Japan color ink [2].*

Ink	CIE LAB values		
	L^*	a^*	b^*
Cyan	53.9	-37.0	-50.1
Magenta	46.6	75.1	-4.4
Yellow	87.9	-7.5	91.5
Black	13.2	1.3	1.9

The colorimetric and optical properties of four Japan paper types were determined from three paper manufacturers. Paper parameters of type 1 paper are displayed in Table 2.

Table 2. *Paper parameters for Japan paper [2].*

Paper type	CIE $L^*a^*b^*$	Brightness (%)	Mass per area (g/m^2)
ISO paper type 1 (Gloss-coated, wood-free)	$L^* = 93$ $a^* = 0$ $b^* = -3$	85	115
Japan paper	$L^* = 91$ $a^* = 0$ $b^* = -2$	80	104.7

The values displayed in Table 1 and Table 2 comply with ISO 2846-1 and ISO 12647-2 [4], respectively. Moreover, Table 3 shows the process ink's color values and transparency requirements according to ISO 2846-1. These values were measured at the M1 condition, 0^o:45^o geometry, illuminant D50, and 2^o observer.

Table 3. *CIE LAB color values and transparency requirements for ISO 2846-1 [1].*

Ink	CIE LAB values			ΔE_{ab}	Transparency, T
	L^*	a^*	b^*		
Cyan	57.0	-39.2	-46.0	4.0	> 0.20
Magenta	50.0	76.0	-3.0	4.0	> 0.12
Yellow	91.0	-5.1	95.0	4.0	> 0.08
Black	18.0	0.8	0.0	-	-

For obtained color values, as shown in Table 3, inks were printed on the printing substrate, as in Table 4. The best ink also can not meet the exact values in Table 3.

Table 4. *The characteristics of the paper for ISO 2846-1 [1].*

Substrate	CIE LAB values		
	L^*	a^*	b^*
ISO 2846-1 paper	95.5 ± 2.0	−0.4 ± 1.0	4.7 ± 1.5

The results show that Japan Color Standard Printing for paper and process inks is based on ISO standards, and these values are smaller than the ISO values, which correspond to actual domestic conditions in Japan [2].

Besides, ISO 2384 standard [5] experiments with a laboratory method to print ink samples based on which the ink film thickness can be estimated. The standard recommends round to flat printing principle (IGT). As a result, the five ink sets were investigated for colorimetric values, transparency characteristics, and ink film thickness based on ISO 2846-1 in this study.

Materials and Methods

Materials

Coated paper with grams per square (gsm) of 200 g/m2 is used in this study. Five CMYK ink sets were popular in Vietnam. The parameters of the paper are measured according to the reference condition of ISO 12647-2 (2013), which are equivalent to the parameters of premium coated (PS1) according to ISO 12647-2 as Table 5.

Table 5. *The characteristics of the paper for ISO 2846-1.*

Substrate	CIE LAB values		
	L^*	a^*	b^*
ISO 2846-1 paper	95.5 ± 2.0	−0.4± 1.0	4.7 ± 1.5
Used paper	92.5± 2.0	1.54 ± 1.	−4.6 ± 1.0

Methods

IGT Proofer 70 tester was used to print samples and measure the weight of the printed ink disc before and

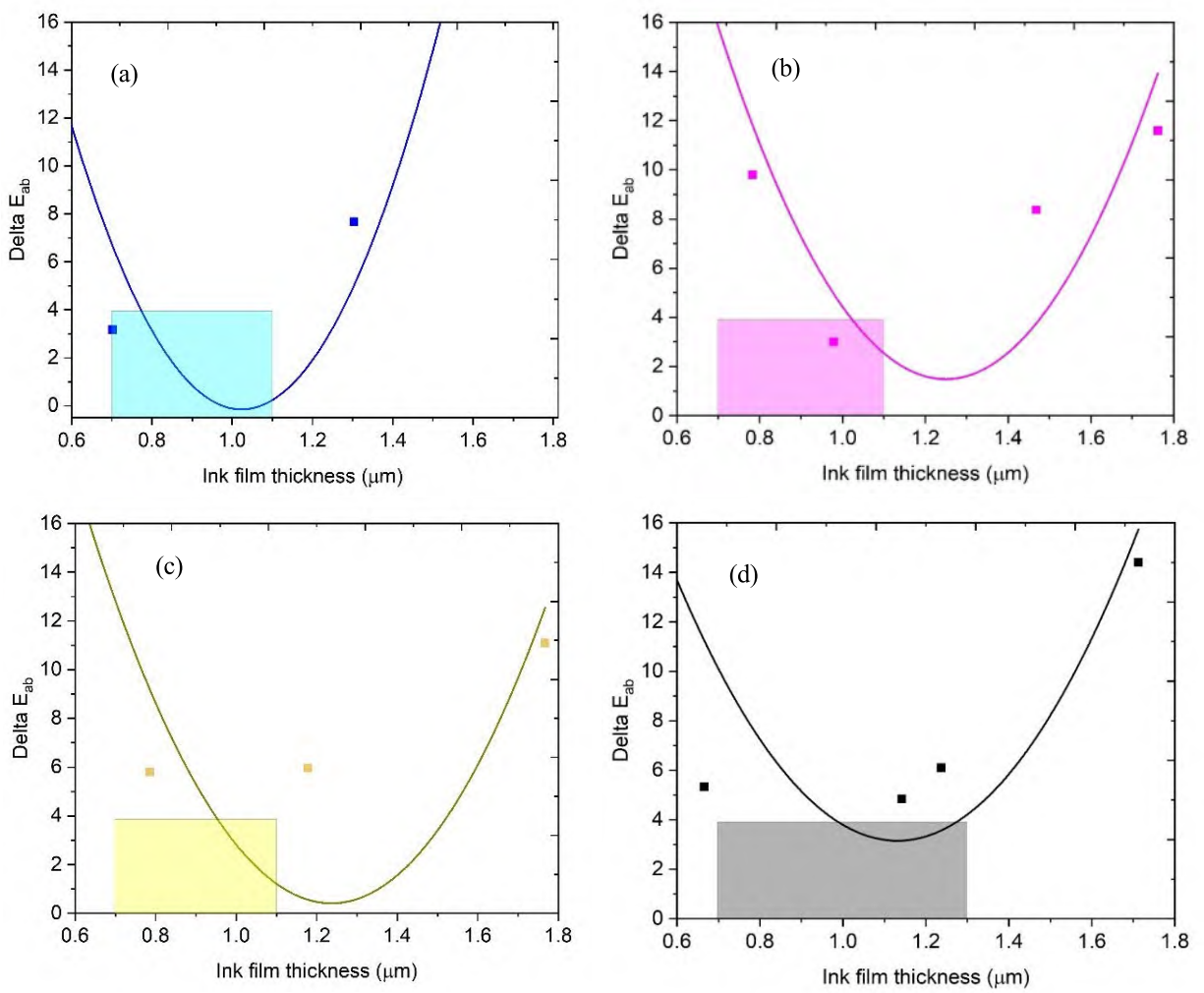

Fig. 1. Correlation between ink film thickness (ITF) and color difference of Ink-set 1: (a) Cyan, (b) Magenta, (c) Yellow, (d) Black

after printing. IGT ink pipet with a resolution of 0.01 ml was used to get inks for printing. The volume of 0.1 to 2.0 ml at intervals of 0.1 was used to print on paper for the ink transfer survey. Experimental procedures are carried out according to ISO 2384 standards. For each of the evaluated inks, a number of test prints will be made, each produced at a different ink film thickness.

Techkon SpectroDen spectrophotometer (Premium, Germany) was used to measure the values of CIE Lab, density, and ink trapping. Before color measurement, all samples shall be thoroughly dry. Inks formulated for oxidation drying will be left for at least 24 hours.

Results and Discussion

Investigation of colorimetric values

Test prints were measured in accordance with ISO 13655, and samples were measured spectrally with a 0°:45° geometry instrument, the CIE 1931 (2°) standard observer, and the CIE standard illuminant D50. Experimental data are fitted according to the function $y = ax^2 + bx + c$ using Origin software. The fitted result of cyan, magenta, yellow, and black is obtained using the following equations.

$$y_{Cyan} = 68.94 - 134.99x + 65.94x^2 \quad (1)$$

$$y_{Magenta} = 75.58 - 118.59x + 47.45x^2 \quad (2)$$

$$y_{Yellow} = 66.34 - 106.60x + 43.09x^2 \quad (3)$$

$$y_{Black} = 50.93 - 84.44x + 37.31x^2 \quad (4)$$

Five ink sets were examined in this experimental part. However, we only present detailed data for ink set 1. The remaining ink sets are done similarly. The fitted results of the ink set 1 are displayed in Fig. 1. Figure 1 shows the relationship between ink film thickness (ITF) and color difference (ΔE*ab) of cyan, magenta, yellow, and black, respectively.

Table 6. *The conformance of the ink set from 1 to 5 with the ISO 2846-1 standard.*

Ink-set	C	M	Y	K
	Conformance to ISO 2846-1			
Ink-set 5	No	Yes	Yes	Yes
ΔE^*_{ab}	8.24	2.64	2.25	2.22
Ink-set 4	No	No	No	Yes
ΔE^*_{ab}	5.40	7.44	10.7	3.10
Ink-set 3	No	No	No	No
ΔE^*_{ab}	10.7	4.44	4.87	5.67
Ink-set 2	No	No	No	Yes
ΔE^*_{ab}	14.1	7.61	9.31	3.11
Ink-set 1	Yes	Yes	Yes	Yes
ΔE^*_{ab}	3.18	3.01	5.80	4.84

The investigation results indicate that the colorimetric values of the ink set 1 conformance with the ISO 2846-1 standard ($\Delta E^*_{ab} < 4$). However, the results of the ink set from 2 to 5 show that some inks do not conform to the

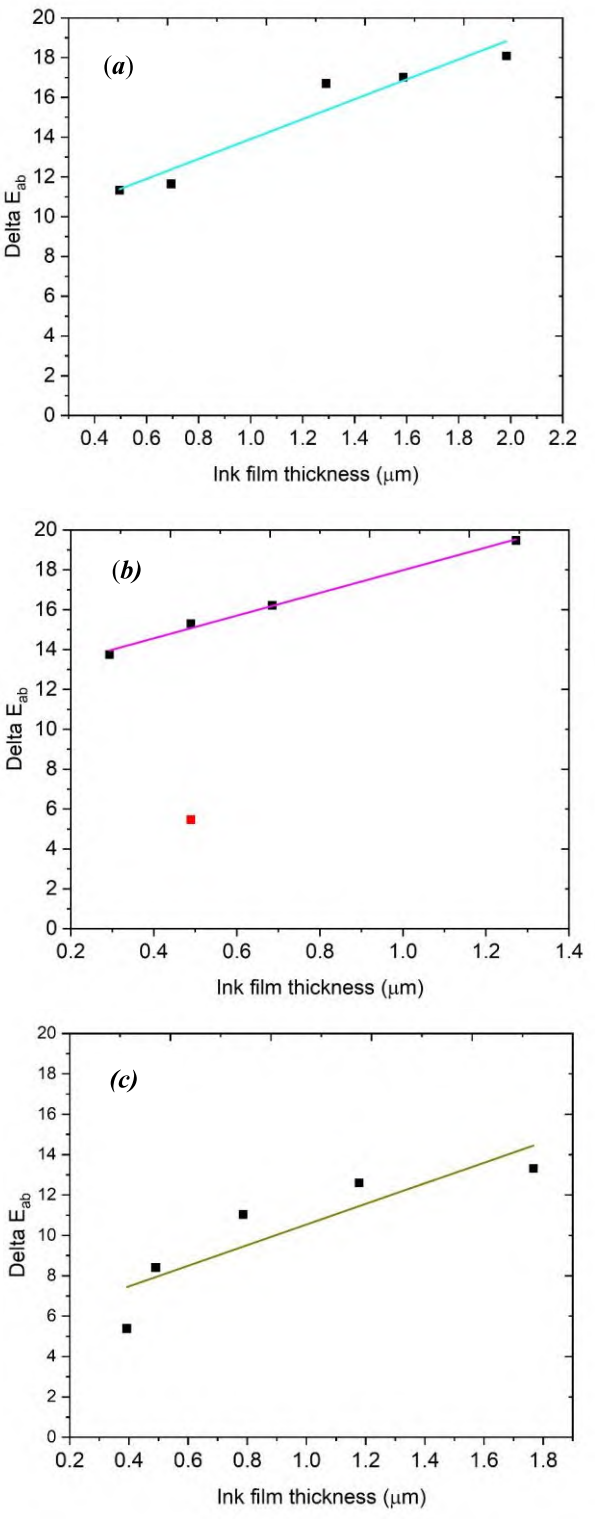

Fig. 2. Ink transparency of Ink-set 1: (a) Cyan, (b) Magenta, and (c) Yellow

standard values (Table 6).

Investigation of transparency characteristics

Transparency is ability transmit light of an ink film [1]. Fig.2 reveals the transparency characteristics of the ink set 1. The experimental data in Fig. 2 are fitted according to the function y = a.x + b. The investigated results are displayed in the following equations from (5) to (7).

$$y_{Cyan} = 8.89 + 5.01x \quad (5)$$

$$y_{Magenta} = 12.28 + 5.70x \quad (6)$$

$$y_{Yellow} = 5.44 + 5.10x \quad (7)$$

The data processing process is performed similarly for the ink sets from 2 to 5, and the results are presented in Table 1. Transparency values are reciprocal of the slope (1/a) of the regression line between ink film thickness (ITF) and colour difference (ΔE^*_{ab}) for overprints of chromatic inks over black substrate [1]. The investigated results in Table 7 show characteristics of the ink sets conformance with the ISO 2846-1 standard except for the magenta color of the ink set 4.

Table 7. *Transparency characteristics of the ink sets.*

Ink-set	C	M	Y
	T ≥ 0.2	T ≥ 0.12	T ≥ 0.08
Ink-set 5	0.20	0.20	0.21
Ink-set 4	0.25	0.10	0.20
Ink-set 3	0.23	0.33	0.22
Ink-set 2	0.20	0.20	0.21
Ink-set 1	0.20	0.17	0.20

Invetigation of ink film thickness

Table 8. *Ink film thickness of the ink sets*

Ink-set	**C**	**M**	**Y**	**K**
	Conformance to ISO 2846-1			
Ink-set 5	Yes	No	Yes	Yes
ITF (μm)	0.74	1.85	1.00	0.96
Ink-set 4	No	Yes	No	Yes
ITF (μm)	1.21	1.10	1.43	1.30
Ink-set 3	No	No	No	No
ITF (μm)	1.50	1.93	2.26	1.74
Ink-set 2	Yes	Yes	No	Yes
ITF (μm)	0.92	0.98	1.43	0.93
Ink-set 1	Yes	Yes	Yes	Yes
ITF (μm)	1.10	0.98	0.79	1.14

Table 8 displays the range of ink film thicknesses in micrometers of the ink sets. The investigated results indicated that the ink film thickness of ink set 1 conformance with the ISO 2846-1 standard, while the ink sets from 2 to 5 do not meet the thickness criteria. The ISO standard indicated that the range of ink film thicknesses is about 0.7 to 1.1 μm with cyan, magenta, and yellow, while it is about 0.7 to 1.3 μm with black.

Moreover, Fig. 3 shows the CIE a*b* plane of the defined colorant descriptions for premium coated paper according to ISO 12647-2 (2013) and the color values of five ink sets. The results indicated that the ink sets conformed with the ISO 2846-1 standard, which then satisfies ISO 12647-2.

Conclusion

This study surveyed five ink sets from five different manufacturers, and these ink types are currently commonly used in Vietnam. The results were performed on grade PS1 coated paper according to ISO 12647-2, showing that only ink set 1 satisfies the ISO 2486-1 criteria. The remaining ink sets have some satisfactory parameters and some unsatisfactory parameters. This research result is very useful for evaluating and comparing the quality of printing inks commonly used in Vietnam today.

Acknowledgement

This work belongs to the project grant No: B2024-SPK-04. funded by Ministry of Education and Training, managed fund by Ho Chi Minh City University of Technology and Education, Vietnam.

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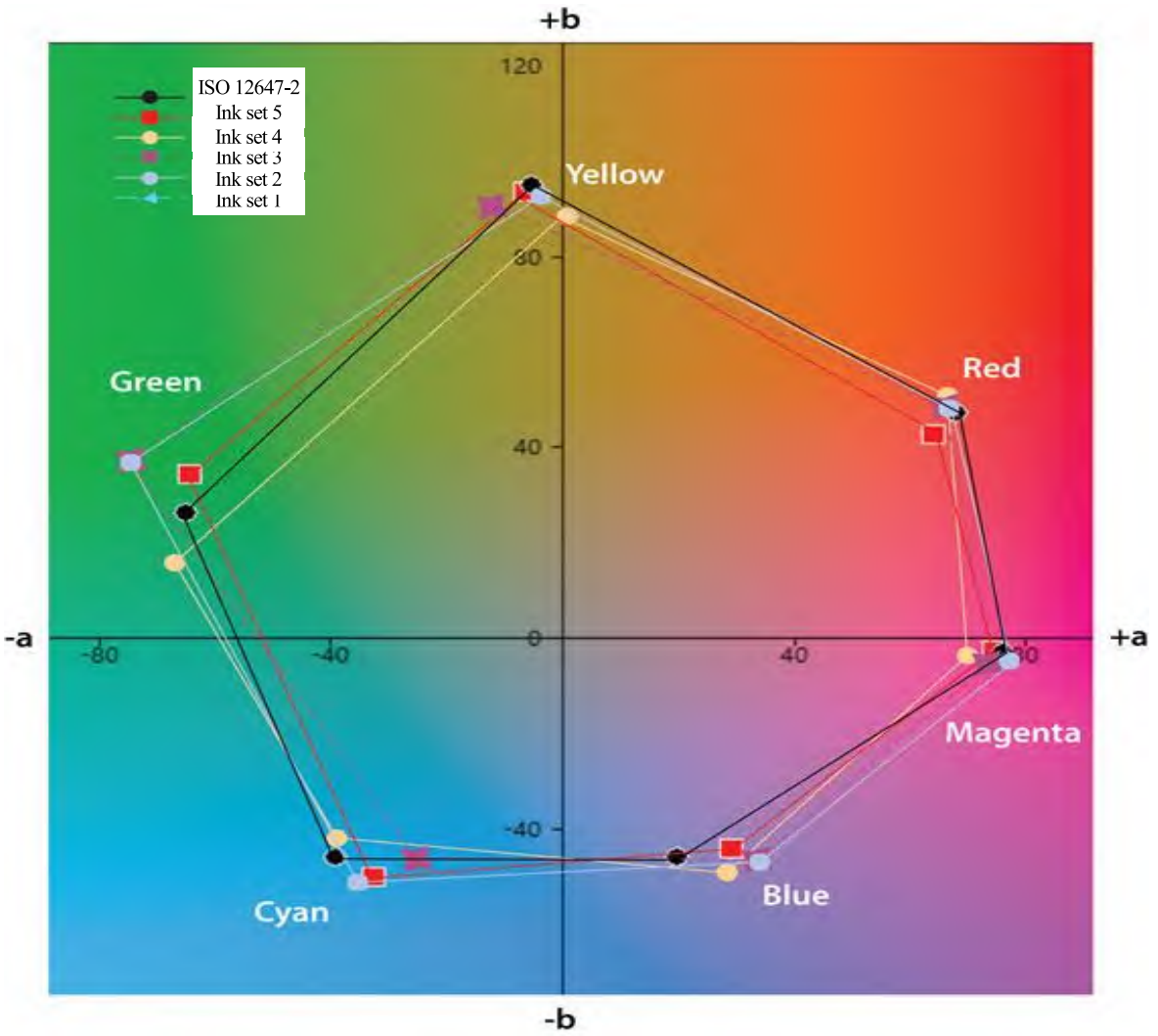

Fig. 3. The CIE a*b* plane of the defined colorant descriptions for premium coated paper according to ISO 12647-2 (2013) and the color values of five ink sets

Development of print quality monitor system using artificial intelligence

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Abstract

This research aims to use AI to detect problems in four-color offset printing processes. To minimize paper size by limiting it to the printing area, quality control strips (color bars) cannot be added. Consequently, print quality monitoring during the printing run relies on the skills and experience of the print operator. Common quality-check parameters include registration, color consistency, and color accuracy, which may vary due to human error. A print monitoring system based on artificial intelligence (AI) has been developed. It consists of imaging equipment, a lighting system, color charts, and image analysis algorithms. The AI compares and analyzes images captured from printed sheets to reference proof sheets. By applying principal component analysis (PCA), the AI can quickly identify discrepancies and various defects in printing. Test results show that the proposed system can effectively detect print defects such as scumming, ink spots, hickeys, color deviations, pattern distortions, and missing or excessive content. This system helps reduce costs, improve consistency, and deliver print quality that meets client requirements.

Keywords: Print quality, Principal Component Analysis (PCA), Artificial Intelligence (AI)

Introduction

Wattana Panich Printing is facing the challenges that arise in producing high-quality printed sheets during the printing process. One of the main issues is the inability to include quality control strips (color bars), which play a crucial role in monitoring and maintaining print quality throughout the entire printing process until the completion of the ordered production run. This issue arises because the paper size has been adjusted to minimize costs, leaving no extra space for the color bars. As a result, depends on the experience and inspections skills of print operators, which can lead to unstable and errors in production printed sheets, If experienced print operators are not available, these challenges become worse, leaving printing facilities vulnerable to production delays and quality issues, The possible and affordable solution to these challenges issue is the adoption of technology.

Print operators shortages have become a persistent issue in the printing industry, particularly for original offset printing processes, requiring innovative solutions to maintain production efficiency.[1]

Currently, there is a growing trend of adopting AI technology across various industries, sparking interest in its potential as an affordable tool for assisting print operators in inspection processes. By integrating AI systems into production printing, the technology can analyze printed sheets and match them with proof sheets, helping print operators identify defects more efficiently. This collaboration between print operators and AI not only enhances the stability of quality control but also reduces the workload of operators, ensuring consistent results and minimizing the potential for defect caused by the human error as printing process.

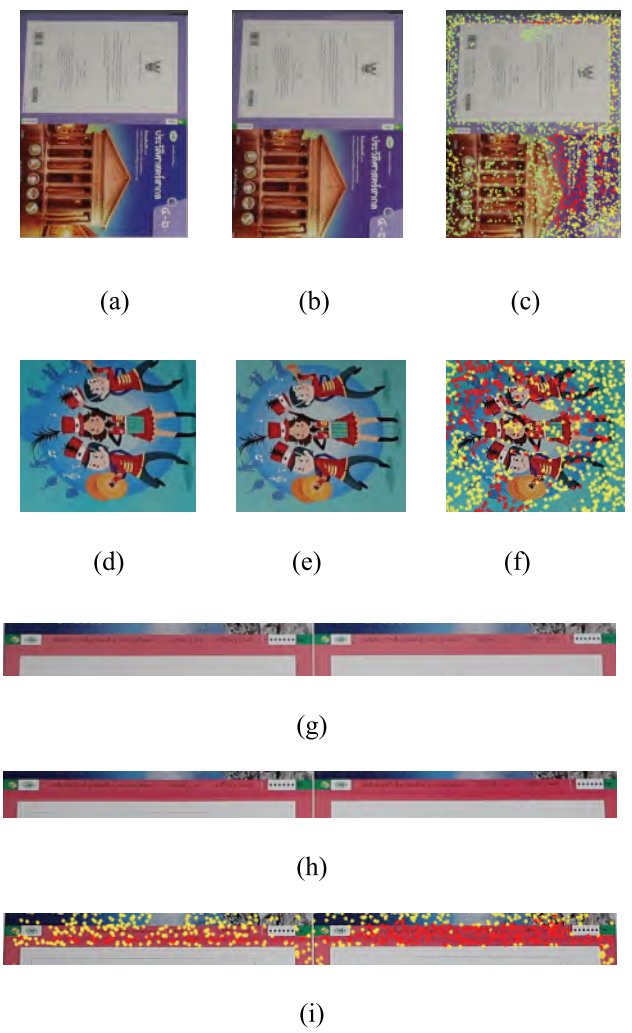
The print quality monitoring system presented in this research integrates two main components: hardware and software. The hardware includes widely available components, such as camera, lighting systems, jig fixture and computer (Figure 1), which can be sourced from general markets at an affordable cost. The software, implemented by the research team, features image analysis algorithms powered by AI. By applying principal component analysis (PCA), the software can rapidly identify discrepancies and detect various print defects by comparing printed sheets with reference proof sheets. PCA enables the system to focus on key discrepancies, allowing for faster and more accurate

defect detection. These defects include scumming, ink spots, hickeys, color deviations, pattern distortions, and missing or excessive content. (Figure 2)

Image acquisition station.

Monitoring for users.

Figure 1. The hardware setup of the system, including equipment.



(a) (b) (c)

(d) (e) (f)

(g)

(h)

(i)

Figure 2. Common print defects examples in production, Printed non-defect sheets (a,d,g), Printed defect sheets (b,e,h), detection defect on sheets by AI (c,f,i).

Methodology

Principal Component Analysis-based Neural Networks for Print Quality Monitoring System

The main focus of our work is to demonstrate the applicability of artificial neural networks to defect pattern recognition on presswork. For this purpose, we extended neural networks based on principal component analysis (PCA) to obtain eigenproofs and combined this network with a classifier. As discussed in this work, the problem of defect detection can be converted into a problem of dimensionality reduction and pattern classification in embedding space. In general, the image datasets can be considered as high dimensional data, in which, important information including specific features embedded in high dimensionality. PCA is suitable for the task of dimensionality reduction since it can remove spatial redundancy and can encode the original data onto lower dimensional representations using linear projection. The principal component technique [2] constitutes transformation-based coding of images since this method represents pixels by means of a parameterized function as verified in the following section.

PCA Neural Networks for Defect Pattern Detection

In this paper, we use color images of press proof as a reference image. Then subimages of size $d = m_1 \times m_2$ are randomly selected and used for training. Note that, the training dataset is uniformly distributed. Each subimage is vectorized into a vector $x_i \in \mathbb{R}^d$. Then the d-dimensional dataset covariance matrix is given by the formula

$$C = \frac{1}{m}\sum_{i=1}^{m}(x_i - \bar{x})\,(x_i - \bar{x})^T \qquad (1)$$

where $\bar{x}$ denotes the mean vector and m is the number of training data points, i.e. subimages. By applying PCA method to d-dimensional image vectors, the eigenvalue decomposition is used to extract the d principal components and the corresponding eigenvalues of the data covariance matrix. Then, PCA can encode the original data onto lower-dimensional compact version using the transformation matrix which is derived from the k leading eigenvectors (where $k \ll d$) corresponding to the k largest eigenvalues of C. These eigenvectors can be considered as global principal components of the data, while the $d - k$ remaining principal components or eigenvectors have become redundant. Thereby, PCA provides linear transformation matrix U_k which can be written as

$$U_k = \left[\left[e_1\right]\left[e_2\right]\cdots\left[e_k\right]\right]_{d\times k} \qquad (2)$$

where the order of the eigenvectors is fixed according to a decreasing sequence of eigenvalues, i.e. $|\lambda_1| > |\lambda_2| > \ldots > |\lambda_k|$. Though data like image or subimage are high-dimensional, the significant number of the features is not as

high as we observe. Assume data should be mapped to dimensionality k where $k = 3$ such that the features emerge in a low dimensional space. These features can be extracted by an explicit forward mapping of $\mathbb{R}^d \Longrightarrow \mathbb{R}^3$ by means of the formula

$$y_i \Leftarrow U_k^T(x_i - \bar{x}) \ . \quad (3)$$

(Figure 3) demonstrates 3D representation, i.e. $y_i \in \mathbb{R}^3$, as the internal structure embedded in high dimensionality. Then, a structure induced by PCA network can be used for the testing stage, such that the test patterns which contain defect / non-defect are randomly selected from color image of presswork. The 1-nearest neighbor classifier has been proposed in order to perform defect pattern detection in the embedding space [3]. Each subimage of the test set, $x_{test} \in \mathbb{R}^{m_1 \times m_2}$, is projected onto 3D embedding space using

$$y_{test} \Leftarrow U_k^T(x_{test} - \bar{x}) \ . \quad (4)$$

Afterwards, the feature vector y_{test} is used for the winner assignment:

$$i^* = \underset{i}{\operatorname{argmin}}\{\|y_{test} - y_i\|\} \ . \quad (5)$$

A test subimage x_{test} can be classified into the class of "non-defect" under a condition as follows:

$$\|y_{test} - y_{i^*}\| \leq \varepsilon \quad (6)$$

where ε is the similarity boundary between two features. Otherwise, the subimage x_{test} is classified as "defect". In the next step, some areas in the test image recognized as defect patterns are categorized into three main levels by using the total color difference (ΔE_{ab}^*).

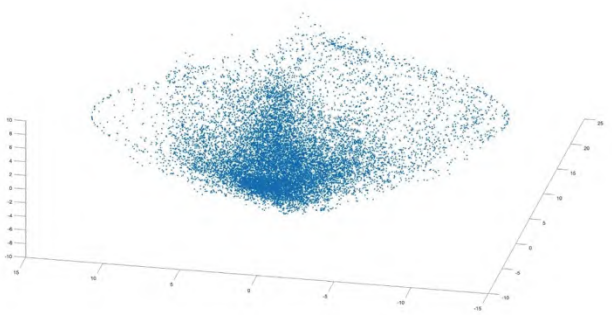


Figure 3. Using the linear projection as defined in PCA neural network to generate the internal structure on the embedding space.

Experimental procedure

First of all, research team used MATLAB as a tool to develop the application, which was developed to allowing tester to image acquisition, run defect analysis algorithms, and verify results. To evaluate the system's performance in a realistic production environment, the research team followed steps.

I. Identify the printing job or production order
   - **a.** Select a printing job or production order to evaluate print operator
   - **b.** Communicate with the print operators that the researchers will be timing the defect inspection process.
   - **c.** Request that operators report the researchers if any issues on printed sheets, for timestamp.

II. Monitor and inspect printed sheets identified by print operators
   - **a.** Collect the proof sheets or sheets approved by the customer to serve as system for training AI.
   - **b.** Use a function timestamp in Excel365 as a tool to record the time taken by operators to inspect each sheet and record the details of the identified defects during the manual inspection process, based on report from print operators.
   - **c.** Collect defect-printed sheets that print operators have notify.
   - **d.** Collect non-defect printed sheets from the selected printing job or production order.

III. Testing the print quality monitor system using artificial intelligence on collected samples.
   - **a.** insert a proofing sheets or sheets approved by the customer to Image acquisition station for training as AI
   - **b.** Input each category of defect sheets and non-defect sheets into the AI system developed.
   - **c.** Compare the AI processing time with the inspections performed by skill and experience print operators, using the identified defects and inspection times for evaluation.

The AI processing was conducted under the following conditions:

I. Training: AI trained with 50,000 subimage per 1 printed sheet for learning defect patterns.
II. Testing: AI validated using 10,000 subimage per 1 printed sheet for inspection defect by AI.
III. Resolution: Input images were set at 1920 x 1080 pixels.

Result and Discussion

Table 1: Data collection from printed sheet inspection by print operators (Manual)

Defect Type	Samples	Avg. Time (μ ± σ, sec)	Max Time (sec)	Min Time (sec)
Color deviations	207	45.43 ± 18.07	127	14
Faded color	23	34.04 ± 12.40	62	14
Smudging	11	23.09 ± 15.21	69	10
Non-defects	312	40.93 ± 18.67	166	9

Table 2: Data collected from print quality inspection using AI (Machine)

Defect Type	Samples	Avg. Time (μ ± σ, sec)	Max Time (sec)	Min Time (sec)
Color deviations	279	9.93 ± 3.97	20.88	2.79
Faded color	53	5.48 ± 2.06	13.82	2.82
Smudging	21	8.32 ± 3.26	14.74	3.63
Non-defects	235	4.16 ± 1.06	6.58	2.50

Table 3: Data collected from print operators justification based on AI results (MAN)

Defect Type	Samples	Avg. Time (μ ± σ, sec)	Max Time (sec)	Min Time (sec)
Color deviations	288	2.60 ± 1.22	9.14	1.32
Faded color	40	2.32 ± 0.67	3.78	1.41
Smudging	49	2.64 ± 1.23	6.19	1.29
Non-defects	22	3.61 ± 1.53	7.96	1.53

Table 4: Combined data from AI and print operators justification (Machine + MAN)

Defect Type	Avg. Time (sec)	Max Time (sec)	Min Time (sec)
Color deviations	12.53	30.02	4.11
Faded color	7.79	17.60	4.24
Smudging	10.96	20.93	4.92
Non-defects	7.77	14.54	4.03

Note: table 1-3 is sample number differ because data were collected from different printing jobs or production orders during periods timing.

The PCA method, as implemented in this study, enabled the AI system to analyze the entire printed sheet comprehensively by focusing on the most critical features. Unlike manual inspection, where print operators rely solely on their vision to check every detail of the sheet, which is inherently time-consuming, PCA allows the AI system to process and identify defects across the whole sheet in a fraction of the time.

The experimental result show that integrating artificial intelligence (AI) with print operators can help inspect printed sheets faster and more consistently. The AI system, which uses PCA (Principal Component Analysis), works by analyzing the entire sheet and defects more efficiently. Comparing manual inspection by print operators (Table 1) with the combined system of AI and human justification (Table 4) shows the following improvements:

- Color Deviations: Reduced inspection time by 72% (from 45.43 to 12.53 seconds).
- Faded Color: Time decreased by 77% (from 34.04 to 7.79 seconds).
- Smudging: Improved speed by 53% (from 23.09 to 10.96 seconds).
- Non-Defects: Inspection was 81% faster (from 40.93 to 7.77 seconds).

The results across four defect types—color deviations, faded color, smudging, and non-defects—show substantial reductions in inspection time, ranging from 53% to 81% faster when compared to manual inspection.

Conclusion

This study the integration artificial intelligence (AI) with print operators significantly improves the efficiency and consistency of the print quality monitoring system inspection process. By utilizing PCA (Principal Component Analysis), the AI system can comprehensively analyze printed sheets and identify defects more quickly than manual inspection, as validated by the experimental results. This increases the inspection frequency within the same timeframe, allowing. the system to evaluate a greater number of printed sheets, the print quality monitoring system enables printing houses to maintain consistent print quality throughout the production process, ensuring that high-quality outputs are delivered to clients reliably and efficiently.

While the current hardware and area setup requires print operators to manually place printed sheets on the acquisition table, this approach complies with supplier warranty restrictions, which prohibit unauthorized modifications to the printing machine. For future developments, integrating automated scanning equipment at the output end of the

printing machine would be an ideal solution to address all issues.

Acknowledgment

We would like to express our gratitude to Higher Education for Industry Consortium (HI-FI) Under Experiential Learning Program, Office of The Permanent Secretary (OPS), Ministry of Higher Education, Science, Research, and Innovation. And Watana Panich Printing co., ltd. for their financial support and provision of resources that made this research possible.

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Report on optimizing the method of calculating the necessary amount of component inks for offset printing mixing based on the database from the previous research project

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1. Abstract

In Machine Learning, linear regression is a supervised algorithm in which the relation between input and output is described by a linear function. This algorithm is also known as linear fitting or linear least square(I). This report discusses the application of linear regression problems in calculating colour mixing based on L, a, b values. In addition, a comparison is indicated to test the effectiveness of this algorithm compared to the previously studied algorithm(II).

2. Introduction

Specifically, this report will reuse the data of the combined colours from Cyan and Medium, Magenta and Medium, Yellow and Medium (the change rate is 10% respectively) as the database for the new algorithm (linear regression) (I) to predict the percentage of the mass of the mixed colours. The results returned by the new algorithm performed on Python are compared with the old algorithm performed on Excel(II), hence, the effectiveness of the new algorithm was evaluated.

Evaluate the simple example given in the previous post: a large house $\boldsymbol{x_1 m^2}$, Have $\boldsymbol{x_2}$ bedroom and city centre $\boldsymbol{x_3 km}$ how much does it cost? Suppose we have statistics from 1000 houses in that city, when a new house with parameters of area, number of bedrooms and distance to the centre is available, can we predict the price of that house? If so, the prediction function $\boldsymbol{y = f(x)}$ What will it look like? Here $\boldsymbol{x} = [x_1, x_2, x_3]$ *is a row vector containing input* information, y is a scalar representing *the output* (the price of the house in this example).

Note on mathematical notation: *in my articles, scalars are represented by letters written in non-bold, possibly uppercase, for example* $(\boldsymbol{x_1, N, y, k})$. *Vectors are represented by bold lowercase letters, for example* $(\boldsymbol{y, x_1})$. *Matrices are represented by bold capital letters, for example* $(\boldsymbol{X, Y, W})$.

In the simplest way, we can see that: i) the larger the house area, the higher the house price; ii) the larger the number of bedrooms, the higher the house price; iii) the farther from the centre, the lower the house price. The simplest function that can describe the relationship between house price and the 3 input quantities is:

$$\mathbf{y} \approx \mathbf{f(x)} = \hat{\mathbf{y}}$$
$$\mathbf{f(x)} = \mathbf{w_1 x_1 + w_2 x_2 + w_3 x_3 + w_0} \approx \ (\mathbf{1})$$

In there, (w_1, w_2, w_3, w_0) are constants, w_0 also known as bias. The relationship $\boldsymbol{y \approx f(x)}$ above is a linear relationship. The problem we are working on is a regression problem. The problem is to find the optimal coefficients $\boldsymbol{y \approx f(x)}$ that's why it's called the Linear Regression problem.

Note 1: y is the actual value of the *outcome* (based on the statistics we have in the *training data* set), while$\hat{\mathbf{y}}$ is the value predicted by the Linear Regression model. In general, $\mathbf{y}$ and $\hat{\mathbf{y}}$ are two different values due to model error, however, we would like this difference to be very small.

Note 2: *Linear* or *linear* simply means *straight, or flat*. In two-dimensional space, a function is called *linear* if its graph is in the form of a *straight line*. In three-dimensional space, a function is called *linear* if its graph is in the form of a *plane*. In a space of more than 3 dimensions, the concept of *a plane* is no longer suitable, instead, another concept is born called *a* hyperplane. Linear functions are the simplest functions because they are convenient in visualization and calculation. We will see in the following articles, *linearity* is very important and useful in Machine Learning problems. My personal experience shows that, before understanding non-linear algorithms, *we need to master the techniques for linear* models.

3. Mathematical analysis

3.1 Form of Linear Regression

In the equation (1) above, if we put $\mathbf{w} = [\mathbf{w_0, w_1, w_2, w_3}]^{\mathbf{T}}$ is the vector (column) of coefficients that need to be optimized and $\bar{\mathbf{x}} = [\mathbf{1, x_1, x_2, x_3}]$ (read as *x bar in English) is the extended* input data vector (row) . Number(1)at the beginning is added to simplify the calculation and make it convenient to calculate. Then, equation (1) can be rewritten as:

$$y \approx \bar{\mathbf{x}}\mathbf{w} = \hat{y}$$

Note that $\bar{\boldsymbol{x}}$ is a row vector.

3.2 Forecast error

We wish that the difference $\boldsymbol{e}$ between real value $\boldsymbol{y}$ and predicted value $\hat{\mathbf{y}}$ (pronounced *y hat* in English) is smallest. In other words, we want the following value to be as small as possible:

$$\frac{1}{2}e^2 = \frac{1}{2}(y - \hat{y})^2 = \frac{1}{2}(y - \bar{\boldsymbol{x}}\boldsymbol{w})^2$$

In which 1/2 (*again*) is for convenience of calculation (when calculating derivatives, the number 1/2 will be eliminated). We need e^2r because $e = y - \hat{y}$ can be a negative number, speaking e smallest will not be correct because when $e = -\infty$ is very small but the deviation is very large. Readers may ask themselves: **why not use the absolute value $|\boldsymbol{e}|$ but use square $\boldsymbol{e^2}$ here?** The answer will be in the next section.

3.3 Loss function

The same happens for all *(input, outcome) pairs.* $(\boldsymbol{x_i}, y_i), i = 1,2,\dots,N,$ with N is the amount of observed data. What we want, the total error to be the smallest is equivalent to finding $(\boldsymbol{w})$ for the following function to have a minimum value:

$$\mathcal{L}(\boldsymbol{w}) = \frac{1}{2}\sum_{i=1}^{N}(y_i - \bar{\boldsymbol{x}}_{\boldsymbol{i}}\boldsymbol{w})^2 \quad (2)$$

Function $\mathcal{L}(\boldsymbol{w})$ is called **the loss function** of the Linear Regression problem. We always want the loss (error) to be minimal, which means finding the coefficient vector $\boldsymbol{w}$ so that the value of this loss function is as small as possible. The value of $\boldsymbol{w}$ The point at which the loss function reaches its minimum value is called *the optimal point*, denoted by:

$$\boldsymbol{w}^* = \arg\min_{\boldsymbol{w}} \mathcal{L}(\boldsymbol{w})$$

Before looking for the solution, let's simplify the math in the loss function equation(2). Put $\boldsymbol{y} = [y_1; y_2; \dots; y_N]$ is a column vector containing all the *outputs* of *the training data* $\bar{\boldsymbol{X}} = [\bar{\boldsymbol{x}}_{\boldsymbol{1}}; \bar{\boldsymbol{x}}_{\boldsymbol{2}}; \dots; \bar{\boldsymbol{x}}_{\boldsymbol{N}}]$ is the input data matrix (extended) whose each row is a data point. Then the loss function $\mathcal{L}(\boldsymbol{w})$ written in simpler matrix form:

$$\mathcal{L}(\boldsymbol{w}) = \frac{1}{2}\sum_{i=1}^{N}(y_i - \bar{\boldsymbol{x}}_{\boldsymbol{iw}})^2] \left[= \frac{1}{2}|\boldsymbol{y} - \bar{\boldsymbol{X}}\boldsymbol{w}|_2^2 \right. \quad (3)$$

with $|\boldsymbol{z}|_2$ is the Euclidean norm (or Euclidean distance), in other words $|\boldsymbol{z}|_2$ is the sum of the squares of each element of the vector. Now, we have a simple form of the loss function written as the equation(3).

3.4 Solution for Linear Regression Problem

The most common way to find a solution to an optimization problem (we've known this since high school) is to solve the gradient equation to zero! Of course, that's when calculating the derivative and solving the gradient equation to zero aren't too complicated. Luckily, with linear models, both of these are possible.

Derivative by $(\boldsymbol{w})$ of the loss function is:

$$\frac{\partial \mathcal{L}(\boldsymbol{w})}{\partial \boldsymbol{w}} = \bar{\boldsymbol{X}}^{\boldsymbol{T}}(\bar{\boldsymbol{X}}\boldsymbol{w} - \boldsymbol{y})$$

You can refer to the table of derivatives of a function in terms of vectors or matrices in D.2 of machinelearingcoban.com. *Now I would like to return to the question in the Prediction Error section above about why not use absolute value but use square. The answer is that the square function has derivatives everywhere, while the absolute value function does not (the derivative is not defined at 0).*

The derivative equation equal to 0 is equivalent to

$$\bar{\boldsymbol{X}}^{\boldsymbol{T}}\bar{\boldsymbol{X}}\boldsymbol{w} = \bar{\boldsymbol{X}}^{\boldsymbol{T}}\boldsymbol{y} \triangleq \boldsymbol{b} \quad (4)$$

(symbol $(\bar{\boldsymbol{X}}^{\boldsymbol{T}}\boldsymbol{y} \triangleq \boldsymbol{b})$ means to *put* $\bar{\boldsymbol{X}}^{\boldsymbol{T}}\boldsymbol{y}$ *equal* **b**).

Height (cm)	Weight (kg)	Height (cm)	Weight (kg)
147	49	168	60
150	50	170	72
153	51	173	63
155	52	175	64
158	54	178	66
160	56	180	67
163	58	183	68
165	59		

If the matrix is square $\boldsymbol{A} \triangleq \bar{\boldsymbol{X}}^{\boldsymbol{TX}}$ non-singular or invertible then the equation (4) has a unique solution: $\boldsymbol{w} = \boldsymbol{A}^{-\boldsymbol{1}}\boldsymbol{b}$.

So if the matrix **A** what about non-invertible (determinant equal to 0)? If you still remember the knowledge about linear systems of equations, in this case either the equation (4) has no solution, or it has infinitely many solutions. Then we use the concept of *pseudoinverse* $\boldsymbol{A}^+$(read as *A dagger* in English). (*Pseudo inverse is a general case of inversion when the matrix is not invertible or even not square. In the scope of this article, I would like to skip this part, if you are really interested, I will write another article just talking about pseudo inverse. See also: Least Squares, Pseudo-Inverses, PCA & SVD* .)

With the concept of pseudo-inverse, the optimal point of the Linear Regression problem has the form:

$$\boldsymbol{w} = \boldsymbol{A}^+ = (\bar{\boldsymbol{X}}^{\boldsymbol{T}}\bar{\boldsymbol{X}})^+\bar{\boldsymbol{X}}^{\boldsymbol{T}}\boldsymbol{y} \quad (5)$$

4. Example on Python

4.1 Problem

In this section, I will choose a simple example of solving Linear Regression problem in Python. I will also compare the solution of the problem when solved by equation (5) and the solution is found using Python's scikit-learn library . *This is a widely used Machine Learning library in Python*). In this example, the input data has only 1 value (1 dimension) for the convenience of illustration in the plane.

We have a data table about the height and weight of 15 people as below:

The question is: is it possible to predict a person's weight based on their height? (*In reality, of course not, as weight depends on many other factors, such as volume*). Since this blog is about simple Machine Learning algorithms, I'll assume that we can predict it.

We can see that weight is proportional to height (the taller the heavier), so we can use Linear Regression model for this prediction. To check the accuracy of the found model, we will keep the 155 and 160 cm columns for testing, the remaining columns are used to train the model.

4.2. Display data on graph

First, we need two libraries numpy for linear algebra and matplotlib for plotting.

```
# To support both python 2 and python 3
from __future__ import division, print_function, unicode_literals
import numpy as np
import matplotlib.pyplot as plt
```

Next, we declare and represent the data on a graph.

```
# height (cm)
X = np.array([[147, 150, 153, 158, 163, 165, 168, 170, 173, 175, 178, 180, 183]]).T
# weight (kg)
y = np.array([[ 49, 50, 51,  54, 58, 59, 60, 62, 63, 64, 66, 67, 68]]).T
# Visualize data
plt.plot(X, y, 'ro')
plt.axis([140, 190, 45, 75])
plt.xlabel('Height (cm)')
plt.ylabel('Weight (kg)')
plt.show()
```

Height (cm)

From this graph, we can see that the data is arranged almost in a straight line, so the Linear Regression model is likely to give good results:

(weight) = w_1*(height) +w_0

4.3. Solution according to formula

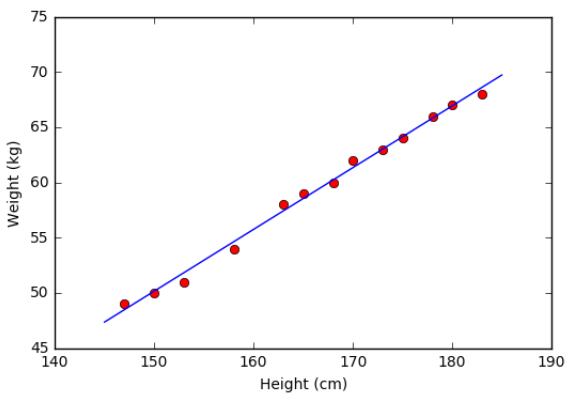
Next, we will calculate the coefficients w_1 and w_0 based on the formula(5). Note: the pseudo-inverse of a matrix **A** in Python is computed using numpy.linalg.pinv(A), pinv which stands for *pseudo inverse*.

```
# Building Xbar
Xbar = np.concatenate((one, X), axis = 1)

# Calculating weights of the fitting line
A = np.dot(Xbar.T, Xbar)
b = np.dot(Xbar.T, y)
w = np.dot(np.linalg.pinv(A), b)
print('w = ', w)
# Preparing the fitting line
w_0 = w[0][0]
w_1 = w[1][0]
x0 = np.linspace(145, 185, 2)
y0 = w_0 + w_1*x0

# Drawing the fitting line
plt.plot(X.T, y.T, 'ro')     # data
plt.plot(x0, y0)               # the fitting line
plt.axis([140, 190, 45, 75])
plt.xlabel('Height (cm)')
plt.ylabel('Weight (kg)')
plt.show()

w =  [[-33.73541021]
[  0.55920496]]
```



From the above graph, we can see that the red data points are quite close to the blue prediction line. So the Linear Regression model works well with the *training* data set. Now, we use this model to predict the weight of two people with heights of 155 and 160 cm which we did not use when calculating the solution.

```
y1 = w_1*155 + w_0
y2 = w_1*160 + w_0

print( u'Predict weight of person with height 155 cm: %.2f (kg), real number: 52 (kg)'  %(y1) )
print( u'Predict weight of person with height 160 cm: %.2f (kg), real number: 56 (kg)'  %(y2) )
Predict weight of person with height 155 cm: 52.94 (kg), real number: 52 (kg)
Predict weight of person with height 160 cm: 55.74 (kg), real number: 56 (kg)
```

We see that the predicted results are quite close to the actual data.

4.4. Solution using scikit-learn library

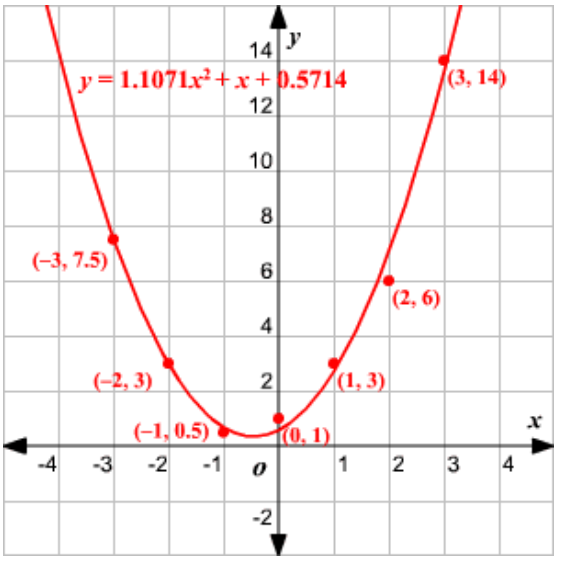
Next, we will use Python's scikit-learn library to find the solution.

```
from sklearn import datasets, linear_model

# fit the model by Linear Regression
regr = linear_model.LinearRegression(fit_intercept=False)  # fit_intercept = False for calculating the bias
regr.fit(Xbar, y)

# Compare two results
print( 'Solution found by scikit-learn  : ', regr.coef_ )
print( 'Solution found by (5): ', w.T)
Solution found by scikit-learn  :  [[ -33.73541021 0.55920496]]
Solution found by (5):  [[ -33.73541021 0.55920496 ]]
```

We see that the two results are the same! (*That means I did not make any mistake in finding the solution above*)



Jupyter Notebook source code for this post.

5. Discussion

5.1. Problems that can be solved by Linear Regression

Function $y \approx f(\boldsymbol{x}) = \boldsymbol{w}^T \boldsymbol{x}$ is a linear function of both $\boldsymbol{w}$ và $\boldsymbol{x}$. In fact, Linear Regression can be applied to models that only need to be linear in $\boldsymbol{w}$. For example:

$$\boldsymbol{y \approx w_1 x_1 + w_2 x_2 + w_3 x_1^2 + w_4 \sin(x_2) + w_5 x_1 x_2 + w_0}$$

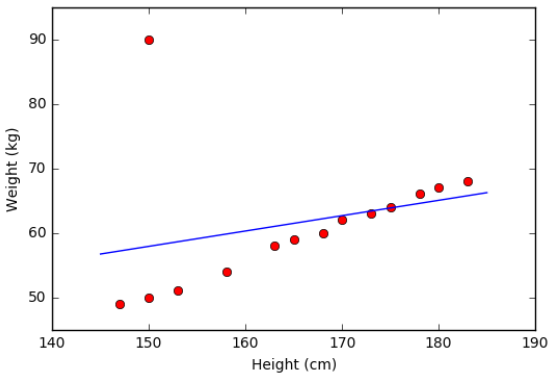
is a linear function of $\boldsymbol{w}$ and thus can also be solved using Linear Regression. For each input data $\boldsymbol{x} = [x_1; x_2]$, we calculate new data $\tilde{\boldsymbol{x}} = [x_1, x_2, x_1^2, sin(x_2), x_1 x_2]$ (pronounced *x tilde* in English) and then apply Linear Regression to this new data.

See more examples of Quadratic Regression .

Quadratic Regression (Source: Quadratic Regression)

5.2. Limitations of Linear Regression

The first limitation of Linear Regression is that it is very **sensitive to noise** . In the example of the relationship between height and weight above, if there is just one *noisy* data pair (150cm, 90kg), the result will be very different. See the figure below:



So, before performing Linear Regression, the noise (outliers) need to be removed. This step is called pre-processing.

The second limitation of Linear Regression is that it cannot represent complex models . Although in the above section we saw that this method can be applied if the relationship between the outcome and the input is not necessarily linear, this relationship is still much simpler than in real models. Furthermore, we will ask ourselves: how to determine the functions $(x_1^2, \sin(x_2), x_1 x_2)$ as above

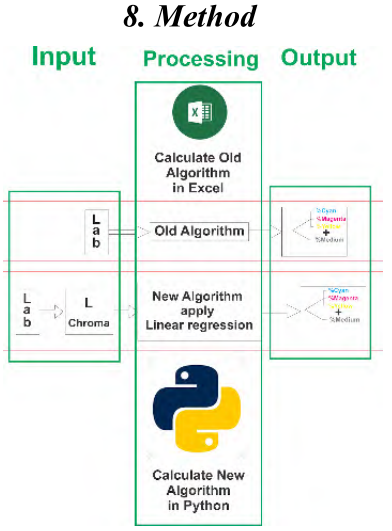
6. Background and related work

In this report, readers need to have knowledge about:
- Linear regression for Parapol
- Reported data have been studied (II)

7. Motivating Example

This report provides a more efficient algorithm than the old algorithm that was studied in the project (II), this is shown in detail in the evaluation section

8. Method



Method: Applicate Linear regression algorithm in expecting the percentage of colour element's weight based on the data set of L, a, b among Cyan, Magenta, Yellow, and Medium colours which is collected in previously studied research(II).

Tool Description: Calculating and visualization are shown by Python programming language instead of using Excellent in previously studied research (II).

9. Result

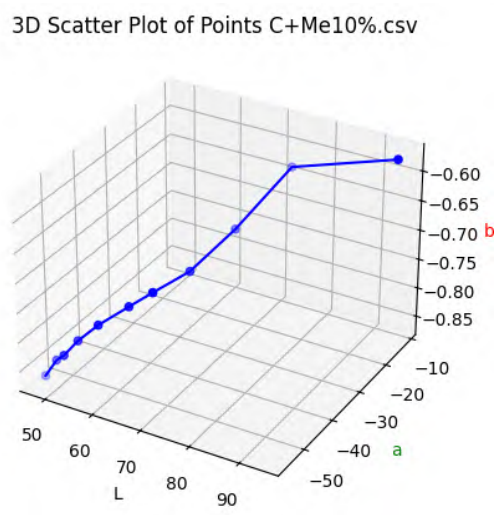
9.1.1 Cyan and Medium colour database

Table a1. The Cyan and Medium color blend data that was used as the database for a previous research project (II)

Cyan (%)	Medium (%)	L	a	b
100	0	48.02	-32.71	-55.6
90	10	49.39	-35.07	-54
80	20	50.71	-36.12	-53.6
70	30	52.19	-36.98	-51.3
60	40	54.97	-38.17	-48.9
50	50	58.94	-37.92	-45
40	60	62.25	-37.92	-42.3
30	70	66.5	-35.09	-36.7
20	80	71.28	-31.94	-29
10	90	77.11	-25.97	-19.2
0.1	99.9	84.3	-16.41	-11.6

* **Notes**: A row of L, a, b values represents a color blended by the ratio of Cyan and Medium at the corresponding row.

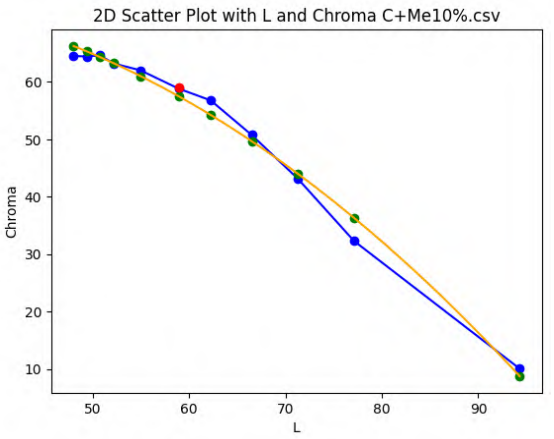
A 3D chart illustrates the L, a, b data for each color sample blended from Cyan and Medium according to table (a1).



9.1.2 Processing data using Linear Regression in Python

Simply put, the data can be presented as a chart of L and Chroma, with Chroma = sqrt (a*a + b*b).

Chart b1. The result is the yellow line representing the predicted outcome of the percentage ratio of Cyan and Medium after applying Linear Regression. (The L and Chroma chart according to the decreasing Medium ratio by 10%).



Explanation: The color data points from the database (green points) are simulated on the yellow linear regression curve. When a color, blended from Cyan and Medium (red points), is predicted, the result will correspond to a point on the aforementioned yellow curve.

9.1.2 Calculation results

Chart c1. Calculation results when testing Cyan and Medium mixed colors on the previous research project (2) and implemented in this report, with the Medium ratios being 15%, 35%, 55%, 75%, 95%, 58%, 72% respectively.

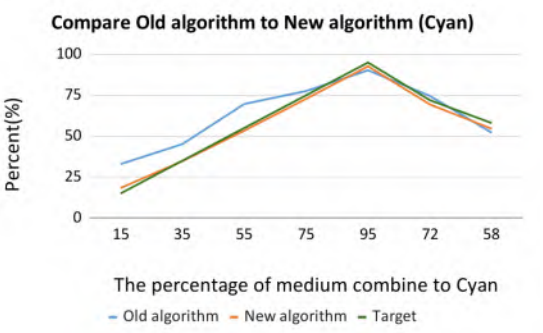
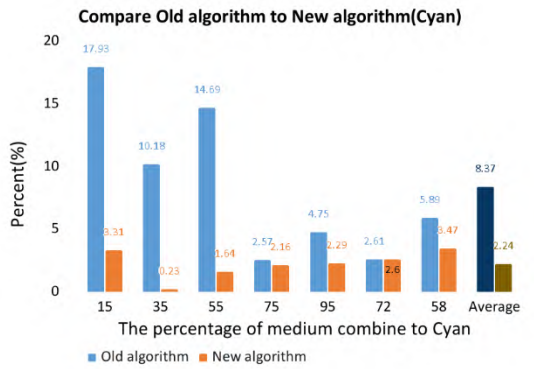


Chart d1. The percentage deviation in the ratio of Medium when testing the Cyan and Medium blends in the previous research project (II) and in this report, with the respective Medium ratios being 15%, 35%, 55%, 75%, 95%, 58%, and 72%.



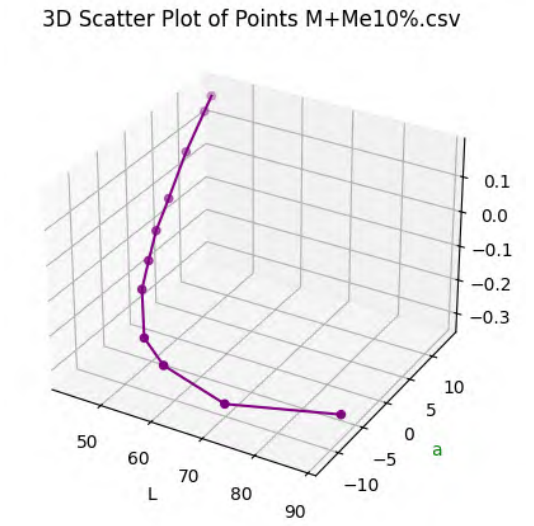
9.2.1 The Magenta and Medium color database

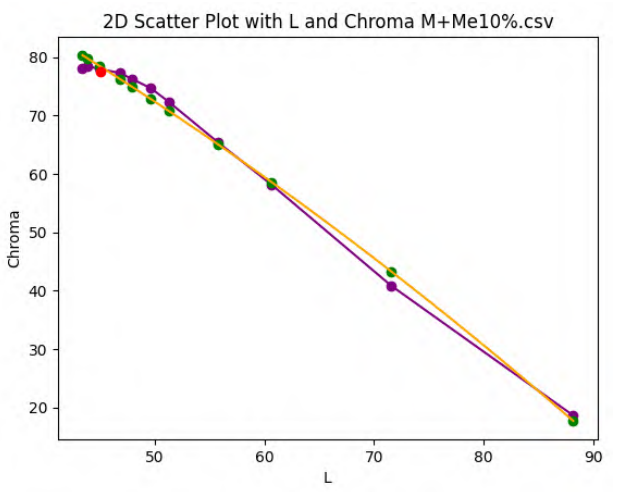
Table a2. The Magenta and Medium color blend data that was used as the database for a previous research project (II).

Magenta(%)	Medium(%)	L	a	b
100	0	43.39	76.98	13.52
90	10	43.8	77.6	11.72
80	20	44.91	77.69	6.97
70	30	46.8	77.28	1.75
60	40	47.94	76.23	-1.76
50	50	49.65	74.52	-4.81
40	60	51.25	71.98	-7.59
30	70	55.73	64.46	-11.42
20	80	60.66	56.79	-12.54
10	90	71.6	39.11	-11.72
0.1	99.9	88.19	17.65	-5.97

* Notes: A row of L, a, b values represents a color blended by the ratio of Magenta and Medium at the corresponding row.

A 3D chart illustrates the L, a, b data for each color sample blended from Cyan and Medium according to table (a2).





9.2.2 Processing data using Linear Regression in Python

Simply put, the data can be presented as a chart of L and Chroma, with Chroma = sqrt (a*a + b*b).

Chart b2. The result is the yellow line representing the predicted outcome of the percentage ratio of Magenta and Medium after applying Linear Regression. (The L and Chroma chart according to the decreasing Medium ratio by 10%).

Explanation: The color data points from the database (green points) are simulated on the yellow linear regression curve. When a color, blended from Cyan and Medium (red points), is predicted, the result will correspond to a point on the aforementioned yellow curve.

9.2.3 Calculation results

Chart c2. Calculation results when testing Magenta and Medium mixed colors on the previous research project (II) and implemented in this report, with the Medium ratios being 15%, 35%, 55%, 75%, 95%, respectively.

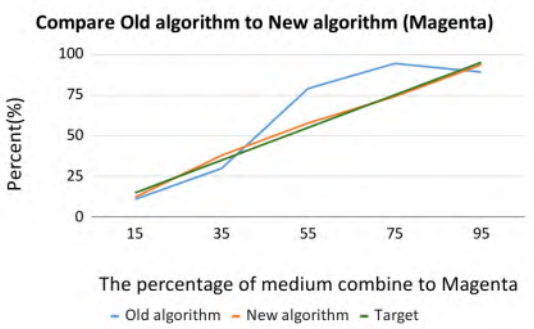
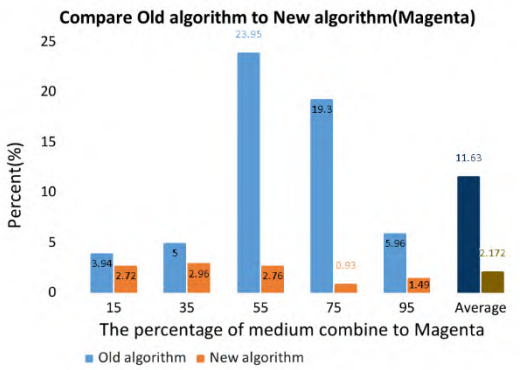


Chart d2. The percentage deviation in the ratio of Medium when testing the Cyan and Medium blends in the previous research project (II) and in this report, with the respective Medium ratios being 15%, 35%, 55%, 75%, 95%.



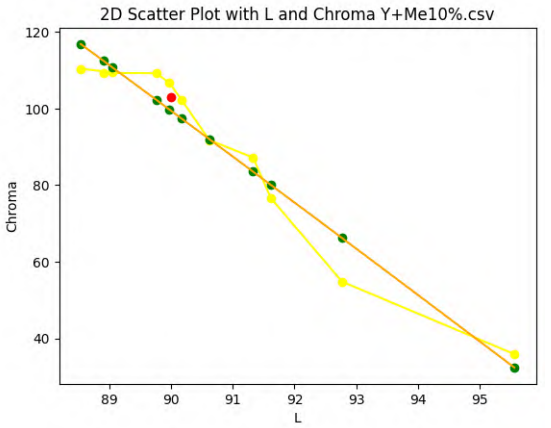
9.3.1 The Yellow and Medium color database

Table a3. The Yellow and Medium color blend data that was used as the database for a previous research project (II).

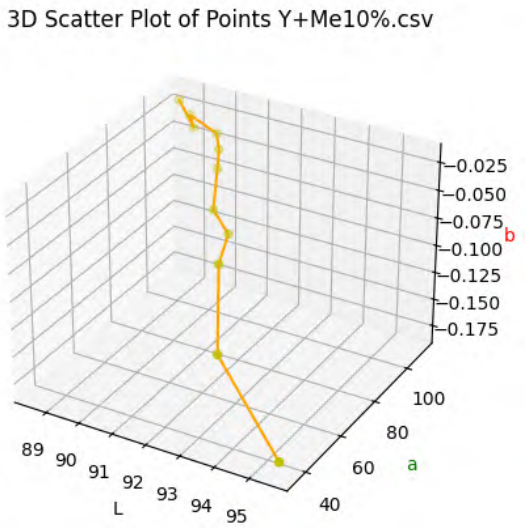
Yellow (%)	Medium (%)	L	a	b
100	0	88.54	-2.61	110.35
90	10	89.05	-3.87	109.21
80	20	88.91	-3.46	109.65
70	30	89.76	-4.4	109.23
60	40	89.97	-5.24	106.67
50	50	90.17	-6.22	102.13
40	60	90.62	-7.21	91.52
30	70	91.33	-7.7	86.85
20	80	91.62	-7.93	76.13
10	90	92.77	-7.67	54.27
0.1	99.9	95.56	-6.34	35.32

* Notes: A row of L, a, b values represents a color blended by the ratio of Yellow and Medium at the corresponding row.

3D chart illustrates the L, a, b data for each color sample blended from Yellow and Medium according to table (a3).



9.3.2 Processing data using Linear Regression in Python



Simply put, the data can be presented as a chart of L and Chroma, with Chroma = sqrt (a*a+ b*b).

Chart b3. The result is the yellow line representing the predicted outcome of the percentage ratio of Yellow and Medium after applying Linear Regression. (The L and Chroma chart according to the decreasing Medium ratio by 10%).

Explanation: The color data points from the database (green points) are simulated on the yellow linear regression curve. When a color, blended from Cyan and Medium (red points), is predicted, the result will correspond to a point on the aforementioned yellow curve.

9.3.2 Calculation results

Chart c3. Calculation results when testing Yellow and Medium mixed colors on the previous research project (II) and implemented in this report, with the Medium ratios being 15%, 35%, 55%, 75%, 95%, respectively.

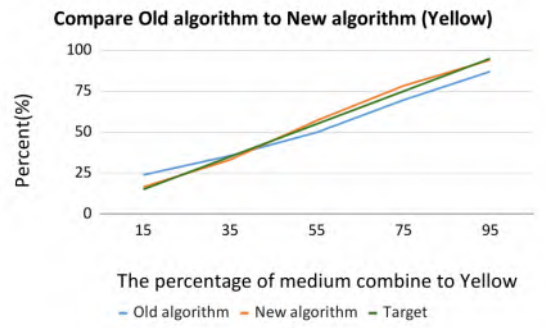
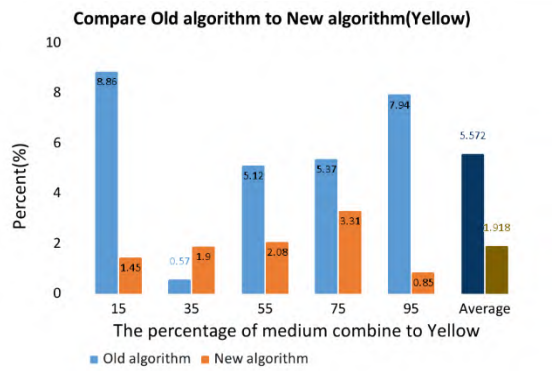


Chart d3. The percentage deviation in the ratio of Medium when testing the Yellow and Medium blends in the previous research project (II) and in this report, with the respective Medium ratios being 15%, 35%, 55%, 75%, 95%.



10. Evaluation

As regards the c1, c2, and c3 charts, the lines illustrate that the new output values(New Algorithm) are significantly near the value targets compared to the previously studied research(II). To be specific, from the d1, d2, and d3 charts, the average values of component colour ratio deviations for the tests are smaller lots times than the average values of component colour ratio deviations for the tests in previously studied research.

Moreover, comparing the proportion of the target Medium colour's weight, the average deviations of the proportion of the expected Medium colour's weight in tests (Cyan, Magenta, Yellow, Medium) are stable and slightly fluctuate (between 1,98% and 2,2%).

11. Conclusion

This report discussed the application of linear regression to calculate ink mixing based on L, a, b values.

Furthermore, a comparison was given to check the effectiveness between the old algorithm and the new algorithm.

The result indicated that the output of the new algorithm was more effective than the old one in tests (Cyan and Medium colour, Magenta and Medium colour, Yellow and Medium colour).

12. Reference

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Development of colorimetry and its application in offset printing quality control

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Abstract

In this study, the research team designed and manufactured a tristimulus colorimeter. The measuring head and optical system models were designed and simulated on a 3D platform for easy observation and adjustment before manufacturing. The processing unit was designed with a PIC32MX460F512L microprocessor. Color measurements were performed under standard light source D65 from Nichia - Japan and a color sensor from TAOS. The research focused on processing and applying results to the quality management of printed products.

INTRODUCTION

Color is a measure used to evaluate the quality of products in textiles, paints, printed products, plastic surfaces, etc. The perception of a certain color by eyes depends on the subjective factor of each observer. Therefore, there needs to be a common standard and a device that can "read" any color accurately. Besides, measurement plays an important role in all fields of science and technology. Color measurement is becoming an indispensable part of quality control systems and modern printing companies.[1]

In Vietnam, although the application of color-measuring devices in technology fields is very popular. But the manufacturing is still not given much attention. Almost all color measuring devices used in our country up to now are imported from abroad at high cost. Therefore, it is necessary to research and manufacture a domestic color-measuring device with low cost and high accuracy.[1]

When designing a colorimeter, determining a calibration method for the device to give us highly accurate results is important. There are many methods for calibrating the device such as the matrix method published by ASTM (American Society for Testing and Material) and artificial neural networks. In this study, the research team will present the process of designing and manufacturing a tristimulus colorimeter and the standardization method to increase the accuracy of color measurement.[2], [6].

METHODOLOGY

Principle of colorimeter

The tristimulus colorimeter senses color according to the same mechanism as the human eye.

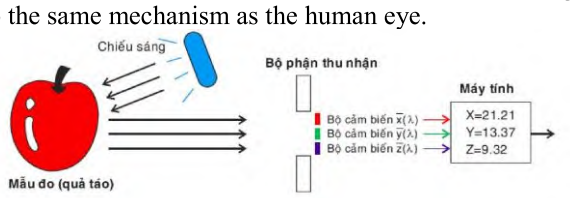


Figure 1. Operating principle of the colorimeter

In this study, the research team selected and used the TCS3200D sensor, a type of color sensor from TAOS, which is composed of silicon photodiodes combined with Red, Green, and Blue filters and simultaneously converts the intensity of these lights to corresponding frequencies and all are integrated on a single chip.

The TCS3200D consists of 8 x 8 photodiodes divided into 4 groups with a total of 16 photodiodes for each group and corresponding to them are 16 Red light filtering photodiodes, 16 Green light filtering photodiodes, 16 Blue light filtering photodiodes and 16 non-filtered photodiodes. The four types of photodiodes are interwoven to minimize the effects of non-uniformity of the incident radiation beam. All 16 photodiodes of the same type are connected similarly. According to color theory, a color can be described by the 3 parameters of the 3 primary colors that combine to create that color. Thus, from the 3 frequency values of the 3 colors Red, Green, and Blue that the sensor reads, we can determine the color we need to measure.

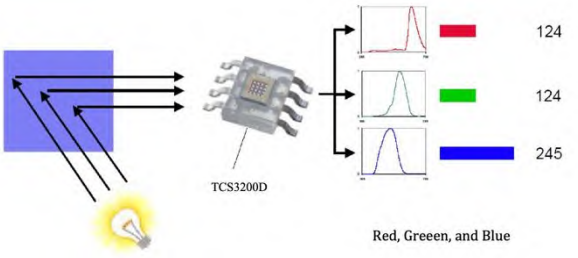


Figure 2. The recognition process of the TCS3200D

Standard light source of the colorimeter

With 3 main factors affect the perception of color: the spectral power density (SPD) of the light source, the reflectance spectrum, and the color synthesis function CMFs.

To adapt to printing production, the colorimeter must be standardized and calibrated to the needs of printers. In addition to calculating the most accurate design, using the criteria recommended by the International Illumination Commission CIE is very necessary. One of the factors that greatly affects the measurement results is the light source. Therefore, in the process of manufacturing the KH-01 colorimeter, the research team chose the D65 light source as the light source with the highest color rendering.

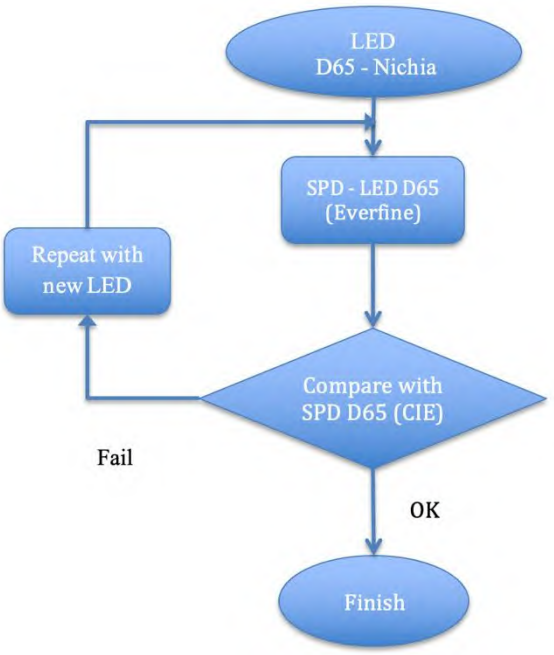


Figure 3. Procedure for selecting D65 light source

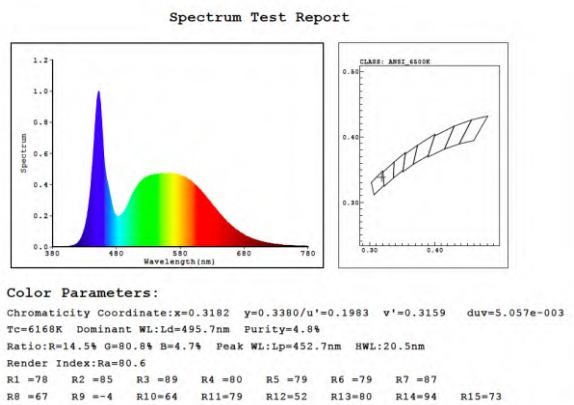


Figure 4. Energy distribution of light source D65 (Measured by Everfine system at Dien Quang Company – Ho Chi Minh City High-Tech Park)

Colorimeter design

The KH01 colorimeter is designed with 2 parts: a measuring head and a result processing unit.

Colorimeter measuring head design: The measuring head of the colorimeter is designed as shown in Figure 5 including the lens system (1), light source holder (2), measuring point position (3), and other parts.

Lens system (1): consists of 2 lenses placed parallel in a metal tube and 10mm apart, with the task of limiting the light beam reflected from the object surface within a radius of 1.5mm and converging at the color sensor position.

Light source holder (2): is designed with 6 LED light mounting positions (3 LED lights of standard light source D65 and 3 incandescent lights of light source A). The illumination angle of the 2 light sources A and D65 is designed to be 450 compared to the direction of the reflected light beam.

Measuring point position (3): is designed with a sample surface area with a radius of 1.5mm.

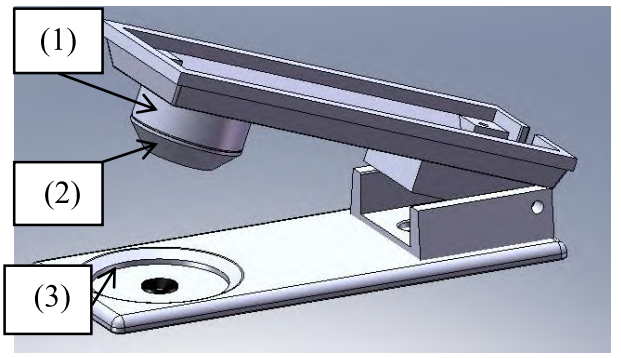


Figure 5. Design model 3D of KH01

With the design of the measuring head, the KH01 colorimeter manufactured by the research team will receive the light beam reflected from the material surface through the lens to the Red, Green, and Blue color filters. The received value is the frequency corresponding to the Red, Green, and Blue color filters. This value will be input into the PIC32MX460F512L microprocessor and processed.

Figure 6. Unit processing board

Figure 7. Phase 2 finished colorimeter

RESULT AND DISCUSSION

Processing results

By design, the KH-01 colorimeter will filter the reflected spectrum from the sample to only allow the three colors Red, Green, and Blue to pass through. At the same time, it will convert the intensity of each color to the corresponding frequency. Therefore, we need to convert these frequency values to the basic color values R G B. From there, we can convert to other color spaces XYZ, L*a*b*....

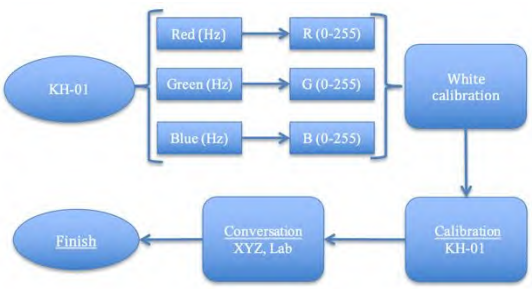


Figure 8. Calibration process of KH01 colorimeter

Define the conversion matrix from frequency to RGB value

To convert, we base the conversion between color spaces as linear transformations.

To find the conversion matrix from frequency to RGB, the research team used the SpectroEye colorimeter and the KH-01 colorimeter to measure a set of colors including 3 basic printing colors Cyan, Magenta, and Yellow.

We have: T.A=B

With: T is a conversion matrix in the form (3x3)

A is a (3x3) matrix with the components of the matrix being the color frequency values of the sample measured by the KH-01 meter.

$$A = \begin{pmatrix} R_{M_{VL05}} & R_{N_{VL05}} & R_{P_{VL05}} \\ G_{M_{VL05}} & G_{N_{VL05}} & G_{P_{VL05}} \\ B_{M_{VL05}} & B_{N_{VL05}} & B_{P_{VL05}} \end{pmatrix}$$

B is a (3x3) matrix with the components of the matrix being the R, G, and B values of the 3 sample colors measured by the SpectroEye.

$$B = \begin{pmatrix} R_M & R_N & R_P \\ G_M & G_N & G_P \\ B_M & B_N & B_P \end{pmatrix}$$

The values of the components of the A, and B matrices are shown in the following table:

Table 1. ***Sample colors measured by the xRite-eXact and KH-01clorimeter***

Sample	xRite-eXact			KH-01		
	R	**G**	**B**	**R**	**G**	**B**
Cyan	0	212.68	249.7	18.76	89.08	160.02
Magenta	214.36	1.18	223.39	172.25	31.8	64.79
Yellow	247.42	118.32	0	244.55	156.26	88.21

Using Matlab to find the matrix:

$$T \square \begin{pmatrix} 1.2299 & \square 0.0.4645 & 0.1552 \\ \square 0.2885 & 1.7121 & \square 0.1477 \\ 0.1631 & \square 1.2581 & 2.1822 \end{pmatrix}$$

After converting from frequency to R G B, the research team used the KH-01 meter to measure the standard white color.

The values of the sample colors measured by the KH-01 are:

Table 2. R G B value results of KH-01 meter after white calibration

Color	R	G	B
P48-7-C (Pantone Solid Coated)	237.187	12.645	69.247
P149-6-C (Pantone Solid Coated)	29.707	64.856	3.212
P107-7-C (Pantone Solid Coated)	13.089	37.244	77.897
Cyan	3.219	125.782	208.180
Magenta	236.894	0.623	113.706
Yellow	249.167	187.115	1.208
Black	1.705	2.183	2.583
White	253.375	252.713	253.420

To convert the color values measured by the KH-01 colorimeter from RGB to XYZ, we use a linear transformation. The transformation matrix is determined based on the values measured by the KH-01 colorimeter with the values measured by the xRite-eXact colorimeter on the same color set. Here we also use the xRite-eXact colorimeter and the process is performed in the research team's laboratory.

Table 3. Measurement values by KH01 and xRite-eXact

Color	KH-01			xRite-eXact		
	R2	G2	B2	X	Y	Z
Red	138.18	49.02	70.70	30.186	16.407	3.155
Green	42.02	58.29	25.09	11.134	22.448	6.527
Blue	35.63	34.36	56.62	6.828	5.346	15.340
Cyan	2.01	156.03	213.79	17.730	24.444	69.004
Magenta	211.02	1.12	119.11	30.650	15.439	18.605
Yellow	239.94	220.24	2.06	65.266	73.005	9.601
Black	2.295	4.645	6.626	1.881	2.795	2.108
White	253.55	255	255	85.24	88.568	69.937
Màu 1	181.61	91.14	122.73	46.676	35.809	21.287
Màu2	52.49	59.53	130.11	16.514	20.055	36.921

Calculated by Matlab, the transformation matrix A is obtained as follows:

$$A = \begin{bmatrix} 0.2435 & 0.1632 & -0.1134 \\ 0.0444 & 0.4456 & -0.1598 \\ -0.1235 & 0.1044 & 0.2459 \end{bmatrix}$$

Calibrate the KH-01 colorimeter

Because the KH-01 colorimeter is designed and manufactured according to standard conditions of light source and measurement angle, to calibrate the KH-01 colorimeter, the research team chose 3 colors Cyan, Magenta, and Yellow in Pantone Solid Coated. The color codes the research team chose to calibrate the KH-01 colorimeter.

Table 4. XYZ value results of KH-01 and xRite

Color	X_{KH-01}	Y_{KH-01}	Z_{KH-01}	X_{xRite}	Y_{xRite}	Z_{xRite}
Cyan	18.730	26.323	71.02	17.730	24.444	69.004
Magenta	29.650	14.392	19.208	30.650	15.439	18.605
Yellow	63.106	77.01	10.62	65.266	73.005	9.601

Calculating the matrix, we get the calibration matrix of the KH-01 colorimeter:

$$T = \begin{pmatrix} 0.1119 & 1.4639 & 0.6777 \\ -3.0261 & 1.97 & -0.0469 \\ -1.744 & 1.6033 & 0.1164 \end{pmatrix}$$

After calibrating the KH-01 colorimeter, the research team tested the meter by selecting several colors according to table 5. The selected colors include the basic colors Red, Green, and Blue, the color group in the Maxilite paint color chart, and some Pantone Solid Coated colors.

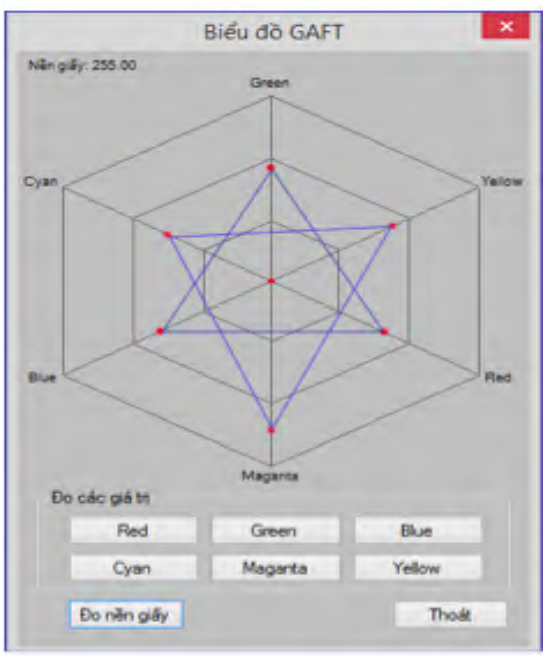
Table 5. Color difference between KH-01 and xRite-eXact

Color	L^*_{KH-01}	a^*_{KH-01}	b^*_{KH-01}	L^*_{xRite}	a^*_{xRite}	b^*_{xRite}	DeltaE
Red	41.01	62.8	65.95	41.47	63.41	64.85	1.34
Green	32.1	-69.44	33.09	32.02	-68.32	33.98	1.43
Blue	8.67	35.32	-47.65	8.71	34.97	-49.73	2.11
BG0022	80.9	-9.39	-11.6	82.69	-8.14	-10.88	2.30
Blue Gem 21391	65.85	-2.13	-15.42	64.53	-1.1	-15.3	1.68
Vintage Violet 71357	79.65	13.16	-8.3	80.02	12.55	-7.09	1.40
Iced Pink 74037	88.46	10.05	6.9	89.11	9.55	6.08	1.16
P4812C Pantone Solid Coated	52.48	43.82	42.83	53.41	42.73	41.76	1.79
P4811C Pantone Solid Coated	54.32	43.73	43.22	53.31	42.92	41.77	1.94
P114-12-C Pantone Solid Coated	53.7	-4.03	-19.11	52.79	-5.98	-18.12	2.37
White	93.38	-1.82	-0.41	92.71	-0.1	-0.38	1.85

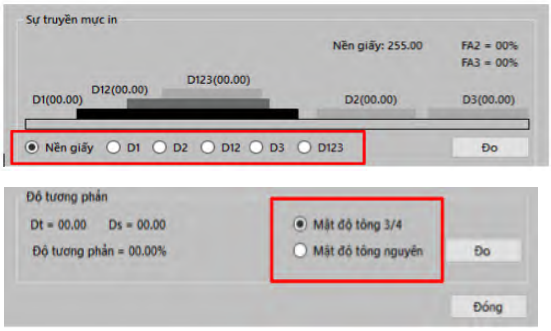
We can see that the DeltaE color difference value between the KH-01 colorimeter and the xRite-eXact colorimeter is less than 2.5. This proves that the KH-01 colorimeter has high accuracy.

Connect KH01 and software to control printing quality

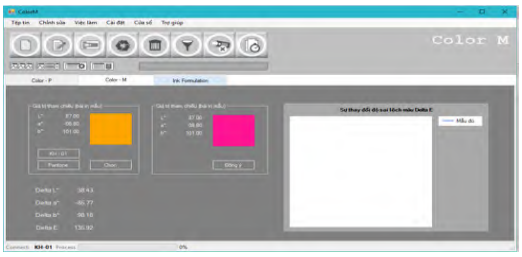
With the Color-M software designed by the research team, printing quality can be controlled in each ink area. And color libraries of Pantone Pallet 2021 were integrated into it. Some key features of the software:



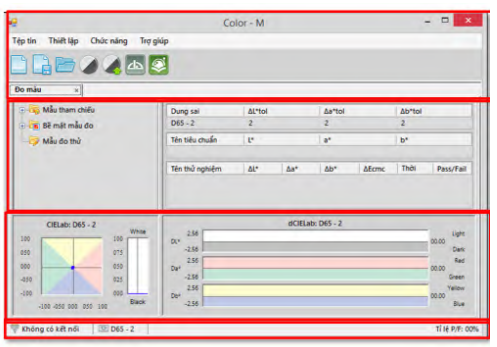
Measure and draw the GAFT graph



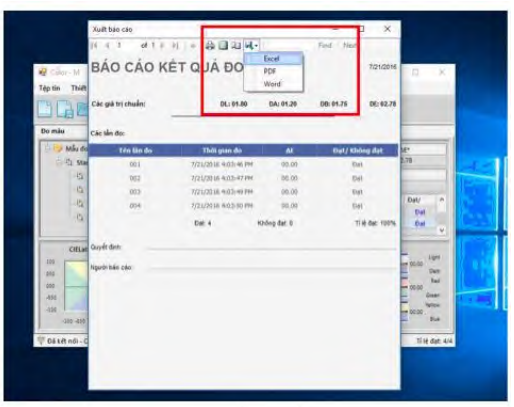
Ink trapping, SID, Trame



Lab and Delta E



Color managerment interface



Export statistical reports

CONCLUSION

The research team has successfully manufactured the KH01 - tristimulus colorimeter and the Color-M software for printed product quality management with the following characteristics:

- The KH-01 colorimeter is designed to operate with a user-friendly touchscreen interface.
- Successfully manufactured the KH-01 colorimeter according to the design, light source, and viewing angle according to CIE standards. The KH-01 colorimeter has the function of measuring color and density. The measurement results are displayed on the GLCD screen and the computer with the Color-M software installed.
- The Color-M software combined with the colorimeter can be applied to control the quality of printed sheets for offset printing machine up to 8 printing units.
- This research result opens up the possibility of designing a compact, low-cost, highly accurate colorimeter domestically to replace expensive imported products.

With the results achieved from the research and manufacturing of the KH01 colorimeter combined with a survey of actual needs, the research team expects that KH01 colorimeter will be widely popular and contribute a small part to the development of the domestic machine manufacturing industry.

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Polypyrrole-ZrO_2 hybrid synthesis and adaptability to the olfactory sensor

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Abstract

We have prepared organic conducting particles which utilize polypyrrole as conducting parts and small ZrO_2 particles as dispersants. The polypyrrole-ZrO_2 nano ink successfully achieved stable colloidal dispersion of polypyrrole in water, which usually aggregate in aqueous liquids. The polypyrrole-ZrO_2 exhibited up to a conductivity of 2.3 S/cm. Applying the polypyrrole-ZrO_2 to an olfactory receptor chip, we measured the resistance during ammonia injection as an odorant, in order to explore its potential as an olfactory sensor.

Introduction

There has been increasing interest in conducting inks for the direct printing of conductive patterns using inkjet systems in the field of printed electronics. In general, these conducting inks are made from metal nanoparticles such as silver and copper. On the other hand, there has been increasing expectations for utilizing conducting inks in the field of biological applications[1]. When considering the application of conducting inks in biological fields, organic inks are preferable relative to metallic inks. Therefore, we have investigated the organic materials which play roles as conducting inks. One of the answers to obtain organic conducting inks is to utilize conducting polymers.

However, conducting polymers are usually insoluble and infusible due to their stiff structure and conjugated backbones. This poor processability must be a major problem which has prevented these materials from acting as inks. A useful approach to overcome the lack of processability of conducting polymers and to make them act as inks is to prepare colloidal dispersions of conducting polymer particles which are described in former paper[2].

In our works, we use polypyrrole as conducting polymer because it is one of non-toxic organic materials. We reported the application of nanocomposite particles of polypyrrole and silica (SiO_2) in the field of electronic papers. In this approach, the SiO_2 particles act as dispersant due to the high surface area for the precipitating polypyrrole (Fig.1). The potential of PPy-SiO_2 particles was demonstrated using conventional inkjet device. However, their solid-state pressed pellet conductivities are consistently lower by 1-3 orders of magnitude relative to bulk polypyrrole powders prepared under the same conditions.

Therefore, recently, we report the result[3] that indium tin oxide (ITO) is used instead of SiO_2 because ITO exhibits much higher conductivity relative to SiO_2. It is well-known that ITO is an electrical conductor while SiO_2 is insulator. However, recently, there has been concerned about the toxicity of indium[4] in ITO.

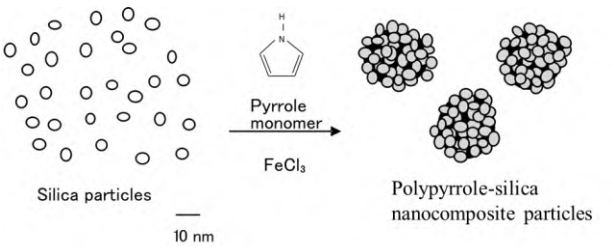

Fig. 1 Schematic diagram showing formation of polypyrrole-SiO_2 particles from the original small SiO_2 particles.

In the present work, we report the result that Zirconia (ZrO_2) is used instead of SiO_2 and ITO because ZrO_2 exhibits higher conductivity relative to SiO_2 in a high temperature and it is known as one of biocompatible materials.

In this study, we examined the application of conducting ink using polypyrrole, focused on “odor sensors” as a potential application. An odor sensor is a device that detects odor molecules in the air and identifies the odor from the sensor response. It is attracting attention as a sensor technology that rivals the sense of smell. However, the sense of smell is easily affected by environmental conditions and individual subjectivity, and it is difficult to quantify. For this reason, the development of highly versatile odor sensors and technologies that can detect specific gases with high selectivity is an issue. Therefore, we have adopted polypyrrole, which has a high response speed and sensitivity to gases and chemicals, as the base material for the odor sensor. The excellent characteristics of polypyrrole-based gas sensors include their sensitivity to ammonia, response speed, and reproducibility[6]. Odor molecules are detected by

detecting changes in electrical resistance when odor molecules are adsorbed on polypyrrole. In our laboratory, we are investigating the possibility of applying polypyrrole-ZrO_2 which are hybrid materials composed of polypyrrole and inorganic fine particles, as odor sensors. In this research, we used an olfactory receptor chip evaluation system (Fig.2). In this system, polypyrole-ZrO_2 were used as receptor chips (Fig.3), and the materials were bonded to the chips using polyvinylpyrrolidone (PVP).

We report on the results of measurements in which odor components containing ammonia gas and having amine groups were introduced into an odor sensor, and the conductivity changes due to the adsorption of the odor by polypyrrole-ZrO_2 were obtained as signals from the odor sensor.

Fig. 2 Olfactory receptor chip evaluation system

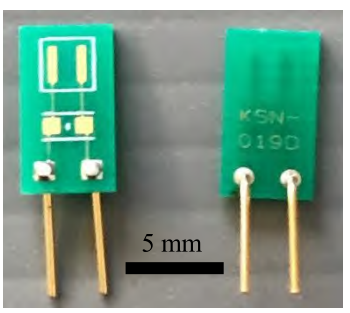

Fig. 3 Receptor chip

Experimental

Preparation of polypyrrole-ZrO_2 conducting inks

A typical Polypyrrole-ZrO_2 conducting ink was prepared as follows. A ZrO_2 dispersion (20 wt%, 1.25–25 ml) was added to the $FeCl_3$ solution (4.55 g) in de-ionized water at 25 °C with constant stirring. The total volume of the solution was maintained at 50 ml. Pyrrole (0.5 mL) was then injected into the stirred solution via a syringe. The solution turned black within a minute. The resulting black dispersions were centrifuged at 16500 rpm for 30 min using an ASONE AS165W instrument, and the resulting black precipitate was redispersed in de-ionized water using an ultrasonic bath. The supernatant was carefully decanted and discarded. The black precipitate was then redispersed in water. This cycle of centrifugation-redispersion was repeated three times until the color of the supernatant solution became clear, ensuring the removal of excess and soluble by-products (such as unreacted monomers and excess oxidants).

Application of conducting ink to odor sensors

0.05 g of polypyrrole-ZrO_2 (sample no.3) was mixed with 0.03 g of PVP and 0.1 mL of purified water. Tche mixture was placed on a syringe receptacle tip and spread using a spin coater (rotation speed 2000 rpm, 20 seconds). The resistance was measured using a resistance meter (HIOKI RM3544).

The olfactory receptor chip evaluation system detects changes in smell by dividing resistance (Fig.4). The input voltage is 10V, and R1 in the device is a variable resistor (0 kΩ to 10 kΩ). The one applied to the receptor chip in the photo at the bottom right is R2.

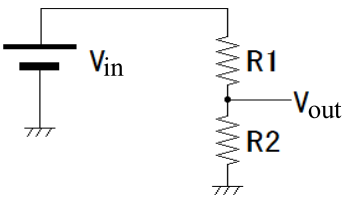

Fig. 4 Dividing resistance

The receptor substrate was then inserted into an olfactory receptor chip evaluation system for testing. After applying odor components, measurements were conducted with 60 seconds for odor adsorption and 120 seconds for odor desorption. The target odor components included ammonia, trimethylamine, triethylamine, and tri-n-butylamine. Specifically, a 25% ammonia solution (Fig.5), a 30% trimethylamine solution(Fig.5), a 99% pure triethylamine(Fig.5), and a 98% pure tri-n-butylamine were used(Fig.5), each in a volume of 0.5 mL, and the measurements were performed accordingly.

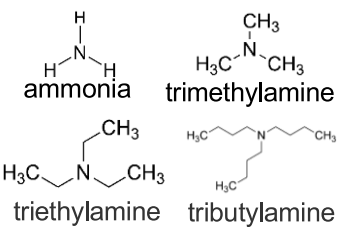

Fig. 5 Structural formula

Result&Discussion

Colloidal state, particle size, conductivity and zeta potential of polypyrrole-ZrO_2

For the colloidal state of polypyrrole ZrO_2 to become a dispersed state, an initial ZrO_2 concentration of at least 1.0 w/v% is required for 50 g of water and 0.5 mL of pyrrole. When the initial ZrO_2 concentration was less than 1.0 w/v%, a precipitate could be seen with the naked eye. In these systems, a small amount of precipitation was observed after storage for a certain period (more than one week), but it was confirmed that the dispersion was easily reformed by shaking the container slightly. This is thought to be because the pyrrole monomer cannot hybrid with ZrO_2 in the dispersion with a low ZrO_2 concentration, and it is polymerized independently as polypyrrole. When the initial concentration of ZrO_2 increased from 1.0 w/v% to 10.0

Table 1 Evaluation of the colloidal properties and conductivity of polypyrrole dispersions according to ZrO_2 concentration

Sample no.	Initial ZrO_2 oxides concentration (w/v%)	Colloid formation	Average particle size (nm)	Zeta Potential (mV)	Polypyrrole content (%)	Conductivity (S/cm)
1	0	No	-	-	100	1.4
2	0.5	No	-	-	-	-
3	1	Yes	518±362	27.1	46	2.3
4	5	Yes	297±196	41.2	16	2.2
5	10	Yes	258±145	42.0	14	0.14

w/v%, the average particle size of the dispersion changed from 500 nm to 300 nm (sample no. 1-5). The stable colloidal formation of polypyrrole-ZrO_2 is due to the decrease in the relative ratio of pyrrole caused by the high concentration of ZrO_2. As the concentration of ZrO_2 in the reaction mixture increases, the size distribution of polypyrrole-ZrO_2 becomes narrower. The ratio of nitrogen atoms to carbon atoms (N/C ratio) As such, the elemental analysis data for CHNS/O confirmed that the poly-pyrrole-ZrO_2 is mainly poly-pyrrole. In the synthesis of polypyrrole-ZrO_2, it was confirmed that the content of polypyrrole decreased moderately from 46% to 14% when the initial ZrO_2 concentration was increased from 1.0 w/v% to 10.0 w/v% (Table 1). The zeta potential of polypyrrole-ZrO_2 ranged from 27.1 mV to 42.0 mV. It was observed that polypyrrole-ZrO_2 takes on a positive surface charge in aqueous media at pH 7, depending on the ZrO_2 composition ratio. Generally, when the zeta potential is ±25 mV or more, the dispersibility is stable[5], so it can be said that polypyrrole-ZrO_2 is in a dispersed state in terms of zeta potential. There are two general methods of preventing particle aggregation: electrostatic stabilization and steric stabilization. Polypyrrole-ZrO_2 has a positive or negative surface charge on each colloidal particle, and a diffusion layer with the opposite charge spreads out in the solution. The interaction between these diffusions layers is energetically unfavorable, causing interaction between two approaching particles. Since the zeta potential of polypyrrole-ZrO_2 is greater than 25 mV, it is thought that the dispersion is stabilized electrically in the same way as the original ZrO_2 particles. Conductivity measurements were performed on pellets made from polypyrrole-ZrO_2 under a pressure of 64 MPa. The pressed pellets were used for measurement without additional heat treatment. As shown in Table 1, when the polypyrrole content of polypyrrole-ZrO_2 was 46%, the electrical conductivity of polypyrrole-ZrO_2 was 2.3 Scm^{-1}, which was equivalent to that of polypyrrole.

Applying and resistance measurements of polypyrrole-ZrO_2

Fig.5 shows the results of applying PPy-ZrO_2 (sample no. 3) to the receptor tip. From the results of Fig.6, the resistance value of PPy-ZrO_2 1% was 0.7 kΩ.

Odor Measurement

The results of the measurements taken by applying PPy-ZrO_2 (sample no.3) to the receptor chip and inserting it into the olfactory receptor evaluation system are shown in Fig.7 to Fig.11. From the results in Fig.8, when ammonia, which is an odor component, was injected, a peak was observed around 65 seconds, when odor desorption began. Similarly, peaks were also observed for trimethylamine and triethylamine. However, no change in resistance was observed for tri-n-butylamine.

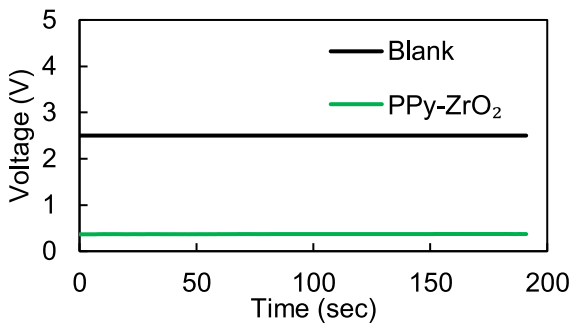

Fig. 7 Before odor injection

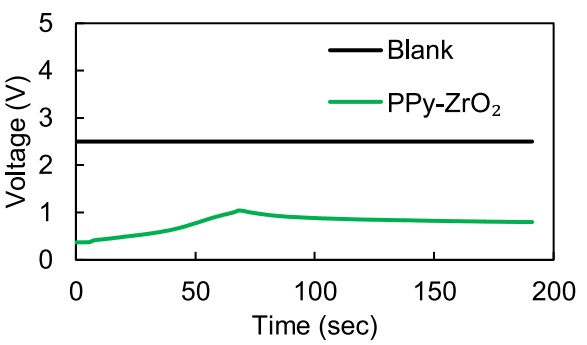

Fig. 8 After injection of ammonia

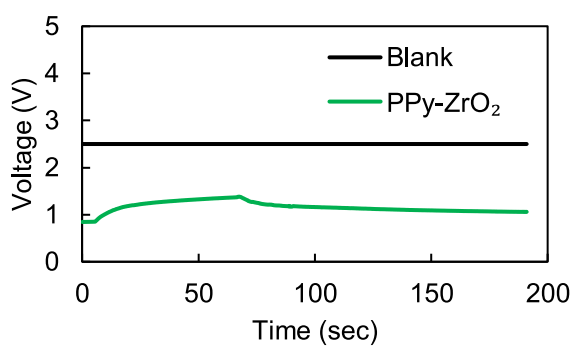

Fig. 9 After injection of trimethylamine

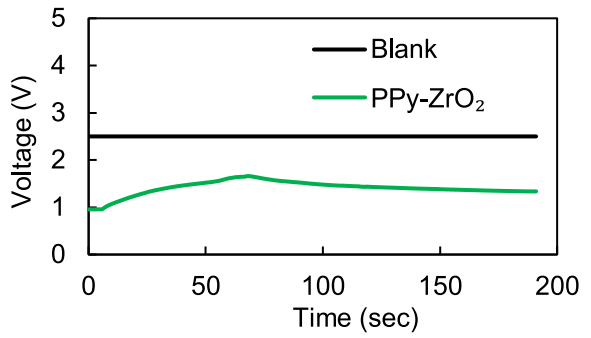

Fig. 10 After injection of triethylamine

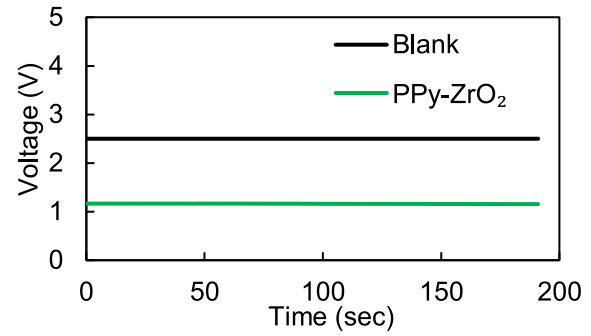

Fig. 11 After injection of tributylamine

The characteristics of the three odor components that could be measured using polypyrrole-ZrO_2 were thought to be that they were amine groups and had low molecular weights. The reaction between the amine group and the polypyrrole-ZrO_2 is thought to be due to the nucleophilicity of the amine group. It is suggested that the reaction occurred because the amine group has high nucleophilicity and affects the conductivity by changing the chemical bonds of the polypyrrole. In addition, it is suggested that the three odor components adsorb to the polypyrrole surface due to their small molecular weight. On the other hand, the reason that tri-n-butylamine, which contains an amine group, did not react is thought to be because the molecular chain is long, and the steric hindrance is large, so it did not adsorb to the polypyrrole and did not react. If the odor component has an amine group and a short molecular chain, it is thought that the polypyrrole-ZrO_2 fine particles may react. It showed a high response to amine-based low-molecular-weight odor components such as ammonia, trimethylamine, and triethylamine, which is thought to be due to changes in conductivity caused by adsorption on the polypyrrole surface and changes in chemical bonding.

Conclusions

We have proposed a new and simple synthesis method for colloidal polypyrrole using ZrO_2, an inorganic oxide nanoparticle, as a dispersant. Polypyrrole-ZrO_2 can be used in a form that is workable, whereas polypyrrole is usually insoluble. Polypyrrole-ZrO_2 has the same conductivity as polypyrrole, and we have found that it has potential as a sensing element in an artificial olfactory system.

Acknowledgements

We would like to thank Dr. Yasuo Kato for his advice and support during this research.

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HCMC UNIVERSITY OF TECHNOLOGY AND EDUCATION
FACULTY OF GRAPHIC ARTS AND MEDIA

THE 14TH ASIAN SYMPOSIUM ON PRINTING TECHNOLOGY
Artificial Intelligence and Sustainable Printing: Trends and Challenges

Synthesis of ZnO nanoparticles-based fluorescent ink for information encryption and security applications

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Printing Material Lab, Faculty of Graphic Arts and Media
HCMC University of Technology and Education

Ho Chi Minh City, 19th December 2024

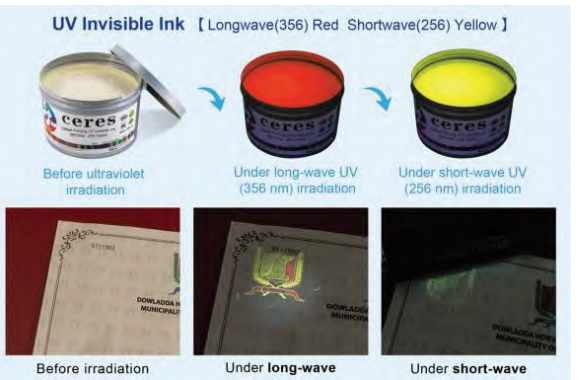
1. Introduction

Including:

- Optical Variable Ink
- UV Invisible Ink
- Temperature Sensitive Ink
- Photochromic ink
- Magnetic Ink
- Water Sensitive Ink
- Water Diffusion Ink
- Reflective Ink
- ……
- Security Paper

1. Introduction

Ex: UV Invisible Ink



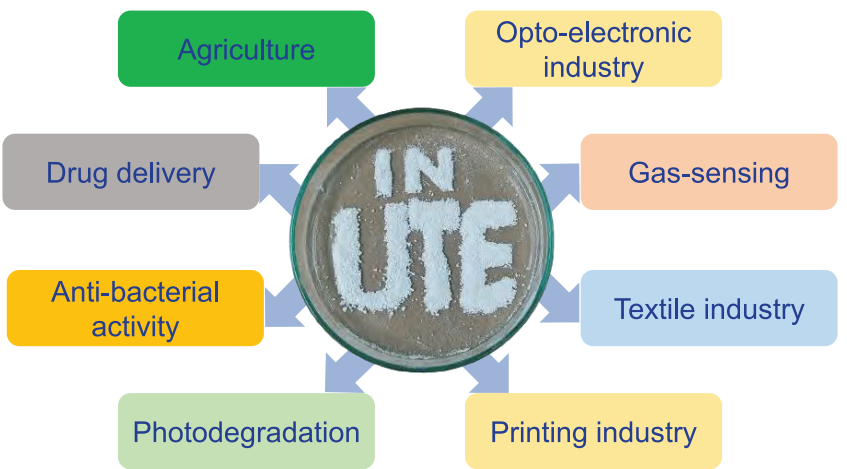
Printing method:
- Screen printing
- Offset printing
- Flexo printing
- And Ink-jet

Applications:
- Mainly used in currency, bills, cards, cosmetics lables, packaging, etc.

Innovation materials play an important role

1. Introduction

Application in many fields



ZnO nanostructure

Why?

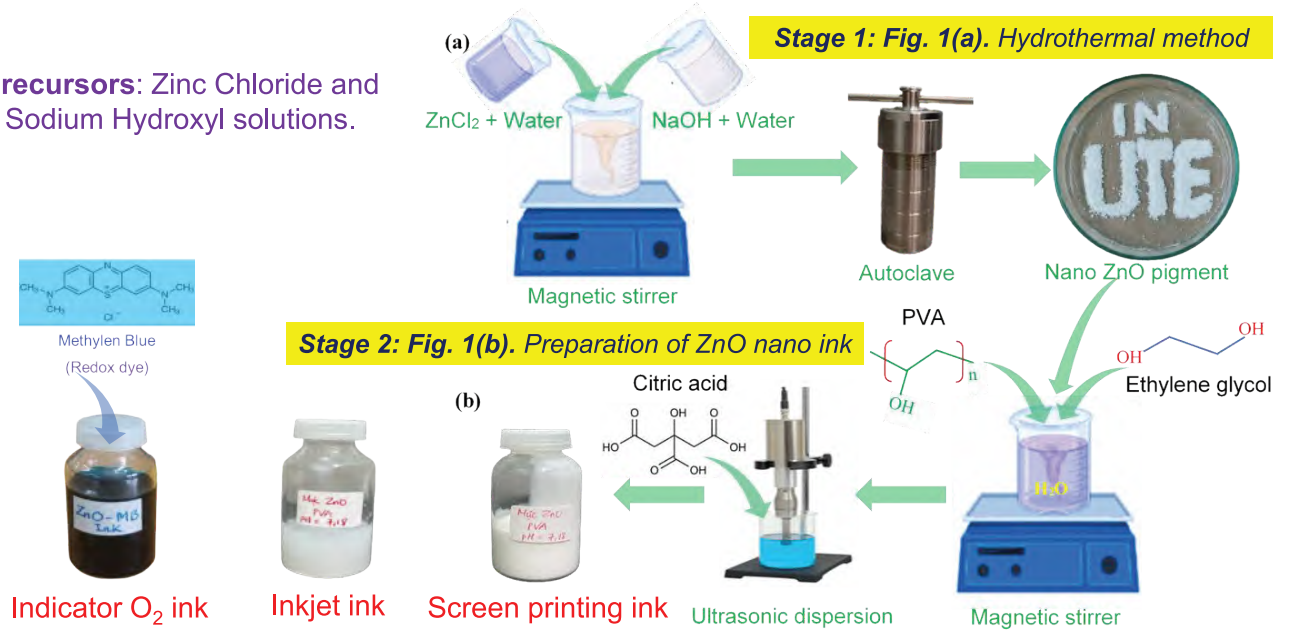
ZnO material:
- Non-toxicity,
- Eco-friendly materials
- High stability in room temperature.

What about applications in printing technology?

There are a few studies.

2. Experiment: *Synthesis of ZnO NPs & ZnO nano inks*

Precursors: Zinc Chloride and Sodium Hydroxyl solutions.



3. Results and discussion: *Structural and Optical properties*

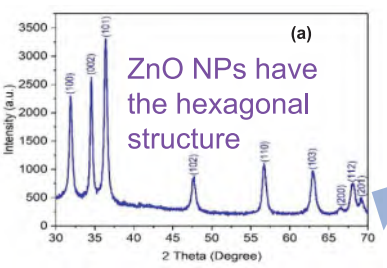


Fig. 2. XRD patterns of ZnO NPs

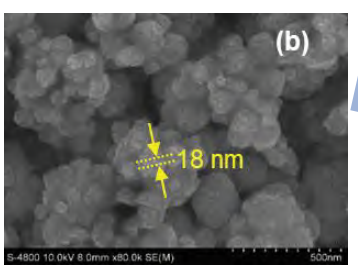


Fig. 3. SEM images of ZnO NPs

ZnO nano pigment

- Origin of the emissions is due to vacancy of Zn and Oxygen.

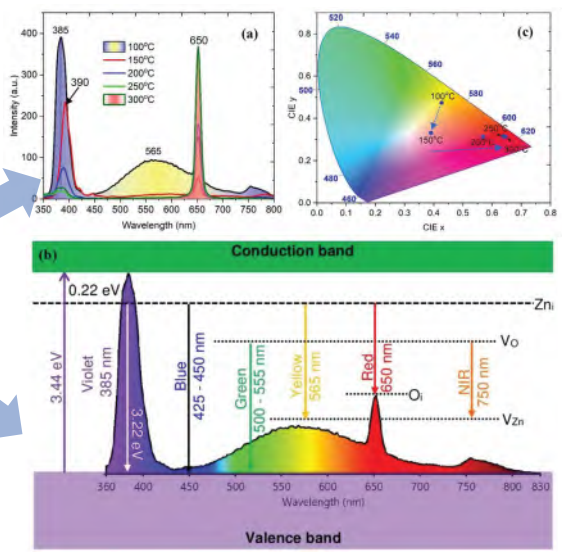


Fig. 4. Optical properties of ZnO nanostructures

3. Results and discussion: *Structural and Optical properties*

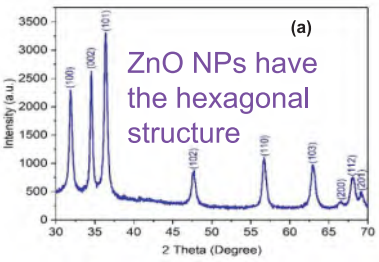


Fig. 2. XRD patterns of ZnO NPs

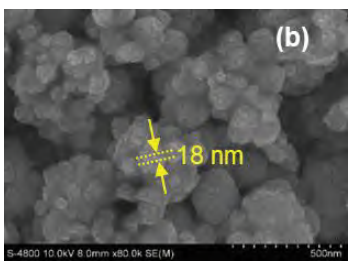
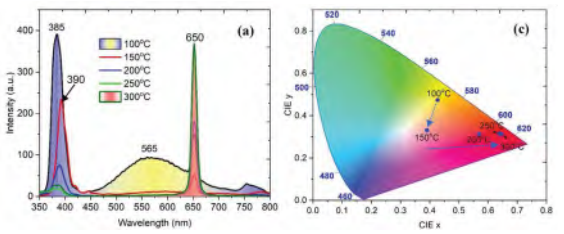


Fig. 3. SEM images of ZnO NPs

Colorimetric oxygen indicators

The result shows that ZnO NPs are suitable for photoluminescent ink.

- Screen printing ink
- Inkjet printing.



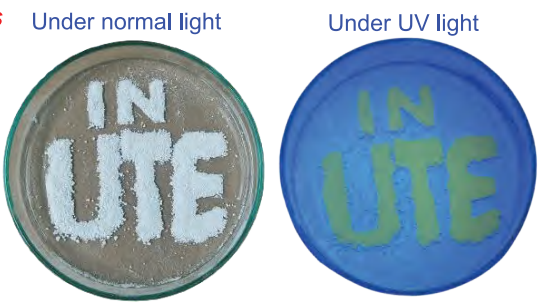


Fig. 4. Optical properties of ZnO nanostructures

3. Results and discussion: *Structural and Optical properties*

ZnO photoluminescent ink

Components:

- Polyvinyl alcohol (PVA): 10%
- Ethylene glycol ($C_2H_6O_2$): 10%
- H_2O
- ZnO NPs: 15%

Properties:

- Absorption peak: ≈ 360 nm
- PL peak: ≈ 565 nm
- Color coodinate: Yellow

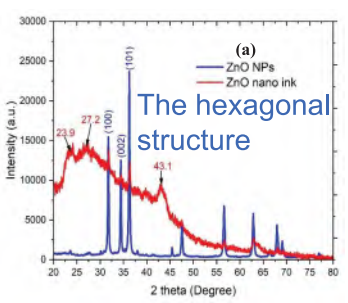


Fig. 5. *(a) XRD patterns of ZnO nanostructures and ZnO nano ink*

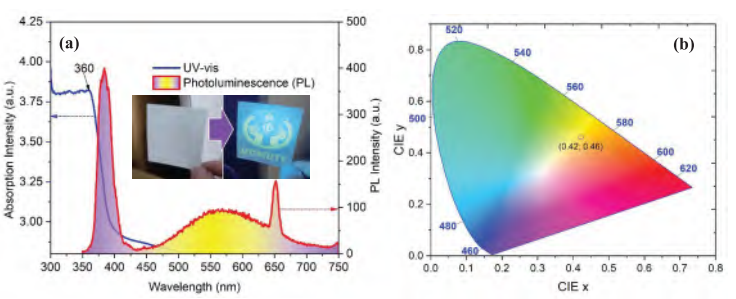
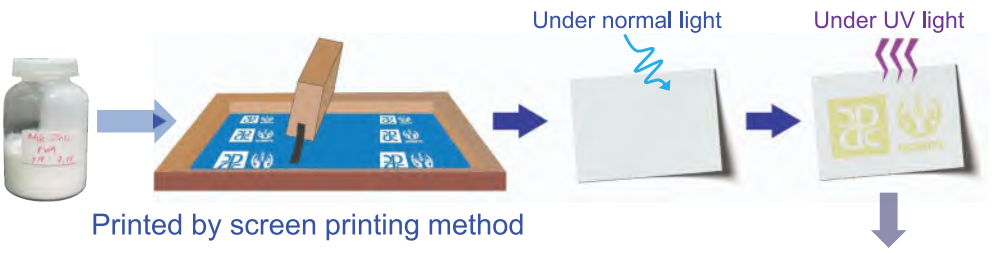


Fig. 6. *(a) Optical properties of ZnO nano ink, (b) CIE (x, y) color coordinate of ZnO nano ink*

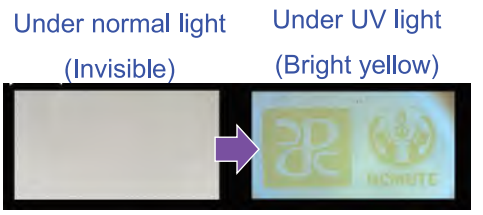
3. Results and discussion: *Structural and Optical properties*

Ink for screen printing



Ink parameters:

- Surface energy: 66 dyn/cm
- Zeta potential: -28.4 mV
- pH: 7.2 ± 0.5
- Viscosity: 814 mPa.s
- Pigment: ≈ 18 nm



Results: Application in security ink

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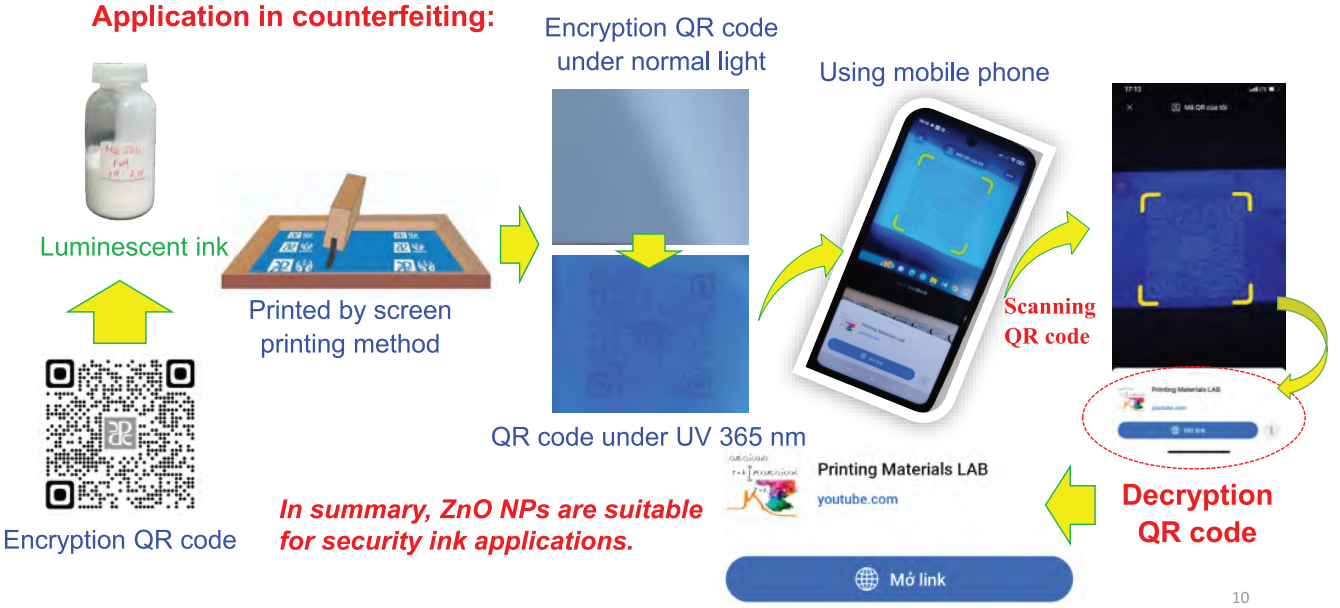
3. Results and discussion: *Structural and Optical properties*

Application in counterfeiting:



In summary, ZnO NPs are suitable for security ink applications.

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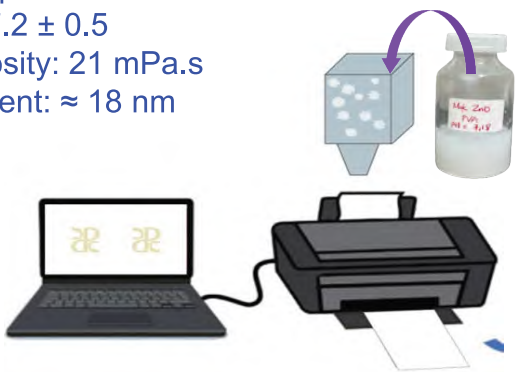
3. Results and discussion: *Structural and Optical properties*

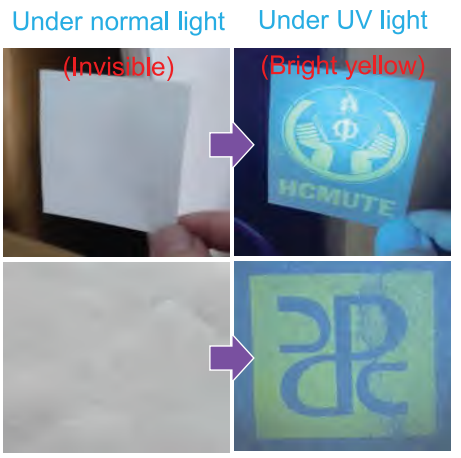
Ink for ink-jet printing

Ink parameters:

- Surface energy: 32 dyn/cm
- Zeta potential: -28.4 mV
- pH: 7.2 ± 0.5
- Viscosity: 21 mPa.s
- Pigment: ≈ 18 nm



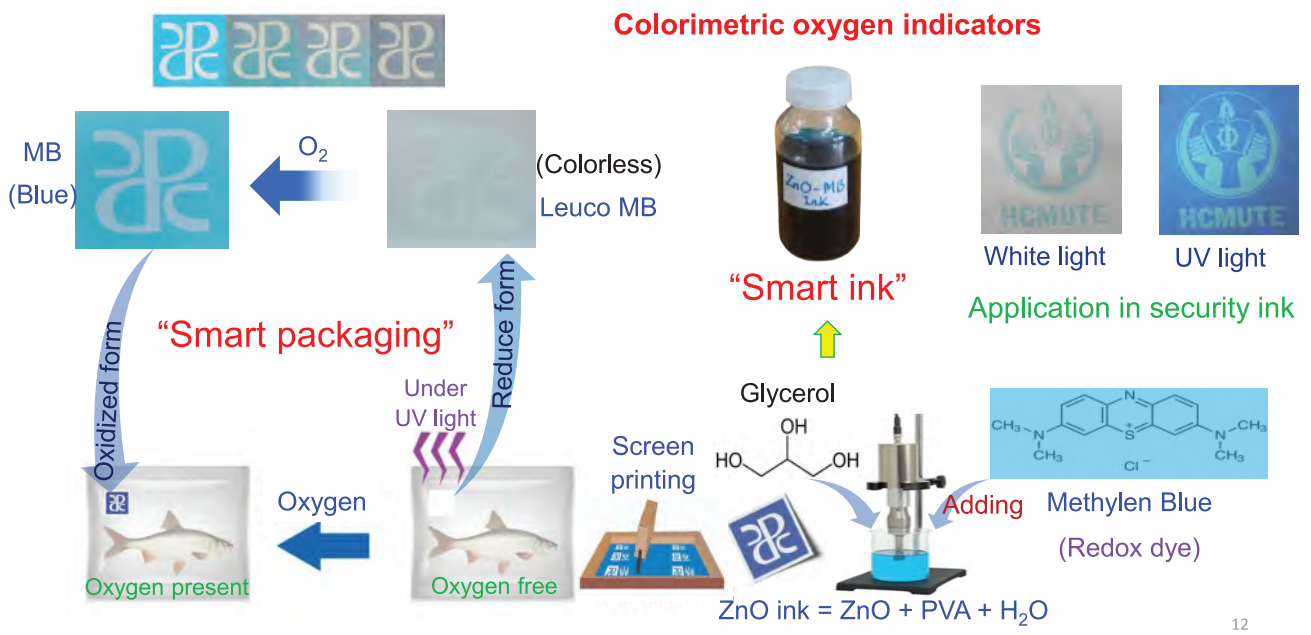
Printed by Ink-jet printing method



Results: Application in security ink

12

3. Results and discussion: *Structural and Optical properties*



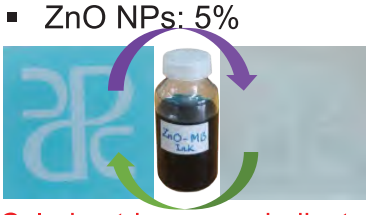
12

4. Summary

Components:
- PVA: 30%
- EG ($C_2H_6O_2$): 10%
- H_2O
- ZnO NPs: 15%

Screen printing ink

Components:
- PVA: 30%
- Methylen Blue: 10%
- Glycerol: 1%
- H_2O
- ZnO NPs: 5%



Colorimetric oxygen indicators

Components:
- PVA: 10%
- EG($C_2H_6O_2$): 10%
- H_2O
- ZnO NPs: 5%

Inkjet printing ink

ELSEVIER

Optical Materials

Volume 157, Part 2, November 2024, 116296

Research Article

Synthesis of ZnO nanoparticles-based fluorescent ink for information encryption and security applications

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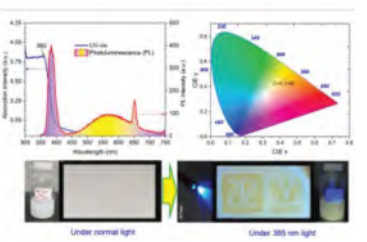
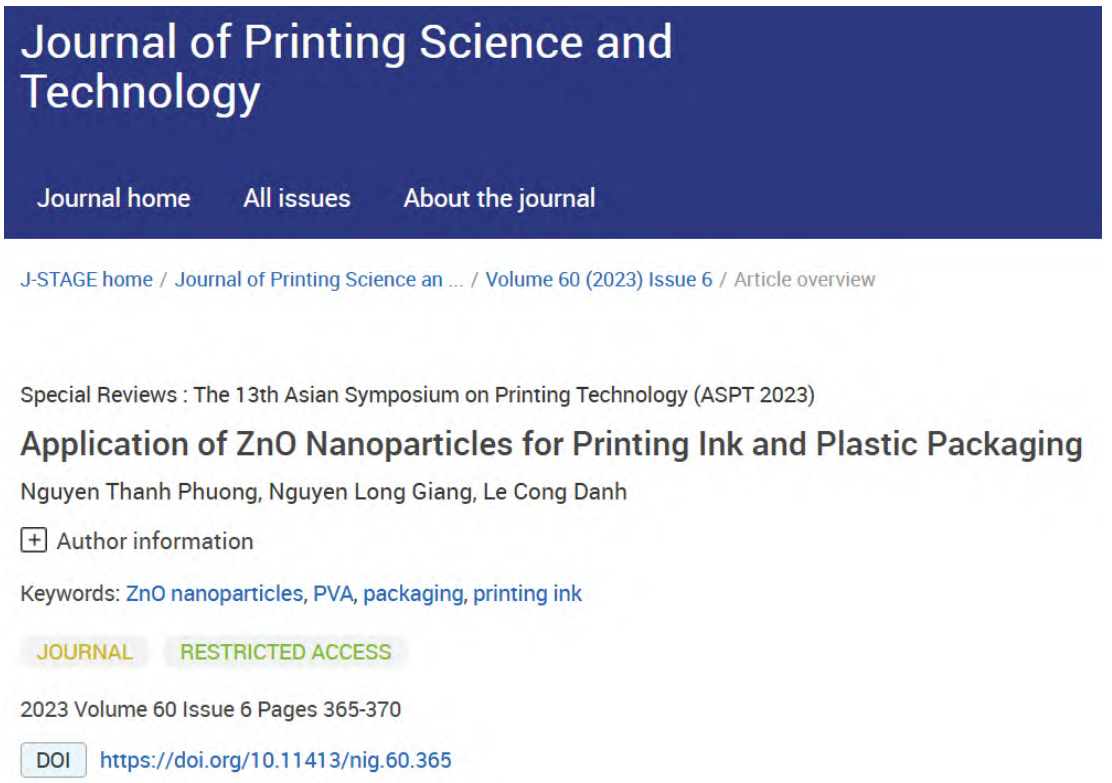
Graphical abstract





5. Publications

1. **Thanh Phuong Nguyen**, Huu Phuc Dang, Long Giang Nguyen, Cong Danh Le, ***Synthesis of ZnO nanoparticles-based fluorescent ink for information encryption and security applications***, Optical Materials, Volume 157, Part 2, November 2024, 116296.
2. Nguyen Thanh Phuong, Nguyen Long Giang and Le Cong Danh, ***Application of ZnO Nanoparticles for Printing Ink and Plastic Packaging***, Journal of Printing Science and Technology, 2023 Volume 60 Issue 6 Pages 365-370.
3. **Nguyen Thanh Phuong,** Nguyen Long Giang, Dang Huu Phuc, Nguyen Ngoc Diem**, *Investigations on structural, photoluminescent, and photometric properties of poly(vinyl alcohol)-capped Mn doped-ZnO nanoparticles for white light emission***, Optical Materials 143 (2023) 114145.
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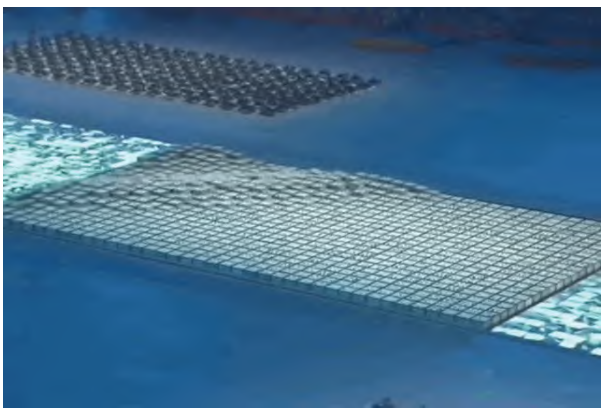
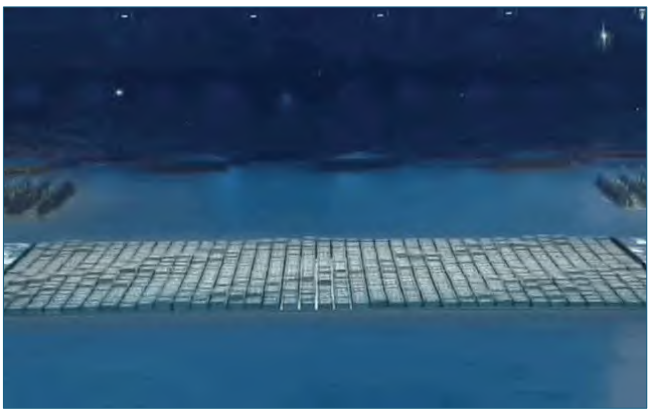
Mineral oil - free antibacterial ink makes printing safer

马长茗-MA CHANG MING
19/12/2024





The visual spectacle of the movable type performance at the 2008 Beijing Olympics Opening Ceremony showcased the elegance and cultural significance of printing, often referred to as the "mother of civilization."

As a professional in the printing industry, this display is a source of deep pride and honor.

Content

- Environmental protection trend
- Market demand
- Products development
- Application of results

Environmental protection trend

French Miniral Oil Control Updates (Draft VS official version)

Mineral oil limitation in inks		Effective Jan. 1, 2023	Effective Jan. 1, 2025
MOAH (C1-C7)	Draft requirement	0.1%	**Total amount of MOAH of C3-C7<1 PPB**
	Official requirement	**1%**	**Total amount of MOAH of C3-C7<1 PPM, MOAH concentration of C1-C7<0.1%**
MOSH (C16-C35)	Draft requirement	1%	0.1%
	Official requirement	**No limit**	**0.1%**
For packages or printed paper products manufactured or imported into France before January 1, 2023, there is a transition period of 12-month for inventory consumption.			
Packaging paper and printing paper manufactured or imported prior to each of the deadlines mentioned above, as well as those that meet the authorization requirements prior to those deadlines, may enjoy a 12-month extended inventory expiration period from those deadlines.			

Environmental protection trend

With the increasingly strict control of mineral oils in packaging materials and printed products in Europe, especially in France, mineral oil-free inks have become an inevitable choice to meet this requirement.

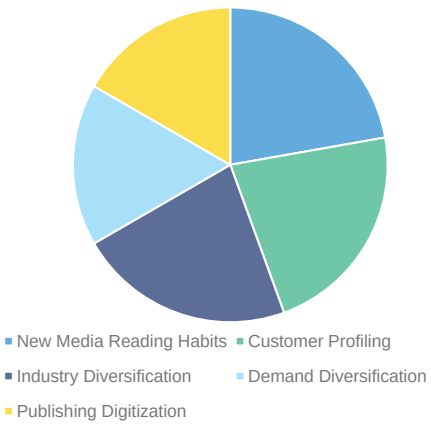
■ Law No. 2020-105 on combating waste for a circular economy dated February 10, 2020 (the AGEC law), prohibits the use of mineral oils on packages and prints for the general public.

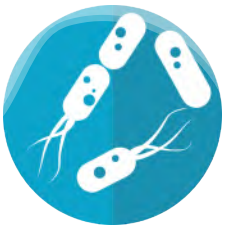
■ Decree No. 2020-1725 of the Environmental Code dated December 29, 2020 provides in D.543-45 and D.543-213 that the ban applies to mineral oils containing substances that disrupt the recycling of waste or restrict the use of recycled materials.

■ From Jan 3, 2022 to Jan 25, 2022, the draft on the "ban to use mineral oils in packages and printed matters" by the AGEC Department of Ecological Transformation conducted a public consultation.

■ On May 3, 2022, France approved and issued the Decree of April 13, 2022 Effective January 1, 2023. The Decree mainly refines the requirements for the control of mineral oils in packaging materials and printed matters proposed by France in 2020, and clarifies the specific substances of mineral oils under control.

Market demand





Market demand

- In recent years, people have become increasingly concerned with improving their quality of life and personal health. This concern is particularly evident in the realm of reading, where the spread of bacteria on books and other physical media has become a notable issue.

- In response to the growing concerns over health and hygiene, we have made the decision to develop an innovative solution—antibacterial ink.

Market demand

- Children books
- Food packaging
- Pharmaceutical packaging
- Express packaging

Products development

Applicable instruction

Uncoated paper	··	Applicable, use after testing
Light-coated paper	··	Applicable, use after testing
Glossy Couche	···	Totally applicable
Card paper	···	Totally applicable
Couche Matt	··	Applicable, use after testing
Non-absorbent paper	▲	Not applicable
Polypropylen materials	▲	Not applicable

Products development

Ink technical data

UNI80-KJ Antibacterial Ink Technical Index

Model	Color categories	Color	Tint	Fineness	Fluidity mm	Viscosity	Dry conjunctiva	Fixation speed min	Odor
			%	μm			h		
UNI80-KJ	Magenta	Reference standard	95～105	≤12	29～39	9～13	≥10	≤20	Reference standard
UNI80-KJ	Yellow	Reference standard	95～105	≤12	26～36	9～12	≥10	≤20	Reference standard
UNI80-KJ	Cyan	Reference standard	95～105	≤12	28～38	9～13	≥10	≤20	Reference standard
UNI80-KJ	Black	Reference standard	95～105	≤12	29～39	9～13	≥10	≤20	Reference standard

Products development

Resistance index

RESISTANCE INDEX			
	Light fast ISO 2835	Alcohol resistance ISO 2837	Alkali resistance ISO 2838
Yellow	3-4	5	5
Magenta	5	4	4
Cyan	8	5	5
Black	8	3	5

Products development

Eco-friendly antibacterial effect reaches over 90%. → Under conditions where the printed surface is not damaged, the antibacterial effect lasts for over one year. → Soybean oil-based products meet environmental protection requirements.

Clear dots gain, vibrant colors, high color density, good gloss, and excellent abrasion resistance. → Good on-machine stability, suitable for high-speed printing. → Book printing, Food packaging, Pharmaceutical packaging, Express packaging

Products development

U.S. FDA 21 CFR 175.300 environmental standards

Meets low acetone environmental standards

Meets EU RoHS regulations regarding heavy metals such as lead, mercury, cadmium, hexavalent chromium, as well as PBBs and PBDEs.

Meets the final rule on specific phthalates in children's toys and children's cosmetics.

Meets the GB 38507-2020 standard for volatile organic compound content

The ink meets the Class III standard for polycyclic aromatic hydrocarbons, while the printed products meet the Class II standard. (Under special requirements, the ink can meet Class II, and the printed products can meet Class I standards.)

Test Microorganism	Concentration of bacteria (CFU/mL)	Experimental group	the average of the common logarithm of the number of viable bacteria recovered from CFU/pcs "0h" contact time Control A	"24h" contact time Control B	"24h" contact time Sample C	Antibacterial activity R*	Single determination
Staphylococcus aureus ATCC 6538	5.2×10^5	1	2.1×10^5	3.0×10^5	<10	4.5	Strong antibacterial effect on Staphylococcus aureus
		2	2.7×10^5	2.7×10^5	<10	4.4	
		3	2.8×10^5	3.1×10^5	<10	4.5	
Escherichia Coli 8099	4.1×10^5	1	1.8×10^5	5.7×10^7	<10	6.8	Strong antibacterial effect on Escherichia coli
		2	2.1×10^5	6.0×10^7	<10	6.8	
		3	2.4×10^5	6.3×10^7	<10	6.8	
Candida albicans ATCC 10231	5.6×10^5	1	3.4×10^5	4.0×10^5	3.9×10^4	1.0	Has antibacterial effect on Candida albicans
		2	3.1×10^5	3.8×10^5	3.0×10^4	1.1	
		3	2.7×10^5	4.2×10^5	3.5×10^4	1.1	

*Remark:
Staphylococcus aureus Antibacterial activity R=4.5≈Antibacterial rate R'>99.9%; R=4.4≈Antibacterial rate R'>99.9%;
R=4.5≈Antibacterial rate R'>99.9%
Escherichia Coli Antibacterial activity R=6.8≈Antibacterial rate R'>99.9%; R=6.8≈Antibacterial rate R'>99.9%;
R=6.8≈Antibacterial rate R'>99.9%
Candida albicans Antibacterial activity R=1.0≈Antibacterial rate R'=90.3%; R=1.1≈Antibacterial rate R'=92.1%;
R=1.1≈Antibacterial rate R'=91.7%

Test Microorganism	Concentration of bacteria (CFU/mL)	Experimental group	the average of the common logarithm of the number of viable bacteria recovered from CFU/pcs "0h" contact time Control A	"24h" contact time Control B	"24h" contact time Sample C	Antibacterial activity R*	Single determination
Staphylococcus aureus ATCC 6538	4.4×10^5	1	2.1×10^5	2.2×10^5	<10	4.3	Strong antibacterial effect on Staphylococcus aureus
		2	1.9×10^5	3.1×10^5	<10	4.5	
		3	2.4×10^5	3.0×10^5	<10	4.5	
Escherichia Coli 8099	3.9×10^5	1	2.6×10^5	5.6×10^7	<10	6.7	Strong antibacterial effect on Escherichia coli
		2	1.7×10^5	5.5×10^7	<10	6.7	
		3	2.3×10^5	4.5×10^7	<10	6.7	
Candida albicans ATCC 10231	5.1×10^5	1	2.4×10^5	6.2×10^5	3.7×10^4	1.2	Has antibacterial effect on Candida albicans
		2	2.0×10^5	4.7×10^5	5.6×10^4	1.0	
		3	1.7×10^5	4.2×10^5	2.1×10^4	1.3	

*Remark:
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R=4.5≈Antibacterial rate R'>99.9%
Escherichia Coli Antibacterial activity R=6.7≈Antibacterial rate R'>99.9%; R=6.7≈Antibacterial rate R'>99.9%;
R=6.7≈Antibacterial rate R'>99.9%
Candida albicans Antibacterial activity R=1.2≈Antibacterial rate R'=94.0%; R=1.0≈Antibacterial rate R'=88.1%;
R=1.3≈Antibacterial rate R'=95.0%

Application of results

博微检测 BOWEL TESTING

JIANGSU BOVTEK CO.,LTD

ANALYSIS AND TEST RESULT

Report No:WT-241119002WSW

1.Sample processing: Pre treat the prepared sample plate according to GBT21866-2008 and conduct testing.
2.Results:

Experimental strain	sample	Total number of viable bacteria (cfu/cm²)	Logarithmic average of viable bacteria count	Antibacterial performance value	Antibacterial rate (%)
Escherrchia coli ATCC 8739	Negative control plate	1.4×10^{6}	——	——	99.35
	Blank control board	3.3×10^{7}	——		
	Antibacterial coating board	2.1×10^{5}	——		
Staphylococcus aureus ATCC 6538	Negative control plate	3.0×10^{7}	——	——	99.25
	Blank control board	2.9×10^{7}	——		
	Antibacterial coating board	2.2×10^{5}	——		

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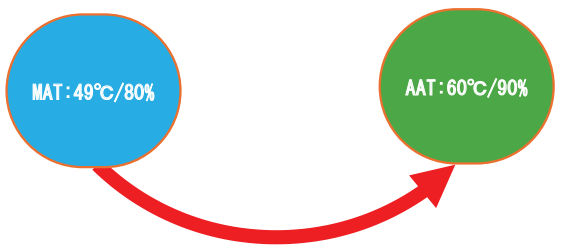
Sample Description	Test item	Requirement	Conclusion
Antibacterial Varnish (Greenmax VH-9100 Antibacterial Varnish+VH-80 Antibacterial Varnish) Printing Paper	Transfer of antimicrobial constituents	Paper and board used in food contact materials and articles EDQM 2021 part II	Pass

老化测试
Aging test



Application of results

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	Antibacterial coating board	2.1×10^{5}	——		
Staphylococcus aureus ATCC 6538	Negative control plate	3.0×10^{7}	——	——	99.25
	Blank control board	2.9×10^{7}	——		
	Antibacterial coating board	2.2×10^{5}	——		

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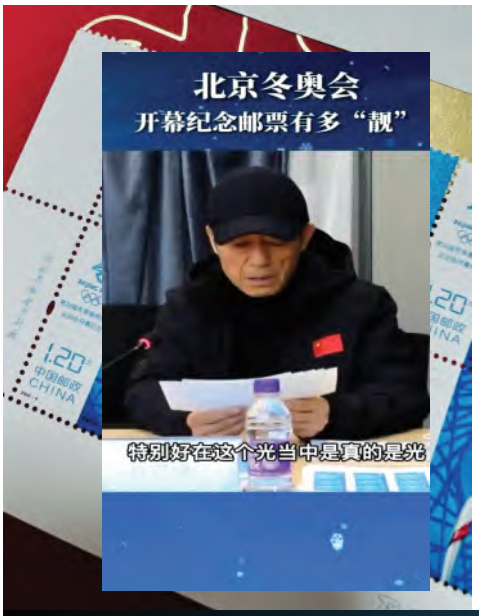
Application of results



The commemorative stamp for the 24th Winter Olympics Opening Ceremony, was praised by chief director Zhang Yimou and others professional technicians, was celebrated for its excellence in three aspects:

1. Vibrant colors: using specially developed cobalt blue ink to capture the event's atmosphere,
2. Advanced craftsmanship: featuring laser holographic cat's eye, embossing, and dynamic diffraction positioning techniques for intricate textures,
3. Innovative design: dynamic effects under sunlight echo the Olympics' green and low-carbon theme, symbolizing purity, technology, and the spirit of the times.

Application of results

Application of results

Innovative Use of Waste Paper from Printing Houses in Molded Pulp Products: Enhancing Quality, Reducing Carbon Footprint, and Advancing Sustainable Materials

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Abstract

Our research aimed to repurpose non-recyclable waste paper from Chulalongkorn University Press (CU Press) by incorporating it into the production of molded pulp at E. Molding International Co., Ltd. (EMI). By utilizing this underutilized resource, we assessed the impact on product quality, focusing on parameters such as surface smoothness, strength, and the overall performance of the final molded pulp products. This innovative approach is expected to reduce environmental impact by minimizing waste disposal and the carbon footprint associated with conventional production processes. The results demonstrated that the collaboration between EMI and CU Press establishes a novel model of circular economy. This partnership enables EMI to develop more environmentally sustainable products, while CU Press successfully reduces greenhouse gas emissions and progresses toward its Net Zero policy objective.

Key words: sustainable molded pulp, waste paper, carbon footprint, waste management

Introduction

The up-circular economy is an evolved concept of the traditional circular economy, focusing not only on recycling and reusing materials but also on enhancing the value of resources through innovation. It seeks to "upcycle" materials, transforming them into higher-quality products that have more utility or market appeal than the original material or product. This concept encourages sustainable product design, where materials are reused in a way that improves their quality or extends their lifespan, rather than simply recycling them back into products of equal or lesser value [1,2].

E. Molding International Co., Ltd., a leading manufacturer of molded pulp products for packaging solutions is now exploring alternative raw materials to reduce dependency on virgin resources and enhance the sustainability of its products. One promising avenue is the repurposing of waste paper generated from industrial processes, providing an innovative way to close material loops and promote a circular economy

Printing industry is one example. It affects significantly to environmental problems, particularly through waste paper generation [3-5]. Overproduction of printed materials, often due to overprinting or outdated content, results in substantial waste paper. While inefficient printing practices, such as poor print quality or excessive use of paper, contribute to waste generation. Waste papers can be categorized into two types, each with its own recycling potential - recyclable waste and non-recyclable waste. Sheet papers and trim waste can be easily recycled into new paper products. For waste paper flakes from book binding processes, they may be recycled, even they are small in size. But modern recycling technology is needed. In Thailand, the waste buyers do not accept such kind of waste. To minimize the environmental impact of non-recyclable waste, there are alternative methods such as incineration, chemical recycling and landfills. However, landfills can significantly damage the environment in many ways - groundwater contamination, air pollution, soil contamination and disruption of ecosystems.

Currently, EMI's molded pulp products are manufactured using recycled or post-industrial paper as raw materials, as well as by-products like corrugated cardboard, used paper (scrap), and bagasse [6] . This research therefore focuses on the potential use of waste paper from Chulalongkorn University Press (CU Press) in Bangkok, Thailand, in collaboration with EMI. We selected non-recyclable waste paper as shown in Figure 1, which are unsuitable for recycling due to its small size and lack of market value. This has posed a significant waste management challenge for both parties.

Figure 1. Waste paper flakes from printing house (left) mixed with conventional recycled papers.

Molded pulp has gained significant global recognition for its functionality and environmentally friendly properties [7]. Beyond its protective capabilities, aesthetic factors such as surface smoothness have emerged as key quality indicators. Currently, a surface roughness (Ra) value of 12 µm or lower is the benchmark for customer acceptance. This research aims to address this quality requirement (Fig.2) and contributes to the standardization of molded pulp criteria.

In addition, this study will examine the applicability of traditional paper testing method to the molded pulp industry, focusing on a key property such as Burst Strength Test (BST). We therefore will emphasize BST as a foundation for establishing future strength standards for molded pulp products.

Figure 2. Waste paper flakes from printing house (left) mixed with conventional recycled papers.

Another key aspect of this research is analyzing the benefits of using non-recyclable waste paper, particularly its potential to mitigate environmental impacts. This includes reducing greenhouse gas emissions and addressing the challenges associated with landfill disposal. We believe that the Greenhouse gas (GHG) reduction enhances brand reputation and reposition the company as a leader in sustainability. In today's landscape, where environmental responsibility and profitability are closely intertwined, effective carbon footprint management is crucial for driving the growth and success of the molded pulp industry

Molded pulp production

Molded pulp production is a process that transforms recycled paper or agricultural fibers into durable and biodegradable packaging products. It is widely used for producing trays, cartons, and protective packaging for various industries. There are several steps as follows:

- **Pulping**: The raw materials are shredded and mixed with water in a pulping machine to create a slurry or pulp. This step breaks down the fibers into a uniform consistency as shown in Figure 3.

Figure 3. Pulping process.

- **Forming:** The slurry is poured into molds designed for the desired product shape (e.g., trays or cartons). A vacuum is applied to remove excess water from the mold and compact the fibers into the desired shape.

- **Drying**: The wet molded products are dried to remove residual moisture. Common drying methods are hot-air dryer or infrared for faster and more energy-efficient drying.

- **Pressing and finishing**: The products are hot-pressed to improve surface smoothness and strength, achieving uniform thickness. Excess material will be cut to refine the product's edges.

- **Quality control**: The final products are inspected for defects, such as cracks or inconsistencies, before being packaged for distribution.

Experiment

The experiment focused on producing trays for electronic parts and consumer products using a dry press

technique, incorporating varying combinations of scrap material from EMI and flaky waste paper sourced from CU Press. The tested ratios included 100% scrap paper, as well as mixtures of 90:10, 60:40, and 50:50 of scrap paper to flaky waste paper. Prepress processes utilized 3D/CNC mold tooling to fabricate ABS molds for product forming and aluminum molds for final product pressing

We evaluated the operating time for each step required to complete the product and determined the optimal ratio between scrap and flaky waste paper. The properties of the resulting products were analyzed, and greenhouse gas (GHG) emissions or Carbon Footprint for each condition were calculated using our custom-developed calculator. The calculation is based on the principles of Life Cycle Assessment (LCA) in accordance with ISO 14067 standard (8). It considers all stages of a product's life cycle—from raw material acquisition and manufacturing to distribution, use, and disposal.

Results and Discussion

In our experiment on molded pulp production, we utilized the same machinery, equipment, and standard operating times currently employed by the company. Adjusting the proportion of flaky waste paper allowed us to speed up the pulping process. Normally, the company maintains a consistent pulping time of 20 minutes. However, we found that mixing flaky waste paper possibly improved the blending of the fibers, making the process faster.

Results showed that using 100% scrap waste paper or a 90:10 ratio of scrap to flaky waste papers produced quite similar products with the exception that the surface appearance of the product made with flaky waste paper was slightly inconsistent in whiteness. This variation was attributed to the inclusion of less amount of flaky waste paper as these ratios did not create a new product.

For the 60:40 and 50:50 ratios of mixed waste paper, we tested reducing the pulping time to 15 minutes. The resulting products exhibited a surface roughness (Ra) within the acceptable range for customers, measuring < 12 µm. However, the average Bursting Strength Test (BST) values were approximately 72-74 kPa, indicating a decrease in strength compared to the standard product, which typically achieves a value of 98 kPa.

Although the BST values for these ratios do not currently meet any customer acceptance criteria, they serve as preliminary data to inform customers. Products derived from these two ratios are considered new products that can add value to EMI by broadening its product portfolio.

Based on the data obtained, we can conclude that a 60:40 ratio of mixed waste papers is likely the most suitable for creating new products incorporating flaky waste paper from CU Press. Table 1 outlines the production steps, materials used, production time, and the calculated carbon footprint of the resulting product.

Table 1: Data of molded pulp production using a 60:40 ratio of mixed waste papers and its Carbon Footprint

System boundary	Units	Materials / Equipment	Electric power of machine(kw/hr)	Time Usage (hr)	Amount	EF* (kgCO2e /unit)	kgCO2e
Materials	kg	Waste paper (in piece) (1)			66 kg	0	0
		Waste paper (in flake) (2)			48 kg	0	0
		Tap water - Industrial Estate Authority (L)			10,000 L	0.258	2,580
		Defected products			6 kg	0	0
		emulsion			0	0	0
Process	kw	Pulping	13.988	0.25	3.50 kw	0.598**	2.093
		Forming	13.520	4.04	54.62 kw	0.598	32.663
		Drying	7.938	8.00	63.50 kw	0.598	37.973
		Heat pressing	37.400	0.909	34.00 kw	0.598	20.332
		Cutting	5.500	6.061	33.33 kw	0.598	19.931
		Eye-Checking	0	0	0	0	0
Transport ation	km	66kg Waste paper (in piece) transportation***			100 km	0.072/ t-km	0.475
		48 kg Waste paper (in flake) transportation****			50 km	0.270/ t-km	0.648
		120 kg Products delivery**			40 km	0.072/ t-km	0.346
Disposal	kg	Land fill			0	0	0
		Recycle- repulping			120 kg	0	0
Total							2,694.461
Number of products							2,182
kgCO2epiece							1.235

* Thailand Greenhouse Gas Emission Factor Database 2019

** Grid Mix electricity

*** Large 6-wheel cargo truck operating under normal conditions with 75% loading capacity/ Max. load capacity: 11 tons

**** Small pickup truck with a 4-wheel load, operating under normal conditions with 50% loading capacity/ Max. load capacity: 7 tons

An interesting point regarding the calculation of the Carbon Footprint (CFP) for this new product when incorporating flaky waste paper from CU Press. EMI could reduce the pulping preparation time from 20 minutes to 15 minutes. However, there was an additional transportation step required to deliver the flaky waste paper from CU Press to EMI. When all greenhouse gas (GHG) emissions are accounted for, including those from transportation, the CFP remained comparable to the original product, which

uses a 20-minute pulping time, with a CFP value of 1.24 $kgCO_2e$ per unit.

The question then arises: what is the benefit of mixing waste papers? The answer lies with CU Press. By utilizing flaky waste paper from CU Press, EMI creates added value by repurposing material that would otherwise be sent to landfill due to its lack of marketability for recycling. This practice not only reduces landfill waste but also provides a renewable fiber source for EMI's production process.

It is important to note that landfill disposal of waste materials inevitably harms soil and the environment, particularly through the release of greenhouse gases (GHGs). According to the Thailand Greenhouse Gas Management Organization (Public Organization), data on GHG emissions from shallow waste disposal sites, based on the IPCC Guidelines for National Greenhouse Gas Inventories – Volume 5 Waste, specifies the emission factor for paper waste at 2.93 tCO_2e/ton of paper waste (9).

If EMI utilizes the flaky waste paper to produce molded pulp products, it allows CU Press to prevent the release of GHG emissions into the atmosphere or generate carbon credits by avoiding the landfill disposal of this waste. Accordingly, for a weight of 48 kg of flaky waste paper, this equates to preventing GHG emissions of 141 $kgCO_2e$. With CU Press generating approximately 800-1,000 kg of this waste paper type each month, it could potentially reduce GHG emissions by up to 2.93 tCO_2e /month. This presents a significant environmental benefit in terms of reducing GHG emissions.

Conclusion and Suggestion

The collaboration between EMI and CU Press represents a new model of circular economy. This partnership not only reduces the disposal of non-recyclable paper waste from the printing house but also enables EMI to develop a more environmentally friendly product, offering a fresh dimension to its brand. While the carbon footprint remains relatively unchanged, the production process has become more efficient, with reduced pulping time, effectively increasing productivity.

The resulting product meets customer expectations for surface smoothness and appearance, although the Bursting Strength (BST) is lower than that of the original product. This will require further consideration of customer satisfaction. Nevertheless, this initiative demonstrates significant progress in sustainable product innovation while maintaining acceptable quality standards.

For CU Press, which has previously implemented GHG reduction initiatives and a Carbon Neutrality project (4,8), this collaboration further builds on its success in reducing GHG emissions and aligns with its Net Zero policy. Transforming non-recyclable waste paper into value-added products, rather than disposing of it through landfilling, enables CU Press to prevent up to 2.93 tCO_2e of GHG emissions per month. This achievement represents a tangible contribution to carbon credit generation for the publishing house and reinforces its commitment to sustainable practices.

Acknowledgement

The authors would like to extend their sincere gratitude to the exchange students from Chiba University, Japan and E. Molding International staff for their cooperation of carbon footprint calculation.

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Enhancing surface properties of activated carbon derived from waste paper in printing houses through H_3PO_4 activation

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Abstract

This research investigated the improvement of surface area in activated carbon derived from waste paper from Chulalongkorn University Press (CU Press), using H_3PO_4 acid activation, and its heavy metal adsorption property in the fountain solution of offset printing presses. Optimizing parameters such as acid concentration, temperature, heating rate, and the ratio of acid and paper were crucial for maximizing surface area. We found that $CaCO_3$ in the paper reacted with the acid and was leached out, which opened the surface of the cellulose structure. This allowed for easier activation and the formation of pores.

Key words: activated carbon, waste paper, printing houses

Introduction

Creating activated carbon from waste involves a series of chemical and physical processes to enhance its porosity and surface area, making it highly effective for adsorption applications such as waste water treatment, gas adsorption, and industrial use. It can be derived from a variety of waste materials rich in carbon content, such as: agricultural waste, paper, sawdust or wood scraps and biomass from industrial waste. For paper waste specifically, such as printing scraps or non-recyclable paper, the cellulose content is essential for the carbonization process. Activated carbon from waste is cost-effective and supports sustainability, aligning with circular economy principles.

The choice of activation agent, such as moisture or chemicals, can significantly affect the pore structure and properties of the activated carbon. Activation atmosphere, temperature and time will control the degree of carbonization and pore development. To consider the properties of the activated carbon, a high surface area is generally desirable for adsorption applications whereas a low ash content is preferred to minimize impurities and improve adsorption capacity.

In this research, we proposed an approach to valorize waste papers from printing houses by converting it into activated carbon. Rather than recycling it into pulp for papermaking, we aimed to add value to this waste through a process involving phosphoric acid (H_3PO_4) activation. This method holds the promise of producing high-quality activated carbon, which has a wide range of applications, including waste water treatment. We expect that the environmental advantages of recycling waste papers into a valuable product helps reducing landfill waste and conserving resources. The results also described the methods used to characterize the activated carbon and the properties achieved, such as surface area and adsorption capacity. However, fillers and other additives in

printing papers like $CaCO_3$ can influence activation efficiency. These additives therefore shall be removed during the activation process.

H_3PO_4 is considered less hazardous than other chemicals like $ZnCl_2$ or KOH used in activation. It allows the utilization of waste paper, reducing environmental burden and supporting waste valorization. A high proportion of phosphoric acid can react with impurities and non-carbon materials in the waste paper, such as calcium carbonate ($CaCO_3$) to produce soluble calcium phosphate salts (such as calcium dihydrogen phosphate, $Ca(H_2PO_4)_2$) rather than hydroxyapatite. These salts will dissolve during the washing process, creating microchannels and exposing more cellulose for subsequent carbonization. The acid also depolymerizes the cellulose in paper, creating a more disordered structure that facilitates pore formation during thermal treatment.

$$CaCO_3+2H_3PO_4 \rightarrow Ca(H_2PO_4)2+H_2O+CO_2 \ldots\ldots\ldots\ldots (1)$$

To improve waste management in Chulalongkorn University Press, we proposed utilizing activated carbon derived from waste paper to treat wastewater, specifically exhausted fountain solution. This approach aims to either repurpose the treated solution for further use or safely discharge it into the drainage system without causing any harm.

Fountain solution is a liquid that serves to keep the areas of the plate that do not have printing images, clean and ink-free. The basic composition of the fountain solution consists of different functional chemicals such as gum, plate preservative agents, wetting agents, isopropyl alcohol (IPA), buffer substances, and anti-microbe additives mixed in water, that keeps the pH between 4.8 and 5.5 and isopropyl alcohol in the proportion of 6% to 8%. In preparing fountain solution, the manufacturer's mixing directions should be followed. Most concentrates are formulated to produce a working fountain solution with a pH of between 3.5 and 5.0 and conductivity range of 800 to 1500 μS.

After printing process, the fountain solution changes its composition due to direct contact with different printing materials (plates, inks, etc.). The solution becomes more contaminated, it shows larger changes in pH and conductivity, indicating that the solution is "out-of-control and it is reported that the solution also contains traces of heavy metal components such as copper, zinc and nickel [1]. It is therefore important to remove these heavy metals from the exhausted fountain solution as effectively as possible, and we hope that the activated carbon will play a key role in adsorbing them.

Experiment

a) Raw Material Preparation:

Collect non-recyclable waste paper from Chulalongkorn University Press for the activation process. Immerse the waste paper in phosphoric acid solutions of 2, 4, and 6 mol/L concentrations, each with a volume of 100 mL, and mix with 50 g of paper per batch. Stir the mixture thoroughly and allow it to soak for 24 hours at room temperature.

Carbonization:

Dry the acid-impregnated waste paper at 105° C to remove excess moisture before carbonization. Place the dried paper in a tubular furnace and carbonize it under an inert atmosphere to prevent oxidation. The carbonization was done at controlled temperatures of 400°C, 500°C, and 600°C, holding each sample at the target temperature for 1 hours. The samples were cooled at room temperature gradually in the same inert atmosphere to prevent oxidation.

Neutralization and Washing:

After carbonization, we washed the activated carbon thoroughly with distilled water to remove residual phosphoric acid and other impurities. Washing was continued until the pH of the rinse water reaches neutral (around pH 7). The washed activated carbon was dried at the temperature 100°C for a few hours until it reaches a stable weight.

b) Characterization and Analysis

The surface area of the activated carbon obtained was measured using BET (Brunauer–Emmett–Teller) analysis. X-ray diffraction (XRD) analysis was conducted on the samples to confirm the presence of specific chemical compounds. X-Ray Fluorescence (XRF) was used to determine the elemental composition of the activated carbon. This analysis confirmed the presence and distribution of elements such as phosphorus, calcium, carbon, and others, providing insights into its chemical composition and degree of activation.

c) Exhausted fountain solution treatment

The activated carbon was packed into a column or batch container to ensure an appropriate bed depth, allowing optimal contact time with the solution. A

filtration technique was proposed to remove large particles or suspended solids from the exhausted fountain solution, preventing interference with the adsorption process. We used an Atomic Absorption Spectrometer (AAS) to analyze the results of heavy metal absorption in the fountain solution.

Results and Discussion

From the experimental results measuring the surface area of the activated carbon, we found that the concentration of phosphoric acid at 4 mol/L and carbonization at a temperature of 500°C are more suitable than other conditions. This resulted in the highest average surface area of 1,659 m^2/g. Using a low temperature may not be sufficient to fully volatilize other components that are not carbon. On the other hand, using a high temperature, such as 600°C, may cause the material's surface to be affected by the heat, leading to the fibers fusing together and closing the porosity of the surface.

In previous experiments, we used steam as the activator to produce activated carbon, which resulted in a surface area of only 228 m^2/g. This demonstrates that using H_3PO_4 as the activator can significantly enhance the surface area.

To make it easier to understand, in preparing the raw materials, we calculated the ratio of the 4 mol/L acid concentration (100 mL) to the amount of waste paper (50 grams) used, which gives a weight ratio of 1:3.43.

The result from the XRD analysis showed no chemical compounds indicating the presence of only amorphous carbon. It can be explained that all substances may be evaporated due to the heat, and the compounds dissolved as a result of reactions with the acid, leaving the activated carbon free from any remaining impurities. The results of the XRF analysis confirmed that activated carbon contains no calcium remaining after carbonization. However, phosphorus compounds were present, which contributed to the acidity. Other substances were found in trace amounts, with no significant relevance.

The results of the heavy metal adsorption analysis showed that the activated carbon could adsorb Cu^{2+} only, reducing its concentration by more than half from the initial 13.18 ppm to 5.39 ppm. This can be explained by the small size of the copper compounds, which are able to penetrate and be adsorbed by the activated carbon. In contrast, the compounds of Zn and Nickel, with concentrations of 17.45 ppm and 1.79 ppm respectively, were not adsorbed as their sizes exceed the pore size of the activated carbon.

Conclusion

Compared with the steam activation, the improvement of surface area in activated carbon derived from waste paper, using H_3PO_4 acid activation is possible, and its heavy metal such as Cu^{2+} adsorption property in the fountain solution of offset printing presses. The ratio of the 4 mol/L acid concentration (100 mL) to the amount of waste paper (50 grams) used was recommended. The proper temperature of carbonization should be 500°C.

Acknowledgement

The authors would like to extend their sincere gratitude to the Chulalongkorn University Press, Dept. of Materials Science, Chulalongkorn University and Chiba University, Japan and This work was supported by JSPS Core-to-Core Program, (grant number: JPJSCCB20220006.).

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Transforming Waste Papers into Value: A Study on Papercrete Applications

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Abstract

This study emphasized the innovative use of waste paper from printing houses by investigating its application as a component in cement-based materials. The goal is to develop a sustainable material by integrating paper waste into a cement-based matrix to create a novel product. This specific type of concrete, known as Papercrete, derives its strength from the reinforcing properties of paper fibers within a binding agent, typically cement. Creating new products from waste aligns with circular economy principles, reducing overall resource extraction and minimizing environmental impacts.

Keyword: Waste Papers, Papercrete

Introduction

Papercrete is a sustainable building material made by combining paper waste with a cement-based binder, often Portland cement, and sometimes sand. The result is a lightweight, porous material with insulating properties. Its strength comes from the reinforcing properties of paper fibers and the binding action of cement.

It is primarily used in niche or DIY construction projects and is not yet widely adopted in mainstream commercial construction. It is more common in eco-conscious building initiatives and experimental structures. However, it has gained attention as an alternative sustainable material. Examples of Papercrete Products such as building blocks, panels, furniture like shelves or stools. Papercrete can be molded into various shapes to create different types of products.

Although papercrete has potential, it faces challenges such as variability in strength, moisture absorption issues, and limited standardization in production methods. Its adoption may increase as sustainable building practices continue to grow.

This project aimed to develop products such as coasters and paving blocks using the water absorption properties of papercrete to enhance their functionality. The design ensures that the coasters prevent water from pooling on their surface during use and that pavement blocks provide effective drainage during heavy rain. This approach effectively adds value to waste paper that would otherwise be discarded or cannot be recycled into new pulp.

Interestingly, when paper waste is transformed into durable products (e.g., papercrete), the carbon stored in the paper remains sequestered instead of being released during decomposition or incineration. Printing house therefore can potentially develop carbon credits based on this concept. By diverting waste paper from landfills and converting it into value-added products, the printing house contributes to measurable reductions in greenhouse gas (GHG) emissions. These reductions can be quantified and potentially certified as carbon credits under recognized frameworks. Once certified, these carbon credits can be sold in voluntary or compliance markets, providing financial incentives while promoting sustainable practices.

Experiment

Figure 1,2 illustrate the equipment and materials used in mixing papercrete and finished product. We divided the experiment into five parts as follows:

1. Materials used

- Non-recyclable waste paper from Chulalongkorn University Press
- cement
- water
- sand
- molds (for paving blocks or coasters)

2. Prepare the Paper Pulp

- shred the waste paper into small pieces.
- soak the paper in water until it becomes soft and pulpy.
- blend the pulp, sand and cement to create a smooth mixture.

3. Molding the Papercrete

- For paving blocks: fill the mold with the papercrete mixture, ensuring it's evenly distributed.
- For Coasters: Pour the mixture into mold and level the surface.

We used a weight-based mixing ratio of cement, sand, waste paper, and water, following recommendations from a ceramics expert with extensive experience in this industry. This approach was based on achieving acceptable strength levels for users, as data given in Tables 1 and 2. The ratio of cement to pulp was to control the strength and weight of the final product. Drying condition was also determined to optimize the drying process and prevent cracking.

Table 1. The ratio of the papercrete mixture for making coasters

raw materials	weight(%)	dry weight (%)
cement	33.33	40.82
ground glass sand	41.67	51.02
waste paper	6.67	8.16
water	18.33	-
Total	100	100

Note: One coaster will require a total wet weight of approximately 100 grams

Table 2. The ratio of the papercrete mixture for making paving blocks

raw materials	weight(%)	dry weight(%)
cement	32.79	39.22
construction sand	40.98	49.02
waste paper	9.84	11.76
water	16.39	-
Total	100	100

Note: One block will require a total wet weight of approximately 1.5 kg. The size of the block is 10x20x6 cm (width x length x thickness)

4. Drying the Papercrete

Oven Drying was used for faster drying at a low temperature (around 100°C). The drying process was monitor to prevent cracking

.

5. Properties assessment

The strength properties of products were determined such as bending strength for the coaster, compressive strength for the paving block.

waste paper shredder

coaster molding machine

shredded waste paper and water

mixture of pulpy, cement and sand

Fig 1. Equipment and materials used in mixing and molding papercrete

Fig 2. Finished coaster products

Results and Discussion

The two resulting products had notable characteristics: they were lighter than expected and demonstrated effective moisture or water absorption, aligning well with their intended purposes. Importantly, they offered cost savings by reducing the use of cement and sand, replaced in part by non-recyclable waste paper. This substitution contributed to a lower carbon footprint compared to traditional products. Interestingly, the strength properties, including the bending strength of the coaster at 5.10 MPa and the compressive strength of the paving block at 3.07 MPa, were within acceptable ranges for practical applications. These findings indicate the formation of strong bonds between the fine fibers, cement, and sand. However, brittleness might occur if the proportions of the three materials are not optimized.

The question then arises: what is the benefit of mixing waste papers? The answer lies with CU Press. By utilizing useless waste paper from the printing house, we could create added value by repurposing material that would otherwise be sent to landfill due to its lack of marketability for recycling. This practice not only reduces landfill waste but also provides a renewable fiber source for papercrete production process.

It is important to note that landfill disposal of waste materials inevitably harms soil and the environment, particularly through the release of greenhouse gases (GHGs). According to the Thailand Greenhouse Gas Management Organization (Public Organization), data on GHG emissions from shallow waste disposal sites, based on the IPCC Guidelines for National Greenhouse Gas Inventories – Volume 5 Waste, specifies the emission factor for paper waste at 2.93 tCO_2e/ton of paper waste (1)

Therefore, the more we produce these products in mass production, the more Chulalongkorn University Press (CU Press) can protect the Green House Gas emission. Normally, CU Press generates approximately 800-1,000 kg of this waste paper type each month, it could potentially reduce GHG emissions by up to 2.93 tCO_2e /month. This presents a significant environmental benefit in terms of reducing GHG emissions.

Conclusion

The innovative use of waste paper from printing houses as a component in cement-based materials is possible. Coasters and paving blocks are examples of products that communities or SMEs in Thailand can adopt, as there are thousands of printing houses across the country that inevitably produce waste paper. This is the case for non-recyclable waste paper, which is predominantly disposed of through landfilling—a practice that significantly contributes greenhouse gas emissions. Repurposing this waste into value-added products without resorting to landfilling represents the best alternative for printing houses. Papercrete offers a promising approach to achieve this goal, providing a sustainable and practical solution to minimize environmental impact while creating new opportunities for innovation..

Acknowledgement

The authors would like to extend their sincere gratitude to the Chulalongkorn University Press, Dept. of Materials Science, Chulalongkorn University and Dept. of Imaging and Printing Technology

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The role of color and printing technology in spring newspaper covers in Southern Vietnam before 1975

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Abstract

Preserving traditional values through period-specific cultural products has become a pressing concern in the digital age. This study analyzes the use of color and printing technology on spring newspaper covers in Southern Vietnam, aiming to identify distinctive color characteristics and their meanings in the context of traditional Tet culture. Colors such as red, yellow, and green are not only expressive elements in the design but also optimize the conveyed message, enhance aesthetic appeal, and preserve cultural and historical values. The research employs fine arts methodologies with an interdisciplinary approach, including document analysis, case studies, and SPSS analysis, to identify patterns and methods of color usage. The findings contribute to the body of research on preserving traditional cultural values while applying these insights to modern design practices.

Key words: symbolic color, Tet magazine covers, print media design, Vietnamese traditional values.

The problem description

The Spring newspaper covers in Southern Vietnam before 1975 were a remarkable cultural and artistic phenomenon, not only representing the Spring press tradition but also reflecting the development of applied science during this period. Going beyond a mere media product, the Spring newspaper covers became a convenient means to create creative artistic styles, while conveying modern cultural values and social messages, representing printing technology products during the period 1900-1975 in Southern Vietnam in particular and Southeast Asia in general. Although there are many research works on Southern journalism, such as Saigon - Old Spring Newspapers by Pham Cong Luan, mainly focusing on content or historical documents, the aesthetic values such as color and printing technology of Spring newspaper covers have not been fully studied. This opens up a necessary research gap to explore the role and influence of Spring newspaper covers in the cultural and social context of the South before 1975.

This article aims to analyze the aesthetic value of Spring newspaper covers in the South before 1975, clarifying design elements focusing on the role of color tones on the newspaper covers. The study also explores cultural, social and historical research factors that influence the composition and color of these types of newspapers, thereby identifying their role in the cultural life of the South before 1975.

The main concepts used in the study include: aesthetics, analyzing visual elements and artistic styles; culture, as the context for creating symbols to achieve characteristics; and historical documents, aiming to identify warning signs as part of the heritage of South Vietnam. The research question is: Does the color in the Southern Spring newspapers before 1975 both express the creative aesthetic value and reflect the cultural and social context of that period?

In the framework of this article, the author is a mask to clarify the role of color in the work expressing the sign of "Spring" on the cover of newspapers in the period 1986-1975 in South Vietnam, on the other hand, showing that those "spring" elements are still preserved and continuously developed in today's press, as an inherent attribute of this genre.

Methodology

The study uses a combination of qualitative and quantitative research methods to collect and analyze data related to color in the design and printing of the Spring newspaper and its role in conveying the "spring element", enhancing recognition and contributing to the creation of a typical Southern text. The data includes iconic Xuan Tieu covers, selected based on representative calculations of time, content, style and additional supporting documents from books, newspapers and related studies. Content analysis helps to decode artistic and cultural elements; comparative methods determine the relationship between color and social context.

The study applies the next guideline related to specialized research, combining art research, cultural research and press history. Qualitative methods are used, focusing on analyzing the design language of the Xuan Nam newspaper cover before 1975 through aesthetic elements such as local layout, color, illustration and symbolism. The application of the PESTEL model in the period from the appearance of the first spring newspaper in 1918 to 1975 shows strong fluctuations. The study not only explores the value of aesthetic research but also

identifies the role of color on newspaper covers as a cross between applied arts and culture, clarifying the characteristics of South Vietnam before 1975.

Spring Newspaper and Development History in Southern Vietnam

Spring newspaper covers in Vietnam have long been an indispensable part of Tet culture, representing the intersection between traditional art and modern creativity. The development of Spring newspaper covers over time, from the early 20th century to the 1950s, not only reflects changes in artistic styles but also contains profound cultural values, especially the Tet spirit. Famous artists such as Le Trung, Thai Van Ngon, or Duy Liem have contributed to shaping images imbued with national identity, from apricot blossoms, peach blossoms to warm family scenes, the prosperity of Spring. The formation and development of the Spring newspaper cover can be divided into three main stages: the early stage from 1918 with the first improvements in layout and color, the 1930s-1940s when the visual style became more distinct, and the 1950s, when the Spring newspaper cover reached its peak in terms of aesthetics and the combination of modernity and tradition. Famous newspapers such as Sai Gon Moi, Thoi Luan, and Tia Sang not only published beautiful Spring newspaper covers but also served as a tool to reflect the cultural spirit of Tet in the South, contributing to preserving and promoting traditional values in the modern era. After Nam Phong, other newspapers such as Dong Thap (1927), Than Chung (1929), and Phu Nu Tan Van (1930) continued to develop and enrich the Spring newspaper tradition. In particular, Phu Nu Tan Van contributed significantly to shaping the design style of the Spring newspaper cover, not only through hand-drawn illustrations but also through the representation of typical images of Tet. The cover of this newspaper became a model, influencing later generations of Spring newspapers.

From 1930 to 1975, Spring newspapers in the South developed strongly. These publications were often designed by professional artists, trained in fine arts schools. The Spring newspaper covers during this period were not only works of applied art but also valuable graphic collections, reflecting the customs and characteristics of the culture and social life of the South. By combining illustrations and aesthetic elements, Spring newspapers became an important means to promote national cultural values in the historical and social context of the South at that time.

Cover of Phu Nu Tan Van Xuan Newspaper 1933, 1934

Color and layout characteristics on Spring newspaper covers through the ages

Spring newspaper covers have become an important part of the Vietnamese cultural communication system every time Tet comes. Over time, artists have created works that not only have high aesthetic value but also contain profound cultural messages about Spring and the traditional Tet. These report covers creatively use familiar symbols of Tet such as apricot blossoms, peach blossoms, lucky money envelopes, or images of families gathering together, expressing the full and warm atmosphere of Tet, creating a connection between visual arts and people's cultural life. One of the important factors contributing to the overall beauty of the Spring newspaper cover is the layout and color. Artists often use local layouts, not bound by fixed templates, to create rich and diverse images, reflecting the flexible and changing light of Spring. The main colors such as red, yellow, and green not only have aesthetic value but also have deep cultural meaning. Red symbolizes luck, yellow symbolizes prosperity and green symbolizes hope, which are the desired gifts every Tet holiday. In particular, the 1932 Phu Nu Tan Van cover is a typical example with the combination of bright colors and flexible layout, creating a product that is both aesthetically pleasing and fits the spacious spring atmosphere.

The illustrations on the cover of the Spring newspaper also reflect the constant creativity of artists through each period. Familiar images such as young women in ao dai, apricot blossoms, peach blossoms or composite family scenes can be displayed from many different angles, from simple images to deep scenes. This not only highlights the beauty of spring but also reflects the connection between art and valuable cultural specialties of Tet. The Spring newspaper of the previous decade still clearly shows the drawing style of folk paintings, especially Dong Ho paintings, with highly stylized drawings but still remains close and easy to understand for readers. This has helped the Spring

newspaper become a work of art with high aesthetic value, while reflecting the spirit and national identity.

In addition to the colors and illustrations, the font and presentation style on the Spring newspaper also play an important role in creating the characteristics of the product. Fonts are often designed in a stylized, commercial and adaptive way but still maintain solemnity, and can honor the traditional Tet festival. On covers such as Saigon Moi or Thoi Luan, this font does not have the function of conveying information but contributes to creating an aesthetic space, which can present freshness and joy while still maintaining the solemnity of Fatal of spring.

The cover of the Spring newspaper is not simply beautiful images but also contains profound cultural messages. The artists have cleverly incorporated elements of Tet culture, such as the scene of a family riding a horse to welcome Tet, conveying spiritual values of hope, reunion and happiness. According to research by M.X. Kagan, assessing the aesthetic value of an art product is not only a combination of form and content but also reflects the spiritual and ideological values of society. Therefore, the cover of the Spring newspaper is not only a simple art product but also a convenient means of conveying messages about spring, about innovation and faith in the future. In short, the cover of the Spring newspaper over time has undergone strong changes but still retains the core elements of Tet culture. Artists have contributed significantly to the creation of beautiful, profound works, while reflecting the spirit and national identity. Creativity in the design of the Spring newspaper cover not only demonstrates artistic talent but is also a way to preserve and promote traditional cultural values, reflecting the good wishes of people during Tet.

Cultural, aesthetic and application values of spring newspaper cover design in South Vietnam before 1975

Aesthetic and cultural values

The cover of the Spring newspaper is a wonderful combination of art and culture, with visual elements reflecting the spirit of Tet and spring. Artists in the period before 1975 skillfully used colors and images to create a joyful and warm atmosphere of the Lunar New Year. Red, yellow, and green, the main colors on the cover of the Spring newspaper, not only have aesthetic meanings but also symbolize profound spiritual and cultural values. Red symbolizes luck, yellow is associated with prosperity, while green symbolizes vitality and new beginnings.

The layout of the Spring newspaper cover is often freeform, with illustrations placed as the focus. Illustrations combine convention and visual space with a single point of view, the main colors such as red, yellow, and green not only have aesthetic meanings but are also associated with the symbol of Tet and luck. For example, the cover of Phu Nu Tan Van (1933) uses a flexible layout, emphasizing the correlation between large and small color blocks to create a harmonious visual effect. This is a form of innovative design and layout based on the exploitation of traditional fine arts and modern aesthetic design.

Each illustration used on the cover of the Spring newspaper is an important part in building the cultural and spiritual space of Tet. Flowers such as apricot and peach are not only considered symbols of spring but also images imbued with Vietnamese cultural identity, especially in the context of Tet Nguyen Dan. Images of family reunions, Ong Cong Ong Tao, or familiar scenes such as grapefruit, banh chung, banh tet, clearly depict the spiritual values of reunion, warmth, and respect for ancestors, creating a full atmosphere of traditional Tet.

In addition, typography also plays an important role in conveying cultural values. The soft, curvy fonts, combined with the reasonable arrangement in space, create a feeling of both solemnity and joy. The fonts on newspaper headlines such as Sai Gon Moi or Thoi Luan are often stylized to harmonize with the overall feeling, creating a joyful but still solemn feeling, in line with the festive spirit. These details not only serve aesthetic purposes but also serve as a means to highlight the atmosphere of Tet, while evoking emotions about tradition and the joy of family reunion. Spring newspaper covers can be considered a form of folk graphic art, where the creativity of artists harmoniously combines with traditional values of the nation. Throughout the years, the images on the covers of Spring newspapers have always maintained a closeness and accessibility to the majority of the public. These images are not only aesthetic in nature but also evoke beautiful memories, about a warm, family-friendly Tet time. Each Spring newspaper cover, therefore, becomes a precious spiritual gift, helping Vietnamese people preserve and spread indispensable cultural values during Tet holidays

Application in modern design

With the strong development of technology and modern design needs, the design principles applied in the covers of Southern Spring newspapers before 1975 can still be applied in contemporary design products. Research on Spring newspaper covers not only helps to discover typical aesthetic elements but also provides valuable lessons for today's designers in incorporating cultural values into graphic design. Elements such as the use of bright colors, easy-to-understand and inspiring illustrations, along with balance in layout, can all be applied to modern designs. For example, in designing Tet product packaging

or Tet advertising campaigns, designers can take advantage of red and yellow colors to create connections with traditional cultural values, while demonstrating modernity and creativity in the use of images and fonts. Applying these principles helps design products not only be beautiful but also have a strong cultural character, creating closeness and familiarity with consumers.

In addition, the Spring newspaper covers can also become an important tool in graphic design education. Studying Spring newspaper covers not only helps students and young designers better understand how to combine art and culture, but also creates lessons on how to create an aesthetic space suitable for cultural content, laying the foundation for future design products. In fact, applying design principles from Spring newspaper covers to teaching and training graphic design can contribute to raising awareness of the importance of combining artistic elements and cultural values in creative work.

In addition, in some modern design fields such as web design, multimedia design or online advertising design, traditional design principles from Spring newspaper covers can also be applied to create products with high aesthetic value and in line with market trends. The application of colors, images and layouts from Spring newspaper covers helps products become more attractive and accessible, while not losing cultural value in the modern context. It can be seen that old Spring newspaper covers are not only a part of Vietnamese art history but also a rich source of inspiration for contemporary designers. Preserving and applying design principles from Spring newspaper covers not only contributes to preserving traditional cultural values but also plays an important role in developing the Vietnamese graphic design industry, creating products that are both modern and imbued with national cultural identity.

Conclusion

This study has shed light on the important role of Spring newspaper cover design in Southern Vietnam before 1975, not only in expressing unique aesthetic values but also reflecting the fusion of Eastern and Western cultures. Through illustrations and the subtle combination of colors, styles and printing techniques, the Spring newspaper cover designs clearly expressed the spirit of traditional cultural values of Tet Nguyen Dan in a new visual language, reflecting the fusion between national artistic heritage and Western influences. Each newspaper cover design is not only an aesthetic work but also an expression of the soul, intelligence and cultural spirit of the Southern people, especially in the modern context, where visual arts have developed and changed dramatically. Visual elements such as red, yellow and illustrations (peach blossoms, apricot blossoms, zodiac animals) not only have profound cultural meanings but also reflect the development and transformation in graphic arts through the periods. Colors, especially red and yellow, are used not only as a symbol of Tet, but also play an important role in creating aesthetic space and enhancing cultural values in design. Over time, the change in the way colors and images are expressed has reflected the development of visual arts in the design of Spring newspaper covers, from traditional elements to the combination with modern techniques.

The study has also pointed out similar and different values in the design of Spring newspaper covers, creating diversity in graphic arts and expressing the mark of a period in the history of Southern fine arts in the early 20th century. The newspaper covers are not only illustrations for Tet Nguyen Dan but also the product of a dialogue between traditional and modern art, with a creative combination of Vietnam cultural, historical and political elements. Although influenced by two cultures, East and West, these works still retain the characteristics of the Southern cultural spirit, demonstrating innovation, creativity and continuing the aesthetic value of Vietnamese fine arts. The research results not only provide an important theoretical foundation for graphic designers, but also open up new directions for future research on journalism and Spring newspaper cover design. Further studies can continue to explore the influence of Spring newspaper cover design in relation to contemporary fine arts, and further research on the application of visual elements in preserving and promoting cultural values through modern design. In addition, the study also suggests opportunities for developing Spring newspaper cover design strategies in a modern context, with an important role in transmitting and educating cultural values to future generations.

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Application of Artificial Intelligence (AI) in Vietnamese food packaging design - Trends and challenges

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Abstract

Since the Fourth Industrial Revolution, the food packaging design industry in Vietnam has witnessed significant advancements thanks to the integration of modern technology, especially Artificial Intelligence (AI). This study focuses on analyzing the trends, impacts, and challenges of applying AI in packaging design, aiming to enhance user experience and increase the smart interactivity of products. The research aims to explore the potential of AI in enhancing aesthetic value, asserting differentiation, and promoting the positioning of Vietnamese packaging brands in the international market. To achieve this goal, a multidisciplinary approach, including document analysis, case studies, and SWOT analysis, is applied to comprehensively assess the benefits and capabilities that AI brings in meeting the increasingly stringent market demands.

Key words: *AI packaging, artificial intelligence, food packaging, packaging design*

1. Problem statement

In the context of economic recovery and increased domestic consumption, the food packaging industry in Vietnam is facing great development opportunities. According to Vietnam Report, the packaging industry is expected to boom by the end of 2024 thanks to the expansion of the food, beverage, and e-commerce markets (Tuoi Tre Online, 2024). Currently, with more than 14,000 operating enterprises, the packaging industry has affirmed its important position in the national economy, especially in the food and beverage segment (Vietnam Economic Association Electronic Magazine, 2023). A recent survey by Vietnam Report shows that the growth of the packaging industry by the end of 2024 is largely driven by the recovery of domestic consumption, especially in the food, beverage, and e-commerce sectors (E-Magazine of Economics and Beverages, 2024). These figures not only demonstrate the industry's outstanding growth potential but also emphasize the essential role of food packaging in meeting the needs of both domestic and export markets, contributing to sustainable economic growth.

The rapid development of the food packaging market imposes new demands on aesthetics, differentiation, and sustainability in design. To remain competitive, brands need packaging that not only effectively protects their products but also reflects their brand values and minimizes environmental impacts. In this context, artificial intelligence (AI) has emerged as a comprehensive solution, enabling the packaging industry to address current challenges and foster innovation in design and production. AI's ability to analyze data, predict consumer trends, and optimize production processes minimizes errors, reduces costs, and enhances creativity in design.

Beyond optimizing the design and manufacturing processes, AI also enables the creation of smart packaging solutions that facilitate direct interaction and promote sustainability. According to a report by McKinsey & Company, integrating AI into food packaging production can reduce costs by up to 20% while improving quality control efficiency (McKinsey & Company, 2020). Similarly, Deloitte, a global leader in auditing, management consulting, finance, tax, and risk, highlighted that AI application has increased design productivity by up to 30%, thanks to its ability to predict consumer trends and personalize products (Susanne Hupfer, 2020). These advancements bring not only economic benefits but also enhance customer experience, strengthening the connection between brands and consumers.

This research aims to evaluate the critical role of AI in enhancing the aesthetics and creativity of food packaging while fostering intelligent interactions, optimizing design processes, and promoting sustainable solutions within Vietnam's food packaging industry. By exploring AI applications in the packaging sector, the study demonstrates how AI supports brands in improving packaging quality and creating designs that fulfill aesthetic expectations, align with sustainability goals, and cater to modern consumer trends.

The research approach includes:

- **Literature Analysis:** A review of prior studies, industry reports, and case studies on AI applications in the food industry.
- **Case Studies:** An analysis of real-world examples of brands applying AI in packaging design, providing practical insights and lessons learned.
- **SWOT Analysis:** An evaluation of the strengths, weaknesses, opportunities, and challenges associated with AI applications in Vietnam's food packaging sector to understand factors affecting AI's success.

This study offers a comprehensive perspective on AI's applications in food packaging design while identifying the difficulties businesses may face during the adoption of new technology. It concludes with practical recommendations for businesses and policymakers to effectively develop and implement AI technologies, thereby improving packaging quality, enhancing competitiveness, and advancing sustainable solutions in Vietnam's food packaging industry.

2. Current popular applications of AI in Food Packaging

2.1. Intelligent Packaging

Intelligent packaging, also referred to as smart packaging, represents a cutting-edge technological innovation in packaging systems. Unlike traditional packaging, which primarily serves to contain and protect products, intelligent packaging integrates functionality that provides added value to both consumers and producers. According to Raghu Das (2020), intelligent packaging *"goes beyond the basic function of passively containing and protecting the product by adding useful functionality with real benefits for the consumer"*.

This emerging technology leverages advanced communication capabilities to enhance decision-making processes, ensuring improved food quality and safety (Yam, Tashitov, & Miltz, 2005). Intelligent packaging systems incorporate tools designed to monitor both the packaged food and its surrounding environment, enabling dynamic responses to changing conditions (Yousefi et al., 2019). A key application of intelligent packaging lies in the food industry, where it is used to monitor the condition of perishable goods such as meat. By capturing and providing real-time information about product quality during transport and storage, intelligent packaging helps extend shelf life and enhance food safety (Kerry, 2006; Ghaani, 2016). Furthermore, it can perform complex functions, including sensing, detecting, tracing, recording, and communicating critical information about the product (Realini, 2014).

Intelligent Sensor Packaging

Sensor-enabled intelligent packaging integrates sensor technologies to monitor and provide information about the product's condition throughout storage, transport, and consumption. These sensors ensure product quality and improve the consumer experience. Common types of packaging sensors include:

- *Time-Temperature Indicators (TTIs):* These sensors track and alert changes in temperature during the transport and storage of perishable foods such as milk and frozen goods, ensuring the appropriate temperature is maintained (Image 2.1).
- *Gas Sensors:* These sensors detect and measure gases like CO_2 and O_2 to monitor food freshness. Packaging can change color to alert consumers when the product is spoiled or unsafe (Image 2.2).
- *Freshness Indicators:* These evaluate food freshness through changes in pH or microbial activity. For example, the RipeSense label enables customers to identify fruit ripeness through color changes (Image 2.3).
- *Moisture Sensors:* These sensors monitor changes in humidity to protect dry goods, spices, and moisture-sensitive products, preventing microbial growth.
- *Light Sensors:* These sensors track light exposure to protect light-sensitive foods such as beer and vegetable oils from oxidation and spoilage, thereby extending shelf life.

These technologies significantly improve food preservation, ensure safety, and contribute to sustainable development within the food packaging industry.

Image 2.1: TTI sensor packaging.

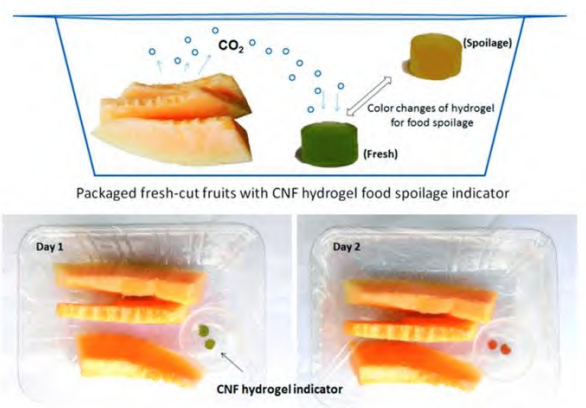

Image 2.2: Expired product warning packaging

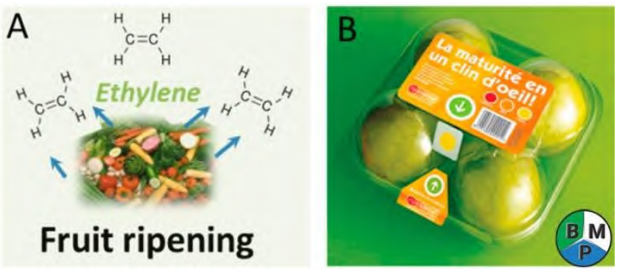

Image 2.3: RipeSense is the first smart sensor label that works by responding to the aroma emitted by the fruit, indicating the ripeness of the fruit. The sensor initially appears red and turns orange and finally turns yellow.

2.2. Interactive Packaging

Interactive packaging can be defined as packaging that incorporates technology to allow consumers to interact with the product or brand through features like QR codes, augmented reality (AR), or near field communication (NFC). This type of packaging is designed to engage consumers in a more personalized, informative, and fun way." (Packaging World, 2020). Interactive packaging allows consumers to engage with products on a deeper level by offering dynamic experiences through modern technologies. The goal is to enhance the consumer experience, increase brand engagement, and provide useful information" (Tetra Pak, 2021). Interactive packaging is fun, memorable, innovative, and a practical means of promoting customer loyalty while maintaining a dynamic relationship between a brand and a customer base.(Atlas, 2022).

Augmented reality (AR) packaging offers significant benefits, particularly in the food industry, by integrating technology to optimize user experiences and enhance marketing effectiveness. First, AR packaging captures attention and increases consumer engagement through rich digital content such as graphics, videos, and interactive games. This creates a captivating "wow" effect, making products stand out on shelves. Additionally, AR packaging enhances user experiences, especially for younger audiences or children, by incorporating games or educational information, fostering a sense of connection and enjoyment during product use. Moreover, AR packaging is highly flexible, allowing for easy updates to content for special events or promotional campaigns. Importantly, AR packaging is cost-effective. By incorporating QR codes and developing AR content, businesses can add significant value to their products without the need for complex physical redesigns of packaging, optimizing budgets while delivering high-impact results. These benefits make AR packaging a powerful tool for food brands to strengthen customer connections and differentiate themselves in a competitive market.

Leading brands have leveraged AR packaging to appeal to Millennials, a demographic that values technology and interactive experiences. According to SmartTek Solutions, AR transforms packaging and labels into powerful marketing tools, helping brands not only stand out on shelves but also become an integral part of the customer journey. A report by PwC (2022) highlights that the integration of AI and AR in food packaging creates aesthetic differentiation and fosters long-term relationships with consumers.

PepsiCo is one of the pioneering brands utilizing AR technology in its packaging. At the 2024 Cannes Lions International Festival of Creativity, Pepsi introduced the "Smart Can," an innovative interactive portal equipped with a digital screen, advanced audio systems, and motion sensors. This groundbreaking packaging delivers a personalized experience for fans through exclusive content, access codes, and promotional programs.

Image 2.4: Smart Can of Pepsico

The Jack Daniel's whiskey brand has utilized AR technology to provide customers with a virtual tour of their distillery from the comfort of their own homes. By scanning the whiskey bottle with their smartphones, customers can embark on an immersive virtual experience, exploring the whiskey production process and learning about the brand's history. Through AR, Jack Daniel's vividly showcases its story and heritage while strengthening consumer engagement, delivering a fresh and captivating experience for customers.

Image 2.5: Jack Daniel's Whiskey Packaging

Glico, a renowned Japanese confectionery brand, used AR technology on the packaging of products like Pocky and Pretz to promote the film *"Stand By Me Doraemon."* The packaging featured illustrations of

Doraemon and his friends, allowing customers, especially children, to color them and scan through a mobile app. The Doraemon character then "came to life" in 3D on the screen, offering a unique interactive experience at home. This campaign not only helped promote the movie but also enhanced customer engagement with the products by creatively blending traditional animation with modern technology, thereby elevating Glico's brand value in the eyes of consumers.

Image 2.6: Glico packaging

In addition to AR, AI is also applied in packaging through smart QR codes, providing detailed product information, fostering trust in the brand, and offering unique experiences for customers. Coca-Cola's packaging utilizes Etik technology, enabling interaction with users' smartphones. By scanning the QR code on the plastic label, users can access Coca-Cola's exclusive website featuring engaging content such as games, videos, and music, and even customize the label's imagery for a personalized experience. This packaging innovation demonstrates the integration of technology to create a new consumer experience.

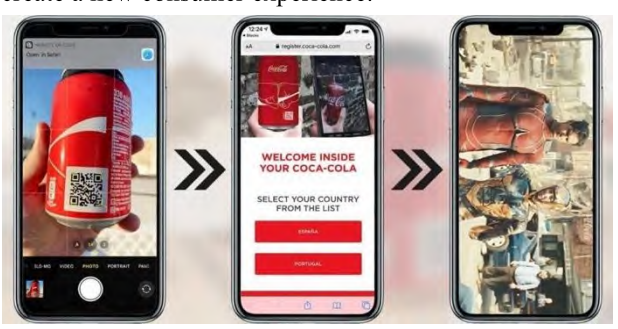

Image 2.7: Coca-Cola's Etik Packaging

The PepsiCo's *LIFEWTR AR Experience* campaign is another example of merging product packaging with digital art. When customers scan the packaging with their smartphones, 3D artworks appear on the screen, providing an interactive and visually engaging experience. These artistic visuals not only highlight the brand's creative messaging but also reflect the connection between the product and artistic values, which are central to the LIFEWTR line. This campaign exemplifies innovative packaging design and showcases the effectiveness of modern technology in brand communication, while enhancing user experience in a more dynamic and immersive way.

Image 2.8: LIFEWTR Packaging by PepsiCo

Additionally, packaging can be designed with special features like LED lights, sound effects, or touch sensors to create novel interactive experiences for users. These features help distinguish products and enhance customer interactions with the brand and product. Heineken introduced the *Heineken Ignite* beer bottle, an innovative product integrating Bluetooth technology and LED lights to create a unique experience at events and festivals. The bottle lights up in sync with music, reacts when users raise it, drink, or clink bottles together. Bluetooth technology connects the bottles to sound and lighting systems at events, creating impressive synchronized effects. The *Heineken Ignite* is not just a beer product but an interactive tool, fostering connections between consumers, the product, and the surrounding environment.

Image 2.9: Heineken Ignite Beer Bottle with Bluetooth and LED Lights

2.3. Personalized Packaging

Personalized packaging is the process of customizing the design and messaging on packaging to cater to the specific preferences and needs of individual customers or customer groups. The goal of this approach is to establish a deeper connection between the brand and the consumer, enhance the user experience, and foster brand loyalty. According to Emarsys, personalized marketing is a method of delivering tailored content to

specific audiences through data collection and analysis. AdAge magazine notes that this requires the integration of accurate data and advanced technology, particularly on a large scale (Brands Vietnam, 2019). Additionally, Deloitte Consumer Review highlights that over 50% of Millennials and Gen Z prefer personalized products, demonstrating the significant potential of this strategy in attracting younger generations (Deloitte, 2024).

The application of AI has significantly enhanced the ability to personalize packaging, enabling brands to optimize processes and meet diverse consumer needs. According to Huang and Yang (2019), AI can analyze customer behavior and data to create designs tailored to individual preferences, thereby improving customer satisfaction and emotional connection with the brand. Another study by Smith et al. (2020) indicates that personalized packaging helps brands stand out among competitors while delivering memorable experiences and positive emotions to customers. AI enables the customization of packaging designs for specific customer segments by analyzing consumer behavior and personal preferences. This not only strengthens consumer-brand relationships but also drives sales.

Several major brands have successfully utilized AI in personalized packaging campaigns. Nutella, a renowned hazelnut chocolate spread produced by Ferrero, launched the "Nutella Unica" campaign, leveraging AI to create 7 million unique, non-repeating packaging designs. Each jar featured a distinct design, combining diverse patterns and colors to offer a personalized experience for consumers. This campaign, conducted in Italy, received positive feedback from the market (Digital Strategy Consulting, 2021).

Image 2.10: Individually created Nutella packaging.

Heinz launched the "Get Well Soup" campaign to encourage customers to send personalized cans of soup with the message "Get Well Soon" to their loved ones who are unwell. Through Heinz's Facebook page, users could order soup cans with the recipient's name printed on the label, creating a meaningful and unique gift. This campaign not only strengthened the connection between the brand and its customers but also demonstrated Heinz's deep care for the community.

Image 2.11: Heinz packaging allows users to add names for personalized gifts.

Oreo implemented the "Oreo Colorfilled" campaign, which allowed customers to personalize Oreo packaging according to their preferences. Through the official website, users could choose from a variety of designs, colors, and add personal messages to create unique packaging.

Image 2.12: Oreo packaging allows users to customize colors before purchase.

By enabling applications such as name printing, personalized messages, or customized designs based on regional characteristics, artificial intelligence (AI) has enhanced the perceived value of products while fostering a deep emotional connection between brands and consumers. These solutions not only increase customer loyalty but also help brands assert their position and stand out in an increasingly competitive marketplace.

2.4. Unique packaging with 3D printing technology and ink

3D printing technology is not only an advanced technical solution but also plays a significant role in enhancing the aesthetics of food packaging. The ability to create complex and unique designs that surpass traditional mold limitations makes 3D printing a powerful tool for adding value to products. According to Huang et al. (2019), this technology fosters exceptional creativity, enabling brands to produce standout packaging that captures consumer attention.

3D printing also supports the integration of sophisticated decorative elements, unique geometric effects, and tactile experiences, distinguishing products on shelves. Furthermore, this technology allows for quick prototyping of various design versions, meeting personalization needs and improving brand recognition (Pan, Liu & Yin, 2019).

In 2018, PepsiCo collaborated with Marvel Studios to create a special edition product line combining soda cans with the movie Black Panther. The main characters were featured on specially designed cans, each adorned with vivid and realistic 3D-printed images. This packaging set also included accessories such as tablets, comic books, LED-lit display boxes, and 3D-printed masks. The use of 3D printing in packaging design generated unique products and attracted significant attention on social media and online platforms.

Image 2.14: Pepsi cans featuring characters from Black Panther, utilizing 3D printing and LED technology.

On the occasion of its 150th anniversary, Beck's experimented with AI in marketing and product development. Combining human expertise with AI technology, Beck's introduced the world's first beer designed and marketed entirely by AI. Using ChatGPT and MidJourney, Beck's developed the packaging and branding for its new product, Autonomous. AI managed the entire design process, from editing to finalizing the product (Figure 2.15).

Image 2.15: Beck's can design created using 3D printing technology.

Beyond aesthetics, 3D printing reduces material waste, enhances product protection features, and improves production efficiency. For instance, PepsiCo employed 3D printing technology to manufacture precision molds for bottles, saving costs and shortening production time, ultimately enhancing product quality and competitiveness (Image 2.13).

Figure 2.13: Bottle mold made with xPEEK147-Black material on Nexa3D NXE 400.

In addition to 3D printing, the application of special inks significantly enhances the visual appeal and attractiveness of packaging. A notable example is Coors Light, which uses thermochromic ink to create a unique color-changing effect. When the beer can is chilled, the mountain emblem becomes vividly visible due to the color transformation of the thermochromic ink, indicating the ideal drinking temperature. This effect not only delivers a fun, interactive experience but also strengthens brand recognition (Image 2.16).

Image 2.16: Coors Light can with thermochromic ink (mountains turn blue when cold).

Similarly, Purdey's Natural Energy Drink bottles are designed with thermochromic technology that reveals information about the product's vitamins as the temperature changes. These applications demonstrate the potential of special inks in combining aesthetics with functionality, enhancing user experience and reinforcing brand image (Image 2.17).

Image 2.17: Purdey's Natural Energy Drink bottle using thermochromic ink.

The combination of 3D printing technology and innovative inks not only brings unique aesthetics but also plays a vital role in promoting sustainability in food packaging design. 3D printing minimizes material waste through precise shaping capabilities while optimizing the use of recycled and eco-friendly materials. Paired with special inks like thermochromic or AI-enabled inks, packaging becomes more appealing and interactive, meeting the needs of modern consumers.

2.5. Packaging Design Based on Consumer Trend Analysis

Through machine learning algorithms, AI can identify and predict packaging design trends, including preferences for colors, shapes, materials, and layouts. For Vietnam's food packaging industry, AI not only helps capture consumer preferences but also enables the creation of highly localized and personalized designs. These designs position packaging as a crucial element in expressing cultural identity and elevating national branding.

Coca-Cola has utilized AI to analyze data from social media and vending machines to identify aesthetic preferences in various markets. Insights from this process allow the company to adapt its packaging designs to align with local cultural nuances, enhancing brand engagement with consumers. A notable example is the Coca-Cola Y3000, which represents a fusion of design artistry and artificial intelligence. This futuristic packaging design was developed based on AI-analyzed data and visuals generated using the Stable Diffusion image synthesis model (Benj Edwards, 2023).

Figure 2.18: Coca-Cola can with futuristic design created using AI-analyzed and synthesized visuals.

In the "Ketchup AI" campaign, Heinz leveraged the DALL-E 2 AI tool to analyze thousands of ketchup-related images, generating packaging designs that mirror the imagery customers associate with ketchup. Using keywords like "ketchup" or "tomato ketchup," AI produced unlabeled ketchup bottle images that resembled Heinz's iconic look. This led to the statement, "Even AI recognizes that 'ketchup' looks like Heinz." The campaign not only reinforced Heinz's brand identity but also showcased innovative creativity in using AI for advertising, capturing significant consumer attention.

Figure 2.19: Heinz utilized AI to analyze thousands of ketchup-related images.

3. Challenges and Obstacles in Applying AI to Food Packaging Design in Vietnam

In the context of rapid technological advancement, artificial intelligence (AI) is increasingly asserting its significant role in the food packaging design sector. With its ability to foster creativity, personalize consumer experiences, and strengthen brand-customer connections, AI enhances design quality and provides sustainable competitive advantages. However, the integration of AI into Vietnam's packaging industry faces several significant challenges.

Lack of technological infrastructure: The uneven development of technological infrastructure in Vietnam presents a major barrier, particularly for small and medium-sized enterprises (SMEs). Many companies lack the advanced machinery and software needed to integrate AI into design and production processes. According to the Ministry of Industry and Trade (2022), over 70% of Vietnamese businesses face difficulties in digital transformation, including AI adoption. While major cities such as Ho Chi Minh City and Hanoi exhibit strong technological growth, rural and mountainous regions struggle with inadequate infrastructure, hindering the effective implementation of AI solutions.

High initial investment costs: Implementing AI requires significant initial investments, including costs for software, hardware, and staff training. This challenge is especially pronounced for SMEs, which account for over 95% of Vietnam's total enterprises (PwC Vietnam, 2022). Although AI can optimize costs in the long run, the upfront and maintenance expenses discourage many companies from embracing this technology.

Shortage of skilled workforce: AI applications in packaging design demand personnel with deep expertise in both technology and aesthetics. However, Vietnam faces a severe shortage of such skilled professionals. Training employees to work with AI tools requires time

and resources, adding to the challenges for businesses attempting to adopt new technologies.

Integration difficulties in production processes: Vietnam's packaging production processes are largely manual and lack technological consistency. Integrating AI requires significant changes to existing production workflows, which may disrupt operations and incur additional costs for system upgrades. Balancing current production efficiency with technological transition remains a challenge for many companies.

Data management and security issues: AI relies on processing large volumes of consumer and product data. However, many businesses lack effective data security systems, making data protection and privacy a significant challenge. Implementing complex data management systems demands high investment levels, which smaller companies are often reluctant to undertake.

Limited awareness: Some businesses perceive AI as unnecessary or overly complex. According to a Deloitte Vietnam (2022) survey, only 23% of companies in the food and beverage sector fully understand the benefits of AI. This lack of awareness not only affects businesses but also slows consumer acceptance of smart packaging, making it difficult to shift usage habits and embrace new technologies.

While AI offers transformative potential for the packaging industry, its effective implementation in Vietnam requires concerted efforts in technological infrastructure development, workforce training programs, and supportive government policies. Raising awareness about AI and its benefits is also crucial for driving digital transformation and enhancing the competitiveness of the packaging sector in the digital age.

4. Conclusion

Artificial intelligence (AI) has become a vital force driving innovation in the food packaging design industry. Beyond delivering creative and personalized solutions, AI optimizes production processes, improves economic efficiency, and meets sustainability goals. These advancements are particularly significant as Vietnam's food and beverage sector experiences robust growth, requiring modern, aesthetically appealing, and environmentally friendly packaging solutions.

However, domestic businesses face numerous challenges. Limited technological infrastructure, high initial investment costs, and a critical shortage of skilled AI professionals are major barriers. Additionally, integrating AI into traditional production workflows and addressing data security and processing demands necessitate significant investment and preparation.

Maximizing AI's potential in packaging design requires close collaboration among businesses, the government, and educational institutions. The government must play a supportive role through financial incentives, technology adoption promotion, and specialized workforce training programs. Businesses need to embrace innovation, invest in technological infrastructure, and develop long-term strategies while enhancing their understanding of AI's benefits.

AI is not merely a supporting tool but a strategic element shaping the future of Vietnam's food packaging industry. Overcoming current challenges will enable Vietnam's packaging sector to enhance global competitiveness and foster sustainable development, creating balanced value across economic, social, and environmental dimensions.

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Impact of cultural factors on packaging design process

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Abstract

In the context of globalization integration, all areas of social life are changing rapidly and traditional cultural values are increasingly being promoted and valued. The development of national cultural identity into graphic design products contribute to promote Vietnamese culture to be more advanced and imbued with national identity, especially when there are many foreign elements appearing in many places. The system of cultural transmission has been corrupted and lost. On the other hand, application design products in general and packaging products in particular are also an effective communication channel in preserving and promoting the cultural values of the ethnic community to consumers and today. The more famous the image of the people and country of Vietnam in the eyes of foreigners. Cultural factors in packaging products become a bridge connecting the contributions that create the values of a brand, containing the characteristics and soul of the nation to consumers in all countries around the world. Thence, it not only contributes to improving trade efficiency, increasing sales but also creating influence and enhancing the country's position in the international community.

Keywords: Design, Application design, Packaging products, Product design.

Introduction

Cultural identity has long been an inexhaustible source of inspiration and a valuable foundation in the field of creative design. Today, products bearing the hallmarks of national cultural identity not only captivate with their uniqueness but also reflect a creative transformation, contributing to the promotion of traditional values among younger generations. Integrating traditional cultural elements into design not only fosters the preservation and enhancement of national identity but also carries profound social significance, particularly when designers skillfully unveil hidden beauty and convey inspiration drawn from distinctive cultural values.

Products that incorporate traditional images and patterns often resonate deeply with a sense of national pride and the innate familiarity within the hearts of individuals. This simplicity and authenticity have turned such creations into cultural symbols, setting them apart from similar products. Amidst an increasingly competitive market, the infusion of indigenous cultural elements has become a unique highlight, elevating brand value and drawing consumer attention.

In the past, packaging was primarily regarded as a means to protect products. Today, however, it has evolved into the "face" of both products and brands. Modern packaging design not only influences consumer behavior but also serves as a powerful promotional tool, enhancing brand image and competitive value. The packaging industry is undergoing significant innovations in materials, shapes, and colors to meet the ever-growing demands of consumers, including trends favoring eco-friendliness, high aesthetics, and multifunctionality.

Against this backdrop, the development of national cultural identity has become more urgent than ever. Incorporating cultural identity into graphic design not only aids in preservation but also helps to advance and disseminate Vietnamese cultural values innovatively and creatively. Leveraging and developing national identity in design strengthens national unity and serves as a bridge to introduce Vietnamese culture to the world.

Several prominent projects exemplify the success of this trend. In 2015, the "Hoa Van Dai Viet" (Patterns of Great Vietnam) project, initiated by the Dai Viet Co Phong group, recreated traditional patterns in vector form and applied them to daily products. This project not only gained widespread support but also effectively connected traditional culture with the younger generation. Similarly, in 2017, the series of posters for the traditional Vietnamese opera "San Hau," utilizing the bamboo pulp medium Truc Chi, won the American Graphic Design Award 2017 in the Student Design category, affirming the power of blending traditional art with modern design.

Figure 1. Poster set of the play “San Hau”

Additionally, the costumes designed for Vietnamese representatives at Miss Universe have garnered significant international attention. Creations such as "Hon Viet" (Soul of Vietnam, 2017) and "Banh Mi" (Vietnamese Baguette, 2018) not only created a global buzz but also highlighted Vietnam's cultural identity to the world. These designs have become cultural symbols, strengthening ties between overseas Vietnamese communities and their homeland while igniting national pride.

Artistic products in applied fine arts and graphic design have emerged as effective tools in preserving and promoting the cherished traditions of the nation. The more these artworks draw from Vietnam's unique cultural imagery, the more they contribute to building a vibrant and beautiful nation, enhancing Vietnam's stature in the eyes of the global community.

Cultural elements in product packaging

Factors Influencing the Design Process

- **Typography in Design**

Language serves as a vital element in facilitating communication between a product and its users, making it an indispensable aspect of product design. Alongside factors like color, symbols, and characters that shape the design approach, language plays a critical role in conveying a brand's story and information to a broader audience.

Typography, which encompasses systems of symbols recorded in written form, represents the expression of language through the use of characters or symbols. In product design, typography fulfills two primary functions: first, to deliver information effectively, and second, to enhance the aesthetic appeal of the product. By capturing attention and engaging customers, typography adds value through its dual-purpose functionality.

Figure 2. Candy label.

It is a miraculous gift and the creative result of human civilization, carrying immense cultural and historical value while encompassing rich ideas, content, and artistry. Each nation possesses its own unique script and culture, contributing to the vast diversity of writing systems worldwide.

To facilitate trade and commerce among countries, designers must incorporate not only local scripts but also English, the global lingua franca. However, it is crucial to note that words with positive connotations in one country may carry negative or even inappropriate meanings in another. Thus, it is essential for designers to have a deep understanding of languages and use them appropriately—a critical skill for any graphic designer.

"The spirit of an era spans vast territories and nations, with its imprints gradually forming distinct stylistic schools. Western civilization and Eastern culture are expressed through various perspectives, one of which is the 'second nature'—the human-made world represented through unique, distinctive, and recognizable styles" [2]. Understanding and recognizing local terminology is an essential part of the design process.

The Importance of Colors in Product Packaging Design

Colors play a central role in product packaging design, serving as the primary element that captivates and engages viewers visually. Each color carries its own "language," evoking emotions and shaping unique perceptions. Beyond influencing feelings, psychology, or gender, colors also embody religious, historical, and cultural connotations.

However, the meanings of colors can vary significantly across countries, regions, and cultures, sometimes even being entirely opposite. For instance, in French culture, the color yellow symbolizes deceit and incompetence, while in Japan, it represents courage, wealth, and sophistication.

Thus, understanding and selecting colors that align with the cultural context of the target market is a critical task for designers. Beyond aesthetics, colors profoundly impact how consumers perceive a brand, playing a decisive role in a product's success in the marketplace.

- **Symbols in Packaging Design**

Symbols are an indispensable element in product packaging, playing a crucial role in conveying messages and meanings quickly, clearly, and visually. They are created from basic lines, circles, numbers, alphabets, or distinctive shapes. The purpose of using symbols in packaging design is to establish an immediate connection between the brand and consumers, allowing them to easily recognize the ideas or messages that the product aims to communicate.

Across the globe, many symbols carry profound cultural significance, deeply reflecting the characteristics of specific regions. Some symbols are so universally recognized that a single glance is enough for viewers to grasp the message they represent. However, the meanings of symbols can vary greatly depending on cultural context. The same symbol can convey entirely different meanings in different parts of the world.

For instance, in China, the snake is revered and associated with deities such as Fuxi, a human-headed snake, and Nüwa, a human-bodied snake, who are considered the founders of Chinese civilization. In Egyptian culture, the snake is seen as a protective deity safeguarding kings. Meanwhile, in Greek mythology, snakes are often linked with deadly dangers and are symbols of the earth and the underworld.

Figure 3. Ancient painting of Nuwa and Fu Xi

Therefore, designers must thoroughly understand the meaning of a symbol before using it, particularly in relation to the region or market their product will target. Many designs have used inappropriate symbols, leading to controversies and even causing products to be boycotted, resulting in significant losses for businesses. This highlights the importance for designers to carefully research the cultural significance of symbols from different regions before incorporating them into their designs.

- **The Connection Between Packaging and Brand Building**

Packaging plays a critical role in containing and protecting products during transportation and usage, making it one of the primary responsibilities of any product's packaging. Beyond this, packaging serves as a powerful tool that indirectly promotes the brand and enhances the product's value. In many ways, packaging acts as a silent marketer, quietly communicating and advertising the brand to consumers. A visually appealing and well-designed packaging has a significant influence on consumer purchasing behavior. Unique packaging design can elevate a product's value and facilitate rapid brand recognition.

Through carefully crafted packaging, businesses can reach a wider audience, stimulate consumer interest, and encourage purchases. The combination of eye-catching design and the content displayed on the packaging allows companies to convey the essence of their products to their target customers, ultimately persuading them to buy. For a brand, packaging is a secret weapon, as it helps differentiate the company's products and services from competitors. An impactful and distinctive design ensures that a product stands out in the market, setting it apart from similar offerings.

Furthermore, a well-designed package with clear and confidence in consumers when choosing a product or brand. Today, the role of packaging design has gained increasing importance among businesses, becoming a key element in building a strong brand identity. Companies are paying more attention to packaging design, ensuring that it is not only durable and safe but also visually striking, unique, and professional. The goal is to create packaging that stands out, attracts customers, boosts sales, and reduces marketing costs. It is clear that packaging plays a crucial role in shaping a brand's identity and connecting it with consumers.

The Local Cultural Identity in Some Modern Packaging Designs

- **Some Packaging Designs in Japan**

For example, the packaging of Sake Komodaru in Japan beautifully integrates two iconic elements: the image of Mount Fuji and a vibrant red sun. The serene beauty of nature, combined with the simplicity of the sun's color, reflects the essence of Japanese cultural thought and aesthetic values. Through the designer's creativity, this packaging becomes a work of art that conveys the cultural identity of Japan. The product is uniquely housed in a straw bottle, adding an authentic touch that highlights the artistic and cultural significance of Japan.

Figure 4: Komodaru Sake product packaging

In Japan, the design philosophy is centered around simplicity, effectiveness, and uniqueness. True to the characteristics of Japanese culture, packaging products in Japan often blend traditional and modern elements. This includes the fusion of ancient cultural symbols, such as those found in animism and spiritual beliefs, with contemporary design features. As a result of these principles and ways of thinking, Japanese design products exhibit a distinct aesthetic that makes them easily recognizable on store shelves. The combination of tradition and modernity in packaging reflects Japan's deep respect for its cultural heritage while embracing innovation and creativity.

Figure 5: Tamanohada soap product packaging

The packaging design of the Tamanohada soap features the shape of the Japanese celebratory fish, the carp. The design's exquisite lines are crafted in traditional style, with simple yet striking decorative elements that leave a strong impression of Japan's national identity. Just by looking at the packaging, both the designer and the consumer are subtly immersed in the cultural heritage of the country that created the product. This design plays a significant role in spreading the beauty and cultural identity of Japan worldwide through graphic design, with a gentle yet highly effective impact.

- **The packaging design of Honey on the Branch**

The packaging design of Honey on the Branch from China draws inspiration from the unique honey produced by black bees in Xinjiang, a region known for this exclusive honey variety. The Pica Packaging Design Lab team chose black as the primary color to highlight this distinctive feature. The design incorporates an illustration of the phoenix, a symbol of virtue, grace, elegance, and harmony between yin and yang. What sets this design apart is the surprise element: when the packaging is opened, customers find the honey hidden inside a flower, an innovative idea that the team came up with. This design beautifully blends aesthetics, the cultural heritage of China, and practical commercial application.

Figure 6: Honey on the Branch

- **Packaging with Mexican motifs**

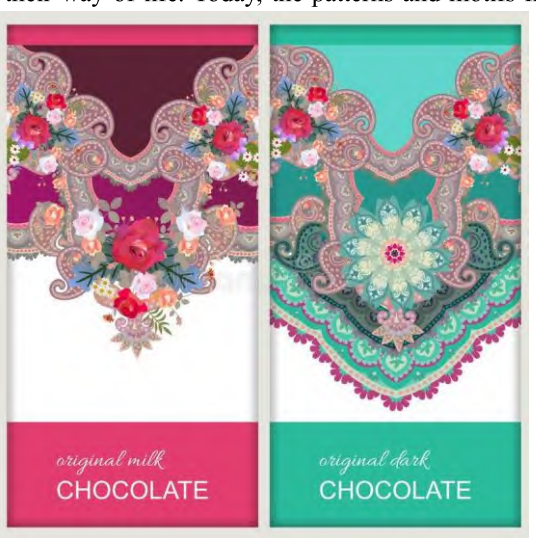
The packaging design featuring Mexican motifs beautifully captures the unique and vibrant culture of Mexico. The product is inspired by the Cinco de Mayo celebration, which commemorates the Mexican army's victory over the French forces. The design incorporates several iconic symbols of Mexico, such as the Pyramid of Kukulkan, the traditional Mexican sombrero, indigenous textile patterns that are part of the national dress, and the famous Mexican mask. Though it is a simple bottle design, the packaging encapsulates the rich, colorful heritage of Mexico, showcasing the essence of its

cultural identity in a visually striking and meaningful way.

Figure 7: Bottle with Mexican decoration

- **Russian Chocolate Packaging**

Each country has its own symbolic images that represent its unique cultural characteristics. Russia is known for its impressive and distinctive cultural symbols. From the iconic Matryoshka nesting dolls, the Balalaika, felt boots, wooden plates, to embroidered patterns, these elements vividly depict the vibrant cultural tapestry of Russia. On traditional clothing and household items, the motifs often feature the sun, birds, and women, symbolizing life's vitality, happiness, fertility, and prosperity. The embroidery techniques of the various ethnic groups in Russia are diverse and deeply connected to their way of life. Today, the patterns and motifs from



traditional Russian costumes continue to inspire designers to create innovative new designs.

Figure 9: Russian Chocolate Packaging

An example of this cultural influence can be seen in the packaging of chocolate candies, which draws on the beauty of Russian traditional attire. Not only does this inspire creativity in consumers, but it also evokes a sense

of pride in Russian heritage. Another example is the Slavianka Russian doll chocolate, where the packaging itself resembles the legendary Matryoshka doll. The design incorporates the rich cultural elements of Russia, creating unique products that delight customers while highlighting the country's heritage. By using cultural symbols in design, these products not only make a distinctive statement but also introduce the beauty of Russian culture to different communities around the world, contributing to the preservation and further development of national culture.

Figure 10: Slavianka Chocolate Candy Product Packaging

Some Product Packaging Featuring Vietnamese Cultural Elements

Sông Cái Gin is a unique gin inspired by Vietnam, featuring the flavors of various herbs and embodying the local way of life. This gin, originating from the northern mountainous regions of Vietnam, is a distinctive product of the country. Sông Cái Gin is crafted through the careful selection and collection of unique herbs and

grains, which are integral to the preservation and continuation of local traditions and lifestyle. This product comes from the Sông Cái Distillery and reflects the essence of Vietnam's natural resources and cultural heritage through its thoughtful and culturally inspired design.

Figure 11: Song Cai Product Packaging

- **Packaging of Phi Long Chầu Nguyệt Gift Set Designed with the Image of the Ly Dynasty Dragon**

The 2023 Tet gift box set, themed "Vượng" by Printgo, is designed with patterns deeply rooted in Vietnam's folk belief culture. The design is gentle and sophisticated, subtly conveying goodwill and positive messages to customers. The packaging is elegant and high-quality, praised for its artistic value and humanistic meaning, symbolizing hopes for a prosperous and fulfilling new year for every household.

Figure 10: Phi Long Chau Nguyet gift box product packaging

The designer skillfully incorporated the image of the Dragon, one of the twelve zodiac animals, which holds a special place in Vietnam's culture and beliefs. It is also a sacred symbol linked to the legend of the dragon and fairy ancestors, representing the history of the nation. The dragon is the foremost symbol of good fortune, embodying absolute strength and vitality. Alongside this, traditional motifs are gracefully integrated, standing out against a vibrant golden color, all harmoniously combined to create a refined and beautiful design.

Conclusion

In today's rapidly developing and integrated economy, product packaging has gained significant attention and importance, with an increasing number of designers being professionally trained to meet market demands. Entrepreneurs have come to recognize the vital role of packaging, investing more in both its functional and aesthetic aspects. As a result, many packaging designs have successfully captured customer attention and built trust. However, the integration of cultural identity and brand values in packaging design still remains insufficiently emphasized. The cultural messages of both the nation and the brand have not been fully conveyed to consumers. For example, some Vietnamese export products still lack packaging that elevates their brand value or cultural identity when entering international markets. Domestically, many designs are too similar and follow conventional paths, with the external appearance of packaging not always aligning with the essence of the product inside. The use of images, symbols, and colors on packaging tends to be informational rather than aesthetically meaningful, failing to highlight the distinctive nature and characteristics of the product. Additionally, the materials

used for packaging in many product categories remain repetitive and lack creativity.

Despite these shortcomings, packaging design today has certainly garnered more attention but still has much room for improvement, especially in showcasing national identity. In an era of globalization, with a multitude of emerging brands, it is essential for each brand to leave a distinct mark through its product packaging. "Cultural elements have become a catalyst, a driving force that attracts customers to a product. These elements encapsulate the material and spiritual values that reflect the creativity of each nation and region. Using cultural elements enhances the prestige and value of a product brand." Packaging, as a communication tool, conveys the cultural and material essence of each brand, reaching consumers across the globe.

Today, packaging is not just about containing and protecting products; it serves as the face of both the product and the brand, influencing and encouraging consumer behavior. Moreover, packaging has become an effective marketing tool, playing a crucial role in building brand value for businesses. The packaging industry is undergoing significant changes, with innovations in materials, shapes, designs, and colors. As consumer demands become more sophisticated, packaging made from eco-friendly materials, with high aesthetic value or smart features, will garner more attention and trust. Additionally, there is a growing focus on traditional cultural elements, reflecting a trend that aligns with current market preferences.

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Application of visual principles in products graphic design

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Abstract

In graphic design, visual principles play an important role in creating intuitive, understandable and attractive products. These principles not only help organize design elements in a logical way but also enhance the user experience, from easy access to information to the perception of the product's aesthetics. The correct application of principles such as contrast, emphasis, proximity or alignment not only makes the product stand out but also effectively reflects the brand's message and values.

I. Introduction

In the information and digital age, graphic design has transcended its traditional role as a mere aesthetic tool to become an indispensable strategic communication and interaction tool. Visual principles, which are rooted in the scientific study of how humans perceive and process images, play a central role in ensuring that a design is not only attractive but also highly effective in communicating a message. The balance of elements such as shape, color, light and proportion not only creates visual appeal but also guides the viewer's emotions and behavior, helping to create a comprehensive and memorable visual experience.

In addition to their fundamental role in shaping aesthetics, visual principles have a profound impact on message memorability, brand perception, and even consumer behavior. These elements do not operate in isolation but interact closely with each other, creating a complex visual system where every detail has strategic significance. In graphic design practice, the application of visual principles is not simply a matter of following rules but also requires a deep understanding of visual psychology, visual culture, and the specific application context.

II. Kind of visual principle and application

Visual principles are the fundamental rules that help organize and present visual elements in graphic design effectively. They not only play a role in ensuring aesthetics but also determine the ability to convey information and emotions of the design product. The importance of visual principles can be seen through the following aspects:

1. The principle of harmony in diversity

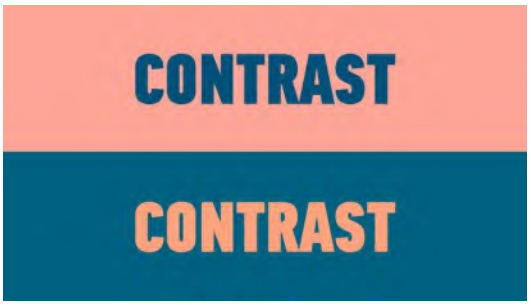
A complete work of art is considered a whole that contains many different elements that show diversity and variability. The harmony in a work of art must show the unity of many different elements that harmonize in a certain theme or idea. If the contradictions of different elements cannot be resolved, it will be impossible to create unity. To create that unity, the main principle must be established. For example, the main color, main tone, main line, main material, main block, etc. It can be said that: "the principle of harmony in diversity" is similar to the relationship of unity and variation in the universe, life and works of art. It is the theoretical basis, guiding the processes of creating unity of visual art forms.

This principle reflects the ultimate principle of the creation, operation and existence of the universe. So perhaps we have to connect many issues to explain this principle with a brief illustration. In short, the key point that we should remember in this principle is: In order for solutions to combine different elements to form a whole, it must be based on the determination: "In harmony with which main system?". The solution to link and create harmony must be based on the spirit that the topic or theme sets out (both objectively and subjectively). If

harmony and unity are achieved but the spirit of the theme is lost, it is considered unsuccessful.

2. Principle of contrast

This principle can be roughly said to be the relationship of opposition and how to apply it in the process of visualizing ideas in visual language, the nature of matter is movement without contradiction, it cannot move. That is the eternal law, going against this law will not be able to exist.



But the important thing is to what level the contradiction reaches is enough, what is too much. Otherwise, it will lead to breaking the balance of the law of movement.

The level of contrast used by the artist in the work must also be in accordance with the spirit and space of the subject. Just like the law of human existence in the most elementary form of medical theory in this life is "must keep the head blood (Yin) and the feet warm (Yang)" "Cold feet means going to the altar" means death (cold soles of the feet).

Because, in the sky is Yang, our heads must be cool (Yin). And the earth is Yin, the soles of the feet must be warm (Yang). It is the survival in the law of mutual contradiction of matter, of heaven and earth. This is like the advice in visual composition that we must maintain the contrast and harmony within the formal elements to create liveliness, change and by all means must regulate the contradiction in a reasonable way to maintain the stability, the unity into a whole of the work on the basis of the spirit of the work.

The two principles: Principle One and Principle Two mentioned above are closely linked to the law of existence and operation of the universe and human beings. And human works and projects, if they want to exist, must also follow the principle of operation and biochemistry of the universe. This second principle is always closely linked to the first principle.

We can analyze more deeply the issues, forms, and shapes of the so-called contrast as follows:

- Contrast in spirit and content: Good and evil, tragedy and comedy, humanity and inhumanity, growth and decline, darkness and radiance, stillness and movement.
- Contrast in area, scale: big and small, great, small...
- Contrast in light: bright and dark.
- Contrast in tone: dark and light, clear and dim...
- Contrast in intensity: strong and weak, fresh and pale.
- Contrast in material: hard and soft, rough and smooth, rough and smooth, opaque and clear...
- Contrast in density: thick and thin.
- Contrast in mass, weight: big, small, heavy, light.
- Contrast in space: near and far, deep and shallow, dark, bright, warm, cold, wide and narrow, tight, loose.
- Contrast in mass: square and round, hard and soft, convex and concave, yin and yang.
- Contrast in style: classic, modern, past and present.
- Contrast in character mood: happy and sad.
- Direct contrast: This term refers to the situation in which the artist wants to emphasize, creating prominence in the character's position in a suitable context, even if it is a bit exaggerated.
- Paradoxical contrast: This term refers to the situation where the artist intentionally creates a paradox to attract attention.

Some terms refer to the forms of contrast:

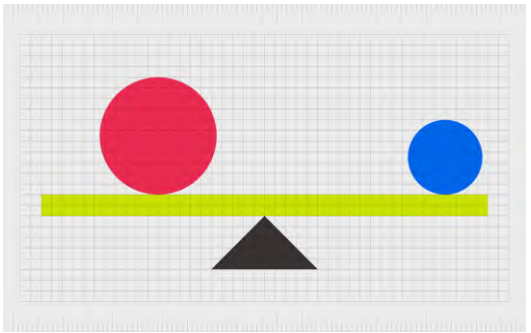
- Contrast of primary colors placed next to each other.
- Contrast of brightness.
- Contrast of intensity.
- Contrast of hot and cold.
- Contrast of quantity.
- Contrast of character.
- Maximum contrast.
- Minimum contrast.
- Contrast by juxtaposition.
- Contrast of style.

In general, the key point that we all know is that when two opposing forces coexist, reducing one side means increasing the other. In the process of finding solutions to create contrast, liveliness without losing the spirit of the subject, the subject is not required.
The problem is how to make the visual elements have good harmony and interaction based on determining the main spirit that is suitable for the theme and topic: suitable for the space and time of the topic to create a reasonable, vivid visual on the basis of preserving the balance and balance in the overall work.

3. Principle of balance

The principle of visual balance is defined as the balance in the combination, arrangement or proportion of graphic elements. Balance is not only applied to layout, but also to color, typography, shape, etc.
Balance in design is created in many forms. The three main common forms are: Symmetry, Asymmetry and Radial balance
Symmetrical balance is a common and easy-to-see approach in design. Because symmetry appears in more places than we think and our perception has accepted this balance as a default order of things.
Applying this principle of visual balance is when the design elements on both sides of the central axis are designed to be similar, as if symmetrical through an

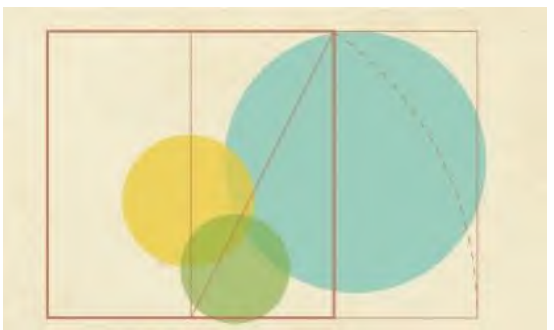
invisible mirror. Symmetrical balance can be from left to right, top to bottom, or both.



While symmetrical balance is suitable for serious, formal or traditional design publications, asymmetrical balance brings a sense of fun, dynamism and modernity to the work. Graphic elements will be arranged naturally, based on the interaction of shapes, negative space and the connection of elements with each other, creating both tension and balance.

4. **Principle of ratio**

The principle of proportion is one of the basic principles of vision, playing an important role in organizing elements in graphic design. Proportion is related to the relative size of different elements in a design, thereby helping to shape the layout, create balance and orient the viewer's attention.



Proportion shows the size relationship between elements or between a part and the whole of the design. Using reasonable proportions helps the image become harmonious, aesthetically pleasing, and at the same time highlights important points. Proportion can be expressed through:

- Geometric dimensions (length, width, height).
- Size of letters, symbols, or images.
- Spacing between elements in the design.

Proportion helps designers create emphasis by highlighting an important element. An element that is larger, or has a superior ratio compared to surrounding elements, will easily attract the viewer's attention. For example, in an advertising poster, the headline is often larger than the body copy to emphasize the main message.

Proportion helps the elements in a design flow together, creating a sense of balance and aesthetics. When elements are arranged in a reasonable proportion, the viewer feels comfortable and is attracted to the tight organization of the layout.

Proportion is not only an aesthetic element, but also has symbolic meaning. For example, using a larger proportion for an element can imply its importance or priority. A larger product in an advertising image can convey superiority or power.

Proportion helps guide the way the viewer moves through the design. By combining elements with different proportions, the designer can guide the viewer's eye from the main element to other details.

- Golden Ratio

The golden ratio is one of the most popular tools in graphic design, expressed as 1:1.618. This ratio brings natural harmony and is widely used in art, architecture and graphic design. For example, many famous logos such as Apple or Pepsi use the golden ratio to create balance and symbolism.

- Rule of Thirds

The rule of thirds divides the frame into 9 equal parts by two horizontal lines and two vertical lines. Important elements are placed at the intersection of these lines to create balance and appeal. This ratio is often applied in photo composition, poster design or web interface.

- Asymmetrical ratio

Proportions do not always need to be symmetrically balanced. In many cases, intentional asymmetry brings a sense of dynamism and creativity, increasing the interest of the design.

The principle of proportion can be applied in the following areas:

- Logo design: Proportion helps create a harmonious, recognizable logo that is adaptable to different sizes.
- User interface design (UI/UX): Proportion ensures that interface elements such as buttons, text, and images are appropriately sized, easy to see, and easy to use.
- Print and advertising: In print design, proportion helps determine the size of elements such as images, headlines, and content to optimize attention.

The principle of proportion is not only a tool in graphic design but also a means to convey messages, guide the eye, and enhance the aesthetic value of the product. Understanding and flexibly applying this principle helps designers create harmonious, outstanding, and effective products, thereby meeting aesthetic and functional needs in the context of modern design.

5. Principle of emphasis and subgroups

The principle of emphasis and subgrouping is one of the core elements in graphic design and visual arts. This principle focuses on drawing the viewer's attention to one or more important elements, while organizing other elements in order of priority, creating a structure. A visual emphasis is an element or area in a design that is easily recognized and focused on first by the viewer. It is the "visual center" of the composition and plays an important role in conveying the main message.

The role of emphasis

- Attracting attention: The emphasis helps the viewer focus on the most important element, ensuring that the main message is not missed.
- Visual guidance: It creates a natural path for the eye to move through the elements in the design.
- Enhance communication effectiveness: The emphasis clarifies the designer's intention and helps the viewer quickly understand the goal of the design.

Accentuating Techniques

- Use of color: A prominent color in a neutral layout will easily attract attention. For example, use red in a predominantly black and white design.
- Size: Increase the size of an important element relative to other elements to highlight it.
- Shape: Use a unique or unusual shape to create distinction.
- Contrast: Create contrast in color, brightness, or texture between the accent and surrounding elements.
- Placement: Place the main element in the center or areas where the human eye is most likely to notice it, such as the intersection of the Rule of Thirds.
- Movement (if present): In dynamic designs, elements that move or change constantly often become focal points.

Subordinate Elements

Subordinate elements are supporting elements in a design that complement, background, or provide visual direction without competing with the main focal point. They help create a harmonious, balanced, and understandable composition.

Role of Subordinate Elements

- Supporting the focal point: Subordinate elements help highlight and clarify the main message.
- Balancing the composition: They help maintain harmony and avoid "overcrowding" one part of the design.
- Visual guidance: Subordinate elements create connections and guide the viewer through different parts of the design.

Characteristics of Subordinate Elements

- Usually smaller in size, color, and shape than the focal point.
- Arranged so as not to distract from or compete with the main focal point.
- Interacting closely with the focal point to create a clear visual flow.

The Combination of Highlights and Subgroups

A successful design requires not only a strong highlight but also well-organized sub-elements. This combination creates a balanced layout, effectively guides the eye, and helps the viewer easily receive the message.

The Relationship Between Highlights and Subgroups

- The highlight plays a leading role, the sub-groups are the background elements that help highlight it.
- Sub-groups are arranged in order of visual priority, creating a natural journey for the viewer's eye.

Practical Applications

- Advertising posters: The headline is the main highlight, while the illustrations and detailed descriptions are sub-groups.
- Website design: The "Call to Action" (CTA) button is the highlight, while supporting information such as product descriptions, images, and sub-links are sub-groups.

The principle of visual highlights and sub-groups is the key to creating effective and engaging graphic designs. Focal points help to attract attention and convey messages, while secondary groups complement and balance the overall layout. The harmonious combination of these two elements not only highlights the main content but also ensures a pleasant and profound visual experience for the viewer. Designers need to understand the purpose, context and target audience to flexibly apply this principle, creating products that are both aesthetically pleasing and functionally effective.

6. Principle of eye guidance

The principle of eye guidance is one of the important principles in graphic design, focusing on guiding the way the human eye moves through the

elements in a layout. This principle helps control the visual journey of the viewer, ensuring that they receive information in the order of priority that the designer wants. Eye guidance is the way the layout and visual elements are organized to create a natural flow for the viewer's eye. Through the use of elements such as lines, shapes, colors, or contrast, the designer can guide the eye from one point to another in a design, thereby increasing the effectiveness of the message conveyed.

The role of eye guidance in graphic design

- Visual direction: Eye guidance helps the viewer know where to start looking, what parts to go through, and where to stop. This is especially important in advertising design, websites, or information presentations, where the main message needs to be received first.

- Increases coherence: A design with good eye guidance will look more coherent and understandable, reducing clutter and helping viewers quickly access the necessary information.

- Creates an interesting visual experience: A layout designed with the right eye guidance is not only effective but also aesthetically appealing, keeping viewers engaged with the product longer.

Elements that create eye guidance

- Visual paths (Lines)

• Straight lines: Horizontal or vertical lines can orient the eye in a certain direction, creating a sense of stability and balance.

• Slanted and curved lines: Create a sense of movement, dynamism, and lead the eye through different areas of the design.

• Implied lines: These are lines created by the arrangement of elements, such as a character's gaze directed towards another part of the layout.

- Visual Hierarchy

• Scale and size: The larger or more prominent element is usually where the eye stops first.

• Color and contrast: High contrast or bold colors attract attention and guide the eye.

• Spacing and negative space: Use negative space to create breathing areas and naturally guide the eye to important elements.

- Natural eye rules

• Left-to-right rule (in a left-to-right reading culture): The eye naturally moves from left to right, top to bottom. Layouts can take advantage of this principle to direct information.

• Focal points: The eye is naturally drawn to the most important points in a design and moves from one focal point to another.

- Use Rhythm and Repetition

• Repetitive or rhythmic elements create a sense of harmony and guide the eye along a specific path.

Practical Applications of the Eye-Leading Principle

- In Advertising Design

• An advertising poster typically leads the eye from the main image (product or character) to the headline and finally to the details or call to action (CTA).

• For example, a soft drink bottle with a tilted liquid stream leads the eye from the bottle to the brand logo.

- In Web Design and User Interface (UI/UX)

• Use the F-pattern or Z-pattern to guide the eye from the headline, image to function buttons.

• CTA buttons are often highlighted with color and placed at the end of the visual journey.

- In Print Design

• A book or brochure typically organizes content in order of priority, with a large headline, illustrations, and sub-content paragraphs leading the reader's eye in a logical sequence.

The principle of eye force is a powerful tool that helps designers control the visual journey of the viewer, ensuring that information is conveyed effectively and coherently. Using eye force correctly not only helps the design achieve its communication goals but also creates an interesting visual experience, increasing interaction and impression with the viewer. Designers need to clearly understand the goals and target users to apply this principle flexibly, while avoiding common mistakes to optimize the effectiveness of the layout.

7. Principles of repetition and rhythm

The principles of repetition and rhythm are an important part of graphic design and visual arts. Both principles not only help organize a layout in a

harmonious and unified way, but also create a sense of movement, guiding the viewer's eye through the elements of the design. Repetition in visual design is the reuse of elements such as color, shape, line, or typeface to create unity and cohesion in the layout.

The role of repetition

- Increase recognition: Repetition helps build brand recognition or message through the use of familiar elements.
- Create unity: Layouts become more cohesive and understandable when elements are reused in a logical way.
- Visual guidance: Repeated elements create a natural flow, guiding the eye through the parts of the design.
- Increase aesthetics: Repetition creates a sense of harmony and balance, especially in complex layouts.

Forms of Repetition

- Direct repetition: Reusing the same element, such as a shape, symbol, or color.
- Variation repetition: Using similar elements with slight variations, such as size, color, or angle.
- Structural repetition: Reusing elements in a certain order, such as in a grid layout or along a leading line.

Rhythm

Rhythm in visual design is the repeated arrangement of elements in a sequence or cycle, creating a sense of movement or flow in a composition. Rhythm is often associated with the viewer's visual sense of harmony and life.

The role of rhythm

- Creating a sense of movement: Rhythm creates continuity and leads the eye from one element to another.

Adding interest: Changing rhythms makes a design more dynamic and engaging.

- Increases cohesion: Rhythm combines repeated elements to create a harmonious and coherent whole.

Types of Rhythm

- Regular Rhythm: Elements are repeated at the same distance and size, creating a sense of stability and order.

Example: A row of columns or rows of squares in a design.

- Progressive Rhythm: Elements are repeated but gradually change in size, color, or shape, creating a sense of movement or progression.

Example: A series of circles that gradually get smaller or larger.

- Alternating Rhythm: Elements repeat in a fixed cycle of change.

Example: Squares alternating with circles in a certain sequence.

- Random Rhythm: Elements that repeat without any certain rules but still maintain balance.

Example: Random spots of color in an abstract painting.

The Relationship Between Repetition and Rhythm

Repetition is the foundation for creating rhythm in design. When elements are repeated in an organized way, they form a rhythm, leading the viewer through the sections of the layout. While repetition emphasizes unity and cohesion, rhythm adds dynamic and visual interest.

Practical Applications of Repetition and Rhythm

- In Graphic Design

• Print Layouts: Repeat elements such as headlines, colors, and typography on each page to maintain consistency.

• Logo Design: Repeat shapes or lines to create a sense of cohesion and recognition.

• Posters: Use rhythm to guide the eye from the image to the main message.

- In Web Design

• User Interface (UI): Repeat interface elements, such as icons or buttons, to create consistency.

• Information Presentation: Use varying rhythm to guide the viewer's eye through the content.

- In art and architecture

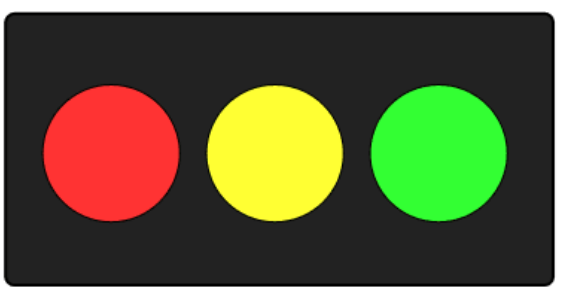
• Decorative motifs: Repeating patterns or shapes to create a sense of formality or dynamism.

• Spatial composition: Using rhythm to create a connection between parts of a space, such as in interior design or landscape.

The principles of repetition and rhythm not only help organize elements in a design in a cohesive and attractive way, but also bring about a pleasant and enjoyable visual experience. Understanding and flexibly applying these two principles can create design products that are both effective and aesthetically rich. Designers need to consider the purpose and context of the design to adjust repetition and rhythm appropriately, avoiding overuse or misuse, thereby optimizing visual impact and effectively conveying messages.

8. Principle of association

The principle of visual association is an important aspect of graphic design, visual arts, and communication. This principle exploits the natural ability of humans to connect different elements or images to create meaning, thereby increasing the appeal, evocativeness, and effectiveness in conveying messages. Visual association is the process by which viewers connect images, symbols, or design elements with meanings, emotions, or memories that already exist in the mind. This process depends not only on the direct content of the design but also on the cultural, social context, and personal experiences of the viewer.



The role of the principle of association in design

- Creating intimacy and empathy

Association helps designs tap into the emotions and experiences of viewers, making them feel closer to the product or message. For example, a design that uses the image of a warm home can evoke feelings of safety and family.

- Increase communication effectiveness

By utilizing familiar images or symbols, associations help viewers understand the message the design wants to convey more quickly, even when the content is complex.

- Stimulate curiosity and exploration

Associations sometimes encourage viewers to think deeper or explore the meaning behind the design, increasing engagement and memorability.

- Create brand identity

Brands often use symbols or colors that are related to the values they want to represent, such as luxury, creativity, or dynamism.

Types of associations in visual design

- Direct association

• Images or symbols that are clearly linked to a specific meaning or message.

• For example, the image of a green leaf in a logo is often related to the environment and sustainability.

- Metaphorical association

• Using design elements to represent an indirect meaning, adding depth and appeal to the layout.

• Example: A painting with an hourglass may symbolize the passing of time.

- Cultural and Social Associations

• Images, colors, or symbols that are associated with specific cultural or social meanings.

• Example: Red is often associated with good luck in Eastern cultures, but represents danger or warning in some Western contexts.

- Emotional Associations

• Images or colors that stimulate strong emotions, such as happiness, sadness, or excitement.

• Example: Yellow is often associated with joy and positive energy.

Applying the Principle of Association in Design

- Logo Design and Brand Identity

• A successful logo is often based on strong associations with the brand's core values.

• Example: Apple's bitten apple logo is not just an image, but also an association with innovation, creativity, and differentiation.

- Advertising and Communications

• Associations help make advertising more effective by connecting a product to positive meanings or familiar experiences.

• For example, a mineral water ad often uses fresh natural images to evoke purity and health.

- Infographics

• Using familiar icons and images to simplify the presentation of complex data, making it easier for viewers to associate and understand the content.

- Product packaging

• Packaging often uses associations to attract buyers, such as using the color green to evoke a feeling of freshness for organic food products.

Factors that influence associations

- Cultural context

Viewers' associations are often strongly influenced by the cultural context in which they live. A symbol may have a positive meaning in one place but a negative meaning in another.

- Personal Experience

Each individual's own memories and experiences also greatly influence how they relate to a design.

- Consistency in Design

Designs should use associative elements consistently to avoid confusion or conflicting messages.

- Subtlety

Overuse or under-subtlety in the use of association can make a design appear exaggerated or offensive.

The principle of association is a powerful tool in visual design, allowing designers to connect messages with the emotions, memories, and deep meanings of viewers. By using it subtly and effectively, association not only makes designs appealing and memorable, but also creates profound and unforgettable visual experiences. Designers need to carefully consider the context, audience, and goals to use this principle optimally.

9. The Principle of unity in style

The principle of unity of style is a fundamental element in graphic design and visual arts. Unity not only creates a harmonious and accessible layout, but also helps to convey a message clearly and effectively. This principle emphasizes the combination of design elements so that they work as a unified whole, consistent with the design's purpose and style. Unity of style is the arrangement and organization of design elements so that they create a sense of cohesion and consistency. It involves applying principles such as color, typography, shape, structure, and visual style to achieve harmony in the overall design.

The Role of Unity of Style

- Creating Consistency

• Unity helps all design elements work as part of a whole, avoiding confusion or disorientation for the viewer.

• For example, in a brand identity, consistent colors and typography across logos, business cards, and promotional materials will make the brand more recognizable.

- Increase professionalism

• A consistent design conveys a sense of neatness and trustworthiness, enhancing the aesthetic value and quality of the product or message.

- Support message delivery

• Consistency helps focus on the main message the design wants to convey, avoiding distraction or lack of focus.

- Improve user experience (UX)

• Especially in user interface (UI/UX) design, consistency helps users easily familiarize themselves with and navigate the product, thereby increasing satisfaction and efficiency.

Elements that create consistency in style

- Color

• Use a consistent color palette throughout the design to create a sense of harmony.

• Example: A spa website design might use soft colors like green and white to create a relaxing and elegant feel.

- Typography

• Choose one or two consistent typefaces to ensure cohesion and avoid clutter.

• Example: A professional report might use a sans-serif typeface for the headline and a serif for the body copy.

- Images and illustrations

• The style of the images or illustrations should be consistent to create a sense of cohesion.

• Example: In an advertising campaign, if real-life images are used, all images should have the same color scheme or shooting style.

- Shapes and Structure

• The shapes and layouts used in the design should have a logical order and relationship to each other.

• Example: In a poster, clearly aligned blocks of content create a sense of order and ease of reading.

- Design Style

• The entire design should follow a specific style, such as minimalism, modern, or vintage.

Principles that support unity

- Repetition: Repeat elements such as color, typography, or pattern to create cohesion.

- Balance: Ensure elements are arranged in a balanced manner, making the design harmonious and stable.

- Alignment: Use a grid or organizational structure to align elements logically.

- Contrast: Create emphasis by using contrast between elements while maintaining unity in the overall design.

Uses of unity in style

- Brand identity: Consistency in color, logo, typography, and messaging helps build a strong and recognizable brand image.

- Product design: Consistency in design style makes products more recognizable and appealing, from app interfaces to product packaging.

- Communication and advertising: A consistent style of advertising campaign will help increase visual impact and communication effectiveness.

- Web design and UI/UX: Consistency in interface and interaction helps improve user experience and increase efficiency.

The principle of consistency in style is the core element that helps create designs that are both aesthetically pleasing and effective in conveying messages. Consistency not only ensures the cohesion of elements but also helps build a professional image and create a pleasant feeling for viewers. Designers need to balance consistency and creativity to ensure cohesion while keeping the design fresh and attractive.

III. Conclusion

The application of visual principles to graphic design is not only the basic foundation for creating aesthetic products but also the optimal means to convey messages clearly and effectively. Principles such as proportion, emphasis, eye-drawing, repetition and rhythm, or association, all play an important role in shaping the viewer's visual experience, making the design both attractive and understandable.

The success of a graphic design depends on the designer's ability to combine these principles to create a balance between art and function. Through the subtle application of visual principles, the designer not only brings aesthetic value but also ensures the interactivity, memorability and communication effectiveness of the product.

In the increasingly competitive and diverse context of the graphic design industry, a deep understanding and application of visual principles not only helps improve product quality but also opens up opportunities for creativity and innovation, better meeting the needs of users and the market. This is a solid foundation for creating impressive graphic design products with long-term influence.

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Tổng quan về Pháp lam Huế - Dấu ấn từ lịch sử đến hiện tại

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MỞ ĐẦU

Pháp lam là một sản phẩm mỹ thuật có cốt làm bằng đồng, bên ngoài được vẽ bằng một hay nhiều lớp men màu được đem nung mà thành. Do cách thức tạo ra sản phẩm đặc biệt nên pháp lam không chỉ đẹp về mặt hình thức mà còn có độ bền rất cao vì vậy mà có khả năng chống chịu cao trước sự va đập, hoặc sự ăn mòn của môi trường và khí hậu. Pháp lam Huế cũng trải qua cũng dấu mốc thăng trầm, phát triển mạnh nhất vào thời vua Minh Mạng (1820 – 1841) rồi sa sút và mất hẳn vào thời vua đồng Khánh (1885 – 1889). Tuy vậy nhưng trải qua hàng trăm năm lịch sử, Pháp lam Huế vẫn là một điểm nhấn vàng son trong trang sử vàng văn hóa nghệ thuật Việt Nam.

Trong thời đại mà chúng ta khao khát muốn tìm về và phục dựng lại những giá trị nguồn cội, thì Pháp lam Huế có thể được nhắc đến bởi sự cầu kì , tinh xảo, trang nhã và vô cùng đẹp mắt. Tuy nhiên hiện nay, Pháp lam vẫn còn là một sản phẩm khá xa lạ đối với nhiều người, thậm chí là trong giới nghệ thuật. Vì vậy mà trong bài nghiên cứu “Tổng quan về Pháp lam Huế - dấu ấn từ lịch sử đến hiện tại” sẽ mang đến một cái nhìn tổng quan về Pháp lam Huế cũng như vì sao chúng ta cần phải bảo tồn nét văn hóa truyền thống này.

I. Cơ sở lý luận và thực tiễn của đề tài.

1.1. Một số khái niệm liên quan đến đề tài.

1.1.1. Khái niệm “Pháp lam”.

Pháp lam (hay đồ đồng tráng men) là những sản phẩm được làm bằng đồng hoặc hợp kim đồng, trên bề mặt được tráng men trang trí để tăng giá trị thẩm mỹ.

1.2. Khái niệm “Pháp lam”.

1.2.1. Lịch sử hình thành và phát triển.

1.2.1.1. Lịch sử về tên gọi

Hiện nay, vấn đề về tên gọi vẫn còn đang tiếp tục được tranh luận bởi giới nghiên cứu về Huế .

Dựa theo một số bài viết của cố họa sĩ Phạm Đăng Trí, những nhà sưu tập cắt nghĩa rằng: "pháp lam" bắt nguồn từ chữ "pha lang" do người Trung Hoa dùng để chỉ một loại đồ tráng men mà các nhà truyền giáo Tây phương trước kia hướng dẫn cho họ sản xuất rồi du nhập kỹ thuật sang Việt Nam. Sở dĩ chữ "pháp lam" phải đọc trại thành "pha lang" (France) là để tránh phạm húy chúa Nguyễn Phúc Lan...

Một số ý kiến khác: Theo một số nghiên cứu, "Pháp" ở đây có thể là chỉ "Pháp" trong nghĩa quốc gia Pháp, nhưng không hẳn mang ý nghĩa là xuất xứ từ Pháp mà ám chỉ một kỹ thuật hay phương pháp. Trong quá trình tiếp xúc với văn hóa Pháp qua các thế kỷ 18–19, đặc biệt trong thời kỳ Pháp thuộc, người dân Huế đã tiếp thu và phát triển một số kỹ thuật thủ công mỹ nghệ từ phương Tây, trong đó có các kỹ thuật chế tác kim loại.

Tuy nhiên, một số quan điểm khác cho rằng từ "Pháp" có thể xuất phát từ thuật ngữ "pháp" trong tiếng Hán, mang nghĩa là phương pháp, kỹ thuật, hay nghệ thuật.

Trong từ "Pháp lam", "lam" được hiểu là màu sắc, đặc biệt là màu sắc của men, vì "pháp lam" nổi bật với kỹ thuật mạ men trên kim loại (đồng). "Lam" còn có thể hiểu là "lam" trong tiếng Hán, tức là màu xanh hoặc là một màu sắc đặc trưng. Đây là lý do tại sao pháp lam nổi bật với màu sắc rực rỡ, đa dạng từ xanh lá, xanh dương đến đỏ, vàng, trắng,..Tên gọi "Pháp lam" ban đầu có thể xuất phát từ sự kết hợp giữa những kỹ thuật chế tác kim loại thủ công (có thể liên quan đến ảnh hưởng của các nghệ thuật phương Tây, đặc biệt là từ thời kỳ Pháp thuộc) và những đặc trưng riêng của nghệ thuật này là sử dụng men để trang trí kim loại.

Lịch sử tên gọi này phản ánh sự giao thoa giữa các yếu tố văn hóa Đông và Tây trong giai đoạn lịch sử nhất định. Trên thế giới, sản phẩm này được người Anh gọi là “painted enamels”, Pháp là “émail peint sur cuivre”, Nhật Bản là “shipouyaki”, Trung Quốc là “pháp lang”... và ở Việt Nam thì nó mang cái tên mới tên là “pháp lam”.

1.2.2.2 Lịch sử hình thành và phát triển

Pháp lam được hình thành trong bối cảnh triều Nguyễn, khi các nghệ nhân Huế kết hợp các kỹ thuật chế tác kim loại truyền thống của Việt Nam với các yếu tố kỹ thuật ngoại lai, đặc biệt là những ảnh hưởng từ Trung Quốc và phương Tây. Cụ thể là kỹ thuật mạ men trên kim loại có thể đã được ảnh hưởng từ các kỹ thuật tương tự ở Trung Quốc và các nước Đông Nam Á. Pháp lam Huế tiếp thu kỹ nghệ Họa pháp lang của Quảng Đông, Trung Quốc.

Quảng Đông là cửa ngõ du nhập công nghệ chế tác Họa pháp lang (Émaux hay Painted enamel) vào Trung Hoa. Khác với kỹ nghệ Kháp ti pháp lang (Cloisonné), từ xứ Byzantine du nhập vào Trung Hoa qua ngã Tây Vực theo vó ngựa viễn chinh của quân Mông Cổ, kỹ nghệ Họa pháp lang xuất xứ từ vùng Limoges ở Pháp và vùng Battersea ở Anh, du nhập vào Trung Hoa theo chân các tu sĩ dòng Tên vào cuối thế kỷ 17.

Theo một số nghiên cứu, Pháp lam có thể đã xuất hiện vào khoảng đầu thế kỷ XIX, dưới thời vua Gia Long (1802–1820), người sáng lập triều Nguyễn. Trong thời kỳ này, các thợ thủ công Huế bắt đầu áp dụng phương pháp mạ men lên đồng, tạo ra các sản phẩm kim loại có độ bền cao, trang trí nhiều màu sắc rực rỡ. Pháp lam trở thành một phần không thể thiếu trong việc trang trí các công trình cung đình và phục vụ các nghi lễ hoàng gia.

Đến triều vua Minh Mạng (1820-1841), dưới triều ông, kỹ nghệ Pháp lam đã được phát triển vượt bậc và được ứng dụng nhiều vào trong các sản phẩm trang trí cung đình. Pháp lam dưới thời ông được chế tác một cách tinh xảo hơn. Đặc biệt là các công trình tôn nghiêm như lăng tẩm và đền thờ cúng.

Triều vua Triều Thiệu Trị (1841–1847) và Tự Đức (1847–1883). Đây là thời kì kỹ nghệ Pháp lam phát triển rỡ nhất . Các sản phẩm Pháp lam không chỉ dừng lại ở các công trình kiến trúc mà còn được sử dụng trong đồ cúng và các dụng cụ sinh hoạt của hoàng gia. Các sản phẩm Pháp lam thời kì này mang đậm tính biểu tượng, phản ánh sự thịnh vượng và quyền lực của triều đình nhà Nguyễn.

Đến thời kì “Tứ nguyệt tam vương” (1883 - 1885) vì nhiều lý do khác nhau như sự biến động về chính trị trong triều đình nhà Nguyễn, ảnh hưởng của chiến tranh cũn như nhu cầu và thị hiếu dần thay đổi dẫn đến việc kỹ nghệ Pháp lam dần sa sút, được chỉnh đốn lại dưới thời Đồng Khánh (1885 - 1889) tuy nhiên không thể phục hưng mà dần dần rơi vào suy thái và bị thất truyền.

Như vậy, thời gian tồn tại của kỹ nghệ pháp lam Huế, từ lúc khai sinh đến khi thất truyền, chỉ hơn 60 năm. Nhưng di sản pháp lam còn lại trên mảnh đất cố đô Huế khá đồ sộ, phong phú về số lượng; đa dạng về loại hình và kiểu thức.

Hiện ở Huế có nhiều nhóm nghiên cứu phục chế Pháp lam, tuy cách thức, công nghệ và đạt những mức độ thành công khác nhau song bước đầu đã đáp ứng công tác trùng tu di tích, hơn thế nữa đã phục hồi được một nghề chuyên sản xuất cho vua chúa mà một thời gian được xem như thất truyền.

II. Kỹ thuật và đặc điểm của Pháp lam Huế

2.1. Kỹ thuật chế tác Pháp lam

Kỹ thuật pháp lam chủ yếu sử dụng kim loại, đặc biệt là đồng làm nguyên liệu chính. Quy trình chế tác bao gồm các bước chính sau:

Đúc và chạm khắc: Các nghệ nhân sẽ đúc hoặc chế tác những sản phẩm bằng kim loại, chủ yếu là đồng, sau đó chạm khắc, tạo hình các họa tiết, hoa văn lên bề mặt sản phẩm. Họa tiết này thường rất tinh xảo, với các hình ảnh như rồng, phượng, hoa sen, tứ quý, chim muông, hoặc các biểu tượng của sự thịnh vượng, may mắn.

- Mạ men: Sau khi các sản phẩm kim loại đã được đúc và chạm khắc xong, chúng sẽ được phủ một lớp men màu. Men này có thể bao gồm nhiều màu sắc khác nhau, từ xanh lá, xanh dương, đỏ, vàng đến trắng và đen,.. tùy vào yêu cầu của sản phẩm. Men được nung ở nhiệt độ cao, giúp tạo ra lớp phủ bóng và bền, làm nổi bật các hoa văn chạm khắc.

- Nung và hoàn thiện: Sau khi mạ men, sản phẩm sẽ được nung trong lò ở nhiệt độ cao, giúp men bám chắc vào kim loại và tạo ra một lớp phủ mịn màng, có độ bóng. Quá trình nung còn giúp sản phẩm có độ bền cao, không bị bong tróc.

2.2. Đặc điểm của Pháp lam Huế

Thứ nhất: Về hoa văn và họa tiết: Các sản phẩm của Pháp lam thường được thể hiện mang đậm nét văn hóa

đặc sắc và tinh thần Á Đông như: Rồng, phượng, hoa sen, vân mây, tranh tứ bình,…thể hiện cho quyền thế, may mắn và sung túc.

Thứ hai: Về màu sắc đặc trưng: Men được sử dụng trong Pháp lam mang nhiều màu sắc, tạo nên những hiệu ứng màu đặc biệt. Điều đó cũng góp phần tạo nên sự đặc biệt của Pháp lam. Các màu được sử dụng nhiều nhất là xanh, vàng, đỏ mang lại vẻ đẹp cổ điển và đầy ấn tượng.

Thứ ba: Sự kết hợp giữa các yếu tố phương Đông và phương Tây: Dù có ảnh hưởng từ các kỹ thuật thủ công của Trung Quốc và phương Tây, pháp lam vẫn giữ được nét đặc trưng của văn hóa Huế, đặc biệt trong việc kết hợp giữa nghệ thuật chạm khắc kim loại và kỹ thuật mạ men. Kỹ thuật này đã phát triển thành một ngành nghề thủ công độc đáo, có ảnh hưởng mạnh mẽ đến các công trình cung đình và các đồ vật thờ cúng.

Thứ tư: Ứng dụng trong kiến trúc và đời sống: Pháp lam không chỉ được sử dụng trong các đồ vật thờ cúng, mà còn được áp dụng trong các công trình kiến trúc như cổng, cửa, cột, mái của các cung điện, lăng tẩm, đền đài, cũng như các sản phẩm trang trí cao cấp cho hoàng gia và giới quý tộc. Những sản phẩm này mang lại sự xa hoa, quyền quý, và tinh tế cho không gian sống và các nghi lễ hoàng gia.

III. Nét đẹp của Pháp lam Huế trong một số sản phẩm mỹ thuật.

3.1. Pháp lam trang trí trên các công trình kiến trúc thời Nguyễn.

Các mảng/khối Pháp lam được sử dụng như một loại vật liệu để tạo hình thành các khối, gắn lên vào các công trình kiến trúc thời Nguyễn ở Huế gồm:

Các thiên hồ biểu tượng thái cực, mặt trời, mặt trăng, các đao lửa... gắn ở chính giữa bờ nóc các kiến trúc trọng yếu trong Đại Nội và lăng tẩm các vua Nguyễn như: Ngọ Môn, Nhật Tinh Môn, Nguyệt Anh Môn, Hiển Lâm Các, Sùng Ân Điện, Biểu Đức Điện, Ngưng Hy Điện, Minh Lâu; trên hai nghi môn ở hai đầu cầu Trung Đạo trong Đại Nội và trên những nghi môn phía trước mộ vua Minh Mạng và mộ vua Thiệu Trị.

Các khối hình rồng, phượng, mây ngũ sắc,.. được gắn ở hai đầu bờ nóc và ở các đầu quyết của cung điện, lầu gác,..tạo thành một dạng đầu đao đầy màu sắc. Tăng thêm phần lộng lẫy cho các công trình kiến trúc.

Các mảng Pháp lam phẳng được trang trí các hình vẽ phong cảnh, động thực vật, tứ quý, bát bửu, tứ bình,… sẽ xen kẽ với các ô thơ chữ Hán theo kiểu thức trang trí "nhất thi, nhất họa", tạo thành các dải cổ lạ mắt bao quanh các mái lá và đầu hồi các cung điện, lầu tạ trong hoàng cung và các nơi lăng tẩm. Trang trí theo kiểu này còn xuất hiện trên nghi môn ở hai đầu các cầu: Đại Nội, Lăng Minh Mạng,..

Có những bức tranh được làm bằng Pháp lam nguyên tấm hoặc do nhiều mảnh Pháp lam ghép lại mà thành. Điển hình là hai bức tranh liên hoàn treo trong nội thất Biểu Đức Điện, gồm hai bức tranh vẽ hoa điểu bằng pháp lam, bốn bức tranh gương vẽ tĩnh vật theo lối phản họa và ba bức bằng gỗ sơn then, thếp vàng có các bài Hán văn khảm bằng ốc xà cừ, hợp thành.

Ngoài ra, các nghệ nhân thời Nguyễn còn chế tác Pháp lam thành những chữ Hán riêng biệt rồi gắn lên nghi môn ở trước khu vực điện thờ vua Thiệu Trị.

Màu sắc Pháp lam trang trí ngoại thất thường rất sinh động và rực rỡ, sử dụng các gam màu chủ đạo là xanh, vàng, đỏ. Vừa đem lại nét cổ kính, uy nghi cho công trình, vừa mang tới sự hài hòa sinh động.

Việc sắp xếp bố trí các mảng/ khối Pháp lam để trang trí còn tùy thuộc nhiều vào tầm vóc, quy mô cũng như chức năng của công trình kiến trúc đó. Ví dụ như các mảng trang trí trên các công điện chính thì các khối Pháp lam được gắn lên đó sẽ là hình rồng, phượng, mặt trời, hạt châu, thái cực,.. biểu hiện cho sự uy nghi. Còn trên các cung, các điện nhỏ sẽ trang trí các mảng Pháp lam mây ngũ sắc,…Còn những vị trí khác ít quan trọng hơn thường chỉ trang trí các đề tài bình dị như hoa lá, cây cỏ, chim muông.

3.2. Pháp Pháp lam trong đồ gia dụng thường ngày thời Nguyễn

Những đồ gia dụng thường ngày được làm Pháp lam có thể kể đến các vật dụng thường ngày như: Tô, chén, bát, đĩa, khay, .., Các món đồ tế tự như: Lư hương, đỉnh hương, chân đèn,.. Hay những vật dụng để trang trí nội thất trong các cung điện, miếu như: Chóe lớn, đĩa treo tường, chậu trưng cành vàng lá ngọc. Ngoài ra, trong nhóm này còn có những hiện vật pháp lam là những cặp đào tiên, quả lựu, quả phật thủ làm bằng kỹ thuật gò nổi trên một mặt phẳng, dùng để trang trí trên tường nhà, hoặc để gắn trên đầu các đôi câu đối treo trong các cung điện, lăng tẩm. Và cuối cùng là những món đồ phục vụ cho yêu cầu thẩm mỹ và giải trí như: Đầu hồ, hộp đựng phấn, hộp đựng nữ trang,..

Các đề tài trang trí trên các loại hình Pháp lam này cũng rất đa dạng, có thể kể ra là hoa lá, tứ linh, bát bửu, sơn thủy,..Màu sắc được sử dụng cũng vô cùng đa dạng và phong phú, từ đơn sắc cho đến hòa sắc. Đối với các món đồ tế tự, gam màu thường được sử dụng sẽ là đỏ, vàng chanh, trắng, xanh đậm. Còn đối với các món đồ gia dụng, gam màu thường được sử dụng sẽ là xanh lam, hồng tía, xanh lục, nâu nhạt,.. Ngoài ra, còn có những hiện vật không được phủ men pháp lam toàn bộ, mà có những khoảng để trống, lộ rõ cốt đồng ở bên trong, hoặc được gắn thêm các chi tiết trang trí phụ làm bằng chất liệu khác như ngọc, đá mã não, thủy tinh màu.

Loại hình pháp lam này chủ yếu được chế tác dưới ba triều vua Minh Mạng, Thiệu Trị và Tự Đức, nhưng những sản phẩm pháp lam được đánh giá cao nhất về thẩm mỹ và kỹ thuật là pháp lam của triều Thiệu Trị. Vua Thiệu Trị chỉ trị vì bảy năm (1841 - 1847), song triều đại của ông lại nổi tiếng về những sản phẩm đồ sứ ký kiểu và đồ pháp lam tuyệt hảo. Những nét trang trí trên pháp lam triều Thiệu Trị rất sắc sảo, màu không bị nhòe và tạo được một cảm giác hài hòa, sống động. Trong khi đó pháp lam triều Minh Mạng và triều Tự Đức lại thô và nước men thì ít mịn màng hơn.

3.3. Một số tác phẩm Pháp lam tiêu biểu tại Việt Nam.

Cổng Ngọ Môn (Đại Nội Huế) Cổng chính dẫn vào Hoàng thành, Ngọ Môn được trang trí bằng các tấm Pháp lam rực rỡ với hoa văn và họa tiết tinh xảo. Những chi tiết Pháp lam ở đây được nung và phối màu kỳ công, giúp cổng trở thành một biểu tượng nổi bật.

Điện Thái Hòa (Hoàng thành Huế) Là nơi diễn ra các nghi lễ quan trọng của triều Nguyễn, Điện Thái Hòa sử dụng Pháp lam trang trí trên các cột và các bức hoành phi, tạo nên vẻ đẹp quyền quý.

Các lăng tẩm triều Nguyễn:

- Lăng Tự Đức: Các chi tiết hoa văn Pháp lam được sử dụng để trang trí các công trình kiến trúc và tạo điểm nhấn cho không gian linh thiêng.

- Lăng Đồng Khánh: Nhiều phù điêu Pháp lam độc đáo được chế tác cho các bức tường và mái của lăng.

- Hiện vật tại Bảo tàng Mỹ thuật Cung đình Huế: Bộ sưu tập hơn 100 hiện vật như bát, đĩa, khay, bình hoa, và lư hương từ thời Nguyễn. Những tác phẩm này được chế tác với kỹ thuật Pháp lam tinh xảo, thể hiện gu thẩm mỹ và sự công phu trong đời sống hoàng gia.

- Pháp lam hiện đại: Một số bức tranh Pháp lam hiện đại do nghệ nhân Đỗ Hữu Triết và ông Diễn chế tác, lấy cảm hứng từ cuộc sống thường ngày và cảnh quan Việt Nam. Đây là sự tiếp nối sáng tạo dựa trên nền tảng di sản truyền thống.

IV. Nhận định giá trị và giải pháp của việc phát huy Pháp lam Huế vào trong đời sống hiện nay.

4.1. Giá trị của Pháp lam Huế.

Pháp lam Huế là một loại hình nghệ thuật độc đáo, không chỉ mang giá trị thẩm mỹ cao mà còn chứa đựng nhiều giá trị về văn hóa lịch sử và nghệ thuật đặc sắc. Không chỉ đem lại giá trị về mặt nghệ thuật mà còn đóng góp không nhỏ cho nền kinh tế.

4.1.1. Giá trị nghệ thuật của Pháp lam Huế.

Giá trị thẩm mỹ: Sự kết hợp giữa thủ công và mỹ thuật cũng như việc pha trộn hài hòa của màu sắc cùng với sự bền bỉ, tạo nên vẻ đẹp lộng lẫy và quý phái, phù hợp với không gian hoàng gia.

Giá trị lịch sử: Pháp lam Huế là minh chứng cho sự giao thoa giữa văn hóa Việt Nam và các kỹ thuật chế tác nước ngoài trong thế kỷ XIX. Những tác phẩm này phản ánh đời sống, văn hóa và tín ngưỡng của giới quý tộc thời kỳ này.

Giá trị văn hóa: Pháp lam không chỉ phục vụ trang trí mà còn được sử dụng trong các nghi thức quan trọng, từ cung đình đến tín ngưỡng, góp phần định hình văn hóa nghệ thuật của Huế. Nhiều hiện vật còn lại là biểu tượng của tinh thần sáng tạo và gu thẩm mỹ tinh tế của người Việt.

4.1.2. Giá trị kinh tế của Pháp lam Huế.

Đóng góp cho thị trường thủ công mỹ nghệ: Các sản phẩm Pháp lam được tạo ra tinh xảo, độc đáo và có chất lượng cao điều đó thu hút được du khách cả trong và ngoài nước. Đem lại nguồn thu nhập ổn định cho các cơ sở sản xuất. Ngoài ra Pháp lam Huế còn có thể là sản phẩm độc bản, từ đó làm tăng giá trị kinh tế của từng sản phẩm.

Đóng góp cho du lịch: Các công trình có sử dụng Pháp lam như Đại Nội Huế, lăng tẩm triều Nguyễn không chỉ là điểm tham quan nổi tiếng mà còn là nơi giúp khách du lịch tìm hiểu về nghệ thuật này. Việc tổ chức các tour trải nghiệm nghề làm Pháp lam cũng có thể thu hút khách quốc tế, gia tăng nguồn thu từ du lịch.

4.2. Giải pháp bảo tồn và phát huy Pháp Lam Huế vào trong đời sống hiện nay.

Hiện nay, Pháp lam Huế có thể nói là đã được khôi phục thành công. Tuy nhiên để có thể bảo tồn cũng như phát huy giá trị của Pháp lam để ứng dụng vào trong đời sống vẫn còn cần nhiều giải pháp cụ thể hơn như:

- Sau khi đã tiến hành nghiên cứu về kĩ thuật và phục dựng lại các tác phẩm cũ thì tiến hành đào tạo và truyền nghề. Đem Pháp lam đến gần hơn với cuộc sống thường nhật

- Ứng dụng Pháp lam vào đời sống. Đưa Pháp lam vào việc sản xuất các tranh, phù điêu, đồ gia dụng và đưa vào các công trình kiến trúc hiện đại để gia tăng nét độc đáo cũng như giá trị của sản phẩm Pháp lam.

- Ngoài ra thì đưa Pháp lam vào du lịch và tổ chức các buổi hội thảo, triển lãm sẽ đưa Pháp lam đến gần hơn với công chúng, khách du lịch cũng như bạn bè quốc tế.

- Hỗ trợ từ chính quyền để xây dựng thương hiệu Pháp lam Huế như một biểu tượng văn hóa của Việt Nam. Tận dụng sự phát triển mạnh mẽ của nền tảng số để quảng bá loại hình nghệ thuật độc đáo này.

V. Kết luận

Trải qua khoảng 200 năm tồn tại, đến nay, nhiều hạng mục trang trí Pháp lam trên các công trình kiến trúc cung đình Huế đang dần bị hư hỏng và xuống cấp. Những năm gần đây, một số nhóm và cá nhân đã ra sức tìm tòi hướng khôi phục lại kỹ thuật chế tác pháp lam Huế nhằm phục vụ cho công tác trùng tu, tôn tạo các di tích cũng như để bảo tồn nghề xưa. Trong đó đáng chú ý là những kết quả thành công khá ấn tượng của thạc sĩ Đỗ Hữu Triết và các cộng sự.

Hiện nay Nghệ thuật Pháp lam đã được khôi phục và có những chuyển biến khởi sắc hơn. Tác giả mong rằng sau bài nghiên cứu tổng quan này, chúng ta có thể biết về Pháp lam, cũng như hiểu hơn về loại hình nghệ thuật độc đáo này. Từ đó bảo tồn và phát huy giá trị của Pháp lam Huế trong đời sống hiện nay.

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Nguyễn Liên Minh

Tuyên bố miễn trừ trách nhiệm pháp lý:

- *Nội dung của tài liệu này là ý kiến cá nhân dựa trên thông tin đại chúng. Tác giả, trong mọi trường hợp không cố tình hay vô tình, gây ảnh hưởng đến bất cứ cá nhân hay tổ chức nào. Vì thế, tác giả công bố miễn trừ tất cả các trách nhiệm pháp lý liên quan đến tài liệu và phát biểu thuyết trình, trong mọi trường hợp;*
- *Tất cả hay một phần nội dung, bao gồm văn bản, hình ảnh, logo và đồ họa trên tài liệu này là tài sản của tác giả, ngoại trừ các thông tin đại chúng và được bảo vệ bởi luật bản quyền và sở hữu trí tuệ hiện hành;*
- *Tham luận này có sử dụng tài liệu công bố đại chúng của Worldbank, Our World Data, McKinsey & Co, Bobst, Reifenhauser GmbH và RE GmbH.*

Sơ lược

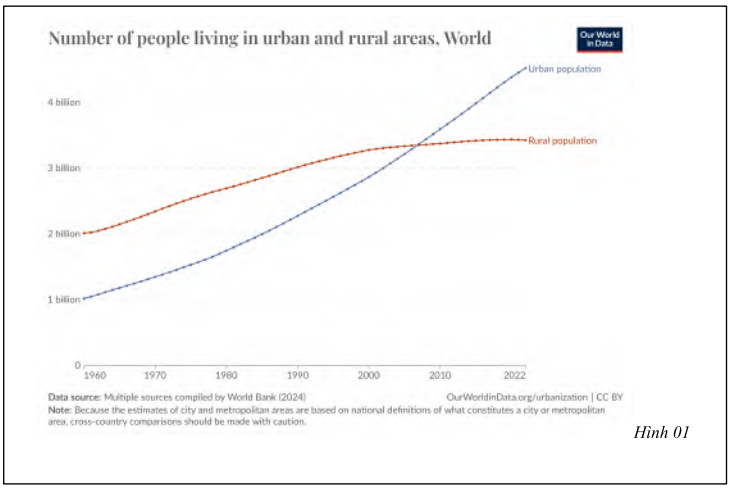
Mặc dù đại dịch Covid 19 đã đi qua, thế giới hầu như đã thích nghi với "bình thường mới – New Normal". Tuy nhiên, sự hình thành và phát triển các hệ quả liên quan trực tiếp đến đời sống và thói quen của con người là điều không tránh khỏi. Thay đổi nhân khẩu học (Demographic change); Sự thay đổi thế hệ (Generation shifts) và Tính bền vững (Sustainability) là các phát triển nổi trội. Những thay đổi này ít nhiều ảnh hưởng đến quá trình sản xuất tạo ra vật chất cho xã hội và đã trở thành năng lượng cho cuộc Cách mạng công nghiệp lần thứ 4 – Công nghiệp 4.0.
*Theo Wikipedia, Công nghiệp 4.0 tập trung vào công nghệ **kỹ thuật số** , kết nối thông qua **Internet vạn vật**, truy cập dữ liệu thời gian thực và giới thiệu các hệ thống vật lý **không gian mạng**. Công nghiệp 4.0 cung cấp một cách tiếp cận liên kết và toàn diện hơn cho sản xuất. Nó kết nối vật lý với kỹ thuật số và cho phép sự tương tác và truy cập tốt hơn giữa các bộ phận, đối tác, nhà cung cấp, sản phẩm và con người nhằm tăng năng suất, cải thiện quy trình và thúc đẩy tăng trưởng.*

1. Vi rút Corona – vật thể Nhỏ thay đổi thế giới Lớn

Sự xuất hiện của vi rút Corona gây Đại dịch Covid 19 trên toàn cầu, ngoài con số thương vong gây tổn thất lớn cho loài người, còn phát sinh ra những qui định mới về giãn cách xã hội, quy chuẩn về vệ sinh cá nhân, phát triển nhanh các mô hình "tế bào" thay vì "tập thể" như làm việc độc lập bán hoặc bất tập trung. Hậu Covid 19, các nhà Xã hội học ghi nhận nhiều sự thay đổi và nổi bật là:

1.1. Thay đổi nhân khẩu học (Demographic change)

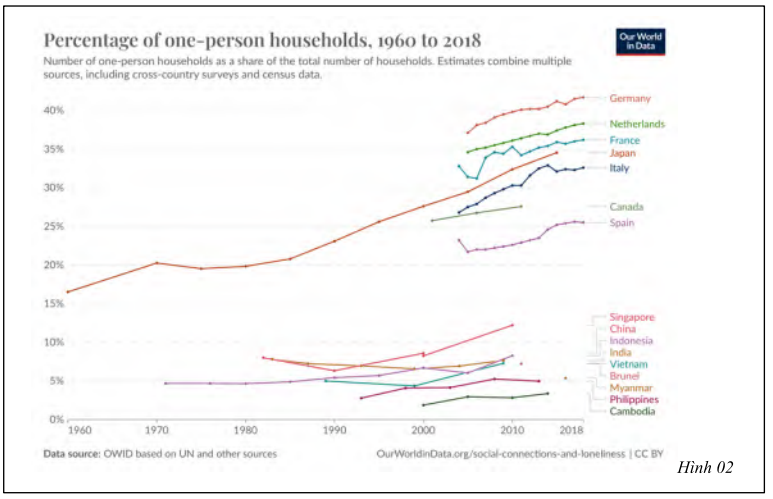
Xu hướng chuyển dịch nhân khẩu từ nông thôn sang thành thị (*), đặc biệt sau Covid 19, gia tăng nhanh (Hình 1). Năm 1960, với dân số toàn cầu là 3,03 tỷ người, tỷ lệ thành thị/nông thôn là 33.7%/66.3%. Tuy nhiên, năm 2022, với dân số toàn cầu đạt 7,95 tỷ người, tỷ lệ thành thị/nông thôn đảo ngược thành 56.9%/43.1%.



Hình 01

(*) Thành thị được xác định dựa trên hạ tầng và dịch vụ bao gồm cả đô thị vệ tinh và đại đô thị.

Ngoài chuyển dịch về địa lý, nhân khẩu học còn ghi nhận xu hướng "đơn độc". Khu vực cựu lục địa, tỷ lệ gia đình đơn lẻ (01 nhân khẩu) tăng vượt ngưỡng 30%, đặc biệt ở các quốc gia có dân số già như châu Âu và Nhật Bản. Sự xuất hiện và gia tăng tỷ lệ gia đình đơn lẻ của khu vực tân lục địa (Trung Quốc, Ấn Độ, Đông Nam Á) đánh dấu sự thay đổi về văn hoá gia đình đa thế hệ sang cuộc sống đơn thân. Các nhà xã hội học cũng ghi nhận được sự trẻ hoá trong nhóm gia đình đơn lẻ này. Đã xuất hiện các gia đình đơn lẻ thuộc Gen Y (sinh năm 1980 – 1994) và Gen Z (sinh sau 1994) thay vì đa phần là Gen "Baby Boomer" (1946 – 1964) như trước đây (Hình 2).



Hình 02

1.2. Sự thay đổi thế hệ (Generation shifts)

Các công việc liên quan đến Sản xuất (Công nghiệp và Nông nghiệp) hiện nay ít thu hút được Gen Y và Gen Z. Hai nhóm chiếm đa phần lực lượng lao động toàn cầu này "tiêu thụ/hấp thụ" thông tin và sản phẩm hoàn toàn khác so với các thệ hệ trước.

Với Gen Y và Z, thuật ngữ "Vạn vật thế giới chỉ ở ngón tay" không hề xa lạ. Hầu hết các nhu cầu cuộc sống cơ bản và công việc đều có thể tương tác thông qua không gian mạng và phương thức số. Giới hạn về không gian và thời gian được làm phẳng trên không gian mạng Internet và tất cả được qui về "thời gian thực". Sự hoàn thành luôn được kỳ vọng "ngay và luôn" (right now) thay vì "nhanh nhất có thể" (as soon as possible) như trước đây. Chuẩn mực truyền thông cũng đã thay đổi từ giao thức hữu tuyến giới hạn sang giao thức internet.

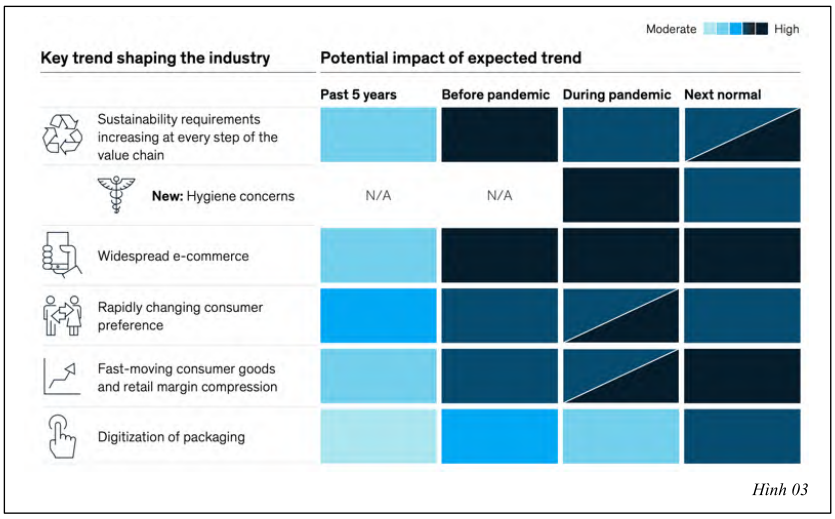
Trích dẫn bài viết của Gilda D'Incerti trên Tạp chí Forbes ngày 21.12.2022 về sự Thay đổi thế hệ:

"Thế hệ trẻ sẽ sớm chiếm 30% lực lượng lao động, số lượng nhân viên Gen Z sẽ tăng gấp ba lần vào năm 2030 và chắc chắn đóng một vai trò quan trọng trong việc định hình xã hội và các ngành công nghiệp trong tương lai. Để phản ánh chân thực thành phần của Gen Z, họ yêu cầu phù hợp hơn với các giá trị của họ khi chọn doanh nghiệp để liên kết. Các nhà lãnh đạo doanh nghiệp nhằm thu hút nhân tài hàng đầu phải đảm bảo rằng công ty của họ thể hiện các giá trị đa văn hóa mà các chuyên gia trẻ đang tìm kiếm. Các công ty có mục tiêu trách nhiệm xã hội mạnh mẽ của doanh nghiệp (ESG) và các sáng kiến đa dạng và hòa nhập khác nhau sẽ ngày càng trở nên hấp dẫn đối với nhân khẩu học này khi họ tham gia lực lượng lao động.

Chúng ta không chỉ ở trong kỷ nguyên của công nghệ và đổi mới, mà thế hệ lao động mới này cũng đang bước vào lĩnh vực chuyên nghiệp sau một sự kiện toàn cầu chưa từng có. Covid-19 đã thay đổi cách tất cả chúng ta sống và làm việc trong xã hội – được cho là mãi mãi. Do đó, ý

tưởng của Gen Z về sự cân bằng giữa công việc và cuộc sống có thể khác biệt đáng kể so với các thế hệ cũ, những người thậm chí chưa bao giờ xem xét khái niệm làm việc từ xa. Trong kỷ nguyên mới này, người lao động yêu cầu tăng tính linh hoạt, đặc quyền chăm sóc sức khỏe và tính xác thực từ người sử dụng lao động của họ. Các doanh nghiệp được kỳ vọng sẽ tạo điều kiện cho một môi trường làm việc hòa nhập hơn, phục vụ cho sức khỏe (cả tinh thần và thể chất) và chia sẻ đạo đức của họ về sự hòa nhập và bền vững."

1.3. Tính bền vững (Sustainability)



Hình 03

Số liệu thống kê gần đây của Công Ty McKinsey (Hình 03) thể hiện sự chuyển dịch xu hướng giao dịch thương mại – hàng hoá toàn cầu và đương nhiên ngành bao bì nói riêng và in ấn nói chung cũng sẽ ảnh hưởng bởi các xu hướng này.

Sự gia tăng quan tâm đến Tính bền vững (Sustainability) về chiều sâu, ở nhiều hình thức là đóng góp của Gen X và Z với kỳ vọng cao hơn về chất lượng cuộc sống. Sự gia tăng tốc độ truyền thông vào trao đổi thông tin cũng thúc đẩy sự bao phủ toàn cầu của khái niệm Tính bền vững. Việc dễ tương tác trên cộng đồng mạng, kể cả mạng xã hội và chuyên nghiệp, đã góp phần lan toả và cập nhật các chương trình liên quan đến tính bền vững. Phong trào Xanh hoá ngày càng lan rộng trong cộng đồng thông qua sự phát triển với tốc độ chóng mặt của EV (phương tiện giao thông điện), của tự động hoá – robotic, của tư duy tái tạo vật chất như năng lượng tái tạo, tái sử dụng vật liệu, v.v…

Thương mại điện tử (e-Commerce) trở thành đặc trưng của Gen X và Z. Sự tăng trưởng nhanh chóng của TMĐT không chỉ do sự phù hợp với nhu cầu của nhóm dân số trẻ mà còn nhờ vào sự trợ giúp của không gian mạng Internet và các nền tảng công nghệ bán lẻ được xây dựng trên nền IoT. TMĐT cũng gây sức ép vô cùng lớn đến thương mại truyền thống (hệ thống bán lẻ) vì giá bán của TMĐT thấp hơn sơ với TMTT do chi phí thấp hơn. Để cạnh tranh, TMTT bắt buộc phải giảm tỷ suất lợi nhuận và tăng cường sử dụng tự động hoá và số hoá nhằm giảm chi phí. Sự phát triển của TMĐT và tăng cường số hoá của TMTT là nền tảng vững chắc cho Bao bì số.

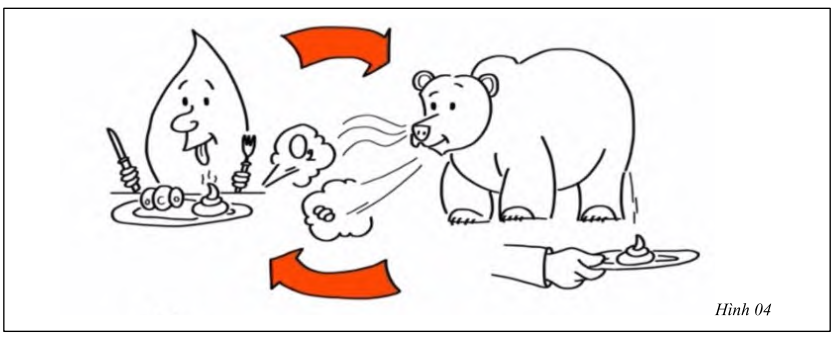
2. Tự động hoá (Automation) và Số hoá (Digitalization) trong Bao bì Bền vững

2.1. Bao bì Bền vững:

a. Khái niệm bền vững:

Theo Từ điển Cambridge, trạng từ bền vững (sustainable) là khả năng có thể tiếp tục trong một khoản thời gian (able to continue over a period of time). Cũng theo từ điển này, danh từ bền vững (sustainability) là chất lượng gây ra ít hoặc không gây thiệt hại cho môi trường và do đó có thể tiếp tục trong một thời gian dài (the quality of causing little or no damage to the environment and therefore able to continue for a long time).

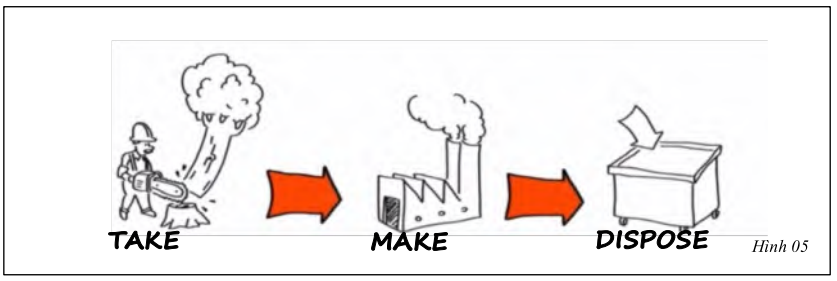
Khả năng phát triển bền vững của tự nhiên với hệ sinh thái động – thực vật đã hình thành, tiến hoá ổn định hàng triệu năm nay và vẫn đang tiếp tục tiến hoá ổn định. Đó là: Thực vật hấp thu CO_2 của động vật thải ra, dùng năng lượng mặt trời để chuyển hoá thành O_2 cho động vật hấp thu ➔ Thực vật dùng năng lượng mặt trời và dinh dưỡng trong môi trường để phát triển ➔ Động vật ăn và tiêu hoá thực vật để phát triển và đồng thời thải ra chất dinh dưỡng để nuôi thực vật. Vòng tuần hoàn của tự nhiên vẫn liên tục hoạt động từ khi có sự sống trên trái đất (Hình 4)



Hình 04

Sự bền vững cũng được chứng minh qua các Định luật Bảo toàn, trong đó, vật chất không mất đi mà chỉ chuyển từ dạng này sang dạng khác. Do có sự can thiệp của con người vào vật chất tự nhiên để tạo thành vật chất nhân tạo (man-made materials) – Hình 5, nên chính con người sẽ phải tiến hoá để xử lý các vật chất nhân tạo được tiếp tục chuyển hoá trong vòng tuần hoàn kín: Recycle – Reuse.

Trong quá trình gia công vật liệu nhân tạo và xử lý công đoạn sau, đòi hỏi phải có năng lượng và nhằm tiết kiệm năng lượng, con người đưa ra khái niệm tiết giảm (Reduce) tham gia vào vòng tuần hoàn.



Hình 05

b. Bao bì bền vững:

Đối với bao bì nhựa chẳng hạn, con người khai thác năng lượng hoá thạch để có vật chất lỏng/khí để tạo vật chất rắn là hạt nhựa. Con người dùng các công nghệ gia công để chuyển hạt nhựa thành các vật dụng đóng gói phục vụ cuộc sống. Sau khi sử dụng xong thì con người cần giải quyết chất thải bao bì, về bản chất cũng là một dạng vật chất. Có một số nơi, người ta đốt chất thải nhựa để chuyển hoá thành năng lượng/công năng. Có một số nơi, họ lọc lựa chất thải nhựa và một phần được đưa vào hoạt động tái chế (Recycle) để tái sử dụng (Reuse), phần còn lại người ta đốt để lấy năng lượng.

Việc chọn lựa hình thức tiếp tục như thế nào là tuỳ thuộc vào khả năng thu hồi vật chất/năng lượng và khả năng đáp ứng của cơ sở hạ tầng, công nghệ. Và cũng có nơi, chất thải nhựa được lưu trữ ngoài môi trường vì chưa có cơ sở hạ tầng cũng như công nghệ để tiếp tục chuyển hoá. Hàng loạt các hoạt động giảm thiểu (Reduce) đối với bao bì đã và đang xảy ra như là: chuyển từ bao bì cứng thành bao bì phức hợp mềm, giảm trọng lượng nguyên liệu sử dụng/thành phẩm,v.v…

Tính bền vững của sản xuất đến từ 3 hoạt động chính: giảm thiểu (reduce), tái sử dụng (reuse) và tái chế (recycle). Các trao đổi về Bao bì Bền vững, Kinh tế Tuần hoàn, v.v…chưa bao giờ hết nóng kể từ khi được giới thiệu. Các tổ chức hiệp hội chuyên ngành liên tục được thành lập và các qui định về pháp luật về bao bì bền vững ngày càng rõ hơn:

a. Ngày 24 tháng 1 năm 2019, tại diễn đàn kinh tế toàn cầu Davos, Thuỵ Sỹ các tập đoàn đa quốc gia về hàng tiêu dùng như Unilever, Nestle, Procter & Gamble, Coca-Cola và Pepsico đã công bố thành lập sáng kiến Loop nhằm liên kết các nguồn lực toàn cầu để thiết kế và sản xuất mặt hàng Bao bì nhựa phức hợp bền vững (sustainable packaging) với cam kết đến 2025:
   - Cắt giảm 50% lượng hạt nhựa nguyên sinh;
   - Sử dụng 85% nguyên liệu tái sử dụng, tái sinh;
   - Thu hồi và xử lý (bao bì) nhiều hơn lượng đã bán.

b. Ngày 21.06.2019, Liên minh Tái chế Bao bì Việt Nam (PRO Vietnam) được thành lập tại Tp.HCM với 21 thành viên là các công ty FDI và Việt Nam hàng đầu trong lĩnh vực hàng tiêu dùng, sản xuất bao bì, bán lẻ và nhập khẩu với 4 mục tiêu chính:
   - Nâng cao nhận thức người tiêu dùng về tái chế và phân loại rác;
   - Làm vững mạnh hệ sinh thái thu gom bao bì sẵn có;
   - Thúc đẩy các chương trình tái chế của nhà máy xử lý và sản xuất bao bì;
   - Hợp tác với Chính Phủ ủng hộ và phổ biến bộ nguyên tắc 3R (Reduce – Giảm thiểu, Reuse – Tái sử dụng và Recycle – Tái chế) trong bảo vệ môi trường, đặc biệt là Recycle – Tái chế, đem đến vòng đời thứ hai cho những bao bì đã qua sử dụng

c. Ngày 10.01.2022, Nghị định số 08/2022/NĐ-CP và Thông tư số 02/2022/TT-BTNMT được đồng thời thông qua, chính thức đưa Việt Nam vào danh sách các quốc gia áp dụng EPR (Extended Producer Responsibility, có nghĩa là Trách nhiệm mở rộng của nhà sản xuất) qui định về trách nhiệm Tái chế chất thải và Xử lý chất thải đối với sản phẩm và bao bì của nhà sản xuất hoặc thương nhân nhập khẩu. (https://epr.monre.gov.vn/vi)

d. Các chương trình hành động theo vùng miền của các tổ chức kinh tế và phi chính phủ mang tính cộng đồng. Tuy nhiên, các hoạt động này chỉ mang tính phong trào nên chưa phổ cập được rộng rãi và triển khai toàn quốc.

e. Ứng dụng thu mua ve chai bằng app đầu tiên của Việt Nam – VECA, mặc dù được sự hỗ trợ rất lớn từ các tổ chức, tuy nhiên sau 3 năm hoạt động, lượng rác thải nhựa thu về chưa đạt kỳ vọng của dự án:

Trong tất cả các loại vật liệu bao bì, nhựa đang được quan tâm hàng đầu trong hoạt động 3R do tính chất phổ biến và khó phân huỷ/xử lý của loại vật liệu này.

2.2. Ảnh hưởng của tự động hoá và số hoá đến bao bì bền vững:

Hệ quả của việc thay đổi nhân khẩu, với dòng di dân từ nông thông ra thành thị, ảnh hưởng đến số lượng và chất lượng nhân sự tham gia quá trình sản xuất tạo vất chất cho xã hội. Các nhà máy, công xưởng, trang trại ở xa thành thị lại càng kém hấp dẫn lực lượng lao động trẻ hơn nữa khi lãnh vực sản xuất đang mất dần sức hút với lực lượng trẻ. Thiếu nhân lực bắt buộc các cơ sở sản xuất công nghiệp và nông nghiệp phải có nguồn lực thay thế để duy trì và phát triển sản xuất. Thừa hưởng từ Cuộc cách mạng công nghiệp lần thứ 3, Cách mạng Kỹ thuật số, các nhà công nghiệp thiết bị máy móc đang gia tăng cung cấp các giải pháp tự động nhằm thay thế con người ➔ máy móc thiết bị ngày càng phải "dễ sử dụng" (Easy – to - Use).

Công nghiệp chế tạo xe ô tô đã thay thế 80% sức người trong dây chuyền lắp ráp xe. Những siêu nhà máy như Tesla Nevada đưa vào hoạt động năm 2020 là minh chứng của xu hướng phát triển nhà máy thông minh.

Ngành cung ứng phát triển cùng với tốc độ phát triển của TMĐT đã hình thành lên hàng loạt nhà kho thông minh phục vụ cho các ông lớn như Amazon, Alibaba và sau này các sàn TMĐT vùng đua nhau hình thành dựa trên các nền tảng dịch vụ cung ứng này. AGV (Automatic Guided Vehicle) được dùng để di chuyển hàng hoá trong kho thay vì con người lái các loại thiết bị nâng hạ. Các phần mềm thu thập dữ liệu người dùng để dự đoán xu hướng hàng hoá và hoạch định lượng hàng hoá cần có. Hệ thống quản trị kho thông minh, kết nối toàn cầu có thể tối ưu hoá

lượng hàng tồn kho tại mỗi kho và tự tính toán đơn đặt hàng đến các nhà cung cấp dựa trên dữ liệu thu thập được, tránh lãng phí và sai sót. Các hoạt động trước đây một thập kỷ còn hầu như do con người đảm nhiệm, nay đã được thay thế bằng máy móc thiết bị.

AGV đã thiết lập chuẩn mực mới của ngành cung ứng kho vận

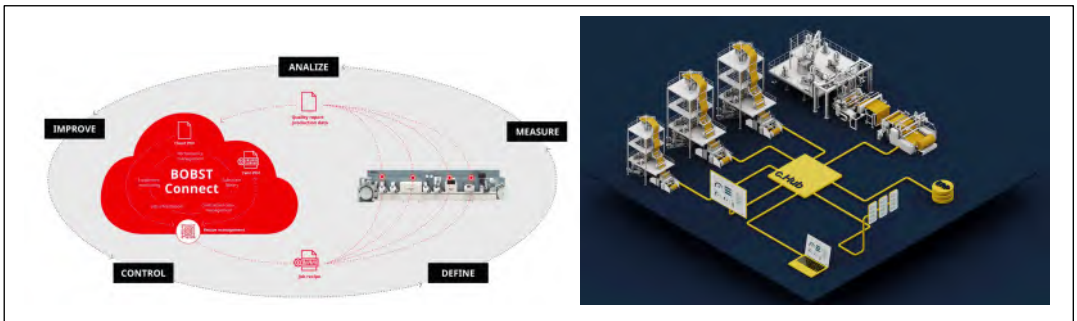
Nhà máy thông minh – Kho thông minh góp phần không nhỏ đến sự phát triển bền vững. Chính nhờ vào cách thiết kế và vận hành hướng đến tối ưu hoá hiệu suất, Nhà máy thông minh – Kho thông minh sử dụng ít tài nguyên và năng lượng hơn các hoạt động truyền thống.

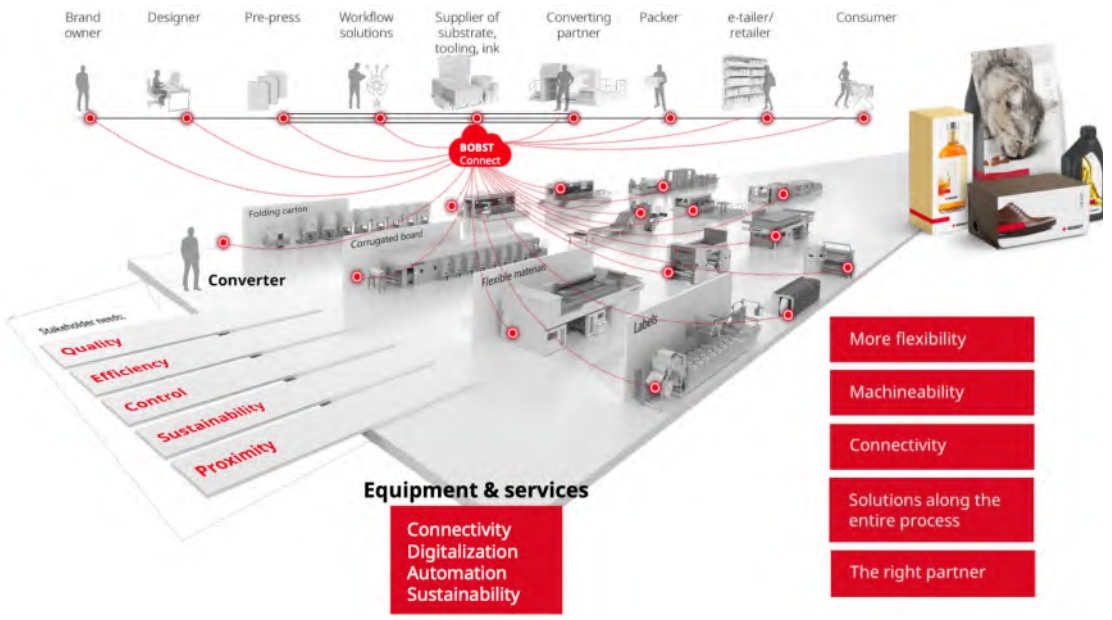
Các qui định về trách nhiệm xã hội và môi trường (ESG) ngày càng chặt chẽ nhằm định hướng công nghệ bao bì nhắm đến tính bền vững.

Các nhà sản xuất thiết bị liên tục đưa ra các giải pháp tự động và số hoá nhằm giải quyết các vấn đề về thiếu hụt nguồn nhân lực và xu hướng bao bì bền vững

Ví dụ như các giải pháp của Bobst với công nghệ in Flexo narrow web hoặc digital flexo nhằm trợ giúp người vận hành thao tác dễ nhất có thể. “Thợ bậc cao” được thay thế bằng các phần mềm và hệ thống tự động.

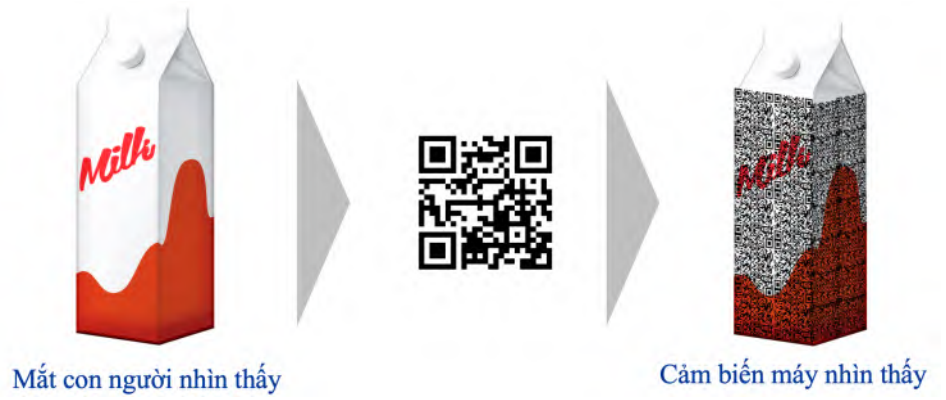
Bobst Connect, RE c-Hub và hàng loạt các giải pháp kết nối đa phương tiện khác bắt đầu đưa vào ứng dụng từ sau Covid 19 nhằm thu thập dữ liệu lớn (Big Data) từ hệ thống tự động (automation) để thực hiện các bước đo lường, phân tích, cải tiến và kiểm soát quá trình sản xuất. Tương lai của sản xuất AI cũng không còn quá xa.





Bobst – Shaping the future of the packaging

Sự xuất hiện Hộ chiếu kỹ thuật số của sản phẩm (PDP – Product Digital Passport) là tất yếu khi dữ liệu đã sẵn có và các nền tảng IoT cũng sẵn sàng. Hộ chiếu kỹ thuật số sản phẩm (PDP) là phương thức thể hiện bằng kỹ thuật số về **vòng đời sản phẩm** và **các thuộc tính chính**, được lưu trữ và chia sẻ ở định dạng chuẩn hóa, an toàn. Nó cho phép sản phẩm mang danh tính kỹ thuật số bao gồm thông tin toàn diện về nguồn gốc, vật liệu, quy trình sản xuất, cách sử dụng và dữ liệu cuối vòng đời. Mục tiêu là cung cấp tính minh bạch, khả năng truy xuất nguồn gốc và tính bền vững trong suốt hành trình của sản phẩm từ khi tạo ra đến khi thải bỏ hoặc tái chế.



Kỹ thuật in Water marking có thể chuyển tải dữ liệu số lên bề mặt vật liệu một cách vô hình với thị giác của con người

Sau đây là một số thành phần và chức năng chính của Hộ chiếu kỹ thuật số sản phẩm:

- Thông tin sản phẩm: Các chi tiết như thành phần, thông số kỹ thuật, nguồn gốc và chứng nhận của sản phẩm (ví dụ: tiêu chuẩn sản xuất có đạo đức, thân thiện với môi trường).
- Khả năng truy xuất nguồn gốc: Theo dõi hành trình của sản phẩm từ nguyên liệu thô đến khi bán ra, bao gồm thông tin chi tiết về chuỗi cung ứng, quy trình sản xuất và mọi thay đổi được thực hiện trong suốt vòng đời của sản phẩm.
- Tính bền vững: Cung cấp thông tin chi tiết về tác động của sản phẩm đến môi trường, bao gồm lượng khí thải carbon, mức sử dụng năng lượng và khả năng tái chế, giúp người tiêu dùng và doanh nghiệp đưa ra quyết định sáng suốt hơn.

- Quyền sở hữu và sử dụng: Bao gồm dữ liệu về chủ sở hữu sản phẩm, chế độ bảo hành, lịch sử sửa chữa, bảo trì và cập nhật. Nó cũng có thể cung cấp thông tin chi tiết về các mẫu sử dụng và hiệu suất.
- Quản lý cuối vòng đời: Theo dõi việc thải bỏ, tái chế hoặc tái sử dụng sản phẩm, đảm bảo rằng sản phẩm có thể được xử lý một cách có trách nhiệm khi đến cuối vòng đời hữu ích của nó.
- Khả năng tương tác: Hộ chiếu thường được thiết kế để hoạt động trên nhiều hệ thống và ngành công nghiệp, giúp nhiều bên liên quan (nhà sản xuất, nhà bán lẻ, người tiêu dùng, đơn vị tái chế) có thể truy cập và cập nhật thông tin sản phẩm.

Lợi ích chính của PDP:

- Tăng cường tính minh bạch: Người tiêu dùng và doanh nghiệp có thể xác minh tính xác thực, tính bền vững và nguồn gốc của sản phẩm;
- Khả năng hiển thị chuỗi cung ứng: Các doanh nghiệp có thể theo dõi và tối ưu hóa chuỗi cung ứng của mình để đạt hiệu quả, tuân thủ và tác động đến môi trường;
- Tính bền vững: PDP hỗ trợ các mô hình kinh tế tuần hoàn bằng cách thúc đẩy tái chế và tái sử dụng, đồng thời giúp theo dõi dấu chân môi trường của sản phẩm dễ dàng hơn;
- Trao quyền cho người tiêu dùng: Người tiêu dùng có thể đưa ra quyết định sáng suốt hơn dựa trên lịch sử, tính bền vững và các cân nhắc về mặt đạo đức của sản phẩm.

Ví dụ về các trường hợp sử dụng PDP:

- Thời trang: Ngành thời trang ngày càng áp dụng hộ chiếu kỹ thuật số cho sản phẩm để cung cấp tính minh bạch về vật liệu, nguồn cung ứng có đạo đức và tác động đến môi trường;
- Điện tử: Đối với thiết bị điện tử tiêu dùng, PDP có thể bao gồm thông tin về các chương trình tái chế và khả năng sửa chữa của sản phẩm, hỗ trợ vòng đời dài hơn;
- Thực phẩm: Đối với các sản phẩm thực phẩm, hộ chiếu kỹ thuật số có thể cung cấp thông tin về nguồn gốc, hoạt động tìm nguồn cung ứng, chứng nhận tính bền vững và khả năng truy xuất nguồn gốc từ trang trại đến bàn ăn.

Khái niệm này đang ngày càng được ưa chuộng khi các doanh nghiệp và người tiêu dùng tìm kiếm các cách để giảm thiểu chất thải, cải thiện tính minh bạch của sản phẩm và thúc đẩy tính bền vững. Nó cũng liên kết chặt chẽ với các khái niệm như "nền kinh tế tuần hoàn", "chuỗi khối" để theo dõi và xác minh dữ liệu và "Internet vạn vật (IoT)" để kết nối các sản phẩm vật lý với dữ liệu kỹ thuật số.

3. Kết luận:

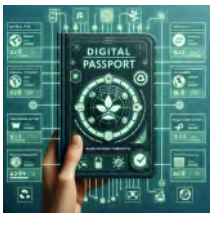
Đứng trên quan điểm của tác giả, giai đoạn hậu Covid 19 đã hình thành nên nhiều khái niệm mới hoặc đẩy nhanh sự chuyển hoá của những khái niệm mới.

Thiếu nguồn nhân lực do: Dịch chuyển nhân khẩu học và thay đổi thế hệ

Sử dụng đơn giản (Easy-to-Use)

Tự động hoá (Automation)

Tuân thủ các Quy định



Tự động hoá ➔ giảm thiểu việc sử dụng nguồn tài nguyên

Số hoá (Digitalization) ➔ Hộ chiếu kỹ thuật số của sản phẩm (PDP)

PHÁT TRIỂN BỀN VỮNG: NHỮNG THÁCH THỨC VÀ GIẢI PHÁP CHO THIẾT KẾ VÀ CHẾ BẢN BAO BÌ HỘP GIẤY

SUSTAINABLE DEVELOPMENT: CHALLENGES AND SOLUTIONS FOR DESIGNING AND PREPRESS OF FOLDING BOX PRODUCTION

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GIỚI THIỆU

Trong bối cảnh thế giới phát triển nhanh chóng không chỉ về kỹ thuật, công nghệ sản xuất, mà còn có sự xuất hiện của trí tuệ nhân tạo… thì mọi lãnh vực cần có sự thay đổi phù hợp. Với mục tiêu phát triển bền vững cho toàn cầu thì ngành in nói chung và việc thiết kế, chế bản cho bao bì hộp giấy cũng đã và đang có những thay đổi mạnh mẽ để không chỉ theo kịp xu hướng mà còn nhằm cắt giảm giá thành và tăng hiệu quả sản xuất. Bài viết dưới đây giới thiệu chi tiết về những nội dung bắt buộc phải có cũng như các kỹ thuật và phần mềm phụ trợ cho sự phát triển bền vững trong thiết kế và chế bản cho sản xuất bao bì hộp giấy.

Các điểm chính của bài viết: Các mục tiêu phát triển bền vững liên quan đến ngành công nghiệp in và bao bì; Công nghệ thiết kế và sản xuất bao bì hộp giấy; Nội dung chính của phát triển bền vững trong thiết kế và chế bản; Các nguyên tắc thiết kế bền vững trong thiết kế; Các giải pháp bền vững trong thiết kế cấu trúc-thiết kế bề mặt – Chế bản; Mức độ ứng dụng các giải pháp phát triển bền vững tại các nhà in bao bì hộp giấy tại Việt Nam

NỘI DUNG

1. Các mục tiêu phát triển bền vững liên quan đến ngành công nghiệp in và bao bì

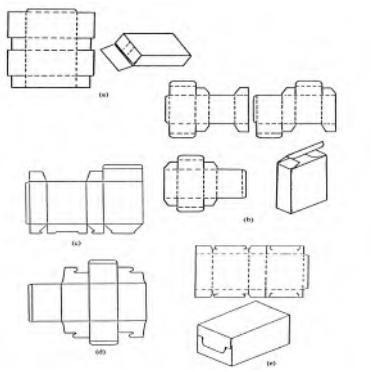
Liên Hợp Quốc và các đối tác tại Việt Nam đang nỗ lực để đạt được 17 Mục tiêu Phát triển Bền vững vào năm 2030. Ngành in bao bì nói chung và thiết kế, chế bản nói riêng đều có liên quan trực tiếp đến 4 mục tiêu (Xem Bảng 1) [1] và [2]

Bảng 1. Mối tương quan phát triển bền vững cấp độ quốc gia và ngành nghề

Mục tiêu số	Cấp độ quốc gia	Liên quan đến ngành công nghiệp in và bao bì
12	Đảm bảo sản xuất và tiêu dùng bền vững	Sử dụng hiệu quả vật liệu và năng lượng là rất quan trọng (giấy, mực, màng…) Tăng hiệu quả sản xuất; giảm thời gian sản xuất và giảm giá thành
13	Ứng phó kịp thời, hiệu quả với biến đổi khí hậu và thiên tai	Giảm lượng khí thải trong quá trình sản xuất
14	Bảo tồn và sử dụng bền vững đại dương, biển và nguồn lợi biển để phát triển bền vững	Áp dụng các công nghệ tiên tiến nhằm giảm hóa chất, nước thải
15	Bảo vệ và phát triển rừng bền vững, bảo tồn đa dạng sinh học, phát triển dịch vụ hệ sinh thái, chống sa mạc hóa, ngăn chặn suy thoái và phục hồi tài nguyên đất	Sử dụng các loại giấy có nguồn gốc rừng trồng; Sử dụng các loại màng dễ phân hủy hoặc màng sinh học
17	Tăng cường phương thức thực hiện và thúc đẩy đối tác toàn cầu vì sự phát triển bền vững	Cập nhật các thông tin công nghệ của các đối tác sản xuất, thương mại nhằm đạt mục tiêu phát triển bền vững

2. Công nghệ thiết kế và sản xuất bao bì hộp giấy

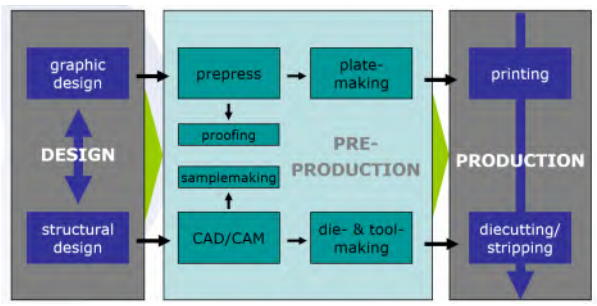
Bao bì hộp giấy (folding carton box) đa dạng về kiểu dáng, vật liệu in (giấy phẳng hoặc sóng) và kích thước được in ấn (nhiều màu như CMYK và các màu pha), gia tăng giá trị (tráng phủ, ép nhũ nóng, dập chìm nổi…) và thực hiện định hình (cấn-bế; gấp-dán).



Hình 1. Các kiểu dáng của bao bì hộp giấy

Hình 2. Bao bì hộp giấy với thiết kế đa dạng phương án màu sắc

Khác với sản xuất các sản phẩm in thương mại là chỉ chú trọng đến thiết kế bề mặt, bao bì hộp giấy coi trọng cả thiết kế cấu trúc và thiết kế bề mặt. Nên việc khai thác hiệu quả toàn bộ quá trình sản xuất và tăng lợi nhuận phụ thuộc rất lớn vào việc kết hợp giữa các phần cứng, phần mềm và dịch vụ trong đó (Hình 3.)



Hình 3. Sự kết hợp giữa các phần cứng, phần mềm, dịch vụ tại thiết kế và Chế bản

3. Nội dung chính của phát triển bền vững trong thiết kế và chế bản

Vật liệu thân thiện với môi trường: Sử dụng các vật liệu bền vững như giấy tái chế; giấy được chứng nhận FSC giúp giảm tác động đến môi trường; mực phân hủy sinh học; bản in không hiện (không xử lý)...

Hiệu quả năng lượng: Triển khai các công nghệ và quy trình tiết kiệm năng lượng trong hoạt động chế bản có thể giảm đáng kể lượng khí thải carbon

Giảm chất thải: Áp dụng công nghệ kỹ thuật số và quản lý sản xuất nhằm giảm thiểu việc sản xuất dư thừa… giúp giảm chất thải trong các giai đoạn thiết kế và chế bản

Nguyên tắc thiết kế bền vững: Kết hợp các nguyên tắc thiết kế bền vững, chẳng hạn như thiết kế để có thể tái chế và sử dụng bao bì tối giản, có thể nâng cao tính bền vững tổng thể của sản phẩm.

Đánh giá vòng đời: Tiến hành đánh giá vòng đời để hiểu tác động đến môi trường của vật liệu và quy trình được sử dụng trong thiết kế và chế bản có thể hướng dẫn các lựa chọn bền vững hơn.

4. Các nguyên tắc thiết kế bền vững trong thiết kế và chế bản

Để có thể đạt được những tiêu chí phát triển bền vững thì người thiết kế CẦN hướng suy nghĩ từ công đoạn sản xuất cuối cùng đến công đoạn đầu tiên: cách thức vận chuyển sản phẩm, cách gia công hoàn thiện, cách in… rồi mới đến công đoạn tạo ra ý tưởng.

Một số câu hỏi cần đặt ra và trả lời trong quá trình thiết kế cấu trúc: Độ an toàn cho người tiêu dùng; Khả năng tái sử dụng và tính hiệu quả; Khả năng tái chế; Việc tuân thủ theo các nguyên tắc bền vững của quy trình sản xuất và đóng gói; …

Một số câu hỏi cần đặt ra và trả lời trong quá trình thiết kế bề mặt: Loại mực và giấy cần sử dụng có gây an toàn, dễ phân hủy không? Khả năng cung cấp các giải pháp thay thế thân thiện với môi trường; Việc giảm thiểu lượng mực in có đáp ứng…

5. Vật liệu in thân thiện môi trường

Việc sử dụng các loại giấy bao bì thân thiện với môi trường cũng cần đến những thiết kế đột phá mang tính định hướng, khích lệ người tiêu dùng chung tay bảo vệ môi trường. Thông tin sẽ hiệu quả nếu sự kết hợp chặt chẽ của các hiệp hội in, hiệp hội bao bì trên, các công ty sản xuất giấy, mực, màng…. trên toàn thế giới.

Các loại giấy in bao bì có thể là giấy Kraft hoặc giấy không tẩy trắng. Ví dụ điển hình như:

- ✓ AquaKote™, OmniKote™, PearlKote™ (Graphic Packaging International)
- ✓ KraftPak® (WestRock) phù hợp cho bao bì hộp giấy tiếp xúc trực tiếp thực phẩm; đạt yêu cầu của Mỹ, Canada, Châu Âu
- ✓ CKB Nude™ (Stora Enso): phù hợp cho bao bì hộp giấy tiếp xúc trực tiếp thực phẩm và nhiều dạng sản phẩm khác

Mẫu in với giấy AquaKote™

Mẫu in với giấy KraftPak®

Mẫu in với giấy CKB

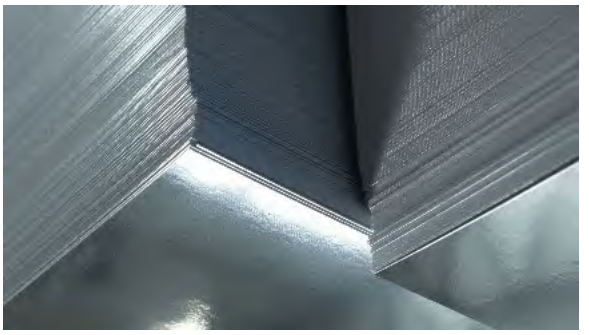
Một số ký hiệu về giấy thân thiện môi trường cần được thể hiện trên thiết kế bao bì:

Có thể tái chế

Các logo chứng nhận giấy có nguồn gốc từ rừng trồng

Điều cần lưu ý là để thể hiện chính xác các thiết kế trên các vật liệu có màu đặc biệt thì cần quan tâm những máy in thử (proofer) nào có thể in trực tiếp trên vật liệu in này. Nếu không thì cần mô phỏng được màu của vật liệu in để có thể thực hiện in thử kỹ thuật số cho ký mẫu (digital proof)

Với những bao bì hộp giấy cần có hiệu ứng ánh kim loại thường sẽ tập trung vào giải pháp ép nhũ nóng, in nhũ lạnh hoặc sử dụng màng phủ kim loại ghép với giấy. Các công nghệ này thường khó khăn cho việc tái chế bao bì hoặc nhũ. Một vài công ty đã giới thiệu các loại giấy in phủ kim loại mỏng đảm bảo cho việc tái chế 100%. Công ty Unifoil sản xuất hai dòng giấy in bao bì phủ kim loại Unilustre® cho in truyền thống và Unilustre® DI cho máy in kỹ thuật số (HP Indigo và các máy in kỹ thuật số khác). Như vậy, nếu người thiết kế nắm được các thông tin về vật liệu in thân thiện môi trường thì cũng sẽ không ngại ngần khi lựa chọn các giải pháp thiết kế cho phần làm đẹp cho sản phẩm (gia tăng giá trị).



Unilustre® với màu bạc

Holo Unilustre® với các hiệu ứng Hologram

Hình 4. Hình ảnh minh họa cho Unilustre® phủ kim loại có thể tái chế 100%.

Đối với bản in Offset thì xu hướng hiện nay là dùng các bản không xử lý (như bản Kodak Sonora Xtra, Kodak Sonora Ultra) sẽ làm giảm nước để hiện, giảm năng lượng sử dụng, giảm chất thải (số liệu thống kê cho thấy nếu 1 nhà in dùng 50.000m2 bản/năm thì sẽ tiết kiệm khoảng 800.000 lít nước, 50.000 KW điện) (Hình 5)

KODAK SONORA
Process Free Plates

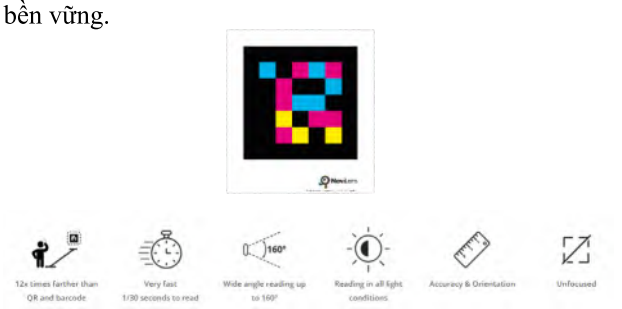
Sonora Xtra

Hình 5. Hình ảnh minh họa bản không xử lý Kodak Sonora

6. Các giải pháp mang tính đột phá (thiết kế tương tác)

Việc hiểu rõ những vấn đề nêu trên trong quá trình thiết kế thì lời giải không chỉ là ý tưởng hay việc sử dụng các vật tư thân thiện môi trường mà còn là việc cập nhật các giải pháp mang tính đột phá. Đơn cử như việc để giảm thiểu phần mực phải in trên bao bì nhưng vẫn đảm bảo được việc việc cung cấp đủ thông tin, rõ nội dung cho khách hàng thì có thể dùng giải pháp mã NaviLens code hoặc mã QR. Các trải nghiệm này cũng theo hướng bao bì tăng trải nghiệm tương tác với người tiêu dùng.

Giải pháp mã NaviLens (ứng dụng NaviLens có thể sử dụng miễn phí cho cả 2 dòng điện thoại Android và IOS) với những ưu điểm vượt trội như nhanh hơn mã QR 12 lần, góc quét rộng lên đến 160 độ, dễ dàng đọc trong mọi điều kiện ánh sáng, độ chính xác cao. Việc phần mềm có thể đọc thông tin 34 ngôn ngữ sẽ giúp cho người mua nhanh chóng nắm bắt được thông nhanh chóng (hỗ trợ cho người mù và trẻ em). Khá nhiều công ty trong lĩnh vực thực phẩm, nước uống, hàng tiêu dùng, mỹ phẩm… đã sử dụng mã NaviLens trên bao bì của họ như Neslé, Coca-Cola, Gillette, Nivea…và đã đem lại nhiều lợi ích cho khách hàng và cho đất nước theo hướng phát triển bền vững.



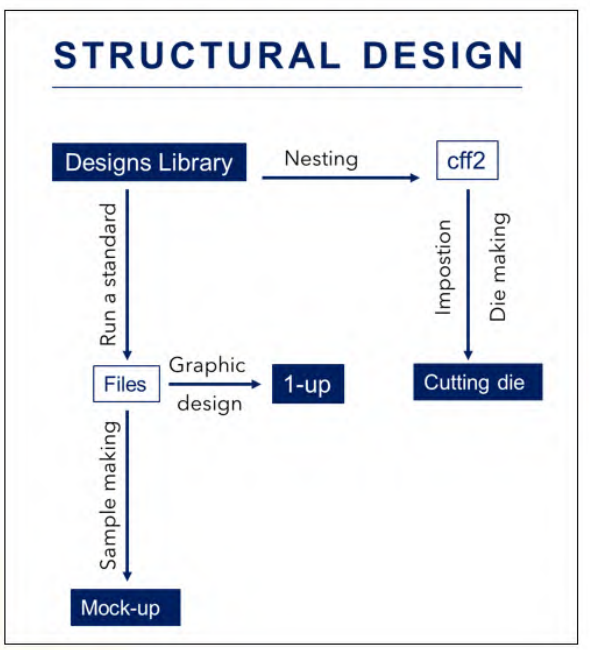
Hình 6. Navilens và các tính năng vượt trội

Hình 7. Bao bì đặc biệt Kellogg's Coco Pops với Navilens

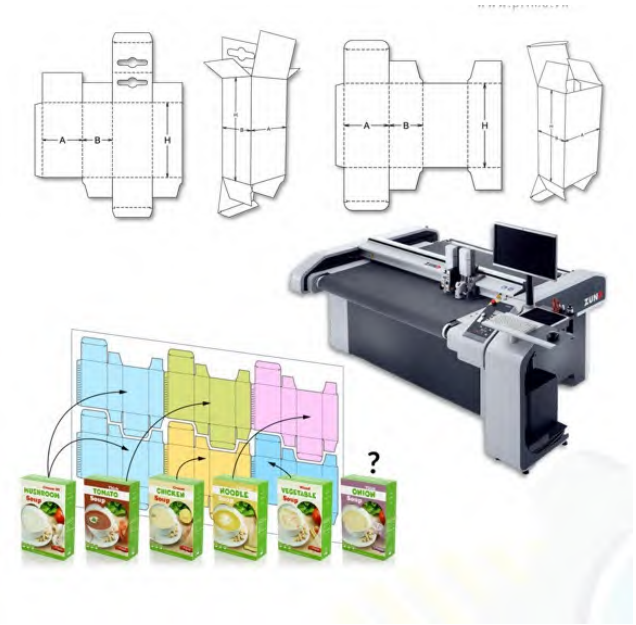
7. Đơn giản hóa việc thiết kế cấu trúc – Tính sơ đồ bình - làm mẫu thử - 3D

Các công đoạn thiết kế cấu trúc – Tính sơ đồ bình - làm mẫu thử - 3D là mấu chốt trong việc giảm thời gian ký duyệt mẫu, sản xuất đại trà và giảm vật tư sử dụng. Chúng đóng vai trò quan trọng cho việc sản xuất bền vững.

Thiết kế cấu trúc nên được làm đúng ngay từ đầu để tránh lãng phí nguyên vật liệu, chi phí khấu hao thiết bị, và thời gian sản xuất. Thiết kế cấu trúc cần phù hợp với công năng sản phẩm, số lượng sản xuất (nếu số lượng nhiều nên hướng tới những dạng có thể thực hiện trên các thiết bị gấp dán hộp tự động).



Hình 8. Mối liên hệ Thiết kế cấu trúc – Mockup - Thiết kế bề mặt – Chế Bản



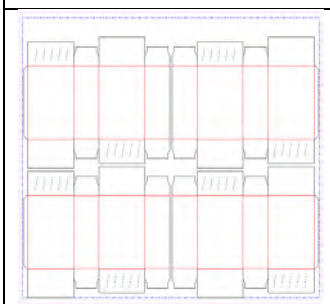
Hình 9. In thử và Mockup (làm mẫu thử)

Việc tính sơ đồ bình trang cần dựa trên những khổ giấy có trên thị trường, hệ số sử dụng giấy hữu ích lưu ý đến độ bền khuôn in để số bộ khuôn in là tối thiểu.

Làm mẫu thử (Mockup) quan trọng để đánh giá mẫu thật về kiểu dáng, công năng của bao bì hộp giấy (chứa đựng, bảo vệ…). Ưu tiên cần có thiết bị cắt không khuôn, máy in thử kỹ thuật số.

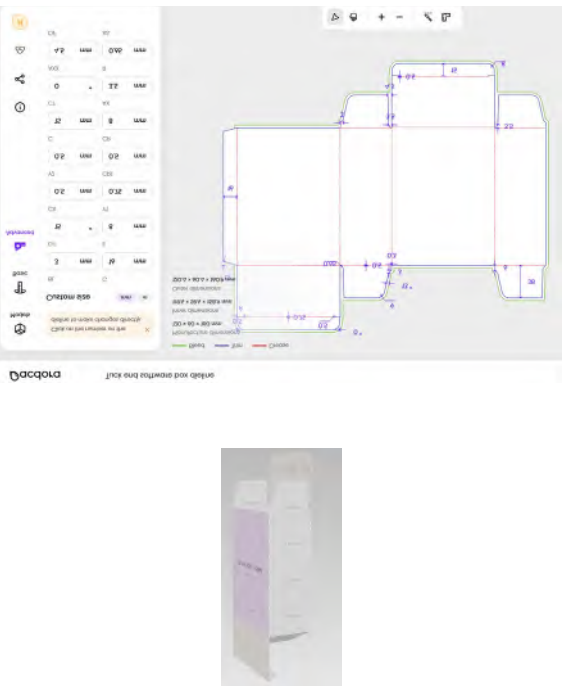
Nếu có sự giúp sức của nhân viên chế bản và với điều kiện in là có các phần mềm CAD-CAM phù hợp (như Artios Cad) thì việc có được thiết kế cấu trúc đúng sẽ trở nên dễ dàng hơn. (Xem Hình 8. 9)

Bảng 2. Sơ đồ bình trang và tỉ lệ hao phí giấy được tính từ phần mềm thiết kế cấu trúc

Sơ đồ bình	Khổ giấy, cm	Nguồn giấy	Tỉ lệ hao phí, %
	**720** x 1020	Tờ rời	53.45
	650 x 860	Tờ rời	38.85
	600 x 720	Xả cuộn	20.87

Ghi chú:
- Khổ trải: 349x 270 mm
- Số in đậm và gạch dưới (ví dụ **720**) là hướng sớ giấy
- Tỉ lệ hao phí giấy: chưa tính phần giấy hữu ích cho phần thang kiểm tra màu và các dấu định vị

Với các công ty không có phần mềm chuyên nghiệp thì việc sử dụng các nền tảng trực tuyến đa năng được thiết kế để tạo mô hình 3D và mẫu khuôn cấn bế như Pacdora, Diecut Template… cũng là giải pháp khá hiệu quả. Chúng có giao diện thân thiện, dễ sử dụng với người không chuyên, có thể xuất ra nhiều định dạng theo yêu cầu như .PDF, .AI, .DXF, .3D (Xem Hình 10)



Hình 10. Nền tảng trực tuyến đa năng Pacdora cho thiết kế cấu trúc và 3D

8. Workflow và các giải pháp tự động hóa tại chế bản

Hiện nay việc chế bản của các công ty in bao bì hộp giấy chủ yếu làm trên nền file PDF (PDF prepress workflow). Việc dùng file PDF sẽ giảm thiểu các vấn đề trong quá trình in và thành phẩm (In: lượng mực phủ quá nhiều, độ phân giải hình ảnh thấp, màu chữ và kích thước chữ gây khó khăn trong quá trình in; Thành phẩm: Không tràn màu cho cấn bế, hình ảnh và chữ rơi vào vùng không an toàn).

Các điều kiện sản xuất cũng thay đổi khá nhiều nên việc kiểm soát chất lượng cho file qua từng công đoạn cũng găp không ít khó khăn. Ngoài ra, việc yêu cầu kỹ thuật cho khuôn in, khuôn tráng phủ, khuôn ép nhũ, khuôn dập chìm nổi, khuôn cấn bế…. cũng khá đặc thù và nhiều thông số. Chính vì vậy, việc tự động hóa tại chế bản trở thành yêu cầu cấp thiết và là xu hướng cho chế bản tại các nhà in bao bì.

Các lợi ích khi áp dụng tự động hóa:

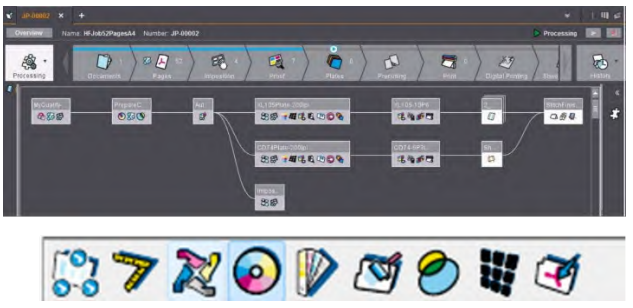
- ✓ Tăng hiệu quả: Tự động hóa làm giảm sự can thiệp thủ công, đẩy nhanh quá trình chế bản và tăng lượng sản phẩm sản xuất
- ✓ Tiết kiệm chi phí: Bằng cách giảm thiểu lỗi và giảm chi phí lao động, tự động hóa có thể dẫn đến tiết kiệm chi phí đáng kể

- ✓ Cải thiện chất lượng: Quy trình làm việc tự động nâng cao đảm bảo chất lượng bằng cách phát hiện lỗi sớm và đảm bảo tính nhất quán.

Lộ trình thực hiện tự động hóa:

- ✓ Đánh giá hiện trạng: Xác định các tác vụ lặp lại: Tìm kiếm các tác vụ lặp lại và tốn thời gian (như preflight và trapping; đặt thang kiểm tra và các dấu định vị cho in và thành phẩm); Đánh giá các nút thắt cổ chai: Xác định vị trí xảy ra sự chậm trễ trong quy trình làm việc hiện tại và tìm cách tự động hóa có thể giải quyết các vấn đề này
- ✓ Chọn phần mềm tự động hóa phù hợp dòng sản phẩm và điều kiện sản xuất: Esko Automation Engine, Heidelberg Prinect Cockpit, Hybrid Cloudflow, Kodak Prinergy… (Xem hình 11 và Hình 12)
- ✓ Đào tạo nhóm làm việc: nhân viên cần được đào tạo kỹ về kỹ năng, khai thác phần mềm, tính chất vật liệu in, cách kiểm soát chất lượng sản phẩm chế bản theo quy trình mới; Cán bộ cấp trung thì cần đào tạo cách khai báo vật liệu in, setting của phần mềm, cách đo kiểm sản phẩm. Trình độ nhân lực luôn là vấn đề đặc biệt cần quan tâm. Họ là người sẽ khai thác hiệu quả thiết bị, phần mềm, triển khai các hướng dẫn kỹ thuật và chuẩn áp dụng để đảm bảo chất lượng, tự động hóa…
- ✓ Áp dụng quy trình mới: Việc áp dụng quy trình mới phải dựa trên những điều kiện sản xuất được ổn định (tình trạn thiết bị in, gia công sau in phải ổn định; Kiểm soát chất lượng phải theo quy trình và có tiêu chí kiểm soát rõ ràng)
- ✓ Kiểm tra và đánh giá toàn diện hệ thống: Đây là công việc của quản lý cấp trung và cấp cao nhằm không ngừng hoàn thiện sản xuất. Là tiền đề dẫn tới quản trị chất lượng toàn diện.

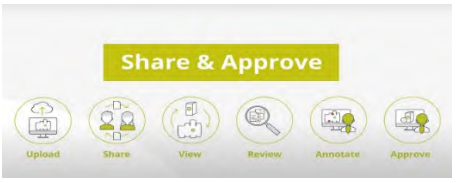
Hình 11. Chu trình sản xuất tự động Esko Automation Engine



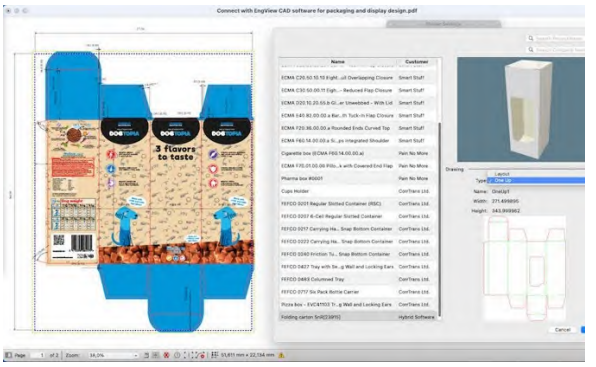
Hình 12. Chu trình sản xuất tự động Heidelberg Prinect Cockpit

Trong trường hợp các công in in bao bì chưa có thể đầu tư được các workflow tự động hóa thì việc chuẩn hóa quy trình, xác định các điều kiện cần và đủ để thực hiện tự động hóa trên từng công đoạn và kết hợp với việc sử dụng tốt các hướng dẫn kỹ thuật, chuẩn công nghiệp và các thiết bị đo… cũng sẽ giúp cho phát triển bền vững được thực thi tại nhà in, trên bình diện quốc gia và quốc tế.

Drupa 2024 trình diễn những tiến bộ vượt bậc trên nền điện toán Đám mây (Cloud). Đối với chế bản thì việc ký mẫu trực tuyến trở nên vô cùng hiệu quả khi áp dụng công nghệ này. Điển hình như Esko (Share & Approve) và Hybrid Software (CLOUDFLOW Approvals)



Share & Approve của Esko



CLOUDFLOW Approvals của Hybrid

9. Mức độ ứng dụng các giải pháp phát triển bền vững tại các nhà in bao bì hộp giấy tại Việt Nam

Tuy chưa có khảo sát nào mang tính chuyên sâu về mức độ đạt được mục tiêu phát triển bền vững trong ngành in bao bì hộp giấy nhưng thông qua việc khảo sát thực tế và kết hợp với các báo cáo thực tập sản xuất của sinh viên trong các năm 2023-2024 tại tp. Hồ Chí Minh và các tỉnh phía Nam thì có được các số liệu như sau:

- ✓ Số lượng công ty lấy dữ liệu: 11 (7 là các công ty trong nước và 4 là các công ty vốn FDI từ Nhật, Hàn Quốc, Thái Lan, Đa quốc gia với trụ sở chính là Mỹ)
- ✓ Các công ty khảo sát đều sản xuất được đa dạng các dòng sản phẩm bao bì hộp giấy, có các giải pháp gia tăng giá trị, định hình sản phẩm
- ✓ Kết quả thống kê: xem bảng 3

Bảng 3. Kết quả khảo sát về khuynh hướng phát triển bền vững

Tiêu chí khảo sát về khuynh hướng phát triển bền vững	**Công ty Việt Nam**		**Công ty vốn FDI**	
	Số lượng	%	Số lượng	%
Số lượng công ty khảo sát	**7**		**4**	
Vật tư				
Chứng chỉ FSC	5	71.4	3	75
Sử dụng Bản Offset không xử lý	0	0.0	2	50
Thiết kế cấu trúc – tính sơ đồ bình				
Có sử dụng phần mềm CAD-CAM để thiết kế cấu trúc	5	71.4	3	75
3D	3	42.8	2	50
Chế bản				
Prefight tại Acrobat (và plugins)	4	57.1	3	75
Trapping bằng phần mềm (và plugins)	0	0.0	1	25
Kết hợp in thử kỹ thuật số để ký mẫu	3	42.9	4	100
Bình trang có dùng file CFF2	1	14.3	1	25
Giải pháp chu trình sản xuất tự động tại chế bản	0	0.0	0	0

Bảng 3 cho thấy:

- ✓ Các công ty sản xuất bao bì hộp giấy FDI quan tâm nhiều hơn đến mục tiêu phát triển bền vững khi dùng giấy FSC, bản in không xử lý; Khai thác công nghệ, phần mềm hiệu quả hơn tại chế bản… dẫn tới hiệu quả sản xuất tốt hơn.
- ✓ Các công đoạn kiểm tra file, trapping, bình trang còn làm thủ công tại các phần mềm dàn trang (dưới 50%) cả ở công ty Việt Nam và công ty FDI. Điều này cho thấy mức độ tự động hóa trong xử lý file còn thấp.
- ✓ Việc chưa có công ty nào khai thác chu trình sản xuất tự động tại chế bản cũng cho thấy vấn đề đào tạo nhân sự chất lượng cao là then chốt cho việc tự động hóa.

KẾT LUẬN:

Bài viết trình bày tổng quan những thách thức và giải pháp cho thiết kế và chế bản cho bao bì hộp giấy nhằm đạt được các mục tiêu phát triển bền vững trong sản xuất bao bì hộp giấy. Hy vọng những chia sẻ sẽ hữu ích cho các sinh viên, nhà nghiên cứu và các công ty thiết kế và sản xuất in bao bì hộp giấy nói riêng và sản xuất bao bì nói chung trong quá trình thực hiện kiên định các mục tiêu phát triển bền vững.

TÀI LIỆU THAM KHẢO:

1. Bài báo của Bộ Công Thương Việt Nam *"17 mục **tiêu phát triển bền vững của Việt Nam"** (đăng ngày 16/09/2021 tại https://moit.gov.vn/tin-tuc/tiet-kiem-nang-luong/17-muc-tieu-phat-trien-ben-vung-cua-viet-nam.html)*
2. ***Take Action for the Sustainable Development Goals*** (https://www.un.org/sustainabledevelopment/sustainable-development-goals/)
3. Các phần mềm thiết kế cấu trúc (Artios Cad, , thiết kế bề mặt (Adobe softwares) và chế bản cho bao bì hộp giấy (Signastation, Hybrid Software, Share & Approve, Esko Automation Engine, Heidelberg Prinect Cockpit…)
4. Tổng hợp các số liệu báo cáo về mức độ áp dụng vật tư bền vững, khai thác công năng phần mềm, mức độ tự động hóa chu trình chế bản của các công ty sản xuất bao bì hộp giấy (báo cáo thực tập tốt nghiệp của sinh viên Công nghệ kỹ thuật in)

Ứng dụng ai: Thách thức và giải pháp tối ưu trong dạy thiết kế đồ họa

Đỗ Thị Hồng Vy

TÓM TẮT

Sự tiến bộ nhanh chóng của Trí tuệ nhân tạo (AI) đã góp phần thay đổi đáng kể lĩnh vực thiết kế đồ họa, hỗ trợ khả năng sáng tạo tiến nhanh hơn. AI đã giới thiệu và đặt ra những gợi ý cho người thiết kế, điều đó gợi mở nhiều ý tưởng hơn cho các thiết kế trong quá trình tạo nên một sản phẩm hoàn chỉnh. Tuy nhiên, việc sử dụng tích hợp công nghệ này cũng đặt ra một số thách thức về các vấn đề như: những lo ngại về đạo đức nghề nghiệp và bản quyền; tính độc đáo và nắm bắt đúng tiêu chí với các văn hóa vùng miền trong thiết kế một cách khoa học (bởi vì AI chỉ hoạt động theo cơ chế tích lũy và cập nhật từ các nguồn không có sự kiểm soát). Bài báo tập trung nêu ra những thách thức khi ứng dụng AI trong thiết kế đồ họa và đề xuất các giải pháp tối ưu để khai thác tiềm năng của nó, đồng thời giảm thiểu các rủi ro liên quan để đảm bảo rằng bản chất sáng tạo của ngành được giữ vững trong khi tận dụng lợi ích của những tiến bộ công nghệ.

Từ khóa: trí tuệ nhân tạo (AI); AI trong thiết kế đồ họa; thách thức và giải pháp tối ưu trong design; thách thức việc tích hợp AI trong design; giải pháp tối ưu ứng dụng AI trong design.

1. ĐẶT VẤN ĐỀ

Thiết kế đồ họa là một lĩnh vực đòi hỏi tính mới và liên tục không ngừng phát triển, nhất là trong thời điểm hiện nay khi nhu cầu của xã hội đang nằm ở giao điểm của nghệ thuật, công nghệ và truyền thông. Trong nhiều thập kỷ, lĩnh vực này đã áp dụng nhiều cải tiến công nghệ, trong đó Trí tuệ nhân tạo (AI) phát triển một vài năm gần đây đã đóng góp khá lớn trong quá trình phát triển của thiết kế. Với sự ra đời của AI, các nhà thiết kế có thể tận dụng các công cụ giúp nâng cao hiệu quả và mở rộng khả năng sáng tạo với những ý tưởng phong phú như: gợi ý những ý tưởng, tạo bố cục, phân tích, giải đáp một số vấn đề cho người thế kế và AI đã trở thành một công cụ không thể thiếu trong quy trình thiết kế hiện đại.

Tuy nhiên, sử dụng và điều khiển AI như thế nào thì đó là những thách thức được đặt ra để tránh những hạn chế của việc "khiển AI hay AI khiển?!". Vì vậy dù có nhiều ưu điểm nhưng bất chấp những lợi thế này, việc áp dụng AI cần được đặt ra những thách thức đòi hỏi các giải pháp chiến lược sử dụng AI trong giảng dạy và thiết kế một cách thông minh và khoa học. Vì AI chỉ là phương tiện hỗ trợ chứ không làm chủ trong công việc sáng tạo, nhất là công việc của họa sĩ thiết kế đồ họa.

Đối với các khuôn khổ về đạo đức trong bài viết "Đạo đức của trí tuệ nhân tạo - Ý nghĩa trong ngành Xây dựng"của Nguyễn Bảo Ngọc có nêu về phân cấp của Ai thông qua khả năng suy luận và cũng nhắc đến sự khó tiên đoán của AI do nhiều yếu tố mang lại bởi sự phức tạp, tự cải tiến, học hỏi của AI, tóm tắt như sau: "Reactive Machines (AI phản ứng): AI chỉ thực hiện các hoạt động cơ bản như phản ứng với một số kích thích. Mô hình không lưu trữ đầu vào và không thực hiện học tập; Limited Memory (AI với bộ nhớ hạn chế): AI sử dụng dữ liệu đã lưu trữ để đưa ra các dự đoán; Theory of Mind (AI dựa trên lý thuyết tâm lý): AI bắt đầu tương tác với suy nghĩ và cảm xúc của con người; Self-Aware (AI tự nhận thức): cấp độ phát triển cao nhất của AI, khi AI có khả năng tự nhận thức và tư duy một cách độc lập so với con người". Điều đó, cho thấy AI tự học hỏi và cải tiến bản thân trong từng giây phút có sự tương tác của con người, vì vậy người sử dụng AI cần biết những ưu điểm, hạn chế mà vận dụng vào việc dạy cho người học thiết kế cần tiếp cận như thế nào.

Đầu tiên, ưu điểm của AI có ý nghĩa trong ngành thiết kế Đồ họa như: AI sẽ rút ngắn được thời gian; đưa ra những gợi ý cho ý tưởng; trau chuốt hình ảnh nhanh chóng cho một phác thảo; giúp tổng hợp nhanh những gì đã tồn tại trước đó, đưa ra các gợi ý thông minh và những tính mới (giả định) về khả năng sáng tạo. Các nền tảng AI có thể hỗ trợ tạo ra các ý tưởng thiết kế, dự đoán sở thích của người tiêu dùng và thậm chí tạo nội dung được cá nhân hóa ở quy mô nhất định. Những khả năng này không chỉ nâng cao hiệu quả mà còn cho phép các nhà thiết kế thử nghiệm các phong cách và phương pháp trực quan phức tạp mà trước đây rất khó hoặc tốn thời gian để thực hiện thủ công cho các phác thảo.

Tuy nhiên, bất chấp với những tiến bộ này thì việc tích hợp AI vào thiết kế đồ họa không phải là không có thách thức. Mối lo ngại lớn nhất là làm mất đi khả năng sáng tạo của con người, Hơn nữa, khi các công cụ AI tiếp tục

phát triển, nhu cầu ngày càng tăng sẽ càng đòi hỏi người dạy và học phải biết cách điều khiển AI trong khi thiết kế Đồ họa một cách thông thái và khoa học sẽ giúp các thiết kế đạt được hiệu quả ở một tầm cao mới.

Bài báo này nhằm mục đích cung cấp một phân tích toàn diện về những thách thức liên quan đến AI trong thiết kế đồ họa và đề xuất các giải pháp khả thi để tối đa hóa tiềm năng của quá trình ứng dụng AI vào thiết kế, trong khi vẫn bảo tồn bản chất sáng tạo của con người. Tìm cách đóng góp vào cuộc đối thoại đang diễn ra về cách tốt nhất để tích hợp AI vào lĩnh vực đòi hỏi tính sáng tạo và tính mới liên tục này.

2. NHỮNG THÁCH THỨC KHI ỨNG DỤNG AI

Mặc dù, ứng dụng AI trong thiết kế đồ họa mang lại nhiều lợi ích như tăng tốc quy trình sáng tạo, giảm chi phí, giảm thời gian và cải thiện hiệu quả công việc. Tuy nhiên, nó cũng tiềm ẩn một số rủi ro trong thiết kế, bởi AI sẽ có những hạn chế điển hình như:

2.1. Hạn chế sự sáng tạo

Việc quá phụ thuộc vào AI sẽ kìm hãm tính độc đáo, dẫn đến các thiết kế thiếu tính riêng. Các hạn chế của AI có thể kể đến như sau:

- Mô phỏng thay vì sáng tạo: AI thường dựa vào dữ liệu đầu vào để tạo ra thiết kế, dẫn đến việc mô phỏng các phong cách hiện có thay vì sáng tạo những ý tưởng mới lạ dẫn đến việc thiếu tính độc đáo và sáng tạo thực sự so với con người.
- Hạn chế cảm xúc và ngữ cảnh: AI không thể hoàn toàn hiểu được cảm xúc, văn hóa, hoặc ngữ cảnh sâu sắc như con người, dẫn đến thiết kế thiếu sự tinh tế. Do AI thường tạo ra các thiết kế dựa trên dữ liệu chung, điều này có thể làm mất đi sự độc đáo và tính cá nhân hóa mà sản phẩm thiết kế cần có.
- Hậu quả: Các sản phẩm thiết kế có thể trở nên đơn điệu, lặp lại hoặc thiếu sự khác biệt cần thiết để nổi bật trên thị trường.

2.2. Mất dần khả năng phản xạ trong tuy duy thiết kế

Khi người thiết kế quá phụ thuộc vào AI, điều đó có thể giảm dần kỹ năng sáng tạo và tư duy trong thiết kế, giải quyết vấn đề thụ động, điều này ảnh hưởng lâu dài đến ngành thiết kế. Vì vậy, để vượt qua các thách thức này, người dạy thiết kế cần định hướng cho người học thiết kế cần học cách sử dụng AI như một công cụ hỗ trợ, kết hợp kiến thức đã được đào tạo để tạo ra những sản phẩm vừa độc đáo vừa hiệu quả với xu hướng của xã hội.

2.3. Mối quan ngại về đạo đức và pháp lý

Các hệ thống AI thường dựa vào các tập dữ liệu lớn đã được tổng hợp chung và phản hồi bằng một nội dung chủ quan, ví vậy, các thông tin có thể bao gồm các tài liệu có bản quyền hoặc các nội dung chưa được kiểm duyệt. Việc thiếu minh bạch trong việc sử dụng dữ liệu này làm nảy sinh các vấn đề về đạo đức và pháp lý, bao gồm cả khả năng vi phạm quyền sở hữu trí tuệ.

Rủi ro trong dữ liệu: AI sử dụng các dữ liệu có sẵn trên internet để học hỏi từ các tác phẩm hiện có, nhưng nhiều dữ liệu này có thể thuộc bản quyền, dẫn đến nguy cơ vi phạm pháp lý khi sử dụng các thiết kế AI tạo ra. Vì vậy khả năng vi phạm bản quyền nếu thiết kế mới sao chép hoặc tương tự quá mức với tác phẩm gốc là điều có thể xảy ra.

Hậu quả: Các vấn đề pháp lý có thể phát sinh, gây tổn thất tài chính và ảnh hưởng đến uy tín của nhà thiết kế.

2.4. Khoảng cách kỹ năng giữa AI và nhà thiết kế

Mặc dù các công cụ AI giúp rút ngắn được một số vấn đề khi bắt tay vào thiết kế, nhưng việc sử dụng hiệu quả chúng đòi hỏi trình độ chuyên môn và hiểu biết của người sử dụng công nghệ này. Nếu không nắm bắt được những kiến thức chuyên môn sẽ khiến nhà thiết kế bị sa đà vào hàng loạt những thông tin pha trộn mất kiểm soát về tính khoa học của thông tin. Những sự chênh lệch đó tiêu biểu trong mấy vấn đề như:

Thiếu sự tương tác cảm xúc: AI không có khả năng cảm nhận cảm xúc hoặc hiểu ngữ cảnh văn hóa một cách sâu sắc như con người. Vì vậy, hậu quả đối mặt là: thiết kế có thể không phù hợp với thị hiếu khách hàng hoặc không truyền tải được thông điệp cảm xúc như mong đợi nếu người thiết kế quá phụ thuộc vào AI.

Phụ thuộc quá mức vào công nghệ: khi không chủ động làm chủ tư duy sáng tạo và đạt hoàn toàn vào AI giải quyết vấn đề thì hậu quả khi sự cố xảy ra thì việc xử lý vấn đề kỹ thuật hoặc thiếu công cụ AI, năng suất và chất lượng công việc có thể giảm sút nghiêm trọng.

Khả năng mất việc làm của nhà thiết kế

Trong quá trình thực hiện từ ý tưởng đến hoàn thiện sản phẩm thiết kế, người thiết kế phụ thuộc toàn phần vào AI mà không có ý tưởng đặc biệt của cá nhân, sẽ biến tất cả những điều đó trở thành tự động hóa quy trình: AI có khả năng tự động hóa các tác vụ thiết kế đơn giản, làm giảm nhu cầu về các nhà thiết kế trong một số lĩnh vực. Khi đó người tiêu dùng, đối tác sẽ không cần đến nhà thiết kế. Điều này đòi hỏi người học thiết kế cần chủ động tiếp cận với AI như một công cụ, phương tiện hỗ trợ chứ không phải là người làm thay. Và để đạt được hiệu quả cao, người dạy

cần nhắc nhở người học thiết kế cần không ngừng nâng cao kiến thức, kỹ năng để duy trì sự cạnh tranh, đặc biệt trong việc kết hợp sáng tạo nghệ thuật với công nghệ AI.

3. CÁC GIẢI PHÁP TỐI ƯU KHI ỨNG DỤNG AI

3.1. Nhấn mạnh sự hợp tác giữa con người và AI

AI nên được coi là một công cụ bổ sung chứ không phải là sự thay thế cho khả năng sáng tạo của con người. Các nhà thiết kế có thể sử dụng AI để xử lý các nhiệm vụ thường xuyên, chẳng hạn như gợi ý các khía cạnh khái niệm và chiến lược của thiết kế và nhiệm vụ của người thiết kế cần có lượng kiến thức nhất định để biết chắt lọc đâu là lựa chọn đúng và chuẩn mực với đạo đức nghề nghiệp.

3.2. Phát triển các nguyên tắc đạo đức

Việc thiết lập các tiêu chuẩn đạo đức rõ ràng cho việc sử dụng AI là rất quan trọng để giải quyết các mối quan ngại về bản quyền và quyền riêng tư dữ liệu. Tính minh bạch trong việc cung cấp dữ liệu và tuân thủ luật sở hữu trí tuệ có thể giảm thiểu các vấn đề pháp lý tiềm ẩn.

3.3. Thúc đẩy giáo dục và phát triển kỹ năng

Nhằm rút ngắn những khoảng cách và hạn chế rủi ro không mong muốn khi ứng dụng AI vào trong thiết kế, các tổ chức và ngành đào tạo nên đưa đào tạo AI vào chương trình giảng dạy và chương trình phát triển chuyên môn của mình để giúp người học tiếp cận một cách khoa học, hiểu được những têu chuẩn bản quyền khi tham khảo cho thiết kế cá nhân. Hay nói một cách khác khi tương tác và ra lệnh cho AI, đòi hỏi người dùng phải biết cách đặt một vấn đề một cách khoa học và có kiểm soát, kiểm chứng, đối sánh trước khi sử dụng thông tin và hình ảnh từ AI.

Hiện nay, việc nắm bắt thông tin để hiểu và đưa ứng dụng vào việc dạy và học thiết kế thông qua AI, cho thấy rất nhiều lợi thế vì AI được nghiên cứu tích hợp với một số ứng dụng hỗ trợ trong thiết kế như:

Adobe Sensei là nền tảng được AI tích hợp trong nhiều sản phẩm của Adobe như Photoshop, Illustrator, và Premiere Pro vào bộ công cụ sáng tạo của mình, cho phép các tính năng như chỉnh sửa ảnh tự động, đề xuất bố cục và cắt xén theo nội dung. Bằng cách kết hợp hiệu quả do AI thúc đẩy với khả năng tùy chỉnh của người dùng, Adobe đã cải thiện thành công quy trình làm việc sáng tạo nếu người dùng biết cách tận dụng tối đa sự tối ưu của công nghệ. Hay một số ứng dụng khác như:

Canva: Công cụ thiết kế trực tuyến tích hợp AI trong việc tạo bố cục, lựa chọn màu sắc và gợi ý thiết kế, giúp người dùng dễ dàng tạo ra các sản phẩm đồ họa. Ví dụ như đề xuất thiết kế và tạo mẫu, thiết kế đồ họa cho những người không chuyên. Việc tập trung vào giao diện thân thiện với người dung, minh họa giúp thiết kế dễ tiếp cận với nhiều đối tượng hơn.

CorelDRAW: Tích hợp AI để tối ưu hóa quy trình thiết kế, cung cấp các công cụ hỗ trợ vẽ và chỉnh sửa đồ họa vector hiệu quả.

Figma: Công cụ thiết kế giao diện và prototyping tích hợp các plugin AI, giúp tối ưu hóa quy trình thiết kế, tăng cường khả năng sáng tạo và cải thiện hiệu suất làm việc.

Midjourney: Công cụ AI chuyên về tạo hình ảnh nghệ thuật, sử dụng các mô hình học sâu để biến ý tưởng trên văn bản thành hình ảnh bắt mắt trong thời gian ngắn.

Khroma: Phần mềm AI hỗ trợ gợi ý phối màu online giúp tạo ra các bảng màu phong phú cho dự án thiết kế.

Designs.ai: Cung cấp bộ công cụ thiết kế AI, giúp tạo logo, video, biểu ngữ và các tài liệu tiếp thị khác, với khả năng tự động hóa và điều chỉnh thiết kế theo sở thích cá nhân.

3.4. Đề xuất giảm thiểu rủi ro:

Cần kết hợp AI với sự sáng tạo của con người để tối ưu hóa kết quả công việc:

Sử dụng AI như một công cụ hỗ trợ thay vì thay thế hoàn toàn nhà thiết kế.

Xây dựng quy trình sáng tạo kết hợp: để AI xử lý các nhiệm vụ lặp lại (như tạo mẫu nhanh, chỉnh sửa chi tiết), trong khi người thiết kế cần tập trung vào ý tưởng, cảm xúc và tính độc đáo.

Đặt ra giới hạn rõ ràng về vai trò của AI trong từng giai đoạn của dự án.

Lợi ích đạt được: Tăng hiệu quả công việc mà không làm mất đi tính sáng tạo mang phong cách riêng của nhà thiết kế và giảm thiểu nguy cơ sản phẩm thiếu tính cá nhân hóa và cảm xúc.

Đảm bảo tuân thủ các quy định pháp luật về bản quyền và sở hữu trí tuệ:

Sử dụng các nền tảng AI có chính sách bản quyền rõ ràng và minh bạch.

Kiểm tra kỹ lưỡng thiết kế cuối cùng để đảm bảo không sao chép ý tưởng hoặc tài sản trí tuệ của bên thứ ba.

Đầu tư vào phần mềm AI bản quyền, tránh các công cụ AI không rõ nguồn gốc dữ liệu.

Lợi ích đạt được: Tránh các vấn đề pháp lý liên quan đến vi phạm bản quyền và bảo vệ uy tín của nhà thiết kế.

Đào tạo và nâng cao kỹ năng cho đội ngũ dạy và học thiết kế

Để hiểu rõ và tận dụng AI hiệu quả thay vì hoàn toàn phụ thuộc vào nó bằng cách:

Tổ chức các khóa học ngắn hạn để người dạy và học thiết kế hiểu rõ cách hoạt động của AI và tận dụng tối đa khả năng của nó.

Khuyến khích nhà thiết kế rèn luyện kỹ năng sáng tạo truyền thống, song song với việc ứng dụng AI.

Đào tạo các kỹ năng phân tích dữ liệu và đánh giá đầu ra của AI.

Lợi ích đạt được: Tăng tính linh hoạt và khả năng thích nghi với công nghệ mới. Đảm bảo được tính riêng độc đáo trong thiết kế và duy trì tính mới trong ngành sáng tạo.

Lựa chọn cẩn thận dữ liệu đầu vào cho AI.

Chọn dữ liệu đầu vào có chất lượng cao, đáng tin cậy và được thu thập hợp pháp.

Thường xuyên kiểm tra dữ liệu để đảm bảo tính cập nhật và đa dạng. Hạn chế sử dụng dữ liệu không rõ nguồn gốc để tránh sai lệch.

Lợi ích đạt được: Cải thiện chất lượng thiết kế, giảm nguy cơ gặp lỗi hoặc sai lệch do dữ liệu không đạt chuẩn.

4. KẾT LUẬN

Trong sự phát triển chung của xã hội hiện nay và sự đòi hỏi sáng tạo ngày càng cao nhất là ngành nghề có tính tư duy sáng tạo thì việc ứng dụng AI trong thiết kế đồ họa mang đến thực tế kép về cơ hội và thách thức. Trong khi AI nâng cao năng suất và mở rộng khả năng sáng tạo, nhưng nó cũng làm dấy lên nhiều mối lo ngại về đạo đức nghề nghiệp trong việc hình ảnh, bản quyền... Bằng cách áp dụng phương pháp tiếp cận cân bằng nhấn mạnh vào sự hợp tác giữa con người và AI, các hoạt động đạo đức và khả năng tiếp cận toàn diện, ngành thiết kế đồ họa có thể khai thác toàn bộ tiềm năng của AI trong khi vẫn duy trì tính toàn vẹn về mặt nghệ thuật của nó.

Trong lĩnh vực thiết kế đồ họa, việc ứng dụng trí tuệ nhân tạo (AI) mang lại nhiều lợi ích như tăng tốc độ và hiệu quả công việc. Tuy nhiên, nó cũng đặt ra những thách thức đáng kể. Một trong những thách thức chính là nguy cơ AI thay thế vai trò của nhà thiết kế trong sự phát triển quá nhanh của công nghệ, dẫn đến sự lo ngại về mất việc làm và giảm tính sáng tạo. Ngoài ra, việc tích hợp AI đòi hỏi nhà thiết kế phải liên tục cập nhật kiến thức và kỹ năng mới để theo kịp sự phát triển công nghệ.

Bài viết khái quát về những thách thức trong quá trình ứng dụng AI vào trong dạy và học thiết kế sẽ đối mặt với những vấn đề gì, từ đó có kế hoạch tiếp cận phù hợp tránh những hạn chế không mong muốn.

Giải pháp đề xuất:

Kết hợp giữa AI và sáng tạo con người: AI nên được xem như một công cụ hỗ trợ, giúp tối ưu hóa quy trình thiết kế, trong khi người thiết kế cần tập trung vào việc phát triển ý tưởng sáng tạo và cảm xúc trong tác phẩm.

Đào tạo và nâng cao kỹ năng: Các nhà thiết kế cần tham gia các khóa học và chương trình đào tạo về AI để hiểu rõ cách thức hoạt động và ứng dụng của nó trong thiết kế đồ họa. Điều này giúp sử dụng AI một cách hiệu quả và sáng tạo hơn tránh được những pháp lý ngoài mong muốn.

Phát triển tư duy thiết kế: Áp dụng tư duy thiết kế (Design Thinking) giúp nhà thiết kế tập trung vào việc giải quyết vấn đề và tạo ra giá trị sản phẩm cho người dùng, thay vì chỉ dựa vào công nghệ. Điều này đảm bảo rằng sản phẩm thiết kế không chỉ đẹp mắt mà còn đáp ứng nhu cầu thực tế của xã hội và đối tác.

Kiến nghị:

Đối với cơ quan giáo dục: là môi trường giáo dục việc cập nhật ứng dụng hỗ trợ từ công nghệ trong thời buổi hiện nay là cần thiết. Tuy nhiên để vận hành như thế nào là khoa học thì cần tạo điều kiện để người dạy có cơ hội học hỏi cách ứng dụng AI như thế nào phù hợp, đúng cách, khoa học và về chuyên môn cần cập nhật tư duy thiết kế, đồng thời tạo điều kiện cho họ áp dụng kiến thức khi bắt tay vào thiết kế có trợ giúp của AI cần tránh những gì.

Đối với người học thiết kế: Chủ động học hỏi và cập nhật kiến thức về AI, kết hợp với việc phát triển kỹ năng sáng tạo và tư duy phản biện, đặt ra các vấn đề để tạo ra những sản phẩm độc đáo và có giá trị bằng phong cách độc đáo của cá nhân.

Việc kết hợp hài hòa giữa AI và khả năng sáng tạo của con người sẽ giúp ngành thiết kế đồ họa phát triển bền vững và đáp ứng tốt hơn nhu cầu của thị trường trong tương lai nếu biết vận dụng nhuần nhuyễn và khoa học giữa công nghệ và tư duy thiết kế.

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Development of Print Quality Monitor System using Artificial Intelligence

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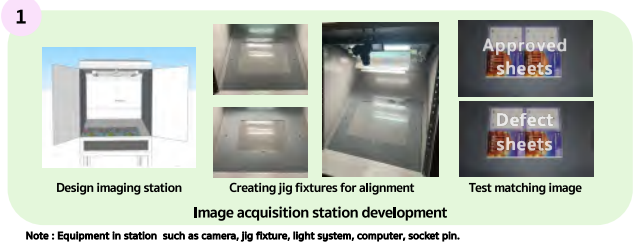
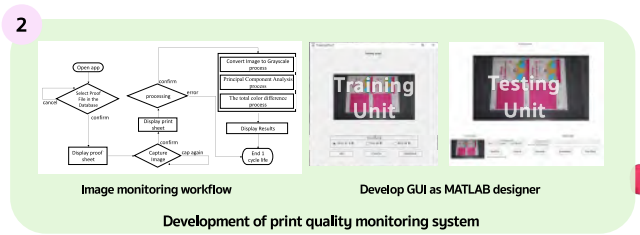
INTRODUCTION

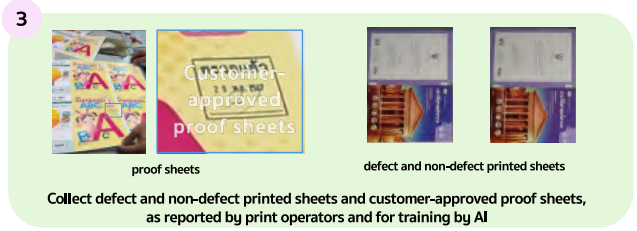
To minimize paper size by limiting it to the printing area, quality control strips (color bars) cannot be added. Consequently, print quality monitoring during the printing run relies on the skills and experience of the print operator. Common quality-check parameters include registration, color consistency, and color accuracy, which may vary due to human error. A print monitoring system based on artificial intelligence (AI) has been developed. It consists of imaging equipment, a lighting system, color charts, and image analysis algorithms. The AI compares and analyzes images captured from printed sheets to reference proof sheets. By applying principal component analysis (PCA), the AI can quickly identify discrepancies and various defects in printing. Test results show that the proposed system can effectively detect print defects such as scumming, ink spots, hickeys, color deviations, pattern distortions, and missing or excessive content. This system helps reduce costs, improve consistency, and deliver print quality that meets client requirements.

METHODOLOGY AND EXPERIMENTAL

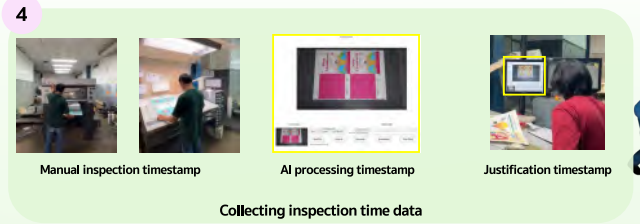


Note : Equipment in station such as camera, jig fixture, light system, computer, socket pin.





Note: During approval process by customers, one printed sheet have stamps and a signature as confirmation from the customer. Additionally, 2-3 other sheets without stamps and signatures are collected during the same printing session and are used to training the AI.



RESULT AND DISCUSSION

Table 1: Data collection from printed sheet inspection by print operators (Manual)

Defect Type	Samples	Avg. Time (μ ± σ, sec)	Max Time (sec)	Min Time (sec)
Color deviations	207	45.43 ± 18.07	127	14
Faded color	23	34.04 ± 12.40	62	14
Smudging	11	23.09 ± 15.21	69	10
Non-defects	312	40.93 ± 18.67	166	9

Table 2: Data collected from print quality inspection using AI (Machine)

Defect Type	Samples	Avg. Time (μ ± σ, sec)	Max Time (sec)	Min Time (sec)
Color deviations	279	9.93 ± 3.97	20.88	2.79
Faded color	53	5.48 ± 2.06	13.82	2.82
Smudging	21	8.32 ± 3.26	14.74	3.63
Non-defects	235	4.16 ± 1.06	6.58	2.50

Table 3: Data collected from print operators justification based on AI results (MAN)

Defect Type	Samples	Avg. Time (μ ± σ, sec)	Max Time (sec)	Min Time (sec)
Color deviations	288	2.60 ± 1.22	9.14	1.32
Faded color	40	2.32 ± 0.67	3.78	1.41
Smudging	49	2.64 ± 1.23	6.19	1.29
Non-defects	22	3.61 ± 1.53	7.96	1.53

Table 4: Combined data from AI and print operators justification (Machine + MAN)

Defect Type	Avg. Time (μ ± σ, sec)	Max Time (sec)	Min Time (sec)
Color deviations	12.53	30.02	4.11
Faded color	7.79	17.60	4.24
Smudging	10.96	20.93	4.92
Non-defects	7.77	14.54	4.03

Note: table 1-3 is sample number differ because data were collected from different printing jobs or production orders during periods timing.

The PCA method, as implemented in this study, enabled the AI system to analyze the entire printed sheet comprehensively by focusing on the most critical features. Unlike manual inspection, where print operators rely solely on their vision to check every detail of the sheet, which is inherently time-consuming, PCA allows the AI system to process and identify defects across the whole sheet in a fraction of the time.

The experimental result show that integrating artificial intelligence (AI) with print operators can help inspect printed sheets faster and more consistently. The AI system, which uses PCA (Principal Component Analysis), works by analyzing the entire sheet and defects more efficiently. Comparing manual inspection by print operators (Table 1) with the combined system of AI and human justification (Table 4) shows the following improvements:

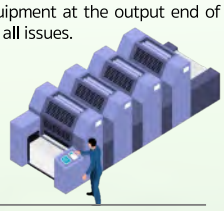
- Color Deviations: Reduced inspection time by 72% (from 45.43 to 12.53 second).
- Faded Color: Time decreased by 77% (from 34.04 to 7.79 second).
- Smudging: Improved speed by 53% (from 23.09 to 10.96 second).
- Non-Defects: Inspection was 81% faster (from 40.93 to 7.77 second).

The results across four defect types—color deviations, faded color, smudging, and non-defects—show substantial reductions in inspection time, ranging from 53% to 81% faster when compared to manual inspection.

CONCLUSION

This study the integration artificial intelligence (AI) with print operators significantly improves the efficiency and consistency of the print quality monitoring system inspection process. By utilizing PCA (Principal Component Analysis), the AI system can comprehensively analyze printed sheets and identify defects more quickly than manual inspection, as validated by the experimental results. This increases the inspection frequency within the same timeframe, allowing. the system to evaluate a greater number of printed sheets, the print quality monitoring system enables printing houses to maintain consistent print quality throughout the production process, ensuring that high-quality outputs are delivered to clients reliably and efficiently.

While the current hardware and area setup requires print operators to manually place printed sheets on the acquisition table, this approach complies with supplier warranty restrictions, which prohibit unauthorized modifications to the printing machine. For future developments, integrating automated scanning equipment at the output end of the printing machine would be an ideal solution to address all issues.



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2. **K. Rujirakul, C. So-In, B. Arnonkijpanich, K. Sunat, and S. Poolsanguan**, "PFP-PCA: Parallel Fixed Point PCA Face Recognition," *IEEE International Conference on Intelligent Systems, Modelling and Simulation*, pp. 409-414, 2013.
3. **A. Kanarach, K. Nakprasit, and B. Arnonkijpanich**, "Estimating the Physical Parameters of Human Arm Motion from Video using Fixed-Point PCA Transform and Nonlinear Least-Squares Method," *IEEE International Conference on Frontiers of Signal Processing*, pp. 86-91, 2022.

ACKNOWLEDGMENT : We would like to express our gratitude to Higher Education for Industry Consortium (HI-FI) Under Experiential Learning Program, Office of The Permanent Secretary (OPS), Ministry of Higher Education Science, Research and Innovation. Also, Watana Panich Printing co., ltd. for their financial support and provision of resources that made this research possible.

ASPT 2024
Ho Chi Minh, Vietnam, December 19-20, 2024
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POSTER CODE: A-XXX

POLYPYRROLE–ZrO_2 HYBRID SYNTHESIS AND ADAPTABILITY TO THE OLFACTORY SENSOR

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INTRODUCTION

Dispersion of polypyrrole-inorganic particles

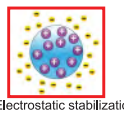

Bulk polypyrrole

insoluble
Poor processability

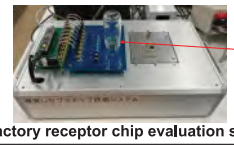

Polypyrrole-silica[1)]
○ Processability
✗ Conductivity
○ Biocompatibility

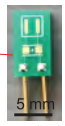

Polypyrrole-ITO[2)]
○ Processability
○ Conductivity
✗ Biocompatibility

?
Polypyrrole-ZrO_2
○ Processability
○ Conductivity
○ Biocompatibility

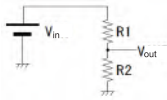

Electrostatic stabilization


Steric stabilization


Olfactory receptor chip evaluation system



Receptor chip



Dividing resistance
Vin = 10 V
R1=receptor chip
R2=10 kΩ

The benefits of using polypyrrole in olfactory sensor

- Can be measured at room temperature
- Rapid responsiveness
- Low operating voltage

Purpose

We are investigating polypyrrole-ZrO_2 nanocomposite particles as an ink and their application to odor sensors.

EXPERIMENTAL

Hybrid synthesis of polypyrrole-ZrO_2 conducting inks

- ZrO_2 dispersions (solution 20 wt%, 1.25-25 mL)
- $FeCl_3$ (4.55 g)
- Pyrrole (0.5 mL)

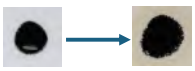

Pyrrole injection

Within 1min

A mixture of polypyrrole-ZrO_2 (sample no. 3) and PVP in purified water is applied to the receptor tip.

Target odor components
Ammonia, trimethylamine, triethylamine, and tributylamine.

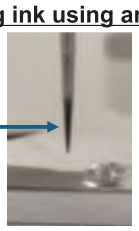
Drop on inkjet paper


(a) (a') (b) (b')

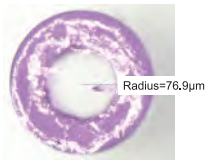
Comparison of bulk polypyrrole(a) and polypyrrole-ZrO_2conducting inks (b) after drying (a') and (b').

Dispensing ink using an electrostatic inkjet system

Polypyrrole could not be dispensed.


Polypyrrole


Polypyrrole-ZrO_2

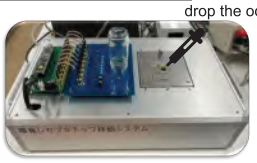


Nozzle diameter

Applicable to inkjet

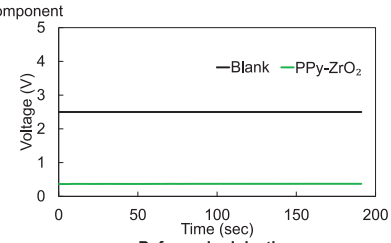
Odor Measurement

drop the odor component

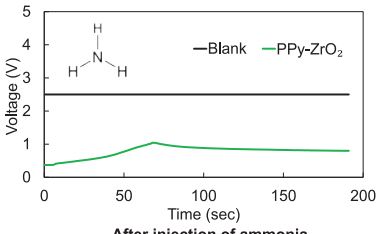

Olfactory receptor chip evaluation system

Measurements were conducted with 60 seconds for odor adsorption and 120 seconds for odor desorption.

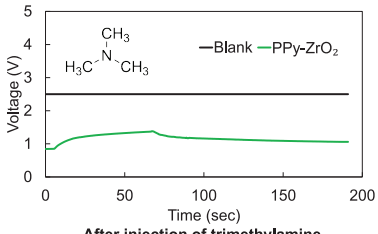
The peak occurs at 65 seconds.



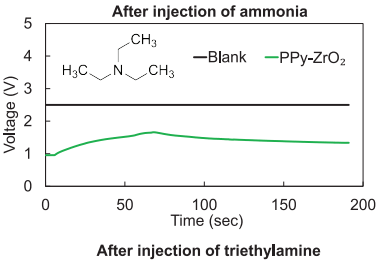
Before odor injection



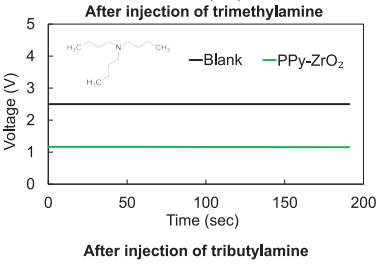
After injection of ammonia



After injection of trimethylamine



After injection of triethylamine



After injection of tributylamine

React reason
The nucleophilicity of the amine group.

No react reason
The molecular chain is long.

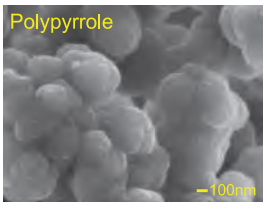
RESULTS AND DISCUSSIONS

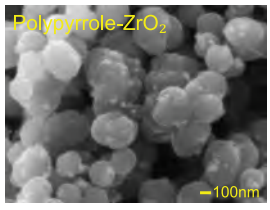
Polypyrrole-ZrO_2

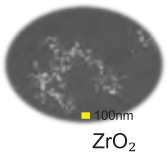
Evaluation of the colloidal properties and conductivity of polypyrrole dispersions according to ZrO_2 concentration

Sample no.	Initial ZrO_2 oxides concentration (w/v%)	Colloid formation	Average particle size (nm)	Zeta Potential (mV)	Polypyrrole content (%)	Conductivity (S/cm)
1	0	No	-	-	100	1.4
2	0.5	No	-	-	-	-
3	1	Yes	518±362	27.1	46	2.3
4	5	Yes	297±196	41.2	16	2.2
5	10	Yes	258±145	42.0	14	0.14

Polypyrrole-ZrO_2 showed the same conductivity as polypyrrole.
Sample no.3 is a conductivity that can be measured using an odor sensor.







ZrO_2

Morphology of polypyrrole-ZrO_2 conducting inks
ZrO_2 particles are adsorbed on the surface of polypyrrole

CONCLUSIONS

1. Proposed a new and simple synthesis method for colloidal polypyrrole using ZrO_2 as a dispersant.
2. Polypyrrole-ZrO_2 can be used in a form that is workable, whereas polypyrrole is usually insoluble.
3. We have found that polypyrrole-ZrO_2 has potential as a sensing element in an artificial olfactory system.

References
1. K. Matsumaka, Y. Tsugita, and S. Maeda, J. Imaging Soc. Jpn., 55, 664 (2016).
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HO CHI MINH CITY OF TECHNOLOGY AND EDUCATION
GRAPHIC ARTS AND MEDIA FACULTY

REPORT ON OPTIMIZING THE METHOD OF CALCULATING THE NECESSARY AMOUNT OF COMPONENT INKS FOR OFFSET PRINTING MIXING BASED ON THE DATABASE FROM THE PREVIOUS RESEARCH PROJECT(2)

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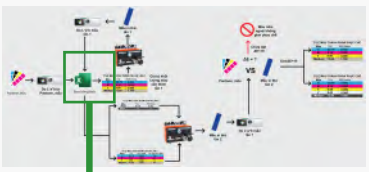
Abstract

In Machine Learning, linear regression is a supervised algorithm in which the relation between input and output is described by a linear function. This algorithm is also known as linear fitting or linear least square(1). This report discusses the application of linear regression problems in calculating colour mixing based on L, a, b values.
In addition, a comparison is indicated to test the effectiveness of this algorithm compared to the previously studied algorithm(2).

Introduction

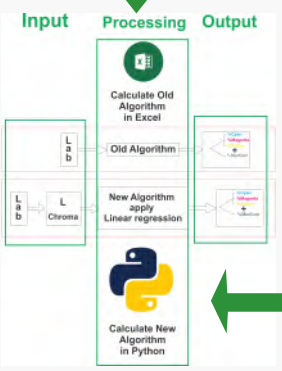
To be specific, this report will reuse the data of the combined colours from Cyan and Medium, Magenta and Medium, Yellow and Medium (the change rate is 10% respectively) as the database for the new algorithm (linear regression)(1) to predict the percentage of the mass of the mixed colours. The results returned by the new algorithm performed on Python are compared with the old algorithm performed on Excel(2), hence, the effectiveness of the new algorithm was evaluated.

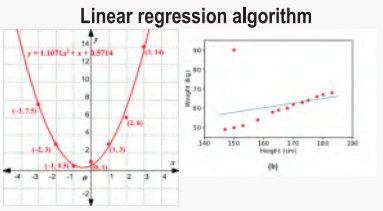
Method



Method:

Applicate Linear regression algorithm in expecting the percentage of color element's weight based on the data set of L, a, b among Cyan, Magenta, Yellow, Medium colors which is collected in previously studied research(2).

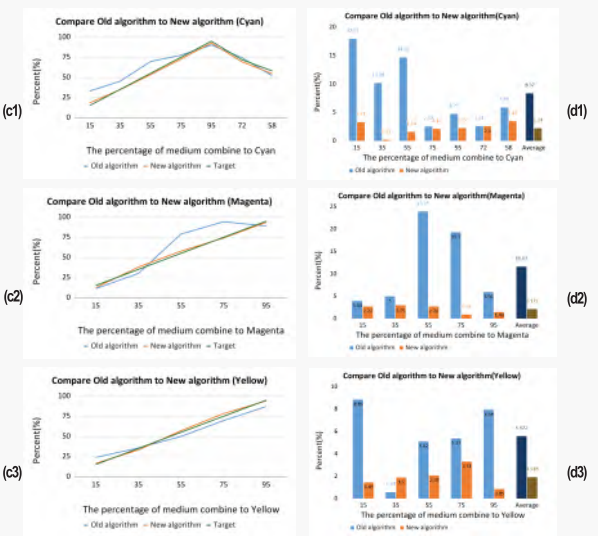




Tool Description:

Calculating and visualization are shown by Python programming language instead of using Excel software in previously studied research(2).

Test and Evaluation

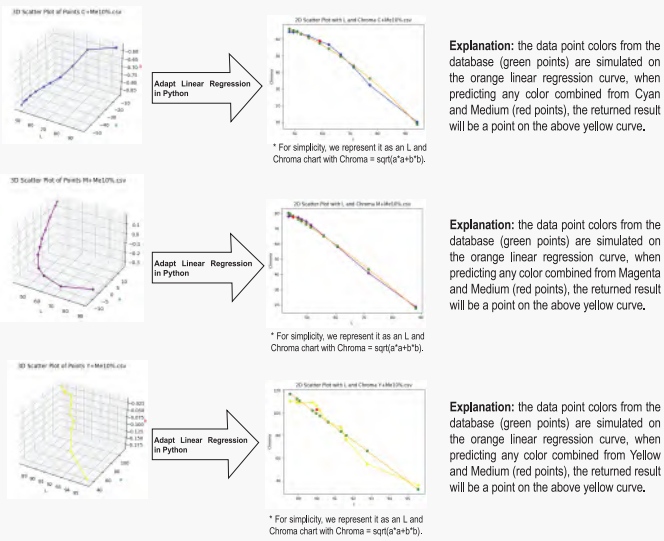


Evaluation:

As regards the c1, c2, and c3 charts, the lines illustrate that the new output values (New Algorithm) are significantly near the value targets compared to the previously studied research(2). To be specific, from the d1, d2, and d3 charts, the average values of component colour ratio deviations for the tests are smaller lots times than the average values of component colour ratio deviations for the tests in previously studied research.

Moreover, comparing the proportion of the target Medium colour's weight, the average deviations of the proportion of the expected Medium colour's weight in tests (Cyan, Magenta, Yellow, Medium) are stable and slightly fluctuate (between 1,98% and 2,2%).

Result



Explanation: the data point colors from the database (green points) are simulated on the orange linear regression curve, when predicting any color combined from Cyan and Medium (red points), the returned result will be a point on the above yellow curve.

* For simplicity, we represent it as an L and Chroma chart with Chroma = sqrt(a*a+b*b).

Explanation: the data point colors from the database (green points) are simulated on the orange linear regression curve, when predicting any color combined from Magenta and Medium (red points), the returned result will be a point on the above yellow curve.

* For simplicity, we represent it as an L and Chroma chart with Chroma = sqrt(a*a+b*b).

Explanation: the data point colors from the database (green points) are simulated on the orange linear regression curve, when predicting any color combined from Yellow and Medium (red points), the returned result will be a point on the above yellow curve.

* For simplicity, we represent it as an L and Chroma chart with Chroma = sqrt(a*a+b*b).

Conclusion

This report discussed the application of linear regression to calculate ink mixing based on L, a, b values.

Furthermore, a comparison was given to check the effectiveness between the old algorithm and the new algorithm.

The result indicated that the output of the new algorithm was more effective than the old one in tests (Cyan and Medium colour, Magenta and Medium colour, Yellow and Medium colour).

Reference

(I) Vu Huu Tiep, Basic Machine Learning, pp.83-90.(2018)

(II) Nguyen Long Giang, Nguyen Tran Phuong Duy, Huynh Huu Huy, Ly Thao Huyen, RESEARCH TO BUILD A DATABASE AND CALCULATE THE AMOUNT OF COMPONENT INK NECESSARY TO MIX OFFSET PRINTING INK AS REQUIRED.

(III) MachineLearningcoban.com

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POSTER CODE: A-XXX

REDUCE COLOR DEVIATION BY USING AI TO CALCULATE COLOR VALUES BASED ON IMAGES FROM CAMERAS

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ABSTRACT

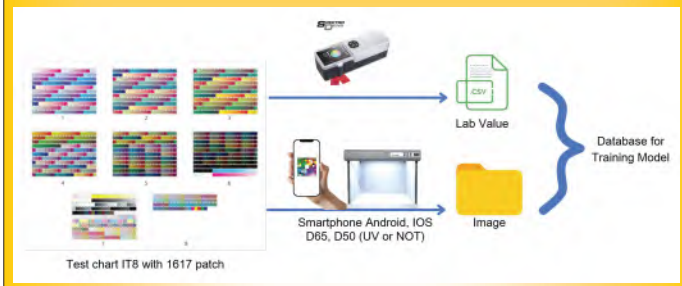
This poster presents a method to improve color deviation by using machine learning to calculate color values based on images from cameras. Unlike traditional approaches from previous projects, which relied solely on manual or formula-based calculations, this study leverages AI to enhance accuracy and consistency. A dataset of Lab color values and images captured by cameras and smartphones was used to train machine learning models, including Linear Regression, XGBoost, and CNN. This work establishes a new framework for training AI models to achieve better color accuracy and adapt to real-world applications.

INTRODUCTION

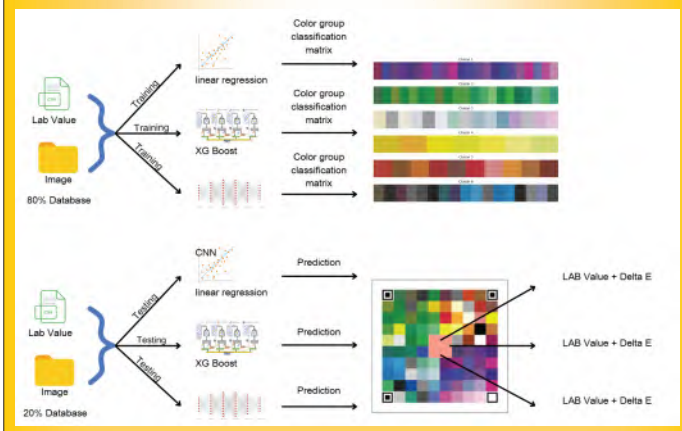
Accurate color prediction is essential in fields like printing, design, and manufacturing, where consistent color reproduction is critical. Traditional approaches often rely on manual calculations or predefined formulas, which are limited in addressing variability caused by environmental factors, device differences, or the natural fading of color samples. This study introduces a machine learning-based method to improve color deviation by leveraging image data from cameras and smart phones. Unlike previous methods, this approach uses AI to learn patterns from Lab color values and image datasets, enabling more precise and adaptive predictions. To achieve this, models such as Linear Regression, XGBoost, and CNN were trained and evaluated. This research provides a foundation for using AI to refine color prediction processes and adapt to real-world applications.

METHOD

Step 1. *Color Data Collection*

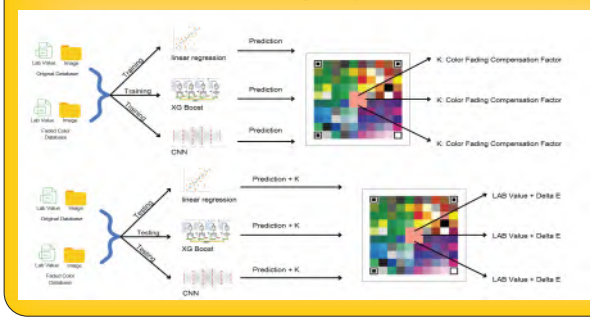


Step 2. *Training and Testing for 3 model: Linear Regression, XGBoost, CNN*



Step. 3. *Comparison of predicted LAB value and Delta E results of 3 machine learning models*

Step. 4. *Faded Color Correction by using 3 model Machine Learning*



***K** is the compensation factor for correcting color fading caused by aging or environmental conditions*

EXPECTED RESULTS

1. Improved Color Accuracy
Achieve a significant reduction in color deviation, with predicted Delta E values consistently ranging from 3-6, ensuring reliable and precise color reproduction across various devices.

2. Performance Comparison of Algorithms
Evaluate and compare the performance of Linear Regression, XGBoost, and CNN in terms of accuracy, consistency, and adaptability to determine the most effective algorithm for color prediction.

3. Device-Independent Color Prediction
Develop a robust machine learning model capable of predicting consistent color values using images captured by different types of cameras and smartphones, ensuring device independence and reliability.

4. Faded Color Correction
Implement a method to detect and correct faded colors in aging color samples, demonstrating the model's ability to handle real-world challenges and extend the usability of color samples over time.

CONCLUSIONS

This study aims to demonstrate the potential of machine learning in enhancing color prediction accuracy. By utilizing Lab data and images from cameras and smartphones, the models are expected to achieve reliable color predictions with Delta E values between 3-6. Linear Regression, XGBoost, and CNN are anticipated to contribute uniquely, with CNN showing promise in correcting faded colors. These results will highlight the effectiveness of machine learning in handling complex color prediction tasks. The approach is expected to offer significant potential for real-world applications in industries such as design, manufacturing, and printing.

ASPT 2024
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SYNTHESIS OF ZnO NANOPARTICLES-BASED SMART INK FOR SECURITY APPLICATIONS AND SMART PACKAGING

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INTRODUCTION

ZnO nanostructures
- Non-toxicity material
- Eco-friendly material
- High stability at room T°

Motivation
- Investigate the properties of ZnO materials at different hydrothermal temperatures
- Investigate the optical properties of ZnO nanostructures and ZnO nano ink
- Applied ZnO nanoparticles on security ink and smart packaging

EXPERIMENTAL

Fig. 1. *Fabrication of ZnO nanoparticles by hydrothermal method*

1. Investigate the properties of ZnO nanostructures at different hydrothermal temperatures: 100°C, 150°C, 200°C, 250°C, and 300°C.
2. SEM, XRD measurement.
3. Optical properties of ZnO nanostructures and ZnO nano ink.

RESULTS AND DISCUSSIONS

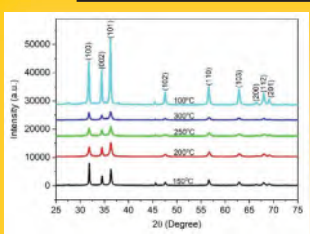

Fig. 2. *The XRD patterns of the synthesized ZnO*

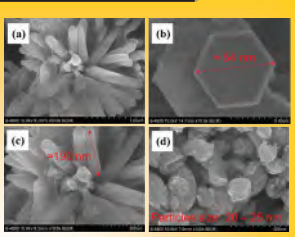

Fig. 3. *The SEM images of the synthesized ZnO*

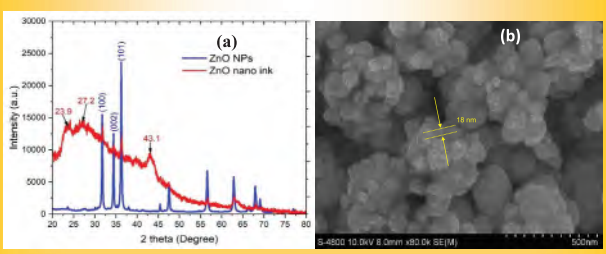

Fig. 4. *(a) XRD patterns of ZnO nanostructures and ZnO nano ink, (b) SEM image of ZnO nano ink*

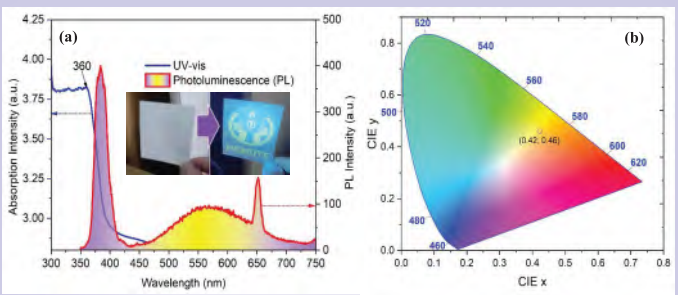

Fig. 5. *(a) Optical properties of ZnO nano ink, (b) CIE (x, y) color coordinate of ZnO nano ink*

Fig. 6. *Applications ZnO nanostructures for security ink*

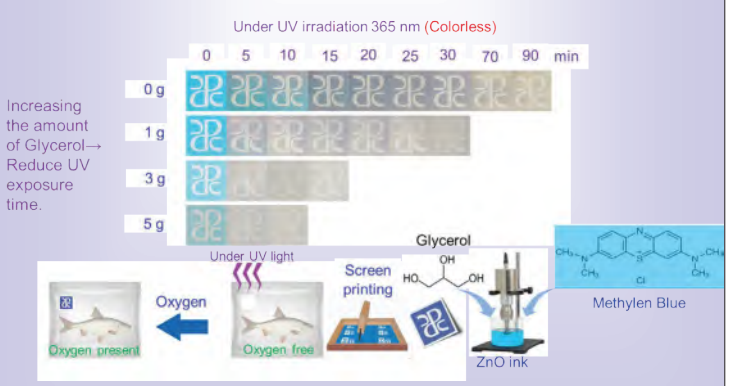

Fig 7. *Application of ZnO nano ink in smart packaging*

CONCLUSIONS

1. Successfully synthesized ZnO nanostructures by hydrothermal method.
2. Investigation of morphology, structural, and optical properties of ZnO structures.
3. Application of ZnO nanostructures in luminescent ink and in smart packaging.

Acknowledgment: *This research was supported by the .....*

ASPT 2024
Ho Chi Minh, Vietnam, December 19-20, 2024
THE 14th ASIAN SYMPOSIUM ON PRINTING TECHNOLOGY (ASPT 2024)
Artificial Intelligence and Sustainable Printing: Trends and Challenges
POSTER CODE: A-XXX

RESEARCHING THE ABILITY TO APPLY AM AND FM SCREENING FOR MULTI-PURPOSE PRINTING CONDITIONS SUPPORTED BY THE PDF TOOLBOX PLUGIN

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INTRODUCTION

Motivation

- Investigate the conditions of the using PDF Toolbox plugin for object screening
- Investigate the dotgain curves of AM and FM screening
- Applied AM and FM screening for multi-purpose printing conditions

Screening techniques

- AM and FM
- Pdf Toolbox (Object screening)
- MetaDimention RIP

EXPERIMENTAL

Poster size: A0

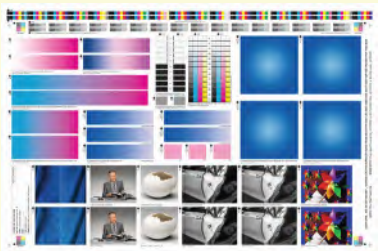

Fig. 1. *Testform for checking the impact of FM and AM screenings on printing quality*

1. Create Test form;
2. Making offset plate (CTP)
3. Offset printing
4. Evaluate printing qualities of AM- and FM screening related zones

RESULTS AND DISCUSSIONS

Fig. 2. *Solid ink densities are accepted*

Fig. 3. *Highlight areas are seen, shadows areas are blocked from 95%*

Fig. 4. *Dotgain of 50% (AM screening is acceptable; FM screening is higher than the technical guideline value (30-36% vs 28%*

Fig. 5. *Monotone continues gradient of FM screening is smoother than AM screening*

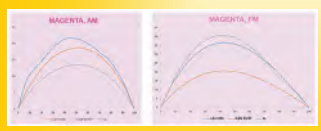

Fig. 6. *Dotgain Curve of AM and FM screenings*

Fig. 7. *AM linear continues gradient is better reproduced*

Fig. 8. *AM radial gradients (round and ellipse) are smoother than FM radial gradients (20 µm and 24 µm)*

Fig. 9. *Moire tests are passed with both AM and FM screenings*

Fig. 10. *Moire tests are passed with FM screening; Moire tests are not passed with AM screening (and color shift to Magenta)*

Fig. 11. *Highlight details of eggs are blur with AM screening; They are more clearly with FM screening*

Fig. 12. *Shadow details are blur with AM screening; They are more sharply with FM screening*

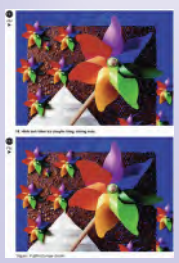

Fig. 13. *Colorful bitmap mages with FM screening got higher contrast than those with AM screening. Some midtones areas are reproduced better with AM screening*

CONCLUSIONS

1. The PDF Toolbox plugin can support the object screening print for multi-purpose printing conditions.
2. The research helps prepress operators to choose suitable screening type according to objects and printing conditions.
3. Following the technical guidelines (Media Standard Print 2018, GRACoL 2013…) are good way to gain good printing quality.

Acknowledgment: *This research was supported by the .....*

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Artificial Intelligence and Sustainable Printing: Trends and Challenges

Marine Biomass Utilization: Exploring *Laminaria japonica* for Cellulose Nanofiber Production

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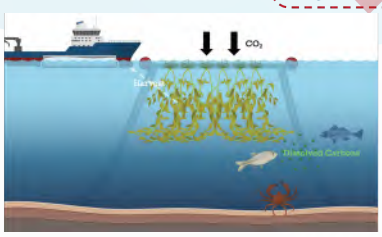
[1]Degree Program in Agricultural Sciences, University of Tsukuba, Japan
[2]Faculty of Life and Environmental Sciences, University of Tsukuba, Japan

Introduction

- Seaweed has emerged as a promising source of cellulose and nanocellulose, offering significant advantages over traditional land-based biomass.

[1,2]

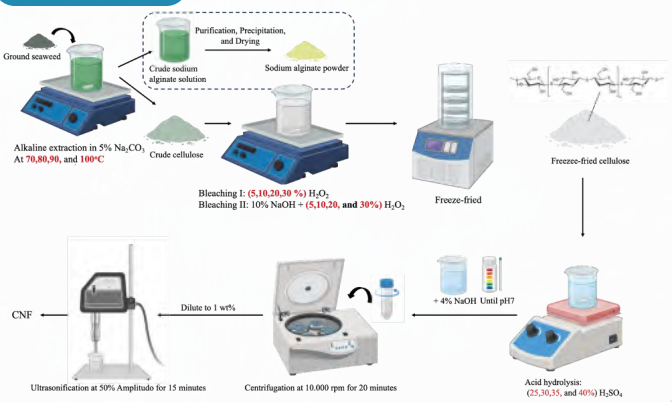


- Seaweed cellulose, enabling its extraction under mild conditions with minimal structural degradation[3].
- Ultrasonication has gained attention as an eco-friendly method for extracting nanocellulose under milder reaction environments[4].

Objective

This study explores the potential using a greener and more sustainable ultrasonication-assisted acid hydrolysis for preparing Cellulose Nanofibers from *Laminaria japonica*. The findings provide a foundation for future exploration and applications of seaweed-based CNFs in diverse fields including printing applications.

Experimental



Results

Fig 1. Freeze-dried cellulose from *Laminaria japonica*

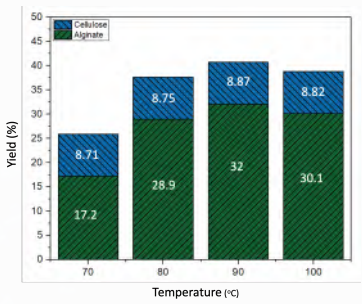


Fig 2. Yields of Cellulose and alginate at varying alkaline extraction temperatures

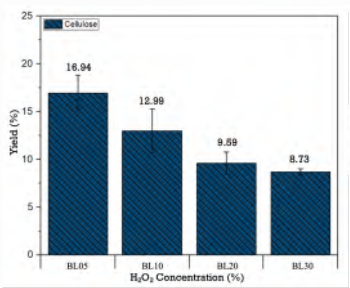


Fig 3. Cellulose yield at different H_2O_2 concentrations

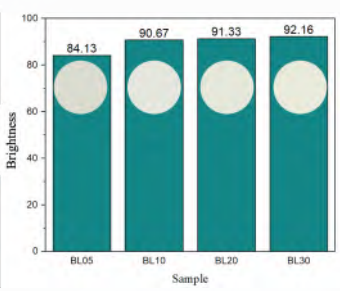


Fig 4. Brightness of cellulose pulp at different H_2O_2 concentrations

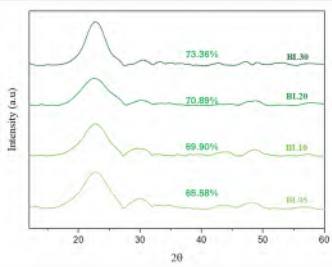


Fig 5. X-ray diffraction (XRD) analysis of cellulose at different H_2O_2 concentrations

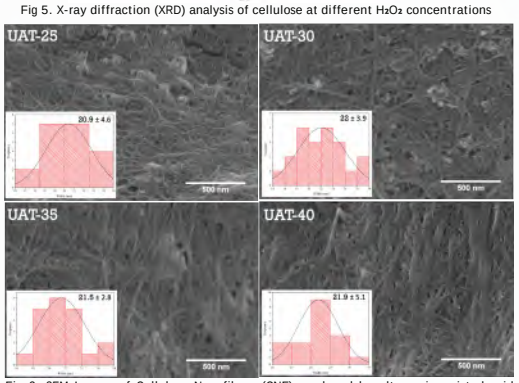


Fig 6. SEM Images of Cellulose Nanofibers (CNF) produced by ultrasonic-assisted acid hydrolysis treatment (UAT) at different acid concentrations (25%, 30%, 35%, and 40%)

Conclusion

- Cellulose was successfully extracted from *Laminaria japonica*.
- The cellulose yield from seaweed was not significantly influenced by alginate removal or extraction temperatures ranging from 70°C to 100°C.
- Bleaching at varying concentrations affected both the yield and whiteness of the cellulose.
- SEM analysis demonstrated that ultrasonic-assisted acid hydrolysis effectively produced cellulose nanofibers (CNFs) with an average size range within the nanometer scale.

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BÁO CÁO THỰC TẬP CHUYÊN NGÀNH 2 SAU IN
GIA TĂNG GIÁ TRỊ SẢN PHẨM IN

GVHD: ThS. Chế Thị Kiều Nhi

Sinh viên thực hiện

1. Đoàn Nguyễn Ái Nguyên 21158204
2. Hồ Minh Thương 21158059
3. Phạm Thanh Như 21158206

PORTFOLIO

Nguyên Thương Như

Thương Hiệu CANDLE-LITE

[EST. 1840] CANDLE-LITE LEESBURG. OHIO

Candle-lite từ lâu đã được công nhận là thương hiệu dẫn đầu trong ngành sản xuất nến trang trí. Candle-lite tự hào đã kỷ niệm được hơn 180 năm sản xuất nến liên tục. Candle-Lite đã trải qua nhiều thay đổi và phát triển kể từ khi được thành lập, từ việc tự động hóa quy trình sản xuất đến việc mở rộng thị trường. Tuy nhiên, họ vẫn giữ vững giá trị cốt lõi của mình là tạo ra những sản phẩm nến thơm chất lượng. Bộ sản phẩm TTCN 2 Sau In, gia tăng giá trị các sản phẩm in của thương hiệu Candle-lite bao gồm: Hộp cấp 2 đựng nến, Hộp quà cấp 3, Túi giấy, Tag.

Hộp cấp 2

3D Visualizer

Tag

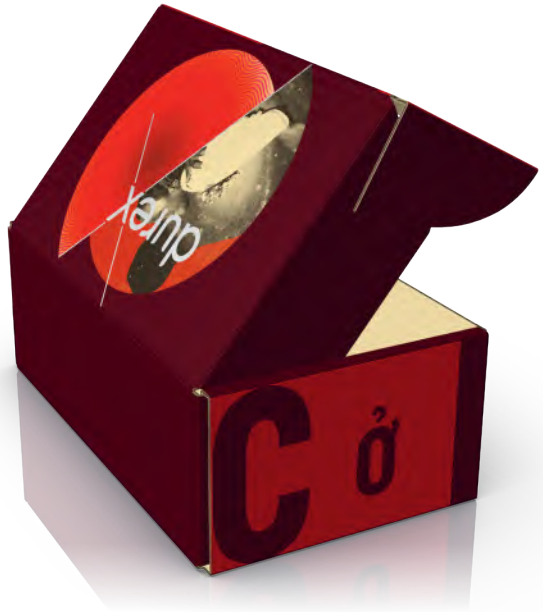
Hộp quà cấp 3

Túi giấy

Nhóm sinh viên thực hiện
Lê Chí Bình_21158027
Lê Thanh Phương_21158052
Vũ Bùi Minh Thư_21158073
GVHD: ThS. Chế Thị Kiều Nhi

durex

Durex là một thương hiệu nổi tiếng về các sản phẩmliên quan đến sức khỏe sinh sản, bao gồm bao cao su, gel bôi trơn và các sản phẩm chăm sóc sức khỏe. Durex đã có hơn 90 năm kinh nghiệm trong việc nghiên cứu và đa dạng hóa các dòng sản phẩm cho trải nghiệm yêu ngày càng thăng hoa, họ tin rằng tình dục là cởi mở,chân thành.



Bao bì cấp 3

Bao bì cấp 2

Sản phẩm bên trong được lấy từ đáy hộp, đáy có thể đẩy vào lại như ngăn tủ mà không cần phải gài lại vào mắc cài.
Sản phẩm bên trong được xếp thành chồng, khi sử dụng chỉ cần bật phần than dưới hộp ra và rút từng cái một. Cấu trúc kết hợp đồ họa mang tính tượng trưng cho chiếc quần và nhắc nhở nhẹ rằng "cởi là mở".
Tai thỏ ở nắp in logo khi trưng bày có thể nhìn thấy logo ở 4 mặt.

Túi giấy, thiệp và cover boxer

Scan để xem hiệu ứng

Minh Thư

Thanh Phương

Chí Bình

HCMUTE

Graphic Art and Media

Thành viên:
Nguyễn Thị Giàu 21158190
Võ Ngọc Mỹ Uyên 21158062
Hồ Duy Thiệt 21158216

Môn: Thực tập Chuyên ngành Sau in
GVHD: Chế Thị Kiều Nhi

PHẤN NỤ HOÀNG CUNG

Công ty TNHH Mỹ Phẩm Hoàng Cung chính thức đi vào hoạt động từ ngày 22/11/2012, là doanh nghiệp sở hữu và phân phối các dòng sản phẩm thuộc thương hiệu Phấn Nụ Hoàng Cung.

Dưới triều Nguyễn, cung nữ đều được tuyển chọn kỹ lưỡng từ con cháu các gia đình "hoàng thân quốc thích". Phấn Nụ là loại mỹ phẩm độc đáo được các ngự y triều Nguyễn dày công nghiên cứu và bào chế thành công. Được xem như báu vật của hoàng cung thời bấy giờ, Phấn nụ chỉ dành riêng để làm đẹp cho các bậc mẫu nghi, công chúa và phi tần triều Nguyễn. Công thức bào chế phấn nụ chỉ được giao lại cho một cung nữ tin cẩn cất giữ và sản xuất. Khi triều Nguyễn cáo chung, người cung nữ cuối cùng giữ bí quyết làm phấn nụ xuất cung và tiếp tục sản xuất phấn nụ để làm kế mưu sinh giữa đời thường.

BAO BÌ CẤP 2

Hộp son

Phấn má

Xem mẫu 3D

Ý nghĩa bao bì cấp 2: Sử dụng hoa văn truyền thống Việt Nam để lan truyền bản sắc dân tộc, với sắc màu cho mỗi loại mỹ phẩm bên trong .Logo " Son nước" và họa tiết sen trong hồ , chim lạc trong trống đồng, hoa cúc được ép nhũ nổi bật lên giúp tôn thương hiệu và gây sự thu hút với người dùng.

BAO BÌ CẤP 3

Ý nghĩa bao bì cấp 3: Lấy cảm hứng từ áo Nhật Bình thời Nguyễn, với sắc đẹp cổ kín, vừa tôn lên sắc đẹp bộ sản phẩm vừa mang ý nghĩa văn hóa dân tộc sâu sắc, giúp tuổi trẻ hướng đến lịch sử dân tộc

Xem mẫu 3D BBC3

BAO LÌ XÌ _QUÀ TẶNG

ĐINH VĂN CƯỜNG 21158185
ĐỖ NGỌC HIẾU THẢO 21158141
TRẦN NGUYỄN HOÀNG 21158036

GVHD: THS. CHẾ THỊ KIỀU NHI

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BỘ SẢN PHẨM THƯƠNG HIỆU ĐÀO TẠO QUỐC TẾ & CAFE CỘNG

Câu chuyện Cộng bắt đầu vào năm 2007. Cửa hàng đầu tiên là một tiệm giải khát nhỏ trên con phố cà phê lâu đời tại Hà Nội – phố Triệu Việt Vương… Phố Triệu Việt Vương tháng 10 năm 2007 chuyển động, cô chủ Linh Dung khoác cho quán cà phê số 152D màu áo mới. Cộng Cà Phê ra đời từ ấy, với cái tên ngắn gọn: “Cộng”, đơn giản được lấy cảm hứng từ chữ cái đầu tiên trong câu Quốc hiệu: CỘNG HOÀ XÃ HỘI CHỦ NGHĨA VIỆT NAM. 2007, khi mà các cửa hàng cà phê tại Hà Nội lúc đó đa phần không quan tâm tới thiết kế cửa hàng thì Linh Dung đã nghĩ rằng: “Cộng phải có một câu chuyện riêng của mình”.

CỘNG®

BAO BÌ CẤP 2

TÚI GIẤY

Khoa Đào tạo Quốc tế (KDTQ) trực thuộc Đại học Sư phạm Kỹ thuật TP.HCM (ĐHSPKT) là đơn vị đào tạo uy tín, chất lượng cao, cung cấp các chương trình cử nhân và thạc sĩ liên kết với các trường đại học hàng đầu thế giới. Khoa được thành lập với mục tiêu đào tạo nguồn nhân lực chất lượng cao, đáp ứng nhu cầu hội nhập quốc tế và phát triển kinh tế - xã hội của đất nước.

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