international circle

International Circle
of Educational Institutes
of Graphic-Media
Technology
& Management

54th IC Annual Conference

CONFERENCE PROCEEDINGS

18–20 September 2023

BERGISCHE
UNIVERSITÄT
WUPPERTAL

Proceedings of the 54th Annual Scientific Conference of the
International Circle Circle of Educational Institutes
of Graphic-Media Technology and Management

Wuppertal, Germany, September 2023

International Circle of Educational Institutes of
Graphic-Media Technology and Management
Stuttgart, Germany, 2023
www.internationalcircle.net

Edited by Anastasios Politis
Oropos, Greece

Associate Editors: Marios Tsigonias, Georgios Gamprellis
Athens, Greece

Graphic Design and Layout: Evgenia Pagani
Athens, Greece

HELGRAMED - The Hellenic Union of Graphic Arts and Media Technology Engineers
Athens, Greece
www.helgramed.gr

Digital edition

ISBN 978-618-81734-4-6

Published by
HELGRAMED - The Hellenic Union of Graphic Arts and Media Technology Engineers
Athens, Greece

International Circle
of Educational Institutes
of Graphic-Media
Technology
& Management

international
circle

54th IC Annual Conference

CONFERENCE PROCEEDINGS

18–20 September 2023

BERGISCHE
UNIVERSITÄT
WUPPERTAL

Published by

HELGRAMED
HELLENIC UNION OF GRAPHIC ARTS & MEDIA TECHNOLOGY ENGINEERS

iarigaiIC
Wuppertal 2023

49th Conference of iarigai | 54th Conference of IC

International Research Conferences of
iarigai & International Circle

18-20 September 2023 | Wuppertal, Germany

PROGRAM

Monday, 18th September 2023 | University of Wuppertal

08:30 - 09:00	Registration	
09:00 - 09:05	**OPENING SESSION** Chair: Gunter Hübner | Auditorium FZH 1	
09:05 - 09:15	Opening address of the conference: Prof. Dr.-Ing. Ulrich Jung	
09:15 - 09:30	Welcome address University of Wuppertal: Prof. Dr.-Ing. Anton Kummert	
	SESSION 1 (Plenary) – Keynotes iarigai Chair: Ulrich Jung | Auditorium FZH 1	
09:30 - 10:00	Practical challenges of color in print Erik Koldenhof - Technical director at Colorware	
10:00 - 10:30	DoD jetting of viscoelastic inks, the print head as a elongational rheometer Prof. Dr. Ir. Frits Dijksman – em. Professor of Fluid Dynamics, University of Twente, The Netherlands	
10:30 – 10:50	Official Photo | Foyer Building FZH	
11:00 - 11:30	**Coffee break | Foyer Building FZH**	
	SESSION 2A | iarigai **Print Technologies & Systems I** Chair: Ulrich Jung | Auditorium FZH 3	**SESSION 2B | iarigai** **Applications I** Chair: Edgar Dörsam | Auditorium FZH 2
11:30 - 12:00	A static compression study on the lateral pressure variations of flexo post-print on corrugated board Li Yang, Hans Christiansson, Anni Hagberg and Cecilia Rydefalk	Optimization of Printable Electrolyte Gunter Hübner, Marvin David Graner and Aakash Grewal
12:00 - 12:30	Control of ink-water balance in offset lithography by machine learning Eric Holle, Felix Knödl, Martin Mayer, Tizian Schneider, Dieter Spiehl, Andreas Blaeser, Edgar Dörsam and Andreas Schütze	Printing biocathodes: Construction and Characterization of an Air Breathing Platform Elise Bessac, Sébastien Solan, Bilal Demir, Nadège Reverdy-Bruas and Anne Blayo
12:30 - 13:30	**Lunch | Foyer Building FZH**	
	SESSION 3A | iarigai **Print material Science** Chair: Cathy Ridgway | Auditorium FZH 3	**SESSION 3B | iarigai** **Applications II** Chair: Fritz Bircher | Auditorium FZH 2
13:30 - 14:00	Influence of atmospheric plasma polymerization on the printability of polycarbonate and poly (methyl methacrylate) Mansi Puro, Dhia Ben Salem and Michael Dattner	Organic solar cells with an inkjet printed P3HT:O-IDTBR layer based on a green solvent by utilizing a heatable printhead Niklas Guhr and Holger Göbel
14:00 - 14:30	The Thermochromism of Organic Pigments Dispersed in Liquid Phase Tim Stiene	Cyanotype – from hand craft to industrial print Thorsten Euler, Jakob Feldmann, Dieter Spiehl, Edgar Dörsam and Andreas Blaeser
14:30 - 15:00	The Fate of Synthetic Polymers - An Analysis on the Future of Plastic Waste Volker Jansen	Development of a guideline for the engineering of a coherent, optimized packaging system based on the holistic systemic analysis Veronika Schenk, Michael Herrenbauer, Christoph Haeberle and Maria Erxleben
15:00 - 15:30	**Coffee break | Foyer Building FZH**	
	SESSION 4A | iarigai **Print Technologies & Systems II** Chair: Branka Lozo | Auditorium FZH 3	**SESSION 4B | iarigai** **Print Technologies & Systems III** Chair: Nona Woolbright | Auditorium FZH 2
15:30 - 16:00	Ink Spreading in Gravure Printing Armin Weichmann, Thomas Sprinzing and Matthias Galus	The Future is Now: Opportunities and Challenges of Integrated Technology in Graphic Communications for Industry 5.0: A Systematic Mapping of the Literature Lucille Trepanier, Areej Syeda and Reem El Asaleh
16:00 - 16:30	Investigation on an alternative printing plate for offset lithography Felix Knödl, Hans Martin Sauer, Jakob Feldmann, Dieter Spiehl, Andreas Blaeser and Edgar Dörsam	TaxoCatalog: costless workflow integration of an expert system environment to personalize product catalogs in omni-channel context Heiko Angermann
16:45 - 18:15	iarigai General Assembly (representatives only) | Auditorium FZH 1	
19:15 - 21:00	**iarigai & IC Evening Reception**	
	Vienna House Easy by Wyndham Wuppertal - Auf dem Johannisberg 1, 42103 Wuppertal Get together with a snacks and a glass of wine	

Tuesday, 19th September 2023 | University of Wuppertal

08:30 - 09:00	Registration	
09:00 - 09:05	**OPENING SESSION** Chair: Fritz Bircher | Auditorium FZH 1	
09:05 - 09:15	Opening address of the IC conference: Prof. Dr. Anastasios E. Politis	
09:15 - 09:30	Welcome address University of Wuppertal: Prof. Dr.-Ing. Ulrich Jung	
	SESSION 2 (Plenary) – Keynotes IC Chair: Anastasios E. Politis | Auditorium FZH 1	
09:30 - 10:00	Print Business in the Digital Age - Challenges and Opportunities Prof. Dr. rer. oec. Drs. h.c. Hartmann Liebetruth - em. Prof. at University of Wuppertal	
10:00 - 10:30	Exploring the market and regulatory challenges of the European graphic industry Laetitia Reynaud - Senior Policy & Economic Advisor at Intergraf	
10:30 – 11:00	**Coffee break | Foyer Building FZH**	
	SESSION 5A | IC **Graphic Communication I** Chair: Gunter Hübner | Auditorium FZH 3	**SESSION 5B | iarigai** **Print Technologies & Systems IV** Chair: Erzsébet Novotny | Auditorium FZH 2
11:00 - 11:30	Color Guides: From early times to today digital world Christos Koutrouditsos, Antonios Tsigonias and Anastasios Politis	Robust method for printed pattern classification and creation of fluid splitting regime maps for gravure printing Pauline Rothmann-Brumm and Edgar Dörsam
11:30 - 12:00	Design Thinking in the Graphic Communication Classroom Charles T. Weiss	Influences of mesh and surface types on the quality and adhesion of screen printed elements Sandra Rosalen and Ulrich Jung
12:00 - 12:30	The EKFIPLUS project Inventory Results on Learning Material Development in the Creative and Cultural Industries Gerasimos Vonitsanos, Evangelos Syrigos, Marios Tsigonias, Pinelopi Nikitopoulou and Georgios Gamprellis	Numerical investigation of the lateral movement of doctor blades in gravure printing Christian Sauder, Tobias Steger, Alina Sersch and Peter Gust
12:30 – 13:30	**Lunch | Foyer Building FZH**	
	SESSION 6A | IC **Education** Chair: Gorazd Golob | Auditorium FZH 3	**SESSION 6B | iarigai and IC** **Print Technologies & Systems V** Chair: Li Yang | Auditorium FZH 2
13:30 - 14:00	Analysis of the current state of the distance education in Ukraine Bohdan Durnak, Jaroslav Uhryn and Orest Khamula	A new Approach to Inkjet Printing of High Viscosity Inks for 3D Applications Stefan Güttler, Jan Christoph Janhsen, Anna Kolesova, Antonia Götz and Karin Chen
14:00 - 14:30	Interaction Design for Print Media – Teaching print media workflows by emphasizing the great diversity of print media products Heiko Angermann	Artificial intelligence in graphic design Ivana Tomic, Ivana Jurič, Sandra Dedijer and Savka Adamović
14:30 – 15:00	The Future of Printing Technology Engineers Education Enn Kerner	Properties of the ink-coating with added SiO2 nanoparticles printed on aluminium substrates Stamatina Theohari, Sanja Mahović Poljaček and Tamara Tomašegović
15:00 – 15:30	**Coffee break | Foyer Building FZH**	
	SESSION 7A | IC **Graphic Communication II** Chair: Markéta Drzkova | Auditorium FZH 3	**SESSION 7B | IC** **Print Technologies & Systems VI** Chair: Pauline Rothmann-Brumm | Auditorium FZH 2
15:30 – 16:00	Making but with Creativity Jiong Liang and Zhicheng Zhang	Creating Block Printing Plates Using a Laser Charles T. Weiss
16:00 – 16:30	Swearing, Fighting, Three Letters and a Space: Joseph Moxon and Printing House Chappel Rules Kenneth Macro	Practical challenges in hybrid conventional-UV offset printing Daiva Sajek
	CLOSING SESSION Chair: Gunter Hübner and Fritz Bircher | Auditorium FZH 3	
16:30 - 16:45	Wrap up and presentation of next conference venue	
16:45	End of conference	
17:00 - 17:45	IC General Assembly (representatives only) | Auditorium FZH 1	
19:15 – 22:30	**iarigai & IC Gala Dinner**	
	Restaurant Scarpati - Scheffelstraße 41, 42327 Wuppertal	

Wednesday, 20th September 2023 - Networking Day

At University of Wuppertal
Rainer-Gruenter-Straße 21, 42119 Wuppertal

09:30 - 09:45	Official opening
09:45 - 10:30	**Keynote presentations**
	The new way to get your talents: How to improve cooperation between industry and academia Dr.-Ing. Daniel Bohn *Third-party funding and research cooperation in Print and Media Technology at University of Wuppertal* Wearable electronics for medical applications Philipp Hoelzl *Technical Sales Manager Printed Electronics at ELANTAS*
10:45 - 12:00	**Printing labs guided tours**
	• Live presentation: Spectral measurements for deeper insight into print products Tim Stiene *Understad what kind of information can we get from our sample based on spectral measurements and how can we use this information profitably in industrial processes* • Livre presentation: Experimental Multimodal Publishing Frederik Schlupkothen and Michael Ruml • Live presentation: Artificial Intelligence for fashion Boqi Wu *Undestand how AI technologies can revolutionise design, production and retail processes, leading to enhanced efficiency*
09:45 - 12:00	**Tabletops**
	Exhibition with leading print suppliers
12:00	Bus Transfer

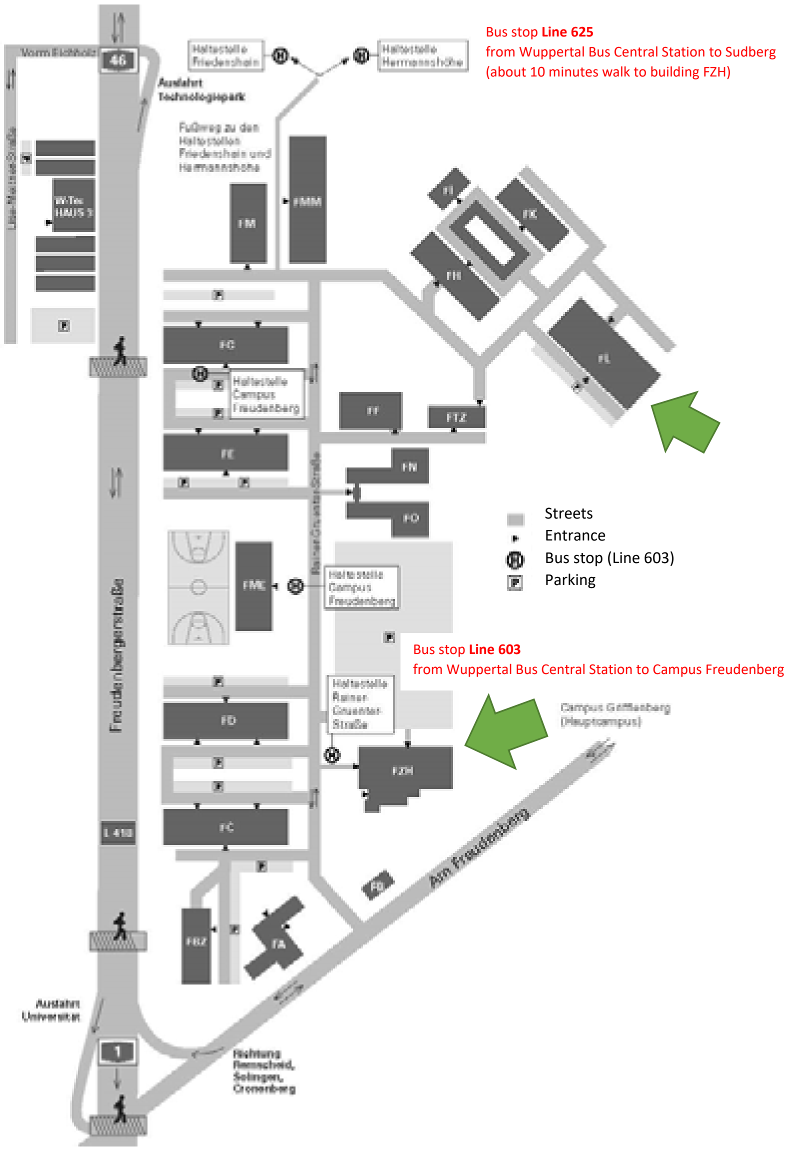
At SPS TechnoScreen GmbH
Kohlenstraße 63, 42389 Wuppertal

12:30 – 14:00	**Lunch for all attendees at SPS TechnoScreen**
14:00 – 17:30	**Machine park live demonstrations**
	• Printed electronics: Demo printing on Atma MF66 camera registration machine with accuracy < 20 µm • R2R screen printing: Demo printing on Atma R2R machine • Combination of digital and screen: Demo printing on the new generation ASTRON QX model servo drive cylinder machine Exhibition with leading print suppliers **will be also be set at SPS for the event's duration.**
17:30 – 19:30	**Evening reception for all attendees** ESMA Ambassador Award ceremony *Get together with finger food and drinks*
19:30	**Closing**

Networking day is offered in cooperation with

Directions - Bergische Universität Wuppertal Campus Freudenberg

Rainer-Gruenter-Straße 21, 42119 Wuppertal



Freeway network (outline)

Table of Contents

Preface

Dear IC members,
Dear colleagues and friends of the Graphic Communication, Print, Media and Packaging fields,

The 54th Annul Conference of IC - the International Circle of Educational Institutes of Graphic-Media Technology and Management, has taken place at the University of Wuppertal on 18-20 September 2023. Following the tradition of the last years the IC Conference has been jointly organized with iarigai. The joint iarigai/IC conferences have been organized in Warsaw Poland (2018), Athens Greece (2021) and Clemson/Greenville USA (2022).

iarigai - the International Association of Research Organizations for the Information, Media and Graphic Arts Industries and IC - the International Circle of Educational Institutes of Graphic-Media Technology and Management are among the most prominent research and educational organisations for print-media and packaging fields worldwide.

The joint organization of the conferences has been proved quite successful, bringing together the three pillars of Research, Industry and Education in the Graphic Communication, Print-media and Packaging fields.

At this digital edition of the Conference Proceedings of the IC, you will find the full papers or abstracts from the colleagues that participated in person or from distance and presented their scientific work at the conference.

As the Chairman of the IC, I Invite you to actively participate at the events planned for 2024:

- DRUPA 2024: The IC will run a stand at the "dna" section of the DRUPA with support from the HELGRAMED organization. During the DRUPA, there will be a networking event on 30 May 2024 at the CCD of the Messe Duesseldorf.
- The 55th annual conference of the IC, will take place from 8 until 11 September 2024 in Zurich Switzerland.

Please follow our website at: https://www.internationalcircle.net/
and our LinkedIn site at: https://www.linkedin.com/company/international-circle/,
for more information and updates on the activities of the IC.

Prof. Dr. Anastasios E. Politis
Chairman of the IC

E-mail: politismedia@gmail.com

Color Guides:
From early times to today digital world

Christos Koutrouditsos [2,3], *Anastasios Politis* [1,2,3], *Antonios Tsigonias* [1,2,3,4]

[1] GRAPHMEDLAB - The Hellenic Graphic-Media Research Lab, University of West Attica, Greece
[2] HELGRAMED - The Hellenic Union of Graphic Arts & Media Technology Engineers, Athens, Greece
[3] University of West Attica, Greece
[4] National Printing House, Greece

E-mails: christos@diagramma.com.gr; politismedia@gmail.com; antonio_tsigonias@yahoo.gr

Abstract

Color Guides used to be the most prominent tool for defining a specific color for a printed job. Numerous suppliers ranging from ink manufacturers to prepress companies and specialized vendors such as Pantone, have created and launched printed and digital color guides.
This paper investigates the history and the evolution of color guides from the early times until today. In particular, the structure and characteristics, the usefulness and the applications, as well as their contribution in the color workflow in design, prepress and printing is investigated and analyzed.
The objective of this paper is to investigate the types of color guides / charts, their course of evolution and their applications in the printing process and workflow. In addition, the usefulness of the color guides is discussed, along with the application of printed color guides and charts in the digital production and workflows in the printing business of today.
The research conducted, has been further focusing on the digitalization of color guides and charts. The degree of digitalization of the color guides and their implementation in digital design, prepress and printing workflows is investigated and the steps from paper/printed guides towards the digital ones is addressed. Finally, the future of printed color guides / charts is discussed.

Keywords: Color Guide, Color Skala, Color Chart, CMYK, Spot color, Multicolor Printing, Pantone

1. Introduction: What is a Color Guide / Chart?

According to Merriam - Webster dictionary, a color guide is “a systematic arrangement of colors or their representations with respect to either the attributes of the colors or the mixing relations of their stimuli. [1]

Another definition is placed at Wikipedia, where color charts are “A color chart or color reference card is a flat, physical object that has many different color samples present. They can be available as a single-page chart, or in the form of swatch books or color-matching fans”. [2]

Typically, there are two different types of color charts:

- Color reference charts, which are intended for color comparisons and measurements. Typical tasks for such charts are checking the color reproduction of an imaging system, aiding in color management or visually determining the hue of color. Examples are the IT8 and ColorChecker charts.
- Color selection charts present a palette of available colors to aid the selection of spot colors, process colors, paints, pens, crayons, and so on – usually the colors are from a manufacturers product range. Examples are the Pantone and RAL systems. [2]

2. History of color guides / charts

The creation of color charts / guides, requires the systematic classification of colors in a given context which is directly related to a specific application. In this context, there are numerous references in the literature concerning the attempts of researchers and scientists to classify colors, which began in antiquity.

2.1 Classification of colors – a historical overview

Based on historical sources from ancient Greece, as in most sciences, it was the ancient Greeks who first theorized about color. Approaching color from a philosophical perspective, but also based on his own observations, Aristotle (Aristotelis, 384-322 BC) is considered the founder of color theory. [3] Aristotle's theory was formulated on the basis of the notion that there is 'transparency' between the human eye and the colored object, i.e. that light is a 'property' of transparency. When the 'transparency' is light, the function of vision is possible. That is, in other words, the postulate that light is color or that without light (i.e. the existence of a light source and the radiation emitted from it), there is no color, was formulated for the first time.

Based on Aristotle's theory, colors are classified in a linear order from white to black with yellow, red and blue in between. Aristotle's classification of colors was based on the observation of the change in the colors of the horizon at sunset, i.e., the change in colors of the 'transparency' in a sunset. Aristotle's theory was the basis for all theories of color until the Middle Ages.

White	Yellow	Red	Blue	Black

Figure 1: The classification of (basic) colors according to Aristotelis - Aristotle
Source: Politis, A: "Introduction to color theory", Notes, The Athens Technological Educational Institute, Department of Graphic Arts Technology, 2018

The classification of color has always been a quite important field of research and development. Observation by sight, the perception of colors, radiation and the rainbow have been subjects of research for centuries, by the Greeks, Romans, the Arabs and researchers in China and Japan. However, the theory of colors and more broadly the one of the process of vision and observation remained at the level of Aristotle's observations until the Middle Ages. For example, even Goethe drew on Aristotle's theory to develop his own theory of colors.

A number of researchers have made particularly important contributions to the development of knowledge in color theory. Indicatively, Arab scientists brought the ancient Greek scientific tradition, observations and discoveries to the Middle East. Alhazen, for example (965-1039), a mathematician, physicist and astronomer, developed recognized theories on optics and chromatic sense that were summarized in his book "Book of Optics". Roger Bacon (England 1214-1294), further developed Alhazen's theory and with his work "Opus Majus", laid the foundations of the science of optics in Europe. [3]

Furthermore, in the period between the 12th and 14th centuries, Aristotle's texts, Euclid's geometry and Ptolemy's astronomy were translated into Latin, giving Renaissance scientists and researchers a major boost in the development of science and new discoveries. Also of particular importance were the astronomical discoveries and the study of the rainbow phenomenon by a number of researchers (among them Keppler and Copernicus) who formulated theories about the creation of the phenomenon.

As such, color classification and of course color spaces are not an issue of today. For example, much earlier, as early as 1435, the Italian Leon Battista Alberti (1404-1472) described the first three-dimensional system for mixing colors (a precedent of the CIE system). Alberti, created his color space, based on the observation of how painters mixed the primary colors (red, yellow, blue) to create more colors and he added the third dimension of "luminosity" to his color space. [4]

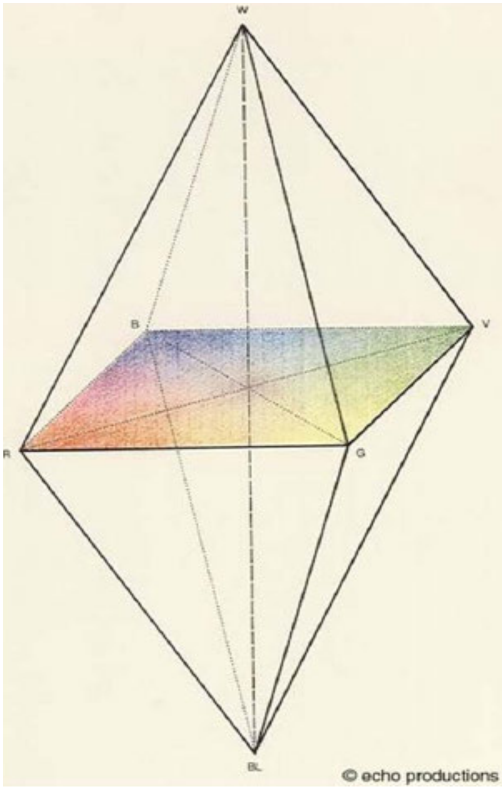


Figure 2: Alberti's first three-dimensional color mixing system
Source: http://www.cg.tuwien.ac.at/courses/Farbe/Textblaetter_WS11/07%20Geschichte%20der%20Farbe.pdf

2.2 Newton and Goethe

Isaac Newton (1643-1727), based on the pre-existing observations and discoveries of previous researchers in the rainbow phenomenon, optics and the observation of colors, developed this initial knowledge by experimenting with a prism (1672) and he was the first to observe the breakdown of white light into the colors that make up the visible spectrum of solar radiation. Newton was the first to form a color diagram, classifying the colors on the two-dimensional surface in such a way as to combine the red-purple and blue-violet color regions, which formed the basis for the CIE-1931 color diagram, by combining the representation of the color regions of the two ends of the visible spectrum observed in Newton's color wheel. [5]

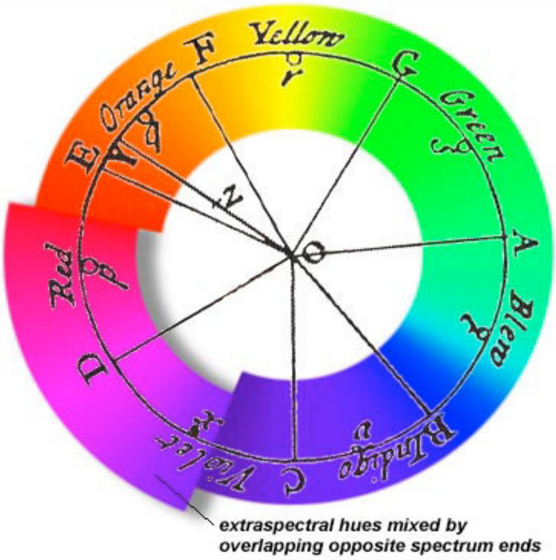


Figure 3: Newton's color cycle
Source: Geschichte der Farbmedien IDD - Technische Universitaet Darmstadt

In contrast to Newton, Goethe (Johann Wolfgang von Goethe, 1749 - 1835), based his theory in his 2000-page work "On the Theory of Colours - Zur Farbenlehre" on the fact that colour is a subjective sense, and therefore man is the primary factor in its analysis. In 1793 Goethe drew a color wheel, classifying colors in a two-dimensional representation.

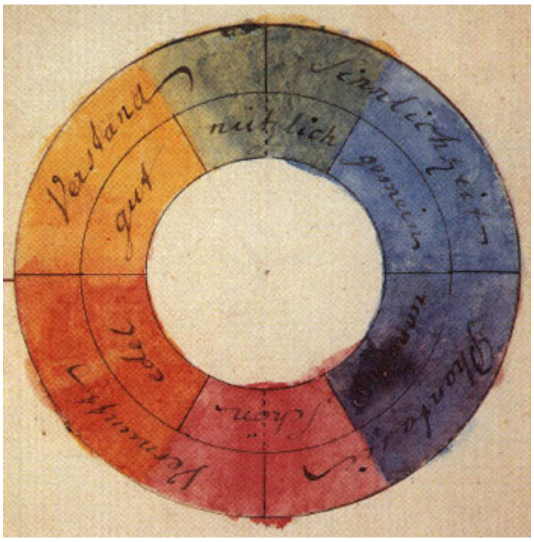


Figure 4: Goethe's color cycle
Source: anthroposophie.net

2.3 Color charts: An issue of today?

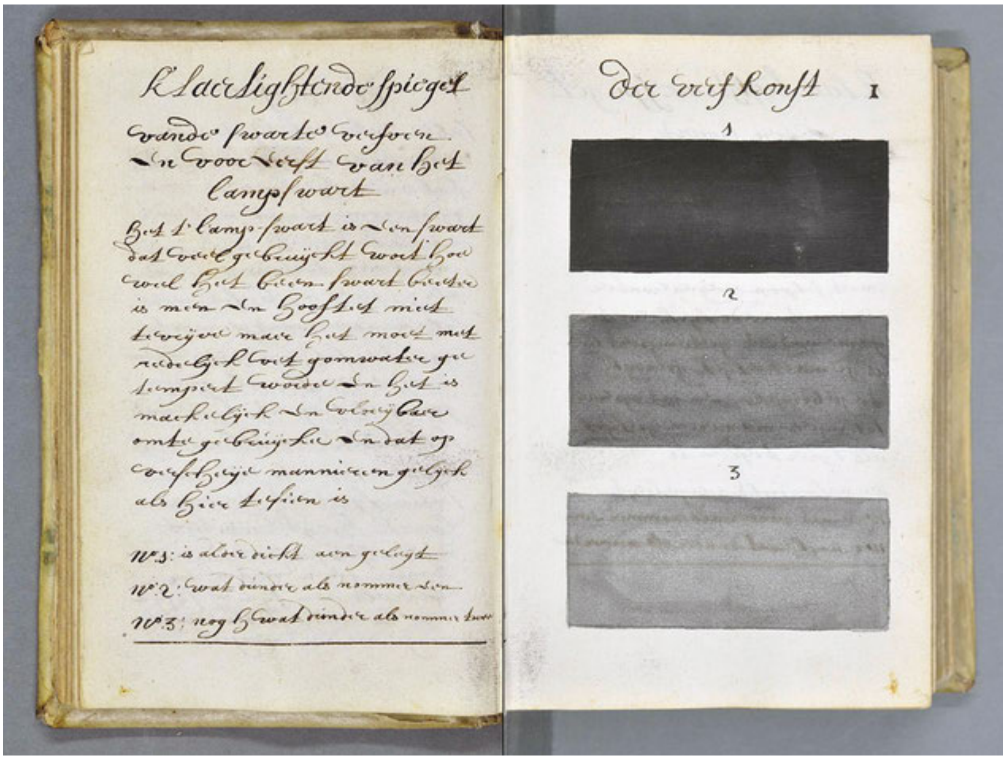
We are all familiar with color guides and charts printed on a specific substrate so we can much a color to be printing. And we all know the Pantone Color Matching System, for specifying colors. Hence, printed color charts were not the first to be created. Some centuries ago, scientists have developed their color chars, mainly to be applied in painting. Two characteristic examples are those from "A. Boogert" [7] and Pier Andrea Saccardo [8].

Some 280 years before Pantone, in 1692, an artist known only as "A. Boogert" sat down to write a book in Dutch about mixing watercolors. Not only would he begin the book with a bit about the use of color in painting, but would go on to explain how to create certain hues and change the tone by adding one, two, or three parts of water. The premise sounds simple enough, but the final product is almost unfathomable in its detail and scope. [7]

In the book of Christopher Jobson (2014) a complete color guide some 270 years after Pantone is presented. It is the work of the artist known only as "A. Boogert" who wrote a book in Dutch in 1692 about mixing watercolors. According to Jobson, "Boogert not only would he begin the book with a bit about the use of color in painting, but would go on to explain how to create certain hues and change the tone by adding one, two, or three parts of water. [7]

Spanning nearly 800 completely handwritten (and painted) pages, the "Traité des couleurs servant à la peinture à l'eau", was probably the most comprehensive guide to paint and color of its time. According to Medieval book historian Erik Kwakkel who translated part of the introduction, the color book was intended as an educational guide. The irony being there was only a single copy that was probably seen by very few eyes. The book is currently kept at the Bibliothèque Méjanes in Aix-en-Provence, France. [7] Images from the A. Boogert color chart are presented in Figures 5a to 5d:

Figures 5a, 5b: The book of water color mixing by A. Boogert
Source: http://www.thisiscolossal.com/2014/05/color-book/



Figures 5c, 5d: The book of water color mixing by A. Boogert
Source: http://www.thisiscolossal.com/2014/05/color-book/

Another example of old color guides / charts is the "Chromotaxy Scale" created by Pier Andrea Saccardo. [8] Saccardo, proposed this "chromotaxy scale" in 1894, to standardize the naming of colors of plant specimens. A sample page of his work is presented at Figure 6:

Figure 6: A page from Saccardo's (1894) color classification and guide for plants

Source: Saccardo's (1894) Chromotaxia, seu nomenclator colorum... ad usum botanicorum et zoologorum (in English, French, German, Italian, and Latin) – digital facsimile from the Linda Hall Library.

An example of today's color charts is the Tauba Auerbach's RGB Colorspace Atlas. [9] Based on data derived from thisiscolossal.com [9], the RGB Colorspace Atlas by New York-based artist Tauba Auerbach is a massive tome containing digital offset prints of every variation of RGB color possible, depicting every color of the visible specturm. At 8in. x 8in x 8in., the perfect cube book was co-designed by Daniel E. Kelm and bound with assistance from Leah Hughes.

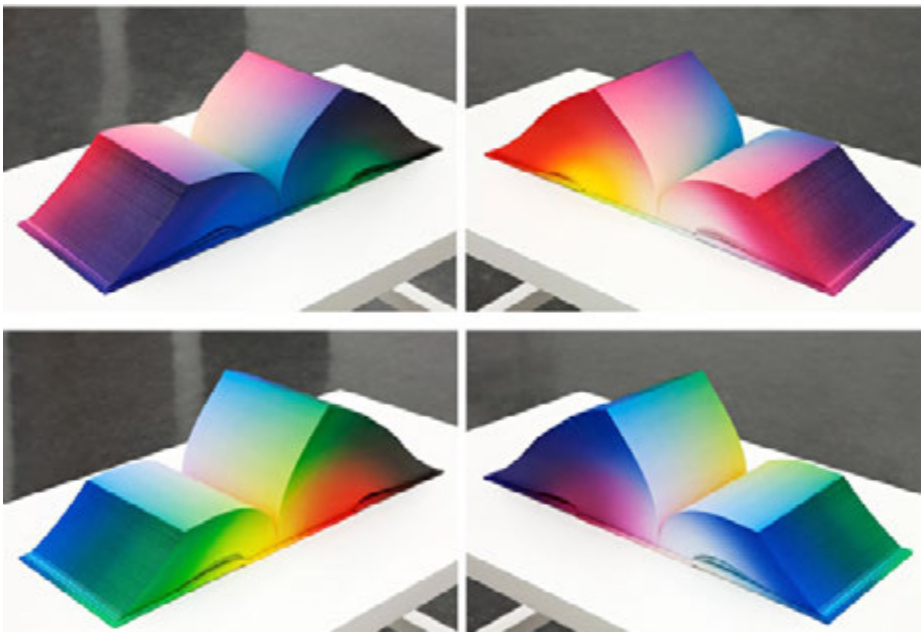


Figure 7: Tauba Auerbach's RGB Colorspace Atlas

Source: https://www.thisiscolossal.com/2012/09/tauba-auerbachs-rgb-colorspace-atlas-depicts-every-color-imaginable/ accessed 23/07/2023

3. Color Guides / Charts

Color guides (charts, guides, libraries or "Skala" - Farbskala in German), are not more than color order systems for color definition in a systematic manner. They constitute quite useful tools for various industries among them textile, wall painting and of course printing. According to The Encyclopedia of Color Science and Technology [10], color order systems can be defined in three ways:

- A system for categorizing colors. An arrangement of perceived colors, color stimuli, or material color samples according to certain rules.
- A subset of the world of color according to three attributes that constitute the coordinates of the color system.
- A rational plan for ordering and specifying all object colors by a set of material standards [10].

For the printing industry in particular, color guides and charts were - and still are, among the most prominent and valuable means for the definition of colors to be printed. Printed on various substrates, they are widely used in the entire printing workflow and from all stakeholders (retailers, designers, prepress, printers and ink manufacturers) as the specification for a given color to be printed on a specific type of a substrate. These guides are not an official standard but they constitute de facto references color definition and communication that assigns unique identification numbers to specific colors. [11]

All types of color guides assign each color - and in particular its hue, with a unique identification – most commonly a number, ensuring consistent and accurate color reproduction across different materials and industries.

No matter their structure or media (printed or digital) color guides are presented as color libraries Color guides can be either physical - printed books and catalogues or, they can be in a digital form – a development applied more intensively nowadays. The digitalization of color guides is applied with specific software, tools or plug-ins that enable the users to identify a color for a specific application. As such, they serve as reference tools for selecting and matching colors in various design and manufacturing processes.

In graphic communication and printing, color guides are printed at certain substrates. The most common substrates are those printed on coated and uncoated paper. Furthermore, according to the ink manufacturers and pantone, color guides for printing include hundreds or thousands of colors.

Color guides are created by a number of basic inks from which every color can be produced based on the percentage of the inks to be used. Guides from CMYK or ECG / EGG are created by the respective inks (four, six or seven inks) whereas color guides for spot colors are based on recipes for mixing out of a set of basic colors. This is a quite significant aspect of spot color since they indicate the number and combination / percentage of basic colors / inks to be used. The number of the basic inks is limited, so printing companies can use them for mixing in the specified proportions set by the guide to get the desired color.

An example of basic inks is illustrated in Figure 8 and described as “Pantone new basic colors”.

Figure 8: The Pantone new basic colors (no further description)
Source: https://baypressservices.com/shop/new-pantone-basic-colors/

Color guides are based on the pioneering work of great researchers or companies. Pantone and Harald Küppers are among them with their pioneering work on color guides and charts, and their invaluable contribution is briefly presented at the following paragraphs.

3.1 The Pantone color guides / charts

The Pantone guides were and still are among the most widely known and used color guides. Their introduction goes back to 1963 but it all started in 1956, when Lawrence Herbert, was hired part-time at M&J Levine Advertising and he used his chemistry skills to systemize the way the company used pigments to produce colored inks [11]. Thanks to Herbert, the printing division became the only part of the company making a profit. Herbert, bought the whole kit and caboodle for $90,000 and renamed it Pantone, being its founder. By doing so, Herbert, innovated a system for identifying, matching, and communicating color. Suddenly, printers were able to communicate the exact color code they needed with their ink supplier who could then create the right color for the client. Herbert, introduced his genius Pantone Matching System (PMS). PMS, has been used ever since worldwide, making people understand eachother, when trying to identify a color for printing. [12, 13]

According to looka.com [14], Pantone revolutionized the printing industry with the PANTONE MATCHING SYSTEM®, an innovative tool allowing for the faithful selection, articulation and reproduction of consistent, accurate color anywhere in the world. The tool organizes color standards through a proprietary numbering system and chip format, which have since become iconic to the Pantone brand. Pantone’s color language supports all color conscious industries; textiles, apparel, beauty, interiors, architectural and industrial design, encompassing over 10,000 color standards across multiple materials including printing, textiles, plastics, pigments, and coatings. [14]

In Figure 9, an abstract of the PMS is illustrated, whereas in Figure 10 the history and evolution of pantone is presented:

Figure 9: Pantone PMS
Source: http://TeesCenX10.com

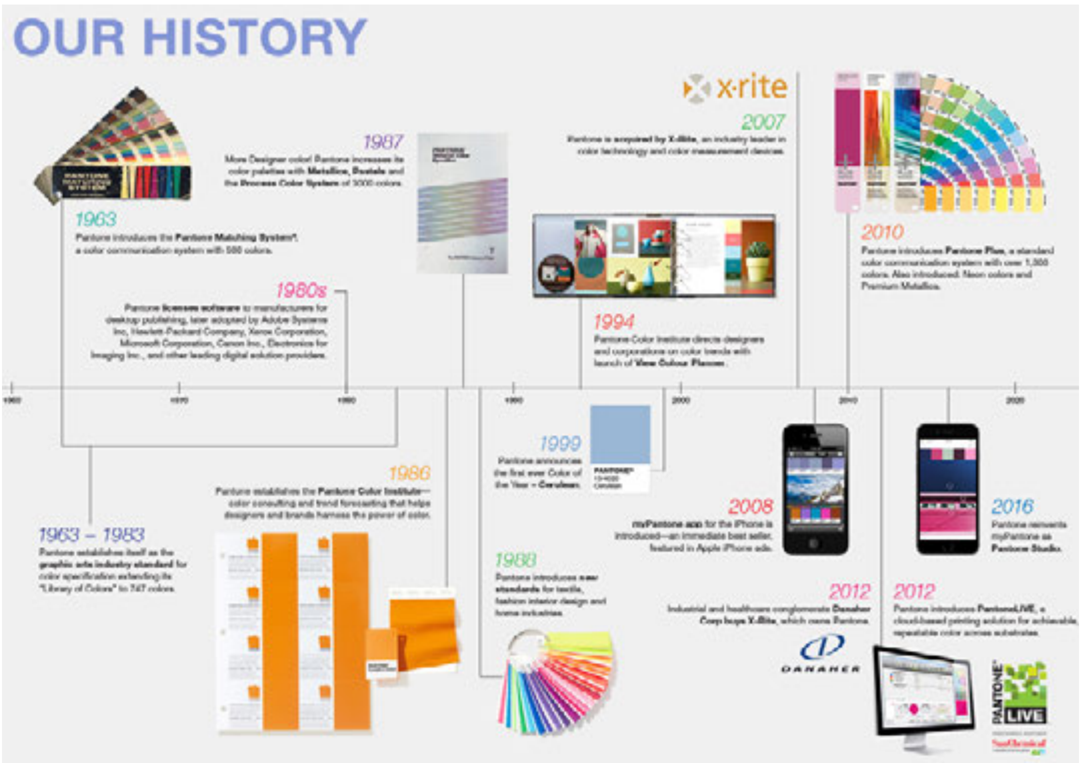


Figure 10: The history and evolution of Pantone color guides
Source: https-/www.pantone.com/about/about-pantone-history

Nowadays, Pantone guides are available both digitally and physically. The range of products include several innovative applications for matching with the today digital workflows in printing, as Pantone-LIVE and Pantone Studio, ensuring market-relevancy and color achievability as technology continues to transform the design and printing processes. In Figure 11, an example of Pantone color guides is presented: [15]

Figure 11: The Pantone Color Formula Guide 1000
Source: https://www.rushordertees.com/blog/pantone-color-system-guide/

3.2 Küppers Farbskala

Harald Küppers is one of the first to study the color separation process, introducing the following main concepts in terms of classifying colors:

- The classification of basic colors in the color separation process, with the eight basic colors. Küppers suggested that according to color theory there are eight (8) basic colors:
    the 6 chromatic colors, violet/blue (V), green (G), orange-red (O), yellow (Y), magenta-red (M) and cyan (C), and
    the 2 achromatic colors white (W) and Black (S "Schwarz" in German).
- The original work on Achromatic color processing
- The Multicolor processing withseven (rasterized) colors [16]

All concepts as invented and studied from Küppers, constitute fundamental and pioneering work. They have been applied by (almost) all prepress systems developed in the last decades such as Color management, CMYK and Multicolor separation. His pioneering research and work, led to the development of the UCR and GCR concepts, as they know them today. [16] (Küppers 1978, 1986)

Küppers developed one of the most complete color guides, which has been summarized in his Dumont's FARBEN ATLAS, in 1978. [17] In Küppers' color guide there are 5500 colors under a systematic classification. In Figures 12 and 13, the cover and one sample page of the Farben Atlas are illustrated:

Figure 12: Küppers' Dumont's FARBEN ATLAS, cover 1978

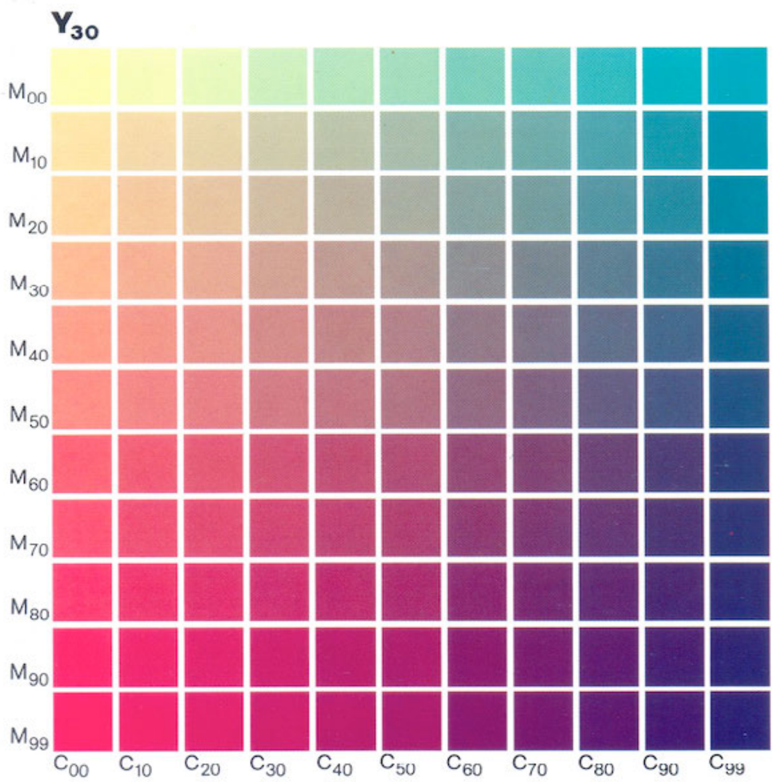


Figure 13: Küppers Dumont's FARBEN ATLAS, Page 99.
Charts of three colors with Yellow at 30% and Magenta - Cyan ranging from 0% to 99%

3.3 Euroscale – Europaskala

Euroscale is the abbreviation for the European color scale for offset printing according to DIN 16539 of 1971, which deals with quality criteria and the properties of inks and is primarily aimed at ink manufacturers and suppliers. [18] In 1954, color scales were standardized for the first time in Germany with the designations DIN 16 508 for letterpress printing and DIN 16 509 for offset printing. In order to meet the requirements for better fastness properties, such as alkali fastness and light fastness, a group of experts from CEPE (European Association of the Paint, Printing Ink and Artists' Colors Industry) recommended a new color scale in 1967. [19]

The name of this new color scale was "European Color Scale", "European Scale" or "Europaskala" (in German) for short. This color definition was laid down in the DIN 16 539 standard. In perfect accordance with the European scale, the international standard ISO 2846 was published in 1976. In the course of an international standardization of various color scales, DIN 16539 was replaced by the ISO 2846 and 2846-1 standard in 2000. Two years later, DIN 16539 was also withdrawn without replacement. In 1990, TC 130 of the International Standards Organization (ISO) decided to include the revision of ISO 2846 in its work program in order to unify the different color standards existing in the most important economic areas of Europe, the USA and Japan. For offset printing, the revision has been completed with the present ISO 2846-1. [19]

In Figure 14, the Euroscale – Europaskala CMYK colors are presented:

Figure 14: the Eurosclale – Europaskala CMYK colors - four-color printing process colors Cyan, Magenta, Yellow, Black according to DIN ISO 2846-1 standard (Lab converted to RGB)

Source: https://upload.wikimedia.org/wikipedia/commons/3/35/CMYK_DIN_ISO_2846_1_LAB_to_RGB.jpg

4. Color guides and Inks

Color guides for printing are used for providing guidance and specification for color selection, measurement, matching and consistency. This means that they are providing the basis to produce and apply inks for printing. As such they should be considered as a quite useful tools for a smooth print production.

It might be nice to see colors and color guides on a screen, but the actual application of the guides at the end of the day, is to facilitate consistent printing conditions related with the printing process, where inks have a crucial role. Therefore, no matter the degree of creation and application of digital color guides and the various systems for color management and processing, they will end up as an ink on a substrate printed by a specific printing process and machine.

The most prominent and common classification is the one between coated and uncoated paper and board, applied for offset and digital printing. Furthermore, there are color guides for other substrates such as flexible materials to be printed with flexography and gravure printing and guides for the various substrates for screen printing.

To create a color guide, it is important to take under consideration various parameters. Among these parameters the following can be mentioned:

- The specific printing process and the various substrates for which the color guide should be created
- The use for CMYK, Spot and Multicolor – EGP/ECG printing
- The selection of base colors to be applied in creating a color guide

4.1 Printing processes, inks and substrates for color guide creation

Since printing methods vary in terms of the printing process, the structure of the inks used, and the substrates. Therefore, it is natural that the guides will be different. In Figure 15, a selection of various printing guides is illustrated:

Figure 15: Various color guides

Source: Anastasios Politis personal archive

As it can be seen in Figure 15, the color guides illustrated are created by various ink manufacturers, including guides for offset and screen printing. Regarding the various substrates, it is vital for a guide to be presented on the appropriate substrate so the fidelity will be guaranteed. Substrates are principally categorized according to their nature namely paper/board, flexible materials, plastics etc.

A wide spectrum of specific guides exist for screen printing, given the various substrates applied which require specific inks (eg. textile, plastics). In offset and digital printing, the guides are mainly classified and created for coated and uncoated paper and board. In Figures 16 and 17, color guides according to the printing process and the nature of paper/board are illustrated:

Figure 16: Color guides for offset (Janecke+Schneemann, Hartmann) and screen printing (Wiederhold Sieb-Druckfarben)

Source: Anastasios Politis personal archive

Figure 17: Color guides for offset and digital printing by Pantone,
for CMYK printing process and for coated and uncoated paper/board
Source: https://www.pantone-colours.com/

4.2 The base colors/inks for the creation of color guides

All color guides are created by a set of base colors where their number and inks vary among the various manufacturers. Having said that, it is important to present the role and contribution of ink manufacturers in the creation of color guides for print. Base inks are fundamental for the creation of color guides. Base inks for CMYK printing are relatively simpler, since, the four colors are applied and used. On the contrary, in spot color, a higher number of base inks is required and applied. In Figure 8 illustrated in chapter 3, there are ten base inks applied for the creation of a color guide for a pantone spot color guide.

Furthermore, in a research project at Clemson University, Zeleznik, experimented with the properties of base inks for a multicolor / 7 color flexographic printing process. [XX]. In Figure 18, there are the initial 22 colors for experimenting and selection for the multicolor seven color printing in flexographic printing for flexible material.

Red	Red 22	C.I. 12315	Brilliant Red RN	x		x
Red	Red 48:1	C.I. 15865:1	Permanent Red 2BN	x	x	x,x
Red	Red 48.3	C.I. 15865.3	Pigment Red 2B3	x	x	
Red	Red 53:1	C.I. 15585:1	Lake Red C	x		x
Red	Red 57	C.I. 15850:1	Lithol Rubine BK	x	x,x	x,x
Red	Red 184	C.I. 12487	Pigment Rubine F6B	x	x	x
Red	Red 266	C.I. 12474	Pigment Red P-F2RK	x	x	x
Orange	Orange 5	C.I. 12075	Permanent Orange RN	x	x	x,x
Orange	Orange 13	C.I. 21110	Permanent Orange G			x,x
Orange	Orange 16	C.I. 21160	Benzidine Orange R	x		x,x
Orange	Orange 34	C.I. 21115	Permanent Orange RLO	x	x	x,x
Orange	Orange 64	C.I. 12760	Orange GP		x	
Green	Green 7	C.I. 74260	Fast Green G	x	x,x	x,x
Green	Green 36	C.I. 74265	Phthalocyanine Green G			
Blue	Blue 29	C.I. 77007	Ultramarine Blue			
Blue	Blue 61	C.I. 42765:1	Pigment Blue AR	x	x	x
Blue	Blue 62	C.I. 42595:4	Brilliant Blue CF			
Violet	Violet 1	C.I. 45170:2	Fast Rose Toner			
Violet	Violet 3	C.I. 42535:2	Fast Violet Toner	x		x,x
Violet	Violet 23	C.I. 51319	Fast Violet RL	x	x,x	x,x
Violet	Violet 27	C.I. 77510	Violet Toner 27			x
Violet	Violet 37	C.I. 51345	Dioxazine Violet			

Figure 18: Base Inks for selection, for flexographic printing for 7 color printing (Multicolor, EGP, ECG)
Source: Zeleznik, 2011, www.flexography.org

In addition, base inks for CMYK printing are determined according to the nature of the substrate / printing process and the country / continent to be applied, as they are presented in Figure 19.

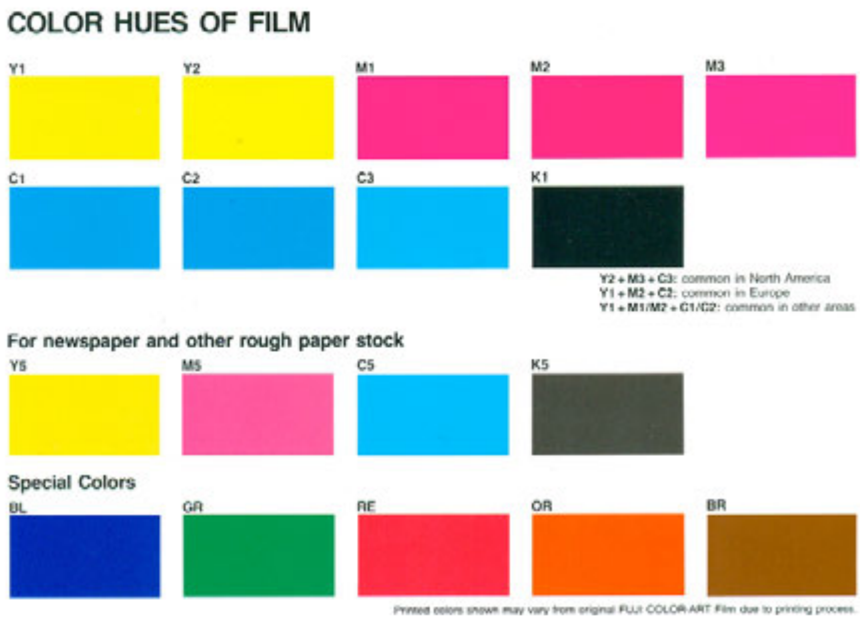


Figure 19: Inks to be used for creation of inks sets for CMYK, categorized according to the nature of substrate, printing process and country / continent used
Source: Anastasios Politis personal archive

In Pantone color guides, there are several updates of the base inks. According to proofing.de, [21], in 2010, the Pantone palette has been was extended by 224 colors, which are named from 7548 to 7771 in the Pantone classification. All these colors have been created by 14 base inks namely:

- PANTONE Yellow
- PANTONE Yellow 012
- PANTONE Orange 021
- PANTONE Warm Red
- PANTONE Red 032
- PANTONE Rubine Red
- PANTONE Rhodamine Red
- PANTONE Purple
- PANTONE Violet
- PANTONE Blue 072
- PANTONE Reflex Blue
- PANTONE Process Blue
- PANTONE Green
- PANTONE Black

In 2012, the Pantone Plus palette was expanded by additional 336 colours, which in the Pantone classification are named from 2001 to 2336. In order to achieve these colours, the previous 14 Pantone base colours were extended by 4 new colours to a total of 18 base colors. The new colours added, borrowed from the Pantone GOE palette are:

- PANTONE Bright Red
- PANTONE Pink
- PANTONE Medium Purple
- PANTONE Dark Blue

The new structure of Pantone base inks has been updated in 2023. Based on a Pantone White Paper [22], Pantone announced the expansion of the Pantone Matching System® color collection in December of 2022 with the exciting addition of 224 new colors.

For this release, Pantone also replaced the base inks used in previous editions with modern environmentally friendly alternatives that are now compatible with post-print coatings. The new Pantone Colors fill gaps in the Pantone Matching System color gamut with more dark neutrals, greens, blues, and violets based on comments and feedback from the global design community. The new base inks are to be used in the latest version of the Pantone Formula Guide and Color Bridge.

According to the paper, "The color appearance of existing Pantone Colors has not changed. Even though existing colors have been formulated with some new base inks, the resulting Pantone Color appearance is stable across viewing conditions, and consistent with the digital libraries available in most design and production software solutions, including Pantone Connect™ and PantoneLIVE™".

What is more, based on Pantone, "It is important to note that the existing Pantone digital values have not changed and the digital values for the 224 new colors have been added [22]. In addition, Pantone claims that now, all Pantone colors, are mixed from a total of only 11 base inks plus colorless extender, which can simplify ink matching and reduce inventory compared to the 18 base inks used previously.

In Figure 20, the new set of base colors/inks are classified:

Existing Base Inks	**Guide Page**	**Pigment IDs**	**Common Pigment Names**	**CI Numbers**
PANTONE Pink	1.1	PR-122	Quinacridone Magenta Y	73915
PANTONE Green	218	PG-7	Phthalo Green	74260
PANTONE Black	298	PK-7	Carbon Black	77266
PANTONE Process Blue	178	PB-15:3	Phthalo Blue	74160
PANTONE Warm Red	53	PR-48:1	Permanent Red 2B (barium)	15865:1
Note: Warm Red pigment has changed to meet new guide criteria - previously pigment was PR-53:1 Red Lake C (barium)				
PANTONE Rubine Red	73	PR-48:2	Pigment Red 2B (calcium)	15865:2
Note: Rubine Red pigment has changed to meet new guide criteria – previously pigment was PR-57:1 Lithol Rubine (calcium)				
New Base Inks				
PANTONE Orange 016	1.5	PO-16	Benzidine (Dianisidine) Orange R	21160
PANTONE Real Purple	1.5	PV-1	Rhodamine B (PTMA)	45170:2
Note: This base tends to fade and bleed so it is used only where a clean, bright purple is required				
PANTONE Violet v2	1.5	PV-23	Carbazole Violet	51319
PANTONE Yellow PY12	1.5	PY-12	Diarylide Yellow AAA	21090
PANTONE Purple v2	1.5	PR-122 PV-23	Quinacridone Magenta Y Carbazole Violet	73915 51319

Figure 20: The new set of Pantone base colors/inks to be used in the latest version of Pantone Formula Guide and Color Bridge.

Source: https://www.pejgruppen.com/wp-content/uploads/2023/02/Pantone-Introduces-New-Base-Inks-for-Formula-Guide.pdf

In Table 1, the base inks derived from an interview with the Greek Printing Inks Manufacturers Druckfarbengroup Hellas are presented:

Table 1: The "Legacy" - specific base Inks for Flexography and Gravure printing processes by Druckfarbengroup Hellas

Source: Interview with Vasileios Giannakis, 11 September 2023

Legacy Base Inks
Existing Base Inks
PANTONE Bright Red
PANTONE Dark Blue
PANTONE Yellow 012
PANTONE Orange 021
PANTONE Red 032
PANTONE Rhodamine Red
PANTONE Purple
PANTONE Violet
PANTONE Blue 072
PANTONE Yellow
PANTONE Reflex Blue

As it can be derived from these data, base colors and ink sets are fundamental for the creation of color guides. Such processes require a lot of experimental work and applied research, where, numerous parameters regarding the ink properties and characteristics should be taken under consideration.

4.3 The CMYK – Spot - Multicolor printing processes and the related color guides

Again, according to Pantone [23], "printers are called quite often to face the dilemma to choose not only the ink but also the total ink set to be applied. This procedure is rather easier, when printing a color work with images, mainly in mainstream commercial printing. Then the established CMYK ink set is applied for the job. Hence there are jobs out there which require either additional colors or a combination of CMYK plus spot colors. Therefore, in many cases it is necessary to decide the type of inks and ink sets to be used for a more demanding job, such as a packaging printing and to compare the ink produced by CMYK or spot color, displayed in a color guide. [23]

Color guides exist not only for CMYK printing but also for spot colors and nowadays for six and seven color printing – namely the Multicolor printing process, expressed with the terms EGP, ECG and FCP. [24] One example is the Pantone Color Bridge guide, which shows the equivalents between spot colors and four-color process (CMYK) inks. For each spot color, two "patches" are presented, one for the spot color and another for the equivalent in four-color process, also indicating the percentages of each CMYK color. In Figure 21, this specific color guide is presented:

Figure 21: Pantone Color Bridge color swatch book presenting the equivalents between spot colors and four-color process (CMYK) inks
Source: https://www.pantone.com/color-bridge-coated-uncoated

Multicolor printing can be defined as a process to expand the color gamut printed by traditional CMYK process colors – inks. Multicolor printing is expressed with the acronyms-terms EGP – Extended Gamut Printing, ECG - Expanded Color Gamut and FCP - Fixed Color Palette just to mention some terms on Multicolor Printing meaning the same process. [25]

In Figure 22, the EGP-ECG-FCP multicolor printing is illustrated:

Figure 22: The EGP-ECG-FCP multicolor printing with the comparison of CMYK and CMYK + three colors
Source: www.esko.com

In most cases in Multicolor printing, a standardized ink set is applied enhancing the color space to reproduce (almost) any color used. The inks added to the CMYK process are: Red or Orange, Green, and Blue or Violet. This method allows for a virtually unlimited number of colors in the design and also for nesting print jobs with different color channels, without changing the ink configuration of the printing machine. As ESKO suggests, the main objective of this process is to replace spot colors with the fixed 7 color printing inks in order to achieve the (almost) same result. [26] In Figure 23, this process is illustrated:

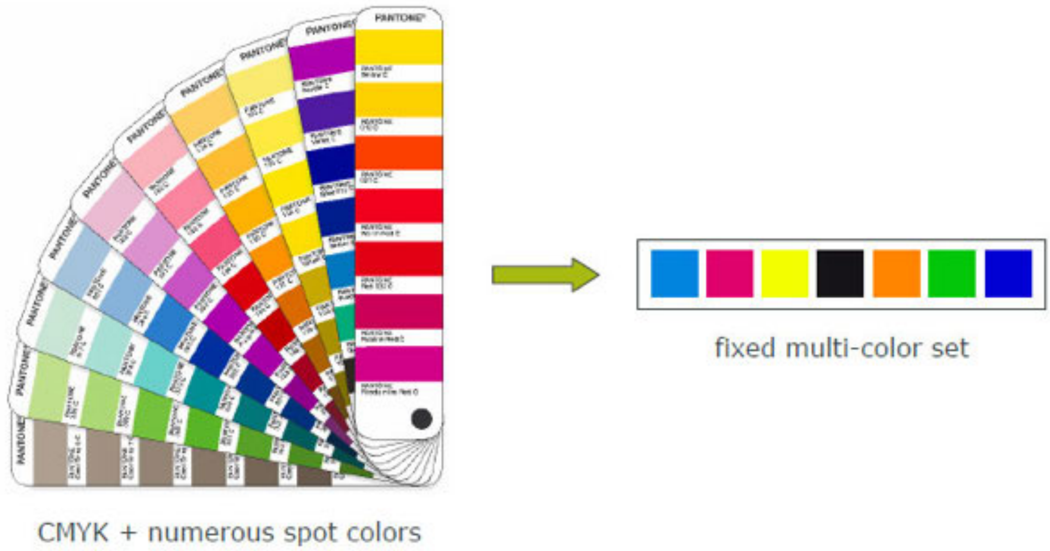


Figure 23: The ESKO / equinox proposal for Multicolor printing with a Fixed Color Palette and a multi-color set of inks
Source: ESKO, www.esko.com

In addition, BOBST uses its own extended gamut philosophy under the name "BOBST onECG" [27]. According to BOBST, Extended Color Gamut Printing – ECG, is a process to digitize color matching, thus making it stable, easy, repeatable, consistent and independent of human interpretation. ECG refers to a set of inks - 4 and beyond, but typically 7, to achieve a color gamut larger than the traditional CMYK ensuring color repeatability irrespective of operator's skill. [27]

Following the multicolor printing evolution, Pantone has published the 7 color printing color guides (under the name "EXTENDED GAMUT Coated Guide Pantone Color Guides (PMS and Process Color Series)". According to Pantone, these guides constitute "new Pantone book designed specifically for the needs of the packaging and label industry,. To achieve this, 7 inks have been used with three more colors - namely Orange, Green, and Violet (OGV) in addition to CMYK" Pantone claims that "using these 7 inks, results very similar to those of spot colors can be achieved. and it aims to address some of the limitations of the Pantone Color Bridge guide that we mentioned earlier, where the equivalence between spot ink and CMYK was rarely exact. [28]

In Figure 24, the EXTENDED GAMUT Coated Pantone Color Guide is presented:

Figure 24: The EXTENDED GAMUT Coated Pantone Color Guide

Source: https://www.pantone.com/products/graphics/solid-to-seven-set-extended-gamut

4.4 Color guides by Ink manufacturers

By nature, color guides for printing, are directly related with the inks applied for the various printing methods. Therefore, ink manufacturers play a crucial role for printing efficiency and color consistency. Although many manufacturers produce inks based on the Pantone charts, they have also created their specific color guides, that are also widely used, especially for spot colors and packaging printing. In this chapter, data for color guides produced by ink manufacturers will be presented:

4.4.1 HKS color guides

HKS is an abbreviation of three German colour manufacturers: Hostmann-Steinberg Druckfarben, Kast + Ehinger Druckfarben, and H. Schmincke & Co. The association of those three companies have defined the colours of the HKS system since 1968. [29]

In Figure 25, a traditional HKS color guide is presented:

Figure 25: HKS color system – color guides

Source: Anastasios Politis personal archive

Traditionally HKS is a colour system, based on the euroscale colourspace. And later on the guidelines of ISO 12647: and the FOGRA Standards. HKS used to be a quite important color system, including color guides for design and prepress. In Figures 26a and 26b, the HKS version of color design in the copyproof system in relation with the color guide is illustrated:

Figures 26a and 26b: The Schmincke colors in relation with HKS color system for the systematic coloring application at the Copyproof processing

Source: Anastasios Politis personal archive (1980)

Another aim of the ink system is to achieve excellent color identity even when using different substrates. For this purpose, different color scale palettes have been defined, which do justice to the color reproduction depending on the printed paper. For differentiation, these are marked with a corresponding capital letter.

Such an example is the HKS color guides where the classification of the substrates is a n important aspect. HKS color guides classify its color guides in four main categories, which are the K, N, Z and E classifications of substrates originating from the initial letters in the German language for coated, uncoated, newspaper and continuous form printing [30]. In Table 2, the classification of HKS color guides based on the type of substrate / printing process is presented:

Table 2: The classification of HKS color guides based on the type of substrate / printing process
Source: https://en.wikipedia.org/wiki/HKS_(colour_system)

HKS Color Guide	Meaning in German language	Type of Substrate / printing method in English
HKS N	Naturpapier	Uncoated
HKS K	Kunstdruckpapier	Coated
HKS Z	Zeitungspapier	Newspaper
HKS E	Endlospapier	Continuous Form Printing

In Figures 27a and 27b, two examples of application of HKS colors for a MacDonald's container for two different substrates are illustrated:

Figure 27a: HKS 4Z for newspaper (Z) and 13K for coated paper (K)
Source: Anastasios Politis personal archive

Figure 27b: HKS 4Z for printing on newspaper substrate and 13E applied for continuous form substrate (Z)
Source: Anastasios Politis personal archive

Nowadays, HKS is developing further with the The HKS color guide, containing 88 so-called basic colors and a total of 3520 spot colors for art print (coated) and uncoated papers. The advantages of these spot colors include the repeatability of the color representation and the precise reproduction of printed fonts. [31] In Figure 28, the today HKS color guides are presented:

Figure 28: The today HKS color guides of today

Source: https://www.hks-farben.de/de_de/produkte/creative-toool-hks-3000-usb-stick-019/

4.4.2 Siegwerk Printing Inks

Siegwerk is the third largest manufacturer in the international printing ink industry, after Sun Chemical and the Flint Group. The family -owned company is divided into the divisions ("Business Units") Flexible Packaging, Sheetfed & UV, Paper & Board, Tobacco, Labels, Beverage Packaging and Publication Gravure. [32] In Figure 29, the range of Siegwerk inks for various offset printing applications is presented:

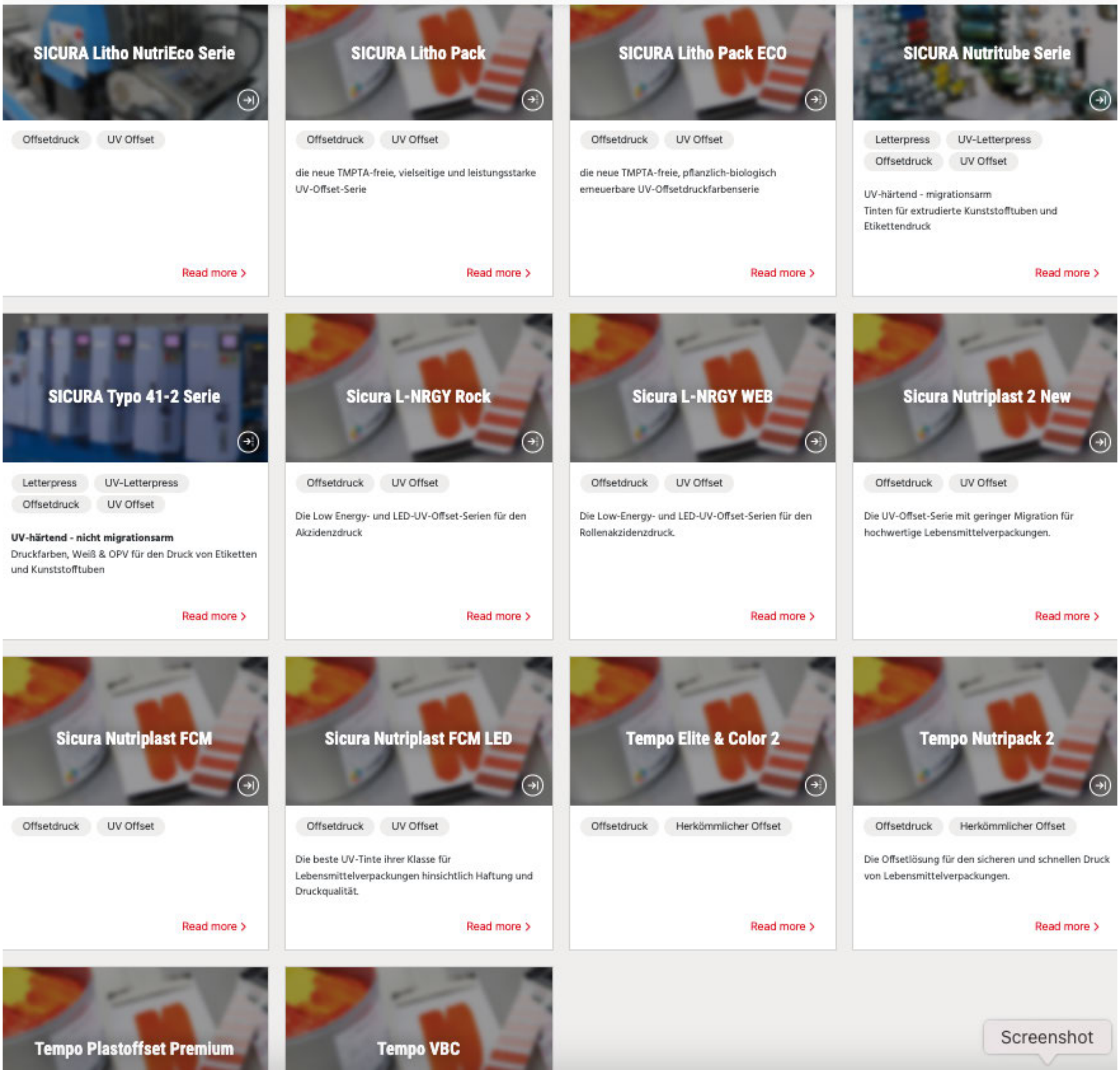


Figure 29: Siegwerk range of inks for offset printing

*Source: https://www.siegwerk.com/de/druckfarben-lacke/druckfarben.html?_gl=1*q0ovpd*_ga*MTI4NDk5NzQ2NS4xNjk0M-DAxOTEw*_up*MQ..*_ga_62C8LQRBQS*MTY5NDAwMTkwOS4xLjAuMTY5NDAwMTkwOS4wLjAuMA..*

5. Digitalization

Color guides could not be excluded from the waves of digitalization and digital transformation of systems and process in the printing industry. This appears is a necessity since all aspects of color management and processing including measurements and ink formulation, are digitized and automated. In this chapter the course of digitalization regarding color guides is investigated. In particular three areas of digitalization can be mentioned:

- The early steps (color libraries)
- Color guides for digital media
- Digitized color guides and processes for print

5.1 The early steps (color libraries in Photoshop / Illustrator) images and work

Following the digital transformation in prepress and the introduction of the prepress processing software, color guides existing only in a printed form, started to be integrated in the prepress . This early steps of digitalization which by the way exists today, has been applied in the Adobe Suite (Photoshop, Illustrator and In Design) in the form of digital color libraries. According to skillsforge.com. [33] The libraries are presenting the various color guides in digital form, as it can be seen in Figure 30:

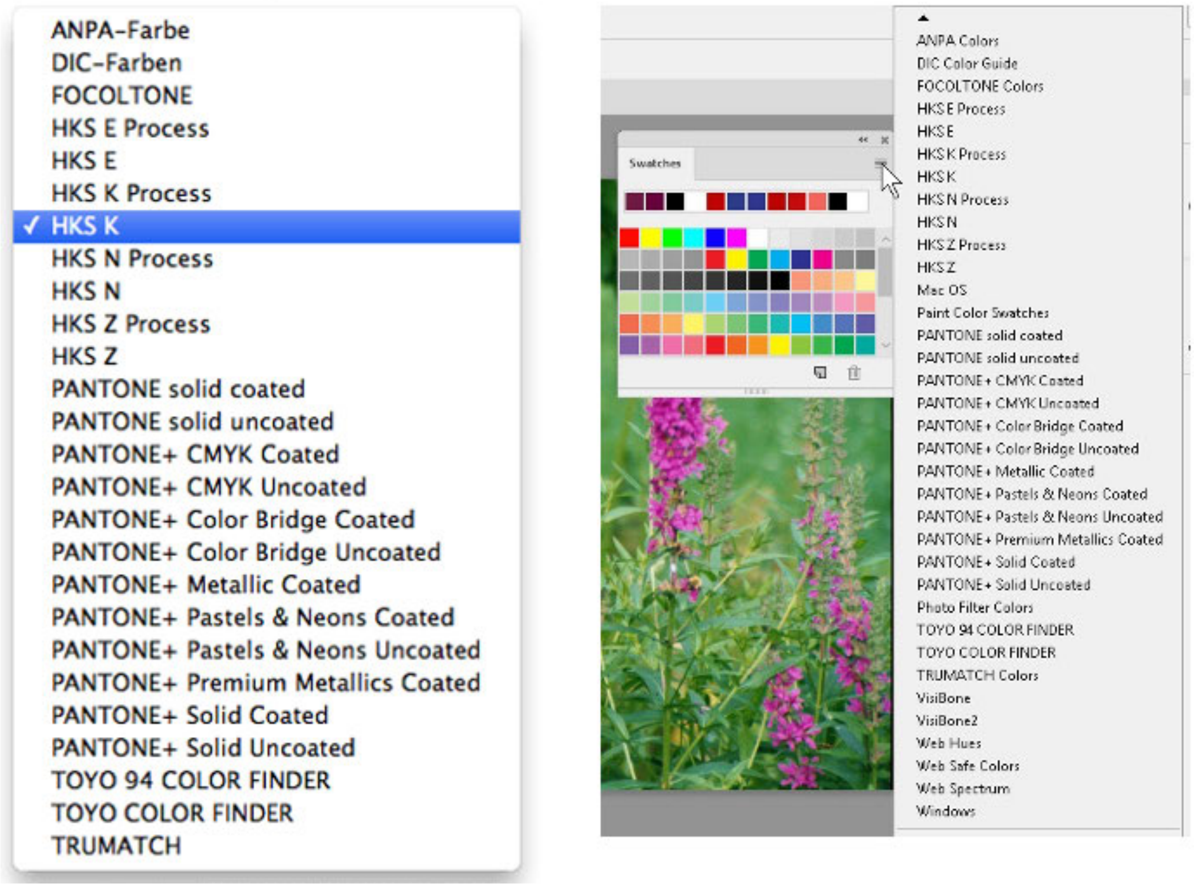


Figure 30: Digital color guides - libraries

Source: https://skillforge.com/use-color-libraries-photoshop/

5.2 Digitalization and digital color guides – the “amateurs”

Searching the web one can find numerous digital color guides and charts for every purpose, as well as software tools for generating customized color guides. This is reflecting the availability of print media procedures in digital forms and application. Color guides could not be outside this general trend. Some examples of this part of digitalization of color charts are shortly described below:

A free to download PDF CMYK Chart can be provided by printhandbook.com [34]. According to the website, each color has a value for cyan, magenta, yellow and black (CMYK). [34]

In Figure 31, there is an image of the downloaded color chart:

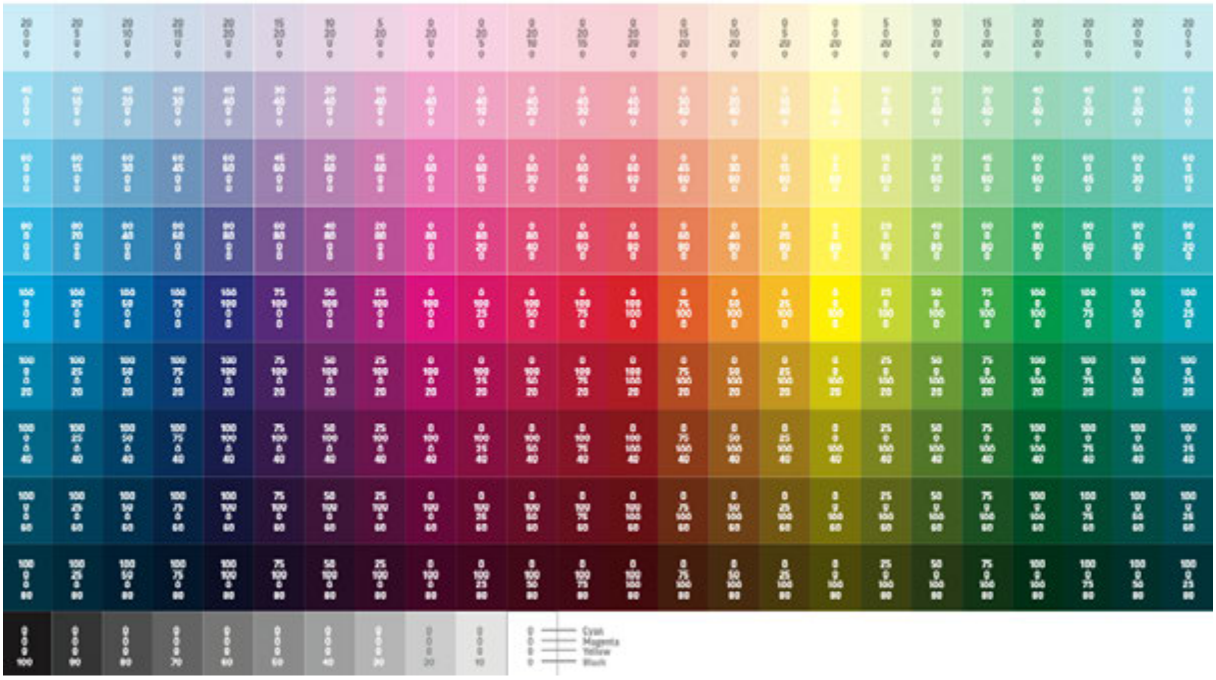


Figure 31: A digitized color chart

Source: https://resources.printhandbook.com/pages/free-cmyk-chart-printable-pdf-download.php

Following the trend, Laney presents the “Printable Palette” containing over 1000 printable color swatches with PMS, CMYK and RGB values. [35]. For just 47 Euro one can get the chart including 1,000+ digital color swatches with CMYK, PMS and RGB codes. [35]

Another art of creation of color pallets is these by the application of color generators such as UI colors [36]. UI Colors is a Tailwind CSS Color Generator that automatically generates a color palette based on any custom color as it can be seen in Figure 32. Some of the features of UI Colors include the input a hexcode or HSL color and the formation of the palette, instantly churning out a range of shades, edit and adjast edit the required hue.

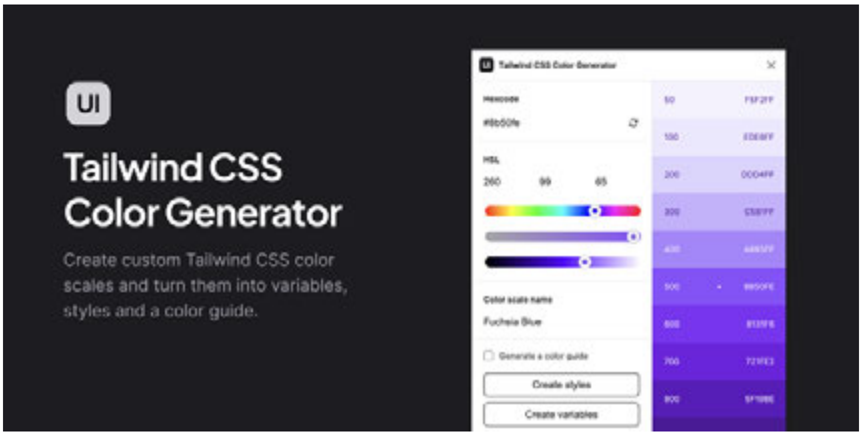


Figure 32: The UI Tailwind CSS Color Generator
Source: https://laravel-news.com/ui-colors

Another color palette generator is the Color Wheel CC, launched by Adobe, which allows the Color palette creation from an image, pre-set themes or custom. [37] (Figure 33).

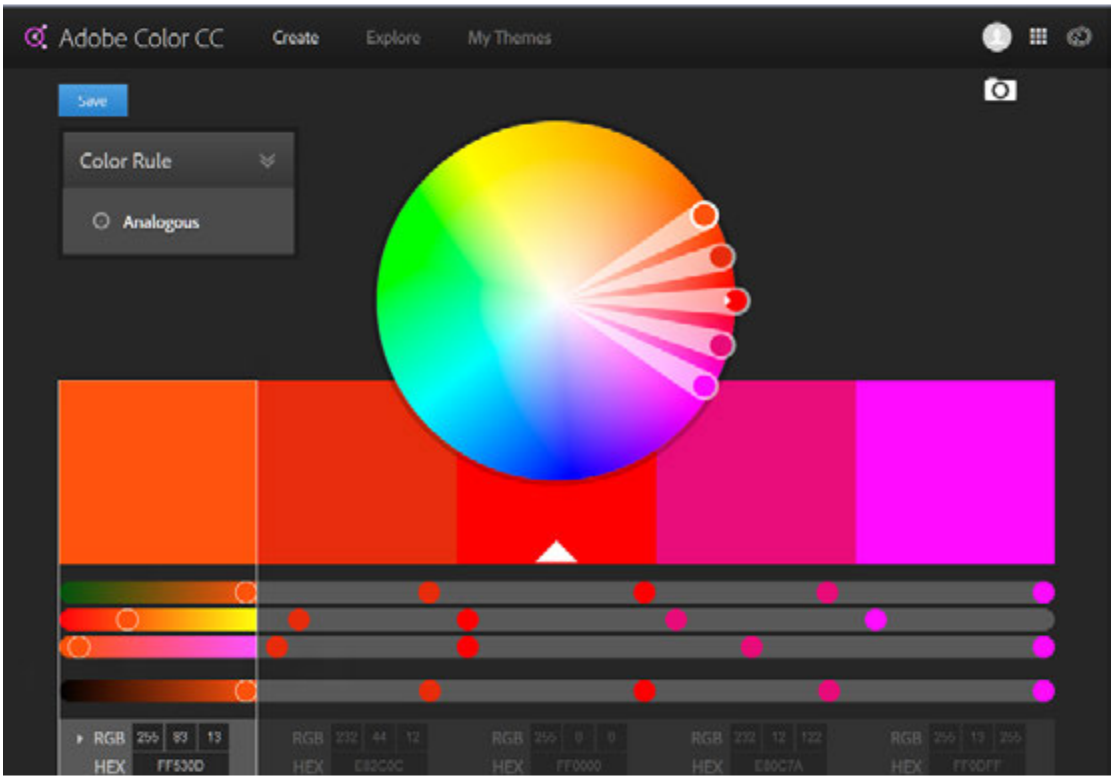


Figure 33: The Adobe Color Wheel
Source: https://color.adobe.com/create/color-wheel/

Another approach for digitized color guides is the formation of customized color libraries for a specific application. [38] An example is the Boise State University which has its own color library for its corporate identity and communication for print and the web. Blue (Pantone 286 C) and Orange (Pantone 172 C) are the official colors of Boise State University, These colors are as important as the university name or logo in identifying the university and reflect its Brand Attributes. They are illustrated in Figures 34a and 34b:

Figure 34a and 34b: Boise State color library

Source: https://www.boisestate.edu/brand/visual-identity/colors/

The customized color library has been created with the Adobe Creative Cloud Libraries application. [39] According to the guidelines, the Boise State official colors should be used on all materials produced in color and be a dominant part of any design to reinforce the Boise State brand.

5.3 Digitalization – The professionals

According to Tietz [40], the future for color reproduction consistency belongs to Digitalization Based on Matthias Haidt interview in Deutscher Drucker magazine, it is suggested that all analog color guides and charts should be digitized or used as a digital reference. Such a process should be applied with the use of a spectrophotometer and the related software. Furthermore, for retailers, this is a high priority, where all substrates used, are digitally referenced and stored in digital color libraries. In image X such a solution is presented including 42 digital color libraries from X-Rite pantone, for a variety of substrates, ranging from aluminium foils to corrugated board [40]. In Figures 35a and 35b, the professional procedure for digital color guides and libraries for print are presented:

Figure 35a: The professional procedure for the creation of digital color guides for printing applications - Color guide creation - with the use of a spectrophotometer.

Source: Tietz, A: 'Schluss mit der stillen Post", Deutscher Drucker, Nr. 6/59 Jahr, 4 May 2023, p. 34

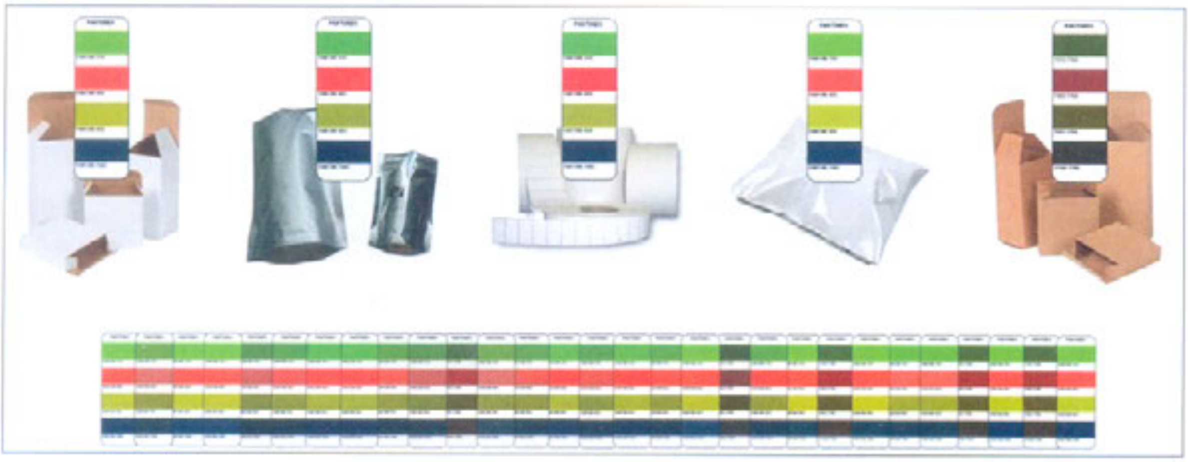


Figure 35b: The professional procedure for the creation of digital color guides for printing applications - 42 digital color libraries from X-Rite / Pantone for a variety of substrates, ranging from aluminium foils to corrugated board

Source: Tietz, A: 'Schluss mit der stillen Post", Deutscher Drucker, Nr. 6/59 Jahr, 4 May 2023, p. 34

Furthermore, as it is stated by Micheli [41], "when working with traditional – printed color guides, there is a potential error on color occurred". This is illustrated in Figure 36a, where the total color difference in a given workflow is ΔE 8.3.

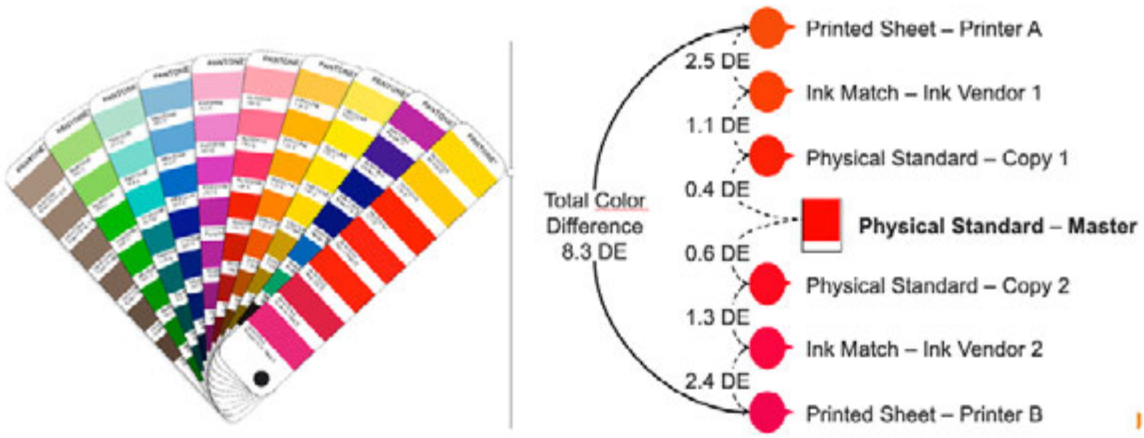


Figure 36a: A total color difference of ΔE 8.3 can be reached, when working with traditional – printed color guides

Source: Micheli Matteo, X-Rite Italy s.r.l.: "How to drive Color consistency in the Packaging process", *Presentation at the iarigai/IC international conference, September 2021, Athens, Greece*

Micheli argues further that the most appropriate procedure is to apply a digital master color from a digital color guide such as from PantoneLive, combined with the application and use of a spectrophotometer. In this way Micheli claims that, with this procedure, the total color difference can be very low, for example at ΔE 0.9, as it presented in Figure 36b:

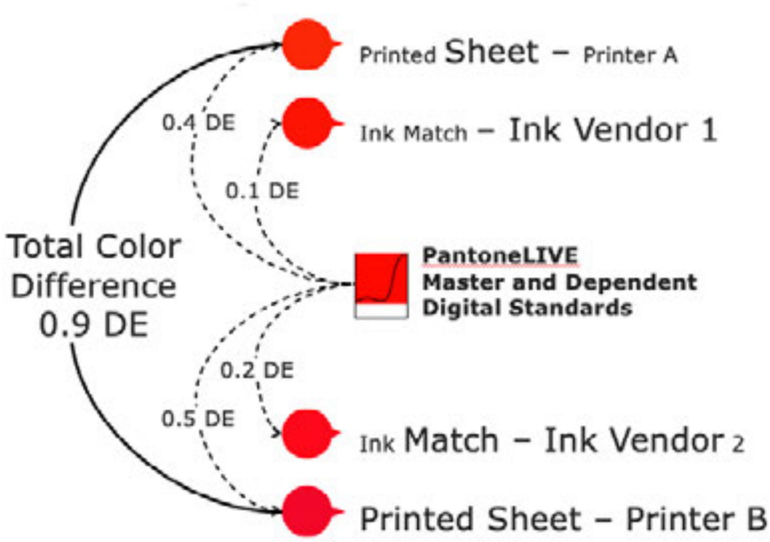
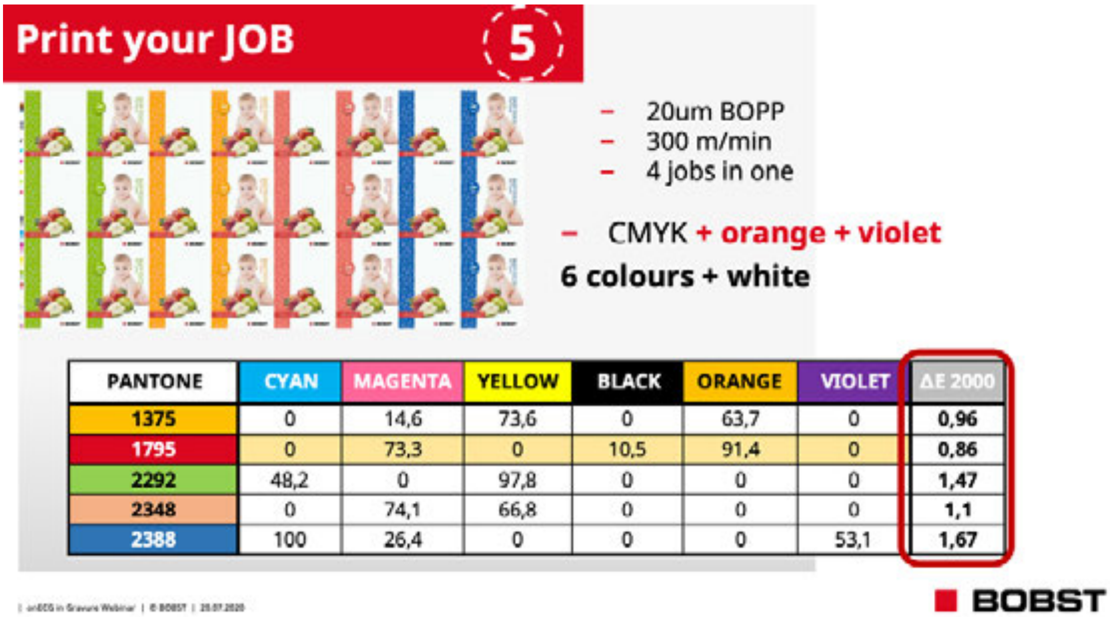


Figure 36b: A total color difference of ΔE 0.9 can be achieved, when working with digital master color from a digital color guide
Source: Micheli Matteo, X-Rite Italy s.r.l.: "How to drive Color consistency in the Packaging process", Presentation at the iarigai/IC international conference, September 2021, Athens, Greece

Alder has developed a solution for the creation of predicted color values from any print device's specific ICC profiles [42]. This can be done by the evaluation of all possible spot colors outside of a particular device's gamut and their conversion into customized gamuts. According to Alder, this leads to the creation of a custom spot color library, containing only the colors that the given device is capable of producing. [42]

What is more, Bobst adds to the discussion by providing a roadmap for the development and application of customized color guides in a digital packaging workflow. [43] As it is stated by BOBST, on the concept of onECG [43], integrated for Flexo and Gravure printing, there are five main steps for an optimized transformation of colors, namely: Optimization, Creation of fingerprint, Creation of the customized gamut, Matching of the color library applied and finally Printing of the specific job with multicolor – ECG procedure [44].

In Figure 37, the final process for printing the job, by matching the colors of the specified gamut, with 6 or 7 color printing is illustrated:



PANTONE	CYAN	MAGENTA	YELLOW	BLACK	ORANGE	VIOLET	ΔE 2000
1375	0	14,6	73,6	0	63,7	0	0,96
1795	0	73,3	0	10,5	91,4	0	0,86
2292	48,2	0	97,8	0	0	0	1,47
2348	0	74,1	66,8	0	0	0	1,1
2388	100	26,4	0	0	0	53,1	1,67

Figure 37: The Bobst onECG multicolor approach

Source: BOBST Rotogravure - ERA Annual Conference September 2021 "Combining sustainable printing and increased productivity for short and medium runs" - onECG in Gravure Webinar | © BOBST | 20.07.2020

Sun Chemical, presents a complete solution on the digital color guide debate in the form of the "SunColorBox Guide. [45] In this, Sun Chemical combines all technologies and procedures for digital color guides and libraries, stating that this comprises a "unique set of tools and services that enables consistent and accurate digital color communication throughout the entire packaging supply chain". More specifically, Sun Chemical's patented technology, enables the communication of a consistent, digital description of the desired appearance of a product. Sun Chemical has licensed the technology to X-Rite to enable PantoneLIVE, the end-to-end color communication ecosystem that bridges the gap in digital color communication between brands/designers and their print, packaging or manufacturing supply chains.

The Guide includes a menu of added-value services, and a tool to manage colors and ensure their consistency, allowing each customer to select the most suitable services based on the size of their business and the investment required. [45]

In Figure 38, the full SunColorBox concept is illustrated:

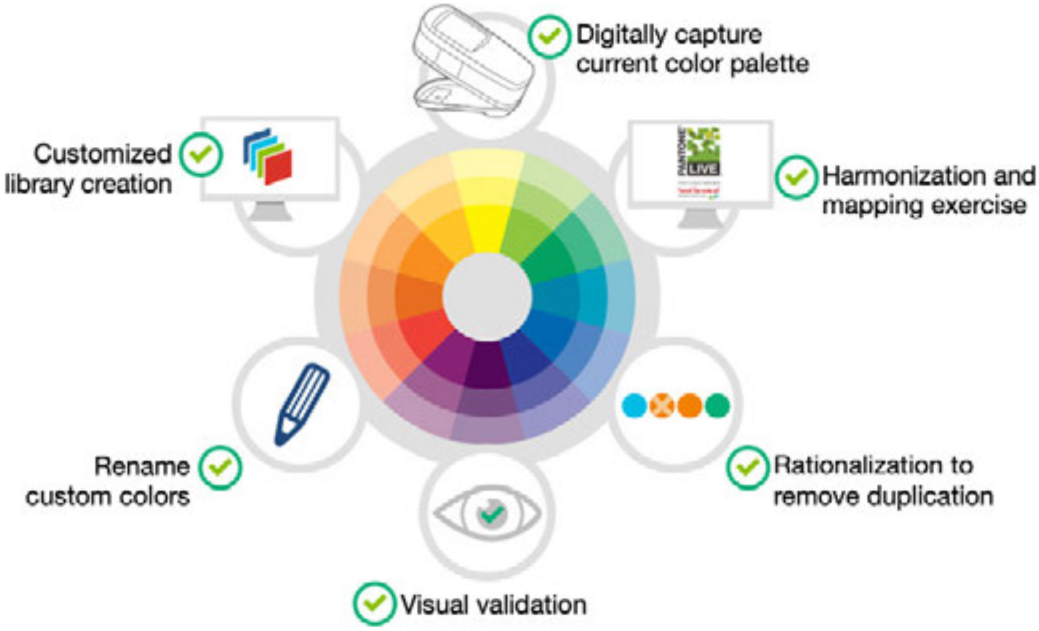


Figure 38: The SunColorBox concept

Source: Sun Chemical_Ensuring Color Consistency in Every Corner of the Globe_A4 Size.pdf

Research on digital color guides revealed that there is a number of advanced applications on customized Spot Color Libraries. Among them the Color Library by colorlibrary.ch and Gamutmap.

Color Library is a database of color profiles for artists, designers, photographers, and printers. It aims to widen the possibilities of color printing, and reflects on the contemporary perception of color as it is shaped by the recent developments in print production. The platform offers a large variety of color combinations, from basic colors to metallics, neons, and pastels.With Color Library, you can convert and print images using two, three, four, or five spot colors of your choice.

The procedure includes the purchase, download, and install the Color Library profiles, followed by selecting and opening a profile on Adobe Photoshop. The image can be opened in RGB, CMYK, Lab, or Grayscale color modes and converted it to spot colors. The profiles will automatically generate the best separation from the input image to match the gamut of the selected colors. By using complementary colors, the Color Library profiles can create gray tones in the image [46]. In Figure 39, the Color Library special color profiles, which can be used to generate the customized color separations are presented:

In Figure 39, the Color Library special color profiles are presented:

Source: Colorlibrary.ch

The freeColour Association, founded in 2016 by German and Swiss colour professionals, is a non-profit association [47]. Among other developments it has launched the "freeColour CIELAB HLC Colour Atlas". The standard version contains 2040, the new XL version even 13283 mathematically-systematically graded CIELAB color tones on 74 pages and has been published as "DIN DIN SPEC 16699:2019-04. In Figure 40, the freeColour CIELAB HLC Colour Atlas is presented:

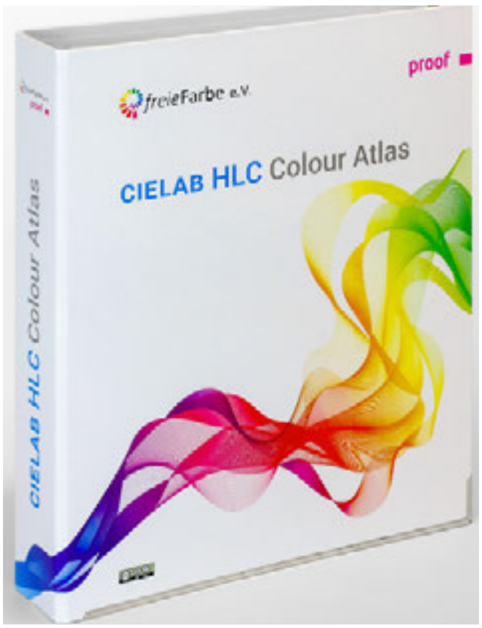


Figure 40: the freeColour CIELAB HLC Colour Atlas

Source: https://proofing.de/free-colour-cielab-hlc-colour-atlas-xl-published-and-can-be-ordered-at-proof-de/

The HLC Color Atlas, is the basis for all stages of professional color communication – from design to the finished product. The Atlas (XL) is produced by the Proof GmbH on an Epson SC-P9000V Spectro printer, with highly saturated colors, based on the use of additional colors orange, green and violet. The Atlas classifies the color according to the Hue value, as it can be seen in Figure 41.

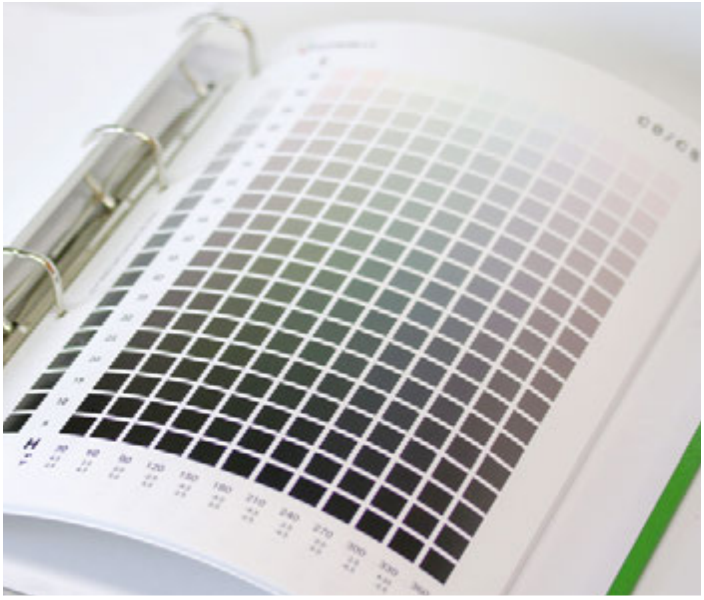


Figure 41: A page of the CIELAB HLC Colour Atlas:

Source: https://proofing.de/wp-content/uploads/2018/02/HLC-Colour-Atlas_freieFarbe_proof_de_8.jpg

6. Conclusions

Digitalization is applied everywhere and in every aspect of printing business and color guides could not be an exception. Research conducted, revealed that digitalization of color guides is taking place in the form of digital color libraries.

There are advanced applications, solutions and software, enabling the digital processing and definition of color for the printing business before printing, with the integration of color guides for color processing and color quality in the printing workflow. The most profound development is the use of digital master colors and the transformation of respective color guides in the form of digital masters, being part of the digital prepress workflow. This procedure includes among others, the generation of customized color guides, and the integration of substrates in the digital color workfow.

Hence, the use of digital color guides and their integration in the digital workflows, is not as simple as using a chip of a printing color guide as a reference for color printing. The process is far more complex, as it includes the printing process, inks and substrates, standards, color tolerances, and data within a digital workflow oriented to everyone job to be printed. This process requires far more advanced and deep knowledge at all aspects of implementing digitally defined color in prepress, printing and quality control for color printing.

Based on the resources investigated, it seems that printed color guides will be used at a certain degree in the future, at the initial steps of the printing process, as long as we will still print ink on a substrate. An example is new / advnaced printed color guides based on new research such as the freieFarbe CIELAB HLC Colour Atlas.

Finally, the trend seems to be that the printed guide will be appearing at the end of the process, in the form of customized color guides and at the end of the digital color workflow. After all, it is still necessary to see define and evaluate color as ink on the substrate.

7. Bibliography

[1] https://www.merriam-webster.com/dictionary/color%20chart, accessed 23/7/2023

[2] https://en.wikipedia.org/wiki/Color_chart

[3] Politis, A: “Introduction to color theory”, Notes, The Athens Technological Educational Institute, Department of Graphic Arts Technology, 2018

[4] Alberti’s first three-dimensional colour mixing system http://www.cg.tuwien.ac.at/courses/Farbe/Textblaetter_WS11/07%20Geschichte%20der%20Farbe.pdf

[5] Newton’s color cycle - History of Color Media, IDD - Technische Universitaet Darmstadt

[6] Goethe’s color cycle: www.anthroposophie.net

[7] Christopher Jobson: “271 Years Before Pantone, an Artist Mixed and Described Every Color Imaginable in an 800-Page Book”, http://www.thisiscolossal.com/2014/05/color-book/, accessed 14 October, 2015.

[8] Saccardo’s (1894) Chromotaxia, seu nomenclator colorum... ad usum botanicorum et zoologorum (in English, French, German, Italian, and Latin) – digital facsimile from the Linda Hall Library

[9] Tauba Auerbach’s RGB Colorspace Atlas: https://www.thisiscolossal.com/2012/09/tauba-auerbachs-rgb-colorspace-atlas-depicts-every-color-imaginable/

[10] The Encyclopedia of Color Science and Technology Renzo Shamey (ed.) Springer Berlin, Heidelberg, https://link.springer.com/referenceworkentry/10.1007/978-3-642-27851-8_232-8, https://doi.org/10.1007/978-3-642-27851-8

[11] https://kettlefirecreative.com/color-space-rgb-cmyk-pantone/

[12] https://www.cevagraf.coop/printing/pantone-colour-charts/

[13] https://www.pantone.com/about-pantone

[14] https://looka.com/blog/every-pantone-color-of-the-year/#:~:text=In%201963%2C%20Lawrence%20Herbert%2C%20founder,right%20color%20for%20the%20client

[15] https://www.pantone-colours.com/

[16] Harald Küppers: “Ich bekenne Farbe” DuMont Literatur und Kunst Verlag, Köln, 2011

[17] Harald Küppers: Dumond’s Farben Atlas, Dumond Buchverlag Köln, 1978

[18] https://www.digitaldruck.info/euroskala.html

[19] https://www.epple-druckfarben.com/de/produkte/normen/iso-2846-1/

[20] Zeleznik, Kristen, “Standardized Data Sets for Expanded Color Gamut” FLEXO Magazine, April 2011, www.flexography.org

[21] Matthias Betz: “pantone-plus-vs-pantone-colours-fans-and-problems”, https://proofing.de/pantone-plus-vs-pantone-colours-fans-and-problems/, published 8 November 2013

[22] Pantone White Paper: “New Pantone Formula Guide Base Inks”, https://www.pejgruppen.com/wp-content/uploads/2023/02/Pantone-Introduces-New-Base-Inks-for-Formula-Guide.pdf, 1 February 2023

[23] Pantone Color Bridge color swatch book, https://www.pantone.com/color-bridge-coated-uncoated

[24] Politis, A: “Multicolor Printing for Packaging” Invited keynote presentation, Offset Printing Association of India, International Conference on Smart Packaging & Printed Electronics, DCRUST, Murthal, Haryana, India 4 September 2022

[25] Anastasios E. Politis, Christos Koutrouditsos, Antonios Tsigonias, Georgios Gamprellis, Maria Gialouri: “Multicolor Printing - The Origins”. Print-Media Science and Technology in the modern era scientific event in the framework ofthe 8th International Conference on Typography and Visual Communication (ICTVC) 9 July 2022, Thessaloniki, Greece

[26] www.esko.com

[27] BOBST Rotogravure - ERA Annual Conference September 2021 “Combining sustainable printing and increased productivity for short and medium runs” - onECG in Gravure Webinar | © BOBST | 20.07.2020

[28] The EXTENDED GAMUT Coated Pantone Color Guide, https://www.pantone.com/products/graphics/solid-to-seven-set-extended-gamut

[29] https://www.hks-global.com/

[30] https://en.wikipedia.org/wiki/HKS_(colour_system)

[31] https://www.hks-farben.de/de_de/produkte/creative-toool-hks-3000-usb-stick-019/

[32] https://www.siegwerk.com/de/druckfarben-lacke/druckfarben.html?_gl=1*q0ovpd*_ga*MTI4NDk5NzQ2NS4xNjk0MDAxOTEw*_up*MQ..*_ga_62C8LQRBQS*MTY5NDAwMTkwOS4xLjAuMTY5NDAwMTkwOS4wLjAuMA

[33] https://skillforge.com/use-color-libraries-photoshop/

[34] https://resources.printhandbook.com/pages/free-cmyk-chart-printable-pdf-download.php

[35] https://designbylaney.com/color-chart-for-printing

[36] https://laravel-news.com/ui-colors

[37] https://color.adobe.com/create/color-wheel/

[38] https://www.boisestate.edu/brand/visual-identity/colors/

[39] https://creativecloud.adobe.com/

[40] Tietz, A: 'Schluss mit der stillen Post", Deutscher Drucker, Nr. 6/59 Jahr, 4 May 2023, p. 34

[41] Micheli Matteo, X-Rite Italy s.r.l.: "How to drive Color consistency in the Packaging process" Presentation at the iarigai/IC international conference, September 2021, Athens, Greece

[42] https://aldertech.com/custom-spot-color-libraries/

[43] https://www.bobst.com/joen/news/detail/article/1575365110-the-digitalization-of-color-in-packaging-a-bright-future/

[44] BOBST Rotogravure - ERA Annual Conference September 2021 "Combining sustainable printing and increased productivity for short and medium runs" - onECG in Gravure Webinar | © BOBST | 20.07.2020

[45] Sun Chemical. Ensuring Color Consistency in Every Corner of the Globe_A4 Size.pdf

[46] https://colorlibrary.ch/how-to-install/

[47] https://www.gamutmap.com/, https://proofing.de/free-colour-cielab-hlc-colour-atlas-xl-published-and-can-be-ordered-at-proof-de/

Design Thinking in the Graphic Communication Classroom

Charles T. Weiss, USA

Abstract

Graphic communication students are very familiar with the traditional design process of thumbnail, rough, and comprehensive. They are also somewhat familiar with the idea of critique, though many of them are not sure of how to properly critique other student's work. The majority of students included in this research were not at all familiar with the design thinking process and after being exposed to the process, found substantial benefits in using the process when it comes to project problem solving. The design thinking process is a solution-based process that is not traditionally used in the graphic communication classroom but is used in various industries and by companies like Google and Apple. It is a non-linear process that focuses on creating multiple versions and focusing on creating best version through feedback and understanding of the problem being solved. The five steps in the process are empathize, define, ideate, prototype and test. Each step provides the chance for feedback and reflection.
This presentation will define the design thinking process and provide real world examples of how the process is implemented in the classroom and in industry and highlight the benefits of using this process. Student reflections on the design thinking process will also be included as data has been collected from three semesters of students completing projects using the design thinking process. The data will highlight the student's familiarity of the process before starting the projects, and their reflections of the process upon completing the project. Students engaged in three different design thinking process projects. The first was a sophomore level portfolio project, the second a group project on packaging and sustainability in developing countries, and the last project a group package design project. Each project utilized the five steps of the design thinking process, and most students enjoyed using the design thinking process to formulate a better solution to the problem.

Keywords: Design Thinking, Critique, Group Projects, Individual Projects

The EKFIPLUS Project Inventory Results on Learning Material Development in The Creative and Cultural Industries

Gerasimos Vonitsanos [1,2], Evangelos Syrigos [2], Pinelopi Nikitopoulou [2], Georgios Gamprellis [2], Marios Tsigonias [1,2]

[1] Hellenic Open University, School of Applied Arts and Sustainable Design, Greece
[2] University of West Attika, Hellenic Graphic-Media Research Lab – GRAPHMEDLAB, Greece

E-mails: gvonitsanos@eap.gr; esyrigos@uniwa.gr; mtsigonias@uniwa.gr

Abstract

The EKFIPLUS project, an initiative focused on enhancing education and knowledge transfer in the The EKFIPLUS project, an initiative focused on enhancing education and knowledge transfer in the creative and cultural industries, conducted an inventory to evaluate the development of learning materials within this sector. This research paper presents the inventory results, highlighting the current state and trends in learning material development in the creative and cultural industries.

The research employed a comprehensive methodology, including literature reviews, surveys, and interviews with industry professionals and educators. The research identified key themes and challenges in learning material development, such as the need for interdisciplinary approaches, the incorporation of emerging technologies, and the promotion of cultural diversity and inclusion.

The findings indicate a diverse landscape of learning material development in the creative and cultural industries, with various formats, platforms, and delivery methods being utilized. Furthermore, the research sheds light on the growing importance of digital resources, online platforms, and the development of interactive learning experiences in this domain.

The paper also discusses the implications of the inventory results for educators, policymakers, and industry stakeholders. It highlights the potential for stakeholder collaboration to foster innovation, bridge skills gaps, and promote lifelong learning opportunities. Additionally, the research paper provides recommendations for future initiatives to enhance learning material development in the creative and cultural industries.

Overall, this research paper contributes to understanding the status and trends in learning material development within the creative and cultural industries. It underscores the importance of continuous adaptation and improvement in educational approaches to meet the evolving needs of professionals in this dynamic sector.

Keywords: EKFIPLUS project, Learning material development, Creative & Cultural industries, Inventory results

Introduction

The creative and cultural sectors are thriving centers of innovation, artistic expression, and economic vitality in a constantly changing global context. A wide range of disciplines is included in these businesses, including visual arts, music, cinema, design, literature, cultural preservation, and more. They have a crucial role in global economic growth, job possibilities, and in helping build cultural identities.

The demand for efficient education and knowledge transfer grows as these businesses keep growing and adjusting to the digital era.

As a reaction to this expanding demand for improving education and information distribution within the creative and cultural industries, the ambitious EKFIPLUS project was born. The project sets out on a complex journey to investigate, assess, and optimize the production of learning materials in those dynamic sectors. The initiative is based on the conviction that a skilled workforce is essential to the sustenance and success of these businesses. The EKFIPLUS project aims to enhance the creation of new, cutting-edge educational and training resources. The project will add capabilities to the current EKFI platform that will facilitate the creation of educational resources.

The EKFIPLUS initiative catalyzes innovation and advancement in educational practices within the creative and cultural sectors. Its goal is to close the knowledge gap between conventional educational methods and the changing needs of a sector characterized by diversity, innovation, and digital change. The EKFIPLUS initiative started a thorough inventory to assess the situation of learning material creation in the creative and cultural industries. The project's efforts have culminated in this research paper, which presents the inventory's findings, emphasizing the most recent trends, problems, and possibilities in this critical field.

The EKFIPLUS project in detail

This project aims to enhance the creation of fresh, creative learning materials for instruction and training. The project will add capabilities to the current EKFI platform that will facilitate the creation of educational resources. By using each other's skills and improving international collaboration amongst educators, innovation via collaboration may be achieved rather than growing independently and concentrating on one's own (school) scenario. It also gives the chance to engage educators throughout Europe affected by the COVID-19 epidemic and ask them to participate in this new initiative by using the EKFI platform and its outputs. This provides the chance to enhance the current platform based on more usage and, therefore, richer user experiences. Although they cannot do it alone, the EKFI project partners will invest in this effort. The outputs that will be created are, in general, targeted, helpful, and available to every school (at least within the sector). The expanded EKFI platform was created so that users with little or no resources may also utilize it. The platform is accessible to organizations with lesser levels of creativity as well, enabling them to make an innovative effort.

"Innovation through cooperation" aims to unite academics, lecturers, and scientists from diverse European nations who will collaborate to design and write educational content at a European/International level. Based on several studies, most of which came from graphic communication, print, and media education, it has been determined that various versions of the same learning materials are available in different countries and among education and training institutions at various schools within the same nation. Authors and lecturers independently create the learning materials for various disciplines. The instructors and authors will collaborate to create the learning content thanks to the expanded platform's cutting-edge technologies for fostering and facilitating collaboration (Schmidt & Tang, 2020). By structuring this development process, it is possible to create learning materials in groups, improving efficiency (saving time and money) and enhancing the quality and originality of the teaching materials by utilizing the diverse competencies of the participants (Jantjies et al., 2018). Four results are included in the work packages during the project, namely:

1. an educational model for teachers to work efficiently and with the latest didactic insights in developing learning material in an (international) team.
2. software as a new part of the EKFI platform (ICT tools) supporting search for pears and defining the request, developing learning material using the results of output 1, project management, and social interaction between the participants in the development group
3. develop new technical/digital learning material supported by outputs 1 and 2. 4. develop new entrepreneurial/management learning material with outputs 1 and 2 on Circular economy in the creative industry.
4. The development of the learning material aligns with the need of schools for these educational materials. The development process is used to test, evaluate, and improve the developed outputs before the completion of the project.

These outcomes are related to the priorities because this project enables VET and HE teachers, developers, and others to identify and include peers with the appropriate competencies in a development process to create shared learning resources that can address developments that call for innovation and the development of new or changeable competencies. This development process will be enabled and supported by (educational) development process methodologies made available through an online platform with ICT tools to assist the different project and process management components.

Importance of Learning Material Development in Creative and Cultural Industries

Learning material development in the creative and cultural industries is essential to promoting innovation, creativity, and economic progress in the modern world. The arts, design, media, and entertainment are just a few examples of the diverse activities within the creative and cultural sectors. These industries have a significant impact on society and economies all over the world. The production and distribution of top-notch learning resources are crucial for promoting sustainable growth and development in these industries. These resources provide the foundation for developing talent, improving skills, and stimulating innovation in the industry.

Effective learning material production helps preserve and advance cultural heritage and provides individuals with the necessary knowledge and skills. It allows aspiring authors, actors, designers, and artists to pick up the skills they need to succeed in their particular areas (Fleener, 2022). Additionally, it promotes the expansion of companies and organizations engaged in the creative and cultural industries. Access to well-designed learning resources may lower entrance barriers for up-and-coming talent, promoting inclusiveness and diversity within these industries (Pratt, 2004). As a result, a more inventive and dynamic workforce helps the entire ecosystem. Beyond acquiring specific skills, learning material development significantly impacts the global competitiveness and sustainability of the creative and cultural sectors.

Creating educational resources for the creative and cultural sectors is essential for preserving and promoting cultural assets. It allows traditional knowledge, abilities, and aesthetic expressions to be passed down from generation to generation, preserving cultural traditions. This is especially crucial in today's quickly evolving world when the possibility for cultural homogenization stems from the globalization of information and technology. The creative and cultural industries may significantly preserve variety and foster cultural sustainability by developing and curating educational resources that honor regional customs and distinctive cultural identities (Patton, 2015).

Additionally, creating educational resources is essential for encouraging interdisciplinarity and collaboration. Breakthroughs in the creative and cultural sectors frequently happen where many art forms and scientific disciplines converge. We can support the creation of new concepts, items, and creative expressions by offering educational resources that promote interdisciplinary research and experimentation. Creating new opportunities for generating income and engaging audiences improves the cultural environment and supports the economic health of the creative and cultural sectors (McArthur et al, 2005).

Research Methodology

A multidimensional strategy was used to comprehensively understand this subject's conditions and developments. This technique included interviews with academics and business professionals and literature assessments (Bilton, 2007).

A detailed evaluation of the body of research on creating instructional materials for the creative and cultural sectors served as the basis for this research. With its thorough awareness of the historical backdrop, theoretical frameworks, and industry best practices, this literature study was an essential first step. The critical texts on educational philosophy, curriculum design, cultural studies, and current literature on new technologies and digital learning materials were studied (Braun & Clarke, 2019).

Complementing the literature review, surveys were conducted to gather quantitative data from a diverse pool of professionals and educators within the creative and cultural industries. These surveys were designed to capture insights into the current practices, challenges, and preferences concerning learning materials. Respondents were carefully selected to ensure representation across various subsectors and roles within the industry, facilitating a well-rounded data analysis (Brown & Smith, 2019).

Additionally, key stakeholders in the creative and cultural sectors were interviewed in-depth to gather qualitative data; these interviews provided insightful perspectives on the nuanced aspects of learning material development, such as the integration of cultural diversity and the role of emerging technologies, and allowed for a deeper exploration of the challenges and opportunities faced by educators and industry professionals (Patton, 2015).

The survey and interview samples were chosen using a purposive sampling strategy to ensure respondents had the necessary knowledge and experience. Quantitative and qualitative methodologies were used in the data processing, including theme analysis of interview transcripts and statistical analysis of survey results. The conclusions were more trustworthy and valid since data from interviews, surveys, and literature were combined (Smith & Johnson, 2016; Smith & Williams, 2020).

Current State of Learning Material Development

Technology improvements, globalization, and shifting consumer preferences have all contributed to the considerable expansion and transition in the creative and cultural sectors in recent years. This vibrant industry spans various disciplines, including visual arts, music, literature, cinema, fashion, design, historical preservation, and more (Vickery, 2015). The creative and cultural industries are essential to society as a source of economic value and cultural expression (Florida, 2011).

Creating educational resources and learning materials is crucial to fostering the sector's expansion and viability in this lively environment. The basis for education, training, and knowledge transfer, learning materials give people the information and abilities they need to succeed in the creative and cultural industries (Hylén, 2006).

1. Interdisciplinary Approaches in Education

The importance of multidisciplinary education is one noticeable development. Professionals in the creative and cultural sectors frequently need a broad skill set that blends artistic inventiveness with technological know-how and financial savvy. Learning materials must incorporate many fields of knowledge and encourage interaction among designers, artists, technologists, and businesspeople to represent this interdisciplinary character (Fleener, 2022).

2. Incorporation of Emerging Technologies

The use of cutting-edge technologies is a further trend influencing educational content creation. Artificial intelligence, virtual reality, augmented reality, and digital technologies are increasingly used to improve learning experiences. These tools for learning provide dynamic and immersive learning experiences that let students interact creatively with the material.

3. Promotion of Cultural Diversity and Inclusion

The creative and cultural sectors strongly emphasize cultural diversity and inclusiveness. Learning materials have to honor various cultural expressions, customs, and viewpoints. Inclusion initiatives guarantee that people from all backgrounds can access the sector's educational opportunities and resources (Smith, 2007).

Education and training programs must change as the creative and cultural industries do to equip professionals for the needs of the industry. Interdisciplinary approaches are becoming increasingly important to address the multidimensional character of creative and cultural labor (Florida, 2011).

Individuals from various backgrounds are encouraged to collaborate and share ideas through interdisciplinary education. For instance, a computer programmer and a fashion designer may work together to develop wearable technology. These collaborations emphasize the importance of interdisciplinary knowledge and abilities.

Incorporating interdisciplinary approaches into learning materials can be achieved through the following strategies:

1. Curriculum Design:

- Develop curricula that combine artistic, technical, and business-related courses.
- Create interdisciplinary projects that require students to work collaboratively across disciplines.

2. Faculty Collaboration:

- Encourage faculty members from different departments to collaborate on course development.
- Foster a culture of interdisciplinary research and teaching within educational institutions.

3. Experiential Learning:

- Provide students with real-world projects that mirror the interdisciplinary challenges they will face in their careers.
- Offer internships and industry partnerships that expose students to cross-disciplinary work environments.

Incorporating Emerging Technologies in Learning Material Development

The ability of technology to support multidisciplinary approaches is one of the critical aspects of its function in creating educational materials. Learning materials for the creative and cultural sectors sometimes require blending several disciplines, including business, technology, history, and the arts, with the help of cutting-edge technologies like virtual reality (VR) and augmented reality (AR) (Bilton, 2007). Educators and content creators can now design immersive, multidisciplinary learning experiences. For instance, museums may employ AR applications to provide visitors with interactive exhibitions that combine historical context with rich visual experiences. This encourages a more comprehensive understanding and knowledge of the subject and increases involvement.

Artificial intelligence (AI) is a game-changer in cutting-edge technology in creating educational content. AI-enabled algorithms can use learner data analysis to tailor curriculum, modify tests, and suggest supplemental materials. This degree of customization ensures that instructional materials fit unique learning preferences and styles, enhancing the learning process. In addition, AI-driven chatbots and virtual tutors have become increasingly popular for giving students quick help and feedback, expanding accessibility, and upgrading the caliber of course materials (McArthur et al., 2005).

Additionally, cutting-edge technology like blockchain might completely transform how the creative and cultural sectors award credentials and certify individuals. With blockchain technology, tamper-proof digital credentials may be generated, giving students a safe and authentic means to demonstrate their abilities and accomplishments. It also encourages lifelong learning by making it more straightforward for professionals to upskill and look for new possibilities regularly. This improves the legitimacy of educational resources (Fleener, 2022).

The quality and accessibility of educational resources within the creative and cultural sectors are significantly impacted by these cutting-edge technologies. Improved interaction, personalization, and flexibility guarantee that instructional materials meet the specific requirements of a wide range of learners. Additionally, cutting-edge technology can eliminate cultural and geographic barriers, providing high-quality educational information worldwide. This accessibility is essential for the creative and cultural sectors because it encourages inclusion and diversity by enabling people from different backgrounds to participate in and contribute to the field (Hylén, 2006).

Challenges and Barriers

The transition to digital learning tools comes with specific difficulties. The digital gap, wherein differences in access to technology and internet connectivity might obstruct prospects for equal learning, is one fundamental cause for worry. Educators, legislators, and industry stakeholders must work cooperatively to address this issue and guarantee equitable access to digital resources for all students. Given that the internet is overloaded with information and documentation of varied veracity, another difficulty is the legitimacy and quality of digital material. Educators and institutions must filter and authenticate digital materials to preserve educational standards. Additionally, for educators to successfully incorporate digital resources into their teaching techniques, the quick growth of technology needs ongoing professional development (Jantjies et al., 2018).

These changes affect the creative and cultural industries as well. They are eagerly embracing digitization. Online platforms have developed into creative and cultural education centers, providing various programs, guides, and materials. Beyond geographical limits, these platforms allow people to discover and cultivate their artistic and cultural abilities. Learning is becoming more engaging and entertaining thanks to the prevalence of interactive learning activities like virtual museums, immersive storytelling, and gamified cultural encounters (Steiu, 2020). By highlighting and maintaining the uniqueness of diverse cultures, the creative and cultural sectors are particularly positioned to use digital resources to promote cultural diversity and inclusion (Smith, 2007).

Conclusions

In summary, the EKFIPLUS project's inventory of learning material production within the creative and cultural sectors provides insightful information about the state of education in this dynamic industry and its possibilities for the future. This research has produced several critical, vital discoveries. The complex terrain of learning material production within the creative and cultural sectors has been clarified, first and foremost. The inventory emphasizes the versatility and creativity available in this industry by showcasing the vast range of formats, platforms, and distribution techniques being used. These findings highlight how education in the creative and cultural sectors is dynamic and constantly changing to fit the needs of both learners and professionals (Brown & Davis, 2017).

The growing importance of online platforms, interactive learning possibilities, and digital resources in this subject is also highlighted in this paper. The employment of cutting-edge technology in education and a broader trend toward digitalization are the causes of this growth. As the creative and cultural industries continue to expand, it is essential to recognize the critical role that digital tools and virtual environments play in offering immersive and engaging learning experiences.

The research also stresses how vital diverse approaches are when developing educational materials (Jones & Brown, 2020). The interdisciplinary nature of the creative and cultural industries, which typically thrive on the merger of multiple disciplines, should be reflected in educational materials. By incorporating concepts from many professions, educators may better prepare students to take on the challenging issues these firms face.

Cultural diversity and inclusion issues have become essential to creating educational materials in the creative and cultural sectors. The findings of this research highlight the value of creating a global viewpoint and encouraging cross-cultural interaction through education. As a result, the learning experience is made more prosperous, and people are better equipped to function successfully in a world that is becoming more linked.

This research makes a variety of contributions to the topic of education in the creative and cultural industries. First, it offers a thorough overview of the present environment, giving educators, decision-makers, and industry stakeholders a more excellent grasp of the difficulties and potential in this field. The inventory results provide a basis for strategic planning and well-informed decision-making (Johnson et al., 2018).

This paper also emphasizes the opportunity for cooperation among industry players. It highlights the importance of collaborations among academic institutions, business leaders, and policymakers in fostering innovation and filling skills gaps. Such cooperative initiatives can open the door for creating specialized educational materials that meet industrial requirements and encourage a culture of lifelong learning.

In conclusion, this research demonstrates the dynamic character of education in the creative and cultural sectors (Smith, 2019). It demonstrates a dynamic field that values interdisciplinary thinking, digital change, diversity, and inclusion. It advocates for stakeholders to continually adapt and innovate while improving our understanding of how learning materials are developed within various sectors. In this way, we can ensure that education and training for careers in the creative and cultural sectors continue to empower both present and future workers.

Anknowledgements

This research was co-financed by the European Union and Greek national funds through the Erasmus+ Programme, under the action "KA220-VET – Cooperation partnerships in vocational education and training"; project title: "ERASMUS+ KA2_Innovation through cooperation_EKFI PLUS"; Project Number: 2022-1-NL01-KA220-VET-000085437.

References

Bilton, C. (2007). Management and creativity: From creative industries to creative management. Blackwell Publishing.

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. Qualitative Research in Sport, Exercise and Health, 11(4), 589-597.

Brown, A., & Davis, M. (2017). Qualitative research in psychology. American Psychologist, 72(9), 947-955.

Brown, S. A., & Smith, T. W. (2019). Methods in survey research. In Handbook of Research Methods in Social and Personality Psychology (2nd ed., pp. 151-172). Cambridge University Press.

Fleener, M. J. (2022). Blockchain Technologies: A Study of the Future of Education. Journal of Higher Education Theory & Practice, 22(1).

Florida, R. (2011). "The Creative Class": from The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life (2002). In: The City Reader (pp. 175-181). Routledge.

Hylén, J. (2006). Open educational resources: Opportunities and challenges. Proceedings of open education, 4963.

Jantjies, M., Moodley, T., & Maart, R. (2018, December). Experiential learning through virtual and augmented reality in higher education. In Proceedings of the 2018 international conference on education technology management (pp. 42-45).

Johnson, R. B., Smith, K. A., & Brown, S. L. (2018). Analyzing and interpreting data. In Educational Research: Quantitative, Qualitative, and Mixed Approaches (pp. 295-336). Sage Publications.

Jones, P., & Brown, M. (2020). Literature reviews in research. In The Handbook of Research Synthesis and Meta-Analysis (2nd ed., pp. 159-174). Russell Sage Foundation.

McArthur, D., Lewis, M., & Bishary, M. (2005). The roles of artificial intelligence in education: current progress and future prospects. Journal of Educational Technology, 1(4), 42-80.

Patton, M. Q. (2015). Qualitative research & evaluation methods: Integrating theory and practice. Sage Publications.

Pratt, A. C. (2004). Mapping the cultural industries: regionalization; the example of south-east England.

Schmidt, J. T., & Tang, M. (2020). Digitalization in education: challenges, trends and transformative potential. Führen und Managen in der digitalen Transformation: Trends, Best Practices und Herausforderungen, 287-312.

Smith, J. A., & Williams, R. L. (2020). Mixed methods in health research: A practical introduction. Sage Publications.

Smith, L. N. (2019). The role of literature in research. In The Handbook of Scholarly Writing and Publishing (2nd ed., pp. 37-52). Jossey-Bass.

Smith, R. C. (2007). The UNESCO Convention on the Protection and Promotion of the Diversity of Cultural Expressions: Building a new world information and communication order? International Journal of Communication, 1(1), 31.

Smith, T. W., & Johnson, R. B. (2016). Sampling. In Educational Research: Quantitative, Qualitative, and Mixed Approaches (pp. 105-142). Sage Publications.

Steiu, M. F. (2020). Blockchain in education: Opportunities, applications, and challenges. First Monday.

Vickery, J. (2015). Creative economy report 2013 special edition: widening local development pathways. Cultural Trends, 24(2), 189-193.

Analysis of the Current State of the Distance Education in Ukraine

Bohdan Durnyak [1], *Yaroslav Uhryn* [1], *Orest Khamula* [1]

[1] Ukrainian Academy of Printing, Lviv, Ukraine

E-mails: bohdandurnyak@gmail.com; uhrynyaroslav@gmail.com; khamula@gmail.com

Abstract

The paper describes historical aspects and peculiarities of introducing and implementing distance learning both in Ukraine and in the world in general. Implementation of distance education in Ukraine is admitted to have a number of difficulties and technical obstacles. Recommendations are suggested to overcome them. A number of tasks are mentioned that must be resolved in Ukraine in order to solve problems on the way to the implementation of distance education. A number of platforms used both in Ukraine and abroad were studied and analyzed. One of these platforms is WINKAMP, which is used in a partner institution in Poland. The paper also describes the obtained results of the research of the factors that influence the process of choosing a particular platform of distance learning in a particular institution of higher education. Eight key factors that directly affect the researched process were defined with the help of the respondents. For calculations, the method of hierarchies was chosen, which is good for calculating quantities that are difficult to describe in the form of mathematical quantities. A graph of connections between the influencing factors, as well as dependence and reachability matrices were built. On their basis, hierarchies were defined and a hierarchical structured model was built. From the obtained model, the conclusion is that choosing a platform for distance education, first of all, it is necessary to pay attention to its ease of use and presentation of information that must be perceived by the student. Less important factors turned out to be: communication tools, which provide technical characteristics of the platforms, as well as the content and administration itself. It should be pointed out that this result is valid for this study, in other cases and with other groups of respondents, other results may be obtained. The paper also highlights that we, at the Ukrainian Academy of Printing, use the Moodle platform, as an open-source platform and it does not require financial costs. Basic configuration of the Moodle system does not contain many important functions, but its popularity, ease of use and the availability to change and add new functionality make it current and popular.

Keywords: information technologies, distance education, factors of influence, infographics

1. Introduction

In the era of wide distribution of information technologies, global use of the Internet and efforts to make educational services cheaper, it is necessary to solve the problem of how to implement the advantages of information technologies into the educational process, which are aimed at flexibility and wide accessibility to education of various segments of the population through distance education.

Distance education in Ukraine became especially relevant during the pandemic [1] and the large-scale hybrid war between Ukraine and Russia [2]. As a result, one of the most urgent directions of modernization of the Ukrainian higher education system has become the large-scale introduction of distance education [3], which allows students to study and fulfill their main activities simultaneously, as well as to receive education for people with disabilities.

The relevance of implementing distance education in Ukraine is also confirmed by sociological studies, out of 60% of school graduates who want to get higher education, 35% prefer full-time and part-time education, and 25% - distance education.

2. Literature review

Unfortunately, theoretical, practical and social aspects of the distance education implementation are currently less developed in Ukraine compared to the countries that have extensive experience in this field.

First of all, this is due to:

- imperfection of the necessary regulatory and legal framework, which regulates the use of distance education technologies provided in various organizational forms;
- absence of state standards that correspond to the international ones and that would facilitate the development of various distance education technologies;
- lack of scientific organizations and institutions of higher education that are actively engaged in the development or use of relevant distance learning courses;
- insufficient level of informatization of Ukrainian society;
- lack of special technical equipment and insufficient financing of the material base of higher educational institutions (HEIs) necessary for the distance form functioning;
- the use of various models, technologies and forms of organization and use of educational content by higher educational institutions, which complicates the exchange of positive results and achievements, and effective exchange of information;
- the development of these systems does not always involve relevant specialists in this field;
- lack of research related to the planning and implementation of distance education;
- teachers are key figures in the educational process, and they need support to master information technologies and introduce them into the educational process [4].

In order to resolve problems on the way to the implementation of distance education in Ukraine, a number of tasks must be solved:

- improvement of the existing normative and legal framework, which regulates the implementation of distance education;
- standardization of the parameters of the distance education process that meets international standards in this field;
- development of scientific ground that would ensure innovation and consistency of distance forms and levels of education, educational programs and curricula;
- development and implementation of distance learning programs in higher education institutions based on studies of educational models, scientific-methodical and didactic developments in the field of distance education of other countries;
- scientific ground of the market of educational literature, computer and multimedia databases, exclusion of the possibility of its monopolization;
- creation of variable methods of distance learning for people with different levels of abilities, age and needs;

- ensuring the transition to interactive methods and practical direction of distance learning;
- formation of the basis of the unification of means of communication and creation of an educational space, which allows to carry out mutually beneficial exchange of advanced achievements in the field of distance education;
- creation of a support system for projects, innovations in distance education technology;
- providing students with the right to study and receive diplomas in various educational institutions in a distance form [4].

Currently, there are many software products that allow to make the entire learning process fully automated. For the system to provide the necessary level of development for the e-learning process, there must meet certain characteristics. The entire e-learning market can be divided into three segments: the education sector, corporate learning, and individual education consumers. In the field of education, active users of distance technologies are also higher educational institutions that implement electronic education systems (LMS) for training specialists in various areas of engineering and economic education. Figure 1 represents the distribution of software products preferred by HEIs [5].

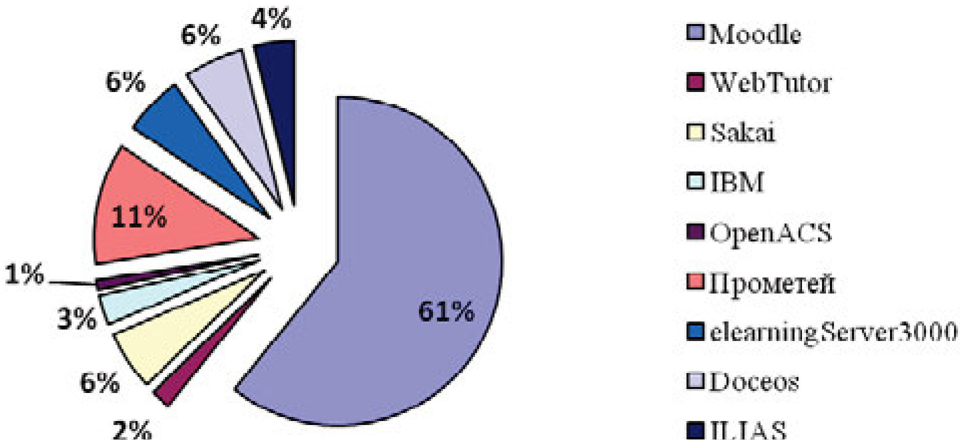


Figure 1. Distribution of software products to provide distance learning in Ukraine

Analysis of information resources on the Internet and feedback on forums about the problems of the distance learning system prove that users of open systems are interested in Moodle. The peculiarity of the project is that the most active international network of developers and users has formed around it, who share their work experience on forums, discuss emerging problems, and exchange plans and results regarding the further development of the platform. The basic configuration of the Moodle system does not contain many important functions, but its popularity, ease of use and the availability to change and add new functionality make it current and popular.

During the research [6], it was possible to get acquainted with the organization of distance education at the Polytechnic University of Lodz (Poland), which uses the WIKAMP platform (Fig. 2):

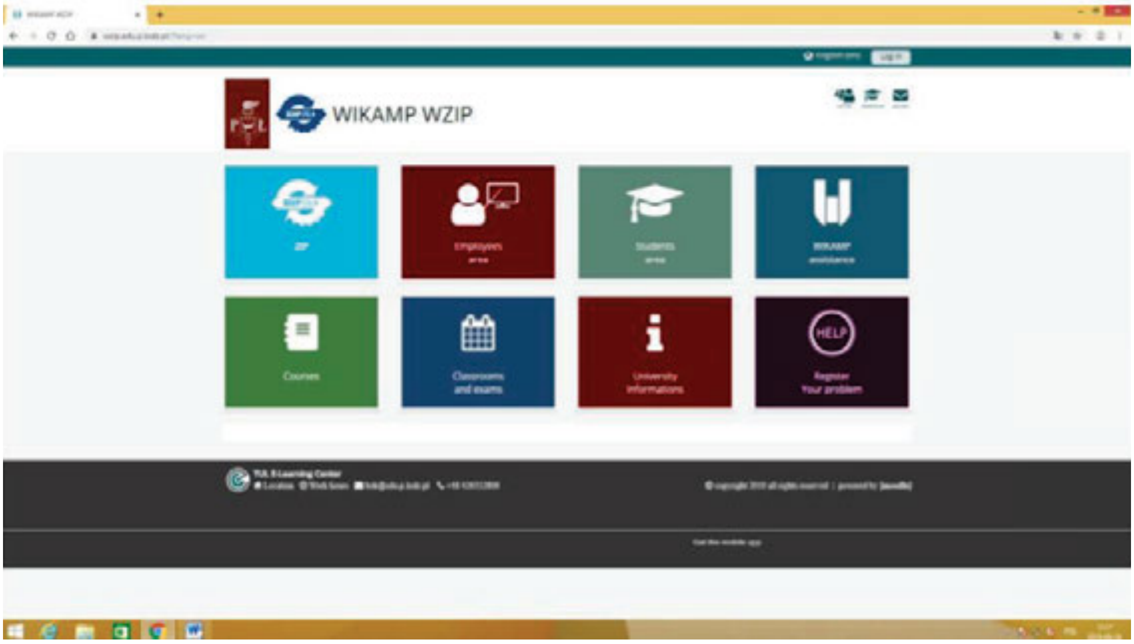


Figure 2. Homepage of WIKAMP

From the conducted analysis of the work description and setting of the WIKAMP LMS, we can say that this system is quite similar in its capabilities to Moodle. It provides an opportunity for comfortable and quick communication between teachers and students on forums. The WIKAMP distance education platform is very safe and reliable for storing the information of the courses and subjects of the educational institution, since the teachers can give access only to the students of their course. One of its advantages is the creation and use of various types of interactive materials for the education process.

3. Results

In the process of researching the issue of comparison of existing platforms and the implementation of distance learning, we conducted a survey of participants of the educational process. The main tasks of this survey were to find out what, in their opinion, factors influence the choice of a platform and implementation of distance education itself. Processing the results of the survey, the following eight factors were mentioned:

1. Communication tools (CT) including: forums, chats, internal mail, messages, notifications, announcements, conferences, collaboration, synchronous and asynchronous tools.
2. Educational objects (EO) including: tests, educational materials, exercises, other created educational products.
3. User data management (UDM) is a set of tracking, statistics, identification of users, their personal profiles.
4. Usability (U): user friendliness, support, documentation and help
5. Adaptation (A) – that is personalization, extensibility, adaptability.
6. Technical aspects (TA) include: standards, system requirements, security system, scaling.
7. Administration (ADM): (user management, authorization management, platform installation).
8. Course management (CM) – creation of courses, assessment of tests, organization of course objects.

To determine the priority of the importance of these factors, we used the method of analysis of hierarchies, which is good for study of processes that cannot be described in the form of mathematical units. This method involves the construction of a directed graph of connections between factors as well as dependence and reachability matrices.

The graph of connections between factors is built according to the graph theory, its values are designated factors (Fig. 3).

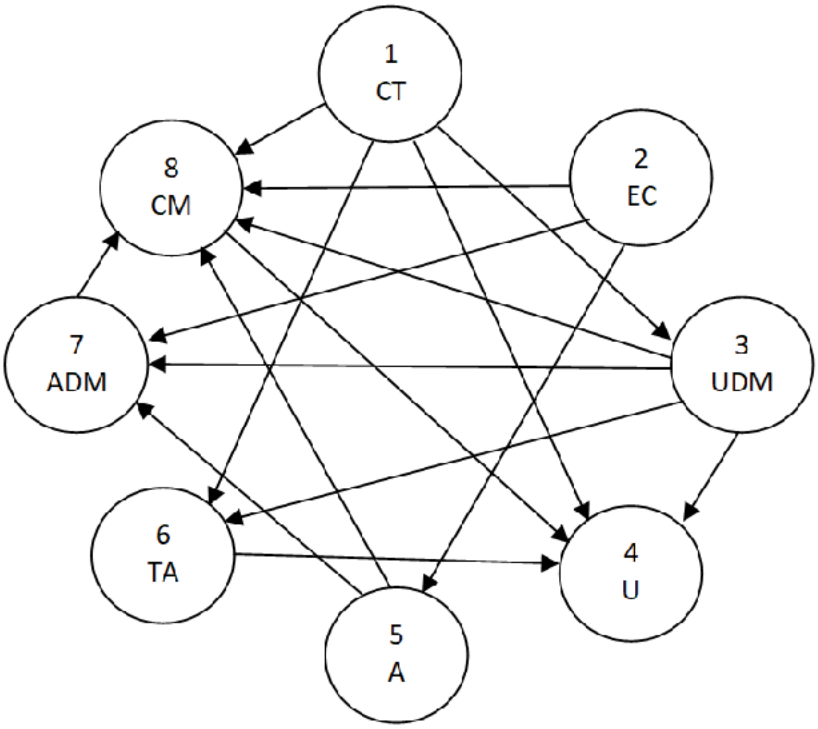


Figure 3. Graph of connections between the factors of a comparative study of distance learning implementation platforms

On the basis of the constructed directed graph and using the hierarchy method, we build a binary dependence matrix (Table 1):

Table 1. Dependence matrix

		1	2	3	4	5	6	7	8
		CT	**EO**	**UDM**	**U**	**A**	**TA**	**ADM**	**CM**
1	**CT**	0	0	1	1	0	1	0	1
2	**EO**	0	0	0	0	1	0	1	1
3	**UDM**	0	0	0	0	0	1	1	1
4	**U**	0	0	0	0	0	0	0	0
5	**A**	0	0	0	0	0	0	1	1
6	**TA**	0	0	0	1	0	0	0	0
7	**ADM**	0	0	0	0	0	0	0	1
8	**CM**	0	0	0	1	0	0	0	0

Using this method and the corresponding logical rule for constructing the reachability matrix, we obtain the following matrix (Table 2):

Table 2. Reachability matrix

		1	2	3	4	5	6	7	8
		CT	**EO**	**UDM**	**U**	**A**	**TA**	**ADM**	**CM**
1	**CT**	1	0	1	1	0	1	1	1
2	**EO**	0	1	0	1	1	0	1	1
3	**UDM**	0	0	1	0	0	1	1	1
4	**U**	0	0	0	1	0	0	0	0
5	**A**	0	0	0	1	1	0	1	1
6	**TA**	0	0	0	1	0	1	0	0
7	**ADM**	0	0	0	1	0	0	1	1
8	**CM**	0	0	0	1	0	0	0	1

Using the obtained matrices and methodology of calculations of the method of hierarchies, we obtain levels of factors hierarchy. The last factor (factors), obtained according to the calculations, are considered the most essential.

So, as a result of performing calculations on the elements of the initial graph (Fig. 3), we get a hierarchically structured model (Fig. 4), which simulates the priority of influence of the selected factors for choice of distance learning platforms for a certain educational institution.

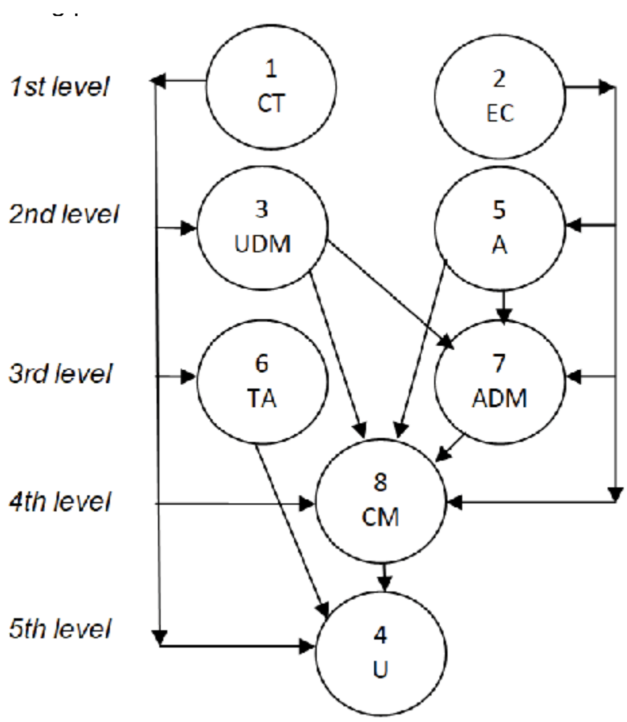


Figure 4. A structured model of influencing factors on the choice of platforms for the implementation of distance learning

4. Conclusions

The structured hierarchical model proved that communication tools and educational objects are less important factors during the implementation of distance education. After them, adaptation and user data management factors are on the second level. Further, there are factors that are part of the technical process, such as technical aspects, administration and course management. From the obtained model, we can state that the factor of ease of use is more important for the choice of distance learning than other factors. That is, when designing distance learning process in a higher education institution, first of all, it is necessary to pay attention to the platform for the implementation of distance education, which will provide the user with convenience and understandability of use. In our case, the system Moodle is such a system for organizing distance education, primarily because it provides the opportunity to use Ukrainian-language content and cover additional necessary modules.

Thus, nowadays, distance education in Ukraine can fully develop only in the availability of its main components: regulatory and legal framework; educational institutions (centers, departments, faculties, institutes or universities of distance learning); a pool of students; qualified teachers; educational curricula and courses; sufficient material and technical base (hardware and software, high-speed communication lines); financial support; development of quality criteria, etc.

Successful solution of the complex issue of implementation of distance education in Ukraine will contribute to the improvement of the quality and level of accessibility of higher education, integration of the national educational system into the scientific, industrial, social, cultural and informational infrastructure of the world community.

References

[1] Chernysh N., Prykhodko T., "What do Students Think about Ukrainian Higher Education in the Conditions of the COVID-19 Pandemic", Visnyk of V. N. Karazin Kharkiv National University, Volume, No 45, pp. 77-85, (2020).

[2] Maksymenko O., "Education as a social institution: History, sociological studies and wartime challenges", Ukrainian society in wartime. 2022: Collective monograph, Kyiv: Institute of Sociology of the National Academy of Sciences of Ukraine, pp. 131-140, (2022).

[3] Tkachenko L., Khmelnytska O., "Peculiarities of implementing distance learning in the educational process of a higher education institution", Pedagogy of personal creativity formation in higher and secondary schools, Volume, No75, pp. 91-96, (2021).

[4] Levchenko S. The current state of development of distance education in Ukraine. URL:https://vseosvita.ua/library/sucasnij-stan-rozvitku-distancijnogo-navcanna-v-ukraini-229977.html

[5] Vidkryta osvita: novitni tekhnolohiyi u navchalnomu protsesi ta osvitnʹomu menedzhmenti yak zasib intensyfikatsiyi rozvytku osvitnʹo-naukovoyi systemy Ukrayiny. Analitychna zapyska Natsionalʹnyy instytut stratehichnykh doslidzhenʹ: Humanitarnyy rozvytok, 2012. URL: http://www.niss.gov.ua/articles/721/.

[6] Khamula O., Konyukhov A. Osoblyvosti vykorystannya platformy dlya dystantsiynoyi osvity WIKAMP. naukovi zapysky UAP, Lviv, Volume, No1 (60), pp. 43-52, (2020).

[7] Tymchenko O., Khamula O., Vasiuta S., Drimaylo M., Dorosh S., Sosnovska O. Determining the Priority of Factors Influencing the Selection of Information Technology for Distance Education. Proceedings of the IEEE 17th International Conference on Computer Science and Information Technologies (CSIT) CSIT 2022. 10-12 November, 2022 in Lviv, Ukraine. pp. 279-283.

Interaction Design for Print Media – Teaching print media workflows by emphasizing the great diversity of print media products

Heiko Angermann [1]

[1] Hochschule Darmstadt – University of Applied Sciences, Faculty of Design, Germany

Abstract

Workflows are a central element in the printing industry for managing and mapping print jobs. Those are used, for example, to define which work steps are necessary to create a certain print media product, which materials are used and, in particular, a sensible sequence of processes is determined by the workflow. To define a workflow, various aspects have to be taken into account. In short, all facets of possible products have to be known. That's why the workflow concept is also an elementary part of graphic education. It helps students to take a holistic perspective of the print media products, but the workflow still allows to focus on certain topics (e.g. processes, sequence). The same applies to the knowledge transfer of related learning contents. However, teaching print media production workflows can be challenging because every product requires a specific workflow. In addition, when it comes to a well-suited teaching methodology, the focus is not on the mere presentation of learning content but rather on supporting active learning by the audience, i.e. the students with heterogeneous interests. Rather, the encouragement to awaken and promote own creativity should be in the foreground. To present a teaching methodology focusing on the promotion of students own creativity for teaching technical competencies is the aim of this paper. The main novelty of the teaching methodology is divided into two aspects. This is a workflow-driven breakdown of the learning content in an industrial context, and a novel type of project area: "Interaction Design for Print Media". This means that on the basis of accompanying projects, print media products have to be created that evoke an interaction between a viewer and the print media product to be produced. The interaction can be achieved by using and combining graphical, digital, and electronic potentials. In the paper at hand, the five main elements of the teaching methodology are presented. This includes the workflow-driven content breakdown by the help of a taxonomy, a summary of interaction capabilities based on the before mentioned three different potentials, and further elements including the encouragement of creativity, the practical application possibility in the laboratory, and promoting interdisciplinary skills. The proposed teaching methodology has been used on a trial basis since this semester as main methodology in the course "Prepress Workflows" for teaching communication design students. A case-study that is based on that trial but real-world usage in the classroom and laboratory, demonstrates the usage of the teaching methodology.

Keywords: Graphic Communication & Media Education, The future of Print Education, Graphic Design, Print Media Production Workflows, UX-UI-Interaction Design

Introduction

In the printing industry, the term workflow denotes the sequence of processes necessary for creating a particular print media product [1]. Logically, the processes to be part of the workflow differ strongly according to the required print job, including the choice of available materials, appropriate techniques, required work steps, cost factors, sustainability factors, and recent applications [2,3]. For example, a packaging product can consist of different partial products (e.g. sleeve, folding box, inlet). The example partial products use different substrates (e.g. transparent foil, a thin cardboard, thick paper). Depending on the substrates, different printing techniques will be used (e.g. inkjet, offset, electrophotography printing). All mentioned techniques differ according to the provided image setting (conventional, non-impact digital), and thus according to required work steps. The materials to be used, and the work steps to be performed affect costs and sustainability accordingly. Regardless of the printing techniques to be used, the print media production workflows for the three different partial products can be automated using recent applications like the eXtensible Job Definition Format (XJDF), or other workflow automation and intelligence-driven standards may be used in addition or instead, etc. [4,5].

The resulting heterogeneity of workflows underlines the complexity of print media production, but also the great diversity offered by print media products. The production of a print media product is therefore always associated with creativity, which can be emphasized, where individualism is desired. Based on the before-mentioned product example above, the conventional technique used for printing on the cardboard would allow additional inline coating, for example. Or, the non-impact digital techniques used for the other substrates would allow to personalize content without additional costs. Of course, these are just a few examples for the particular product in the given product example. In addition, the current consideration only refers to graphic printing. Synergies with new technologies arise further diversity for (graphic) print media products. E.g., by personalizing content based on cross-channel analysis (e.g. shopping behaviour), or by interacting with mobile devices (e.g. smartphone, virtual and mixed reality), or by combining graphical printed media with additive manufacturing (3D printing) [6,7,8].

From an educational perspective, workflows are well suited for introducing students to graphic printing [9]. This is, as workflows enable print media products to be viewed holistically, and at the same time to focus on specific processes. However, a major challenge remains. Teaching in general is not just about dividing content logically and presenting topics. Rather, good teaching is about constantly promoting students' willingness to learn and encouraging to develop own skills in different perspectives. For that reason, the practical application of the learning content in the laboratories is often used in graphic education to activate learning. However, the maximum willingness can only be achieved if the students want to engage intrinsic. This is achieved within the framework of own projects, which require the taught competencies, but still promote the students' individual creativity. Consequently, the teaching person has to provide a project area, in which the learning content must actually be applied, but the individuality of the students is not limited by this. To propose such a possible project area is the aim of this paper. This is the project area of: "Interaction Design for Print Media". It comprises the design and production of print media products that evoke a potential interaction between viewer and media by using graphical, electronic, or physical potentials. The derived teaching methodology consists of five elements, taking into account a workflow-driven breakdown of the learning content by the help of a taxonomy, the project area itself, the encouragement of creativity, practical application of the learning content based on the project area in the laboratories, as well as the included method for promoting interdisciplinary skills.

The remainder of the paper is organized as follows. Section 2 describes the motivation to develop this teaching methodology, which is presented in Section 3. In Section 4, the application of the methodology is demonstrated using one recently taught course, before the work finally concludes in Section 5.

Background

This section describes the motivation that led to the development of this teaching methodology. Two aspects are necessary to be explained. This is the underlying study degree program, including its organization within the faculty and university. Based on that, the technical competencies required to be taught to the students of this program in terms of print media production workflows are explained.

Study Program Communication Design

The Faculty of Design[1] is one of a total of 12 faculties of the Hochschule Darmstadt University of Applied Sciences. Around 500 students are enrolled at the faculty to ensure individual support at all times. The main decision criterion for admission to the faculty is the determination of artistic ability. Two degree programs are offered at the faculty, which lead to the academic degree of Diploma Designer: Industrial Design, and Communication Design. Both have a standard period of study of ten semesters (300 ECTS), analogous to a master's with a previous bachelor's degree. And, both study programs are characterized by a breadth of specialization possibilities, and excellently equipped laboratories. This is, as the aim of the programs is in supporting finding the own area of artistic specialization (see Figure 1).

In the Department of Communication Design (and the accompanying study degree program), the focus regarding artistic specialization is on developing independent design thinking skills, especially in terms of sub disciplines like corporate design, experience design, information design, conceptual design, and speculative design. The laboratories of the department demand and promote developing individual competencies in this areas. This are a computer laboratory offering computer aided design (CAD) and publishing software, a screen printing workshop offering analogue and computer-to-screen printing, two photography studios, a laboratory for photography postproduction offering digital and analogue photo development, a printing workshop for analogue printing, and a laboratory for commercial printing.

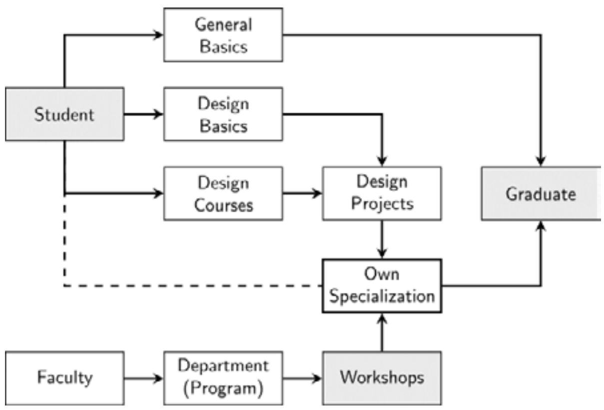


Figure 1. Own creative specialization as part of the study program.

Required Print Media Competencies

In a large number of projects, an analogue output is encouraged by the underlying design projects (see Figure 1). That is, why different printing facilities are provided in the laboratories across the faculty to support artistic printing, commercial printing, but also fine art printing. Thermal printing, and additive manufacturing (3D printing) have additionally been added recently (in 2023) (see Table 1).

1 design.h-da.de

Table 1. Printing techniques in the Department of Communication Design.

Technique(s)	Teaching Focus	Main Subject
Linocut, Etching	Artistic Printing	Illustration
Letterset	Artistic Printing	Typography
Screen	Artistic Printing	Illustration
Offset, Risography	Commercial Printing	Technical
Electrophotography	Commercial Printing	Publishing
Inkjet	Fine Art Printing	Photography
Thermal, 3D Printing	Experimental	Experimental

Most projects are artistically experimental, meaning the design experience is the desired result, rather than achieving a predefined goal. However, besides design-specific competencies, the graduates require further social competencies, e.g., working in cross-functional teams. And, in terms of print media production, technical competencies have to be taught, as many graduates are working at graphic design agencies. Such students have to understand for example, how a graphic design can convince a viewer, but also color management, etc. In more detail, the students require a cross product introduction in an industrial print job context, including the choice of available materials, appropriate techniques, resulting required work steps, cost factors, sustainability factors, and recent applications (see Figure 2) [2,3]. For example, which printing technique is aimed to print on a cardboard, and why. Some for required soft- and hardware apart from the press. This in turn additionally allows, to better understand design-specific potentials of printing techniques, and of soft- and hardware. For example, the advantages of using inkjet printing. Or, the requirements of using data-driven instead of desktop publishing for page layout setting.

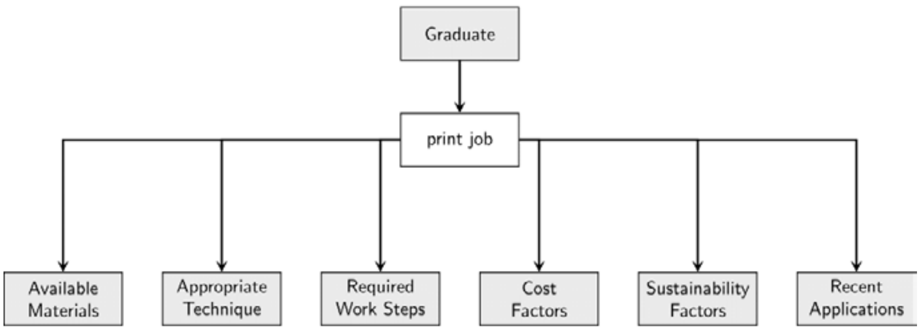


Figure 2. Required competencies in terms of print media production workflows.

Methodology

In this section, the proposed methodology for the module "Print Media Production Workflows" as part of the study degree program Communication Design is explained. It starts by explaining a workflow-driven breakdown of the learning content. Afterwards the novel project area "Interaction Design for Print Media" is discussed. Hereby, the three further elements including the encouragement of creativity, the practical application possibility in the laboratory, and promoting interdisciplinary skills is discussed.

Workflow-Driven Content Breakdown

The module "Print Media Production Workflows" aims in teaching graphic print media production from an introductory level. This means that students from different scientific background, with different existing expertise and affinity should understand the different aspects in a top-level perspective. To cover all aspects of a possible print job, the standard workflow serves as main element for breaking down the learning content of the entire module. This enables print products to be viewed holistically and at the same time to still focus on specific subjects. The resulting taxonomy is as follows (see Figure 3):

- The entire module is divided into the four process groups that are always necessary to produce a print media product. This allows a meaningful and yet standard division into four resulting individual corresponding courses. Consequently, the module provides one course on Premedia, another course on Prepress, another course on Press, and finally, another course on PostPress.
- The individual processes contained in one process group, depict the main learning contents for one course. For example, for the premedia course, the processes of content management, layout setting, color management, and file export, are the four included learning contents.
- The topics relevant for one particular process depict the single competencies, which should be conveyed. Consequently, a collection of relevant competencies results in understanding one particular process. For example, for the learning content color management, topics like color profiles, color mapping, etc., will be discussed in the learning units of the course on premedia.

Based on the taxonomy-driven breakdown, a course sequence can be built analogous to the print media production workflow in an industrial setting. This is, as the output of one process group (and course), depicts the input for the subsequent process group (and course).

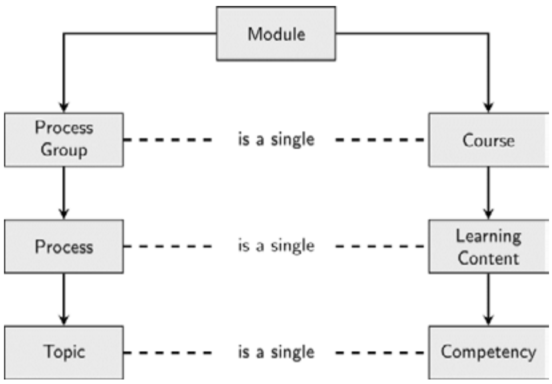


Figure 3. Workflow-driven breakdown of the learning content and resulting taxonomy.

Interaction Design for Print Media

The workflow-driven breakdown using the resulting taxonomy provides the theoretical foundations (manuscripts) for the four different courses. However, elements are required for promoting students' willingness to learn and encouraging to develop own skills in different perspectives. For the teaching methodology at hand, this is achieved by proposing a new type of project area: "Interaction Design for Print Media". This project area comprises the design and production of print media products that evoke a potential interaction between the viewer (or viewers) and the print media product. This can be achieved by using (and combining) graphical, electronic, or physical potentials (see Figure 4). This type of project area affects that the competencies to be taught are manifested in a practical application, and the resulting projects still ensure creative freedom. In addition, of course, the students may also be involved in the development of new types of print media products, and by making use of an interdisciplinary design approach. And further, students can also deal with technologies that depict a synergy with the medium of print. For example, by combining CAD and 3D printing with graphic printing, or by automating the personalization of content using analysis techniques in cross-channel context, or by mixing reality.

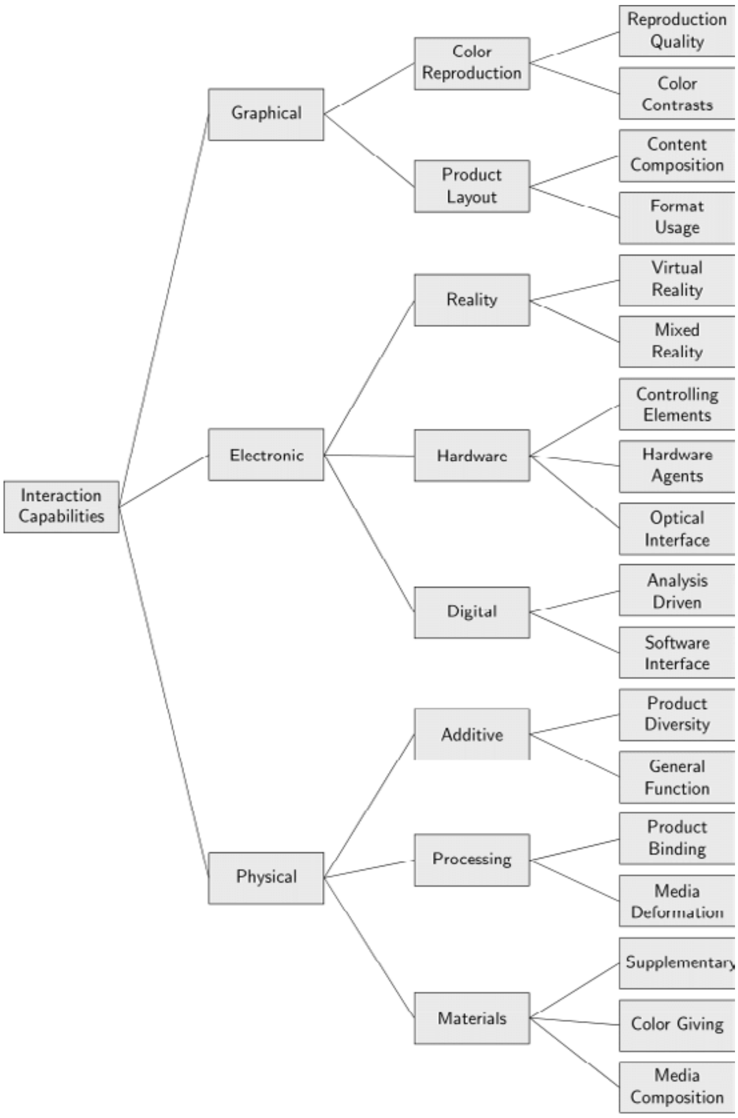


Figure 4. Interaction Design for Print Media based on technique capabilities.

The above-mentioned project area sets the second foundation for the single courses to be taught. Now in the form of a practical foundation, which also serves as a basis for evaluation in form of a project assignment. Consequently, each student will be involved in one project of this project area as part of the single courses. Hereby, the project area is identical for all four courses: "Interaction Design for Print Media". However, the characteristics of the projects are determined based on the underlying process group defining one particular course. In more detail, all assignments have the objective to produce a print media product evoking an interaction potential between a viewer and the print media product, but on the basis of one particular process or a collection of competencies for the particular process group. For example, for the premedia course, the students have to produce a print media product evoking an interaction potential on the basis of one particular premedia process or related premedia competencies.

To support experimental freedom, the improvement of design-thinking skills, as well as to encourage creativity, the assignments are only pre-defined using four minimalistic specifications. The objective to produce a print media product that evokes an interaction potential between the viewer and the printed media on the basis of the underlying construction and its design sets the main specification. On purpose, this print product has not yet been pre-defined in more concrete terms. The purpose of the product is also free. For example, students can design a packaging solution with an integrated game. To use the facilities of the faculty to design and produce the print media product sets the second specification. However, if the students develop products that cannot be implemented at the faculty, the products can also be produced elsewhere. The third and last given specification is to produce minimum two identical products (print job run length = 2). The projects are organized in parallel to the learning units to ensure an industry-like project setup. In addition, the projects should, if possible, be implemented as group work, which finally outlines the fourth and last given specification to help improving social skills.

Case-Study

As an illustration of the proposed teaching methodology let us consider one course of the module in detail. This course is entitled “Premedia Workflows”. This course covers processes of premedia, and is part of the module “Print Media Production Workflows”. In the mentioned course, the proposed teaching methodology has been used on a trial basis in the current semester (summer term 2023).

Example Course “Premedia Workflows”

The learning content is defined on the basis of the processes of the process group premedia. This includes the processes of content management, page layout, color management, and content export. The topics of particular learning contents are defined according to the processes itself (see Figure 3):

- For the learning content of Content Management, the required competencies to utilize a content management platform depict the topics: capture, store, preserve, deliver, manage content [10].
- For the learning content of Page Layout, the required competencies to perform the layout setting are included as main topics: document format, number of pages, type of media content.
- For the learning content of Color Management, the required competencies to fulfil color fidelity across media are included as main topics: color profiles, paper classes, gamut mapping.
- For the learning content of Content Export, the required competencies to export a print template for data exchange are included as main topics: data format, export features, export standards.

In the first learning unit, the project objective (assignment) is presented by means of the specifications mentioned in the previous section. Additionally, exemplary products are mentioned. Some of the provided examples for the course “Premedia Workflows” are: a board game describing the work steps of page layout setting, a flipbook showing different fillings for a raster cell, a card game with questions and answers for content export, a packaging print product emphasizing different sizes for color spaces, a book with different papers according the reflexion capability, a puzzle for a color space of a particular color profile, a book with different values of subtractive color mixture. One prototype for the course “Premedia Workflows” is shown in the figure below (see Figure 5). This is a print media product allowing an endless format. It is realized by combining graphic printing using a thermal printer with a 3D printed mobile reader. In other courses, other prototypes are shown accordingly. For example, a print media product prototype evoking an interaction by parallel deformation of the paper. This prototype was submitted to the Gmund Award 2023 and nominated as a finalist there in the category: Art.

Figure 5. Two exemplary prototypes showing potentials of interaction for graphic print media.

After the manuscript has been prepared and the assignment explained, the teaching of the learning contents finally took place with the help of the manuscript structured according to the taxonomy (see Figure 3). Besides the theoretical and practical foundations, related exercises, practical examples and different demonstrations using laboratory facilities are presented as well. The course “Premedia Workflows” was attended by a total of six students. At our faculty, this corresponds to an average course size for courses that are not suited for all students of any semester. The number of students resulted in two projects. Both projects took a closer look at the topic of color management. Logically, the result for outcome of both projects is that a graphic print media product was designed and produced evoking an interaction between medium and viewer on the basis of graphic potentials.

Exemplary Student Projects

The first student project resulted the print media product entitled “CMYK Quartet” (see Figure 6). The product consists of three partial (print media) products. This is a folding box, an instruction manual, and the quartet cards. Each card has a color box printed at the top of the card. with colors that are created on the basis of subtractive color mixture. The individual color separations (C, M, Y, K) serve as one possible element to compare individual cards. Using this criteria, a player receives the card of the other player if the selected color separation has a higher color value than that of the other player.

Figure 6. Two exemplary prototypes showing potentials of interaction for graphic print media.

The second student project resulted the print media product entitled "Gamut Puzzle" (see Figure 7). The print product consists of three partial (print media) products. This is a template, the puzzle, and an outer packaging for the puzzle. Each puzzle element serves as one piece to reproduce the given gamut.

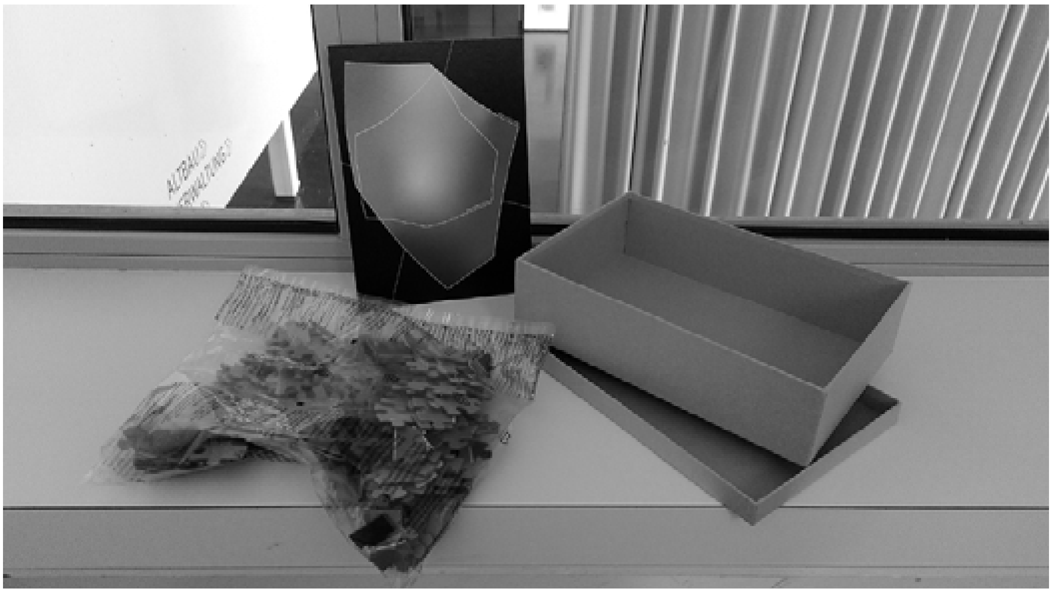


Figure 7. Two exemplary prototypes showing potentials of interaction for graphic print media.

Conclusions

This work presented the teaching methodology "Interaction Design for Print Media" based on a novel type of project area for print media products. The aim of the methodology is to convey the learning content in a meaningful way and at the same time create an experimental working atmosphere that encourages students' creativity. Main elements of this teaching methodology is logically, the project area itself, but also the meaningful workflow-driven breakdown of the content in line with the basic concepts and the resulting taxonomy. The usage of the methodology on a trial basis in a real-world course demonstrates the potentials of the methodology. Consequently, it will be used in further courses.

References

[1] Hoffmann-Walbeck T., "Workflow Automation: Basic Concepts of Workflow Automation in the Graphic Industry", 96 p., Springer (2022)

[2] Collins W, Hass A., Jeffery K., Martin A., Medeiros R., Tomljanovic S., "Graphic design and print production fundamentals", 215 p., Bccampus (2015)

[3] Thompson R., "Printing materials: science and technology", Pira International (2004).

[4] Hoffmann-Walbeck T., "Smart factory: JDF and XJDF", Journal of Graphic Engineering and Design, 9(1), 5-9 pp., (2018).

[5] Hoffmann-Walbeck T, Angermann H. "Workflow Automation at colordruck Baiersbronn". In: The CIP4 Organization – Success Story, https://www.cip4.org/colordruck.html, (2023).

[6] Angermann H., "TaxoCatalog: costless workflow integration of an expert system environment to personalize product catalogs in omni-channel context", In: 49th International research conference of IARIGAI: "Advances in Printing and Media Technology", (2023).

[7] Grasset R., Dunser A., Billinghurst M., "The design of a mixed-reality book: Is it still a real book?", In: 7th IEEE/ACM International Symposium on Mixed and Augmented Reality, 99-102 pp., (2004).

[8] Özdemir S., "Supporting printed books with multimedia: A new way to use mobile technology for learning". British Journal of Educational Technology, 41(6), 135-138, (2010).

[9] Hoffman-Walbeck T., Adams R., “Online Workflow Puzzle”. Journal of Graphic Engineering and Design, 11(1), 1–5, (2020).

[10] Angermann H., “Manager’s Guide to SharePoint Server 2016: Tutorials, Solutions, and Best Practices”. Apress, 171 p., (2017).

The Future of Printing Technology Engineers Education

Enn Kerner, Estonia

Introduction and background

- Printing industry is in rapid change
- New technologies
- New materials
- New sustainable development goals
- Role of printing technology engineers
- Politicians and public opinion of citizens

- Aging society and the wide range of the different attractions and high competition employ new people;
- Lower level of valuing the hard skills during the elementary or secondary education, especially at STEM subjects;
- Closers of printing technology educational programs at vocational and university level on different member countries of IC;
- The digital transformation of education lays the foundation that printing technology occupation's will listed hierarchical at International Standard Classification of Occupations (ISCO) in order to give structured overview occupations at printing industry.

- Professional identity of the printing technology engineers;
- Ensuring that professional qualifications of printing technology engineers of the IC member countries;
- Printing technology engineers role and responsibility in society to secure industry circle economy and sustainability;
- Safeguarding and promoting the professional interest of printing technology engineers and by the free movement within IC members countries.

- Strategic Direction
- Affirm the Professional Identity of engineers in Printing Industry;
- The single voice of Printing Technology Engineers in printing industry segments;
- Printing Technology Engineers Network;
- Informing Society on New Printing Technologies.

Methods

- "Printing industry engineers education – cross-border development project" from 2014;
- Cloud based technology DLMS and Virtual Training Mentor for printing industry engineers and print operators;
- Stimulating a sense of initiative, entrepreneurial attitudes and skills in learners: will include specific training to operationalize the EU Entrepreneurship Competence Framework;
- Facilitating the flow and co-creation of knowledge between HE, VET and the business sector.

- EDUCATION - means structured learning advancement at university or avocational education institution. The graduates will awarded a degree according to the European Qualification Framework, namely,

  MSc = EQF7 (minimum 300 ECTS), sc. Second level of degree;

  BSc = EQF6 (minimum 180 ECTS), sc. First level of degree;

  or operator level EQF = 5 or 4 etc., after successful defence of a relevant thesis and examinations.
- TRAINING - means troubleshooting with one or a few competences to be improved for the trainee. A certificate of participation, sometimes with test of learnings, will follow training.

- The methodology will be structured on 3 pillars:
- Assess current situation;
- Anticipate future needs;
- Monitor progress on a yearly basis.

- The future is a multidisciplinary engineering education, with only a few IC countries having a university specializing in engineering for printing technology.
- Printing technology engineers education will go through digital transformation;
- New materials and sustainable development goals, circular economy "cradle-to-cradle" will be a center point of printing technology engineers education;
- Printing technology engineers will have competences of soft skills in engineering pedagogy.

Discussion

- Printing Academy's by industry:

  Koenig&Bauer Academy, Windmöller&Hölscher Academy, Comexi TEC, BOBST MEX ect.
- Structure of Skills Council of Printing Technology engineers:

  EC (commission), policy maker (packaging and printing industry);

  IC Advisory Board;

  Industry and Brand Owners as partners;

  Assembly representatives - Industry champions, Students, Standards bodies etc.

Artificial Intelligence in Graphic Design

Ivana Tomić [1], Ivana Jurič [1], Sandra Dedijer [1], Savka Adamović [1]

[1] University of Novi Sad, Faculty of Technical Sciences, Department of Graphic Engineering and Design, Serbia

Abstract

Artificial intelligence has entered into many aspects of our lives, and design is by no means an exception. In the last couple of years, we have witnessed rapid development in this segment. Many new solutions have emerged, flooding the software market and offering designers opportunities to change the way they create and collaborate. In this article, we present an overview of the current use of AI in graphic design and discuss the role it might take in the design process. The primary goal of AI tools in graphic design used to be optimization and speed - replacing designers in doing repetitive tasks or analysing the vast amount of user data to create better solutions. Today, AI is not only speeding up processes, allowing designers to focus on the creative part of their work, but also creating designs from scratch by following users' input. AI tools offer more flexibility and creativity in finding the best solution for different tasks like font and color selection, image editing, creating the best layouts and compositions. They also provide a high level of automation, mostly in image editing and UI/UX design. On top of that, with the rise of tools able to create personalised and adaptive design content based on user requirements, the roles are changing, and designers might be inclined to see those tools as threats. Luckily, that is still not the case, and we firmly believe it will not be in the near future.

Keywords: Artificial intelligence, graphic design, AI tools, design process, automation

Introduction

Artificial intelligence (AI) is a branch of computer science whose goal is straightforward to understand but challenging to achieve – creating intelligent machines that can automate processes, make predictions, and improve performances by simulating the human way of understanding the world and learning from the experience. AI technologies include machine learning, deep learning, natural language processing, expert systems, and speech and vision processing [1].

AI is rapidly evolving with applications in many industries, including healthcare, finance, transportation, and more. The design sector is no exception. In the creative industries, there is an ongoing debate about whether AI solutions are "killing creativity" and "replacing designers" by creating products much faster and cheaper than humans. AI-generated art (like those shown in the BrainDrops platform [2], for example) is also gaining popularity. Even though we can argue its real artistic value, it is evident that there is a massive hype for such creations. It is irrelevant whether it is a simple novelty or some sort of curiosity that ignites it. In this work, we wanted to summarize the use of AI in graphic design and analyze whether designers have any reasons to fear being replaced by AI in the future.

AI in graphic design

In graphic design, AI is primarily used to speed up processes and, some would say, increase creativity by offering designers different solutions for a given task. The advantage of AI, when compared to a human, lies in its power to analyze vast amounts of diverse data and to predict or even create the outcome – the most appropriate design for a particular application. It is done mainly by machine learning, a process that simulates the way humans are acquiring knowledge. The algorithms use different methods to extract information and create outputs from input data, gradually improving the performance as the number of samples they are trained upon increases.

Some tasks where AI is used in graphic design include image editing, font and color selection, creating different layouts and compositions, user research and personalization, and automation. We will discuss these applications as follows.

Image editing

In image editing, there are many new AI-powered tools facilitating processes that used to be time-consuming. Adobe Sensei, a suite of AI and machine learning technologies used to increase Adobe's creative tools, uses many AI algorithms to automate repetitive tasks, improve the accuracy of complex selections, optimize images and videos, and enable intelligent search and discovery of a content [3]. It also provides features like facial recognition, object recognition, and natural language processing that can help content creators streamline their workflows and improve the quality of their work [3].

When it comes to automation, we can mention auto-reframing, which encompasses resizing and cropping images/videos to different formats for various social media, smart tagging that enables better search and recognition of image content, or scene-stitching that creates a perfect composite of multiple images of the same scene. For faster background object extraction and background correction, there is a fantastic tool we have been using in Photoshop for many years now - Content-Aware Fill. Apart from machine learning, it also employs pattern recognition techniques to analyze surrounding pixels in an image and generate the most appropriate content.

The Object Selection tool is another excellent solution for selecting objects in images. Before its introduction, selecting had to be done manually and sometimes required a lot of patience and precision. Patience is still required, because image processing usually takes some time, but not as nearly as before. This tool is still under development, so some small manual intervention is sometimes necessary since not all the objects are ideal candidates for automatic extraction.

Photoshop has just introduced Generative Fill, a tool which brings image editing to a whole new level [4]. It is powered by Adobe Firefly, a generative AI engine that allows users to describe desired effects in an image with simple text prompts [5]. The option is available from Photoshop beta and can be found in the Contextual taskbar. After creating a selection of an area where new object should be placed, the user can choose Generative Fill and describe the object and its properties. A more precise description would lead to a better result, where the created object is fully integrated into the scene regarding its position, colors, shadows it casts, etc. Users can choose from different solutions and send the feedback to Adobe to improve the algorithm. Generative Fill can be used not only to add objects but also to extend the background by creating realistic content that looks like as if it is part of the original scene [4].

If we look at cloud-based editing platforms, we must mention Pixlr by Autodesk. This solution incorporates many AI-based tools such as AI cutout for selecting and removing background from an image, AI Background Replacement Tool for changing the background automatically, as well as features for enlarging images without losing quality.

The latter feature is a typical example of the power of machine learning and is incorporated not only in Pixlr but in many other software solutions. An excellent overview of the most popular software for upscaling can be found at [6]. In our previous work [7], we tried Gigapixel-AI, whose algorithm was trained with millions of photographs, with an intention to reconstruct instead of interpolate information [8]. It did great work in improving resolution in cases where extreme pixelation is caused by compression, and in reconstructing very blurred images.

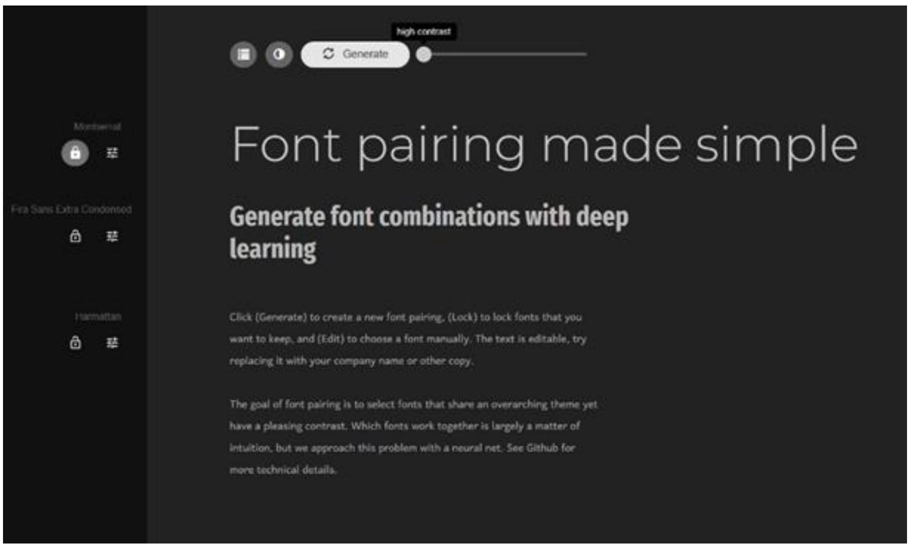
Another AI-powered solution from the same company, Topaz Photo AI [9], solves not only the resolution problems but also corrects noise, sharpness, and focus. After image analysis, the proper correction is automatically defined. Face detection is used to detect essential areas in photographs and to perform selective sharpening, accentuating only parts of interest and improving the overall impression [9].

Font and color selection

Choosing a font combination is a challenging task in the design process. Many things had to be considered for typography to fulfill its purpose and to be visually satisfactory. The same stands for colors. They convey meaning and had to be combined by following design rules and considering the intended outcome. AI can assist a designer in choosing font and color combinations by defining those that fulfill desired requirements and are visually appealing.

Font selectors can help determine visually complementary fonts and usually allow choosing three fonts (which is more than necessary). Most of those we had evaluated [10, 11] work the same way – the software can pick all three based on the desired level of similarity/contrast, or principal choice(s) can be defined and locked, letting the software find the complementary pairings. An example is shown in Figure 1, where we defined and locked the font for the main title (in the example: Montserrat regular). In the first case (Figure 1a), we specified high contrast between the fonts, while in the second (Figure 1b), we wanted a combination where fonts are as similar as they can be. The results are pretty satisfactory.

(a)



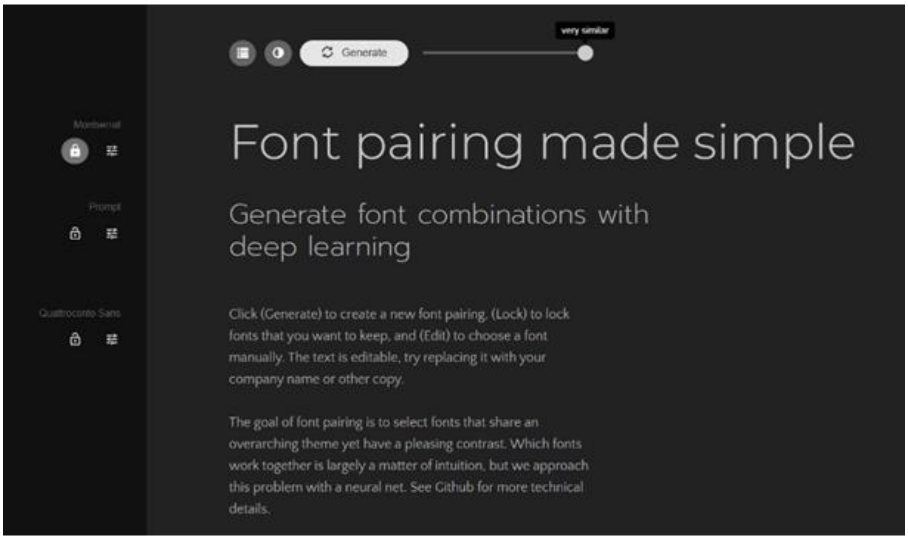
(b) 

Figure 1. Font selection in Fontjoy when the primary font was locked, and the rest were defined based on (a) the slightest similarity, i.e., highest contrast, (b) the biggest similarity

When it comes to a beautiful world of colors, AI algorithms can help designers by extracting color schemes from images (thus enabling the creation of the right mood and appropriate theme for a project) [12-14], defining color combinations that work well based on color theory and good practice in design [12-14], and by performing image colorization [15].

Colors can be chosen from palettes that reflect a certain mood, are generated randomly, or are created by specifying one or more colors and letting AI pick the rest. A user can also specify the term and pick the color based on it, as in the case of Picular [16], upload the photo and extract color scheme [12-14], or check whether the contrast of the chosen color combination allows for good visual accessibility [12, 13] (Figure 2). All the tools allow palettes to be saved and exported, increasing flexibility.

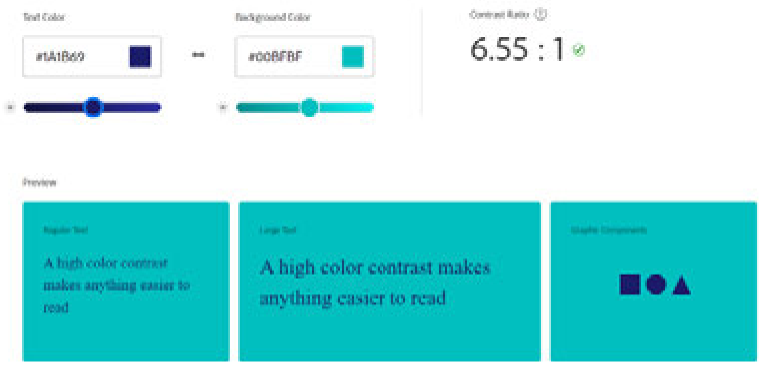


Figure 2. Contrast Checker, part of Adobe Color, allows a designer to evaluate the contrast of the chosen color combination.

Layout and composition

AI algorithms can analyze a design brief and suggest different layouts and compositions based on design principles and best practices. Currently, AI online tools can create logos, mockups, flyers, videos, banners, landing pages, entire websites, etc. [17-20]. In addition, systems like DALL·E 2 can make a realistic images and art based on a given description [21].

To create an AI-assisted design, the user must specify the relevant inputs. When making a logo, for example, typical inputs would be: the name of the business, keywords that best describe the ideas/messages the logo should transmit, elements it should contain (text, icon, slogan), font style, and preferred colors for icon, text and the background [17, 19]. Preferences toward a style or a color scheme can also be detected by showing different solutions to the users and asking them to pick a certain number of those they like [17].

Figure 3 shows some of the 300 solutions we obtained from BrandCrowd [19] for an imaginary business called "iCreate," where keywords were "art, design, modern, creative, design agency," font was defined as "modern," and we made no color preferences. They are all quite different since no more specific inputs were given to an algorithm. If keywords were better defined, the outcomes would be refined, and some could even be satisfactory for less demanding users.

Figure 3. BrandCrowd AI-powered logo design solutions

We have also tried Microsoft Designer, an AI-powered design app that uses text prompts to create different visual content [22]. The result of one of such prompts, namely "creating a colorful poster for the conference in Wuppertal containing some images of the city," is seen in Figure 4. It is clear that the results are not satisfactory - if we neglect the composition, it is evident that the second solution lacks an image, while the third is showing the wrong one. Illustrations created this way, especially those portraying humans, are also very primitive since they are made by combining different images. This app allows a high level of customization, so obtained results can be altered, but some background in design is necessary to make the outcome visually appealing.

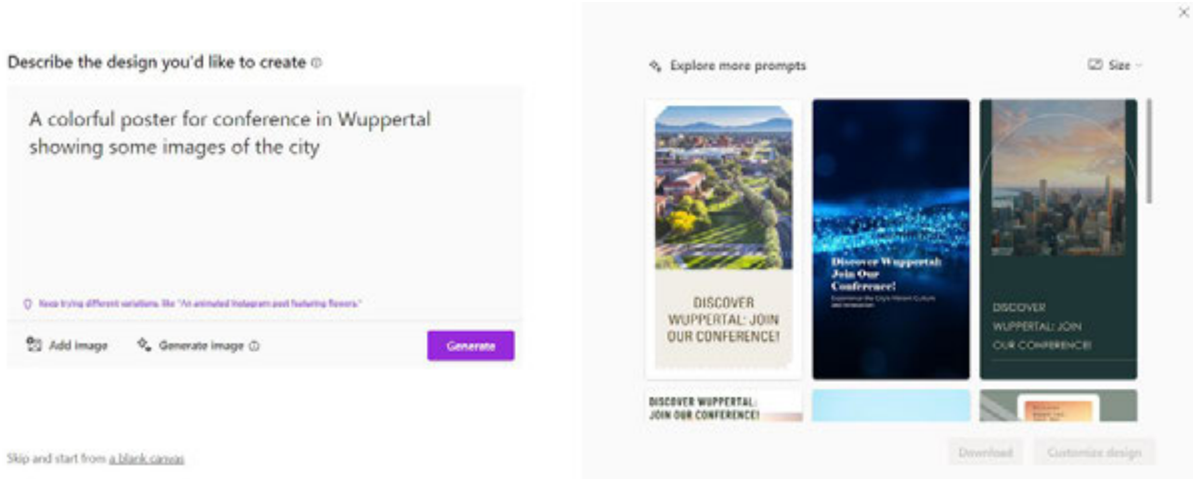


Figure 4. Using Microsoft Designer to create a poster

On the other hand, an app specifically made for creating posters like Vinci can even successfully compete with human designers regarding the creation of layout and composition [23]. And DALL·E 2 can certainly compete human illustrator/designer when it comes to making images from given descriptions [21].

Creating landing pages is another example of AI's capabilities. AI can not only generate pages based on provided input [18] but also offer content suggestions, as demonstrated by Ryting [24]. Solutions such as [20] can go beyond mere page generation and create entire web pages, including content and images. Furthermore, tools like [17] enable the creation of complete marketing campaigns.

All these applications are, of course, very limited, and they most certainly cannot compare to human designers when it comes to originality. For example - to make a meaningful logo, a user would have to have at least some basic design knowledge to decide which font or color combination is appropriate for a message that should be conveyed. If that is missing, the outcome might be visually appealing, but the point could easily be lost.

On the other hand, a human designer could never compete with the computer regarding speed. In BrandCrowd we obtained 300 logos right upon the click (and it took us a minute or so to feed the app with the necessary data). The AI apps are also affordable (some even free), and users can always customize the outcome (something that computers don't mind, unlike human designers).

User research and personalization

As already mentioned, the main advantage of AI models compared to human designers is the ability to analyze vast amounts of data. It can be quite beneficial in user research, where more personalized solutions can be offered based on the results of data analysis.

News feeds and social networks are doing this all the time by showing us relevant content based on our preferences and search history. Any business can use this approach since AI tools offer solutions adapted to user preferences and behaviors [25]. Those algorithms use browsing and purchase history, as well as search behavior, to create more dynamic content adapted to the user [25]. AI-powered dynamic content generation can include product descriptions and suggestions, blog posts, pop-ups, triggered emails, and even web pages or apps UI [26, 27].

Adobe Target, for example, enables one-click website personalization [28]. Multiple machine-learning models allow changing the whole site experience for every user and adapting it over time as user's interests change. It can also execute A/B and multivariate tests across various digital channels, allowing the designer to review the results and select the most suitable solution for the desired target group.

Automation

Replacing a designer with doing repetitive tasks so that he/she can focus more on the creative side of the process is another great way of using AI in the design sector. We have already mentioned many such examples in image editing. In UI design, Microsoft's Sketch2Code can create working HTML prototypes from hand-written drawings [29], speeding up the creation process. Auto-Animate option in Adobe XD or Smart-Animate in Figma are also good examples of automatization in UI/UX design.

Ethics of using AI in graphic design

This topic is quite complex since many aspects of using AI must be considered and analyzed. Here, we will highlight just a few factors concerning the ethics of using AI tools.

We are all aware of the importance of privacy when sharing our personal data online, so anyone relying on AI tools to gather and process information should ensure that data is correctly handled and not shared with third parties.

In machine learning, the result is highly influenced by the availability of the data being processed. In UX design, this can mean that the result obtained reflects the majority of the population and excludes some specific groups not represented in the data set, leading to a design that is not inclusive. Another issue would be biased design which is, again, the result of the biases in the data.

Furthermore, when AI-generated content becomes intrusive or offensive, questions about accountability arise. Is it the fault of the algorithm, the vendor, or the user for not providing the software with the correct input?

Conclusion

In the future, we can expect AI tools to become more sophisticated and enable higher levels of automation, replacing designers in repetitive and time-consuming tasks. Pfeiffer Report on creativity suggests that AI will help designers to focus on more difficult creative work such as coding, AR/VR, 3D, motion graphics, and video [28].

It is clear that in the years to come, there is no reason for designers to see AI as a threat. Competing with the machine (especially in terms of speed) would not only be pointless but also unwise. As humans, we can always rely on our strong points - originality, creativity, empathy, and everything that defines "human touch" in any discipline, not only design.

Therefore, we strongly believe that AI tools will not be able to replace human designers any time soon. On the contrary, designers should treat and use AI tools as very powerful assistants. The synergy of AI and human designers will enable faster creation of solutions that will be more visually appealing, engaging and adapted to the users' needs. Hence, we should all embrace this new (r)evolution and make the most of it, just as humankind has done many times in the past. As nicely stated by Miklos Phillips [30]: "Technology in the past made us stronger and faster. AI will make us smarter."

Acknowledgments

This research (paper) has been supported by the Serbian Ministry of Education, Science and Technological Development through project no. 451-03-68/2022-14/ 200156 "Innovative scientific and artistic research from the FTS (activity) domain."

References

[1] Chopra, R. (2012) "Artificial intelligence, a practical approach", New Delhi, S. Chand Publishing.

[2] BrainDrops (2023) "BrainDrops - A platform for AI-generated Art", Available at: https://braindrops.cloud/ (Accessed: 21 June 2023)

[3] Adobe (2023) "Adobe sensei: Machine learning and artificial intelligence", Available at: https://www.adobe.com/sensei.html (Accessed: 20 June 2023)

[4] Adobe (2023) "Dream Bigger with Generative Fill", Available at: https://www.adobe.com/products/photoshop/generative-fill.html (Accessed: 17 July 2023)

[5] Adobe (2023) "Dream Bigger with Adobe Firefly", Available at: https://www.adobe.com/sensei/generative-ai/firefly.html (Accessed: 20 June 2023)

[6] Wayne, H. (2023) "Top 15 Best AI Image Upscalers (September 2023) | Upscale Your Images Free", Available at: https://topten.ai/image-upscalers-review/ (Accessed: 01 September 2023)

[7] Tomić, I., Pinćjer, I., Miketić, N., Adamović (Majkić), S. (2022) "Artificial intelligence in printing", Proceedings of the 11. International symposium on graphic engineering and design, Novi Sad, Serbia, pp. 453-458.

[8] Topaz Labs (2023) "Gigapixel AI, Exceptional AI image upscaler delivering enhanced detail and resolution by 600%", Available at: https://www.topazlabs.com/gigapixel-ai (Accessed: 17 April 2022)

[9] Topaz Labs (2023) "Introducing Topaz Photo AI: Your autopilot for maximizing image quality", Available at: https://www.topazlabs.com/learn/introducing-topaz-photo-ai-your-autopilot-for-maximizingimage-quality (Accessed: 17 April 2022)

[10] Fontjoy (n.d.) "Font pairing made simple, Generate font combinations with deep learning", Available at: https://fontjoy.com/ (Accessed: 26 March 2023)

[11] Designs.AI (2023) "Inmagine, Content Creation Revolutionized", Available at: https://designs.ai/fonts/ (Accessed: 26 March 2023)

[12] Adobe (2023) "Adobe Color", Available at: https://color.adobe.com/create/color-wheel (Accessed: 10 June 2023)

[13] Coolors (n.d.) "Coolors – create a pallete", Available at: https://coolors.co/7c6c77-dadff7-a0c1d1-093824-1f271b (Accessed: 10 June 2023)

[14] Colormind (2023) "Colormind – the AI powered color pallet generator", Available at: http://colormind.io/ (Accessed: 10 June 2023)

[15] DeepAI (n.d.) "Image Colorization API", Available at: https://deepai.org/machine-learning-model/colorizer (Accessed: 10 June 2023)

[16] Picular (2023) "The color of anything", Available at: https://picular.co/ (Accessed: 10 June 2023)

[17] Designs.AI (2023) "Create logos, videos, banners, mockups with A.I. in 2 minutes", Available at: https://designs.ai (Accessed: 19 February 2023)

[18] Headlime (2020) "Writing copy has never been easier", Available at: https://headlime.com/ (Accessed: 8 December 2022)

[19] BrandCrowd (2023) "Design & Branding Made Easy", Available at: https://www.brandcrowd.com/ (Accessed: 19 February 2023)

[20] 10Web (2023) "Launch and grow your business online with AI", Available at: https://10web.io/ (Accessed: 15 April 2023)

[21] OpenAI (2023) "DALL·E 2", Available at: https://openai.com/dall-e-2 (Accessed: 28 August 2023)

[22] Designer (2023) "Unleash your creativity: Create stunning designs lightning-fast with AI", Available at: https://designer.microsoft.com/ (Accessed: 17 May 2023)

[23] Guo, S., Jin, Z., Sun, F., Li, J., Li, Z., Shi, J., Cao, N. (2021) "Vinci: An Intelligent Graphic Design System for Generating Advertising Posters", In Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21). New York, NY, USA, Article 577, pp. 1–17.

[24] Rytr (2022) "Let AI write content for website and landing pages", Available at: https://rytr.me/use-cases/website-landing-page (Accessed: 11 April 2023)

[25] Raitaluoto, T. (2023) "The role of AI in website personalization", Available at: https://www.markettailor.io/blog/role-of-ai-in-website-personalization (Accessed: 19 April 2023)

[26] Luicien, C. (2023) "From Content Creation to Website Design: How Generative AI is Transforming the Marketing Landscape", Available at: https://www.linkedin.com/pulse/from-content-creation-website-design-how-generative-ai-luicien/ (Accessed: 19 April 2023)

[27] Dynamic Yield (n.d.) "Personalized experiences that make all the difference", Available at: https://www.dynamicyield.com/ (Accessed: 21 June 2023)

[28] Mejia, T. (2019) "The State of AI in UX/UI Design at Adobe", Available at: https://business.adobe.com/blog/basics/state-of-ai-in-ux-ui-design-at-adobe (Accessed: 6 April 2023)

[29] Microsoft (2023) "Sketch2Code", Available at: https://www.microsoft.com/en-us/ai/ai-lab-sketch2code (Accessed: 6 April 2023)

[30] Philips, M. (n.d.) "The Present and Future of AI in Design (With Infographic)", Available at: https://www.toptal.com/designers/product-design/infographic-ai-in-design (Accessed: 11 May 2023)

Properties of the Ink-Coating with Added SiO2 Nanoparticles Printed on Aluminium Substrates

Stamatina Theohari [1], Sanja Mahović Poljaček [2], Tamara Tomašegović [2]

[1] University of West Attica, School of Applied Arts and Culture, Graphic Design and Visual Communication, Greece
[2] University of Zagreb Faculty of Graphic Arts, Croatia

E-mails: stheochari@uniwa.gr; sanja.mahovic.poljacek@grf.unizg.hr; tamara.tomasegovic@grf.unizg.hr

Abstract

Aluminium is a material used in various printing applications due to its extremely favourable properties. It is a sustainable material with many advantages due to its decorative role, surface stability, chemical resistance, light fastness, and others. To print an ink-coating on the aluminium surface, it is usually specially treated to ensure the stability of the applied coating. The optimization of the aluminium surface includes various mechanical and chemical treatments that provide the defined surface roughness and chemical structure. One of the most commonly used printing techniques for applying various coatings to aluminium surfaces is screen printing. The inks used for the printing process should have certain properties depending on the application and printing requirements. In this study, the properties of ink coatings on aluminium substrates with different surface roughness were investigated. The printing process was carried out with unmodified and modified printing inks. Modification of the inks was done by adding silicon dioxide (SiO2) nanoparticles to the ink composition. The printed samples were aged in a weathering test chamber to determine the effect of the addition of nanoparticles on the properties of the ink coatings. The surface and colorimetric properties and gloss effect of the ink coatings were measured and evaluated to observe the influence of ageing on the printed samples. The research results provide information on the possible use of SiO2 nanoparticles in inks printed on aluminium surfaces, as well as the influence of the surface structure of aluminium on the colorimetric properties and lightfastness of the printed coatings.

Keywords: aluminium, printing ink, SiO2, screen printing

Introduction

Screen printing is a printing technique used for printing on various substrates and for various applications [1,2]. Its main advantage is the possibility to print on different types of paper, cardboard, polymer substrates, textiles, metals, etc. Another advantage is the ability to use different inks that can be applied to different substrates, and especially the use of different inks for specific purposes. These advantageous properties of screen printing are made possible by the process of ink transfer to the substrate, in which a printing plate with defined properties is used and the ink is pressed through the screen onto the substrate. Because of this wide range of applications, the screen printing process and the materials used for printing should be particularly studied. The interaction of contact materials, inks, and substrates must be carefully selected and matched to produce a stable and functional print. Another feature of screen printing that should be thoroughly researched, in addition to inks and substrates, is the characteristics of the printing process and the properties of the printing plates used. The above-mentioned influencing parameters, such as ink-plate-substrate and their application require deep consideration and analysis in screen printing.

Aluminium is a material commonly used for the application of different technical coatings. It is a cost-effective and sustainable material that can be reused or recycled, making it an environmentally friendly choice for various applications. Compared to other metal substrates, it has several positive aspects that allow it to be used for various types of panels, traffic signs and labels, tags, barcodes, awards, stickers, etc. [3-5]. Aluminium has excellent physical and chemical surface stability, which can be in line with the requirements of the application and has an attractive appearance for decorative applications.

To print an ink-coating on the aluminium surface, this should be specially treated to ensure the stability of the applied coating. Optimization of the aluminium surface includes various mechanical and chemical treatments that provide the defined surface roughness and its chemical structure. In addition, the inks used in the printing process should have adjusted properties depending on the application and printing requirements [6-7].

The aim of this research was to investigate the colorimetric stability of coatings printed on aluminium substrates with different surface roughness. In addition, the possible improvement of certain properties of the ink coatings by modified inks was investigated. SiO2 nanoparticles were used for the modification of the inks used in this study. Colloidal SiO2 (fumed silica) has numerous applications in the paint and coatings industry. It is used as an anti-settling or suspending agent for fillers and pigments, for rheology control of paints depending on the application, for the improvement of gloss and colorimetric properties, scratch resistance, self-cleaning of surfaces, and others [8-11]. In this case, the influence of SiO2 nanoparticles on surface hydrophilicity/hydrophobicity and colorimetric properties of coatings was studied.

Experimental Part

Coupons of AA1050 aluminium alloy were mechanically and chemically treated to produce a different structure of their surface. Three types of grinding belts were used for mechanical treatment (#100, #240 and Scotch Brite very fine). Then, the chemically cleaned samples were anodized in a sulfuric acid solution, applying a constant current density of 1.4-1.6 A/dm2 at 18-20°C until an anodic oxide layer with a thickness of about 15 μm to be formed. After this treatment, three different surface structures were formed and the coupons were ready for the printing process. The obtained aluminium tiles were marked as A1, A2, and A3.

The solvent-based ink Marabu 073 black (Marabu GmbH & Co. KG) was used for this study. It is suitable for printing on polyvinyl chloride (PVC), acrylonitrile butadiene styrene (ABS), acrylic glass (PMMA), polycarbonate (PC), thin anodized aluminium and others [12]. A hardener was added to the ink at a concentration of 10% by mass (as recommended by the manufacturer) prior to printing. The ink was modified by the addition of colloidal silica (Aerosil 200) with an average primary particle size of 12 nm (CAS No. 112945-52-5) at mass concentrations of 2, 3.5 and 5%. The mass concentration of nanoscale silica in an ink was determined according to the previously published research results, taking into consideration that the amount is related with the desired function [1,13].

The printing process was performed by printing the three different aluminium coupons with modified and unmodified inks. Printing was performed using a manual screen printing machine (Bochonow, Drucktisch 2000 50/70). A printing plate with a mesh density of 100 lines/cm (SEFAR® PET 1500 100/255-40 PW) was prepared according to the conventional plate-making process [14-15].

After the printing process, the printed samples were dried at a room temperature of 25±2 °C for 48 hours and then were aged in a weathering chamber for 240 hours. Ageing was performed by irradiating the printed coatings with xenon radiation in the range of 280-3000 nm at a standard black temperature of 50 °C.

Various measurement techniques have been used to evaluate the quality of printed coatings. 2D and 3D microscopy was used to observe the surface structures of the treated aluminium and printed coatings. 2D images of the aluminium surfaces without coatings were taken using an Olympus BX51 microscope (Evident Corporation). To obtain a more detailed overview of the aluminium structures, 3D images of aluminium samples were taken using a Troika AniCAM 3D scanning microscope (Troika Systems). Surface analysis of the printed coatings was also performed using the 3D microscope to determine the smoothness of the coatings printed on aluminium coupons with different roughness.

The colorimetric properties of the ink coatings printed on differently textured aluminium surfaces were observed using the TECHKON SpectroDens spectrodensitometer (TECHKON GmbH) on unaged and aged samples. Measurements were made in accordance with ISO 13655 (D50, 0/45°, 2° standard observer). Optical density was measured and lightness (L*) parameter from CIELAB colour space [16]. The gloss effect on unaged and aged coatings was measured using a Lovibond glossmeter TG 60/268 and GQC6 quality control software in accordance with the ISO 7668 standard. The glossmeter determines the intensity of the light reflected from the coated surface at three measurement angles of 20°, 60° and 85°.

To investigate the effect of the addition of nano-silica particles to the ink on the surface properties of the printed coatings, a contact angle measurement was performed. Since the water contact angle is one of the most important tools for detecting the hydrophobicity and hydrophilicity of the surfaces, the results of these measurements can allow conclusions to be drawn about the self-cleaning properties of coatings. The contact angle was measured using the sessile drop method. The droplets were in a spherical shape and had a volume of 1 μL. The measurements were performed with a DataPhysics OCA 30 goniometer (DataPhysics Instruments GmbH).

Results and discussion

The 2D and 3D images of the surface structure of the aluminium samples are shown in Figure 1. It can be seen that the surfaces of the treated samples show differences. Aluminium sample A1 has the roughest surface structure, and sample A2 shows smaller irregularities in the surface compared to sample A1. The least roughness was observed in sample A3, which exhibits the smoother surface. So, it is confirmed that the different conditions in the treatment process led to the formation of structures with different roughness. Specifically, the 3D images show the irregular surface of the investigated samples, where the red areas represent the highest and the blue ones the lowest surface structures. It was found that the distance between the highest peak (red) and the lowest valley (blue) was 17.7 μm for sample A1, 15.7 μm for sample A2, and 14.9 μm for sample A3.

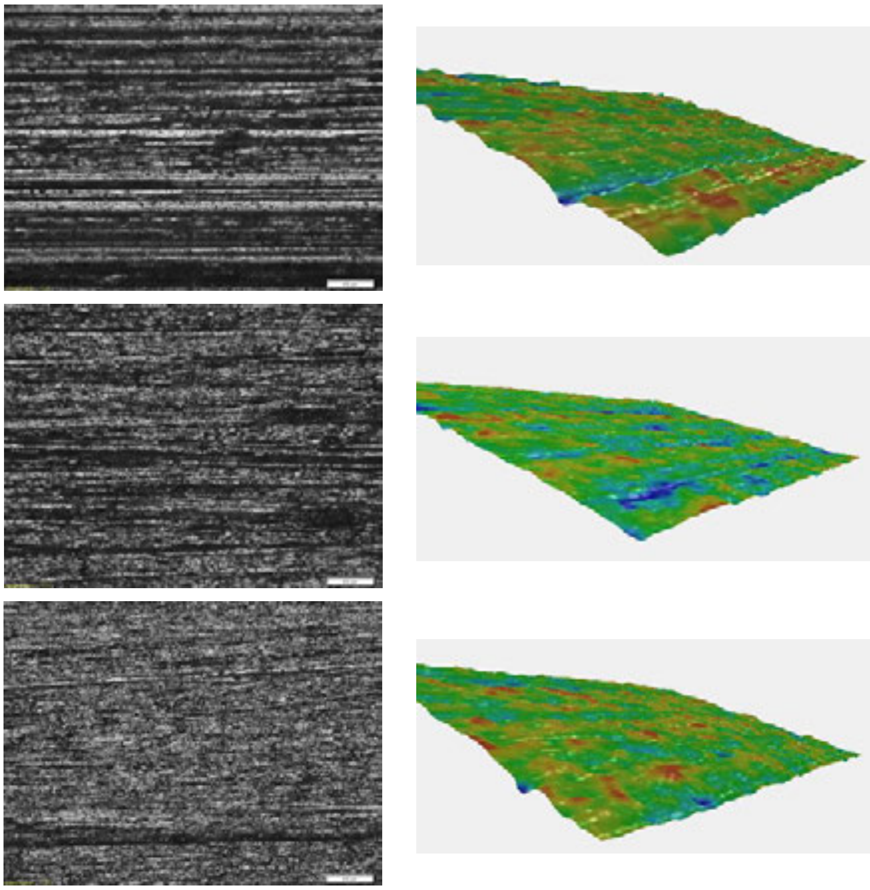


Figure 1. 2D and 3D images of aluminium samples: a) A1, b) A2 and c) A3 (mag. 20×)

These microscopic 2D and 3D images and visual observation of the surface textures agree with the previously measured values of the roughness parameter Ra, which defines the arithmetic mean deviation of the surface profile (DIN 4768, ISO /DIS 4287-1) of the same samples. The measurement was performed using the stylus method with the MarSurf PS 10 measuring instrument (Mahr GmbH). The stylus of the moving head was 2 μm in size and the measuring force was 0.00075 N. It was found that Ra (A1) was equal to 3.05 μm, Ra (A2) = 2.37 μm and Ra (A3) = 2.05 μm.

Figure 2 shows the surfaces of printed coatings with unmodified black ink. These images show the surface texture of the printed coatings and the effect of surface roughness on ink spreading. Specifically, Figure 2.a shows the ink coating printed on aluminium sample A1, Figure 2.b shows the ink coating printed on aluminium sample A2, and Figure 2.c shows the ink coating printed on aluminium sample A3. It can be seen that the differences in the surface texture of the aluminium samples have a small, insignificant effect on the smoothness of the printed coatings. The surface of the coatings is relatively smooth, with no visible irregularities on the three different aluminium samples. The distance between the highest peak (red) and the lowest valley (blue) is 17.5 μm for the A1 coating, 15.3 μm for the A2 coating, and 13.2 μm for the A3 coating, showing that the different textures of the aluminium did not cause significant differences in the spread of the ink on the aluminium surfaces. In general, the surfaces of the printed coatings follow and reproduce the structure of the substrates.

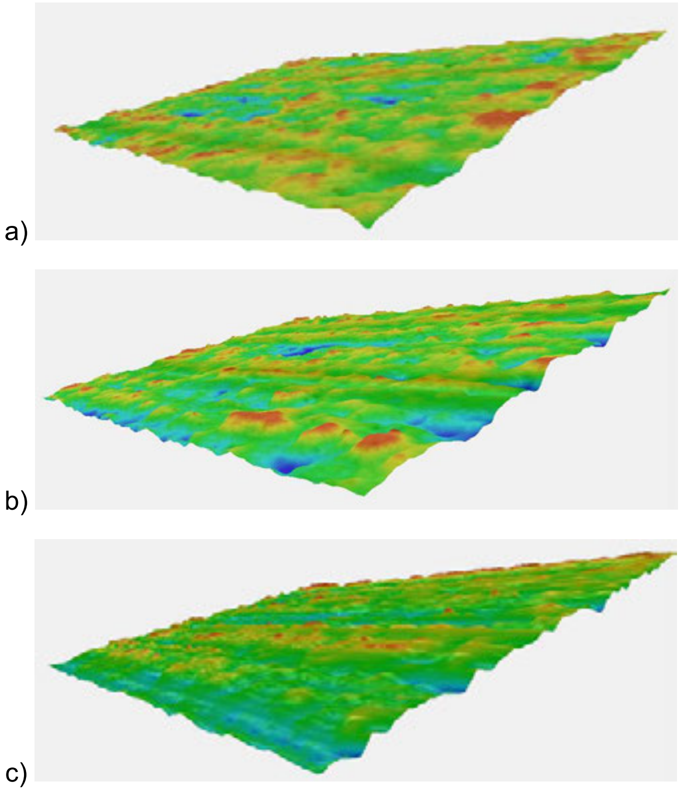


Figure 2. 3D images of ink- coatings on aluminium samples: a) A1, b) A2 and c) A3 (mag. 20×)

Continuing the research, the colorimetric properties of the unaged and aged coatings printed with the unmodified and modified inks were measured. The optical density of unaged and aged printed coatings was measured to determine the effect of nano-SiO2 on the changes in optical density of printed coatings. Since there is no official standard for the density of printed coatings on aluminium, the density of the printed unmodified black ink, which is about 3.0 density units, was used as the nominal value for this study. The results of the measured optical density on unaged samples are shown in Figure 3.a. It can be seen that the addition of different concentrations of nano-SiO2 decreased the optical density for all samples. Higher concentrations of SiO2 nanoparticles reduced the values of the density of the samples in a slightly greater extent. Moreover, it is observed that the differences in the density units are due to the different aluminium textures. The lowest optical density is observed for the printed unmodified and modified inks on the aluminium sample with the highest roughness value (A1) and, in contrast, the highest density was measured on the aluminium sample with the smallest roughness value (A3).

Figure 3.b shows the results of optical density measured on aged samples printed with unmodified and modified ink. It is shown that the ink density has generally decreased only slightly due to the ageing process. Specifically, it is observed that unmodified coatings on aluminium samples A2 and A3 have the same density unit (about 3.0), which is similar for the samples A2 and A3, while a more pronounced decrease is observed in the case of A1 sample, which exhibits the highest roughness. In addition, it can be seen that the density value of the printed coatings also decreased with the modified ink in comparison with the unmodified one. The smallest difference was measured for sample A3, which had the lowest roughness. It can be said that the roughness of aluminium sample A3 and the addition of different concentrations of nano-SiO2 caused the smallest changes in optical density and resulted in some better stability of the printed coatings during the ageing process.

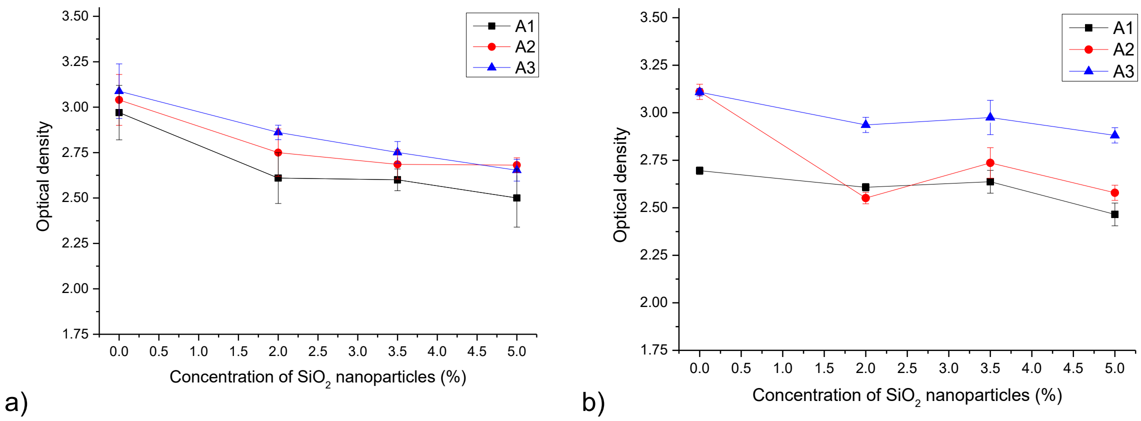


Figure 3. Optical density of ink-coatings on aluminium: (a) unaged and (b) aged samples

The results of the lightness (L*) of unaged and aged ink coatings on A1, A2 and A3 samples are shown in Figure 4. It is observed that the lightness on all unaged samples was increased by the addition of nano-SiO2. The smallest difference was observed between the aged and unaged A1 aluminium samples. The unmodified ink showed no difference in ageing when printed on aluminium samples A2 and A3. The unmodified ink coating on the A1 sample, which has the highest roughness, showed higher lightness values after ageing. Furthermore, the lightness was not affected significantly by the ageing process for the modified coatings on samples A2 and A3, indicating that the presence of nano-SiO2 did not influence negatively on the lightfastness of the printed samples, which exhibit an almost stable behavior during the ageing process.

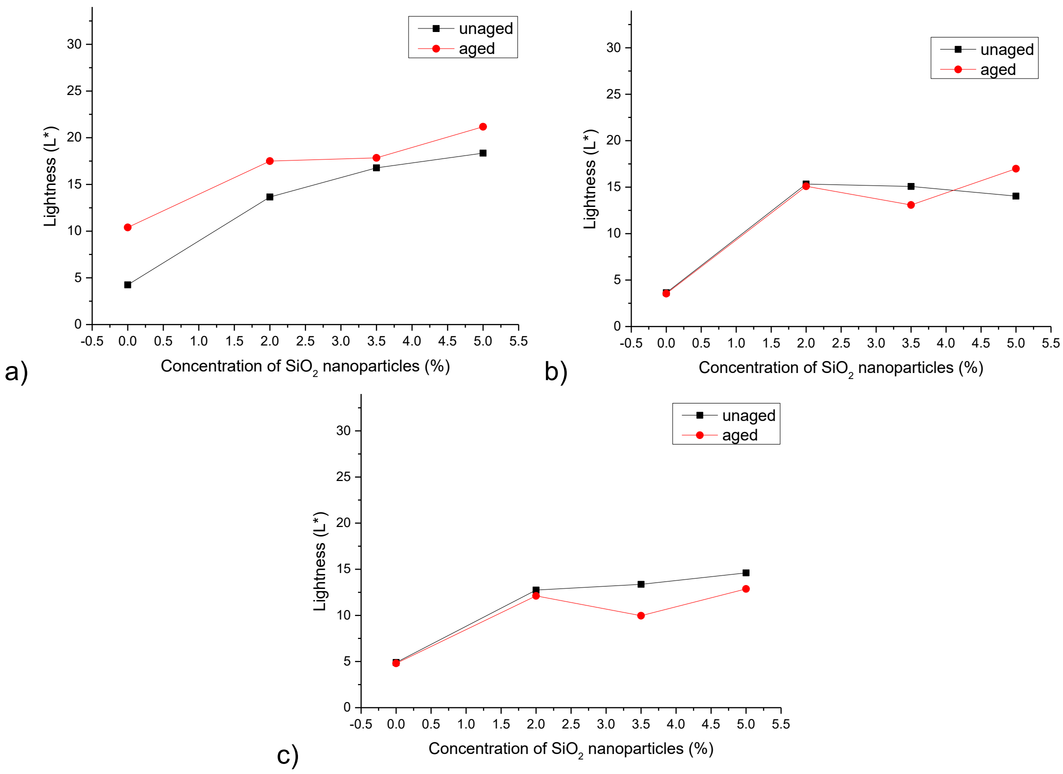


Figure 4. Lightness of unaged and aged ink-coatings on aluminium samples: (a) A1, (b) A2 and (c) A3

Results of the gloss level measurements on the ink-coatings printed on aluminium samples were expressed in GU (Gloss Units) and are presented in Figure 5.

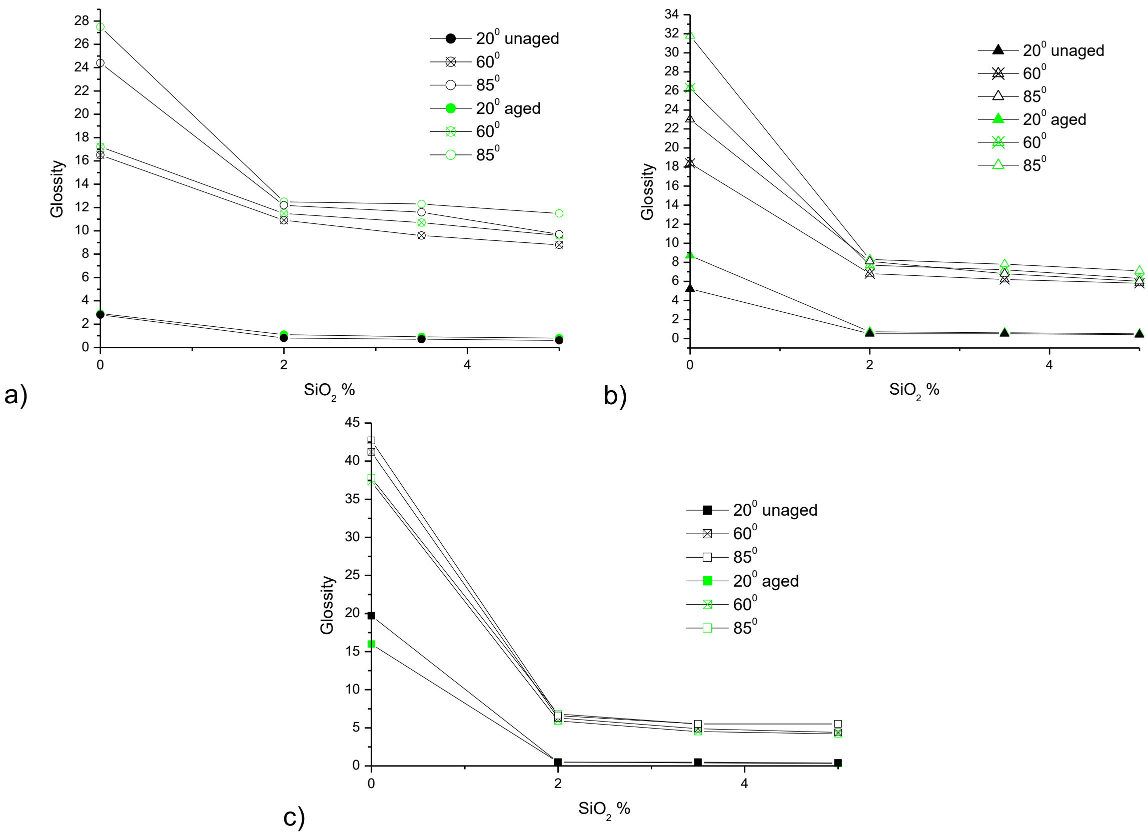


Figure 5. Gloss level of ink-coatings with and without the addition of nano-SiO2, before and after the ageing on aluminum samples: a) A1, b) A2 and c) A3

The results of the gloss effect of the ink coatings showed that the gloss generally decreases with the addition of nano-SiO2 for all aluminium substrates. However, their concentration does not seem to cause any significant difference. The above results also showed that the glossiness of the printed samples is inversely proportional to the state of their surface roughness, i.e., the sample A1 with the highest roughness exhibits the lowest glossity, while the sample A3 with the smoothest surface is the glossiest. However, the ageing process does not significantly affect the values of the glossity of all samples printed with the modified inks.

The results of the measurement of the contact angle of water are shown in Figure 6. They are presented to show the changes in surface polarity after the addition of nanoparticles in the ink and after artificial ageing of the printed coatings.

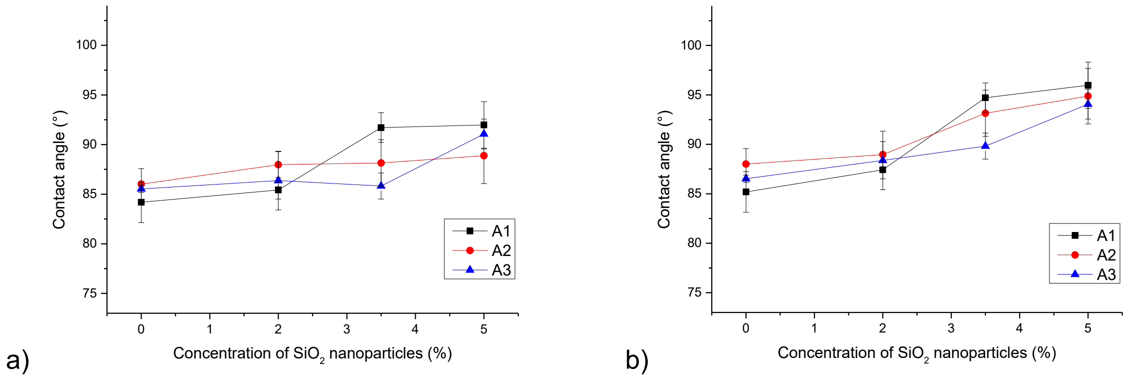


Figure 6. Contact angles of water on ink-coatings on: a) unaged and b) aged samples

It can be seen that the addition of nanoparticles causes a slight increase in the contact values of water for all samples. This means that the wetting of the ink coatings was reduced and that the SiO2 nanoparticles in this case led to an increase in the hydrophobic properties of the observed coatings. Since the hydrophobic surfaces can repel water and dust contaminants by sliding or rolling the particles off the surface, the addition of SiO2 in the ink can obviously improve the self-cleaning of the printed coating.

Conclusions

The aim of this research was to investigate the colorimetric stability of coatings printed on aluminium substrates with different surface roughness. In addition, the possible improvement of certain properties of printed coatings by modified inks with the addition of SiO2 nanoparticles was investigated. The influence of SiO2 nanoparticles on surface hydrophilicity/hydrophobicity and colorimetric properties of coatings was also studied.

The results showed the following:

- the surface roughness of the samples affected the properties of the printed samples, their optical density, lightness and glossity. The sample with the roughest surface exhibits the lowest optical density and glossiness, and the highest lightness. The sample with the smoothest surface exhibits the highest optical density and glossiness, and the lowest lightness.
- the addition of nanoparticles causes reduction of the optical density and glossiness and increase in lightness of the printed samples, but their concentration doesn't seem to be an important factor.
- the addition of SiO2 nanoparticles in the ink can improve the self-cleaning of the printed coating.
- the presence of SiO2 nanoparticles in the ink doesn't significantly affect the printed coating after the ageing process.

Acknowledgments

The publication of the article was fully funded by the «University of West Attica».

References

[1] Mahović Poljaček, S.; Tomašegović, T.; Leskovšek, M.; Stanković Elesini, U. "Effect of SiO2 and TiO2 Nanoparticles on the Performance of UV Visible Fluorescent Coatings", Coatings 11, 928-946, (2021)

[2] Kipphan H., "Handbook of print media", 1st ed. Berlin, Heidelberg, Springer, (2001)

[3] Theohari, S., Iakovidis, I., Karampotsos, A., Sianoudis, I., "Printing on Anodized Aluminium Surface", Open Journal of Applied Sciences, 6, 783-795, (2016)

[4] Mayer P., Dmitruk A., Kaczmar J. W., "Adhesion of functional layers based on epoxy and polyurethane resins for aluminum substrate", International Journal of Adhesion and Adhesives, 109, 102899, (2021)

[5] Polini W., Sorrentino L. "Analysis of adhesion in an aggressive environment of a protective paint coating on an aluminium alloy surface treated by air cold plasma", Journal of Adhesion Science and Technology, 18:14, 1643-1661, (2004)

[6] Leena K., Athira K.K., Bhuvaneswari S., Suraj S., Lakshmana Rao V., "Effect of surface pre-treatment on surface characteristics and adhesive bond strength of aluminium alloy", International Journal of Adhesion and Adhesives, 70, 265-270, (2016)

[7] Mahović Poljaček S., Tomašegović T., Theohari S., Kapović D., Orfanoudakis, S., "Adhesion and colorimetric analysis of acrylate resin-based screen-printed inks on anodized aluminium substrate", Journal of Adhesion Science and Technology, 37, 14, 2082-2103, (2023)

[8] Ferch H. "Amorphous synthetic silica products in powder form", Progress in Organic Coatings, 9, 2, 135-163, (1981)

[9] Al-Kattan A., Wichser A., Vonbank R., Brunner S., Ulrich A., Zuin S., Arroyo Y., Golanski, L., Nowack B., "Characterization of materials released into water from paint containing nano-SiO2", Chemosphere, 119, 1314–1321, (2015)

[10] Sung L., Stanley D., Gorham J.M., Rabb S., Gu X., Yu L.L., Nguyen T., "A quantitative study of nanoparticle release from nanocoatings exposed to UV radiation", J. Coat. Technol. Res. 12, 121–135, (2015)

[11] Jacobs D.S., Huang S.R., Cheng Y.L., Rabb S.A., Gorham J.M., Krommenhoek P.J., Yu L.L., Nguyen T., Sung, L., "Surface degradation and nanoparticle release of a commercial nanosilica/polyurethane coating under UV exposure", J. Coat. Technol. Res, 13, 735–751, (2016)

[12] Marabu Printing Inks, "Solvent-based screen printing inks", (2017), [online] Available at: https://www.marabuinks.com/products/product-overview/screen-printing-inks/solvent-based.html.

[13] Dubbert W., Schwirn K., Völker D., Apel P., "Use of nanomaterials in coatings", Federal Environment Agency, Dessau-Roßlau, 9th April, (2014)

[14] Faine B., "The New Guide to Screen Printing", North Light Books, United States, (2001)

[15] FESPA, "Future of screen printing", (2001), [online] Available at: https://www.fespa.com/en/news-media/industry/the-future-of-screen-printing

[16] Hunt R. W. G., Pointer, M. R., "Measuring Colour", Ed. 4, John Wiley & Sons, (2011), [online] Available at: https://www.wiley.com/en-us/Measuring+Colour%2C+4th+Edition-p-9781119975373

Graphic Technology in the Digital Age: Fostering creative talents for the future of printing

Jiong Liang [1], Zhicheng Zhang [1], Huaming Wang [1], Wan Zhang [1], Lixin Mo [1]

[1] Beijing Institute of Graphic Communication, Beijing China

E-mails: joanlian@bigc.edu.cn; zhangzhicheng@bigc.edu.cn

Abstract

The traditional printing industry is facing challenge from digital media. It seems that the printing foundation is crumbling and being substituted. Is it valuable to sustain higher education in printing? We have carefully considered this matter and conducted some tests on it.

Firstly, we analyze the conventional three-level education model from two perspectives, the learning contents and potential future employment prospects. Considering the significant impact of the Internet on the printing industry, we look ahead to anticipate the potential changes in these aspects. We assert that multidisciplinary knowledge is poised to become an integral part of the foundation of the printing service domain. The bachelor education can undertake this task.

Secondly, we strive to discern what the fundamental essence of printing is. Printing plays a major role in the replication of graphics and texts. No matter what output condition there will be, it can always seek an adaptive method to achieve high-quality graphic reproduction. Therefore, all the aspects around graphics and texts can be considered as what printing serves. We propose renaming the major of Printing Engineering to Graphic Technology.

Thirdly, we advocate the cultivation of digital thinking and engineering design thinking centered around a product concept, by which expanding the printing technologies from the traditional 2D presentation on ink and paper to encompass super dimensions. This includes the computer display and mobile phone as added substrates beyond traditional paper, plastic, textile and more. We also consider the inclusion of 3D pop-up models in addition to the planar substrate, and explore information communication that includes lighting, sonic electronics beyond color tones.

Fourthly, we mention that STEAM skill and cross-media creation skill guided by user experience principles are two major aspects to cultivate student's comprehensive thinking ability. Making connection between the mobile app and the traditional paper-based product, and incorporating the electronic sensors, will bring us a new style of print-involved products. This fosters the interactive experience between the user and the product, enabling the data collection and analysis for product improvement. The practical training model is based on the multidisciplinary background, aiming to foster the STEAM skill in student.

Lastly, we emphasize the importance of mastering the printing fundamental theories and technologies, which ensures students to form a comprehensive knowledge application framework on the manufacturing of a printed product.

Over the last 7 years, we have introduced new courses in digital media while retaining the fundamental printing courses. Our education aim in graphic technology is to foster the digital thinking and engineering design thinking in student. Although a new teaching system for undergraduate students is under construction, it requires further refinement.

Keywords: cross-discipline, product concept, creative competence, engineering design thinking

1. Introduction and background

The traditional printing industry has historically played a vital role in disseminating social information through the professional graphics replication techniques with ink on various surfaces. Adapting to the techniques' application and their development, the higher education for bachelor degree in printing in China has ever significantly contributed to China's printing industry development. The graduates entering the printing industry, armed with four years of professional education in specialty printing knowledges, also possess a good understanding of digital information and the application of professional mechanical devices, enabling them form a big barrier from the people of other different disciplines.

However, in the current Internet era, the rapid technological advancements have led to smart manufacturing processes. The digitized and standardized processes in printing can help ease the pressure at work, reducing the reliance on the specialized knowledge and skills of people. It results in a shift in the competitive advantage for professionals.

The information sharing methods have gradually shifted from the paper focused to the display focused in our life, even with AR and VR technology added. The transformation has challenged traditional print products. Newspapers, book, paper advertisement or product booklet and more have forced to move out of some of their business, leaving them for digital media. Many print shops are converting their business models (Soyang , 2023). In the universities ever with the major of printing, some stopped student recruitment, and some are changing the cultivation objective.

For the Bachelor of Science in Printing Engineering, Beijing Institute of Graphic Communication (BIGC), is exploring the new objective of creativity cultivation in response to the potential transformation of future market (Guseva, 2019). This exploration centers on two aspects:

First, the new advanced technologies are being imported into the traditional printing for learning. High effectivity of technology has prompted the high efficiency in production, which brings new requirement for additive value of product. The future development asks the printing as an industry to be with the creative function for social wealth accumulation, rather than just engage in a manufacturing role. For the curriculum, the new knowledge contents involved shall be added. We expand the contents on cross-media and printed electronics. Second, the Internet and AI technology blurs the boundaries among different professions, which catalyzes the knowledge merging other than only accumulation. This necessitates the development of comprehensive thinking ability in student to address the complex nature of modern product formation and manufacturing. We are focusing on engineering design thinking rather than just accumulating professional knowledge in the new curriculum system.

We propose focusing on STEAM skill cultivation in student, which is based on the prospect that the future printing will serve the creation of graphic-involved product in a cross-media style.

Our key contributions in this paper are summarized as follows:

- We analyze the change trend of the three-level education model in the field of printing.
- Based on the foundation of printing as graphic technology, we underscore the importance of cultivating students for bachelor's degrees with digital thinking and engineering design thinking centered around a product concept.
- We advocate for the development of two essential aspects to foster the comprehensive thinking abilities among students: STEAM skill and cross-media creation skill, guided by user experience principles.
- In addition to the aforementioned, we emphasize the fundamental importance of traditional printing theories and technologies within the framework of engineering thinking cultivation.

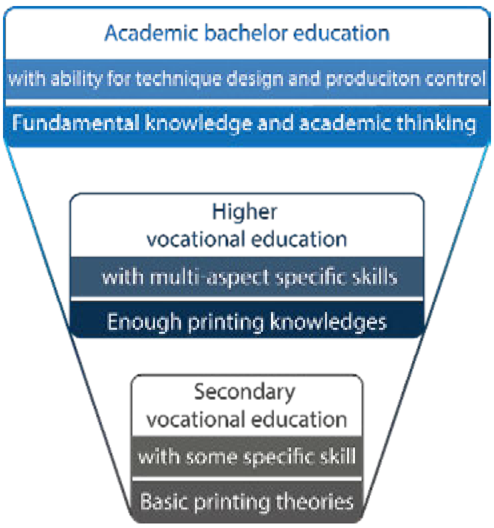
2. Change of the Three-level Education Model in Printing

2.1 Current status of Three-level Education Model in Printing

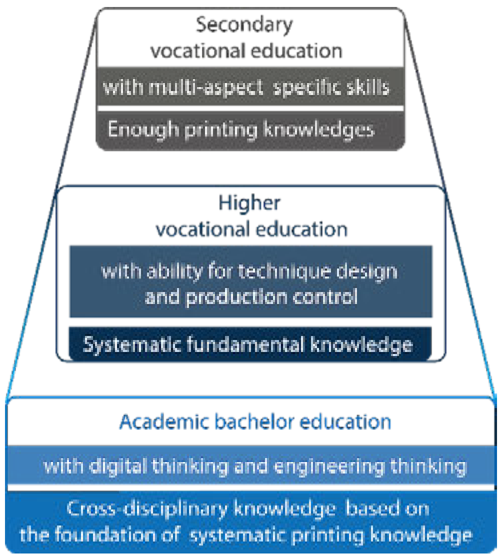
The printing industry is traditionally considered a specialized and somewhat closed field, where knowledge and problem-solving skills are primarily acquired through practical experience and the accumulation of work-related expertise. In China, there exists a three-level education model for individuals pursuing careers in printing: secondary vocational education (SVE), higher vocational education (HVE) and academic bachelor education (ABE). The latter two are considered different higher education levels. The foundation of the three levels primarily relies on empirical knowledge and its established printing principles. We distinguish these levels in terms of learning content and potential career paths (Figure 1(a)).

- Secondary Vocational Education (SVE): At this level, students receive instruction in basic printing principles and knowledge, with a focus on specific skill training in one or fewer aspects of the industry.
- Higher Vocational Education (HVE): HVE students gain a deeper understanding of printing knowledge and receive training in multiple aspects of the field to develop a range of specific skills.
- Academic Bachelor Education (ABE): ABE students undergo systematic training in fundamental printing knowledge and academic thinking methods. They are required to comprehend the entire printing process, including the effects of different combinations of materials and tools on production. ABE students are expected to contribute to areas such as technique design and production control.

However, despite their varying levels of education, individuals in these roles often find themselves starting at a similar point in their careers due to the significant reliance on accumulated experience in the industry. This lack of distinction in roles, especially in printshops facing a shortage of skilled professionals, may deter exceptionally talented individuals from pursuing printing careers. Consequently, extraordinary talents may struggle to stand out, potentially leading to disillusionment with the industry and a declining interest in pursuing printing as a career choice among younger generations. Many young people are drawn to fields such as IT and fashion, which they perceive as more challenging and innovative, leading to an oversaturated job market. This challenge is not unique to the printing industry and extends to other manufacturing sectors as well [Septiyanto,2023].



a. Conventional cultivation model



b. Modern cultivation model

Figure 1: Changes on the cultivation contents in the three-level education model

2.2 Potential Change in the Three-level Education Model Today

The contemporary era is characterized by digitization and the widespread use of the internet. Terms like automation and AI are common in various industries, including manufacturing, where the substitution of human labor with robots is a growing trend. While this shift promises increased efficiency and effectiveness, it also necessitates the adjustment to the conventional three-level professional education model.

In this evolving landscape, it is conceivable that traditional SVE-trained individuals may find themselves displaced from their current positions, and have to elevate them to the HVE level. Then, the HVE level would request to develop systematic thinking akin to that of ABE-trained individuals, allowing them to tackle problems related to different technical collaboration and improvement. This raises an important question regarding the role of ABE-trained professionals in the future. Instead of merely focusing on the current state of the industry, ABE-trained individuals should commit to fostering industry development. The printing industry has traditionally served a specific niche of product requirements in society. However, the Internet and digital technologies are giving rise to new consumer product demands and breaking down the boundaries between industries through information sharing. The fusion of industrial knowledge is the wellspring of innovative products [Razzaq,2013]. Thus, the responsibility of ABE-trained individuals is to explore the potential product types that the digital era can bring to printing.

As information sharing across industries continues to grow, ABE-trained professionals must demonstrate their creative competence by incorporating multidisciplinary knowledge, which should be encompassed into the bachelor education curriculum, building a solid foundation for digital and engineering design thinking (Fig.1(b)).

3. Our Methods

3.1 What is the Foundation of Printing?

Through analyzing the evolution of the printing industry, we describe the printing as a kind of manufacturing method to help graphical elements be presented on various kind of substrates, with appealing appearance and high quality requirements. Instead of emphasizing the role of printing in replication, it is crucial to know that printing is actually a combined group of graphic technologies. That is why we suggest to rename the major of printing as the major of graphic technology. Truly, printing is a process that can realize copy in a fast speed with low cost, but its real function is to form a product with graphical elements on the surface. The critical aspects of printing are the methods to promise the faithful or appealing presentation of color tone. Experiences gained in the aspects of color sense formation, primary colors' function, color separation, halftoning and RIPing process and more when facing white paper surface remain relevant. Nowadays, large amounts of graphical elements are still as what they originally are, but the substrates are rapidly expanded. We are becoming habitually to read information on the digital media with the mobile phone widely used in our life. Is the foundation of graphic technology different from the traditional? No. it is just the same foundation are required to face different substrates.

We introduce the term "cross-media depended graphic technology" to describe the new form of printing, wherein the fundamentals of color presentation and its control are expanded rather than transferred. The printing will shift the service objective from the paper-focused to the graphic presented, allowing it to cater to various surfaces, such as paper, plastic, textile, computer displays, mobile devices and more. Although we integrate new technique, we continue transmitting the basic printing-involved technologies to our students, ensuring their grasp of printing and graphic fundamentals for both traditional and digital media or other substrates.

3.2 Exploring on New Product Creation

The future demands printing to serve the product design and creation. Besides the aspects of shape and graphic arts design, the engineering design thinking (Natalya, 2020), such as material and manufacturing process design, will play a crucial role in product creation in future.

The traditional printing products like book, packaging box and poster, primarily present information on the flat surface. While we care about what kind of paper or ink should be used, and how to control the printing quality to enhance the product's appearance, we often neglect active participation in product design. Although the inks bring the abundant colorful appearance for the print products, they still look a little flat and dull.

With the development of scientific technologies, the information reproduction will go beyond the restricted 2D representation. We explore technologies to expand the products' 2D appearance to super dimensions. What technologies can be utilized here?

Digital thinking on the product is a very important part in the Internet era. The new concepts like virtual reality, augmented reality and metaverse etc.[Wan, 2021], reflects the trend of human growing demand for the communication between virtual and real reality. The presentation technology on computer display and mobile phone can be leveraged. A super dimension product with digital communication function can be with attractive appearance and comfortable usability.

Combining the different information presentation styles is a manifestation of engineering design thinking. We can create an appealing product integrating paper media, sensor and digital media. Beyond color tones, the knowledges on lighting, sonic and electronic sensors are also embraced. The customers can interact with the product by sensors to make experience intuitive.

Moreover, we expand the page shape by incorporating 3D pop-up models. The materials with unique visual texture or tactile perception in art is utilized as part of product design. Some surface embellishment techniques such as embossing, foil stamping, UV varnish, laser engraving and die cutting can all enhance the product's appeal (Figure 2).

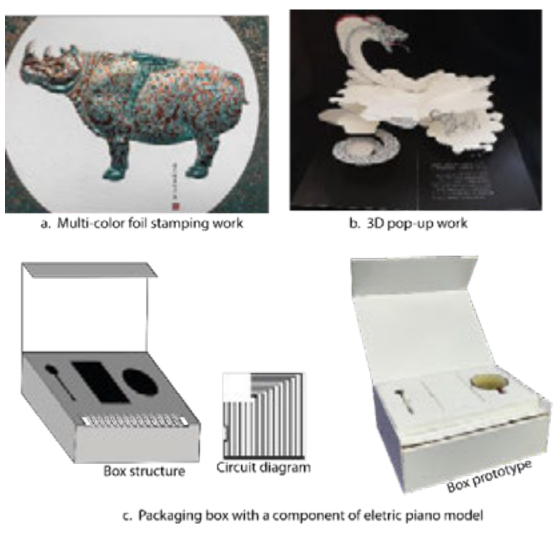


Figure 2: Designed product samples

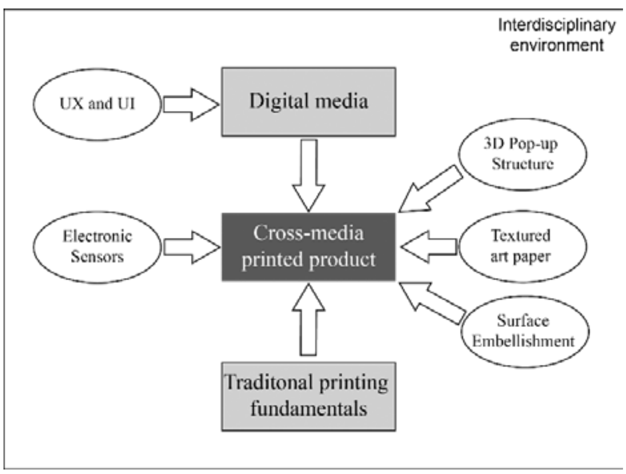


Figure 3: A curriculum system around cross-media products

3.3 Methods on the Cultivation of Comprehensive Thinking Ability

3.3.1 Fostering STEAM Skill in Printing Higher Education

Facing the future, one of the challenges is that the specialist and mono-disciplinary approach are no longer sufficient for preparing student for the job market or for addressing the complexity of society's problems and needs [Carter,2021]. In the Internet era abundant with shared information, it is a fact that the mono-disciplinary learning structure is a big limitation for the students' future development.

The major of graphic technology combines the engineering property and aesthetic requirement, necessitating the knowledge in image processing, graphics creation and page layout, geometric transform, color conversion, digital halftoning, chemistry and material etc. It is inherent with the STEAM property, science, technology, engineering, arts and mathematics. However, the traditional teaching contents in graphic technology generally focus on the specialized process control in printing for product manufacturing, leaving students with minimal exposure on systematic engineering design for the product.

Nowadays, the traditional printing is facing the threat from modern digital media. The best way to solve the problem is to serve the new media style. Digital media brings new knowledge and skill requirement for a student, not only on digitized manufacturing, but also on fulfilling interactivity and 3D modeling. The students also shall be with the knowledge on material, the appealing effects that manufacturing techniques take, and 3D shape construction methods on paper folding and unfolding or moving, and the special consideration facing different substrates. The above techniques look complicated, but they can give a product super dimension property.

After learning, the student can grow rapidly on their comprehensive thinking ability. Certainly, it is evident that the abundant knowledge requirement increases the amount of learning time. Are there enough learning hours to our students? The answer is no. An available way to solve the problem is to employ a project-focused method instead of the problem-centered method. We are exploring the method to encourage team collaboration[Jiong, 2021]. We set competition project or course project, inviting the tutors and students from the majors of Computer Informatics Science and Arts &Design to participate.

The students can be immersed in a project-centered process that stresses teamwork and collaboration across disciplines. An authentic, real world task can lead the students to deep understanding for what they are interested in. There are ample opportunities to realize their ideas and present their talents. The knowledge can also share by both tutors and students in the projects [Carter,2021].

Sam Altman, the current CEO of OpenAI said on himself in a recent interview, "…being like having broad knowledge that's very shallow and then in a couple of areas that I am particularly interested in, having deep knowledge and then figure out what I can do at the intersection of that." Our education system should expose the students to diverse subjects while guiding each of them toward some areas of interest, nurturing him with deep expertise in those domains.

3.3.2 Cross-media Creation Emphasizing UX Rule

Connecting a mobile app with the paper-based product, and incorporating the electronic sensors to it, this can create the interactive opportunities between the user and the product (Drew,2010). Then, the User Experience (UX) and User Interface (UI) design are very key on a modern printed product, considering customer satisfaction. A good UX design will make the product easy and enjoyable for people to use, while a good UI design will provide the product with aesthetic appeal and comfortable response time.

To create a super dimensional product satisfying customer's demand invovles a systematic thinking and realization process. Supporting on this, we set a course on interactive digital media with a project task assignment in it. The UX design principles and rules are its important content parts (Berni, 2021). The students are asked to conduct customer behavior research and then determine how the product will work. UX design is one kind of service design methods, which brings additive value to the product.

3.3.3 Expanding the Course Contents on Traditional Printing Involved Technology

The fundamental theories and technologies supporting on traditional printing involve color science, graphics processing, typesetting and typography, printing materials (e.g., paper and ink), printing replication technology, postpress finishing technology etc. The study of these related courses in the undergraduate program is still very key, which helps students form a comprehensive knowledge application framework on the manufacturing of a printed product, from the input to the processing to the output.

Our new curricular settings do not break the knowledge chain, but introduce some new elements around them. On color theory, we add the content on the control of color presentation on the different substrates, such as monitor display, art paper etc. On graphics processing, 3D scanning and modeling are included. On typesetting and typography, the technology on digital page description, such as html, css, JavaScript are integrated, even with the content on database programming. On printing replication technology, digital printing and the output performance on different material surfaces are added. On postpress finishing, the design of paper pop-up structure is included, also with the content on printed electronics. All the above added facilitate the design of an innovative and high-quality printed product (Fig.3).

Additionally, we change some previously mandatory courses on fundamental theory of chemistry and material principles in the old curriculum into the optional, balancing the teaching contents to accommodate students' interests and goals.

4. Results and discussion

In this paper, we deeply reflected on the core task of printing as an industry, and expose that its core task is to ensure the excellent presentation of graphics and texts layout. That is the reason why we ignored its unique property of low-cost replication in large amount, and mentioned that the printing engineering involved major in higher education can be named as the major of graphic technology. And we tried to analyze the industry's development and its possible requirement for the talents in the future. We focus on the cultivation goal of fostering creative competency in student.

We believe it is interesting for the individual with more experience and resources taken from the advanced techniques in a rapidly changing world. It will help him build the comprehensive design thinking with abundant new development chances, standing on the established background of graphic technology major. Over the last 7 years, we have introduced new courses in digital media, encouraging students to collaborate across disciplines while retaining the core printing fundamentals to ensure them with the physical understanding on product manufacturing. During this time, the student teams with interdisciplinary background have completed numerous intriguing projects, ranging from 3D pop-up structure designing to creating interactive product with Arduino or Raspberry Pi electronic board, and using delicately textured surface art paper for booklet or brochure. Our education aim is to equip the students with engineering design thinking around the cross-media printed product, based on the prospect of printing development in the future world.

Although the new curriculum system for undergraduate graphic technology is under construction at BIGC, the further improvement and refinement are necessary for its full implementation and availability.

5. Conclusions

The enterprises that can hold the future shall possess the capacity to create things for society, not just serve manufacturing purpose. Higher education serving society, it must evolve with the technological and the social development. The academic bachelor education shall prepare for the future demands of market. Its responsibility lies in developing the creativity cultivation system that has sensitive insight into the future development, shaping the cultivated students to become the intellects that guide and serve the future industry.

We have done an analysis of the three-level education model within the realm of traditional printing. Our proposal seeks to enrich the curriculum system for bachelor's education in graphic technology, particularly in the context of the Internet era. We recommend expanding the curriculum to encompass a range of multidisciplinary knowledge areas, including digital media, printed electronics, and 3D pop-up structures etc. These additions are poised to provide students with a robust foundation, facilitating the development of their capacities in digital design thinking and engineering design thinking, centered around a product concept. We advocate for the cultivation of STEAM skills and cross-media skills as pivotal elements in nurturing comprehensive thinking abilities among students. It is also important to underscore that the significance of traditional printing theories and technologies should not be disregarded within the framework of engineering thinking cultivation.

Acknowledgements

We would gratefully acknowledge the fund support of the BIGC Key Project of Pedagogical Innovative Research (2017), and the Beijing Pedagogical Innovation Project of Higher Education of Undergraduate (2021-180) to this research.

References

Berni, A., Borgianni, Y. 2021. From Definition of User Experience to a Framework to Classify Its Applications in Design. Proceedings of the Design Society, 1, 1627-1636.

Carter, C. E., Barnet, H., Burns, K., Cohen, N., Durall, E., Lordick, D., Nack, F., Newman, A. and Ussher, S., 2021. Defining STEAM Approaches for Higher Education. In: European Journal of STEM Education, 6(1), 13, 25-30.

Drew, D., 2010. Cross-Media Communications: An Introduction to the Art of Creating Integrated Media Experiences. Pittsburgh: ETC Press.

Guseva, V. 2019. Structural changes in the professional training of higher education students in Russia. In: Amazonia Investiga, 8(23), 693-706.

Jiong, L., Huaming, W., 2021, An innovative way on undergraduate education of printing around international engineering education standards. In: Packaging Engineering, 12(42), 171-175.

Natalya, S., Adekunle, O., Kim, W., Eddie, Lou, 2020, Design Engineering Handbook. New York:InVision.

Razzaq J., Townsend T., Pisapia J., 2013, Towards an understanding of interdisciplinarity: The case of a British university, In: Issues in interdisciplinary studies, 31, 149-173.

Septiyanto,A., D. Oetomo ,Indriyanti ,N. Y., 2023, Analysis of students' attitudes towards engineering and technology viewed from school area differences. In: AIP Conference Proceedings 2540, 110011, Surakarta, Indonesia.

Soyang, E.,2023. 2023 Print Industry Report. Accrington, Lancashire:Soyang Europe.

Wan,Z., Gaimei, Z., 2021, Research on simulation experiment in printing and packaging by virtual reality technology with innovative engineering ideas. In: Packaging Engineering, 12(42), 155-157.

Swearing, Fighting, Three Letters and a Space: Joseph Moxon's printing house chappel rules

Kenneth Macro [1]

[1] The California Polytechnic State University, San Luis Obispo, California, USA

E-mail: kmacr@calpoly.edu

Abstract

Joseph Moxon's second volume of Mechanick Exercises: or, the Doctrine of handy-works Applied to the Art of Printing (1683) is the first essential written standard operating procedure manual for letterpress printing and production protocol for the printing business of the times. A resident printer in London, and a renowned member of the Royal Society of London, Moxon assisted in bringing an enhanced awareness of the complicated art, tasks, and duties surrounding letterpress printing to the general public. Along with this, he provided further insight into the establishment of community amongst the dedicated workers of the print house—including the rules of the chappel. This short seminar will investigate these rules further and report on the contemporary effects they have had on the student curators who operate a current student-run letterpress museum on the Campus of Cal Poly—without any remuneration of solace.

There have been formerly Customs and By-Laws made and intended for the well and good Government of the Chappel, and for the more Civil and orderly deportment of all its Members while in the Chappel; and the penalty for the breach of any of these Laws and Customs is in Printers Language called a Solace.

Joseph Moxon (1683)

Mechanick Excercises: or, the Doctrine of handy-works Applied to the Art of Printing - The Second Volumne, p.

Culture

Culture is an all-encompassing phenomenon. Studied by many disciplines, theorized by scores of academicians and philosophers alike, and captured in an eternal array of discourse and publications, humankinds' quest to understand the behaviors of human belongingness—the spoken and unspoken, written and unwritten, the instinctive compliance to rituals, traditions, and customs of people, has been the defining foundation for understanding the vast idiosyncrasies that determine a group, or a tribe, or an organization.

Anthropologists, archeologists, sociologists, psychologists, as well as many business professionals, observe and codify behaviors of select cultures (often embedded within) to best understand them. Since the advent of printing (as a craft then industry), sociologists have studied and gained insight into this unique grouping of people. Often misplaced and misunderstood, printers often set up shops in buildings that were dark and cold, spending an enormous amount of time preparing casting type, meticulously setting forms, and printing works well into the night. Considered a dirty and relatively dangerous craft, they found consolation amongst themselves as they identified with one another.

Thorstein Veblen (1857-1929), an American sociologist who authored the paper The Theory of the Leisure Class: An Economic Study of Institutions (1899), gained great interest in the culture of "The Printer." His studies expanded upon the understandings surrounding social class, social stratification, the division of labor (middle class and working class) in industrialized occupations, as well as consumerism. As such, he determined that to define a social class the laborer employed there within required an internalized possession of dignity, honor, and self-worth.

Veblen is acknowledged with coining the term and phenomena known as "conspicuous consumption." Conspicuous consumption is essentially a sociological phenomenon that measures the value of materialism accepted by a member in a given community required to remain a member of that community. In comparing a farmer in the country to a man in the city, Veblen (2001) wrote, "This method is therefore more readily resorted to, and in the struggle to outdo one another in the city population push their normal standard of conspicuous consumption to a higher point, with the result that a relatively greater expenditure in this direction is required to indicate a given degree of pecuniary decency in the city" (p. 66).

Veblen, in studying conspicuous consumption, took great interest in the labor class employed within the confines of the city. Most particularly, he made observations of journeymen printers. Veblen (2001) posited that journeymen printers, "among the lower middle class of the urban population," were renown to possess many habits that contributed to the form of conspicuous consumption pertaining to vogue. Drinking and smoking in public places were often associated with this class. Recognized by the aristocracy to be slightly moral deficiency, printers engaged in this kind of activity to remain in their own social clique (Veblen, 2001, p. 67). Hence, the ability to differentiate between a blue-collar labor and a white-collar businessman became more prevalent.

In his observations, Veblen (2001) also took notice to the degree of skill required by the journeyman printer. He wrote, "this occupation requires more than the average of intelligence and general information, and the men employed in it are therefore ordinarily more ready that many others to take advantage of any slight variation in the demand for their labour from one place to another" (Veblen, 2001, p. 67). Additionally, Veblen wrote of the printer's ability to transition from place to place, as a direct result of their attributed skills—both mechanical and communicative. Veblen believed that the printer engaged in dissipation—with regards to conspicuous consumption—because of their enhanced "ease of movement and the more transient character of acquaintance and human contact in this trade" (Veblen, 2001, p. 68). In other words, printers, in their own class, possess an advanced intellectual prowess that is comprised of enhanced communicative skills, technological acclimation, and the ability "fit in" wherever they are placed within an organization. Today, unlike other occupations where the introduction of manufacturing technology is long and gradual, printers have had to undergo great technological change in short periods of time which has inadvertently lessened the institution's reliance on their workforce's intelligence. When printing became a manufacturing process, the printer transitioned from a respected craftsman to a simple machine operator caught in a social black hole of class displacement offset by brandished conspicuous consumption.

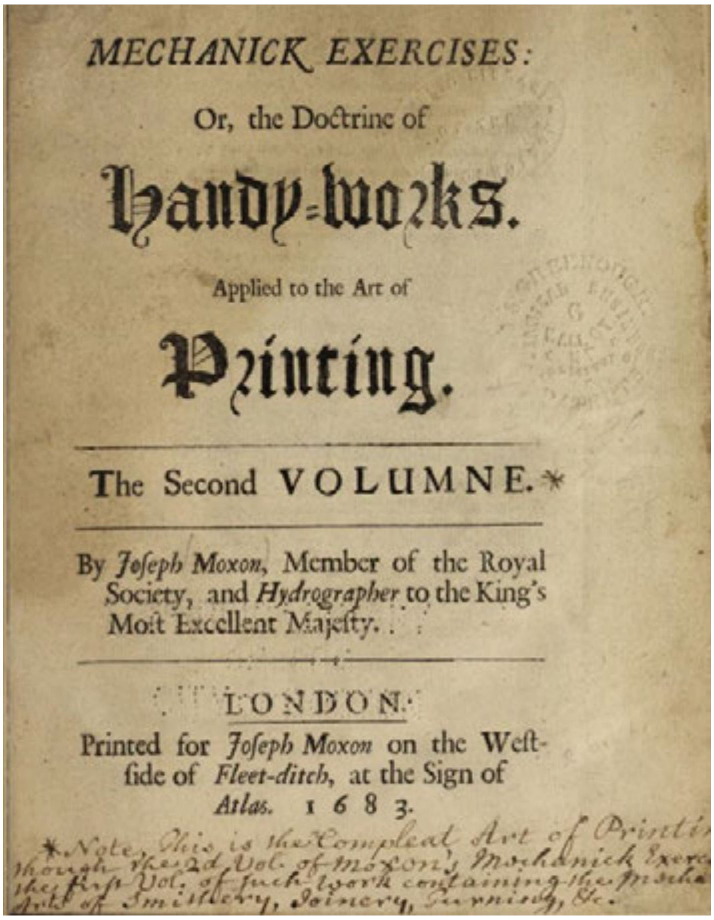
Joseph Moxon

It is of no doubt that Veblen, amidst his studies, ran across the works of Joseph Moxon, a printer from 17th century England. Moxon, born in Wakefield, England in 1627, was raised a printer as his father set up press in London in 1647. Here, Moxon learned the trade of printing and all of the other facets of the operations including letter cutting, mold-making, casting, type composing, paper making, ink making, signature impositioning, binding, and press preparation and operation. So entrepreneurial was Moxon and his enhanced yearning for knowledge that he also expanded into the making and selling of globes and spheres, the making of mathematical and astronomical instruments and tools, and the selling of books. Because of multiple interests, he became acquainted with budding scientists associated with the Royal Society (Hooke, Newton, Ashmole, Pepys, Halley, Hobbes, Boyle, etc.) and, was inducted himself in 1678, the first for any tradesmen and/or printer at that time. Because of his rising and prominent status among these men, he was also appointed Royal Hydrographer under the reign of King Charles II (see his portrait in Figure 1, below).

Figure 1. Joseph Moxon. National Portrait Gallery, London. 2023.

Having taken great pride in his induction into the Royal Society, it was during this time that Moxon decided that it would be in the best interest of the scientific and academic community to acknowledge the contributions of the tradesman to the Baconian mantra of applied science. It is here where Moxon began his magnum opus: Mechanick Exercises for the Doctrine of Handy Works Applied to the Arts of Smithing, Joinery, Carpentry, Turning–Volume I (1678); and, Mechanick Exercises for the Doctrine of Handy Works Applied to the Art of Printing – Volume II (1683). Volume I of Mechanick Exercises was considered by historians to be the first true Instruction Manual the trades and a necessary mode for preserving—and standardizing—mechanical traditions and crafts.

Upon Moxon's release the first edition of Mechanick Exercises or the Doctrine of Hany-Works Applied to the Art of Printing, Volumne II by Joseph Moxon, Member of the Royal Society, and Hydrographer to the King's Most Excellent Majesty, this masterpiece was a 394-page tome complete with 35 copperplate engravings (see Figure 2). The book was the first manual of printing to be written in any language but cemented in the traditional vernacular of middle-class English society. The genius of Moxon was not lost on this opus, for, as a printer himself, Moxon's enhanced and applied knowledge of the craft made him to be the perfect author. Moxon understood that the average person, or educated aristocrat, or even applied scientist, did not truly grasp the extended talents and intellectual prowess the printer possessed. When reading a book, for example, one takes for granted each individual letter placed within a word, so well-spaced within a sentence, stacked upon one another and equally placed within columns upon a page, strategically arranged into signatures that are—like a puzzle—bound within a book that is so easy to read.


MECHANICK EXERCISES:

Or, the Doctrine of

Handy-works.

Applied to the Art of

Printing.

The Second VOLUMNE.*

By *Joſeph Moxon*, Member of the Royal Society, and *Hydrographer* to the King's Moſt Excellent Majeſty.

LONDON.

Printed for *Joſeph Moxon* on the Weſt-ſide of *Fleet-ditch*, at the Sign of *Atlas*. 1683.

*Note, This is the Compleat Art of Printi
though the 2d Vol. of Moxon's Mechanick Exer
the first Vol. of such work containing the Mecha
Art of Smithery, Joinery, Turning, &c.

Figure 2. Title Page. Jospeh Moxon (1683), Mechanick Exercises Vol II, p.4.
https://archive.org/details/mechanickexercis00moxo_0/page/356/mode/2up?view=theater

Because of Moxon's comprehensive understanding of the printing processes, his contribution to details pertaining to each of the components executed within, were extraordinary. His familiarity with metals, punch making, typecasting, matrix construction, typesetting, and the printing process itself—complete with pagination and binding alike, filled pages of extremely meticulous explanation of tacit knowledge—rarely codified—of these processes in explicit and detailed formation. And, because of Moxon's association with the academic and elite communities at the time, knew that the very books collected by the Fellows within the Royal Society were the output of highly skilled, intelligent and gifted tradesmen versed in mathematics, chemistry, metallurgy, reading, writing, and often theology, philosophy, astronomy, and geometry. Moxon knew Typographie and the Typographer. He wrote:

> I mean such a one, by his own Judgement, from solid reasoning with himself, can either perform, or direct others to perform from the beginning to the end, all the Handy-works and Physical Operations related to Typographie. Such a Scientifick man was doubtless he who was the first inventor of Typographie; but I think few have succeeded him in Science, through the number of Founders and Printers be grown very many: Insomuch that for the more easie managing of Typographie, the Operators have found it necessary to divide it into several Trades, each of which (in the strictest sense) stand no nearer related to Typography than Carpentry or Masonry & are to Architecture. (Davis and Carter, 1958, p.12)

In publishing this fine work, it is obvious that Moxon's intent was to create a comprehensive manual that would "describe methods current in printing houses" and to "offer practical guide-lines for composing and printing" (Janssen, 2000, p.154). Furthermore, his "aim is to describe the correct techniques and methods, supply 'Rules that every one that will endeavor to perform [these Handy-works] must follow" (Janssen, 2000, p. 154). According to Derick Long, in writing Mechanick Exercises Volume II, Moxon eloquently "described with great care the tools and the skilled movements that had produced masterpieces of the craft" (Long, 2013, p. 94). The book became a standard textbook for the trades for over a hundred years and, even to this day, is referenced by letterpress printers and hobbyists who print using these tools and presses of past. For Moxon, Mechanick Exercises Volume II was an attempt to establish a basis for operating a printing facility that effectively generates high-quality output in an efficient manner, and in doing such, also maintaining a productive and nurturing culture.

The Chappel and the Solace

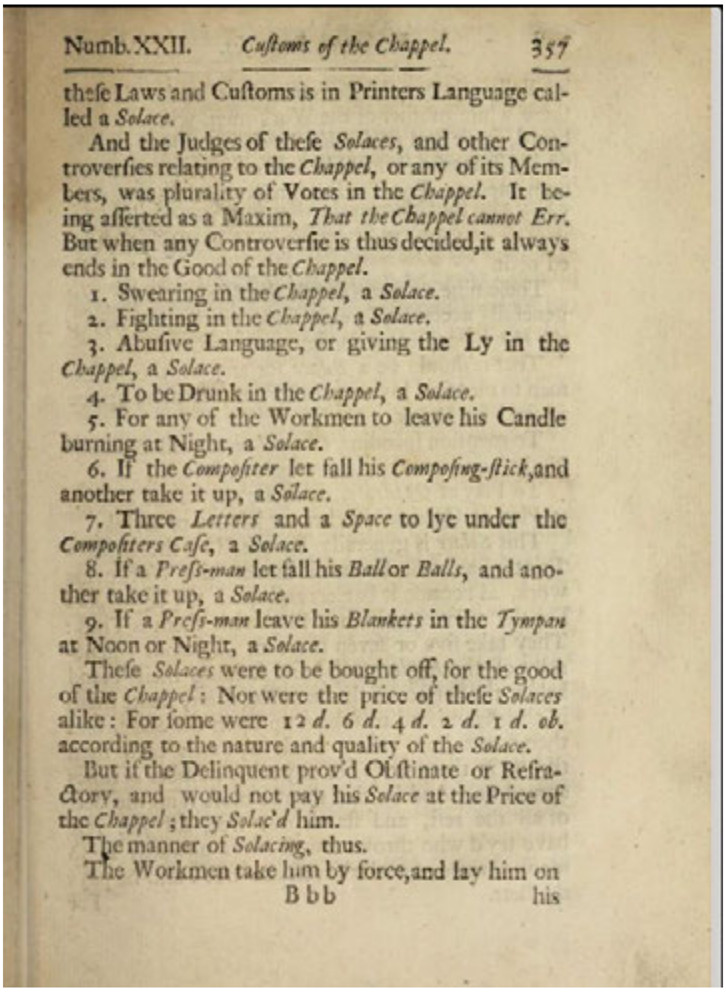
It is in the appendix of this book, however, that Moxon takes liberties to address the importance of culture and traditions within the selective halls of printing establishments strewn amongst 17th Century societal landscape. So important were understanding the closeness of the printing house and all those employed within that Moxon authored a separate insert entitled "Customs of the Chappel – Ancient Customs used in a Printing-House." Like Veblen, Moxon understood the necessity to codify this unknown and unique system that—when executed—provided a means of belonginess for all that engaged within the institution, as well as a set of laws, rules, and guidelines for conducting one's work, interacting with one's co-worker, maintaining one's behavior, preparing for the end of the shift, properly cleaning the workplace, understanding any applicable disciplinary processes, and, more importantly, implementing celebratory events.

The Chappel, according to Moxon, is a term rendered by the church of years gone by. Davis and Carter (1958) trace its origins to a printing house in Antwerp in the early 17th century and believe it to have derived from an old name pertaining to workers who wear hats while they work (p. 383). In the opening quotation at the top of this paper, Moxon identifies the purpose of the Chappel and the consequences an employee must assume in the event of a breach, in the form of a solace or a fine. Davis and Carter (1958) attribute the word solace entirely to the printing discipline. As such, each employee was required to pay money (as identified as a solace) in the form of dues, fines, free-will offerings into a collective pot for which the proceeds could be used for communal celebrations, feasts, and gifts for weddings and births (p. 384).

Moxon lists the primary offenses (see Figure 3) and their equivalent fines most accustomed to the Printing-House Chappel (Davis and Carter, 323-324):

1. Swearing in the Chappel – one solace
2. Fighting in the Chappel – one solace
3. Abusive language, "or giving the Ly in the Chappel" – one solace
4. To be Drunk in the Chappel – one solace
5. For any of the Workmen to leave his Candle burning at night – one solace
6. If the Compositor let fall his Composing-stick, and another take it up – one solace
7. Three Letters and a Space to lye under the Compositors Case – one solace
8. If the Press-man let fall his Ball or Balls, and another take it up – one solace
9. If a Press-man leave his Blankets in the Tympan at Noon or Night – one solace

As it were, according to Derek Long (2013), a Moxon biographer, these solaces were to actually be delivered as a physical punishment consisting of "eleven blows on the buttocks with a paper-board given by a fellow workman 'laid on according to his own mercy" (Long, 2013, p.103). However, these solaces could be waived for a price, as set by the individual chappel, which would be then paid to the common coffers or account for the good of the chappel and to assist in funding future celebrations or events. This was the normal outcome, but Long (2013) notes, "if the delinquent proved obstinate and would not pay, he was duly solaced" (p. 103).


Numb. XXII. *Cuſtoms of the Chappel.* 357

theſe Laws and Cuſtoms is in Printers Language called a *Solace*.

And the Judges of theſe *Solaces*, and other Controverſies relating to the *Chappel*, or any of its Members, was plurality of Votes in the *Chappel*. It being aſſerted as a Maxim, *That the Chappel cannot Err*. But when any Controverſie is thus decided, it always ends in the Good of the *Chappel*.

1. Swearing in the *Chappel*, a *Solace*.
2. Fighting in the *Chappel*, a *Solace*.
3. Abuſive Language, or giving the Ly in the *Chappel*, a *Solace*.
4. To be Drunk in the *Chappel*, a *Solace*.
5. For any of the Workmen to leave his Candle burning at Night, a *Solace*.
6. If the *Compoſiter* let fall his *Compoſing-ſtick*, and another take it up, a *Solace*.
7. Three *Letters* and a *Space* to lye under the *Compoſiters Caſe*, a *Solace*.
8. If a *Preſs-man* let fall his *Ball* or *Balls*, and another take it up, a *Solace*.
9. If a *Preſs-man* leave his *Blankets* in the *Tympan* at Noon or Night, a *Solace*.

Theſe *Solaces* were to be bought off, for the good of the *Chappel*: Nor were the price of theſe *Solaces* alike: For ſome were 12 *d.* 6 *d.* 4 *d.* 2 *d.* 1 *d.* *ob.* according to the nature and quality of the *Solace*.

But if the Delinquent prov'd Obſtinate or Refractory, and would not pay his *Solace* at the Price of the *Chappel*; they *Solac'd* him.

The manner of *Solacing*, thus.

The Workmen take him by force, and lay him on

B b b his

Figure 3: Customs of the Chappel, Joseph Moxon, 1683, Mechanick Exercises Vol II. p. 357.
https://archive.org/details/mechanickexercis00moxo_0/page/356/mode/2up?view=theater

It is apparent that Moxon understood the value of community and culture in maintaining productivity and quality within the confines of the printing house. He also recognized how unique the printing community (and subsequent culture) were particularly when compared to other craftsmen, guilds, and other industrialised disciplines. Printers, as such, developed a conditioned level of hierarchical respect within the divisions of labor and thus established a need for the codification of rules and/or guidelines for maintaining a civil, organized, clean, safe—and fun—working environment.

Moxon makes mention to the playing of Quadrats, a gambling game that printing house workmen would play involving the throwing of quadrats—typemetal spacers used in setting type that were formed with nicks for better placement. Workmen would throw five to seven quadrats onto to a stone at that same time, whilst placing bets, and count the number of nicks landing upward and the one with the least is resolved to pay the debt.

Additionally, life events also required a payment to the community coffers. Moxon (1683) wrote: "If a Journey-man marry, he pays half a Crown to the Chappel. When his Wife comes to the Chappel, she pays six Pence: and then all the Journey-men joyn their two Pence apiece to Welcome her. If a Journey-man have a Son born he pays one Shilling. If a Daughter born, six pence" (Davis and Carter, 1958, p. 328). Again, the money collected was used to fund the payment of Holidays (not on a Sunday) for all of the workmen based on their assigned wages for a day's work. Remaining funds were used to pay for a Waygoose, or celebration, coordinated by the Master Printer in the month of August to mark the beginning of the season "of working by candlelight" (Long, 2013, p. 104). The Waygoose celebration generally fell in conjunction with St. Bartholomew's Day which was usually scheduled on the 24th of August each year.

Moxon also describes—in vivid detail—another great annual celebration that was inclusive of all of the London printing community: "Printers of London, Masters and Journeymen have every year a general Feast, which since the rebuilding of Stationers' Hall is commonly kept there" (Davis and Carter, 1858, p. 329). This celebration was known as May Day (usually around the third day of May) which began with a procession from Stationer's Hall to a selected church for a sermon and prayers, and then back again to the hall for the feast itself. Moxon wrote:

> The Tables being furnished with variety of Dishes of the best Cheer and Beer, Ale and Wine of all sorts; And to make their Cheer go cheerfuller down they are entertained with Musick and Songs all Dinner time. Healths are drunk and a collection made for the relief of Printers Poor Widows. The Ceremony being, over such as will go their Ways; but others that stay, are Diverted with Musick, Songs, and Dancing, Farcing till at last they all find it time to depart. (Long, 2013. p.105).

Throughout Moxon's Mechanick Exercises on the Whole Art of Printing it is evident that his passions for the all-encompassing processes of printing were inescapable and vast. The details that he captured in explaining these processes required for the successful production of the printed sheet and all the professional personnel and duties assigned therein are predicated on his experiences and his emerging love of science. Moxon wrote, "For my own part, I weighed it well in my thoughts, and find all the accomplishments, and some more of an Architect necessary in a Typographer: and thought my business not be Argumentation, yet my Reader, by perusing the following discourse, may perhaps satisfie himself. That a Typographer ought to be a man of Sciences" (Davis and Carter, 1958, p. 10). To Moxon, and much like Thorstein Veblen, the art of printing required a multitude of skills and intelligence. An environment that necessitated literacy, proficiency in multiple languages, understanding of basic mathematical and astronomical formulas, dexterity, and patience, the uniqueness of the community that formed was integral to its success. As Veblen remarks, from his observations, how interesting the printer "fits in" amongst his peers, it is within this community that emits the brilliance of the printing house and the foundation of the chappel that keeps it stabilized.

Lean Culture

Although not associated nor acknowledged within the contemporary Lean Manufacturing communities, it is important to take a moment to recognize Moxon's contributions as such. Joseph Moxon, member of the Royal Society, Hydrographer to the King's Most Excellent Majesty, Printer, Author, Translator, Maker of Globes and of Spheres, Maker of Maps and of Mathematical Instruments, Engraver, Entrepreneur, is the quintessential Renaissance Man. A tradesman living in a time of great scientific intrigue and discovery, Moxon, rightfully contributed his scientific discoveries—in the forms of tutorials and manuals written for the common man—as a testimony to all printers who have helped in the progression of the Scientific Revolution. For without them, books would not have been printed, knowledge would not have been shared, and innovation and discovery would have been possibly retarded and/or stifled.

Moxon's Mechanick Exercises Volume II was the first scientifically influenced instructional manual and guide for the trades. But more importantly, it was the beginning of the concept of standardized work, a term made most popular after World War II within the automotive manufacturing industry. Coming out of the war in Japan, in 1946, Toyota Motor Company was attempting to recover and, therefore, in need of ramping up their production. As such, they were forced to re-group their community and re-start within their given infrastructure, which was rather difficult given the damage that they suffered from the War.

To gain perspective, a management team was assembled and tasked with codifying detailed practices of current processes employed. These processes provided further insight into the development of standardized work—that is—detailed descriptions of work tasks and activities shared with all personnel for working more efficiently, effectively, and in a standardized and orderly fashion. This is exactly what Moxon accomplished 1680. "At Toyota" writes Liker and Meier, "the primary tool that dictates the work method is standardized work, which defines who, what, when, and where work is to be performed." And, with regards, to standardization, Liker and Meier posit "'To eliminate waste, we must reduce or eliminate variation within processes. Variation is the antithesis to standardization. By definition, variation implies the inability to standardize. [t]he isolation of variation is a key to the establishment of standardized work methods and procedures" (Liker and Meier, 2006, p.118). Joseph Moxon's Mechanick Exercises Volumes I and II were the catalyst to perfecting and improving technological discovery (for an example, see Figure 4, below).

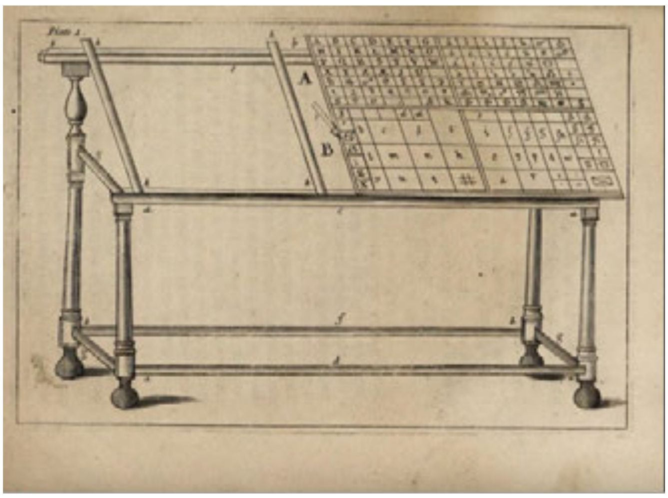


Figure 4. The Type Case (an etching by Moxon). De Vinne (1896), Mechanick Exercises, p. 18.

Based on seventeenth-century scientific modelling, Moxon created a new way to perfect—and standardize—the use of technology for continuous improvement. And, as Thorstein Veblen would submit, it would be the attributed to the printing establishment's ability to maintain a culture of customer, traditions, collectiveness, hierarchy, respect, and camaraderie—a constant in Moxon's formula as exhibited in his books and in introducing the Printing House Chappel to his current and future readers.

Today, printing and packaging manufacturing enterprises spend many resources and time in gaining insight to their production processes. As such, many employ Lean practices which seek to eliminate waste within the production milieu with aspirations of reducing costs, diminishing errors, improving quality, and enhancing productivity. Many firms today study Lean philosophies which stem from the Toyota Production System (TPS). These philosophies are rooted, essentially, in continuous improvement and cultural development. Mike Rother (2010) writes, "Any organization whose members can face unpredictable and uncertain situations (which are the norm) with confidence and effective action, because they have learned a behavioral routine for doing that, can enjoy a competitive advantage" (Rother, 2010, p.19). This mantra correlates to Moxon's observations and reasoning for including the chapter regarding the rules of the Chappel within the Printing-House. Moxon knew that printers, who amongst themselves were conditioned to long hours, unfavorable working conditions, persistent perfection, and the possession of the utmost of patience, also enjoyed their playtime as well and therefore required "rules" for governing themselves so that they would contribute to the betterment of the whole community and—at the same time—maintain productivity levels and enhanced quality output. This, in turn, would provide them with the competitive advantage that they inevitably needed.

Conclusion

Today, culture has even more relevance. With all the technological advancements that have been made over the past one hundred years, enhanced digital communication, integrated work-flow systems, enterprise-wide management systems, robotic automation, and the recent emergence of applied artificial intelligence, organizations struggle in developing a comprehensive culture that provides value for their constituents. Social media has confounded the process (all some would posit that it has helped) for generating a consistent core culture that is established around rules, etiquette, commitment, and respect.

In the Graphic Communication program at the California Polytechnic State University, a working letterpress museum is placed on the first floor of the department. It is called the Shakespeare Press Museum. Containing all sorts of original letterpress equipment and a large collection of metal type ranging from 1840-1950 (California Gold Rush Era), students work daily on projects of self-interest and curiosity. The collection was bequeathed by Mr. Charles Palmer in 1956. He owned a small press in Fresno California and was a writer and poet. His nickname was "Shakespeare," hence the name The Shakespeare Press Museum.

Over the years, students have come and gone and, as such, have left a multitude of set type for projects in galley trays strewn throughout the museum space. The type has been set and used but, unfortunately, not replaced into the appropriate cases designated for each of the selected fonts chosen. It has been a primary mission over the past two years to rectify the problem and make progress in properly identifying the type font family, size, and case location. The Shakespeare Press Museum club (complete with two museum curators and four club officers) has embarked in this enormous task and have gained an understanding for Moxon's rules of the chappel.

To date, the Shakespeare Press Museum Club has formed an official Chappel and constructed a written decree that lists all of Moxon's improprieties—along with some more contemporary matters—that all students engaging in typesetting and printing activities must officially sign before beginning their projects. The results have been overwhelmingly positive and a community has been formed along with a newly agreed-upon numerical valuation of the chappel's solace (1 = 25 cents). Additionally, the fighting and swearing has stopped…except, of course, when they find three unidentified letters and a space on the floor from the preceding day.

Joseph Moxon provided a basis for establishing a working community in need of developing a productive culture through the introduction of the chapter: "Ancient Customs used in a Printing-House." He could have very easily edited this chapter out of the book without any loss. However, because of his experiences and his understanding for encompassing force that contained and defined this discipline, he was so moved to add it complete it in vivid detail and reverential respect. Joseph Moxon was able to stand amongst the giants of science, namely, Newton, Hooke, Boyle, Hobbes, Ashmole, and Pepys, and submit his own work that would properly acknowledge the paradigm of print as a purveyor of power and knowledge, a contributor to the advance of science, and, most importantly, purvey the printer as one with the reputation of a good and curious Work-man.

Three letters and a space found on the floor? One solace.

References

Davis, H. and Carter, H. (1958). (Ed). *Mechanick Exercises on the whole art of printing – Volume II* by Joseph Moxon, 1683. Oxford, England: Oxford University Press.

Liker, J. and Meier, D. (2006). *The Toyota Way Fieldbook: A practical guide for implementing Toyota's 4ps.* New York, NY: McGraw-Hill.

Long, D. (2013). '*At the Sign of the Atlas': The life and works of Joseph Moxon – A Restoration Polymath.* Donington, Lincolnshire, UK. Shaun Tyas.

Janssen, F. (2000). "The First English and the First Dutch Printer's Manual: A Comparison" *Quaerendo* (30:2). 154-158.

Rother, M. (2010). *Toyota Kata: Managing people for improvement, adaptiveness, and superior results.* New York, NY: McGraw-Hill.

Veblen, T. (2001). *The theory of the leisure class* (1899). New York, NY: Modern Library.

De Vinne, T. (1896). *Moxon's Mechanick Exercises or the Doctrine of Handy-works applied to the art of Printing: A literal reprint in two volumes of the first edition published in the year 1683.* New York, NY: The Typothetae of the City of New York.

Moxon, Joseph. (1683). *Mechanick Exercises: Or, the Doctrine of Handy-Works. Applied to the Art of Printing, The Second Volumne.* Retrieved online from: https://archive.org/details/mechanickexercis00moxo_0/page/356/mode/2up?view=theater

Creating Block Printing Plates Using a Laser

Charles T. Weiss, USA

Abstract

Traditionally block printing plates are etched by hand. This is a long process that is very meticulous and often very frustrating. Today's college students are very excited about the world of analog printing but are not very excited about hand etching a plate in linoleum or word. The addition of a laser to etch the plates makes this process much more appealing to the students, while still keeping them excited about analog printing.

Students can now design original pieces of art in an illustration software and then instead of having to hand etch the details manually, they can use a laser etcher/cutter to engrave the wood or linoleum plate. The use of a laser to etch the plate speeds up the entire block printing process and is especially helpful to those students who do not have the desire or patience to hand etch a plate. The laser etching provides students the chance to move quickly from the digital world of their computer, to the analog world of hand printing.

This presentation will highlight some research conducted by students on this subject as well as research conducted by a faculty member. Specific details on the laser intensity as well as materials used to etch will also be included. Traditional wood was used to create the laser-etched wood blocks and linoleum was used to create the laser-etched lino blocks. The positives and negatives of both processes will be discussed in detail. Costs and specific material requirements will also be reviewed. Details on the laser etching machine will also be shared.

While some might say the art of block printing is tied to etching by hand, the laser etcher provides a safe manner in which to cleanly etch very high detailed imagery onto a wood or lino block. This use of the laser etching machine to create the blocks makes this printing process more accessible to students who are not enrolled in a traditional art program, but rather a graphic communication program that may not include fine art reproduction processes.

Keywords: Block Printing, Laser Etching, Lino Prints, Wood Blocks

Practical Challenges in Hybrid Conventional-UV Offset Printing

Daiva Sajek, Lithuania

Abstract

Hybrid printing is used to merge the capabilities of flexography, offset and digital printing technologies. Hybrid printing presses make it possible to achieve high-quality especially in the production of packaging and labels using various inks in the different units of the press, various drying and curing technologies, etc. Hybrid printing provides the flexibility to convert prints in-line, decorate and finish various production in a single pass.

However, another printing technology present in the market is also called hybrid one, when only one type of inks is used in one offset printing press at a time. Thus, with proper preparation of the press, the type of inks can be changed at once in all its printing units. This technology is applied in the hybrid offset printing presses when conventional printing inks can be replaced with UV inks and vice versa. Manufacturers can change inks and drying sources accordingly based on the characteristics of the printed material and products.

Today, different UV curing technologies and its modifications from various manufacturers are available in the market: Low Energy UV (Heidelberg), High Reactive UV (KBA), LEC-UV, LED-UV (Manroland), and H-UV (Komori,) etc. The use of inks that cure exposed to different lengths of UV light waves allows printing on non-absorbent surfaces, and the ink layer has to cure almost instantly due to the reaction of polymerization induced by photoinitiators present in these inks. This is particularly important when printing packaging which has to be cut or folded immediately after printing.

The possibility of application UV technologies in hybrid offset printing presses can be considered as very convenient, yet some difficulties may arise in practice. The transition from one ink to another, when the inks are chemically incompatible, requires an appropriate preparation of all units of the printing press, including cleaning of the output device; washing of the ink rollers; change of the offset rubbers and dampening solution, etc. As practice showed, preparation of the hybrid printing press for the transition from oil-based inks to UV printing inks can be time-consuming ranging from 12 to 15 hours, as the process requires a large number of repetitive washing cycles of the ink rollers and a large amount of special washing materials and pastes. In all cases, the transition from conventional printing with oil-based inks to UV printing with UV curing inks and vice versa was time-wasting and complicated, even if it is done by experienced printing press operators-instructors. Unproductive labour is accompanied by the use of a significant amount of chemical materials, water wastage which is not environmentally friendly and does not always give a desirable result.

As practical studies in a printing company showed, even after a thorough preparation of the printing press in accordance with all instructions, the quality of the prints can be poor. For these reasons, some printing press operators often do not take advantage of the capacities of the hybrid printing presses to print with both types of inks.

The study analyses challenges that arise using conventional and UV offset printing technologies, i.e. oil based and UV offset printing inks alternately on a hybrid printing press. The main challenges were analysed: time consumption and complexity of equipment preparation to the transition; the quality of prints printed after the transition.

Prints printed on Metalprint Silk metallized cardb oard, 309 g/m^2, after the transition from conventional to H-UV inks, were assessed in the printing shop immediately after printing using TESA 4104 adhesive tape. The prints were tested in the using Ink Rub Tester Kinsgeo KJ-8310 JIS5701, 24 hours and 30 days after printing. The results showed that the ink adhesion and fixation on the print is not sufficient, as the ink layer peels off with a help of the adhesive tape when tested at different intervals: 5-10 min and 15-20 min after printing. The H-UV ink layer also rubs off the surface when tested with Rub tester 24 hours after printing. The situation is different when the prints are rubbed 30 days after printing. In this case, the rub resistance is significantly higher and the prints rub off slightly, as shown both by visual assessment and Delta E spectrophotometric measurements (Sajek et al. "Analysis of problems using conventional and H-UV technology in the hybrid offset printing press". International Circular, Issue 14, pp. 1-13).

Keywords: H-UV technology, UV inks, hybrid printing press, UV curing, rub resistance

ISBN 978-618-81734-4-6

International Circle
of Educational Institutes
of Graphic-Media
Technology
& Management

international
circle