

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

55th IC Annual Conference

CONFERENCE PROCEEDINGS

08-11 September 2024



"Future Orientations for Print-Media Education"

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Published by





50th Conference of iarigai | 55th Conference of IC

International Research Conferences of iarigai & International Circle

08-11 September 2024 | Zurich, Switzerland



Day 1

Sunday, 8th September 2024

14:00 - 17:00 Board meeting

At the GEP Pavillon

18:00Welcome reception at GEP Pavillon, Zurich
Registration start (at the Pavillon)





GEP Pavillon is at the west end of ETH historic main building (HG), Center campus

Day 2								
Monday, 9 th September 2024								
08:30 - 09:00	Welcome coffee (Foyer D -Nord)							
08:30 - 9:00	Welcome and registration ETH Zurich, Center Campus, Historic Main Building, D-Floor, Foyer D-Nord							
09:00 - 10:30	Opening session iarigai, Room D1.1							
09:00 - 09:10	Opening of the conference Fritz Bircher, President of <mark>iarigai</mark> and Conference Director							
09:10 - 09:15	inspire - Welcome addresses Dr. Martin Stöckli, COO inspire AG							
09:15 - 09:20	ETH Zurich - Welcome addresses Dr. Jan-Helge Zimmermann, Industry Relations, ETH Zürich							
09:20 - 09:40	What can research do, to evolve with functional printing towards industry Fritz Bircher, inspire Zurich							
09:40 - 09:45	Introduction of new members							
09:45 - 10:00	JPMTR - iarigai scientific publishing platform Daniel Bohn, Editor-in-Chief							
10:00 - 10:30	Invited opening presentation A vision on functional printing in 2024 Bart Verlinden, YPI-SAS - Belgium							
10:30 - 11:30	Plenary session 1 - New dimensions of printing, Room D1.1 Chair: Fritz Bircher							
10:30 - 11:00	Keynote 1 Additive manufacturing in pure and high-density metals at the micro- and nanoscales Dr. Alain Reiser, Assistant Prof., KTH Stockholm - Sweden Prof. Ralph Spolenak, Chair of the Laboratory for Nanometallurgy, ETH Zurich - Switzerland							
11:00 - 11:30	Keynote 2 Packaging, so what? - How fast changing market dynamics fuel the need for operational efficiency in packaging print production Jan de Roeck, Director Industry Relations & Strategy, ESKO - Belgium							
11:30 - 12:00	Coffee break (Foyer D -Nord)							

Room D1.1

12:00 - 13:15	Session 2 A – Additive Manufacturing	Session 2 B – Print Quality				
	Chair: Daniel Bohn	Chair: Cathy Ridgway				
12:00 - 12:25	Multi-material fused deposition modelling (FDM) technology for extended product's functionality and enhanced production flexibility	Influences of printer speed, mesh and glass surface types on the quality and adhesion of screen-printed elements				
	<u>Li Yang</u> , Henrik Petterson, Jonathan Olofsson and Philip Palmaer - Sweden	<u>Sandra Rosalen</u> and Ulrich Jung - Germany				
12:25 - 12:50	Research on the Design of Lightweight Energy-absorbing Bionic Structure for 3D Printing	Objective Multi Parameter Surface Gloss Classification				
	<u>Lin Lin Liu</u> , Si Long Liu, Shao Xue Sun, Ruo Bing Han and Yi Lin Liu - China	Michael Dattner, Saira Viviani and <u>Tim Stiene</u> - Germany				
12:50 - 13:15	AM printing of desoldering paste for the disassembling of electronic components from PCBs	Design of a color quality label in large format printing				
	<u>Tomáš Syrový</u> and Lucie Syrová – Czech Republic	<u>Fons Put</u> - Belgium				

13:30 - 15:00 Lunch Dozentenfoyer

Room D1.1

15:00 - 15:50 Session 3 A – Print and Media Technologies Chair: Branka Lozo S 15:00 - 15:25 MetalicEffects – Graphic Design applications using the Bronzing Effect G Heiko Angermann, Thorsten Euler, Luca Härtel and Andreas Blaese - Germany É 15:25 - 15:50 Towards Model- and Data-driven Automation and Control in Pad-Printing -Test Stand and Rheology Model G

development <u>Fabian Post</u>, Dieter Spiehl, Edgar Dörsam and Andreas Blaeser - Germany

Room D1.2

Room D1.2

Session 3 B – Print Material Science Chair: Li Yang

Formulation of bio-based inks for pad printing on molded cellulose

Élise Jacachoury, Zelda Monteil-Ochs, William Pierron and <u>Anne Blayo</u> - France

Comparative color and gloss measurements on printed metallic surfaces

<u>Carl Fridolin Weber</u>, Hans Martin Sauer, Andreas Blaeser, Edgar Dörsam and Martin Schmitt-Lewen -Germany

16:00-17:15 iarigai General assembly (appointed representatives iarigai only), Room D1.1

17:15-18:00 Board meeting (members only), Room D1.1

Day 3

Tuesday, 10th September 2024 09:00 - 10:30 Opening session IC, Room D1.1 Chair: Anastasios Politis 09:00 - 09:10 Opening and welcome IC Anastasios Politis, Chairman of IC 09:10 - 09:30 The role of education in functional printing Anastasios Politis, Chairman of IC 09:30 - 10:00 Keynote 3 Gravure-printed electronics - Recent progress in tooling development Dr. Jakob Heier, Head of Functional Thin Film Solution Processing, EMPA - Switzerland 10:00 - 10:30 Keynote 4 Multi-Nozzle electrohydrodynamic inkjet printing Dr. Patrick Galliker, CTO Scrona AG - Switzerland 10:40 - 11:30 Plenary Session 4 - Advances in Print and Media Education 1 (IC), Room D1.1 Chair: (Gunter Hübner) 10:40 - 11:05 The Future of Cloud-Based Digital Printing Technology Education Enn Kerner - Estonia 11:05 - 11:30 Enhancing User Experience and Human-Machine Interaction with Eye-Tracking Systems in the Printing Industry Gerasimos Vonitsanos, Andriani Goutou, Evangelos Syrigos, Evgenia Pagani and Marios Tsigonias -Greece

11:30 - 12:00 Coffee break (Foyer D -Nord)

Room D1.1

12:00 - 13:15 Session 5 A – Sustainability (iarigai) Session 5 B – Print, Media and Packaging Science and Technology (IC) Chair: Tomas Syrovy Chair: Daiva Sajek 12:00 - 12:25 Flexo printable glucomannan-based biofilm **GRACE:** "Steps forward in the Graphics Industries towards a Circular Economy" Kholoud Al-Ajlouni, Sinan Sonmez and Alexandra Fons Put, Willem Uyttendaele - Belgium Pekarovicova - USA Natural plant dyes: sustainable inks set their 12:25 - 12:50 Academic Publishing in the Digital Era: The own challenges Role of Cross-Media Publishing in Expanding the Scope and Accessibility of Research Patrick Gane, Katarina Dimić-Mišić and Monireh Evgenia Pagani, Marios Tsigonias - Greece Imani - Finland 12:50 - 13:15 Formulation and printing of black coldset Human Capital Development in the Printing inks with bio-based pigments Industry: Investigation in Sector-Oriented Approaches Jérémy Manifacier, Anne Blayo, Agnès Boyer Anastasios Politis and Ioannis Sofias - Greece and Jules De Bardonnèche - France

Room 1.2

13:30 - 15:00 Lunch Dozentenfoyer

Room D1.1

15:00 – 15:50 Session 6 A – Other (iarigai/IC)

Chair: Nona Woolbright

- 15:00 15:25 Augmented Reality Experience and Perception Theory: A Quantitative Study Using Eye Tracking to Investigate How Mobile Phone Users Perceive Multiple Layered Depths Donna Templeton - USA
- 15:25 15:50 Evaluation of the possibilities of accurate micro-image reproduction in digital printing systems

<u>Daiva Sajek</u>, Virgis Valčiukas, Gitana Ginevičienė and Vidas Vainoras - Lithuania

16:05 - 16:15 Closing of the conference, Room D1.1 Chair: Fritz Bircher 16:00 - 16:10 Wrap up Fritz Bircher, Conference Director and President of iarigai Anastasios Politis, Chairman of IC

16:10 - 16:15 51st International Research Conference, Pardubice, Czech Republic, September 2025 Presentation by the University of Pardubice (Tomas Syrovy)

16:20-17:00 IC General assembly (IC members only), D1.2

18:00 – 19:00 Apéro Zoocafé, Zoo Zurich

Take Tram n° 6 from Zurich Main Station or from ETH/Universitätsspital till the tram end station Zoo (Fluntern). From there to the Zoocafé, walk 5 minutes (see map on the lower right-hand side).



19:00 – 19:55 Guided Tour through Masoala Hall

20:00 Gala Dinner Altes Klösterli, Zoo Zurich

The Restaurant Altes Klösterli is within 5 minutes walking from the Zoo.

Room D1.2

Session 6 B –Advances in Print and Media Education 2 (IC)

Chair: Evgenia Pagani

PrintBase: context-based training on an electrophotographic press by implementing an on background knowledge based expert system

Heiko Angermann - Germany

Benefits of interactive H5P learning applications for implementing an activitybased learning approach for printing engineers Bianca Gierth-Scheer and Ulrich Nikolaus - Germany



Station Z

statue football

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Preface

Dear IC members,

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

The 55th Annual Conference of the IC – the International Circle of Educational Institutes of Graphic-Media Technology and Management, has taken place at ETH, Zurich, Switzerland, on 8-11 September 2024. 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), Clemson/Greenville USA (2022) and Wuppertal Germany (2023).

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.

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

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

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The Future of Cloud-Based Digital Printing Technology Education

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ABSTRACT

In light of the recently concluded drupa2024 and the successful organization of the Worldwide Charity Cloud Printing Technology Competition, a significant influence has been made to initiate a new future-oriented education system for the printing and converting industries.

The printing industry is undergoing rapid changes, expanding into new technologies and materials for pharmaceutical and food packaging, functional printing, and more. The industry's focus has shifted, and there are increasing requirements for young, talented printing technology specialists. These specialists need to possess a broad knowledge of printing technology and be able to learn and specialize within the industry where they will build their careers, rather than focusing on a narrow spectrum such as the best "offset print operator".

For efficiency and alignment with new sustainable development goals, the emphasis on material safety and recyclability remains unclear to the broader society.

In this respect, the role of printing technology engineers is crucial. They can improve awareness among brand owners, industry leaders, politicians, and the public about the importance of sustainable practices in the printing industry.

Keywords: printing technology engineer, printing and engineering education, european qualification framework, cross-border mobility, drupa2024

Introduction and Background

The global trend shows that the printing industry must compete against various other professions that have used better tools and more money for marketing than we have. As a result, printing technology labs in vocational schools, universities of applied sciences, and universities are being closed, and equipment is being sold or reclaimed by donors. This is not because machine vendors do not want to donate, but rather due to the high fixed costs for educational institutions, low student enrolment, and the negative image of the profession in society.

Second, and even more important, is the aging society and the wide range of different attractions and high competition for new employees. The number of young printing technology engineers is declining year by year.

Some background reasons include the lower value placed on hard skills during elementary or secondary education, especially in STEM subjects, and the negative image of the printing and packaging industry among politicians and the public, particularly concerning the environmental impact of packaging. This paper aims to initiate a new structure for printing technology education, using all theoretical and digital-practical tools available on the market to build a new education system. This system aims to make education accessible to young people and industry partners as stakeholders. The digital transformation of education lays the foundation for listing printing technology occupations hierarchically in the International Standard Classification of Occupations (ISCO), providing a structured overview of occupations in the printing industry.

Moreover, the ongoing war in Ukraine, which began on February 24, 2022, has severely impacted international relationships, cooperation, and efforts towards a sustainable future, affecting IC members as well. Recent events, including high energy costs and increased inflation, have also significantly influenced career opportunities for many people in the EU and globally, affecting the future prospects of young printing technology engineers within the IC.

Methods

Based on the undersigned's earlier work from 2014, "Printing Industry Engineers' Education – Cross-Border Development Project" [1], and the latest work organizing the Worldwide Charity Cloud Printing Technology Competition [3], it has been demonstrated that a new Cloud-Based Education Institution is needed. This new initiative, starting with first-level educational studies, has proven that the industry urgently requires a reduction in the time employees need to adapt to the work environment. This is particularly important when they come to work "from the street" without any competencies or when talented students enter the workforce. The industry needs to evaluate new employees' real knowledge and competencies effectively.

As stated earlier, the situation has led to a point where most major printing machine manufacturers have opened their own Printing Academies, such as the Koenig & Bauer Academy, Windmöller & Hölscher Academy, Comexi, and BOBST, etc. These are great initiatives, but the focus of these Academies is mainly on supplying professional employees for their own manufacturing companies at the level of mechanics and electrical technicians training. They do not emphasize printing technology subjects unless specifically requested by the manufacturer's end customer.

Referring to the above and drupa2024 discussions, all important stakeholders today are recognizing the role of education in the printing industry and are willing to participate in the printing technology Skills Council to support proper curriculum design and keep it up-to-date throughout the lifecycle of the printing industry.

Therefore, in this paper, the major definitions of education vs. training have been explained, and the terminology adopted in the discussion [2]:

EDUCATION means structured learning advancement at a university or vocational education institution. Graduates will be awarded a degree according to the European Qualification Framework (EQF): MSc = EQF7 (minimum 300 ECTS), i.e., second level degree; BSc = EQF6 (minimum 180 ECTS), i.e., first level degree; or operator level EQF = 5 or 4, etc., after the successful defence of a relevant thesis and examinations. Such studies at universities and vocational learning institutions provide theoretical and practical education based on a didactic learning curve, progressing from elementary to advanced levels, supported by cross-disciplinary science, technology, engineering, and mathematics (STEM) subjects.

TRAINING means troubleshooting with one or a few competencies to be improved for the trainee. A certificate of participation, sometimes with a test of learnings, will follow the training.

SKILLS COUNCIL means the Cloud-Based Education Institution technical committee, where members are from industry stakeholders, material and machinery vendors, and representatives from educational institutions where printing technology is still taught.

The Cloud-Based Education Institution is designed to support global printing technology education in countries where education is absent or where vocational schools and universities exist but lack specialized printing labs. Therefore, our role at IC is to improve printing technology and engineering education to secure the future of sustainable printing and converting industries. Over the last six months, preparing for the Worldwide Charity Cloud Printing Technology Competition at the drupa2024 live finals has demonstrated strong interest from regions ranging from Japan to Latin America. This shows that education needs to change, and the new Cloud- Based Education Institution, with proper pedagogical and technological teams of specialists, is ready to make a commitment and launch the beta version in early 2025. We need to be agile in implementing new teaching and coaching methods and the digital transformation of printing technology and engineering education to engage more young talented people through innovation. The work here is based on implementing globally reachable virtual engineering curricula in the Cloud, where global Virtual Engineers mentor the studies of print operators. The aim is to provide access to all students worldwide who are interested in studying the basic theories of printing technology. After completing their studies at the Cloud-Based Education Institution, students will undertake practical tasks at printing engineering universities within the IC network and through industry associations. The most important aspect is the mobility of students to fulfil practical tasks at IC member organizations or as apprentice engineers in the industry. This allows them to bring back field feedback to the Cloud-Based Education Institution's educational program, ensuring it meets the latest industry requirements.

The basic diagram of the new Cloud-Based Education Institution has been designed and will be introduced to industry stakeholders to gather feedback from those willing to contribute and participate in the institution's launch.



Methods

We need to involve a broad spectrum of partners, ranging from academia to industry, with our main customer being the latter. Change has occurred, and further change is already upon us. The drupa2024 and Worldwide Charity Cloud Printing Technology Competition have indicated the direction in which education needs to move and highlighted the relevance of updating printing technology curricula. The role of printing technology education and the number of engineers eager to apply scientific results to everyday manufacturing are growing daily.

The main objective of this new Cloud-Based Education Institution is to foster digital innovation and resilience among printing technology engineers through the acquisition of new competencies, including diverse skills, green competencies, and leadership characteristics. The focus is on the digital and green transformation of the printing industry and, above all, on engineering pedagogy. This aims to prepare future coaches for printing industry employees at both industry and Cloud-Based Education Institution network levels

References

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- (2) EUR Ing. Enn Kerner, https://www.linkedin.com/pulse/education-world-skills-eur-ing-enn-kerner
- (3) EUR Ing. Enn Kerner, <u>https://www.drupa.com/en/Program/Programoverview?ticket=g_u_e_s_t&ems_event=worldwide-charitypackaging-productivity-contest-offset-printing-final-404493</u>

Author's biography

EUR Ing. Enn Kerner is MSc printing technology engineers graduated 1987 Moscow State of Printing Arts University, updated competences in packaging and flexo technology at DFTA and HdM Stuttgart, educator and teaching diploma from Tallinn University and manufacturing leadership diploma from Tallinn University of Technology. Working closely with Aalto University researcher Prof. GANE team. Since 2021 EUR Ing. Enn Kerner is attributed with Certificate of EUROPEAN ENGINEER, issued by ENGINEERS EUROPE Association (former FEANI). Working closely with Graphic Technology Research Association of FOGRA as Process Standard Printing Partner and active implementer of printing standards at industrial level. Among professional activities EUR Ing. Enn Kerner actively working at voluntary sector like: Advisory Board member of IC, Executive Board Member of ENGINEERS EUROPE (EE) and the member of Strategic Working Group FUTURE ENGINEERS (EE), vicepresident at ESTONIAIN ASSOCIATION OF ENGINEERS and ect.

Enhancing User Experience and Human-Machine Interaction with Eye-Tracking Systems in the Printing Industry

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Extended Abstract

The printing industry is undergoing transformation, driven by advancements in digitalization, automation, and smart technologies. Key among these advancements is the need to enhance User Experience (UX) and Human-Machine Interaction (HMI) for operators interacting with complex machinery and software. This study investigates applying eye-tracking systems to improve UX and HMI within the printing industry, aiming to create intuitive, efficient, and safe operator-machine interactions.

Modern printing machines are embedded with advanced digital interfaces, artificial intelligence (AI), and augmented reality (AR) capabilities. These features require a deep understanding of operator behaviors to optimize their usability. Eye-tracking technology is invaluable for assessing these interactions by capturing visual attention, gaze patterns, and focus areas during machine operation. Beyond interface optimization, the integration of eye-tracking with 3D printing also opens up innovative applications in packaging design and neuromarketing, enabling the creation of realistic mockups that test consumer attention and engagement in simulated retail environments.

This research employs a mixed-methods approach, combining quantitative data from eye-tracking metrics with qualitative feedback from printing machine operators. Participants in the study are divided into experienced and novice user groups, allowing for a comparative analysis of how skill level affects user engagement with machine interfaces. Tasks are designed to test operator responses in realistic scenarios, such as identifying subtle print errors and adjusting machine settings in response to job specifications. Eye-tracking data captures critical metrics like fixation duration and saccadic movement, while post-task interviews provide user insights on interface usability and areas for improvement.

Preliminary findings suggest that eye-tracking can reveal common patterns in operator focus, highlighting areas where interface design could be simplified to improve UX. For instance, experienced operators tend to fixate more on specific control areas, indicating familiarity with task-critical regions of the interface. Conversely, novice operators often exhibit longer fixations on less relevant screen areas, indicating a need for additional guidance. These insights are foundational for developing interfaces that align with experienced and beginner workflows, potentially integrating AR overlays to guide users in real-time.

This study also emphasizes the role of continuous training supported by adaptive interfaces and real-time feedback. By incorporating eye-tracking feedback into UX design, interfaces can be customized to meet user needs dynamically, with AI systems adjusting to different operator skill levels. This approach aims to foster an intuitive operational environment where users can quickly learn machine functionalities, reducing training time and enhancing overall productivity.

Integrating eye-tracking data into the UX and HMI design process presents a transformative opportunity for the printing industry. The findings from this study are expected to contribute to the development of adaptive, user-friendly machine interfaces that prioritize operator comfort and efficiency. As the industry advances, these enhancements could lead to reduced error rates, improved job satisfaction, and greater alignment with Industry 4.0 principles. The research ultimately demonstrates that human-centered design, supported by eye-tracking insights, is key to achieving sustainable operational advancements in the printing sector.

Keywords: user experience (UX), human-machine Interaction (HMI), printing industry, augmented reality (AR), eye-tracking systems

References

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GRACE: "Steps forward in the Graphics Industries towards a Circular Economy"

Fons Put¹ & Willem Uyttendaele²

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Short abstract

For the first time since the creation of both organizations, Centexbel-VKC (Knowledge Center for the Textile and Plastics Sector) and VIGC (Flemish Innovation Center for Graphic Communication) will join forces to prepare the Print & Sign sector towards a circular economy.

The GRACE project wants to offer the Large Format Print & Sign sector tools to make their products more circular. This is done by providing insight into the possibilities of material efficiency, material reuse and recycling through training, demonstrations and publications.

Both parties target all companies in the LFP & Sign value chain to share knowledge within this theme, create overview and insight and, where necessary, conduct additional research and thus build a bridge between all parties.

The GRACE project is based on the knowledge of the graphics sector that VIGC has and on the expertise of Centexbel-VKC and VIGC in the field of circularity.

In this project we want to focus on an integrated approach by:

- Research existing circular initiatives

- Mapping production and waste flows to identify the necessary actors in the entire value chain. The end goal is to create more awareness and coordinated action within the sector. We look at the problems at different levels and strive to improve circularity based on the principles of the Reduce, Reuse and Recycle principle.

Keywords: digital printing, large format, sustainability

The Large Format Print & Sign market

The market is characterized by its large variability in substrates and printing methods. A 5% CAGR is predicted for 2028 (<u>https://www.marketsandmarkets.com/Market-Reports/large-format-inkjet-printers-lfp-market-523.html</u>). If you take for example a Formula1- event (Zandvoort, Netherlands), 25.000m² large format prints are made for this weekend event! A centralised value chain will be necessary to improve the circularity of large format prints. Every stakeholder will have to contribute towards a more sustainable large format Print & Sign market.



Figure: The need for a centralised value chain in large format print & sign.

Reduce, Reuse, Recycle

The building block to achieve more sustainability are reduce, reuse and recycle of materials. First printing trials have been carried out to investigate if less ink consumption is possible without compromising graphic quality. Setting a maximum ink limit, building colors with maximum use of black ink and advanced screening are the graphic parameters that determine the ink consumption. In printing more complex print products, material can be saved by using nesting & ganging software.

Reuse of large format prints could be possible if the printed top coating is easily removable. This is currently under investigation for a number of materials.

A major Dutch large format printer has successfully initiated a 'recyle' action. Printed material has been collected, shredded and under pressure and heat reformed to a new printable substrate (<u>https://sig-nagain.com/</u>). This product has been recently awarded at the latest DRUPA (<u>https://edpawards.com/</u><u>wp-content/uploads/2024/05/EDP_Awards-Winners_2024_Press-Release_FINAL.pdf</u>).

Academic Publishing in the Digital Era: The Role of Cross-Media Publishing in Expanding the Scope and Accessibility of Research

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Abstract

Academic publishing is experiencing a period of transformation due to the rapid evolution of digital technologies. At the same time, cross-media publishing plays a crucial role in the distribution and access of scientific knowledge. Current research explores the distribution of content in various channels (print-digital-web) and the potential of cross-media publications to integrate multimedia content such as video, audio, interactive graphics, and other digital media. This form of content allows researchers to present their results in a more interactive and understandable way, allowing a wider audience to better understand and absorb knowledge. Additionally, cross-media publishing can enhance interaction with readers through interactive elements that promote participation and feedback.

The article also analyses the challenges that arise from the adoption of cross-media publishing in the academic community. These include questions related to copyright management, quality assurance, and the integrity of scientific research. Copyright management in environments that include multimedia and interactive elements requires new approaches and partnerships between publishers, authors, and technology providers.

The research methodology includes case studies by academic publishers that have already incorporated cross-media publishing into their practice. Research also includes statistical analysis of data from digital publishing platforms to evaluate the effectiveness and impact of cross-media publishing. The results of the survey show that cross-media publications offer significant opportunities to expand research and improve knowledge access. Academic publishers adopting these practices can provide rich and diverse content, promote dissemination, and understand the results of the research. Additionally, strategies for the adoption of cross-media publishing must take into account challenges and develop solutions that ensure quality and copyright protection.

Finally, the article concludes that cross-media publishing is an effective tool to improve academic publishing in the digital age, offering new opportunities for the dissemination of knowledge and reaching broader and diverse audiences. The results aim to provide useful guidance and best practices for the adoption of cross-media publishing in academic publishing, contributing to expanding research impact and enhancing access to knowledge.

Keywords: cross-media publishing, academic publishing, multimedia, accessibility, scientific research

Introduction

Academic publishing has traditionally referred to the dissemination of research conducted within academic institutions and research centres, public or private. Historically, this form of publishing has included academic journals, collected works such as conference proceedings, academic books (monographs and trade books), textbooks with scientific content, as well as various guides and reference works. (Hall, 2022; Wissenschaftsrat, 2022)

At its core, academic publishing serves as the validation and sharing of new knowledge, ensuring that research findings reach the scholarly community and contribute to the broader societal discourse. The process had until recently been strongly associated with the physical production and distribution of printed materials. Researchers access content primarily through university libraries, where printed journals and books were the norm. However, physical access presented inherent limitations in terms of reach, timeliness, and distribution. The advent and widespread adoption of the Internet led to a profound transformation in the field of academic publishing. The shift from physical to digital distribution represented a structural change that not only improved access but also significantly influenced the creation, review, and sharing of scientific knowledge. In some domains, digital publishing has almost or completely replaced print media, introducing new paradigms in accessibility, interactivity, and cross-referencing.

This digital transition has brought with it new business models and new publication formats. One notable example is the rise of Cross-Media Publishing, which integrates print, digital, and web formats into a unified platform for research dissemination and allows for a wider outreach, dynamic content presentation, and personalised experiences for readers and contributors alike. (Wissenschaftsrat, 2022: 5; Veglis, Dimoulas & Kalliris, 2016). In addition, digital technologies are now embedded in the research process itself, from data collection and analysis to publishing and peer review. Enhanced metadata, interactive figures, and embedded datasets are some of the features that add value to content once constrained by the limitations of print. These advances are reshaping the academic publishing industry and redefining the ways in which scientific content contributes to innovation and social progress (Robogete et al., 2012).

Aim and Objectives

This paper aims to critically examine the changing role of multimedia publishing in the academic publishing landscape, especially in the context of continuous digital transformation. The study analyses the distribution of content on printed, digital, and Web platforms and aims to show how cross-media publications support the dissemination of more interactive and inclusive research.

The purpose of this study is to investigate whether the use of multimedia allows for a dynamic and interactive presentation of research results, improves knowledge transfer outside traditional academic audiences, and provides insight into the role of multimedia in forming and enriching the dissemination of research results. The objectives also include identifying and analysing the challenges associated with the adoption of media in the academic community, evaluating the practical results of media strategies using empirical data.

Challenges in Academic Publishing Today

The role of academic publishing in disseminating scientific knowledge is crucial in promoting scientific thought, supported by a series of interconnected sub-functions: quality assurance, orientation, allocation, distribution, and storage, all are implemented in different ways in every academic discipline, espe-

cially in the humanities and social sciences, where different publishing practices and conventions prevail (Gläser, 2006; Taubert, 2019). The composition and the production processes of academic texts are governed by a dual complexity, which firstly concerns the structural and semantic richness of the academic artefact itself. Academic articles and monographs are complex editorial structures that include critical elements such as footnotes, citations, bibliographies, figures, and inserts. They also provide essential metadata such as title, subtitle, author information, and persistent identifiers such as ORCID that are essential for the evaluation and discovery of digital environments. In addition to the surface elements, academic texts require deep semantic structures to improve their usefulness and integration into large-scale digital databases. The development of technologies such as XML (Extensible Markup Language) enables the representation of rich machine-readable content that is essential for accurate storage and retrieval in open repositories and databases.

The other complexity is based on the academic workflow, which encompasses a sequence of standardised steps, including text submission, peer review, revisions, and final publication. These stages are not merely procedural but critical mechanisms that reinforce the scholarly rigour and ensure the credibility of the published work. Another challenge is access rights, since academic publishing is traditionally dominated by subscription-based models, which limit access to well-managed institutions. However, the landscape has developed rapidly and changed to open access because of the growing consensus that scientific knowledge should be freely and immediately accessible after publication. The leading authorities expect Open Access to be the next default model to revolutionise academic communication and maximise the social impact of research (Fauchié & Yann, 2023; Wissenschaftsrat, 2022).

Cross-Media Publishing (CMP)

The printing and publishing industry has undergone profound changes in products, technologies, business processes, and production processes over the past decades. These changes laid the foundations for the emergence and adoption of cross-media publishing (CMP), which enables the distribution of content in several media formats, such as print, e-books, and applications, while maintaining consistent and almost identical core content. (Rogobete, 2012: 17-29)

Cross-media publishing extends traditional publishing methods by integrating multimedia elements into digital media formats and improving content delivery flexibility, which is especially related to the publication of databases, such as reference books and catalogues. At the same time, it supports parallel distribution of media products across different channels, such as printed books and CD-ROMs, and ensures that the same content is reproduced in different formats of transmission (Veglis & Pomportsis, 2009). Strategic change has practical applications in various areas of communication, including publishing, media production, gaming, and education. In the publishing sector, CMP focusses on simultaneous production of content-identical outputs that adapt print and digital specifications (such as mobile applications and interactive PDFs), while integrating rich media content such as video, audio, or interactive elements into digital versions. The aim of multimedia publishing is to automate as many stages as possible of the production process. This includes automated publication generation based on metadata such as logical and layout structures. The reuse of text and image data in various media formats is a fundamental part of CMP because it ensures consistency and reduces unnecessary work.

To start an automatic CMP workflow, two basic steps are required: (a) develop a workflow that is suitable for printing and digital publishing formats at the same time, and (b) Establish a basic structure and architectural principle for automating document creation. This method ensures that each output format is efficiently reused and adapted to its content, with minimum manual intervention. In contrast to traditional publications, which are usually limited to static output formats, cross-media publications enrich and diversify user experiences (Veglis, 2012).

Single-Source Publishing

In the field of the cross-media publishing sector, single-source publishing plays a decisive role. The term means generating multiple formats from a single source (text, metadata, bibliographic data, images, or other media). It is a process that stores and manages information in a single data source and then publishes it in different formats or even on different media. Various formats include screen versions, mobile versions and printer-friendly versions of documents, reports, presentations, manuals, etc. (Meyer, 2005; Bühler, Schlaich, & Sinner, 2019).

The purpose of single-source publishing is to create a separation between content and to presentation and store information at a specific location for automatic recall, processing, and publication in different formats. Although often discussed in tandem with cross-media publishing, single-source publishing bears a distinct conceptual and operational identity. Single-source publishing is fundamentally content-driven, built around a singular textual source that can be transformed into multiple output formats (Figure 1), while cross-media publishing is output-driven, focused on distributing content across various media and platforms without being bound to a single content source. In this model, content may be drawn from various inputs and individually adapted to each output format, while the SSP emphasises reusability and automation from one uniform data set (Rosati, 2007; Walsh, 2007).



Figure 1. Schema of a single-source publishing process with conversion and transformation stages. (Fauchié & Yann, 2023)

Single-Source Publishing & Academic Publishing

In the evolving landscape of digital and cross-media publishing, single-source publishing (SSP) is a key strategy for content production and dissemination. SSP is the basic term for generating multiple output formats from a single source of content, such as text, metadata, bibliographic data, images, and other media. This process facilitates the centralisation, management, and reuse of information, and promotes its redistribution to different platforms and media, including screen formats, mobile-friendly versions, and printed output optimisation.

In particular, the main goal of the SSP is to clearly distinguish between content and presentation and allow information to be stored once and then retrieved, processed and published in various formats with minimal manual intervention. This approach maximises efficiency by reducing duplication of content and simplifying editorial workflows. For example, a single SSP database can simultaneously generate a

PDF version for printing, an XML for data storage, and HTML for web dissemination. The implementation of SSP presents considerable organisational and technological challenges, especially for academic publishers and digital distributors. It requires a strong content management infrastructure and a cultural change towards collaborative content workflows.

However, the potential advantages of the SSP far outweigh the initial obstacles. A) Horizontal workflows encourage cross-departmental collaboration and allow writers, editors, designers, and distributors to work simultaneously on the same data set. B) It was shown that minimising repetitive tasks and automating formatting processes saved time and energy. C) Clarity and coherence improve as all changes and updates are made at a single centralised point. D) Format convergence allows the simultaneous production of various outputs (PDF, HTML, EPUB, etc.) with shared content logic. E) Collaboration reduces redundancy in export processes and allows teams to reuse work efficiently. F) Simplified archives and maintenance minimise the risk of inconsistentness and data loss when only one version of the content requires updating. G) Through SSP, academic communities benefit from simplified workflows and better content reliability. For each distribution channel, the same information should not be written or rewritten. On the contrary, a single-source repository ensures that all published materials, regardless of the platform, originate from a coherent and accurate source. H) Single-source publishing represents a paradigm shift in academic and cross-media publishing and moves the industry toward a model of centralised content control, enhanced editorial coordination, and scalable output production. SSP offers not only a solution but also a strategic advantage for institutions and publishers who seek efficiency, consistency, and adaptability in the digital era. (Fauchié & Yann, 2023)

Structured Academic Publishing Workflow

In the evolving academic publishing landscape, the need for rich structured content has gone beyond traditional word processing tools such as Microsoft Word (.doc or.docx), which are ubiquitous among researchers but lack the capacity to create semantic structured documents and media-independent documents. Advances in content structure technology have led to what is known as a 'single source' where the same basic content can be reused in multiple outputs that are adapted to different audiences and platforms.

In this respect, the adoption of XML (eXtensible Markup Language) has been an important development. XML provides media-independent storage and structured information and allows metadata to identify contents not only with formatting but also with meaning and function descriptions. This metadata-based approach allows publishers to adapt content to multiple output formats, such as PDFs, HTM-Ls, and various XML schemas, for specific publishing contexts. Among these XML standards, two major frameworks are highlighted in academic publishing. Journal Article Tag Suite (JATS) and Text Encoding Initiative (TEI). Each serves different communities and objectives, but shares the foundations of robust structured markup.

JATS: A Standard for Journal Publishing

JATS is an XML-based standard, specifically developed for journal articles, widely used in scientific and medical fields, humanities, and social sciences. JATS is maintained by the National Information Standards Organisation (NISO) and facilitates the interoperability of content between publishers, libraries, and archives (NISO, 2021). JATS supports three main tag sets, each with specific purposes: (1) journal archive, designed for the long-term preservation of academic content, allowing the migration and storaging of articles on platforms with minimal information loss; (2) journal publishing, focused on the standardization of articles to be distributed and presented through publishing systems and repository; and (3) journal author, author, creating a structure for authors to create and submit content with modelling tools that apply consistency and validity in real time. This three-way structure ensures that JATS not only supports the dissemination and preservation of journal content but also seamlessly integrates into the editorial workflow and content management system. (Figure 2). (NISO, 2024)

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Figure 2. Some of the elements in the NLM/JATS element index.

TEI: Flexibility Beyond Journals

In contrast to JATS, the Text Encoding Initiative (TEI) is a more flexible and expansive framework that supports the encoding of a wide range of texts, including books, manuscripts, archival materials, and digital humanities projects. Founded in 1987 and maintained by the TEI Consortium (TEI-C) since 2001, TEI defines comprehensive guidelines for encoding both the structural and semantic features of texts in machine-readable formats (Figure 3).

The adaptability has been widely adopted by libraries, museums, and academic institutions for projects centred on the digital preservation and scholarly editing of historical or literary texts. Because of its extensible schema, TEI can be customised to specific research goals, which makes it ideal for complex or unconventional content structures.



Figure 3. Some of the elements in the TEI Guidelines

Insights from Global Publishing

The landscape of academic journal production has undergone substantial changes over the past decade, driven by various technical tools, metadata standards, and changes in the expectations of access formats expectations. The results of a global survey by Scholastica (2022) entitled "State of Journal Production and Access" provide important insights into these developments. The survey was conducted between June and October 2022 and received 82 responses from academic publishing organisations representing 28 countries. The largest number of responses came from the United States, Great Britain, and Canada.

The study explores two major fields: journal production (including article formatting and metadata marking) and access (such as funding models and perceived sustainability). The conclusions show that, despite increasing emphasis on digital innovation, traditional formats such as PDF continue to dominate academic publishing. By 2022, 94% of the respondents said publishers continued to produce PDF articles, down slightly from 98% in 2020, while adoption of HTML formats rose. Over the course of two years, the adoption of HTML articles has increased by 14%, indicating a shift to a more responsive and mobile accessible publishing model. (Scholastica, 2022)

Despite these progresses, the transition to full-text XML is still limited. Only 38% of the publishers surveyed in 2020 and 2022 published full-text XML papers, a format essential to facilitating interoperability and indexing through systems such as PubMed Central.

Only 40.3% of the publishers reported that they had produced JATS-compliant XML, the scientific publication standard, in at least one journal, the largest publisher managing more than 11 journals achieving a higher rate of adoption. (Figure 4)



Figure 4. Less than half of publishers surveyed produced full-text XML articles.

When asked which formats are most important for achieving the publication goal, most of the respondents placed PDF and HTML as their priorities. Full text XML and printed formats are ranked as less essential and printing becomes the least preferred (Figure 5). This priority emphasises the continuous centrality of the PDF format not only for printing but also for the status of an academic professional symbol and legacy publishing. At the same time, the growing recognition of its importance may reflect the wider shift in the academic community towards the provision of content that is digital first and responsive to devices.

Interestingly, the value of the full-text XML was perceived to be inconsistent. Although XML plays an important role in back-end processes such as metadata tags and cross-platform indexes, many respondents do not seem to have the right to know, which may reflect the gap between publisher infrastructure and reader-concept. This means that the advantages of structured metadata and machine-readable formats are substantial but are not sufficiently communicated or appreciated in academic work.



Figure 5. Most of the respondents said that PDF and HTML are the most important formats for their readers.

Overall, the academic publishing ecosystem is increasingly open to digital innovation, but the complete integration of advanced metadata and content delivery standards such as JATS-compliant XML is uneven. Indirect, but important, advantages of such standards can be exploited through strategic investments and education to accelerate the transition to fully digital native and interoperable scholarly publishing.

Case Study 1: Integrating Animated Medical Resources in Open Access Publishing

The California Digital Library (2020) initiative, which aims to produce multimedia-rich medical texts adapted to physicians and radiologists working in unstaffed healthcare facilities, is an example of how digital innovations transform academic publishing. The project, titled "Ultrasound in Resource-Limited Settings: A case-based open access text", has been developed through the eScholarship Labs programme to address global disparities in the use of diagnostic imaging (Figure 6).



Figure 6. The project 'Ultrasound in Resource-Limited Settings: A Case-Based Open Access Text" developed through the eScholarship Labs programme.

Recognising the unique cost-effectiveness, portability, and diagnostic versatility of ultrasound, the team was seeking to design a concise and clinically relevant living text. The text not only provides high-quality images and animations, but also supports diversity and global reach in multiple languages. Due to the extensive multimedia requirements of GIFs and high-resolution videos, the Manifold platform has been chosen as the most effective system for publishing. This approach not only improves the accessibility of physicians in the field but also illustrates the ability of digital platforms to enhance educational value and the functional relevance of the medical research literature. (California Digital Library, 2020)

Case Study 2: Revue2.0 and the Future of Scholarly Publishing in the Humanities

Revue2.0 is an impressive example of how digital workflows can transform university publishing in humanities and social sciences, led by the Canada Research Chair on Digital Textualities (2021) between 2018 and 2021. The project aims to explore the historical mission of academic journals and how this mission can be reinterpreted in the digital age.

One of the main innovations in Revue2.0 was the adoption of a single source publishing model. In this model, some of the journals that participated in the project have tried to simplify editorial processes using shared digital infrastructures. This approach was primarily based on the use of the semantic editor Stylo (stylo.huma-num.fr/), which was designed specifically for academic publishing in the humanities. Stylo enables journals to manage a single content source that integrates the main text body with metadata and bibliographic information. From this unified source, the journals can automatically generate multiple output formats (Figure 7), ensuring access and response from HTML to Web publications, ensuring download and print ready versions that can be distributed through magazine websites, and promoting metadata interoperability and long-term preservation from PDF to XML format to archive and digital dissemination platforms.



Figure 7. Revue2.0: output formats

This editorial model challenges the three main pillars of traditional print-centred paradigms of openness, interoperability and semantic enrichment. It also reflects a broader philosophical shift in academic publishing: a shift from dissemination to publication. Revue2.0 believes that digital transition calls for journals to return to the roots of the term "publication" and to make it public by redefining access and distribution in a more democratic and inclusive way. The case study focusses on the rearticulation of the editorial mission in an increasingly open and networked academic environment, thanks to technological innovations such as semantic editing tools and single-source workflows (Canada Research Chair on Digital Textualities, 2021).

Conclusions

The future of academic publishing is undergoing profound changes, driven by the convergence of digital innovations, the rapid expansion of open-access models, and the growing importance of technical interoperability and metadata standards. Key developments, such as the mandate for machine-readable formats such as HTML and XML, indicate a significant change in the discovery and accessibility of academic output across platforms. Survey data reflect the growing emphasis on increasing visibility through the optimisation of journal and article search engines, and the production of HTML versions is considered a practical step towards this goal. However, this impulse is not without friction. Many small and medium-sized publishers face obstacles to fully complying with the article-level metadata requirements, in particular the production of JATS-compliant XML, which is necessary for long-term archive and indexing.

Despite these challenges, optimism prevailed. The increasing availability of affordable digital production tools is a way of overcoming existing technical deficiencies and encouraging the widespread adoption of structured metadata and open standards. The use of these tools is essential not only to improve system integration, but also to support the sustainability of publishing models that include various organisational capabilities. The open-access movement remains the most important strategic priority for publishers. The commitment to maintaining and expanding full-access publications is widely shared and is driven by the dual needs of increasing readership and securing funding through institutional subsidies,, competitive subsidies or publication fees. However, there is still uncertainty about the long-term financial sustainability of these models, particularly for independent publishers. Likewise, there are still questions about the widespread implementation of transformational agreements and the capacity of the academic community to meet increasingly technical requirements.

Academic publishing remains a key mechanism for spreading knowledge and academic exchange. In today's digital environment, the need for flexible cross-media publishing infrastructures is increasingly obvious. These systems must support the diversity of content formats and facilitate interaction between platforms, disciplines, and audiences.

The boundaries between publishing formats are becoming more fluid and the timetables are being compressed, and the academic publishing ecosystem is being transformed into a more flexible, open, and interconnected one. This evolutionary process not only democratises access to knowledge, but also rethinks the definition and measurement of academic value, influence, and authority. To ensure that this future is sustainable and equitable, researchers and publishers must be equipped with the tools, standards, and strategies needed to adapt to the changing landscape of academic communication.

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Evaluation of the Possibilities of Accurate Micro-image Reproduction in Digital Printing Systems

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Abstract

The current market for visual graphic communication includes a wide range of printed products for publishing, packaging and advertising purposes. They are printed on various materials using various printing inks and printing technologies, including both digital, such as Electrophotography and Ink Jet. Each of these product categories is subject to different levels of quality requirements, depending on the purpose of the products, lifetime of the product, conditions, etc. In general, it can be stated, that the print quality evaluation includes the evaluation of colour rendering and evaluation of image micro-detail reproduction.

It is also very important to consider mechanical and environmental impact during the lifetime of the product, i.e. abrasion due to friction, colour resistance to aging, etc. Factors of environmental impact can affect the colour characteristics, as well as thin micro-lines, screen dots, brightness of other marks, definiteness and geometrical dimensions. Graphic images on prints often contain extremely fine graphic details, such as micro-lines or micro-text elements, which are often part of various identification, security markings, codes, etc. It is very important to ensure the brightness of these details, its legibility and geometric dimensions meet the requirements, not only immediately after printing, but also, after a certain period during the life cycle of the printed production. Therefore, a very important issue is, how to model the variable functional properties of modern visual 2D printed products already at the stage of design.

Currently, various digital print quality control wedges are used to ensure the reproduction accuracy of graphic micro-images. Yet, all those tests lack information to allow the accuracy of reproduction of a wide range of micro-images to be monitored. During this study, a unique wedge to control and pre-model the reproduction quality of digitally printed linear micro-images was developed in Adobe Illustrator. This original wedge is designed to assess and model the reproduction quality and geometric accuracy of linear micro-images when printed by various digital printing methods on different materials. The fragment of the control wedge with monochromatic positive micro-lines, arranged individually in parallel, perpendicular directions and in 45° direction to print is shown in Figure.

0,01 /	0,02 /	0,03 /	0,04 /	0,05 /	0,06 /	0,07 /	0,08 /	0,09 /	0,1 /	0,11 /	0,12 /	0,13 /	0,14 /	0,15 /
0,02	0,04	0,06	0,08	0,1	0,12	0,14	0,16	0,18	0,2	0,22	0,24	0,26	0,28	0,3
			1											

Fig. The fragment of the control wedge for 0,01-0,15 mm width positive micro-lines

The width of the micro-lines was measured under the microscope Dino Lite AM4013MT to assess the accuracy of the dimensional reproduction and the deviations from the nominal value. To assess the influence of different parameters of the printing system "press-paper-ink" on the reproduction of image microelements, the prints were printed using different dry-toner and liquid ink (electro-ink), electrophotographic and Inkjet printing presses and different types of paper. The width and deviations of the micro-lines on the prints were measured along all three print directions. The surface smoothness characteristics of the paper were measured by the surface roughness metre TR200.

Measurements of the reproduction accuracy of monochrome micro-line images, printed in different printing systems, showed that the accuracy of micro-line reproduction depends on the parameters of the printing press (dpi), the characteristics of the paper and the type of ink. It is also evident, that the quality of micro-image reproduction also depends on the direction of the positioning of the micro-lines on the printed sheet.

The obtained results allow applying mathematical methods to compare the capability of digital printing systems to reproduce linear micro-images on printed products of any size and geometric orientation. These results also presuppose selecting optimal systems for printing specific products with micro-images and modelling the layout at the design stage by assessing the orientation of the micro-images on the printed sheet while assessing the environmental impact during the life cycle of the product.

Keywords: electrophotography, inkjet, digital printing, control wedge, micro-lines, print quality

Human Capital Development in the Printing Industry: Investigation in Sector-Oriented Approaches

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Abstract

Drupa 2024, has proved to be the world's most important printing technology exhibition, being the only one of its kind in the world, showcasing developments and innovations of all kinds for the printing industry. What is more, drupa offered a platform for networking, knowledge-sharing, and collaboration, engaging with industry experts, staying updated on trends and developments, and exchanging ideas with fellow professionals, can foster innovation and drive the industry forward The print-media education and research world, has actively participated at drupa, via the International Circle and HELGRAMED booth at the dna-drupa next age Hall.

The main question - request from the hundreds of visitors to the IC and HELGRAMED booth, was the search for people for employment for companies in the sector, revealing the acknowledged shortage of people to staff the printing and packaging sectors, and indeed at all levels.

This need is now particularly critical, especially with the implementation of numerous innovations in design, management and production in printing and packaging. At the same time, it reveals an obvious weakness in the education and training of people to staff the graphic arts, printing and packaging sectors. Furthermore, it shows that in most cases, the existing education and training formations, are not sufficient to meet the needs for qualified people in the above-mentioned sectors. It is true that print media education, is constantly evolving towards all directions and dimensions in the last decades. One could observe that all education and training establishments, from professional and secondary education up to the postgraduate levels, struggle to adapt with all kinds of developments and changes in the industry with new learning methods, such as blended and distance learning. What dominates, is the in-house training and specific oriented seminars on print-media systems, machines and technologies in general.

Previous research conducted, provide evidence that players in the education domain, ranging from ministries and industrial sectors to education development state organizations, do create study programs and courses, curricula and learning outcomes. These are principally based on different education levels, which continues to be the dominating process comprising a rather traditional mindset in education design. This distinction is mainly expressed in the form of a clear separation between secondary and tertiary education levels.

Hence, such approaches might not be convenient anymore, in the rapidly evolving society and the new requirements for proper education design. Additionally, in many cases, this traditional approach of education design based on different levels, might not be appropriate anymore, for specific sectors and fields, such as the print-media and packaging sectors. Such procedures are raising walls for the mobility of people between education, training and the world of work, between theory and practice and among professional - and scientific domains.

As it has been seen at drupa 2024, evolution in the industry, requires new-alternative approaches and a new mindset, oriented on the holistic development of people in the printing and packaging industry.

This paper investigates existing procedures towards sector-oriented activities for the development of people in the printing industry. In particular the sectoral approach for the development of people is discussed, consisted mainly by the establishment of sector councils, bodies/authorities for education design formed by the Social partners organizations / associations and initiatives to attract young people for study and employment in the printing industry. Therefore,

The paper concludes by discussing an alternative approach for people in the printing industry, taking under consideration the full needs and requirements of a sector regarding education and training required.

This approach, suggest a new, sector-based holistic strategy for all people related with the sector and the industry. The most prominent difference of this holistic approach from the traditional settings is that it places people in the foreground; thus it is anthropocentric, for the holistic development of people in the sector, no matter their relationship or position, and taking under consideration the needs and requirements of the print-media sector at all levels.

Keywords: drupa 2024, people and print, education and training, sector-oriented development of people, sector councils

PrintBase: Context-based Training on an Electrophotographic Press by Implementing an on Background Knowledge Based Expert System

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Short Abstract

Teaching graphic printing is facing various challenges across levels of education. At the secondary educational level, print shops have difficulties finding suitable trainees who would like to learn the profession of printer. As a result, there is a need to deploy people that are solely trained onthe-job. At the tertiary educational level, universities face similar difficulties of finding potential students, why some institutions have reduced the range of courses in the field. This in turn affects that profound expertise about printing technology and print product diversity is also dwindling at management level. Whereas technological expertise is partly overcome by technical progress, a decline of product expertise remains a challenging factor. For example, printing on a lithographic offset press requires experiencing special features like color water balance, etc. Instead, operating a print job on a digital electrophotographic press mainly requires knowing the sequence of press specific instructions. However, understanding, why a stitch bound print product requires a number of pages divisible by four, why a new substrate requires a particular color profile, how the thickness of the substrate influences different criteria of print product quality, etc., can still be only understood by professionally educated print experts. To provide an expert-like training, the method for an artificially intelligent expert system entitled PrintBase is proposed. The aim of PrintBase is to professionally train print job operators on-the-press by providing a context-based training environment, which enables a training progress regardless of educational and professional background, and without requiring a human trainer. The method of PrintBase is developed by mimicking the knowledge of a print expert with tertiary educational level as so-called background knowledge inside the intelligent system. This background knowledge is organized hierarchically inside a taxonomy to enable a context-based training environment. This is, as the instructions are similar to the expert-driven knowledge, also structured inside a taxonomy. Consequently, the interfacing between both taxonomies leads to a path of instructions to be choosen by the operator on the press, with explanations focusing on the path of instructions provided by PrintBase. For example, the graphic user interface of the press allows choosing from a number of standard color profiles to be used for a print job, and PrintBase provides the necessary explanations, why different color profiles exist. If a color profile is choosen by the operator, PrintBases evaluates if the choosen color profile matches the paper to be used for the press. Another example, if the operator wants to produce a 36 pages brochure on a paper having a too thick grammage, it is explained, how the thickness of the paper influences the envelope behavior, but also how the thickness may influence the opacity of the paper. At the conference, the method of PrintBase will be explained, including first results of implementing the prototype of the artificially intelleigent expert system prottotype for an electrophotographic press using the lobic programming language of Prolog. In addition, it will be discussed how the protoype is already used for teaching students on-the-press.

Keywords: artificial intelligence, expert System, taxonomy, context-based training

Benefits of Interactive H5P Learning Applications for Implementing an Activity-based Learning Approach for Printing Engineers

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ABSTRACT

The development and implementation of innovative teaching and training concepts in the engineering sciences in general and printing technology in particular often includes e-learning applications. While this seems to be appropriate for standard knowledge transfer scenarios, the promotion of in-depth under¬standing and application knowledge is usually more challenging. This paper offers some suggestions as to how the open-source content cross-platform framework H5P can be used to develop interactive, activity-based e-learning content for printing engineers and which potentials and limitations of this technology can be derived from that.

Keywords: activity based learning, printing engineers, H5P

Introduction

At least since the COVID-19 pandemic severely disrupted tried and tested teaching processes, e-learning in higher education is back in the focus of interest. As an extensive bibliographic survey in (Aristovnik, Karampelas, Umek, & Ravšelj, 2023) has shown, engineering education was (along with health education) one of the most-discussed topics. The quality of online learning mechanisms and active learning activities were among the hotspots of online learning research (l.c.).

Topics like these were dealt with in the surfaceCOLLEGE project, aimed at the creation of innovative digital learning content to be embedded in a blended learning concept for printing engineers (GRAVOmer, 2024). This content is aimed at the DQR Level 5 of the German Qualifications Framework / Deutscher Qualifikationsrahmen (Federal Ministry of Education and Research, 2024), intended to bridge the gap between German vocational training (DQR Level 4) and academic education, which is a bachelor's degree (DQR Level 6) or higher. Future learners in this course are likely to have very different levels of subject-specific knowledge, know-how in dealing with online media and varying amounts of professional experience. Therefore, a learning method had to be found that supports e-learning-based, self-determined learning and allows for multiple repetitions. Following a market analysis, H5P (an abbreviation for HTML 5 package), was identified as a suitable technology for this purpose, supporting the creation and sharing of digital learning content, the application of distributed, asynchronous and location-independent learning, and configurable feedback.

H5P is an open-source content collaboration framework intended to make it easy to create, share and reuse interactive e-learning content (H5P Group, 2024a). Thereby, it touches on a topic that has been studied intensively as early as the 1990s, when Multimedia Authoring Systems were developed with the intention to provide easy-to use tools for instructional designers, educators and teachers to develop interactive multimedia and hypermedia learning environments (cf. (Cutler & Candan, 1996), (Dabbagh,

2001) or (Rutledge & Hardman, 2001)). Authoring tools like Authorware, Asymmetrix Toolbook or Macromedia Director were intended for authors with a didactic background, but little or no programming experience (Dabbagh, 2001). They used different organizing metaphors (or authoring paradigms) to structure instructional materials and learning activities. Authorware, for instance, used a flow control paradigm, organizing the educational content in a decision-tree-like structure. Toolbook used the metaphor of an interactive book, and Director used a movie metaphor, in which multimedia elements are arranged on a timeline, comparable to a storyboard in film (Cutler & Candan, 1996). Although these authoring tools were quite popular in the day, mutual incompatibilities, limited reusability and proprietary standards were a recurring issue. Besides, the different authoring paradigms were often well suited for a certain type of e-learning application, but less so for another. The decision tree-approach of Authorware, for instance, was very well suited for complex question-and-answer-scenarios, but less adapted to the implementation of complex animations.

With the advent of the internet, Web Based Training (WBT) became more important, although it lacked the sophisticated interaction or animation capabilities that desktop-based authoring systems already possessed at that time. However, content delivery and accessibility due to online connectivity, and thus, the delivery and management of instructional content and the organizational aspects of online learning became a core topic of scientific discussion (Watson & Watson, 2007, p. 28). This led to the development of Learn Management Systems (LMS) such as Moodle, ILIAS or OLAT, mainly focused on the organization of the learning process and course administration (l. c.). Because these were based on standard web technologies like HTML, CSS and JavaScript, they were platform-independent, (at least in theory) open-source, and easily accessible.

However, Learning Management Systems require adaptable, scalable and reusable e-learning modules; so-called learning objects (l. c., p 30). H5P is an innovative solution to develop this kind of learning content, which remedies several disadvantages that older desktop-based authoring systems had: It is web based, free to use, open-source, non-proprietary and compatible to multiple LMS (Rekhari & Sinnayah, 2018, p. 192). Besides, H5P also implements multiple authoring paradigms, named content types (H5P Group, 2024b): The H5P content type branching scenario, for instance, is very similar to the decision-tree metaphor of Authorware, H5P course presentation closely resembles the interactive book paradigm of Toolbook, and H5P interactive video uses the movie metaphor of Director. Thus, multiple paradigms that formerly only existed in mutually incompatible, proprietary implementations, are now integrated in one unifying concept.

Interesting as this idea might be from a scientific standpoint, it is, of course, important to evaluate H5P under practical learning conditions. Therefore, the surfaceCOLLEGE project tried to test several content types to create custom learning environments for printing engineers. For each content type evaluated, a real-life learning scenario was chosen, sample didactic content was created and the results were evaluated. The primary results will be discussed below.

Methods

The evaluation of the H5P technology for the education of printing engineers began with an identification of the DQR level 5 target group, an assessment of their learning needs and a mapping of these needs to a corresponding learning matrix. In line with this concept, sample topics suitable for interactive online learning were identified and matched to corresponding H5P content types. After that, sample topics were selected for a prototyping implementation. To cover a broad spectrum of options, four comparably complex scenarios were chosen, each of them using one of the H5P "meta" content types that allow for the integration of other content types (cf. (Gierth-Scheer, 2023, S. 22)): a material detection course using a flow control paradigm, an interactive book on color theory, an interactive video on paper manufacturing and a 360° 3D scenario intended for situated learning in a virtual printing room.

All prototypes were developed with the free to use version of H5P. There is also a commercial version available on h5p.com, which provides additional functionality for collaboration, the management of user rights and more (for an overview of all the differences please cf. (H5P Group, 2024c)). To integrate the sample content in a LMS, the H5P WordPress plugin was used.

Results

The H5P interactive book has a rather traditional authoring approach that is also used in presentation tools such as PowerPoint or Keynote. It can display images, texts and audio as well as more complex interactive content (H5P Group, 2024d). Complex interactions can, for instance, be achieved by integrating other H5P content types such as Agamotto (interactive sliders, cf. Figure 1, above right) or Image Hotspots (cf. Figure 1, below left). The content can be divided over several pages; the document structure can be accessed via a vertical scrollbar on the left, allowing for a user-controlled, non-linear navigation. Progress indicators and a summary page can be included as well (Bauer, 2023).



Figure 1. Cover, samples of interactive pages and a feedback page for self-assessment from a H5P interactive book. The table of contents is visible on the left-hand side of each screen (Bauer, 2023)

The H5P Branching Scenario enables authors to arrange content in a decision tree with multiple branches (H5P Group, 2024e). Emulating a lab-course on material detection and identification, this interactive prototype presents the learning content (explanation of different identification methods) in a demand-oriented way (cf. Figure 2, above left). Thus, experienced users can, for instance, skip the introduction, while less experienced users repeat difficult sections multiple times. After choosing a certain method for a given identification problem, different test outcomes can be simulated by showing different decision paths (cf. Figure 2, right). Thus, different identification methods can be tried out until the optimal solution is found (Felka, 2023).



Figure 2. Teaching density measurement methods using the H5P branching scenario. Several detection methods are presented (above left) and can be explored while navigating through a decision tree (right). Real-life decisions can be simulated, and feedback is given (below left) if mistakes occur (Felka, 2023)

For the creation and delivery of videos enriched with interactive content, the H5P interactive video is the method of choice. In surfaceCOLLEGE, this content type was used to enhance existing lecture recordings on papermaking (Gierth-Scheer, 2023). Existing video files can be embedded directly into a corresponding H5P container, but referencing YouTube, Vimeo or Panopto files is also possible. To enhance the linear video, accompanying texts, pictures, interactive links and junctions or quizzes can be added (again, other H5P content types can be used for that).

Another interesting feature are the so-called intersections. This type of additional content begins with a branching question leading the learners to different jump points depending on their choices. This feature exists in addition to traditional bookmarking, which is used to access chapter beginnings or other markers and is implemented in the H5P interactive video as well. Thus, multiple video access strategies for recall, repetition and in-depth understanding are possible.

In general, the accessibility rules of the Web Content Accessibility Guideline (WCAG 2.1 AA) apply to most of the H5P content types, with a few exceptions (H5P Group, 2024f). In the case of videos 'VTT' subtitle files can be added to the H5P module.

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Figure 3: H5P interactive video sample on paper manufacturing. The play bar below the video allows for basic video control (start and stop, skip forward and back, above left). Predefined bookmarks facilitate jumps to specific topics (below right). Knowledge queries (below left) are marked with a circle (O) on the progression bar, intersections (above right) are marked with two arrows pointing in different directions ([∧]/). (Gierth-Scheer, 2023)

The H5P content type Virtual Tour 360° (H5P Group, 2024g) was used to create a faithful virtual reconstruction of a printing room used for the training of prospective print engineers. Using a SLR camera with fisheye lens, equirectangular pictures were taken from six different positions within the room, which were used to create several 360° panoramic interactive environments (Benter, 2023). Thus, all the machinery within the room can now be viewed from different locations, and the interactive experience is further enriched by adding close-ups, text information or interactive hotspots.

Using the virtual tour, learners can familiarize themselves beforehand with all the machinery without time limits or supervision. Print related knowledge can be acquired in a realistic application situation, thus enabling situated learning.



Figure 4: Virtual Reality visualization of the university's printing room. Positions indicated by arrows can be accessed using a map (above, left) or by mouse interaction. Hotspots give access to additional information (Benter, 2023)

Discussion

The technical analysis of all H5P prototypes led to several conclusions. The development of the H5P Interactive Book was more or less straightforward. However, the control over layout and object spacing was somewhat limited and the content type offered no support for a responsive adaptation to different screen sizes or dynamic layouts. Furthermore, the inclusion of the Agamotto content type resulted in some problems with the slider control due to the Interactive Book referencing an older malfunctioning version (Bauer, 2023, S. 55). Furthermore, a learning progress of more than 100 % could be achieved on the summary page (cf. Figure 1, below right) caused by a current malfunction through which Agamotto is not considered as an interaction.

The self-directed learning approach of the H5P branching scenario prototype received a mostly favorable response in a preliminary expert evaluation, although a breakdown in even smaller sub-units was suggested. From a technical perspective, both an overall progress indicator that maps the learners' progress along the decision tree and a mechanism to store interim results were missed (Felka, 2023). Due to a lack of functionality flaw in decision tree editing, deleting of branching nodes leads to a complete deletion of the sub-tree below, which made subsequent modifications very difficult.

The enrichment of video content with interactive media using the H5P interactive video worked more or less as intended. Due to the requirements of the General Data Protection Regulation (GDPR), the inclusion of videos from third-party platforms is currently restricted in the EU or not possible at all. Therefore, the prototype discussed here used a direct embedding. This, however, led to a storage problem that made further editing of H5P files impossible if the video files were larger than about 120MB. Unfortunately, a cropping of video data within the content type is currently not possible (Gierth-Scheer, 2023). However, as of February 2024, the storage problem seems to have been resolved.

The 360° Virtual Tour of the printing room turned out to be a rather voluminous application, too, containing six different 360 panoramas taken from different viewing angles enriched with about 50 additional scenes. This led to a H5P file of about 153 MB in size, and even this was only attained after the panorama shots were significantly reduced in size, which led to minor graphical distortions. Unfortunately, an automated preloading of information without further interaction is, sadly, currently not available in H5P (Benter, 2023). Likewise, load balancing (the adaption of download speeds to available network capacity) or the inclusion of data streams in different resolutions (high resolution for desktop viewing, low resolution for smartphones) would be welcome additions.

In general, when editing or creating learning content, the options to undo changes and to correct mistakes were often limited for media types other than text. This may lead to a slightly increased effort, especially when rearranging content for didactic reasons.

Apart from these technical limitations, the use of standard web technologies (HTML5, CSS, JavaScript) proved to be a clear advantage of H5P, allowing for an easy access via web browsers, good cross-platform compatibility and a more or less seamless integration in many Learning Management Systems. Due to the inclusion of many different authoring paradigms (book metaphor, flowchart, timeline) and the possibility to interleave specific content types, developers can choose from a wide variety of options to create, share and reuse interactive learning objects.

Conclusion

In this paper, a wide variety of H5P content types were tested regarding their potential to implement activity-based learning concepts for printing engineers. H5P turned out to be an open-source, plat-form-independent, web standard based technology that offers a wide range of organizing metaphors to authors of e-learning applications, which makes it a very powerful and flexible tool. H5P applications tend to be reusable and can be seamlessly integrated in many Learning Management Systems.

The prototypes shown above illustrate how H5P technology is used to create and present scientific content for printing engineers. This was also confirmed in the surveys of future users. One of the identified core potentials lies in supporting needs-oriented learning and easy access through web browsers.

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