FROM THE IMAGE OF THE MOLECULE TO THE MOLECULE OF THE IMAGE: EXPLORING DIANNE IVERGLYNNE'S METHODS WITH A ONLINE PLATFORM FOR THE PRODUCTION OF ECOLOGICAL IMAGES

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Abstract

This paper presents an online platform for sustainable education based on the Ecology of Images framework, developed for an Arts Education, Technology, and Society (AETS) course. Originally conceived as a research tool, the platform has since evolved to incorporate didactic dimensions that address ecological image production processes, thereby transforming into a multifunctional archive. In this communication, we focus on the platform's narrative dimension, which bridges its educational and research components, demonstrating significant potential for Research-Based Learning (RBL) [1].

The archive comprises textual, geographical, temporal, and audiovisual data related to the history of Ecology of Images. It is designed from the perspective of digital humanities, where data is understood not as neutral or objective, but as inherently interpretive and shaped into narratives aligned with particular epistemic frameworks [2]. We propose four exploratory axes to develop these concerns: Historical, Laboratory, Artistic, and Educational. These axes serve as intersecting categories through which the narrative dimension can be expanded. For instance, the Laboratory axis includes data on molecules involved in photographic development, the Educational axis features teaching resources such as exercises for sustainable image production, and the Historical axis documents the environmental consequences of the photographic industry, from silver extraction in analogue photography to the resource demands of digital imaging technologies.

To illustrate the narrative dimension, we interviewed Dianne Iverglynne to tell us about her discovery of the spearmint-based photographic development formula in 1997 [3]. At the time, Dianne was studying Fine Art Photographic Illustration at the Rochester Institute of Technology. She enrolled in the Technical Photography Chemistry course taught by Scott Williams, who discovered the coffee-based developing formula, Caffenol. The final assignment for this course was either a chemistry exam or the discovery of a new formula. However, Dianne was an artist, and her passion for photography and its processes set her off searching for a molecule that would enable a new formula. Compared to her colleagues, she had no chemistry literacy. She borrowed a book, and with her training and ability to recognize visual patterns, she discovered the similarities between thymol and hydroquinone benzine, which led her to the final solution.

Today, we can think and experiment with images more sustainably using this and other methods. However, the processes must be researched, organized, stabilized, and systematized. Above all, there is much to research and discover in this context.

One of the didactical challenges we propose is using today's technologies with Dianne's research methods and exploring the idea of using archival images/representations of molecules and pattern recognition in search of new development formulas. We can even use technologies such as artificial intelligence (AI) so that the software itself can learn to recognize patterns. Our paper ends by questioning these different approaches, such as the conscious relationship established with the environment through biochemistry and the unsustainable energy consumption of AI.

Keywords: Arts Education, Ecological Photography, Research Based Learning, Digital Humanities.

1 INTRODUCTION

Since 2015, researchers, students, and educators have been using Caffenol and Dianne Iverglynne's formula, with thyme and mint, to develop photographic film and paper in Junior University workshops. The initial motivation was to reduce the toxicity of photographic development processes, especially in educational settings involving young participants. However, this practice soon gave rise to broader

concerns about the production of images. Out of this context, the Bioimages project emerged. Initially conceived as a pedagogical initiative, it has since evolved into a research-oriented program. The project was first implemented at the Soares dos Reis Art School (EASR) [4], [5] in its pedagogical aspect, and is currently being adapted for integration into the curriculum at the Faculty of Fine Arts at the University of Porto (FBAUP).

Although the original focus was on mitigating the use of hazardous chemicals for health reasons, the project gradually expanded to include environmental and social concerns. This evolution is grounded in the recognition that human health is intrinsically linked to planetary health. The focus was on the chemistry of development, but we changed when we asked how we could think about the entire image production process, from capture to its final 'materialisation'.

That question has no trivial answer. Over the years, our close engagement with the project has made us acutely aware that issues which seemed self-evident within our community were not part of broader public discourse. There is a general awareness that analogue photography involves polluting and toxic processes. The toxicity of industrial processes and how humanity deals with it has been discussed since the 1960s and 1970s [6], [7]. Digital imaging emerged as a clean alternative to the chemical processes involved in analogue photographic production.

Isn't digital imaging sustainable? Contrary to popular assumptions, digital imaging is not inherently sustainable. Digital is not sustainable, and numerous data and projects, such as those by The Shift Project, demonstrate this. While digital's carbon footprint could already reach 5.5-7% by 2025, it is predicted, for example, that the uncontrolled implementation of 5G alone could increase this footprint by 18-44% by 2030 [8]. These figures suggest that digital infrastructures are increasingly incompatible with the Paris Agreement's 1.5ºC global warming threshold. And what if we add the costs of the latest artificial intelligence (AI) developments?

Most discussions around sustainability in digital contexts focus primarily on devices and energy-intensive infrastructure, rather than on the content itself. Yet, it is precisely through this lens that we can begin to understand the responsibility for sustainability in a mediatized society governed by images. CISCO estimates that video streaming will account for 82% of global traffic by 2022 [9]. The energy costs and ecological footprint that AI-processed images represent will further increase the burden. It is estimated that the 'Compound Annual Growth Rate (CAGR)' of AI growth in data centres alone will be around 40% by 2027 [10], with little mention of the weight of images in these figures. In any case, analysts can no longer hide the lack of fulfilment of net-zero commitments [11], and, above all, the declarations of significant figures, such as Eric Smith, in their techno-solutionism faith assert that the problem will become the solution [12].

However, our issue is not only in the unsustainable image in the present. Our study also raises the historical problem that, since the invention of photography, the image has never been sustainable and has established a direct relationship with extractivism and the consequent environmental and social impact on extraction areas.

The photographic industry once accounted for 40% of silver mining and, in the 2000s, with the democratisation of digital, the photographic industry still accounted for 20% of this market [13].

Thus, how should we approach the question of ecological imaging today?

In practice, not just the materials and chemicals are at stake, but the entire laboratory and its extensions. This insight led to the development of the idea of Ecolab, a concept of space that we can imagine as a photographic laboratory, a photographic garden where we plant mint and thyme, a makerspace for producing ecobjects. These are sustainably produced tools that support image capture and development [3], [5], [14]. The boundaries between these forms are not rigid; on the contrary, they present pedagogical challenges within educational settings and serve as frameworks for experimentation in artistic residencies, such as the Black/White/Green project [15], [16].

Parallel to the physical Ecolab, we conceptualized a digital space to serve as the informational and narrative layer of the project. This digital archive contains diverse content, from the history of photography to the biography and experimental methods of Dianne Iverglynne. However, the digital space can no longer be seen simply as a repository of information. On one hand, there is an archival dimension as a set of events in which the relationships and rules of their formation are sought [17]. On the other hand, its digital affordances expand the technological context itself, creating new possibilities for translating methods such as Dianne's and for reconfiguring digital production with ecological concerns.

The platform — built on the MediaWiki architecture — serves as both an aggregator and amplifier of research in image, ecosophy [18], and Ecology of Image [19]. We begin this inquiry with the story and methodology of Dianne Iverglynne, who identified the reducing potential of thymol, a compound found in various aromatic plants, and developed a novel formula for photographic development [18].

2 METHODOLOGY

The initial phase of the project involved structuring data using Backdrop, a Content Management System (CMS), organized across four dimensions: Historical, Laboratory, Artistic, and Educational. However, Backdrop proved insufficient for addressing the investigative and structural complexity required by Arts-Based Educational Research (ABER) practices. These practices, particularly when applied to the historical and ecological dimensions of image production, demand novel perspectives and flexible taxonomies. The cross-referencing and classification of data in this context requires a semantic framework grounded in situated knowledge [20], which often stands in tension with dominant, globalized epistemologies.

To enable semantic data structuring—specifically in the form of triples (subject, predicate, object)—we transitioned to the MediaWiki ecosystem. Through a Wikibase instance, we were able to implement a semantic structure more conducive to exploratory and pedagogical goals. Moreover, the wiki-based infrastructure supports an open and collaborative environment aligned with the educational values of the project.

The platform we developed begins by retrieving and aggregating this data to better understand the problem. The resulting archive includes textual, geographic, temporal, and audiovisual data related to the history and theory of image ecology. The resulting archive includes textual, geographic, temporal, and audiovisual data related to the history and theory of image ecology. The aforementioned four dimensions (*Historical*, *Laboratory*, *Artistic*, *Educational*) function as intersecting axes for analysis and interpretation. For example, the Laboratory axis contains information such as molecules that act in photographic development; offers didactic resources such as exercises for sustainable image-making, and the Historical axis features the story of Dianne Iverglynne and her contributions.

Technologically, the platform employs a decoupled Docker-based architecture, combining a MediaWiki back office with a React-based front end. This architecture emerged from the project, *Breaking the Code: Algorithmic Non-Normativity in Creative Digital Humanities* [21]. This project seeks to challenge various forms of normativity embedded in digital systems by embracing principles such as error, failure, and situated knowledge.

To *decyclopaedicise* with systems such as Mediawiki and Wikibase, we structured the data in a dialogue between encyclopaedic and universalising knowledge with situated knowledge, from different positionalities, using different practices and methods of artistic research and education. In doing so, we sought to subvert the normative tendencies of encyclopedic platforms like Wikipedia. The custom front end developed in React enables a variety of visualizations and navigation modes, including maps, timelines, and network graphs. Usability was tested through scripted tasks designed to evaluate the platform's navigational and pedagogical potential.

After the first usability tests, we realised that they could be adapted to pedagogical practices. This led to the development of narrative-based exercises that encourage critical reflection on the Ecology of the Images. That is how we decided to use Dianne Iverglynne's story as a motto for research into more sustainable and ecological photographic development. Our pedagogical example consists of a quiz with tasks <https://tinyurl.com/echoimages-form> requiring navigating the platform <https://echoimages.labs.wikimedia.pt/> to find answers to the questions.

3 RESULTS

The central narrative of our platform begins in 1997, when Dianne Iverglynne was enrolled in the Fine Art Photographic Illustration program at the Rochester Institute of Technology. Motivated by a continuous curiosity and a desire to explore alternative photographic processes, Dianne registered for the course Chemistry of Technical Photography, taught by Professor Scott Williams. One of the course's focal points was the coffee-based photographic developer known as Caffenol, a formula developed by Scott Williams and introduced in his classes [20].

The final assessment for this course was an exam. However, each year, Williams offered an alternative challenge: students could opt out of the exam if they succeeded in formulating a new photographic

developer. Dianne was not a science student and knew from the outset that she would have little chance of succeeding in the exam. Without a background in science and lacking confidence in her ability to perform well on the exam, Iverglynne accepted this challenge. Despite her limited knowledge of chemistry, her artistic training and deep engagement with image processes guided her exploration.

She requested a chemistry textbook from her instructor and began analyzing molecular structures, using visual pattern recognition skills derived from her arts background. By placing a diagram of the hydroquinone molecule — commonly used in photographic developers — on her refrigerator, she initiated a process of informal comparison, visually examining other molecules for structural similarities. This led her to thymol, a compound found in aromatic plants such as mint and thyme, which shares visual and functional similarities with hydroquinone.

Through a series of practical experiments, Dianne successfully developed a novel method for processing photographic film and paper using thyme and mint extracts. This discovery demonstrated significant potential for environmentally conscious photographic development practices.

Building upon this narrative, we developed a script with tasks that began by giving historical examples of the photographic industry and related environmental problems, until we reached alternative solutions and the story of the discovery of Dianne's formula. Thus, as the script conclusion, we presented some representations of molecules to see if those who browsed the platform could identify hydroquinone and thymol as active components in photographic development.

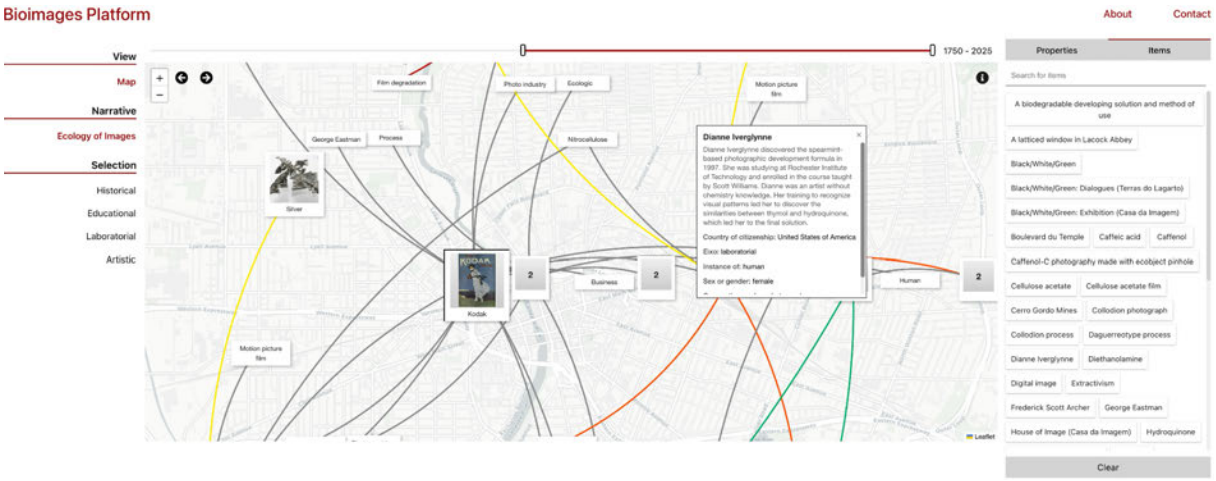

Figure 1. Ecology of Images platform.

4 CONCLUSIONS AND FUTURE WORK

We turn to the history of the ecology of images in search of new narratives, alternative processes, and more sustainable relationships with visual production. This approach does not entail the rejection of digital technologies; on the contrary, our project is firmly grounded in digital infrastructures, encompassing both object production and image creation. By experimenting with alternative methods of image production, such as those developed by Dianne, we aim to foster a slower, less industrialised engagement with images, encouraging the reflection on the relationship between the image and the material from which it is generated. This offers opportunities to demystify the "black box" of technological processes [21], and promotes more conscious interactions with the digital realm.

Our methodology seeks to explore more sustainable techniques from different fields and translate them into new actions and critical-social perspectives. In addition to Dianne's contribution, we draw on sustainability philosophies in line with Fukuoka's [22] and David Holmgren [23]. Through these frameworks, we aim to utilise technology in a critical and context-sensitive manner, looking for the most appropriate and sustainable solution.

Today, we can think and experiment with images more sustainably using this and other methods that reduce the toxicity of development processes and make them more accessible. However, these approaches require rigorous research, organisation, stabilization and systematisation. The field remains ripe for further inquiry — not only into the techniques themselves but also into the research tools needed for transdisciplinary methodologies within a research-based learning (RBL) framework.

The platform we have developed functions simultaneously as a research tool and a pedagogical device in the field of image ecology, fostering interdisciplinary dialogue.

Returning to Dianne's story, the relationship she established between the discipline of chemistry and the visual analysis of molecular structures presents a productive model for speculation and experimentation. This pedagogical strategy invites students to explore new photographic formulas while deepening their understanding of image production processes. Accordingly, we are developing an archive with a database that includes visual and graph representations of relevant molecules, to put this exercise into practice, through proposals and games to be developed on and off the platform.

In parallel, we envision this database serving as the foundation for a locally hosted artificial intelligence (AI) system capable of identifying visual patterns and generating potential new photographic development formulas. This approach privileges localised, self-hosted AI solutions over cloud-based infrastructures, thereby promoting sustainability and data sovereignty. By enabling software to recognise structural similarities among molecules, we aim to support the development of innovative, eco-conscious photographic processes. Perhaps the images produced in this way are more interesting than those generated by AI. Using digital devices to reduce their use could be a more interesting challenge than fetishising them.

As a more accessible and sustainable use of AI, we plan to integrate local implementations of LLM with Open WebUI [24]. Our starting point is Graph2Token [25], a method that enables molecular graphs, such as those used to represent chemical compounds in photographic development, to be translated into token sequences understandable by Large Language Models (LLMs), without requiring changes to the LLM architecture. This approach makes it possible to integrate molecular data with textual or narrative information, allowing for semantic reasoning across domains.

As a tool for analysis and comparison, the digital platform and AI possibilities are contaminated with the stories that feed them, transforming their use and aligning them with movements that seek truly sustainable and ecosocial alternatives. As well as looking for new reducing agents that will enable new formulas for developing film and photographic paper, with the help of the archive and AI tools, we intend to continue the research into a more ecological alternative to photographic fixatives, which began in the Bioimages project. This new solution enables another line of sustainable research and development, thus seeking to close the loop on more environmentally friendly and sustainable image production.

What might emerge from comparing and articulating these two approaches? Could the visualisation of molecular structures lead to new ways of producing sustainable and ecological images?

Ultimately, the most significant outcome for us lies in the questions these practices provoke. We contend that through environmentally attuned methods, it becomes possible to imagine — and enact — new modes of living and relating to images, technologies, and the world at large.

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