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II

DESIGN HERITAGE AND VISUAL MEMORIES

Poster World

Bespoke AI Meets Curator Expertise for Public Engagement

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Abstract
Though museums are digitising their archives, online consultations remain low. New forms of engagement bring these digital memories to life and can support museums in maintaining and developing digital resources. Artificial Intelligence presents opportunities to showcase this rich heritage, but it also raises issues of transparency and cultural relevance. We explored these questions through a collaboration with Zürich's Museum für Gestaltüng on its unique poster collection. We looked at how calculating similarities between digitised documents could create new user experiences with emotional and cognitive impact. Throughout the project, designers worked with engineers to investigate bespoke algorithms and graphic representations of their outputs. After an initial state of the art and preliminary tests, we developed three scenarios for a museum installation. Investigating three hypotheses, we evaluated the prototype scenarios with user experience psychology protocols. Our results show the value of combining artificial intelligence with curator expertise, the impact of similarities extracted by mathematical modelling and the importance of how they are visualised. We also found no significant difference between the perception of novices and experts in our results. This fosters a strategy for museums which brings different audiences together. The final installation, which combines elements from all three scenarios, opened to the public at the Museum in February 2022.

1. Introduction

Museums digitise their collections to increase visibility, accessibility and use for academic research. The latest study performed by the Network of European Museum Organisations (NEMO, 2020) reported a digitisation rate of 43.6%. This leads to huge and rich databases of digital memories. However, despite promising perspectives (Anike & Chinelo, 2017), visits to museum archive websites remain low, particularly in comparison to other cultural institutions such as libraries (Nauta et al., 2017). Furthermore, these sites' complex navigation and indexing reduces accessibility to the wider public (Machidon et al., 2020). It is, therefore, critical to raise the interest of large audiences through new forms of engagement to make value out of this digitised heritage. This could not only bring effective engagement between museums and society but also help to confront the current challenges and threats to digitisation (Pandey & Kumar, 2020).

Creative applications of artificial intelligence (AI) present exciting opportunities to bring heritage to new audiences. This can be seen in examples such as Microsoft's *AI for Cultural Heritage program* and the Horizon Europe-funded *Saint George on a Bike* project. We identified three key challenges and opportunities for using AI for cultural heritage.

Firstly, new forms of interaction with AI confront questions of responsibility and transparency (Pisoni et al., 2021). These can be complex to manage; for example, information transparency can also lead to information complexity. Therefore, information, visualisation and interactions must be controlled in order to moderate user understanding and engagement (Ribes, Henchoz, et al., 2021).

Secondly, many digital archive experiences that use AI present the largest possible amount of content. This can be seen in examples such as the *t-SNE Map Experiment* by Google Arts & Culture. This shows the collection's richness and uses AI's ability to generate new insights from massive databases. However, we hypothesise that this can overload visitors and reduce their capacity to see clear narratives from the experience. Traditional exhibitions, which showcase a limited number of elements through curatorial direction, are well-versed in creating a clear statement which relates the heritage to cultural, historical and social contexts. They also allow different aspects of the museum collection to be brought out at different moments, allowing a regular stream of new narratives for visitors.
Finally, AI and associated techniques have the capacity to adapt museum content to individuals, which is often seen as something positive (Pisoni et al., 2021). However, other work stresses the benefits of museum sociality, where different audiences, from novices to experts, can meet and engage together (Jafari et al., 2013).
In light of these observations, how can we make the most of AI's potential to engage the public with digital museum archives while maintaining a curator's critical input? What new forms of interaction are required? How do we gain cultural relevance and transparency while using mathematical modelling? And how does it remain a social experience?

1.1. From Design Research to an Implemented Solution

We explored these challenges through a design research project in collaboration with the *Museum für Gestaltung* in Zürich. Working with the museum's poster collection, the

objective was to design and deliver an installation for the museum that would enhance the public's cognitive understanding and emotional connection with the archive. From the outset, we investigated AI and related technologies as a way to open design perspectives. Our team of designers, engineers and psychologists also looked to provide a new approach addressing transparency and cultural relevance in this context.

1.2. The Poster Collection

The museum's poster collection is one of the largest in the world, with more than 360,000 items, of which 52,000 are digitised. At its core, the poster is a visual communication medium reproduced in mass to promote products, services, people or ideas (Muller-Brockmann et al., 2004). Posters are complex graphical objects which can combine photography, fonts, illustrations, colours, composition grids and other visual elements in a single image. Creative combinations of these elements give posters a particular visual salience (Wilson et al., 2015), allowing them to communicate a memorable message rapidly. The posters in the *Museum für Gestaltung's* collection can be considered for their capacity to reflect the society of their time. For our work, we had access to the full digitised poster database as well as to 35 books of the Poster Collection series produced by the museum.

2. Creative Directions

Combining initial desk research, observations and discussions with curators and designers, we grounded the design of our installation on the following four directions. The first was to display a sample of the collection instead of the whole

archive. This sample had to be defined by the curator to provide a coherent ensemble of articles related to a topic. This approach would also allow the museum to change the content on a regular basis. The first curated sample consists of around 2000 posters from the Swiss collection between 1907 and 2021. The intention was that this would also be an appealing theme related to the Swiss imaginary for novice visitors.

The second direction was to highlight poster features by presenting a small number of visually or historically similar posters together. Using AI to do this would create a strong visual impact to engage visitors whilst also revealing the elements that make up the poster's visual saliency. This was inspired by previous works, including the museum's books and the project *Poster N°524* (Boomgaard & Kleerebezem, 2013), in which the authors deconstructed a poster series by isolating and reconstructing specific characteristics.

The third idea looked at expressing poster features. To reduce the potential complexity created through transparent AI, we decided that each feature should be expressed graphically instead of with text or numbers. To build more culturally relevant associations, we also wanted to investigate how algorithms could be trained with relatively small amounts of curated content (such as poster books) as opposed to large open-source databases. The challenge was how to isolate the potentially intertwined poster features and the lack of an annotated database.

The fourth creative direction was to show the relationship between individual posters and the selected collection. We aimed to display a focused poster view, highlighting a small number of similar posters at full size and a collection view, showing the selected subset of posters as an ensemble (Kutay, 2016).

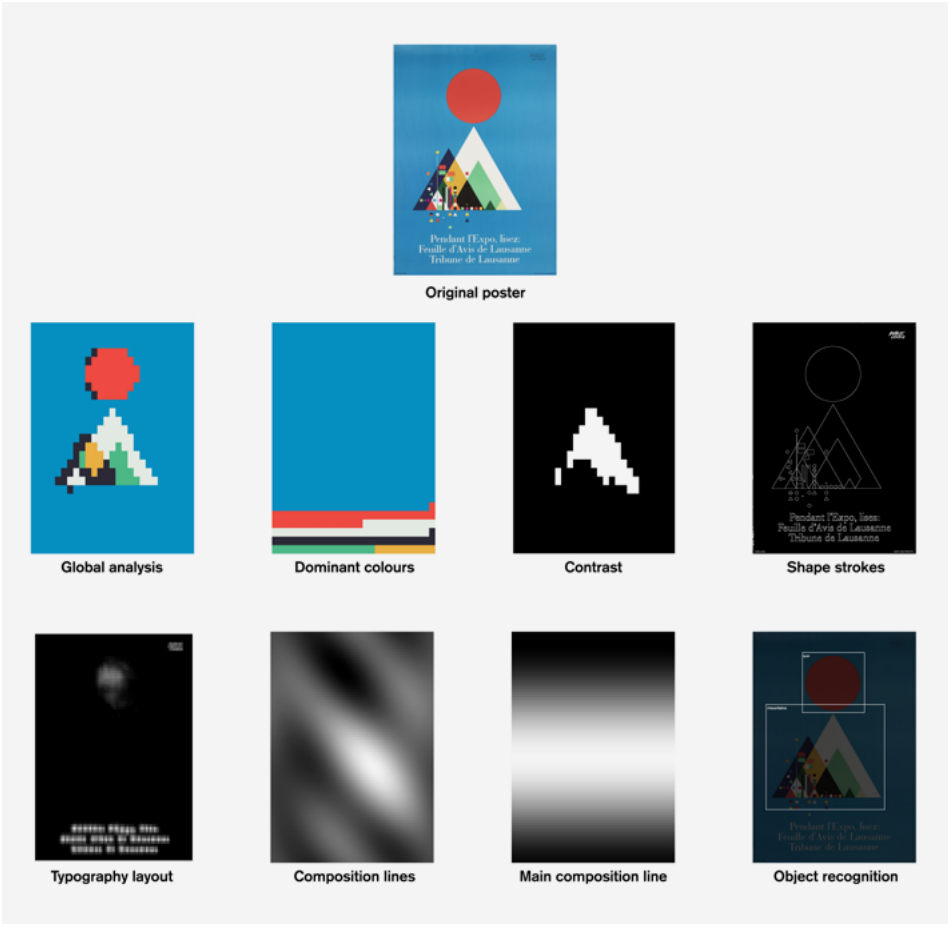

Figure 1. Graphical representations of analysed poster features.

3. AI Investigations

These challenges led to engineering investigations throughout the project. The first was to develop algorithms to extract poster features that could manage the medium's complexity, then transform the extracted features into graphical representations, and finally showcase these results in both a poster and collection view.

Dominant colours, shape strokes, contrast, and composition lines (Fig. 1) were extracted using existing image processing algorithms, i.e., k-means clustering, the Canny edge detector, the minimum cross entropy thresholding algorithm and the fast fourier transform, respectively. We tuned these algorithms to the specificity of the medium, and for each of them, we used the algorithm's outcomes as a graphical representation. A ResNet-18 (He et al., 2016), an 18-layer neural network for image classification, was applied to each outcome. This was implemented in combination with a 2D t-SNE (Van der Maaten & Hinton, 2008), an algorithm for visualising high-dimensional data sets to create the collection view. To facilitate user understanding between the collection to poster view, we used the t-SNE 2D coordinates to calculate similarities.

For object recognition, we used YOLO (Redmon & Farhadi, 2018) on the raw poster image in combination with a 2D t-SNE for the poster view and collection view. We displayed bounding box images of the detected objects to represent this feature graphically.

For a global poster analysis, we used the museum's whole digitised poster collection to train a convolutional autoencoder (an artificial neural network used to learn efficient codings of unlabeled data). The graphical representation is a low-resolution version of the image with only dominant colours.

The Character-Region Awareness For Text detection algorithm (CRAFT) was used for the typography layout feature. The character region map, an output of CRAFT, was used as the visual representation. As for the image processing algorithm outputs, a ResNet-18 was applied in combination with a 2D t-SNE for the poster and collection views.

Finally, we developed an AI framework to create a narrative from the museum's curated poster books to reach more culturally relevant outcomes. We started by clustering objects and then generated narrative series. The model was validated via user tests with professional graphic designers (Ribes, Bernasconi, et al., 2021).

4. Low-Fidelity Experiences

We performed preliminary user tests with 14 participants and low-fidelity prototypes to further our design directions. We wanted to define the number of associated posters to show at once in the poster view and to determine how to express the features. The results showed that presenting three posters together balanced diversity with a clear perception of a common feature. We also compared three features driving poster association: one with an obvious feature (colour), a second with a shared theme, while the third was random. Though users ranked the obvious feature first, the theme second and the random association last, the results showed low differences. This supported the idea of presenting posters through associations but also showed that non-explicit associations can remain attractive to visitors. Combining these results with the AI investigations, we established a list of features to be integrated into the next prototypes. This list was also based on the literature and tested with graphic design experts. These were global analysis, dominant colours, maximum contrast, shape strokes, composition lines and main composition line, typography layout and object recognition. In addition, we used metadata on the designer, client and keywords from the museum's database to add contextual information for each poster.

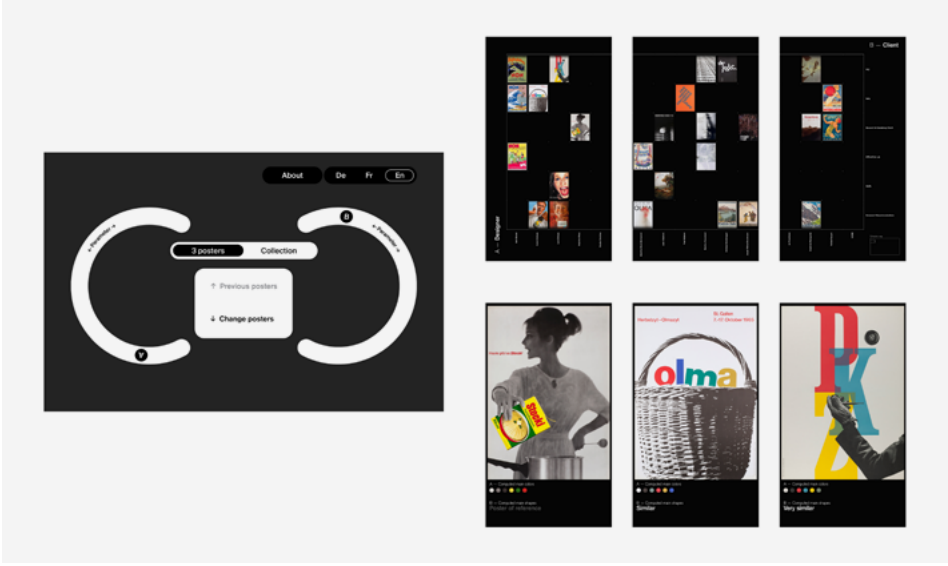

Figure 2. Scenario 1: controller with two feature selection (red), collection view axed on two selected features (green), poster view with association based on two selected features and highlight on similarities (blue).

5. Three Scenarios

We built three different scenarios, each relating to a specific hypothesis to test. Each had a collection and poster view. Scenario 1 (Fig. 2) allowed the users to organise the collection on a 2D graph by choosing two features (one for each axis). Once the user had selected the two features, all the posters were automatically sorted. The user could switch from this collection view to the poster view, where the computer randomly took one poster and associated two others based on similarities to the two selected features.

Scenario 2 (Fig. 3) was dedicated to explicit visualisations of the features. The user could select one feature and then see the posters either in their original appearance or in a new rendering that expressed the feature. This could be done either in the collection view (organised by global analysis) or in the poster view.

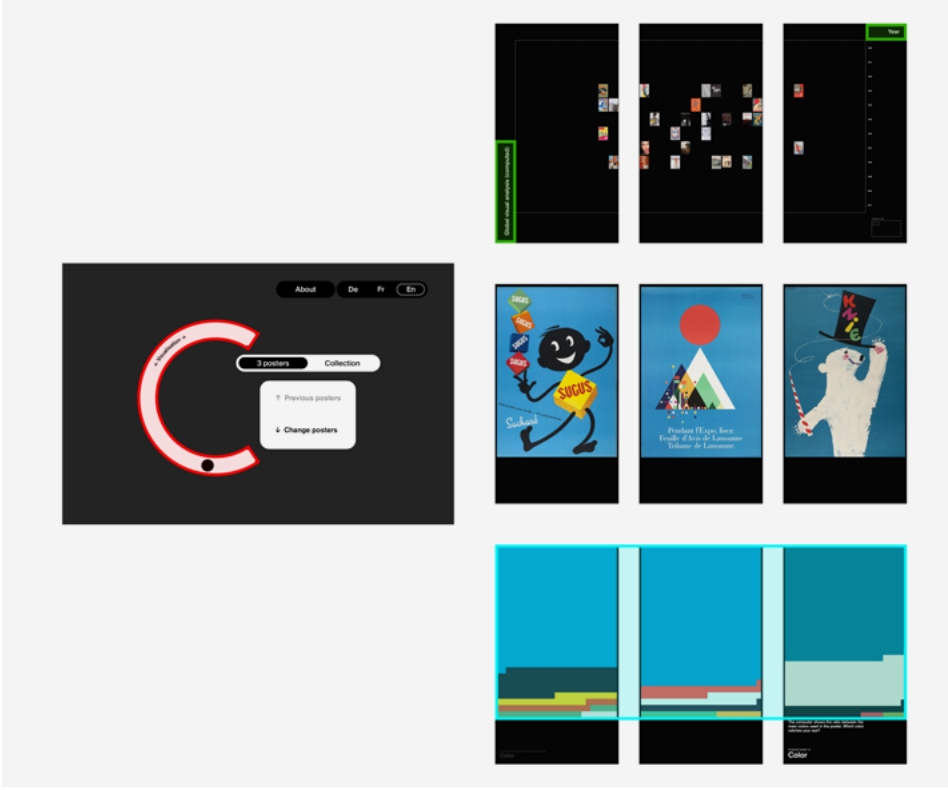

Figure 3. Scenario 2: controller with one feature selection (red), collection view axed on global analysis (fixed) (green), poster view with association based on the selected feature, feature analysis view (blue).

When switching to the poster view, the computer took one poster and associated two others via a similarity calculation. Scenario 3 (Fig. 4) allowed users to select a poster in the collection freely. This started in the collection view with the posters displayed on a 2D graph according to their similarity along two features, one that could be selected by the user and the second that was fixed (the year). The user selected one poster, and the system automatically moved to the poster view and showed the two most similar posters according to the selected feature.

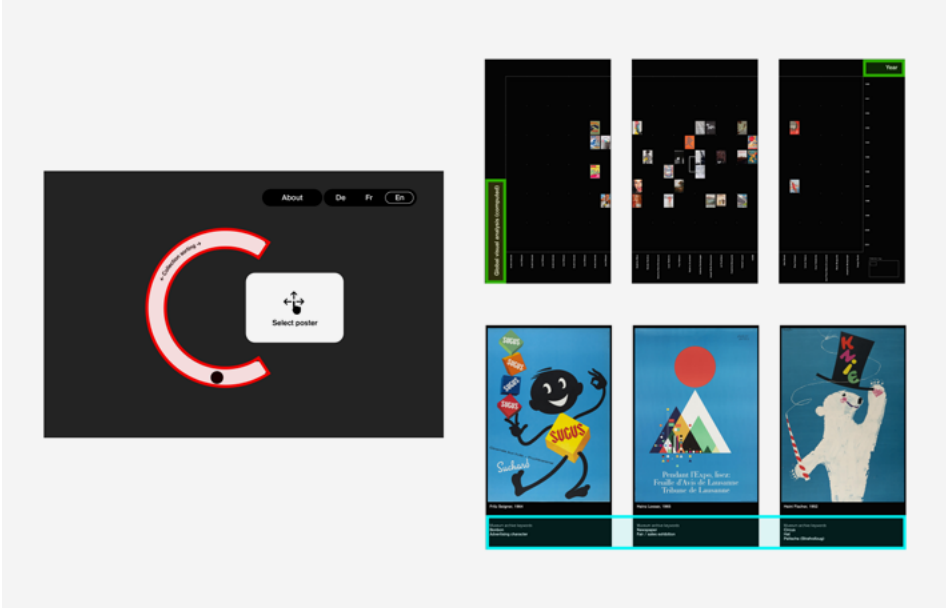

Figure 4. Scenario 3: controller with one feature selection (red), collection view axed on the selected feature and the year (fixed)(green), poster view with association based on the selected feature (blue).

Our aim was to compare these scenarios and combine learnings into a final, permanent installation for the museum. We, therefore, used the same physical set-up, as well as compatible screens and interfaces.

The set design used a supernormal strategy for design research (Henchoz & Mirande, 2014). This relates to the idea of extracting the *essence of normality* beyond the functional approach (Fukasawa & Morrison, 2007). We used three vertical screens which matched the scale of the physical posters. We placed them close together so that they could form a single surface to present the collection view. Screens were mounted on black steel structures inspired by standard Swiss poster supports. These stand on a circular platform covered in gravel, echoing the urban outdoor context (Fig. 5).

Figure 5. 3D render of the scenography: a supernormal concept with a relationship to posters on the street. The circular form fosters interaction around the installation.

It also acts as a social place for visitors and allows the technical elements to be hidden. The interface was a standard tablet partially covered by a metallic plate to emphasise the interactive zones and guide the fingers. To accommodate the three different scenarios, we designed interchangeable variations of the metal plate to cover the tablet.

6. User Tests

The objective of our user tests was to use the three scenarios to test different variables. We used scenario 1 to analyse the impact of feature association on poster perception. Scenario 2 allowed us to evaluate the effect of feature graphic representations. Scenario 3 was designed to explore the relationship between the poster view and the collection view.

All three scenarios implemented our last creative direction, having both a collection and a focused poster view. We also investigated the overall experience and compared data from design experts and novices.

61 people participated (male = 28, female = 30, 2 = non-binary, 1 = don't want to disclose). The youngest was 18 years old, and the oldest was 72 (M = 37, SD 12). 67% of the participants had a profession linked to design, and 33% had a profession not linked to design.

To measure the emotional impact of the installation, we assessed if the installation was perceived as attractive, interesting and easy to understand through questions with a 1-7 Likert scale. To measure user experience, the UEQ-S, a common and valid 8-parameter version of the User Experience Questionnaire (UEQ), was applied (Schrepp et al., 2017). Perception of the graphic representation of features was measured qualitatively with questions regarding satisfaction with the given freedom to interact with the poster collection, the amount of available information, and the proposed associations. We evaluated if feature associations were better understood after the interaction and, therefore, if the installation had a cognitive effect on the test participants. Finally, we employed the widely used Net Promoter Score (NPS) to measure overall satisfaction.

The set-up included a 1:1 prototype of the installation and a computer for the questionnaires (Fig. 6). All participants tried the three scenarios in a randomised order. The test started with the installation displaying three posters.

Figure 6. Room set up for testing the three scenarios.

Feedback was asked about initial perception and understanding of specific features before any interaction. Participants were then invited to play with the three scenarios, one at a time, with a questionnaire between each interaction. During the interactions, they were left alone, within a limit of 7 minutes. Finally, a summary questionnaire was filled out to evaluate the overall impact after interactions.

7. Results

7.1. General User Experience

The Net Promoter Score showed that 97% of the participants would recommend the installation to a friend. Evaluation of the UEQ-S revealed that all three scenarios are classified as *above average*.

7.2. Emotional Impact

At first glance, the installation seems attractive (M = 5.13, SD = 1.27) and interesting (M = 5.21, SD = 1.05) but not complex (M = 2.43, SD = 1.49). There were no significant differences between novices and experts for interest, attraction or complexity (all > 0.05). In terms of positive qualitative statements, the scenography design comes first (21), followed by its interactive nature (18). The only negative qualitative comment reaching more than three answers was that it looks ordinary (7).

There are high scores for interest, both before (M = 5.22, SD = 1.03) and after (M = 5.52, SD = 1.3) the interaction. Scenario 1 (M = 5.68, SD = 1.11) keeps the highest score in terms of interest compared to scenario 2 (M = 5.15, SD = 1.37) and 3 (M = 5.28, SD = 1.02). A chi-square test revealed that participants think that scenario 2 (feature graphic representations) is the most inventive (52%) compared to scenarios 1 (27%) and 3 (21%) (Chi-square(2) = 11.01, p =.004).

20 out of 61 qualitative user statements show that the visualisation of scenario 2 was positive. Freedom of interaction was mentioned 13 times positively for scenario 1 and 12 times for scenario 3. However, people said they missed the option to select a poster in scenarios 1 and 2, and some were not content with the given information on scenario 2.

Overall, participants were more satisfied with scenario 2 (mean rank = 33.21) over scenario 3 (mean rank = 32.76) and scenario 1 (mean rank = 26.66), though the difference is not significant (H(2) = 1.67, p = .44). The qualitative statements

also show that the graphic representation of the features in scenario 2 is perceived positively, reaching the highest number of positive mentions (21).

7.3. Cognitive Impact

When looking at poster associations before using the installation, 89% of participants correctly named the colour association, 15% identified the typography layout, and 20% identified the composition line 20%. This systematically but marginally increases after using the installation, reaching 92% for colour, 18% for typography layout and 26% for composition line. Additionally, 74% of the participants subjectively felt that they improved their understanding of posters after experiencing the installation.

8. Reflections

From the results of both our preliminary and final tests, we see that poster association by features induces a strong impact, marked by a perception of coherence among users. This could be due to several aspects. First, in line with our first creative direction, as the content was defined by a museum curator on a specific theme, there was an inherent unity of the collection subset. Additionally, the poster features were selected from a design expertise point of view, based on the identity of the considered posters, combining different types of metadata and analysis.

The graphic representations of the associated features also appear to be essential, as users often are not able to identify them explicitly (unless obvious, like colour). These graphic representations have an emotional impact, as they received

the biggest number of positive statements. Scenario 2 is especially praised as innovative, though people are interested to know more about the feature than was given. This can explain why the objective cognitive gain remains low, which suggests further work to improve their understandability. Nevertheless, the overall preference goes for scenario 2 based on feature graphic representation, followed by scenario 3, focusing on poster selection, while scenario 1 gets a lower rating. Freedom of choice and interaction are praised in scenarios 1 and 3. The interest in choosing an object from the collection was also supported qualitatively. However, scenario 1, which involves choosing two features, led to some complexity. We keep here the fact that the final installation should allow the selection of a poster as well as one feature to streamline the user experience.

Thanks to the continuous dialogue between engineers, curators and designers, we developed a set of algorithms dedicated to posters and this installation. A special effort was made to make the action of the algorithms understandable and valued by the users (they were overall most satisfied with the scenario focused on graphic representation). This project opens paths for *culturally relevant AI*. The algorithmic decisions are more understandable, and specialising AI models can generate effective associations when trained only with museum content. Our work has shown that these associations can, despite a small data set, generate sequences in which users perceive a narrative value.
The inspiration of supernormality, which is extensively explored by our lab (Henchoz & Mirande, 2014), seems relevant

for this installation: it can foster a direct connection with the content, preserve attractiveness and induce a sentiment of simplicity. Some user statements quoted the installation as normal in the list of negative statements. But the recommendation rate of 97% indicates that it did not affect the installation attraction.

Finally, we found no significant differences between the perception of experts and novices. Rather than clustering audiences and developing adaptive experiences, which is a trend in AI (Pisoni et al., 2021), we can design experiences that bring different people together around the same installation and content. It improves the cost and efficiency of content creation and supports social behaviour.

Figure 7. The interface. Photo credit: Daniela & Tonatiuh / EPFL+ECAL Lab, 2022.

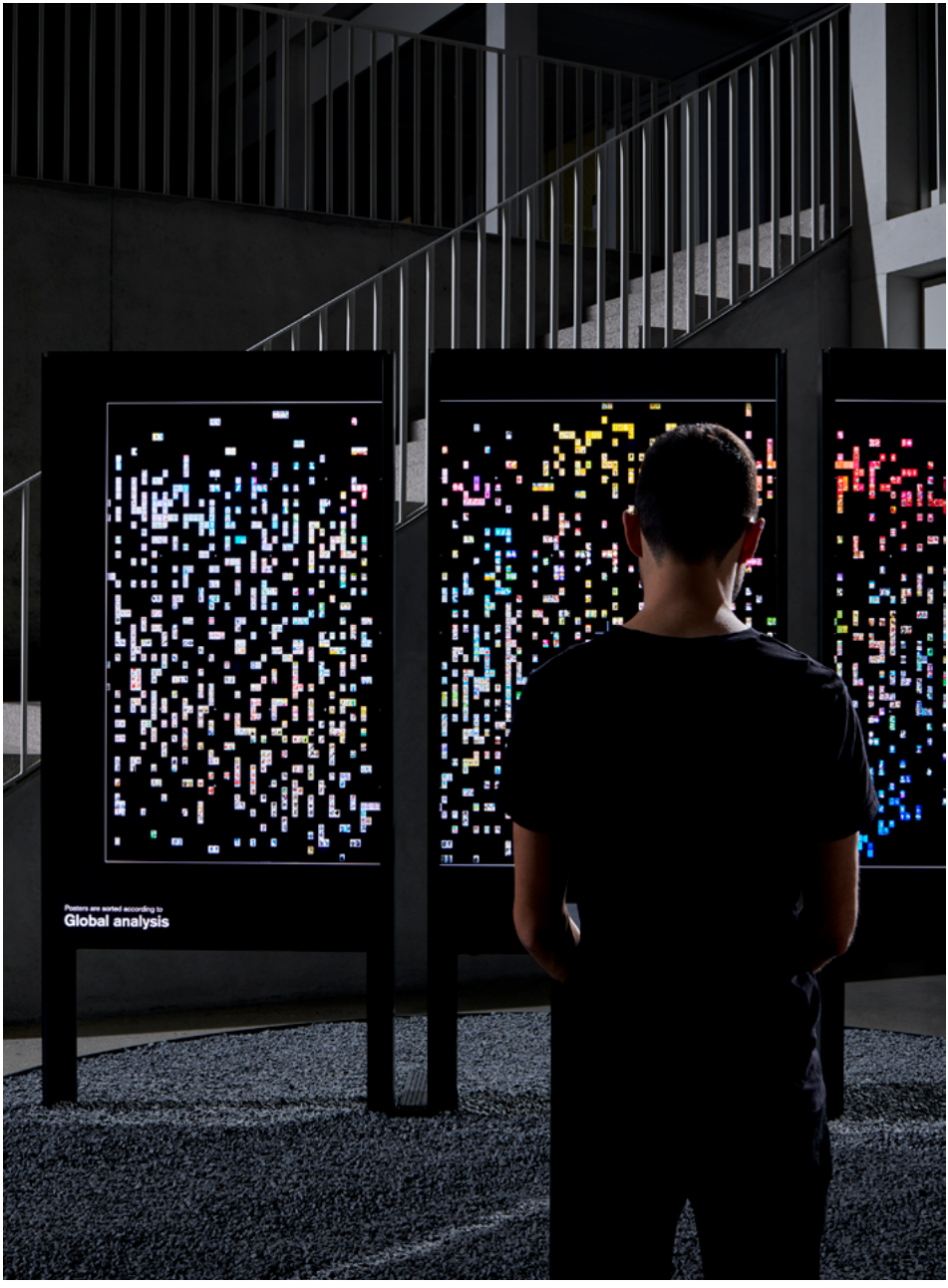

Figure 8. The collection view. Photo credit: Daniela & Tonatiuh / EPFL+ECAL Lab, 2022.

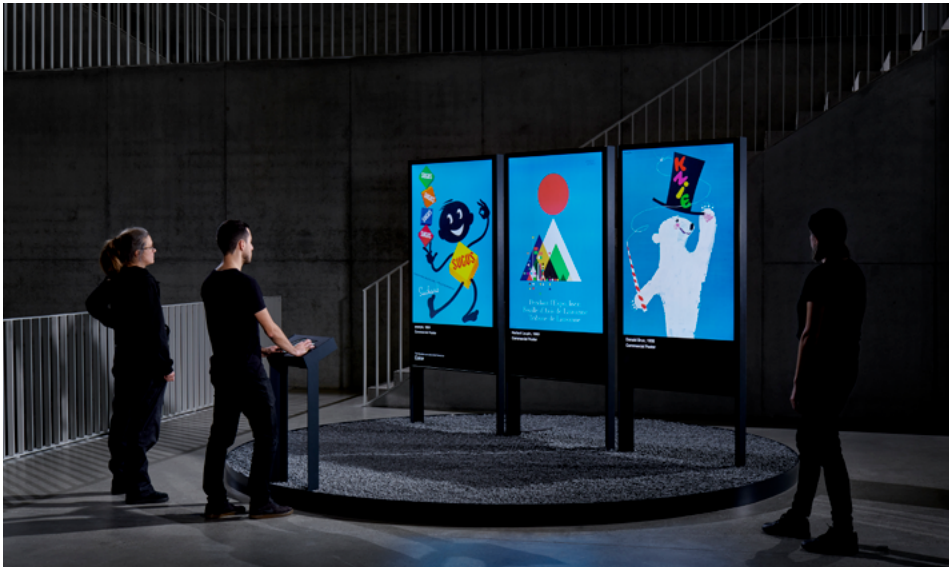

Figure 9. The poster view. Photo credit: Daniela & Tonatiuh / EPFL+ECAL Lab, 2022.

Figure 10. The feature graphic representation view for the composition lines. Photo credit: Daniela & Tonatiuh / EPFL+ECAL Lab, 2022.

9. Poster World – The Final Installation

Using these learnings, we created the final installation, *Poster World,* for the *Museum für Gestaltüng*. A standby mode shows a succession of posters linked by different features, making the association process more visible. When a user touches the interface (Fig. 7), the screens flip into the collection view (Fig. 8). Posters are arranged in a 2D space according to a single feature. Users can change this feature, causing the poster collection to move into a new configuration. If the user selects one poster, it appears on a 1:1 scale on the central screen. Two others follow it on either side, which the system has chosen as the most similar according to the selected feature (Fig. 9). Then, the feature can be revealed by a specific graphic representation for the three displayed posters (Fig. 10). Animations were introduced to make all of the interactions, visual transition and narrative more explicit. The installation's physical structure evolved into a full museal device.

10. Conclusion

Though museums are increasingly digitising their archives, interaction with virtual content remains low beyond expert communities. Therefore, this project looked at how AI could be used to create new and engaging user experiences with digitised heritage for wider audiences. We ran an integrated design research process that combined curator skills with technological performance and design insight. Though some decisions were directed by technical feasibility, this creative collaboration led to an installation that offers attractiveness and cognitive impact both to novices and experts. In light of this, further developing the system's algorithms, according to

technical developments and user feedback, could open up new directions for future engagement. In terms of impact for the museum, the installation's emotional resonance and the ability for content to be renewed in the future suggest long-term effectiveness.

To confirm this proposition and widen the installation's potential, evaluations of the final set-up in the context of the museum, as well as with other poster content, or even other media, could be conducted. Nonetheless, this project's process, installation and existing results contribute to a sustainable valorisation of digitised archives that brings social benefit through dialogue between diverse audiences.

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IV

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She is a Material Social Futures PhD student in the Department of Languages and Cultures and the Lancaster Institute for the Contemporary Arts at Lancaster University. Her interdisciplinary work is supervised by Dr Emily Spiers and Prof. Paul Coulton. Her PhD explores the future of infinite data storage and scenarios in which we will be able to store everything. She is interested in how human memory metaphors shape computer memory's design and vice versa.
Her research can be generally described as Speculative Design, through which she strives to understand how people and technology (will) interact with each other.
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Upon completing a BA in Philosophy, Andrea Facchetti holds a MA in Visual and Multimedia Communication (Iuav University of Venice). In 2017 he completed a PhD at the Iuav School of Doctorate Studies in the program "Design Sciences", where he developed a research regarding speculative practices and knowledge production in visual design.
Since 2018 he is a Research Fellow at the Free University of Bozen-Bolzano, Faculty of Design and Art.
He is co-founder and co-director of Krisis Publishing, an independent publishing and curatorial platform focusing on media culture, politics of representation and social research.
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Sabrina Melis is an Italian artist and designer. She is currently a PhD student at the Department of Architecture, Urban Planning and Design of Alghero. In her practice she intertwines artistic and scientific research focused on the exploration of possible approaches to find a way to integrate complex information avoiding the problem of oversimplification.
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Award-winning designer, he co-founded Sheldon.studio the first studio that focuses on immersive information-experience-design. Matteo Moretti was vice-director of the Interaction & Experience Design Master at the University of the Republic of San Marino, lecturer at the Faculty of Design of the Free University of Bolzano, at the University of Florence, at the SPD Milan, and guest professor at the Data-Design Master of the Elisava in Barcelona.
His design research projects, presented in many academic conferences and events such as TEDx and Visualized.io received the Data Journalism Award 2015, the European Design Award 2016 and 2017.

Moretti has also been a jury member at the World Press Photo 2017-18 (Immersive journalism category) and one of the 100 ambassadors of Italian design in the world 2018, named by the Italian Ministry of Foreign Affairs.
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Her research topics and publications concern visual identity and communication design applied to public context such as Museums, territories, and cultural heritage, with a particular attention on the public utility and impact.
She is co-founder of Studio Taller, a graphic and communication design studio based in Rimini. Since 2018 she has been collaborating as a volunteer and professional consultant for "Il Palloncino Rosso", a social promotion association with which she works on projects for social innovation and cultural promotion, creating exhibitions of regional interest, publications and participatory projects related to the conscious reuse of abandoned buildings.
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Mathieu Salzmann's research lies at the intersection of machine learning and visual recognition. He has published over 100 articles at top-tier peer-reviewed machine learning and computer vision venues, including CVPR, ICCV, NeurIPS, ICML, IEEE TPAMI, IEEE TNN-LS.
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Visual Communication and Graphic designer, Elettra Scotucci is in the second year of her PhD in Design at Sapienza University of Rome. Her main research topics are Typography and Graphic Design History, and the relationship between Design and New Craft in the field of the contemporary production of display typefaces for letterpress printing.
Together with his Ph.D. colleague Andrea Vendetti, she runs a letterpress studio in Rome, Slab, which is also a key spot for historical research, experimentation, and educational projects.
Currently she is Teaching Assistant in the Type Design course, both in the English and Italian curricula, at the DCVM master's degree, at Sapienza.
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After graduating from Sapienza University of Rome with a thesis on the clandestine presses of the Italian Resistance, and after a study period at ENSAD in Paris, he graduated from ISIA in Urbino with a thesis on the historiography of graphic design. He is in the final year of his PhD in Design at Sapienza University of Rome: his research consists of a survey on primary sources for the study of the history of wooden typefaces in Italy.
He teaches Graphic design and History of printing and publishing at Rufa. He works as a graphic designer with archives and associations and is the co-founder of Slab, a letterpress studio in Rome. Slab is a workshop where teaching and research are carried out to safeguard Italian typographic culture, and where workshops, exhibitions and conferences are held. Andrea Vendetti has been an AIAP national councillor since 2022.
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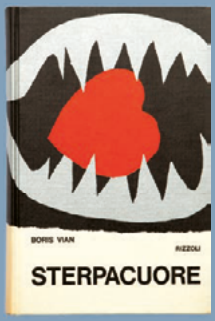
AIAP CDPG, the Graphic Design Documentation Centre. Working to collect, catalogue, archive, enhance and promote any documents related to graphic design and visual communication. These documents (originals as well as layouts of projects, books, posters, prints, catalogues, correspondence, photographs) help to rewrite the history of graphic design in Italy and to support research and educational activities, as it is the CDGP's intention to make these documents widely available.



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