Casual Leisure in Rich-Prospect: Advancing Visual Information Behavior for Digital Museum Collections

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As digital cultural collections become increasingly sophisticated in their scope and functionality, there is a need to build an in-depth understanding concerning the information behaviors of users in this new domain. Research has demonstrated that many digital museum visitors are engaged in casual leisure during exploration of a collection, suggesting that they do not have an inherent information goal but rather seek new experiences or learning opportunities based on personal curiosity and moments of discovery. Consequently, understanding how to translate casual leisure contexts into meaningful interaction design may play a critical role in designing engaging digital collections. Our study reports on the user experience of a largely unexplored user interface design framework called *rich-prospect*, which was originally developed to enhance browsing and discovery for complex visual collections. We performed a mixed-method, within-subjects study (N=30) that simulated a casual leisure approach to information browsing and retrieval across three different rich-prospect interfaces for digital cultural heritage. Our results show that rich-prospect scores well in the hedonic facets of its user experience, whereas pragmatic aspects have room for improvement. Additionally, through our qualitative analysis of participant feedback, we derived salient themes relating to the exploratory browsing experience. We conclude with a series of design implications to better connect interactive elements with casual leisure contexts for digital cultural collections.

CCS Concepts: • **Human-centered computing → Empirical studies in interaction design**; **Visualization theory, concepts and paradigms**; *User studies*;

Additional Key Words and Phrases: Digital collections, casual leisure, rich-prospect browsing, graphical user interface

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1 INTRODUCTION

Digital collections are a common feature of many museum websites, representing a culmination of digitization efforts at institutions around the world. However, unlike the carefully curated exhibits typically found on gallery floors, digital visitors must increasingly contend with the massive influx and staggering complexity of cultural data on the web [14, 48]. Research in information behavior has attempted to address the challenges of modern information seeking, but studies in this domain tend to focus on task-oriented activities as a fundamental starting point [17, 40]. In contrast to this traditional narrative, research has demonstrated that a substantial portion of visitors to museum websites include non-experts and casual browsers who do not have any explicit information seeking goals [34, 40]. This has important but largely underexplored implications for the design of interfaces that mediate between users and cultural heritage.

The present study investigates *rich-prospect*, a first-of-its-kind design framework for digital cultural heritage interfaces. Proposed originally by Ruecker [30] and later formally developed by Ruecker et al. [31], rich-prospect refers to interfaces that visualize the entirety of a collection immediately upon access, and provide additional tools to further manipulate and reorganize the display. Formulated with cultural collections in mind, the framework attempts to optimize exploration and discovery along with other casual browsing behaviors.

Few studies currently address the design implications of rich-prospect, especially from the perspective of new and emerging information behaviors such as exploratory search, information serendipity, and other browsing activities related to casual leisure. Originally described by Stebbins [37, 38], casual leisure refers to intrinsically rewarding and pleasurable activities that may include play, relaxation, active/passive entertainment, and sensory stimulation. During in-person museum visits, casual exploration activities are commonly observed and researchers have codified these behaviors into visitor models [1, 11, 41]. Furthermore, research has demonstrated a connection between the ways people move in museums and how they process information cognitively [2]. Understanding these information behaviors and how they translate into digital contexts can help designers empathize with the particular needs of users who do not have explicit information goals and improve the **user experience (UX)** of browsing collections on the web.

To that end, our investigation extends the initial findings of Morse et al. [26], whose original study reported on the UX of rich-prospect browsing and the framework's seven design principles. We reintroduce and significantly extend the analyses of the original experiment (N=30), which observed user behavior across three different experimental conditions—in this case, three different digital cultural heritage collections: *Coins* (Münzkabinett Berlin) [16], *Curator Table* (Google Arts & Culture) [7], and *Museum of the World* (The British Museum) [27]. Additionally, our in-depth qualitative analysis provides insights on browsing rich-prospect collections without the necessity to satisfy an inherent information need. We conclude with a discussion of design implications for the future development of rich-prospect in the context of casual leisure.

2 RELATED WORK

This section discusses the history and development of rich-prospect browsing, highlighting two key aspects underlying the framework: *affordance* and *prospect*. Thereafter, we introduce casual leisure as a part of the serious leisure framework of Stebbins [37, 38] and consider its relation to traditional and emerging information behavior research.

2.1 Rich-Prospect Browsing

Ruecker et al. [31] introduce rich-prospect as a user-centered, domain-specific user interface framework for cultural heritage collections. They attribute the term *rich-prospect* to designer Jorge Frascara, but its origins as a design framework first appear in Ruecker's [30] early work on archives of scholarly texts. Since that time, the framework has extended into visual collections and comprises seven underlying principles (Table 1): *representation*, *organization*, *depth*, *availability*, *multiplicity*, *coherence*, and *selection*. These principles were previously

Table 1. Seven Core Features of Rich-Prospect as Defined by Ruecker et al. [31] and Named by Morse et al. [26].

Feature	Description
Representation	The primary page or screen should show a meaningful representation of every object in the collection.
Organization	The user should be able to adjust various controls to reorganize these objects.
Depth	Each object should link to more data.
Availability	The available metadata about the objects should determine the tools available (e.g., metadata about dates might offer a timeline visualization)
Multiplicity	Where possible, more than one object should be available so that the user can choose among alternatives.
Coherence	The visual organization of the objects should bear meaning that is apparent to the user.
Selection	The user should be able to mark or select objects to keep track of them.

unnamed by the original authors, but Morse et al. [26] assigned individual labels to each principle for the purposes of their study. We adopt these same labels for the present work.

As an example, user interfaces with *representation* visualize collections in their entirety on the main page (e.g., Figures 1 and 2), which can prevent objects from being lost in the depths of an archive while also providing a sense of the collection as a whole. Additionally, interfaces with strong *multiplicity* and *availability* draw on collection metadata to offer different viewing possibilities (e.g., deep zoom, 360° view) and the ability to filter objects based on their unique attributes (e.g., country of origin, such as in Figure 1). In other words, the interface responds dynamically to the domain-specific information encoded within each object. Interfaces with strong *coherence* bear meaning that is immediately apparent to the user, such as in Figure 1(a), where pile size indicates the number of coins collected and margins around piles designate individual countries.

These broadly defined yet interrelated functionalities have important implications for visual collections, namely their ability to represent the inherent meaning and purpose of a collection by dynamically communicating patterns and relationships in the metadata. The seven principles of rich-prospect are extensions of two underlying ideas that inform its conceptual framework: *prospect* and *affordance* [31].

Prospect refers to Appleton's [3] assertion that human beings have an atavistic tendency to be drawn to environments where they can observe from a distance or without being seen. Appleton's work on the cognitive experience of landscapes, both as physical spaces and even as depictions in artwork, suggests that human beings derive visual satisfaction from unimpeded views of the land because it allows them to anticipate oncoming danger and make sense of their environment more readily. According to this logic, Ruecker et al. [31] suggest that user interfaces that offer meaningful visualizations of collections in their entirety have the potential to trigger a sense of *cognitive reassurance*, that is to say, a satisfaction brought about by unimpeded vision. Given et al. [13] support this claim based on their study using a rich-prospect interface for pill identification in which elderly users (N=12) claimed to experience cognitive reassurance during a pill identification exercise. This early study suggests that the *representation* feature of rich-prospect has the potential to trigger satisfaction, but it does not illustrate any definitive connection between prospect as a feature and its relation to the evolutionary psychology of aesthetics. Moreover, as this study focused on the visualization of medication and not museum collections, it fails to advance rich-prospect in a meaningful way for cultural heritage contexts. Our study addresses this gap by specifically targeting digital collections from the cultural sector.

The second concept, *affordance*, considers the interaction possibilities available to the user while browsing a collection. In the context of rich-prospect, affordances typically refer to visual cues that suggest interaction

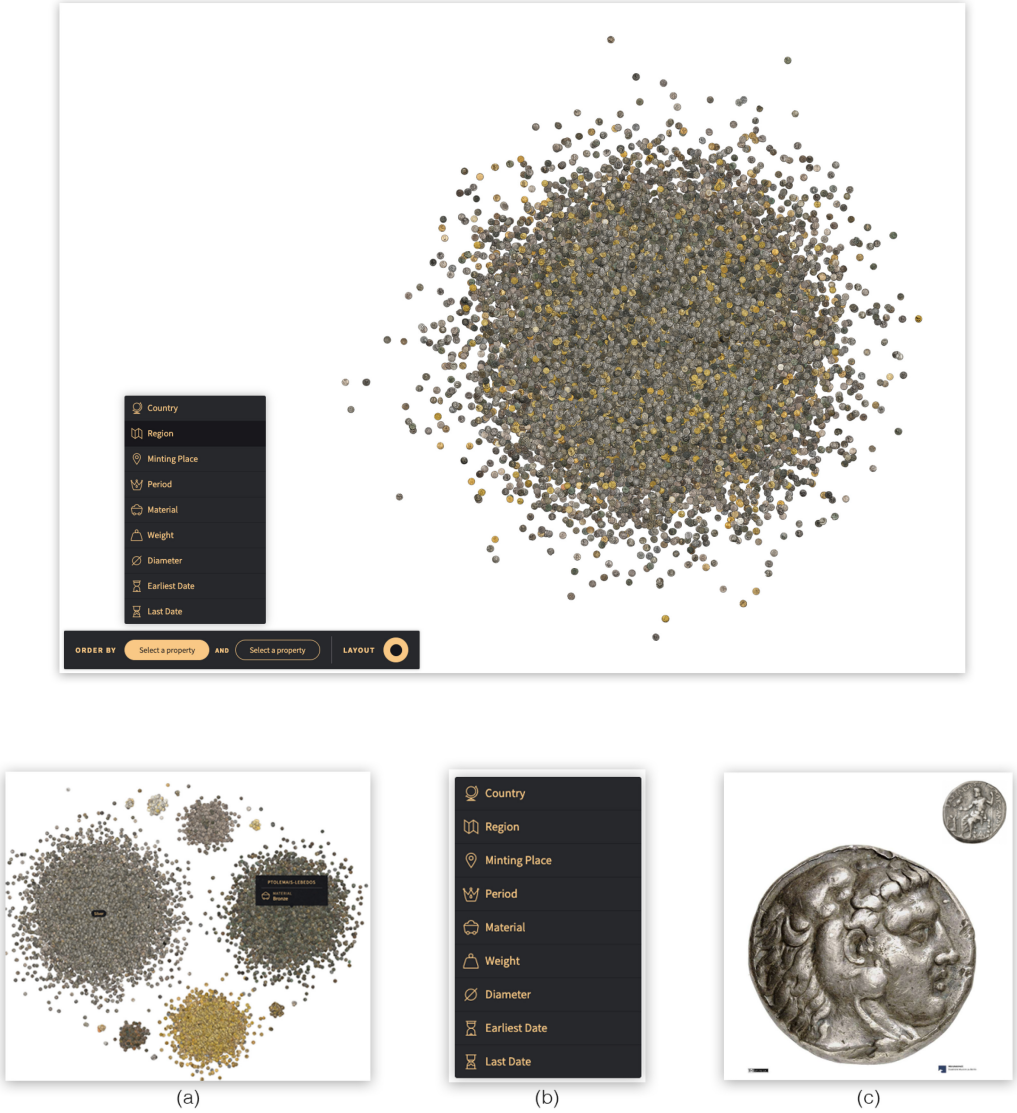
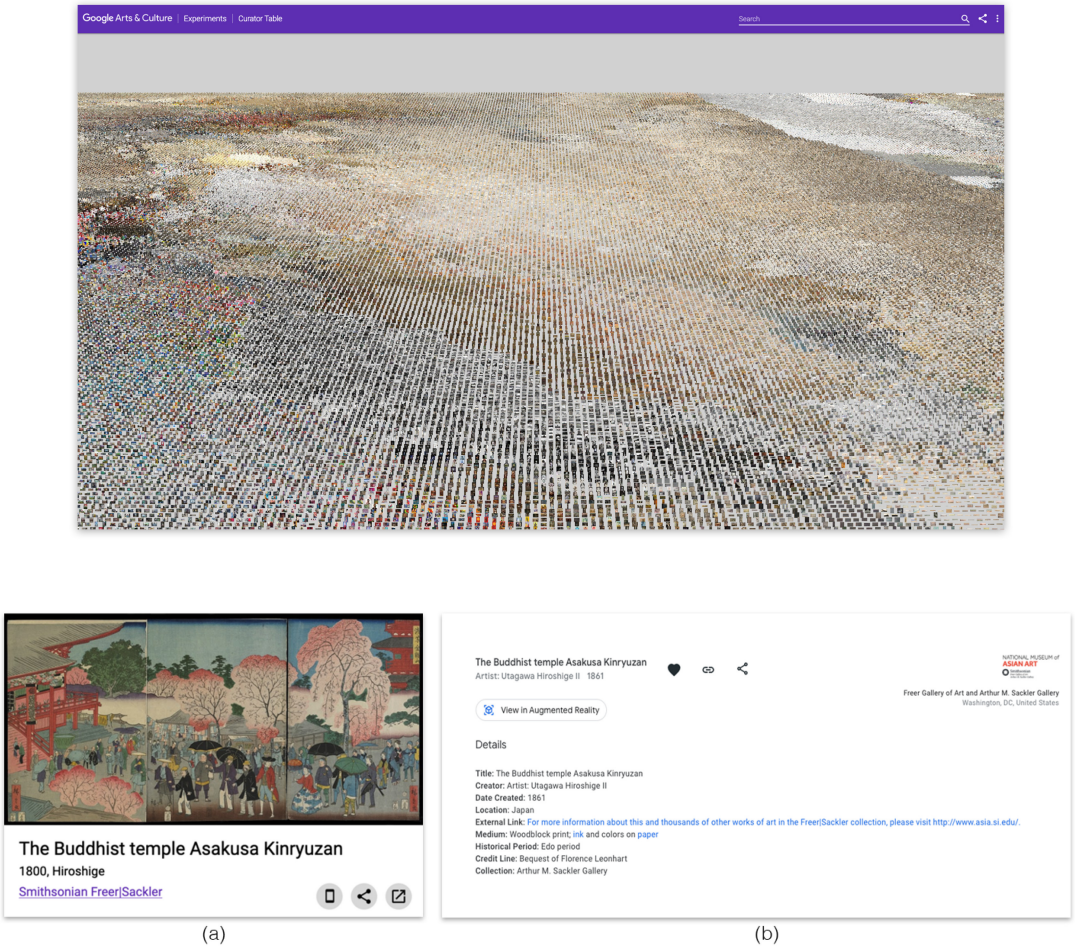


Fig. 1. The *Coins* interface by Gortana et al. [15], visualizing all coins in the collection (*representation*). Includes examples of *coherence* (a: size of coin piles and margins between coins indicate meaning), *availability* (b: metadata-based organization), and *multiplicity* (c: front/back view of coins).

based on domain-specific attributes. For example, collection metadata with interrelated hierarchies of objects (e.g., works by the same artist across time) should afford users the ability to navigate them based on those properties (e.g., a timeline). Moreover, this functionality should be immediately apparent to the user.

Although Ruecker et al. [31] draw largely on Gibson's [12] definition of *affordances* as "actor-independent possibilities in a given environment," we suggest a more nuanced view of affordances insofar as they relate to both digital technologies and casual leisure. Instead, we assert that rich-prospect makes use of Norman's [28] *perceived affordances*, or in consideration of Norman's (2008) [29] later stance, *signifiers*. In other words,



(a) (b)

Fig. 2. The *Curator Table* interface [7], featuring all objects in the collection (*representation*). Additionally, includes examples of *depth* (a: objects link to more information) and *selection* (b: ability to save objects as favorites using the *heart* icon).

rich-prospect depends on interactive cues to communicate how something is used or what it means in a particular use context. For example, when viewing an image of an artwork, a mouseover or touch effect might signal to the user that zooming in/out is possible.

Additionally, Hartson's [18] model of *physical*, *cognitive*, *sensory*, and *functional* affordances comprise the various interaction opportunities relevant to browsing modern websites and offer an additional lens to assess and communicate interaction possibilities. For example, in fulfillment of the *coherence* feature described earlier, visually grouping subcollections by size may serve as a cognitive affordance to indicate the strength of a collection or the particular focus of the museum. In both cases, the affordances described by Norman and Hartson more accurately reflect the respective purposes and behaviors of affordances in digital environments.

Rich-prospect connects the cultural heritage sector to emerging interface design theories that emphasize exploratory browsing and serendipitous discovery. These developments have grown out of earlier research on information behavior, and have resulted in a number of information seeking models. In the following section, we will discuss this development, paying special attention to casual leisure contexts.

2.2 Information Behavior for Casual Leisure

Information behavior concerns the totality of human behavior in relation to information, including both active and passive information seeking and use [47]. Central to this relationship between user and information has been the perception of an information need or goal. Researchers have articulated the establishment of information needs in a variety of ways, which we summarize in this section.

Wilson's [45, 46] information behavior model helped pioneer the notion of affect and cognition in relation to search and knowledge construction. It posits that psychological processes and other intervening variables related to the unique circumstances of an individual have direct implications on the establishment and prioritization of information needs. Kuhlthau's [20] *information search process* model also describes an individualized approach where users experience a moment of awareness of information lack that initially results in feelings of apprehension. This lack of knowledge or information presents itself as a gap in Dervin's [8] *sense-making model*, in which individuals identify an information problem that they must bridge through sense-making activities to achieve a state of understanding. Through sense-making activities, individuals acquire new information about the world around them that they can apply toward the desired solution. In this case, sense-making activities comprise decisions about what knowledge is important or relevant for overcoming the gap. Sandstrom's [32] *optimal foraging theory* considers these information decisions more closely by investigating how researchers create efficient and sensical paths toward information goals. Sandstrom's information foraging adopts the language of evolutionary ecology, connecting scholarly work to that of subsistence foragers in the wild in a quest for search and retrieval optimization.

Accordingly, these models have influenced the development of tools for various information seeking contexts but share a common assumption that users have a pragmatic, information-oriented goal. Moreover, the various authors developed these models almost exclusively by applying them to highly specialized audiences such as academics and other working professionals [21]. In other words, there is little to no consideration of casual users who have no inherent information need in mind, such as (digital) museum visitors. More recent work has gone as far as to argue that exploratory digital museum environments should reject the notion of information needs altogether in support of casual leisure contexts [42].

As a result of these developments, researchers have begun to consider information contexts that are specific to casual leisure, such as casual browsing, exploratory search [14, 44], and serendipity, also referred to as *information encountering* [10, 24]. Although some audiences have preconceived goals in relation to their museum visit, either in-person or digitally, many others have no established need in mind. For example, a study by Skov and Ingwersen [34] found that almost 30% of its participants (39 of 132) had no specific information goal while browsing a museum collection. Additionally, the study demonstrated the importance of visual exploration to create moments of discovery and serendipity. Other studies, such as those of Windhager et al. [48] and Villa et al. [40], confirm that casual users often (1) do not have the domain-specific knowledge required to make use of traditional information seeking methods (e.g., a search bar), and (2) benefit from increasingly sophisticated browsing and discovery functionalities.

Ruecker et al. [31] emphasize the necessity of providing a wealth of well-designed information over artificially restricting content. Whitelaw [43] demonstrates this idea of artificially restricted content in his example of the gallery attendant who asks visitors what they want to see rather than giving them direct access to walk around the gallery floor. This metaphor for the search bar illustrates the limiting nature of query-based information retrieval. Arguing instead for *interface generosity*, Whitelaw describes a model for interfaces that provide content-rich, navigable representations of complex digital collections that support "thoughtful engagement rather than purely functional satisfaction of an information need." Rather than asking users to specify what they are looking for by means of a search bar, generous interfaces instead offer information to users to help them navigate and discover objects of interest.

The affordances of rich-prospect have the potential to support visual information seeking behaviors that emphasize exploratory browsing over targeted search. This type of interface generosity has an early precursor in

the visual information seeking mantra of Shneiderman [33], which posits *overview first*, *zoom* and *filter*, then *details on demand*. Based on this notion, Shneiderman describes a more specific taxonomy of tasks for information visualization environments: *overview*, *zoom*, *filter*, *details-on-demand*, *relate*, *history*, and *extract*. Similar to rich-prospect browsing, these principles emphasize gaining an overview of a collection before exploring objects of interest more deeply. Shneiderman's model spans macrocosm to microcosm, enabling users to access details at multiple scales, to discover relationships between objects, and to maintain the structure of their browsing history.

Despite the interconnections between Shneiderman [33], Whitelaw [43], and Ruecker et al. [31], current research presents contradictory evidence concerning the UX of these design approaches. For example, a recent study by Speakman et al. [35] found that generous interfaces did not inherently increase visit duration or user engagement, concluding instead that it first was necessary to understand the information behaviors of casual users, something this study aims in part to address. In contrast, Miyakita et al. [25] discuss a successful implementation of a generous interface within a MOOC environment that supported open-ended exploration by users. In the case of this study, however, the results do not extend to a casual leisure context.

This shift in focus to casual leisure implicates a new kind of user, a non-subject expert who may have no preset goal or orientation when navigating a collection. Dörk et al.'s [9] *information flaneur*, a behavior archetype designed to represent a more dynamic, serendipitous mode of information seeking behavior finds a welcome home in the rich-prospect universe. In contrast to the subject specialist, the information flaneur learns about a collection through arbitrary exploration, following whatever piques her interest throughout the journey rather than actively seeking a particular object.

3 RESEARCH OBJECTIVES

The objective of this study is to advance research in user interface design for digital cultural heritage by understanding how rich-prospect browsing can support casual users, an increasingly important but underrepresented audience in the literature. To address these challenges, we investigated the following research questions:

(1) What is the UX of rich-prospect browsing across different types of digital cultural heritage environments?
(2) How can rich-prospect accommodate and enhance browsing in casual leisure contexts where there is no specific information need?

4 METHODOLOGY

To address our research questions, we performed a mixed-method, within-subjects study (N=30) across three different rich-prospect user interfaces. We asked participants to browse each interface without any specific information goal in mind and then measured the UX of each interface using questionnaires and semi-structured interviews. We then derived insights from the data to understand how different kinds of museum visitors engage in casual leisure while browsing digital collections.

4.1 Participants

We recruited 30 participants (20 female, 10 male; Table 2) for our study using paper advertisements hung in public spaces and announcements on social media targeted to the general public in Luxembourg and the surrounding region. The study received prior approval from the university ethics committee, and all participants gave their informed consent to take part. Additionally, all participants received financial compensation for their time.

The average age was 34.4 years (*Min*=19, *Max*=70, *SD*=11.76), and participants represented 17 different nationalities. None of the participants had any prior knowledge or experience with rich-prospect. Participants provided additional information about their museum visiting habits during the past year and also self-identified as one of five museum personas as developed by Falk [11]: *explorer*, *experience seeker*, *facilitator*, *professional/hobbyist*, and *recharger*. We slightly adapted the original descriptions of each persona by placing them in the first-person to

Table 2. Table of Participants

ID	Age	Sex	No. Visits	Persona	Assigned Interface
P1	26	F	10+	Explorer	Coins
P2	41	M	6–10	Explorer	Coins
P3	27	M	6–10	Explorer	Coins
P4	52	F	2–5	Professional/Hobbyist	Curator Table
P5	19	M	2–5	Explorer	Curator Table
P6	31	F	6–10	Explorer	Curator Table
P7	19	F	1	Experience Seeker	Museum of the World
P8	45	F	2–5	Recharger	Curator Table
P9	28	M	10+	Professional/Hobbyist	Museum of the World
P10	32	F	2–5	Explorer	Museum of the World
P11	34	M	6–10	Recharger	Coins
P12	26	F	2–5	Explorer	Curator Table
P13	40	F	10+	Professional/Hobbyist	Museum of the World
P14	49	F	2–5	Professional/Hobbyist	Museum of the World
P15	43	F	2–5	Professional/Hobbyist	Coins
P16	31	F	2–5	Recharger	Coins
P17	40	F	10+	Explorer	Museum of the World
P18	54	F	2–5	Professional/Hobbyist	Museum of the World
P19	31	M	2–5	Explorer	Curator Table
P20	70	M	10+	Recharger	Coins
P21	45	M	2–5	Explorer	Curator Table
P22	23	F	2–5	Explorer	Museum of the World
P23	24	F	2–5	Recharger	Curator Table
P24	28	M	2–5	Explorer	Coins
P25	20	F	6–10	Explorer	Coins
P26	33	F	2–5	Professional/Hobbyist	Museum of the World
P27	39	F	6–10	Explorer	Museum of the World
P28	26	M	10+	Explorer	Curator Table
P29	31	F	10+	Explorer	Coins
P30	25	F	6–10	Professional/Hobbyist	Curator Table

help participants empathize with each persona more easily (Table 3). Referring back to Dörk et al.'s [9] *information flaneur* archetype, we see in Falk's [11] model that the flaneur relates closely with the *explorer* whose sense of curiosity is a primary motivator for browsing and discovery. For this reason, we pay special attention to the participants who self-identified as *explorers* to guarantee that the study comprises casual users, among others.

4.2 Rich-Prospect Interfaces

We chose three rich-prospect interfaces as representative concrete examples for digital cultural environments: *Coins*, *Curator Table*, and *Museum of the World*. Rich-prospect browsers do not often explicitly identify as such, and therefore it was necessary to match the features of the applications with those described by the framework through expert assessment by a group of five HCI researchers. The final selection was based on the following criteria:

(1) The interfaces comply with the seven rich-prospect browsing principles.

Table 3. Falk's [11] Museum Visitor Personas

Persona	Description
Explorer	I am curiosity-driven with a general interest in the content of the museum. I expect to find something that will grab my attention and fuel my learning.
Experience Seeker	I am motivated to visit because I perceive the museum as an important destination on my list of things to see. My satisfaction primarily derives from the mere fact of having "been there and done that."
Facilitator	I am socially motivated. My visit is focused on primarily enabling the experience and learning of others in my accompanying social group.
Professional/Hobbyist	I feel a close tie between museum content and my professional or hobbyist passions. My visits are typically motivated by a desire to satisfy a specific content-related objective.
Recharger	I am primarily seeking to have a contemplative spiritual and/or restorative experience. I see the museum as a refuge from the work-a-day world or as a confirmation of my spiritual beliefs.

(2) The collections on exhibit come from the cultural heritage sector.
(3) The user should be exposed to a variety of information environments, with each interface featuring a different kind of visual collection (fine arts, archaeology, etc.).

By selecting three different types of cultural heritage collections, it was possible to investigate the applicability of rich-prospect more generally rather than focusing on a specific type of art, artifact, or information environment. Although our study evaluated the UX of each interface, our primary aim was to isolate the core principles of rich-prospect across three different experimental conditions to understand their relation to serious leisure contexts.

Coins [16], developed by Gortana et al. [15], is a digital numismatics collection created in collaboration with the Münzkabinett Berlin (see Figure 1). The application allows visitors to explore one of the world's largest coin and medal collections in an interactive and playful manner. The interface presents users with a large pile of historical coins that can be individually selected, moved, and viewed at different zoom lengths. Users also have the option to manipulate various filters to reorganize the display of the coins into more meaningful patterns.

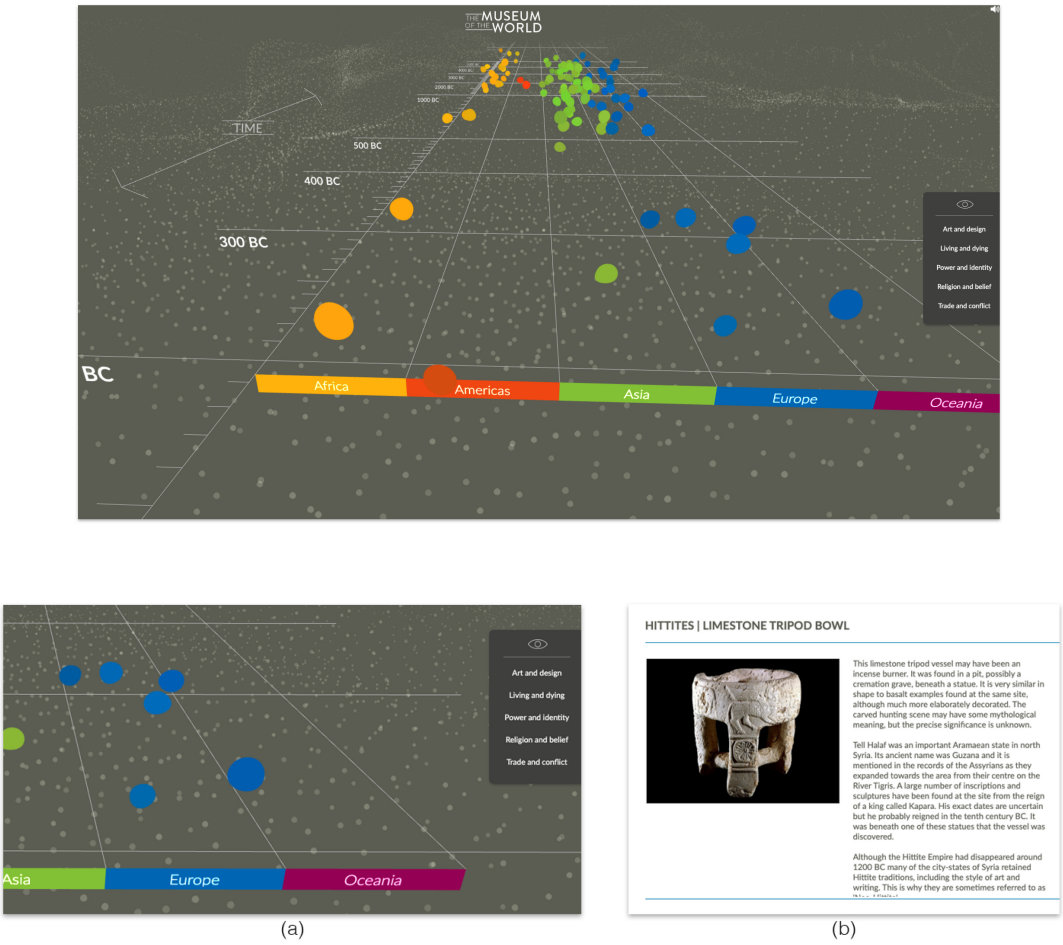
Curator Table [7] is an interactive mosaic featuring the cultural collections of the 600+ partners affiliated with Google Arts & Culture (see Figure 2). As the application loads, artwork and other cultural objects fall from the top of the screen into a giant map of images. Users can navigate the collection spatially or perform searches based on a variety of parameters such as artist name or even a particular concept (e.g., 'tree").

Finally, *Museum of the World* [27]is a collaboration between the British Museum and the Google Cultural Institute (Figure 3). Its interactive geographic timeline spans more than 2 million years of history and features a diverse collection of art and archaeological finds. Objects are spread across the timeline as individual selectable nodes that provide high-resolution images, textual information, and even audio clips from the museum's curators discussing the object's history.

All together, we settled on the three user interfaces to represent a diverse array of cultural heritage contexts: fine art, numismatics, and archaeology.

4.3 Procedure

We conducted 30 user tests inside the User Lab at the University of Luxembourg. The lab facility is specifically designed for user studies with digital technologies. Each session lasted approximately 1 hour. Prior to each



(a) (b)

Fig. 3. The *Museum of the World* [27], featuring an interactive timeline meaningfully ordered along an axis of region and time (*coherence*). Also pictured are examples of *organization* (a: tools for reordering the layout such as time/region and a thematic sidebar) and *depth* (b: objects link to more information).

session, we randomly assigned participants to one of three experimental conditions: *Coins*, *Curator Table*, or *Museum of the World*, with 10 participants assigned to each condition.

To observe their unbiased reactions to the different applications, we did not provide participants with any information about rich-prospect, nor did we introduce the cultural collections in advance. Additionally, we controlled for the technology used to access the collections. All participants performed the user tests on the same Apple iMac running Chrome (v. 70.0.3538).

The experiment consisted of multiple phases:

(1) *User test with assigned interface*: Participants casually browse the rich-prospect interface assigned to them for 10 minutes having received the following instructions:
   (a) *Explore the collection and discover objects of interest to you*
   (b) *Narrate your experience while using the application (think-aloud technique)*

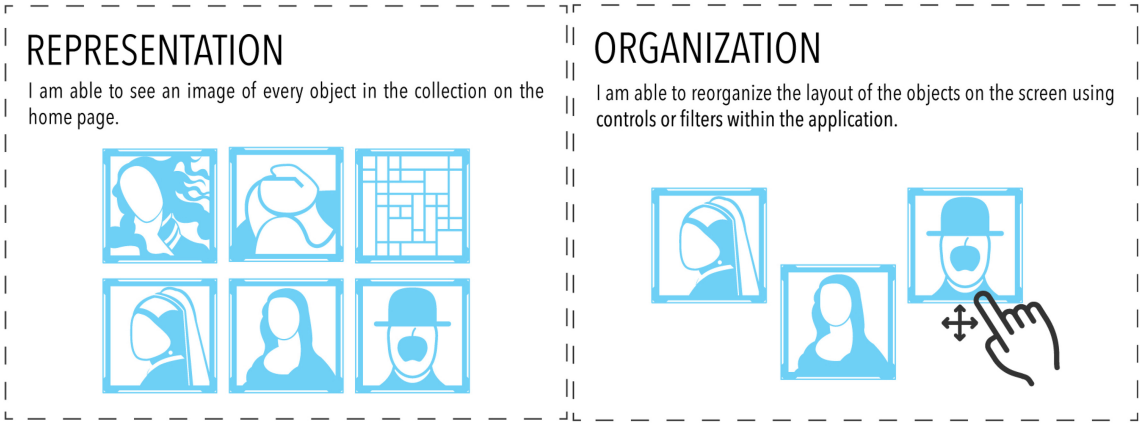


Fig. 4. Rich-prospect browsing cards designed by Morse et al. [26].

(2) *UX Evaluation*: Participants report on the UX of their assigned condition through an AttrakDiff survey [19] and a semi-structured interview.
(3) *Introduction to rich-prospect*: The researchers introduce participants to the concept of rich-prospect using visual cards designed specifically for the study that describe each of the seven core principles (Figure 4).
(4) *User test with second interface*: Participants repeat the same exercise described in phase 1 with one of the remaining two interfaces, randomly assigned. The researchers then follow up with a brief semi-structured interview about the UX of this second experimental condition.
(5) *User test with third interface*: Participants repeat the same exercise described in phase 1 with the remaining interface. The researchers then follow up with a brief semi-structured interview about the UX of this third experimental condition.
(6) *Evaluation of rich-prospect*: Using the rich-prospect browsing cards as a reference (see Figure 4), participants reflect on which interface made the best use of each respective feature (e.g., *Coins* made the best use of the *representation* feature) and write their final answers on a grid. Finally, participants rate the seven core features from least useful (1) to most useful (7) overall for their browsing experience.

To simulate the browsing contexts associated with casual leisure, we provided participants with only minimal instructions, namely to discover objects of interest to them. During the user testing phases (phases 1, 4, and 5), we observed from the adjacent User Lab observation room, which provided a live feed of the computer screen in addition to audio and video recordings of the testing area. Participants narrated their experiences using the think-aloud technique, in which they described their real-time reactions while browsing the collections.

We returned to the testing room after each phase and briefly discussed with participants regarding their experiences navigating the collection and finding objects of interest to them. We administered the AttrakDiff only once after the user test in phase 1 but repeated the semi-structured interviews after each user testing phase. The combination of questionnaire, think-aloud technique, and semi-structured interviews allowed us to quantitatively compare the UX of each individual interface while simultaneously drawing insights from participants' verbal reflections.

After completing the initial UX evaluation using the AttrakDiff, we introduced participants to rich-prospect browsing in preparation for the second and third interface sessions (phases 4 and 5). With this new information available to the participants, we were therefore able to ask them to reflect on how well rich-prospect browsing helped them to get a sense of the collections they tested and to discover objects of interest.

4.4 Materials

4.4.1 AttrakDiff. We implemented the AttrakDiff survey to measure the UX of browsing in rich-prospect. Hassenzahl et al. [19] developed the AttrakDiff, one of the most commonly used instruments for the quantitative measurement of UX. The AttrakDiff is based on a multidimensional model of UX that comprises four aspects: the pragmatic quality (PQ), two different hedonic qualities of UX (HQ-S, stimulation; HQ-I, identification), and general product attractiveness (ATT).

The pragmatic quality (PQ) of an interactive product measures usefulness, usability, and the extent to which a product matches the tasks or behavioral goals of the user. Hedonic-quality identification (HQ-I) indicates how well a user identifies with an interactive product, measuring the level of self-expression or self-image in relation to its use. Hedonic-quality stimulation (HQ-S) considers user stimulation or excitement from product use. Finally, global attractiveness (ATT) rates the overall attractiveness and product appeal.

4.4.2 Rich-Prospect Browsing Cards. We designed a series of seven illustrated cards (see Figure 4 and Table 1) that featured the names and descriptions of each principle of rich-prospect. We pretested the cards with a group of UX researchers to confirm that the meaning of each card was clear and understandable. After a series of iterations, we converted the final definitions into first-person to help participants empathize with the meaning attributed to each principle. Furthermore, we changed the name of one principle, *relevance*, to *coherence*. The term *relevance* created confusion during the pretests and did not adequately represent the precise definition.

4.4.3 Interface Grid. We designed a grid to assess which application made the best use of each of the seven principles (e.g., *Curator Table* made the best use of *representation*, or *Coins* made the best use of *coherence*). To complete this activity (phase 6a), participants would have to consider each principle in isolation, thereby enabling the researcher to correct any misunderstandings participants might have about the individual definitions of each. The final activity (phase 6b) built on the previous exercise by asking participants to order each principle from least useful (1) to most useful (7) based on their experiences during the testing.

5 RESULTS

We performed a mixed-method analysis on the quantitative and qualitative data to understand the overall UX of each collection and user perceptions on the rich-prospect browsing experience. We reintroduce some of the quantitative results of the original study by Morse et al. [26] and extend this analysis more deeply. Thereafter, we discuss the qualitative results and identify design implications as a result of user perceptions on the rich-prospect browsing experience.

5.1 The User Experience: AttrakDiff

The AttrakDiff measures UX across a spectrum of −3 (negative UX) and 3 (positive UX), with scores between 0 and 1 being considered standard, neither positive nor negative [22]. The scores for the three collections (Figure 5) show a generally neutral-to-positive UX across the various dimensions.

Weak areas for all three collections include *technical –human* (Coins: $M = -.30$, $SD = 1.25$; Curator Table: $M = -.70$, $SD = 1.89$; Museum of the World: $M = -.40$, $SD = 1.58$), *unpredictable –predictable* (Coins: $M = -.40$, $SD = 1.43$; Curator Table: $M = -.50$, $SD = 1.84$; Museum of the World: $M = -.40$, $SD = 1.51$), and *separates me – brings me closer* (Coins: $M = -.20$, $SD = 1.23$; Curator Table: $M = -1.20$, $SD = 1.81$; Museum of the World: $M = -.10$, $SD = 1.79$).

In contrast, *unprofessional –professional* (Coins: $M = 1.80$, $SD = 1.14$; Curator Table: $M = 1.10$, $SD = 1.20$; Museum of the World: $M = 2.50$, $SD = 1.27$), *tacky –stylish* (Coins: $M = 1.60$, $SD = 1.07$; Curator Table: $M = .80$, $SD = 1.93$; Museum of the World: $M = 2.40$, $SD = .52$), and *unimaginative –creative* (Coins: $M = 1.60$, $SD = 1.65$; Curator Table: $M = .70$, $SD = 1.64$; Museum of the World: $M = 2.10$, $SD = 1.37$) scored favorably across the three collections.

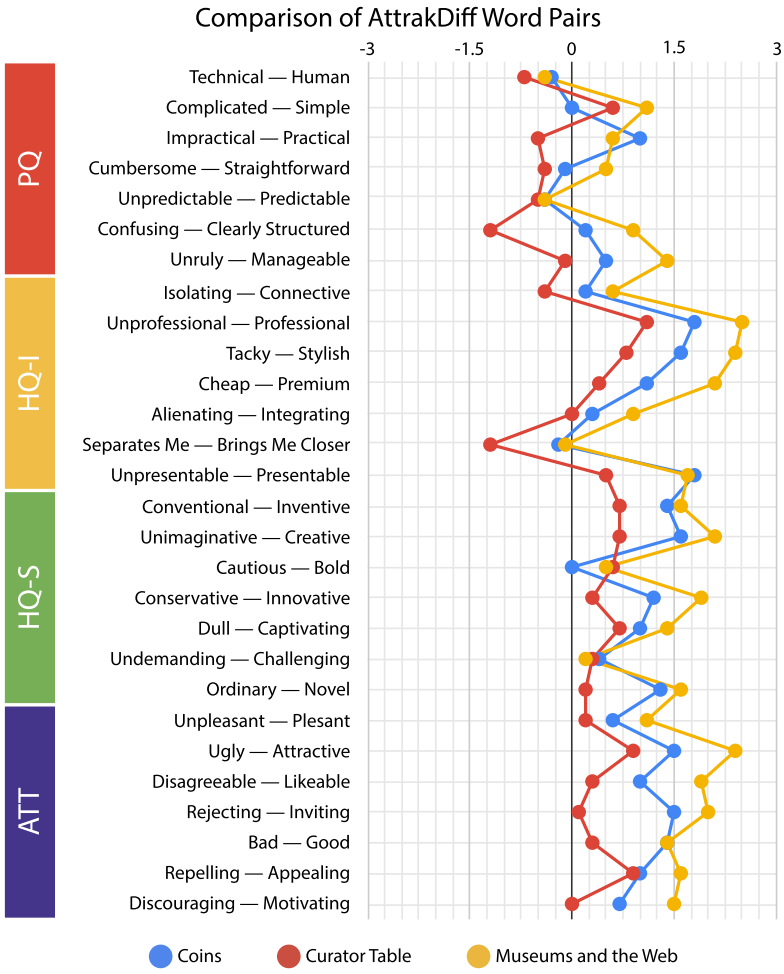


Fig. 5. AttrakDiff scores based on word pairs across four subscales.

We conducted a series of one-way ANOVAs to investigate the effect of user interface type on the AttrakDiff subscale scores in more detail.

There was no significant effect of interface on the AttrakDiff pragmatic quality (PQ) at the $p<.05$ level for the three conditions [$F(2,27)=1.83$, $p=0.18$, $\eta 2=.12$]. In addition, there was no significant effect of interface on the hedonic-stimulation quality (HQ-S) at the $p<.05$ level for the three conditions [$F(2,27)=1.20$, $p=0.32$, $\eta 2=.08$].

There was a significant effect of interface on the AttrakDiff hedonic identification quality (HQ-I) at the $p<.05$ level for the three conditions [$F(2,27)=4.8$, $p=.02$, $\eta 2=.26$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for *Museum of the World* ($M=10.1$, $SD=5.17$) was significantly different from *Curator Table* ($M=1.2$, $SD=7.91$) at the $p<.05$ level. However, *Coins* ($M=6.6$, $SD=6.02$) did not significantly differ from *Museum of the World* and *Curator Table*. Figure 6 shows the results.

There was also a significant effect of interface on the AttrakDiff global attractiveness quality (ATT) at the $p<.05$ level for the three conditions [$F(2,27)=3.69$, $p=.04$, $\eta 2=.22$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for *Museum of the World* ($M=11.9$, $SD=5.20$) was significantly different from *Curator Table* ($M=2.7$, $SD=7.70$) at the $p<.05$ level. However, *Coins* ($M=7.7$, $SD=9.29$) did not significantly differ from *Museum of the World* and *Curator Table*. Figure 7 shows the results.

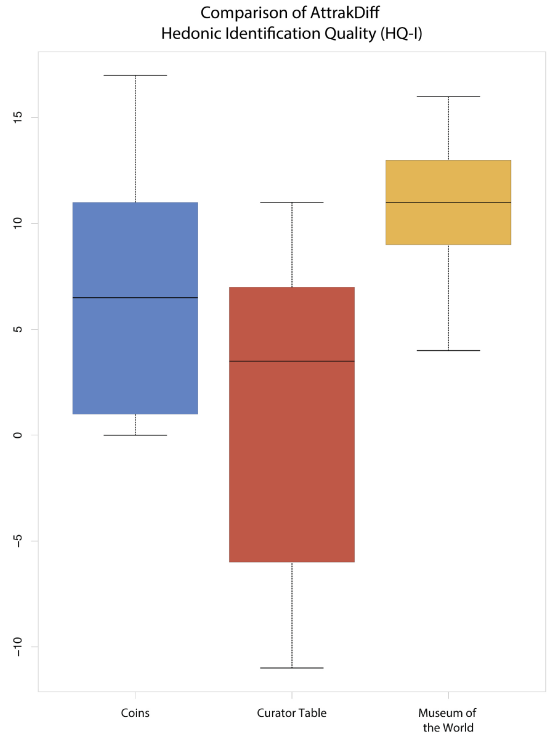


Fig. 6. ANOVA results for AttrakDiff hedonic-quality identification (HQI).

Additionally, the study identified three salient features in the design of rich-prospect: *coherence* (M=5.2, SD=1.63), *depth* (*M*=5.13, *SD*=1.54), and *availability* (*M*=4.73, *SD*=1.57). We derived these results from the ranking exercise (1 = least useful, 7 = most useful) performed in the final phase of the user test. Although there is some variation, participants tended to prefer a strong *coherence* (a collection that is meaningfully visualized), *depth* (multimodal access to information about an object of interest), and *availability* (a comprehensive series of object-specific filters for reorganizing the layout). In contrast, *representation* (displaying all objects in a collection on the primary page or screen) scored the lowest (*M*=2.8, *SD*=2.41).

We then analyzed the feature ranking results based on the museum personas that participants selected at the start of the user test. Table 4 presents these results for three persona types: *explorer*, *professional/hobbyist*, and *recharger*. Our study had only 1 *experience seeker* and 0 *facilitators*, and therefore we did not include these personas.

Coherence and *availability* ranked highly across all three persona types, whereas *depth* only appears in the *explorer* and *professional/hobbyist* types. For *explorers*, *depth* ranked as the most useful feature. Additionally, although *coherence* ranked highest for the *recharger* and *professional/hobbyist*, for the explorer, both *depth* and *availability* supersede it. This appears to fall in line with the anticipated behavior of an *explorer* or *information flaneur* who rather than seeking specific meaning from the interface instead cares about maximizing possibilities for object information (*depth*) and ways of exploring that information (*availability*).

5.2 Qualitative Results

Our qualitative data analysis provides further insights into participants' assessment of the three interfaces, particularly regarding the constraints and requirements of the interfaces for a positive UX. All audio recordings

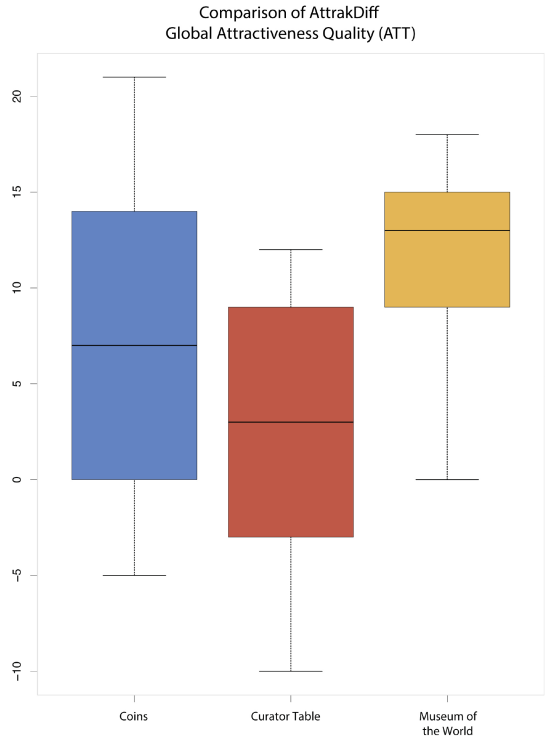


Fig. 7. ANOVA results for AttrakDiff global attractiveness (ATT).

Table 4. Descriptive Statistics for Rich-Prospect Feature Rankings by Persona from Morse et al. [26]

Persona (n)	**Top 3 Ranked Features**
Explorer (n=16)	(1) Depth (*M*=5.63; *SD*=1.31) (2) Availability (*M*=5.13; *SD*=1.54) (3) Coherence (*M*=4.81; *SD*=1.68)
Professional/Hobbyist (n=8)	(1) Coherence (*M*=5.25; *SD*=1.75) (2) Depth (*M*=4.88; *SD*=2.03) (3) Availability (*M*=4.13; *SD*=1.64)
Recharger (n=5)	(1) Coherence (*M*=6; *SD*=1) (2) Organization (*M*=4.8; *SD*=2.59) (3) Availability (*M*=4.6; *SD*=1.67)

of the think-aloud protocols and the interviews were transcribed non-verbatim and imported into the Atlas.ti analysis software. We applied open coding combined with thematic analysis, as described by Blandford et al. [5]. We identified three emerging themes from the material: *purpose*, *familiarity*, and *affinity*. Here, we provide a detailed description of the themes and illustrate them with excerpts from the qualitative data. We pay special attention to *explorers* who most closely represent the casual leisure context.

5.2.1 Purpose. The first theme that emerged in the coding process was about the context of use. Most of the participants wondered about the designated purpose of the interface. This confusion about the context of use of

the interface was emphasized by one participant who explicitly divided this experience in two phases, a playful phase and a more pragmatic phase:

> Now I start looking at the descriptions. Beforehand it was more like a playful experience of just the visuals and the images and now I'm starting to look at the details and try to explore it more in-depth. (*Curator Table*, P19, *explorer*)

This divide was also reflected by another participant who highlighted that he would enjoy engaging with the interface in a playful way, but at the same time described that this would not be inherently useful:

> Okay, it's really cool that it makes a sound, love that. But I feel like I would just play around with the song. I would play around with the song, I don't feel like I would actually be getting a lot of information or knowledge, because this would keep me very distracted. In fact I do just feel like doing this over and over again, which I still am, but I'll stop. (*Museum of the World*, P5, *explorer*)

On another note, some participants reported a "gamification-like", pleasurable experience. Based on our qualitative analysis, *Coins* appeared to have succeeded in communicating this playful element to its users most cleary, which was also reflected in the following statement:

> I like the sorting. How it actually looks like a physical pile of coins and you can take any coin from this pile and just move it out, regardless of the sorting . . . It makes it feel like a real pile of coins, like a child playing with the coins, like they say in the description. (*Coins*, P29, *explorer*)

The theme *purpose* highlights an imbalance between the perceived utility of the interfaces and the experiential quality of them. There seems to be a tension between the perception and enjoyment of playful, hedonic elements of the interface (e.g., "like a child playing with the coins") and uncertainty about its usefulness. In other words, participants seemed to enjoy the interaction, but, at the same time, the interfaces did not communicate their purpose clearly.

5.2.2 Familiarity. This theme describes the ways users explore the interface and continuously look for familiar information. Here, most participants commented extensively about the need to find something familiar and relatable in the interface. One participant wondered if the feature for which they were looking was not available or if they simply did not manage to find it:

> There is some cool animation. I might be a little stupid, but I think this is hard to navigate. I don't really see a search engine or anything. The page is separated into continents, which is helpful, I guess . . . I just really miss a search engine. Or maybe I'm just blind. (*Museum of the World*, P7, *experience seeker*)

On a similar note, one participant expressed their disappointment with the interface. They described their search for something familiar and, since they did not manage to find familiar elements, their subsequent disappointment and frustration with the whole experience:

> Kind of like in the Natural History Museum in London, I felt like this is maybe meant for children. I see it more as a game, something to play and mess around with, rather than a research environment. I feel like it is too playful in that sense. I was looking for maybe things that I could recognize, but there was really nothing incredibly interesting. I feel like this was probably the worst out of them all. I didn't really want to engage with it. And even with the coins, when I spent more time with it I had questions and I wanted to use it more. But this, I was pretty much done halfway through. (*Museum of the World*, P5, *explorer*)

The exemplary quotes emphasize the need for familiar information in the interface. The wish of the participants to find something familiar indicates their need for signposting about the purpose of the interfaces. In other words, we hypothesize that the participants looked for familiar elements as reference points to contextualize the interfaces.

5.2.3 Affinity. The last theme in our findings describes the need of many participants to experience the inherent meaning of the interface, in this case of the digital collection. One participant emphasized that the structure, in an architectural as well as in a conceptual sense, was essential for the whole experience:

> Organisation is most important because: I want to understand how the collection is constructed. First, that's for me the most interesting one to know. Okay, what are the main, like the general shape of the museum, the different areas for example, the collection within it. (*Museum of the World*, P28, *explorer*)

P27 described this precise notion in the context of a physical museum visit:

> The first thing I do when I come into an exhibition space is to make an idea for myself about who made this and how. And I hate exhibitions when it starts with a huge explanation where they have the whole bio of the artist, and you stand there for ten minutes . . . you don't know how much time you will need, you don't know how to manage your energy. (*Museum of the World*, P27, *explorer*)

To summarize, in the first round of thematic analysis, *affinity*, *familiarity*, and *purpose* appeared to have some similarities. However, the main difference between them was that in *purpose*, some users did not have a clear idea of what the browser should be used for (e.g., fun or research). In *affinity*, the collection communicated its inherent meaning (e.g., its internal structure). Hence, the interface played an active role. In contrast, users actively searched for familiar aspects to structure their browsing experience in *familiarity*.

6 DISCUSSION

Returning now to our original research questions, we consider the UX of our three experimental conditions and reflect on its transferability to rich-prospect more generally. We also discuss the implications for causal leisure contexts and how rich-prospect can support users without specific information needs. Our results indicate that there is potential to improve the UX of rich-prospect browsing, and we observed an important challenge, which was that the users had difficulty understanding the intended use of the different collections. We discuss this challenge across the three dimensions of the UX described earlier: *purpose*, *familiarity*, and *affinity*, and summarize the resulting design implications in Table 5.

6.1 User Experience of Rich-Prospect

The results of the AttrakDiff survey reveal an overall neutral-to-positive score across the four dimensions. However, it is important to note that the pragmatic quality (PQ) scored lowest across all three experimental conditions, even falling into the negative in the case of *Curator Table*. Participant verbal feedback reiterates this finding. Relating back to the theme of *purpose*, it was not always clear to participants how the interfaces were designed to be used, and often there was a conspicuous shift between playful browsing and task-oriented information seeking. As an example, although *Coins* appears to have communicated its playful elements most successfully, it nevertheless did not score well in the pragmatic dimension.

Examining the framework more generally, our results suggest that rich-prospect may in fact address the needs of the so-called *information flaneur*. In other words, the hedonic aspects of browsing the collection, such as interest, novelty, or play, create moments of pleasure for users but do not immediately fulfill a particular information need, which would explain the lower PQ scores. We can extend this notion to the *explorer* persona as well, for whom general curiosity and free-form discovery is also an important motivation. Based on the feature breakdown

Table 5. Summary of design implications across three dimensions: *purpose*, *familiarity*, and *affinity*

Dimension	Recommendation	Example Implementation
Purpose	Design affordances in accordance with leisurely interaction.	In a coin collection, simulate play as it would naturally occur (e.g., *building towers of coins* or *throwing piles of coins around*).
Familiarity	Apply variations of visualization onboarding and interaction guidance that take into account navigation functionalities obscured by cognitive load (e.g., filter confusion).	For users who have become lost within too much filter depth, periodically trigger contextual reminders to support backwards navigation without having to reset the page.
Affinity	Use *coherence* as a way to visually communicate the meaning or story behind a collection.	In designing for serendipity, or to communicate the diversity of a collection, connect seemingly unrelated objects by idiosyncratic qualities (e.g. *broken objects from the 19th century*).

by persona (see Table 4), only *explorers* ranked *depth* as the most important feature, suggesting that they have less interest in the internal structure and meaning of a collection and more interest in the ability to learn about objects as they encounter them. We might contrast this with the *recharger*, for whom *depth* does not even appear in the top three. Since *rechargers* care about highly contemplative and even spiritual experiences, understanding the hidden meanings or internal workings of a collection may be more relevant (*coherence*). Nevertheless, it is also important to note that although explorers may be more likely to default to exploratory activities, all individuals have this capacity despite their self-identified visitor type.

Representation ranked the lowest overall. This suggests that visualizing the entire collection was of low importance for most of the participants. This finding, coupled with verbal feedback from participants who were overwhelmed or confused by the full-scale visualizations, contradicts Ruecker et al.'s [31] assertion that representation can trigger cognitive reassurance in users. Nevertheless, despite its lack of popularity, participants ranked *representation* as the most important 16.67% of the time, suggesting that the feature is popular with some users. We believe additional work is necessary to understand how *representation* can be used to optimize the browsing experience.

6.2 Communicating Purpose

Ruecker et al. [31] assert that providing a wealth of well-designed visual information results in a more optimal experience compared to artificially or arbitrarily restricting content, and therefore rich-prospect should free the user from targeted search and allow a more intuitive and exploratory approach. However, participants were often unsure about the general purpose of the interfaces they tested. In addition, others felt frustrated because of their preconceived notions about the underlying purpose of the applications (e.g., as a research tool). In this case, the playful or serendipitous qualities of the interfaces did not translate due to prior expectations by the user.

With this in mind, it may be helpful to communicate purpose to users in ways that support casual leisure activities, especially for users with no previous exposure to rich-prospect. One approach is to *design affordances in accordance with leisurely interaction*. For example, *Coins* primes visitors by evoking an image of a child playing with their parents' coin collection. However, for some users, the interaction possibilities did not match this original image, such as in the case of P9:

> It's very confusing . . . It's not that stimulating for my mind because the coins are all looking the same for me still. It's too small, and just 2D. (*Museum of the World*, P9, *professional/hobbyist*)

P9 was frustrated that the interface only allowed users to move coins along a 2D axis when picking them up, and also that the resolution of the coins was not high enough to be able to zoom in very far. To view coins in high resolution, users have to access the individual record pages of each coin in a separate browser tab. Building on the story of a child playing with coins, a user might anticipate that the coins could be moved along a 3D access, which could simulate picking up a coin and bringing it very close to one's face, or they may expect to be able to pick up groups of coins and throw them around. In other words, they would expect to be able to *play* with the coins freely. Aligning interface affordances with leisurely interaction therefore may encourage users to explore the playful aspects of the collection more readily.

6.3 Cultivating Familiarity

Participants echoed a common frustration that they often struggled to familiarize themselves with the different interface functionalities. This lack of familiarity created a burden on cognitive load, leading to what Morse et al. [26] identified as *generosity blindness* and *filter confusion*. Participants who felt overwhelmed by the interfaces often missed instructional cues about how to use various features, and in other instances participants failed to realize that they had filtered the objects on the screen to a point where they no longer had access to the larger collection. Additionally, participants commented on the lack of traditional search functionality:

> It's very difficult to look for something specific here. Maybe this is not even their goal, but this is a point that I think . . . if they already have all this database, why couldn't I . . . if you want to look for something specific, why not be able to type something in and then they show you immediately? Yeah, maybe [this is] not that intuitive for people who are not that tech savvy. (*Museum of the World*, P6, *explorer*)

Consequently, we hypothesize that current rich-prospect browsers could apply variations of *visualization onboarding* [39] and *interaction guidance* [6] that take into account phenomena such as generosity blindness and filter confusion. *Onboarding* helps users understand how an interface functions, especially during first use (e.g., a tutorial), whereas *guidance* adapts to different use contexts (e.g., a recommendation system). By establishing a visual literacy with the unique qualities of the interface, the user is more likely to feel capable of experimenting with new features without defaulting to task-oriented information seeking habits.

In the context of generosity blindness, onboarding can help to simplify the initial learning curve. Instructions in the *Coins* interface demonstrate how to reorder the layout across two different dimensions, but this introduction often went unnoticed, which resulted in only one dimension being applied at a time. Filtering in *Curator Table* also created confusion because the filter reset button was not always visible to the user. In these cases, initial onboarding might acquaint users with new features by first isolating them from the rest of the interface and darkening the screen around it. It might also demonstrate the active and inactive states. For example, *Curator Table* might first show how to filter images and then also demonstrate how to reset those filters afterward.

Having comprehensive filters provides users with a variety of ways to organize, compare, and comprehend a complex visual collection. However, in some cases, participants experienced filter confusion. In these cases, participants had filtered their results to such an extent that they were left with few remaining objects, and were either lost or unaware that they needed to release the filters they had selected before being able to search again. Typically, this was remedied by reloading the interface completely, resulting in the participant losing their browsing history. For example, in *Museum of the World*, many participants did not realize that they had selected a particular thematic category, which greatly reduced the number of available objects on the timeline. Without knowing how to release the filter, they spent the majority of their time exploring only objects within a particular theme. Here, interaction guidance can support onboarding efforts. For example, designers can *implement*

contextual reminders. If a particular feature goes unused for a period of time, the interface might unobtrusively make users aware that the feature exists.

6.4 *Coherent* Curation for Affinity

Design for *coherence* represents an interface's capacity to communicate its visual organization at all levels of use. In its most realized form, this communication should happen directly and without unnecessarily burdening cognitive load. The visual organization must therefore bear meaning that is immediately apparent to the user. In contrast, inconsistent *coherence* can confuse or frustrate the user. For example, P27 described her general frustration with physical museum exhibitions that do not communicate their structure from the start, and this was the same issue She encountered during her experience with *Museum of the World*:

> Of course you are curious about what is behind these [dots], but given the amount of time you cannot turn them all. (*Museum of the World*, P27, *explorer*)

For P27, it was difficult to gauge how much time and effort would be necessary to make good use of the interface because all of the objects on display were hidden behind colorful dots without any inherent meaning. With this and other failures of interface *coherence* in mind, designers should consider how to effectively communicate the internal structure of a collection or exhibit. Based on our results, we hypothesize that it is likely through the *coherence* design principle that users can achieve what Ruecker et al. [31] describe as cognitive reassurance.

In the case of casual leisure, designers can implement *coherence* in a number of ways to support affinity in an exploratory context. For example, by highlighting the path taken during the exploration of a collection, visitors will have an active awareness of objects they have already seen as well as a path back to them. Additionally, *coherence* can help to create moments of serendipity. For example, introducing elements of ambiguity into organization schemes can create "cracks" that result in unexpected discoveries or connections [24]. In the context of casual leisure, interfaces could create constellations of objects based on unconventional yet shared features (e.g., *paintings by artists with three vowels in their last name* or *broken objects from the 19th century*). In this way, *coherence* can bring moments of playfulness while also communicating the diversity or strength of a particular collection.

7 LIMITATIONS AND FUTURE WORK

Although we aimed to make a contribution toward building an in-depth understanding of the experiential qualities of rich-prospect interfaces, we can nevertheless identify some limitations in our approach. First, we attempted to simulate conditions for a casual leisure browsing experience by asking participants to freely explore collections and discover items of interest. However, many users defaulted to traditional information seeking behaviors, such as desiring a search bar instead of embracing the exploratory nature of the rich-prospect design ethos. As the study was done in a lab setting, it is possible that the environment inhibited free exploration behavior as other studies have reported [23]; nevertheless, we contend that this is meaningful because it reflects how users commonly think about digital collections and their use, and the results of our study help us consider new approaches to the adoption of exploratory information seeking behaviors.

An additional limitation concerns the three interfaces we chose for the study. Although we concluded that each complied with the seven principles of rich-prospect browsing, the interfaces were most probably not designed with the framework in mind. One might speculate to what extent the results would differ when intentionally designing for rich-prospect through a complete UX process, and this constitutes an interesting question for future work. This also has important implications for casual leisure design in emerging technology contexts, such as mixed reality (AR/VR). Rich-prospect originally grew out the web browser experience, but recent work in mixed reality development has demonstrated a distinct lack of actionable guidelines for AR/VR user interface design [4]. Here, a user study on the applicability of rich-prospect to these contexts may simultaneously advance rich-

prospect *beyond the browser* and also establish a suite of user interface design guidelines in AR/VR. Additionally, mixed reality environments may support the playful aspects of rich-prospect in a tangible way. Building on recent work in substitutional reality for cultural heritage where visitors hold 3D printed objects in their hands that appear as real museum objects inside of a VR simulation [36], one can imagine recreating the *Coins* interface using 3D printed coins to allow users to truly pick them up and move them around.

Finally, the three applications we tested focus primarily on tangible cultural heritage. Generally speaking, the objects featured in each application have a physical counterpart within their respective museums. Future studies might investigate the implementation of rich-prospect browsing in the context of intangible cultural heritage, offering new insights into how cultural professionals can design around this highly nuanced and oftentimes culturally specific dataset. Nevertheless, we believe that in both the case of tangible and intangible heritage contexts, applying insights from this study to future work in user interface design for casual leisure may lead to the development of novel UX evaluation perspectives.

8 CONCLUSION

The present study reports on the UX of rich-prospect in the context of casual leisure activities for digital museum collections. We extended the original work of Morse et al. [26] by investigating design implications derived from the mixed-method approach, and our results trouble the view that rich-prospect on its own is inherently more intuitive or suited for casual leisure purposes. We hypothesize instead that the framework can be situated on a continuum between an intuitive or exploratory interaction paradigm and a more traditional, task-oriented information seeking paradigm, both of which have unique design requirements.

Based on our analysis, we introduced three themes from the data to support casual leisure: *purpose*, *familiarity*, and *affinity*. These themes point to current benefits and drawbacks of the rich-prospect browsing context when no information need is present, and for which we have derived a series of design recommendations. As a user interface framework for cultural heritage, rich-prospect has the potential to create engaging browsing environments for casual users, and we expect this research to contribute to increasingly sophisticated user interface design for digital museum collections going forward.

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REFERENCES

[1] Moneerah Almeshari, John Dowell, and Julianne Nyhan. 2019. Using personas to model museum visitors. In *Adjunct Publication of the 27th Conference on User Modeling, Adaptation, and Personalization (UMAP'19 Adjunct)*. ACM, New York, NY, 401–405. DOI: https://doi.org/10.1145/3314183.3323867

[2] Angeliki Antoniou and George Lepouras. 2010. Modeling visitors' profiles: A study to investigate adaptation aspects for museum learning technologies. *Journal on Computing and Cultural Heritage* 3, 2 (Sept. 2010), 1–19. DOI: https://doi.org/10.1145/1841317.1841322

[3] Jay Appleton. 1975. *The Experience of Landscape*. John Wiley & Sons, London, UK.

[4] Narges Ashtari, Andrea Bunt, Joanna McGrenere, Michael Nebeling, and Parmit K. Chilana. 2020. Creating augmented and virtual reality applications: Current practices, challenges, and opportunities. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI'20)*. ACM, New York, NY, 1–13. DOI: https://doi.org/10.1145/3313831.3376722

[5] Ann Blandford, Dominic Furniss, and Stephann. Makri. 2016. *Qualitative HCI Research*. Morgan & Claypool.

[6] Davide Ceneda, Theresia Gschwandtner, Thorsten May, Silvia Miksch, Hans-Jörg Schulz, Marc Streit, and Christian Tominski. 2017. Characterizing guidance in visual analytics. *IEEE Transactions on Visualization and Computer Graphics* 23, 1 (Jan. 2017), 111–120. DOI: https://doi.org/10.1109/TVCG.2016.2598468

[7] Google Arts & Culture. n.d. Experiments: Curator Table. Retrieved April 24, 2020 from https://artsexperiments.withgoogle.com/curatortable/

[8] Brenda Dervin. 1998. Sense-making theory and practice: An overview of user interests in knowledge seeking and use. *Journal of Knowledge Management* 2, 2 (1998), 36–46.

[9] Marian Dörk, Sheelagh Carpendale, and Carey Williamson. 2011. The information flaneur: A fresh look at information seeking. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, New York, NY, 1215–1224.

[10] Sandra Erdelez. 1999. Information encountering: It's more than just bumping into information. *Bulletin of the American Society for Information Science and Technology* 25, 3 (1999), 26–29.

[11] John H. Falk. 2009. *Identity and the Museum Visitor Experience*. Left Coast Press, Walnut Creek, CA.

[12] James J. Gibson. 1979. *The Ecological Approach to Visual Perception*. Houghton-Mifflin, Boston, MA.

[13] Lisa M. Given, Stan Ruecker, Heather Simpson, Elizabeth (Bess) Sadler, and Andrea Ruskin. 2007. Inclusive interface design for seniors: Image-browsing for a health information context. *Journal of the American Society for Information Science and Technology* 58, 11 (Sept. 2007), 1610–1617. DOI: https://doi.org/10.1002/asi.20645

[14] Paula Goodale, Paul Clough, Nigel Ford, Mark Hall, Mark Stevenson, Samuel Fernando, Nikolaos Aletras, Kate Fernie, Phil Archer, and Andrea de Polo. 2012. User-centred design to support exploration and path creation in cultural heritage collections. In *Proceedings of the 2nd European Workshop on Human-Computer Interaction and Information Retrieval (EuroHCIR'12)*.

[15] Flavio Gortana, Franziska von Tenspolde, Daniela Guhlmann, and Marian Dörk. 2018. Off the grid: Visualizing a numismatic collection as dynamic piles and streams. *Open Library of Humanities* 4, 2 (Oct. 2018), 30. DOI: https://doi.org/10.16995/olh.280

[16] Flavio Gortana, Franziska von Tenspolde, Daniela Guhlmann, and Marian Dörk. n.d. COINS: A Journey Through a Rich Cultural Collection. Retrieved April 24, 2020 from https://uclab.fh-potsdam.de/coins

[17] Jenna Hartel, Andrew M. Cox, and Brian L. Griffin. 2016. Information activity in serious leisure. *Information Research* 21, 4 (Dec. 2016), 1–19. http://www.informationr.net/ir/21-4/paper728.html

[18] Rex Hartson. 2003. Cognitive, physical, sensory, and functional affordances in interaction design. *Behaviour & Information Technology* 22, 5 (Sept. 2003), 315–338. DOI: https://doi.org/10.1080/01449290310001592587

[19] Marc Hassenzahl, Michael Burmester, and Franz Koller. 2003. AttrakDiff: Ein Fragebogen zur Messung wahrgenommener hedonischer und pragmatischer Qualität. In *Mensch & Computer 2003*, Gerd Szwillus and Jürgen Ziegler (Eds.). Vol. 57. Vieweg+Teubner Verlag, Wiesbaden, 187–196. DOI: https://doi.org/10.1007/978-3-322-80058-9_19

[20] Carol C. Kuhlthau. 1991. Inside the search process: Information seeking from the user's perspective. *Journal of the American Society for Information Science* 42, 5 (1991), 361–371.

[21] Dipak Kumar Kundu. 2017. Models of information seeking behaviour: A comparative study. *International Journal of Library and Information Studies* 7, 4 (2017), 1–13.

[22] Carine Lallemand and Guillaume Gronier. 2018. *Methodes de Design UX* (2nd ed.). Eyrolles, Paris, France.

[23] Carine Lallemand and Vincent Koenig. 2017. Lab testing beyond usability: Challenges and recommendations for assessing user experiences. *Journal of Usability Studies* 12, 3 (2017), 22.

[24] Stephann Makri, Yi-Chun Chen, Dana McKay, George Buchanan, and Melissa Ocepek. 2019. Discovering the unfindable: The tension between findability and discoverability in a bookshop designed for serendipity. In *Human-Computer Interaction—INTERACT 2019*, David Lamas, Fernando Loizides, Lennart Nacke, Helen Petrie, Marco Winckler, and Panayiotis Zaphiris (Eds.). Vol. 11747. Springer International, Cham, Switzerland, 3–23. DOI: https://doi.org/10.1007/978-3-030-29384-0_1

[25] Goki Miyakita, Shun Arima, Motoki Yasui, and Keiko Okawa. 2019. Exploring digital cultural heritage beyond MOOCs: Design, use, and efficiency of generous interfaces. In *Proceedings of the 2019 IEEE Conference on Learning With MOOCS (LWMOOCS'19)*.42–46. DOI: https://doi.org/10.1109/LWMOOCS47620.2019.8939644

[26] Christopher Morse, Vincent Koenig, Carine Lallemand, and Lars Wieneke. 2019. Art in rich-p: Evaluating next-generation user interfaces for cultural heritage. In *Proceedings of the 23rd Annual MuseWeb Conference (MW'19)*. http://orbilu.uni.lu/handle/10993/39104

[27] The British Museum and Google Cultural Institute. n.d. The Museum of the World. Retrieved April 24, 2021 from https://britishmuseum.withgoogle.com/

[28] Donald A. Norman. 1999. Affordance, conventions, and design. *Interactions* 6, 3 (1999), 38–43.

[29] Donald A. Norman. 2008. Signifiers, not affordancea. *Interactions* 15, 6 (2008), 18–19.

[30] Stanley Ruecker. 2003. *Affordances of Prospect for Academic Users of Interpretively-Tagged Text Collections*. Ph.D. Dissertation. University of Alberta Edmonton.

[31] Stan Ruecker, Milena Radzikowska, and Stéfan Sinclair. 2011. *Visual Interface Design for Digital Cultural Heritage: A Guide to Rich-Prospect Browsing*. Ashgate, Surrey, England. http://www.routledge.com/Visual-Interface-Design-for-Digital-Cultural-Heritage-A-Guide-to-Rich-Prospect/Ruecker-Radzikowska-Sinclair/p/book/9781409404224

[32] Pamela Effrein Sandstrom. 1994. An optimal foraging approach to information seeking and use. *Library Quarterly: Information, Community, Policy* 64, 4 (1994), 414–449.

[33] Ben Shneiderman. 1996. The eyes have it: A task by data type taxonomy for information visualizations. In *Proceedings of the 1996 IEEE Symposium on Visual Languages*. 336–343. DOI: https://doi.org/10.1109/VL.1996.545307

[34] Mette Skov and Peter Ingwersen. 2014. Museum web search behavior of special interest visitors. *Library & Information Science Research* 36, 2 (2014), 91–98. DOI: https://doi.org/10.1016/j.lisr.2013.11.004

[35] Robert Speakman, Mark Michael Hall, and David Walsh. 2018. User engagement with generous interfaces for digital cultural heritage. In *Digital Libraries for Open Knowledge*. Lecture Notes in Computer Science, Vol. 11057. Springer, 186–191. DOI: https://doi.org/10.1007/978-3-030-00066-0_16

[36] Jocelyn Spence, Dimitrios Paris Darzentas, Yitong Huang, Harriet R. Cameron, Eleanor Beestin, and Steve Benford. 2020. VRtefacts: Performative substitutional reality with museum objects. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference (DIS'20)*. ACM, New York, NY, 627–640. DOI: https://doi.org/10.1145/3357236.3395459
[37] Robert A. Stebbins. 2001. *New Directions in the Theory and Research of Serious Leisure*. Edwin Mellen Press, Lewiston, NY.
[38] Robert A. Stebbins. 2001. Serious leisure. *Society* 38, 4 (2001), 53–57.
[39] Christina Stoiber, Florian Grassinger, Margit Pohl, Holger Stitz, Marc Streit, and Wolfgang Aigner. 2019. *Visualization Onboarding: Learning How to Read and Use Visualizations*. Open Science Framework. DOI: https://doi.org/10.31219/osf.io/c38ab
[40] Robert Villa, Paul Clough, Mark Hall, and Sophie Rutter. 2013. Search or browse? Casual information access to a cultural heritage collection. In *Proceedings of the 3rd European Workshop on Human-Computer Interaction and Information Retrieval (EuroHCIR'13)*.
[41] E. Véron and M. Levasseur. 1989. *Ethnographie de l'exposition: l'espace, le corps et le sens*. Centre Georges Pompidou, Bibliothèque publique d'information.
[42] David Walsh and Mark M. Hall. 2015. Just looking around: Supporting casual users initial encounters with digital cultural heritage. In *Proceedings of the ECIR Supporting Complex Search Task Workshop (ECIR'15)*. 3.
[43] Mitchell Whitelaw. 2015. Generous interfaces for digital cultural collections. *Digital Humanities Quarterly* 9, 1 (May 2015). http://www.digitalhumanities.org/dhq/vol/9/1/000205/000205.html
[44] Max L. Wilson and David Elsweiler. 2010. Casual-leisure searching: The exploratory search scenarios that break our current models. In *Proceedings of the 4th International Workshop on Human-Computer Interaction and Information Retrieval (EuroHCIR'10)*. 28–31.
[45] Thomas D. Wilson. 1981. On user studies and information needs. *Journal of Documentation* 37, 1 (1981), 3–15.
[46] Thomas D. Wilson. 1997. Information behaviour: An interdisciplinary perspective. *Information Processing & Management* 33, 4 (1997), 551–572.
[47] Thomas D. Wilson. 2000. Human information behavior. *Human Information Behavior* 3, 2 (2000), 49–55.
[48] Florian Windhager, Paolo Federico, Gunther Schreder, Katrin Glinka, Marian Dork, Silvia Miksch, and Eva Mayr. 2018. Visualization of cultural heritage collection data: State of the art and future challenges. *IEEE Transactions on Visualization and Computer Graphics* 25, 5 (2018), 2311–2330. DOI: https://doi.org/10.1109/TVCG.2018.2830759

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