

# Investigating Human-Rare Historic Book Interaction among Young Adults

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**Abstract.** This paper reports on research conducted to improve understanding of human-rare historic book interaction as a necessary first step in order to design and develop physical-virtual renderings of rare books that provide integrated haptic, audio, olfactory, visual and cognitive human-rare book interaction for the public. Our synthesis of relevant literature proposes that current research and technology can be categorized according to five characteristics: expected users, content and content management, navigation, presentation, and interaction control. Our research investigates how young adults (novices) in northern Europe interact with a rare historic book and their reflections about their interaction. Results indicate that interaction engendered appreciation and curiosity regarding individual human behaviour and social practices, and regarding design and technology for novices. Interaction also had an affective impact, eliciting personal memories and emotions. Participants reported that interacting only visually with books or their representations would not have afforded the same results. The results suggest several design recommendations for future physical-virtual renderings of rare historic books.

**Keywords:** Rare historic books, human-rare historic book interaction, human-rare book interaction, human information interaction, e-books

## 1 Introduction

Rare historic books are national and international treasures that provide unique insights into everyday life, art, literature, cultures as well as technology and design across time and geographic locations. It is important to allow individuals access to rare books so they can experience their beauty and craftsmanship, expanding their appreciation and understanding of the past and, ideally, construct new understandings and practices in today's society. People continue to be very curious about rare historic books, spending their own resources and time to experience them. For example, *The Book of Kells*, a decorated manuscript of the four Christian gospels in Latin text created around 800 AD, is consistently the fifth most popular fee-paying attraction in Ireland with over 500,000 visitors per year according to Fáilte Ireland, Ireland's National Tourism Development Authority [1, 2]. *People of the Book* [3] tells the story of a rare historic Jewish book. It has become an international best seller and was awarded the Australian Book Industry Award Book of the Year Award and the

Australian Literary Fiction Book of the year in 2008 [4]. Rare historic books continue to inspire innovation and excellence today. For example, in the book, *Envisioning Information*, Tufte [5] recreates graphical examples in rare historic books. The book has won 17 awards. Harzing's Publish or Perish citation software [6] reports over 5,000 citations to this book. Rare historic books have inspired countless improvements in digital graphic design today. Clearly there is both scholarly and public interest in rare historic books.

Currently, individuals can only fully experience rare historic books if they visit a rare book collection and are fortunate enough to be given permission to use and handle a book. Typically, with the exception of select scholars and specialist librarians, no one is allowed to handle the rare books in library collections. This means most individuals never have the opportunity to fully experience rare historic books. At most they may look at aspects of rare books (or replicas of rare books) through glass display cases or view digital copies of such materials online or on screens located in libraries, museums or archives.

The number and quality of digital versions of rare historic books has increased over the past decade due to technical advances and funding from national, international and private funding agencies. With these digital rare book systems users can search meta-data and other descriptors, and they can browse book pages one by one, e.g., by clicking on small icons of book pages, or by clicking on arrows near the edge of a page as if they were turning pages in a book. Virtual and mixed reality book systems, including research prototypes, provide some additional features such as interaction via gestures, search using patterns, page turning sounds, multi-media annotations and haptic feedback simulating some action in a story.

However digital, virtual and mixed reality book systems ignore the materiality of rare books. There is no system that allows individuals to fully experience a rare historic book, including how the pages, covers and bindings of rare historic books feel, sound and smell. All of which we propose convey meaning and are essential components of engagement and learning. Neither is it usually feasible to make accurate replicas of rare books. For some rare books the knowledge regarding their construction has been lost, and it can take many years to rediscover this knowledge. Furthermore, making replicas of rare historic books can be cost prohibitive for libraries, museums and archives.

## 1.1 Research goals

The goal of our research is to increase understanding of human-rare book interaction in order to develop motivation and, ultimately, design requirements for the development of a system which supports the creation of physical-virtual renderings of rare books that provide integrated haptic, audio, olfactory, visual and cognitive human-rare book interaction for the general population.

For example, a physical-virtual rare book system might include a high-end 3D printer which can "print" with a variety of materials to create realistic rare book covers (and boxes.) We could use these to construct physical "books" that are generic in their shape and appearance, or specific to a particular rare historic book. Pages using paper handmade using traditional methods could be added. This physical

artifact could serve as the base interaction component that readers will hold and manipulate. Because we will know the precise shape of the book we may then be able to (a) track the book as is it held/manipulated by a user, and (b) project content onto the covers and pages of the book. The hardware (micro projectors, cameras and other sensors) to achieve these tasks could be mounted on a frame or a goose-neck reading lamp-type device under which the book is placed, as done in the TESIS device [7]. Alternatively, continuing advances in haptic device technology may be able to produce sensations that mirror the touch and feel of rare historic books, so a different virtual book design may be possible. However, today such technologies do not exist. Furthermore, we do not have a sophisticated understanding how individuals interact with rare historic books today. Neither do we understand what types of interaction are most meaningful to them, and therefore likely to be important in a future physical-virtual rare book system.

As a first step we synthesized the research literature and state-of-the-art applications and practices relevant to human-rare book interaction. We next conducted a study investigating how novices, i.e., young adults, interact with a rare historic book and their reflections about their interaction. Results from the study indicate that interaction involving all senses with an actual physical rare book engendered appreciation and curiosity regarding individual human behaviour and social practices, as well as generating appreciation and curiosity regarding the design and technology of the printed item. It also had an affective impact, eliciting personal memories and emotions of wonderment and awe. Study participants reported that interacting only visually with books or their representations would not have afforded the same results, and they recommended that others be given the same type of opportunity although they also recognized dangers in allowing this.

The study reported in this paper, and subsequent studies with additional study populations, will serve to generate a theoretical framework of human-rare book interaction and technology recommendations that can guide the creation of a physical-virtual or virtual book system which can be deployed in libraries and museums to allow individuals from all socio-economic backgrounds and all ages to have the opportunity to interact with rare book surrogates in ways that closely mirror, if not completely duplicate, how they would interact using their five senses with actual rare books. Furthermore, such systems could also be linked together over the Internet to facilitate new ways to share and collaboratively explore and study rare books across geographic distances. No human-rare book information behavior framework currently exists.

## 2 Relevant Literature

Research and literature relevant to human-rare book interaction is multi-disciplinary in nature, spanning human-computer interaction, library and information science, archival science and computer science. Relevant concepts include virtual books, mixed reality books, augmented reality books, e-books, virtual research environments, digital archives and digital libraries. This section provides an overview of the state-of-the-art with respect to research and practice regarding digital book systems, including

virtual and mixed reality systems. This includes research prototypes as well as state-of-the-art systems. Our focus is not to debate whether a prototype is a virtual book, mixed reality book, digital library or digital archive system. Rather we synthesize the diverse literatures to present an overview of features spanning application and prototype systems that support new ways to access digital book materials, including systems that provide access to one book, a collection of books, or multiple collections of books. Our primary emphasis is on research and systems that focus on rare historic books, but research and systems focusing on other types of books are included. This research and these systems can be described and understood in terms of five characteristics: expected users, content and content management, navigation, presentation, and interaction control.

## **2.1 Expected users**

The design and implementation of digital rare book systems are rooted in assumptions about their expected users. The three most common categories of expected users mentioned in the literature are: visitors, or casual users, who are assumed to be similar to visitors to physical archives, libraries and museums; humanity scholars and other researchers who use rare historic books in their research and teaching, including computer science researchers who view and use digital rare historic books as research objects, e.g., as test cases for automatic pattern recognition algorithms (e.g., [8]); and system administrators, such as archivists and librarians who manage physical and digital rare book collections.

Unfortunately, these categories largely ignore the level of knowledge an individual may have with respect to rare historic books. Dreyfus and Dreyfus [9] propose a five-stage model of adult skill acquisition. The five stages are: novice (minimal knowledge), advanced beginner (knowledge of key aspects), competent (good knowledge of multiple aspects), proficient (deep knowledge of all aspects) and expertise (authoritative knowledge). Visitors to digital archives may actually possess novice, advanced beginner, or competent knowledge about rare historic books. For example, serious amateurs, master students and high school history teachers most likely have competent knowledge about rare historic books. We found no discussion in the literature regarding how access to digital versions of rare historic books accommodate users who are neither novices nor experts. We also found no features in implemented systems that provide differentiated services for users whose level of knowledge about rare books is either at the advanced beginner, competent or proficient level.

## **2.2 Content and Content Management**

The content of rare historic book systems typically consists of meta-data that describes a book or manuscript, images of books and manuscripts, and materials associated with a book or manuscript.

Meta-data are typically created and maintained by librarians, archivists and humanity scholars, and are used in identifying and searching for objects within and

across collections. Meta-data fields describing a rare historic digital object include: title or name, author contributors, place, printer/publisher, data, language, format, extent, medium, provenance, subject, temporal, related documents, uniform resource identifier (URI), shelf-mark, repository, settlement, country (e.g., see [www.manuscriptorium.com](http://www.manuscriptorium.com)). There are active research and practitioner communities, such as the Dublin Core Metadata Initiative ([dublincore.org](http://dublincore.org)), developing meta-data standards and best practices.

In terms of volume, most content in digital rare historic book systems consists of images from books and manuscripts. Typically, digital images of all components of an object, e.g., a book's spine, binding, front and back covers, end papers, and pages are included. Traditionally librarians and archivists have controlled and managed these images in operational digital archives and libraries.

More recently systems allow materials associated with a digital book or manuscript to be created and/or uploaded by a (registered) user for the user's individual benefit or for use among selected users. In some systems, these materials are limited to text annotations such as user-created notes. However, in other systems (e.g., [10, 11]) the materials can be in any format or media, and can include links, bookmarks, videos, images and music. Users can also re-assemble images and other content to make new digital books (e.g., [12]). The terms, personal collection management and virtual research environments, are often used when describing systems with these features.

### **2.3 Navigation**

Searching and browsing are the two ways users navigate within digital books, and within and across collections of digital books. Searching frequently requires a user to input (or select) a query consisting of terms, or keywords, in various meta-data fields that are associated with the digital books and related materials in a collection. The terms are then matched to identical or similar term occurrences in the collection's meta-data to identify relevant digital books and materials. Because optical character recognition (OCR) systems have difficulty recognizing and parsing older scripts, searching via terms within a digital rare book is not available unless the book has been transcribed. However, systems that support pattern searching are emerging. For example, the DocExplore system [10] allows users to select sections of text or a pattern or a series of patterns (e.g., within an illustration) on a page in a digital book, and the system then searches for the pattern selected. Research on pattern recognition and its use to search historic objects is ongoing.

Browsing involves looking through lists and/or small images of digital books and other materials. Systems with larger collections typically allow users to browse by subject, edition, year range, or type of content.

### **2.4 Presentation**

Presentation of digital books can be categorized as image-, book-, context- and haptic-presentations. Over the past decade these approaches to presentation have been influenced by available technology, and current systems may use a combination of

approaches. The earliest approach used to present digital rare historic books was an image-presentation that supported viewing a book image by image. That is, the digital image of each component of a book was presented as a unique object to users. The assemblage feature that exists in physical books was not represented except through labels or names of images.

As technology advanced, images began to be virtually assembled and presented as if they were a physical book. A 3D representation of a digital book is typically presented today. Some systems also provide imagery and sounds that mimic page turning in physical books to facilitate the illusion that a digital book is similar to a physical book. Audio recordings of book passages may also be available, such that a book is “read” to a user for entertainment and/or educational purposes.

The context-presentation approach recognizes that books have connections with other objects and eras. Thus, digital materials describing and illustrating these connections are created and used when presenting a digital or physical book. A context-presentation can augment a book-presentation or replace it. For example, Angeletaki and colleagues [11] have created digital books in which supplementary materials relevant to the page or section of the book currently displayed are shown to the user. Supplementary materials include explanatory text and notes, pictures, drawings, videos, audio segments and 3D models. Tranouez and colleagues [10] created a toolkit supporting this capability for use by creators of digital books. In comparison, Carrozzino, et. al. [13] completely replace book-presentations with a context-oriented presentation. For example, the primary display of one of their digital books is a map of 15th century Europe. Within this map, relevant sections of a travel book written by a 15th century Norwegian as he travelled throughout Europe are displayed. When the user selects a geographic location, the relevant section of the digital book is enlarged so that it can be read.

Other systems that use a context-presentation approach focus on augmenting physical books. These systems (often referred to as mixed reality book systems) track where a person is in a physical book using cameras or RFID (radio frequency identification) tags coupled with electric field sensing, and then provide related audio (e.g., [14]) or display related material on a nearby display device, such as on a tablet computer (e.g., [15]), on blank book pages [16], or directly on the book [17]. Displays on real objects are achieved using digital light projectors to “paint” dynamic imagery on physical objects [e.g., 18, 19, 20]. The approach is compelling because the physical objects offer high-fidelity 3D (because they are physical objects with real 3D shape), while the overlaid projected digital imagery adds an almost magical dynamic aspect.

Another recent presentation approach is haptic-presentation. In this approach haptic devices that produce vibration patterns are used to give the reader a sense of touch that ideally mirrors a motion, emotion or event described in a story. For example, in a prototype system developed by Alam, et al. [21] haptic actuators embedded in arm bands, a jacket and a sofa are triggered as a user reads a passage describing an action such as a sea storm, traveling in a boat, airplane or car, and riding a bike. In addition actuators are triggered when a user reads a passage describing emotions such as fear, joy or love. The FeelSleeve prototype [22] used sensors in mittens attached to a tablet device to provide children reading a story on a tablet with a variety of experiences simulating events, motions and emotions. Evaluation of the

prototype demonstrated that when compared to reading the same book without haptics, comprehension for readers in grades 1 through 3 increased for a story that focused on space travel. Haptics made no significant difference to readers' comprehension for a second story that focused on interaction with animals. It could be that the readers had personal experiences touching animals (compared to no experiences travelling in space) which meant that the book's haptics did not provide new knowledge or additional engagement.

Because all presentations are digital, their size can vary from small mobile screens to larger-than-life images projected on to screens (e.g., [23]) or connected monitors. That is, for digital books presentation size is not determined by the object or the system, but rather by the presentation device used. This is a significant difference between digital and physical books.

In comparison, our focus is not on using audio or haptics to simulate events, motion or emotions described in a book's text, or to vary the size of a book. Rather our aim is to simulate the touch and feel of actual rare historic books whose materiality is very different from the touch and feel of today's books. We are investigating whether this materiality is engaging and carries meaning, and whether it provides a tangible physical link with the wider societal milieu in which the rare historic book was originally produced. This materiality could, therefore, potentially be a very useful conduit to a series of long-passed people, events, emotions and practices.

## **2.5 Interaction control**

As one might expect, methods to control interactions with digital book systems and mixed reality book systems have typically followed popular advances in human-computer interaction technology. Mouse and keyboard interaction is commonly required. Touch screen interaction explicitly designed for interaction with book systems is emerging, influenced by the availability of touch screen technology and touch screen design features. Free form gesture recognition has been used for larger display systems such as those used in museum installations. For example, in the Italian Drawings project at Roskilde University in Denmark individuals walked up to a "larger-than-life" display of a digitized book in the museum exhibit and turned the pages of the book using hand motions that were detected through Microsoft Kinect sensors [23]. An earlier similar system, LibroVision [24], supported gesture recognition to control interaction with a digital book using a camera to recognize hand images and movement. Other work [25] has investigated the use of facial expressions to interaction with a digital book.

## **2.6 Reflections on relevant work**

While research and systems have endeavored to increase access to and engagement with rare historic books, these efforts have been primarily driven or determined by available technology, and less so by user needs. Increasingly researchers are acknowledging the importance of materiality, especially with respect to books (e.g., [26, 27]). Yet we do not have an in-depth understanding regarding how this

materiality works or what is most important about it for users, especially with respect to rare historic books. For example, reflecting on his decades of pioneering work creating digital rare historic books (e.g., see <http://www.rossettiarchive.org/>), Jerome McGann commented “that all that he came to learn was that he didn’t actually know what books were or how they worked...How does a book by Fenimore Cooper work? A book, not a text - an actual material artifact that had come into existence in determinate human times and spaces” [28].

Cranny-Francis [29] suggests that touch has meaning with respect to connection, engagement, contiguity, differentiation and positioning. However, the requirements for physical safety and preservation of rare books have meant that it has never been possible to allow individuals, except a very few select scholars as well as librarians and archivists, to touch them. The literature discussing how scholars, librarians and archivists should handle rare historic books primarily constrains touch (e.g., [30]), although there is discussion regarding the efficacy of some of these traditions (e.g., [31]). We have discovered no prior research investigating how individuals, whether they are novice, competent or expert users, actually interact with rare historic books. Thus it is necessary to explore how such individuals interact with this material and what that interaction means to them in order to identify design recommendations that can guide the creation of future physical-virtual rare historic book systems.

Understanding human behavior and identifying design requirements grounded in empirical research as early as possible in the research and development (R&D) cycle could lead to more useful prototypes, which, in turn, could reduce subsequent product development and time to deployment costs. Usability studies typically focus on determining isolated technology requirements, e.g., requirements for haptic response time over networks [32]. In comparison our ‘visioning study’ approach provides a method to identify potential technology design features and their benefits as well as unintended consequences while computer science research focusing on technology is ongoing. It employs a mixed method and grounded theory approach utilizing different types of empirical data to identify behavior, develop a deep socio-cultural understanding of the behavior, and propose how technology could augment the behavior in meaningful ways. Sonnenwald led the development of this approach when generating requirements for the nanoManipulator Collaboratory [33, 34] and 3D telepresence technology in emergency health care [35, 36]. This project uses this approach to develop an understanding of human-rare historic book interaction and its significance to participants, and from this understanding contribute to a theory of human-rare historic book interaction. It is envisaged that this will, ultimately, identify design requirements to guide technology research and development.

### **3 Research Methods**

#### **3.1 Visioning study research design**

We employed mixed methods [37] and grounded theory [38] to explore the fundamentals of human-rare historic book interaction. Our visioning study research design included focus groups and a post questionnaire with open-ended questions.

The focus group data technique [39] was selected to allow each study participant to individually interact with a rare historic book and think-aloud about that interaction with a researcher present to answer participants' questions, facilitate participation, and prevent unintended damage to the book. A post-questionnaire was used to obtain study participants' individual, private reflections on their interaction. We view interaction with an actual physical rare historic book as the "gold standard" and a vital component of research regarding human-rare historic book interaction.

### 3.2 Study participants

Fifteen young adults, ages 18-21, participated in two focus group sessions held in Dublin, Ireland. All were undergraduate students in the social sciences. An additional eight young adults participated in a session held in Taipei, Taiwan, but due to space limitations analysis of data from this focus group session is not included in this paper. No participant had prior interactive experiences with rare, historic books, although several participants reported having seen images of rare books, such as pages in magical spell books and scrolls, in movies and television programs.

### 3.3 The rare historic book

The rare historic book that study participants interacted with during the focus group sessions was Rabbi Isaac Ben Judah's (d.1508) *Commentary on the Torah*; the Torah is a sacred Jewish text which consists of the first five books of the Bible. This book was chosen because it is an object with significant physical presence and impact, but also because it is written in a language (Hebrew) which none of the study group understood. Hence, they would be precluded from interacting in any intellectual way with the text, and would instead have to deploy their physical senses to try to make sense of the object in front of them. The participants' inability to engage intellectually with the text would be strengthened, it was felt, by the fact that the Hebrew text begins at what they were all used to thinking of as the end of a book.



Fig. 1. Pictures of *Commentary on the Torah*

*Commentary on the Torah* was published in Venice in 1584. This book is potentially very significant because of the unusual way in which the text has been bound (see Figure 1). The text is bound within wooden boards, and these wooden boards have a series of intricate geometric and floral patterns. The heavy boards transform this text into a weighty physical object of some bulk (2.25 kg). The markings on the binding are not perfectly symmetrical; the lines and patterns often do not meet exactly where the artist intended them to meet. The decoration of the book was finished with two brass alloy clasps decorated with a crude vernacular design scraped into the metal. It is highly likely that the artist responsible for the decoration was not a professional bookbinder, and the work may have been undertaken as an act of individual or communal piety.

One might dismiss the binding and clasps as crude and unsophisticated, but that would be to miss the beauty and charm of the physical object. The workmanship might be described as ‘sturdy’ but it is also of a very high quality; today, after almost 450 years the boards remain strong, the binding is intact and the clasps still open and close with an audible ‘click’.

### 3.4 Data collection

Each focus group session lasted approximately 2.5 hours. At the beginning of each session the study, its purpose and the focus group activities were introduced. Next the library collection that contains the book and the book were briefly introduced.

The study participants were then given multiple opportunities to handle the book. Participants were asked to take “reasonable, normal care” in handling the book but they “should not be frightened to handle the book”. The first time participants handled the book, it was closed. Participants were free to interact with the closed book however they preferred, and each participant had two opportunities to handle the closed book.

Next the book was opened. Due to insurance restrictions, the book was opened by a library professional (the second author) and its spine was well supported on archival-quality foam supports. Each participant had two opportunities to touch, turn and read pages in the book in whatever manner they preferred. As mentioned previously, the book’s text is in Hebrew, and participants did not have knowledge of Hebrew.

After this the book was closed but its latches connecting its front and back covers were opened. Each participant had the opportunity to interact with the latches, including opening and closing them. In order to minimize the potential for damage to the book, the process for using the clasps was explained individually to each participant, and a member of library staff was in close proximity to assist if needed.

Participants were encouraged to think aloud [40], sharing what they were thinking about as they interacted with the book. Their interactions and utterances were video-recorded using two digital cameras, capturing the interaction from multiple perspectives.

After interacting with the rare book the participants were asked to “blog,” i.e., write (on a laptop) about their experiences interacting with the rare book. The blogs included three open-ended prompts exploring what the interaction experience meant to them and the future of human-rare book interaction for themselves and others. Each

participant was individually provided with a laptop to type in their responses, and participants' responses were not shared with the other study participants. The responses were viewed by the researchers only after the session ended and all participants had left.

### 3.5 Data analysis

The audio portion of the video recording was transcribed, and the blog data was saved in text files. The transcribed audio and blog text data was analyzed using grounded theory techniques [41]. Specifically, we analyzed the data using open and axial coding. Open coding included multiple, detailed readings of the data to identify major codes or themes emerging from the data. Axial coding involved additional careful readings of the data to identify and verify all text relevant to the codes that emerged during open coding. As axial coding was completed, multiple topic memos that synthesize themes and relationships among codes were created. The topic memos explore the meaning and implications of the data. The results of the analysis reported in this paper focus on participants' perceptions of their interaction with the rare book and their perceptions regarding possible future interaction with rare historic books.

Subsequent analysis will focus on analysis of the video data to identify specific human-rare book interaction behaviors.

### 3.5 Limitations

A limitation to this study that poses a threat to its internal validity is its use of the focus group format. During focus group sessions, participants may feel pressure from other group members or the session facilitators to provide a response, or a certain type of response. We employed several techniques to address this issue. First, participants were given the opportunity to privately share their individual opinions at the end of a session via "blogging", i.e., writing responses to open-ended prompts on a laptop. The responses were not shared among study participants and were not viewed by the session facilitators until after every participant had left the session. Second, the facilitators set a non-judgmental and appreciative tone for each session when introducing the study and during all session activities. Participants were not instructed regarding how to interact with the rare book; they were encouraged to interact with the book however they wished within the confines of ensuring the safety and security of the item being viewed and handled. Third, the facilitators used neutral, non-judgmental wording based on their decades of experience interacting with individuals and groups. They were prepared to halt any behavior displayed by participants which might have unduly influenced other participants; however, no such behavior emerged. In fact one participant reported:

*It was really enjoyable talking and listening to other people's interpretations of the book.*

Another threat to internal validity inherent in the focus group approach is that participants may feel they did not have sufficient time to interact with the book and/or to state their thoughts. Our participants expressed mixed feelings about this issue. The following quotes from participants' blog entries illustrate this:

*I think the time that we each individually got to interact with the book was adequate as I was able to view all aspects of the book.*

*I would rather have my own time to inspect and explore.*

Due to resource and insurance constraints we could not provide individual sessions with the rare book. We propose that despite this practical limitation there is much to learn from the focus group sessions.

A threat to the reliability of this study that should be taken into account when examining the results is the lack of comparative data. Interaction occurred with only one rare historic book, and while that book has features similar to other rare historic books, interaction with different books may produce additional or different experiences and perspectives. Another threat is that study participants were somewhat homogeneous in that they did not span age groups or cultures. Further research is needed to understand human-rare book interaction across age groups and cultures.

## **4 Results**

Participants interacted with the book in many different ways, including: smelling the book when it was closed or open; tracing the patterns on the book's front and back covers with a finger; rubbing fingers along the book's spine and its different edges; tapping on the book's covers; moving the book up and down as if to better experience its weight; listening to sounds made when pages in the book were turned; pressing down on book pages; rubbing fingers or entire palm over pages in the book; listening to the book's clasp when it was opened or closed. These interactions enabled participants to personally experience the rare book and they interpreted that experience in different ways.

Analysis of the audio and blog data shows that the interactions increased participants' appreciation of, and curiosity about, the book being handled, as well as about the culture and technology of the society in which the book was produced, circulated and read. This appreciation and curiosity engendered reflection on contemporary human behaviour, social practices as well as design and technology. The interaction also had an affective impact on participants, generating personal memories and emotions of wonderment and awe with many of them connected with episodes in their childhoods. Participants expressed their desire to interact with the book and other rare historic books in the future, reporting that interacting only visually with rare books or their representations would not have afforded the same results. They further recommended that others be given the same type of opportunity, although they recognized dangers in allowing this. These themes are explored in more detail below.

#### 4.1 Appreciation and curiosity regarding individuals, individuals' behaviour and social practices

When interacting with the book and reflecting on that interaction, participants expressed appreciation and curiosity regarding individuals earlier connected with the book, as well as their behaviour and social practices connected with the book. Somewhat surprisingly, and in comparison with how history is often taught, study participants rarely contemplated the historical time period in which the book was created or subsequent historical periods that the book witnessed. That is, when handling the book and writing in their blogs participants did not ask questions about or discuss the historical periods related to the book. For instance, no one reflected on events occurring in Venice or Europe when the book was created. Instead participants focused on individuals and their behaviours and practices connected with the book. For example, they considered how the first owner used and perceived the book:

*I'm imagining a person who bought this so long ago going in to the shop and actually getting it made.*

*You start really forming a picture in your head about the person who owned it.*

*I suppose that...the book must have been of great personal value to the first owner.*

Participants also considered the individual(s) who made the book:

*Whoever did this really went to full length and did himself a lot of justice*

*I'm just wondering if the person who designed the book, if he did this or got someone else to do this.*

They further considered how individuals used the book:

*I'm curious...[in] times gone by, sitting at a candlelit desk...[I'm] just think[ing] about the kind of people who worked on this and read this.*

*A lot of the corners are worn more than the edges - the side edges and top edges - which makes you think maybe it was used, it was read.*

*What surprises me is the discolouration inside the book. You can tell there is wear and tear here. It was actively used by whoever owned it or maybe even in a community. It was nothing that was just preciously kept from any public experience or handling.*

Some participants also contemplated earlier and contemporary social practices that may have emerged around the book:

*Were the clasps put on to keep people from reading it?*

*It kind of looks like it... maybe just sort of decorated your home as well...[a show of] status.*

*It feels like, compared to a book today, like a coffee table book.*

*It sort of makes you think that us today - we don't really take care of things in general compared to people at that time. It's on us.*

Meta-data for rare historic books and descriptions in rare book displays in museums and archives seldom focus on a rare book's first owner and/or individuals who are not famous who have used the book across time. They also seldom focus on how the rare book has been used. Perhaps this is because it is only with the sense of touch and smell that connections with a rare book's prior owners, its users and its use come to the fore.

For the study participants, employing their sense of smell and touch in addition to vision increased their curiosity about and connection with the book's earlier owners and users. It provided motivation to value the past. As participants' explained:

*The opening of the book was my favourite moment...I smelt the mustiness...the smell is exciting and promising...the history of the book is contained in that smell. Interacting with a used/old/rare book is more than just being able to read it, it is feeling and touching and smelling the book's history and imagining the journey that the book has taken and that it has taken others on.*

*Touch for me is a particularly important aspect...This makes me feel in contact with the previous users, others who touched it.*

#### **4.2 Appreciation and curiosity regarding design and technology**

The study participants had no background in book restoration or book publishing, yet many expressed appreciation and curiosity regarding the rare book's design and technology. For example, participants appreciated the artistry and craftsmanship of the book's covers (see Figure 1), comparing it to the quality of contemporary book covers. They commented:

*I enjoyed studying the cover closely and being able to feel it and touch it, especially the designs on the cover and spine. The amount of detail surprised and amazed me. It's a work of art really. I imagine the amount of work and time put into creating something that is only used to cover pages of text.*

*[I'm] just [thinking about] the work that went in to this cover. Nowadays everything just looks the same. The same copy of everything in the shops. The work that went in to this is amazing.*

*The cover is so intricately designed, but yet extremely functional, proven by its age. It's strange for me to experience this when often I use books to put drinks on, and often they end up ruined.*

*Is there a purpose to the design [of the cover]?*

*Examining the cover of the book, and looking at all the detailing gone in to its production. It sparked a curiosity...why someone would put so much work into a cover.*

For many, touch and smell was essential to appreciating and understanding the book's cover:

*The cover of the book was intricately detailed and if we had only been able to look at the book we would not have felt the textures of the design.*

*The cover was the part of the book I found to be the highlight of my experience, mostly because of the high level of detail that I was allowed and even encouraged to examine with my own fingers. This gave me a deeper understanding of the craftsmanship that went into its design.*

*I got to feel the design and decoration and the weight of the book which you wouldn't believe if someone had just told you it.*

Touch and smell was also essential to appreciating and understanding the inside of the book:

*I immediately feel how different the pages are than any type of page I've held before. Obviously, I can't understand a word of it but it's printed perfectly...The pages almost feel like there are tiny little lines in them. Even when you rub like that you can feel lumps and bumps in the pages and stuff.*

*The thin, soft texture of the pages [is in] contrast with the heavy, wooden like bindings, and it's almost as if it's telling a story in its own right. The designer or embellisher seems to be making a statement for themselves.*

*Getting to flick through the pages of the book was quite enjoyably strange. The pages had a really strange texture and it felt so different to our books of today.*

*If you were just viewing it [a page] for the sake of what's on it...you wouldn't appreciate how old it is.*

*The turning of the fragile and almost translucent pages was exciting as it allowed me to gain further insight into...its usage and how it was treated by its owner or users.*

Participants were perhaps most surprised by the clasps that hold the covers of the book together (see Figure 1). This surprise increased their appreciation of the older technology. They reported:

*It's mad how easy that [closing and opening the clasps] is considering the age of it.*

*They are actually quite sturdy, the clasps. I thought they would be weaker almost. It's kind of cool the way they decided to keep it closed...It's quite easy to actually close it. It's kind of scary.*

*It's kind of satisfying the way it clicks in kind of like magnets.*

*They are thinner than I thought. And metal on it there. The fact that they move so easily - they aren't rusted and stuck or anything. You can just close it. Now that it's closed it feels sturdy like you are keeping something safe, something important. It's much sturdier and I think it adds to the overall look of the book having it closed, the aesthetics of it. It's nice and tidy.*

*I also liked being able to close the clasps on the book because I was able to really experience it as people would have so many years ago. I felt transported back in time...entering the world of where the book came from.*

### 4.3 Affective impact

In studies that involve participants, we strive to design a comfortable, and even pleasant, experience for them. We did not anticipate that interaction with the rare book would had a positive affective impact on participants. For some participants, aspects of interacting with the book, particularly the sounds made when interacting with the book, elicited personal memories, such as:

*As I could hear them flipping the pages...it reminded me of hearing my dad in the sitting room. You could always know he was reading the paper.*

*The sound is very intriguing and it...reminds me...of autumn leaves...when you are walking through a forest in the autumn and the rustling of those leaves.*

*The sound...reminds me of...[when] you are at mass and everyone turns the page.*

Many participants also expressed emotions stemming from their interaction with the book during the focus group sessions and in their blog entries. The emotions most often expressed were feelings of wonderment, excitement and awe.

*I felt in awe of the book: its weight, design, texture, colour...all of these aspects of the cover of the book were only possible to truly experience by being able to physically hold it.*

*[I had] the feeling of opening a treasure box - a form of excitement. Almost a child-like curiosity of touching something so old, and, a sense that I had access to some important information.*

*It does give you a sense of wonderment because you begin to understand how much it has seen, how long it has been around.*

*I find it so extraordinary that I was lucky enough to even touch such an old book.*

When we interact with today's books, especially novels, the text often has an affective impact on its readers. We designed our study such that the participants could not read the book's text (recall, the text was in a language unfamiliar to the

participants and they were likely to be further disorientated by having to ‘start’ working through the book from its ‘end’), and yet interaction with the book’s physical properties still had an affective impact on participants.

#### 4.4 Future Interaction

As discussed earlier we asked participants to blog about their possible future interaction with this book and interaction with rare historic books for others. Specifically we asked: “If you had more time to interact with the book, what – if anything – would you like to do? Why?” Participants’ responses varied. No one type of interaction (i.e., haptic, visual, olfactory, auditory or cognitive interaction) dominated the responses and all of these types of interaction were mentioned. Many responses to this question were rather lengthy, reflecting their aspirations to have additional interaction. Examples of responses include:

*If I had more time to interact with the book I would first like to sit down with it in a small room, open it up and enjoy the smell. I would like to look at every single page and search for the little markings that were added by the people that have touched and used the book and imagine what they mean or why they were put there. I would like to be able to use a magnifying glass to view the characters on the pages and the designs on the covers more clearly. I would like to have a list of characters that are used in the book so that I could try to pick out symbols that have meaning to me. In this case I would like to have seen the Hebrew symbol for the word God, for example. I would like have a translation of the book by my side so that I could imagine that I was reading the lines of Hebrew on the page.*

*[I would like to] turn all of the pages for closer inspection, markings and damage in an attempt to learn more about its history, provenance, origins and purpose. Further, I would spend some more time investigating the techniques used in producing the cover to further my understanding of its value and how much labour went into the making. If I had access to a Hebrew interpreter, it would add to the experience to obtain an understanding of the content in order to consolidate this with the impressions of the book’s value and importance.*

*I would quite like to actually translate some of the book and read it. I think it’d help me understand the books importance in context if I could understand its meaning a little bit more. I too would like to simply look through more of the book, because it was interesting to see how the pages had aged over time. Although an unrealistic hope, I’d really quite like to test a book like this, and see how sturdy it really is, and determine whether its longevity is the result of good care or simply a high quality cover.*

We also asked, “Should others be given the opportunity to interact with this book, or other rare books? Why or why not?” As some earlier quotes indicate, participants

suggested physically interacting with a rare book had unique value, especially compared to reading or looking at a rare book. They commented:

*Interacting with a used/old/rare book is more than just being able to read it; it is feeling and touching and smelling the book's history and imagining the journey that the book has taken and that it has taken others on.*

*Reading digitally is not the same experience. Your mind does not become as creative (in my opinion) as [i.e., when] reading online.*

*I think other people should be given an opportunity as it is something very unique. If they were looking at a book electronically they would not gain the same experience. It was interesting to hold something so valuable and to see the design. It felt magical in a way to experience a book so old and to think many years ago people used and read these book and they would not have placed the same importance in them as we do now. I think rare books are a valuable resource as they give us insight into the past.*

*[It is] rather refreshing to get to interact with a historical artefact as opposed to just hearing or seeing. It is only when all the senses are entertained that one can truly appreciate something.*

Participants further viewed interaction from a social equality perspective:

*History cannot repeat itself and more than the privileged should be able to [interact with rare books]*

*I think that while it is necessary to preserve these rare books, it is also a shame that shall I say 'lay' men do not get the chance to interact with these books. In all of my other experiences with historical artefacts, it has always been a case of viewing from a distance and never getting to interact, while this is alright and I can appreciate the need for preservation [but] it is not quite as good a getting to interact as we did today.*

However, participants also recognized the need for caution when allowing the public to interact with rare books:

*I think others should be allowed to interact with the rare book but only under supervision because of the age that the books are.*

*There has to be participation from both sides, otherwise, collections of rare books will fall into disarray if there aren't the people and interest to maintain them.*

*I would like to say that everyone should have the chance to interact with books like this, but there would be obvious problems. For example, if large groups of people were handling the book every day, the wear would be increased*

*significantly. Of course, it would only be a matter of time until somebody tries to steal the book.*

One participant added that interaction with rare books could also benefit organizations preserving rare books because interaction brought awareness and interest. The participant commented:

*Interaction and raising awareness of the significance of the rare books through interaction is vital for the future of these collections. I didn't know Marsh's Library [where the focus group session was held] even existed before a week ago.*

## **5 Discussion**

Scholars have long believed that their research benefits from interacting with actual physical rare books, and many will travel thousands of kilometres to do so. This study explored the potential value of extending the privilege of interaction to others, illuminating aspects of human-rare book interaction.

The study participants' prior experience of rare historic books was primarily limited to images from TV and movies, although some had seen digital images of rare books. In many countries we can easily access these images via the Internet more quickly and at higher resolutions than ever before. Increasingly we can also manipulate the images, viewing them from different angles.

However the study participants, who were young adults and novices with respect to knowledge about rare historic books, reported that visual interaction is not as engaging, informative or emotional as interaction that involves multiple senses. Interaction with an actual rare book increased appreciation and curiosity about individuals who had contact with the book in the past. It is an engaging starting point from which to explore and appreciate historical and current individual behaviour and social practices. It inspires our imagination, enabling us to unfold and understand history from the standpoint of those who have lived it.

Our participants were amazed and delighted that the book's technology still functioned after 500 years. Interaction with a rare book increased their appreciation and curiosity regarding design and technology in the past. Thus, interacting with historical artefacts using multiple senses enables individuals to challenge the assumption or claim that contemporary technology is always superior. Such challenges promote a more balanced evaluation of technology across time, and increases the prospect of learning from past technology which may ultimately improve future technology.

### **5.1 Design recommendations**

The results from this study suggest several design recommendations for physical-virtual renderings of rare historic books, including recommendations regarding augmented material, haptics and olfaction.

Recommendations regarding three categories of augmented material, or information that should be provided along with a physical-virtual rendering of a rare historic book, emerge from our results. The three categories are: information about the book's owners and readers (users), information about the book's socio-technical design, and translations of the book's content.

The results reported in Sections 4.1 and 4.2 suggest that material focusing on individuals who may have made, used or owned the book - and how they interacted with the book - throughout time should be provided. No study participant pondered whether any one famous or well-known had owned or used the book, and this implies the augmented material should focus on 'common' or 'typical' individuals. Information about ownership and use from both individual and social perspectives should be included. Examples of these topics include: how the book was used by an individual and/or group of readers or scholars, and what ownership of the book might have meant socially.

Augmented material should also include information regarding the socio-technical design of the rare historic book. None of the study participants were studying socio-technical design yet they expressed curiosity regarding technology and social practices relative to the design and construction of the book. Thus we recommend that material regarding the book's design and construction, situated in its historical, cultural, social and technical context, as well as and comparison with other historic and current design and construction techniques be provided.

A third category of augmented material concerns the translation of a book's content. This is a common type of augmented material provided in exhibitions of rare historic books today. However, it was the least mentioned by our study participants, and this suggests that providing translations of short passages could be sufficient for individuals who are not scholars studying the text of the rare book.

Other design recommendations focus on haptics. Study participants appreciated the opportunity to touch all components of the book. While 3D printing or sensors could possibly be used to replicate some components of the books, such as it covers and spine, it is not clear if these technologies are sufficient to replicate other components that provide a more nuanced haptic experience. For example, participants expressed fascination regarding the pages of the book, including roughness provided by the materials used in making the pages, the corners and edges of the pages that exhibited wear, and traces of book worms and other small holes on pages. Further research is needed to investigate whether sensors along with visualizations and audio could be sufficient to provide a realistic interactive experience, or whether the use of paper made with traditional materials and methods would suffice. Or might some combination of sensors with traditionally-made paper be sufficient to recreate the feel of the book's interior? Study participants also expressed fascination regarding the thinness of the book's metal clasps and the etchings on the clasps. If 3D print or sensor technology cannot support the type of interaction provided by the clasps, perhaps the clasps could be reproduced using metal cutting and engraving technology.

Olfaction also emerged as an important aspect of interaction with the rare historic book. Smells have been added to food and other products for decades, and more recently the smell of old books has been investigated [42, 43]. There is an aerosol product called Smell of Books ([smellofbooks.com](http://smellofbooks.com)) that promises to provide a musty book odour, and a scented candle that claims to mimic the smell of paperbacks and

hardcover books in a public library. Companies such as FEELREAL ([www.feelreal.com](http://www.feelreal.com)) are developing odour generators and smells for 3D video games. Thus, building on these and related research and products, it may be feasible to incorporate smell into a physical-virtual rendering of historic books.

## 5.2 Future directions

In comparison to other research that focuses on re-creating, manipulating and/or augmenting the textual and graphical contents of a book, we focus on recreating the materiality of books. That is, our vision is to create a system which supports the creation of physical-virtual renderings of rare books that provide integrated haptic, audio, olfactory, visual and cognitive human-rare book interaction for the general population and collaborating scholars.

The results from developing this technology may also be applicable to other domains, such as archaeology, as well as education for medical technicians and other professions that often require the expert use of senses such as touch, smell and sound in conjunction with seeing.

We hope our results will also encourage libraries, archives and museums to think about ways in which they might allow more physical interaction with rare historic books. When this issue was discussed with our study participants, they recognized the dangers of allowing such interaction to take place unsupervised. The focus group approach, such as the one we employed that utilizes an interesting book but perhaps not the rarest or most valuable book in a collection, could be further investigated as a viable approach to facilitate interaction with limited negative preservation consequences.

Further research directions for us include studies exploring how participants' cultural backgrounds may influence interaction with different types of rare books, and how additional populations, e.g., from advanced beginners with some knowledge of rare books to experts with authoritative knowledge of rare books, interact with rare historic books. Such research will increase our understanding of human-rare historic book interaction, and may well lead to a comprehensive theory of human-rare historic book interaction, as well as elucidating additional design requirements for book technology.

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