FRAMEWORK TO GUIDE DESIGNING OF INTERACTIVE TOOLS FOR ART GALLERIES.

by

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Submitted in partial fulfillment of the requirements
for the degree of Master of Computer Science

at

Dalhousie University
Halifax, Nova Scotia
August 2019

Reeju and a small city in Southern part of India, Trivandrum.

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Abstract

The thesis proposes a framework which will help in designing and building of interactive tools for art galleries. The research started with the background analysis of all the factors that influence the planning of an exhibit/show at an art gallery. One-to-one interviews were conducted with the art curators from different art galleries in Nova Scotia, Canada. The data collected from the interview were qualitative. Thematic analysis has been done on the collected data to find out factors or features that should be considered while building an interactive tool. These factors were grouped to form modules which eventually was used to design the framework. The Maud Lewis exhibit (present at Art Gallery of Nova Scotia, Halifax) has been used as a reference. Different solutions for the Maude Lewis exhibit have been suggested based on the data analysis and the framework.

A part of this thesis has been published in a paper, "Protocol to build a Framework for Designing Interactive Tool for Art Gallery Visitors", accepted at the HUMAN'19 workshop at ACM Hypertext conference 2019 in Hof, Germany.

List of Abbreviations and Symbols Used

AGNS	Art Gallery of Nova Scotia
AR	Augmented reality
BIM	Building Information model
CML	Contextual Model of Learning
ISO	International Standards Organization
MoMA	The Museum of Modern Art
PDA	Personal Digital Assistant
PDA	Personal Digital Assistants
RFID	Radio Frequency Identification
SLAM	Social, Location, Annotation, Mobility
UAPs	Universal Access Points
VR	Virtual reality
WARC	World Advertising Research Center

Acknowledgements

I would like to thank my parents for everything they have sacrificed for me. They are my constant source of support and have encouraged me to take chances in life.

I would also like to thank my supervisor, Dr. J. Blustein, for guidance in every step of the research. It was an immense pleasure in working with him. I would also thank Drs. Kirstie Hawkey and A.-B. Graff for their help.

Nevertheless, I would also like to thank Aditi Nair for being my companion in this journey. I would also like to thank Mir Masood Ali for teaching me LaTeX. I would also like to thank Dinesh Shenoy for helping me with LaTeX.

Last but not the least, I would like to thank Sweta Sarkar, Taj Mohammad and Reetoja Taj for being with us and supporting us throughout the journey.

I would also like to thank Supriya Patel, Sagarika Ghosh for being a part of the journey.

Chapter 1

Introduction

1.1   Overview

The thesis aims to assist designing of interactive tools for art galleries and museums. As shown in the Figure 1.1 we attempted to find ways to facilitate visitor engagement
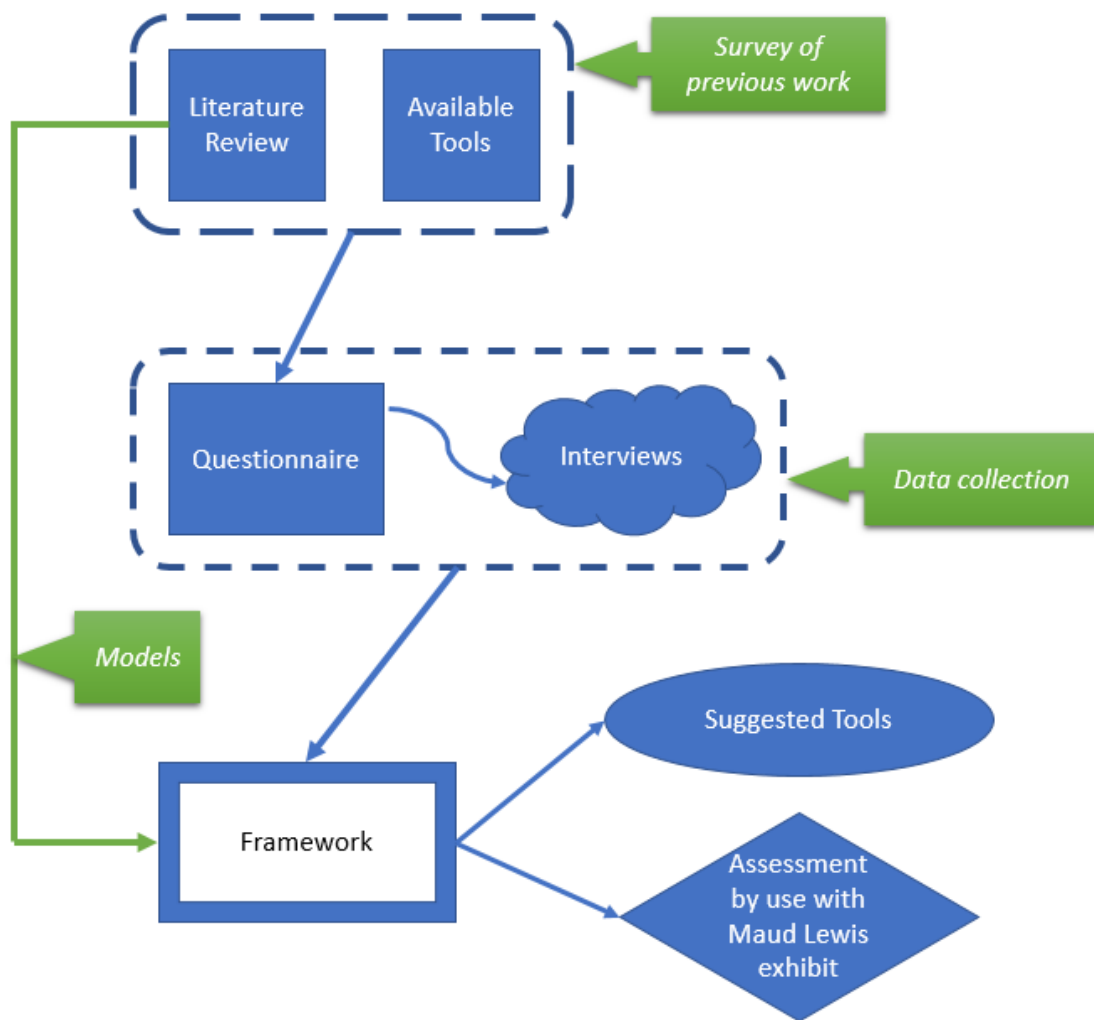
Figure 1.1: Thesis Overview

by using interactive tools. We also explored requirements of art galleries and museums and different available options (present in art galleries and museums) which helped us in design the questionnaire to conduct interviews with curators from different art galleries of Nova Scotia. The data collected from the interviews were further used to design the framework that assists in deciding and selection of tools for a particular exhibit. We also referred to models of engagement to facilitate engagement with the suggested tools. We used our framework to find suitable tools for the Maud Lewis Exhibit present at the Art Gallery of Nova Scotia (AGNS), Halifax.

"**Models** can be described as theories with a [. . .] narrowly defined scope of explanation" [46, p. 2]. They are mostly for description and explanation. **A framework** "usually denotes a structure, overview, outline, system or plan" [46, p. 2] to guide the creation or development of something. In our case, the outcome is the suggested tool and our framework is used to find factors that influence the selection of the tool.

1.2   Museums and Art Galleries

It has been observed that people often find museums and art galleries intimidating as they feel uncomfortable in the hushed environment of the galleries [45]. Museums and art galleries are often considered as intellectual places where the visitors must be knowledgeable and should know how to appreciate a piece of art. They often feel uncomfortable to interact or ask for assistance to look around the gallery. In reality, museum and art galleries are there to assist, share knowledge and interact with everyone. Therefore, we have to find a way which will give a sense of community and encourage people to come forward and enjoy the exhibits [53]. Interactive art galleries can help to break down the notion that art galleries only belong to the elite and are not welcoming for a family visit. These galleries can help family members to interact, bond, share knowledge and have an engaging time. But while designing the interactive tool(s), it should be kept in mind that it should not disrupt the aesthetic appreciation of the exhibits. [27].

Most galleries have fixed time slots in which they provide a guided tour around the gallery. It may happen that a visitor visits the gallery at a time other than those fixed time slots. In such situation an option for virtual guidance can be an effective solution. Sometimes art galleries provide audio guides, quick response code (QR code)

scanners or other mobile application based tours. Such tools serve as virtual guide to the visitors. Those tools provide a platform for interaction and provide additional assistance. Providing an interactive tool can help to bridge that gap and the tool can assist the visitor to engage with the exhibit on their own.

But before designing any interactive tool, we should first try to understand what visitors want, what level of assistance the tool should provide and how the tool should interact with the visitors as well as the exhibit. Understanding what visitors want can help in increasing their engagement in the art galleries. It is not always the case that a visitor gets the actual intention or the story behind the piece of art but finding a pattern or an intention behind the art helps the visitor connect with it [12].

1.3 Motivation

We agree with Hoggart [37, p. 59] that "any decent society must give all its members the opportunity to open their minds to what are generally regarded as the best kinds of creativity and the best works of the intellect and imagination".

The perception of 'art' has changed radically in the last three decades. Previously art was supposed to be reserved for members of the high class and the subject were displays such as things, paintings which were to be seen and were kept in a separated area of gallery or museum. But now with development art is now considered as the participation, engagement and interaction with people rather than passively watching an object or painting [14].

Art is embedded in our everyday life and is influenced by our rituals, political impact, culture, religion as well as our daily habit. Art provides a medium of expressing one's views and opinions [14]. Art also influences our day to day activities such as selection of a consumer product. The presence of art is usually associated luxury and exclusivity so a product image which can be associated with art will appear lucrative to the consumer and influence the consumer's evaluation of the product [25].

It has also been observed that the nature of museum or art gallery visitors have changed over time. The younger generations specially so-called 'millennials' do not like spending much time in reading the labels or panels attached adjacent to art object nor are they interested in the flyers or the information desk present at the gallery [21].

Art galleries and museums also act as important location of programs offered to people with mental and physical health issues.

For example,it has been observed that people suffering with dementia and their caregivers find increase in enthusiasm, confidence, enjoyment and social contact while participating in creative art. Effects include decrease in depression and increase psychological well-being of the patient and their care-givers. Art programs also promote the sense of community and make us reconsider the traditional setting of care-giving [5]. For example, MacPherson et al. [38] developed a 6-week program at the National Gallery of Australia involving people with mild to moderate dementia and their family members. Educators trained by staff from Alzheimer's Australia and Dr John Zeisel (founder of ARTZ). The educators facilitated discussion on four selected artworks from the Australian collection each week for 45–60 minutes. It was observed that participants enjoyed the sessions, sparked new interest in art and increased social contact. Although no long lasting changes were reported the participants appeared enthusiastic and confident in the gallery setting [38].

1.4   Idea

Introducing a new interactive method has been found to be beneficial for both the gallery and the visitors. An interactive immersive experience will leave the visitors satisfied and can help in pulling future visitors too. An increase in the appreciation and the number of visitors will increase the popularity of the gallery and which will eventually raise a possibility of gaining funds [22]. The suggested tool should not disrupt the exhibit's aesthetics appreciation [27].

Usually visitors interact with exhibits using their senses such as sight and hearing, introducing technology can help in creating a more interactive and comprehensive experience. Today, many people use Personal Digital Assistants (PDA) and other mobile devices for different daily activities [23, p. 280]. Using a hand-held device will help the visitors to explore an exhibit on their own. The visitor can explore the gallery freely and will be able to control the type and amount of information available to them [10, p. 132].

Each visitor has their own interest and knowledge which opens the gate for a the unique perspective of what is relevant to that visitor from the mass of information

available at a particular gallery. Using interactive tools or devices, we can try to design tour guides which the visitors will be able to customize based on their preference [32, p. 3788].

Interactive tools in art galleries can help in bridging the gap between the art and the viewers. It is not always the case that a visitor gets the actual intention or the story behind the piece of art but finding a pattern or an intention behind the art helps the visitor connect with it [12]. Again, most of the artifacts displayed in an exhibit are preserved in a protected environment making them available only for viewing — not touching — by visitors. Hence introducing different interactive tools are likely to help in making the knowledge transfer more interactive and engaging.

An interactive device can also be more appealing to the younger generation than the traditional docent-led tours.

The research started with an approach to understand appropriate inclusions aimed at driving engagement of visitors in art galleries. Hypermedia factors such as semantic navigation, multiple ways of interaction will be considered before designing the tool. The approach chosen, as a result of this research, will be intended to enhance the essence of the exhibit. Besides, it should be ensured that the chosen method (which may be a device), does not overshadow the essence of the exhibit itself.

1.5 Stakeholder audience

For this research, we will be focusing on the three major stakeholders of art galleries: **Artists and their works, Art curators** and **Visitors**.

The Figure 1.2 shows a part of the display of paintings by Maud Lewis present at Art Gallery of Nova Scotia (AGNS), Halifax. Her paintings were inspired by the beauty of Nova Scotia. **Artists and their works** are the soul of an art gallery.

Sometimes as an observer, it may be difficult for a visitor to understand the artist's work, know their intention and what they want to express through their work. Providing an interactive tool can assist their experience and learn more about the work.

Art Curators are responsible for selection, assembly, preparation, display, explanation and archiving of art works [19]. They bridge the gap between the art and the visitors. Their activities guide visitors through an exhibit and help visitors to

Figure 1.2: The Maud Lewis Exhibit at Art Gallery of Nova Scotia, Halifax, Canada. The photo collage was made on the website https://www.photojoiner.net/.

understand the art. But it is not possible for the curators to be present for each visitor, thus collecting their views and thoughts can help us in our research. Lastly, the third division is the **visitors**. For the initial stage, we have divided the types of visitors based on their purpose of visit. They are:

Primary visitors: People who have come to visit the gallery with an intention. They may be students, tourists, or art enthusiasts.

Incidental visitors: When the intention of visit was not defined a priority, the visitor is classified under this category. For example, a person can enter a gallery to take shelter from rain.

For our research we focused on the primary visitors and find out the types of visitors who come for a visit in an art gallery or a museum and how they behave or how a tour should be customized based on their preferences.

We started with a blank canvas and tried to find out the needs of the gallery. The first step was to interview curators from different art galleries of Nova Scotia. The art curators are one of the important stakeholders who are responsible for the learning part of the gallery. The other stakeholders include board members, investors, government (in case of provincial or national art galleries). We have not considered their perspective for this research. While designing interactive tools we have to keep in mind that there are certain limitations such as these devices cannot be intrusive and can distract the visitor from the exhibit, again these devices interfere with the social interaction of the visitor as most of the devices can be used by a single user at a time. Rather than overwhelming the visitors with an excess of information, we can set learning levels configurable by the viewer. The focus should be to augment and enhance rather than replace the existing resources present for an exhibit.

The research started with a background study of how we can use the major components of the gallery to design an interactive tool. It also involved looking into different available options and how these background study can help to design a set of interview questions for art curators. The interview questions were mostly open questions which may lead to a detailed conversation on the topic. The responses of the curators were mostly qualitative in nature and a thematic approach to find out different themes or approaches that can assist in the finding out the influencing factors. The framework was build with modules derived from the influencing factors. The framework guide future designers on how to design interactive tool for art galleries and museums. The framework will assist in choosing the tool(s) and their features based on the exhibit at hand. The designer does not need to do the requirement analysis and determine factors to consider for the tool.

Chapter 2

Background Research and Related Works

Before we start designing any interactive tool, we should start with a background analysis so that the designing process will be both cost- and time-efficient. We will first start with explaining the term engagement, then discuss about the different components of art galleries, accessibility issues and finally discuss about the available interactive options in art galleries.

2.1   Visitor Engagement

According to Bitgod [27, p.8]: **"an interactive exhibit is defined as a device in which the visitor's response to the exhibit produces a change in the exhibit."**

Although the Canada Council for the Arts has not defined 'engagement in art galleries', it can be said to be the attendance, interaction and learning using electronic media, or physical, mental, emotional interaction [22].

Visitors' engagement is not only during the time they look at the exhibit but also what they do and how they develop an interaction with the exhibit [17]. Often museum visitors interacting with other visitors while viewing an art work can change the overall experience of the artwork [6]. So engagement involves interacting with both the exhibit as well as the environment around it. At top level, we can characterize engagement with three attributes: the first are **attractors**, those factors which entice a visitor towards a particular exhibit or artefact, the second are **sustainers**, the factors that keep the visitors engaged during the first initial interaction and lastly are the **relaters**, the factors which help in establishing a relationship between the visitors and the exhibit so that they return to the exhibit in future occasions [18]. In case of art galleries, types of exhibits include paintings, sculptures, environmental works as well as interactive works [18]. If we take the example of a visitor looking at

a painting, the interaction may not be visible and may appear static. By static[1] we mean that the painting is not actively coming out of the frame and interacting with the visitor. But the visitor may develop an emotional connection with the work. This engagement is not always visible to an on-looker. Our approach will help in assisting this interaction and make it more immersive and engaging.

For our research, we have consider two models: **Bilda's model of engagement** [17] and **Contextual Model of Learning (CML)** [58].

We are using two models to facilitate the visitor engagement using interactive tool as well as how we can help the visitor's learning. Bilda's model of engagement shows the interaction of a visitor with an interactive tool [17]. This model will help us to validate our suggested tool and determine whether it supports the different phases of engagement with the visitor.

Museum or art gallery experience is also a learning experience. Learning is not restricted to learning about the exhibit, it may happen the visitor learns something new about themselves, walk away with a new question about the world.In order to support the learning of a visitor we have followed the CML [58] model.

2.1.1 Bilda's model of engagement

Bilda's model of engagement [17] has four interaction phases: **adaption, learning, anticipation and deeper understanding**.

As shown in Figure 2.1, in the **adaptation phase** the visitor is uncertain and try adjust to the changes in the environment, understand the way they should behave and set their expectations. The visitor moves from the unintended mode to deliberate mode in this phase. In the **learning phase**, the visitor starts to develop an internal/mental model of the system and how it behaves. Thus, they start interacting with the exhibit mentally, emotionally and can build up expectations. This phase occurs when there is a change from the deliberate mode to intended/in-control mode. The **anticipation phase** occurs from the deliberate mode to intended/in control mode. When in this phase, the visitor can predict the effect of interaction so the intention will be more grounded than the previous phases. For example, if the visitor looks at an exhibition which shows the effects of World War II, the visitor might be shocked

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[1]I would like to thank Dr. Reilly in helping me understand this and pointing this out.
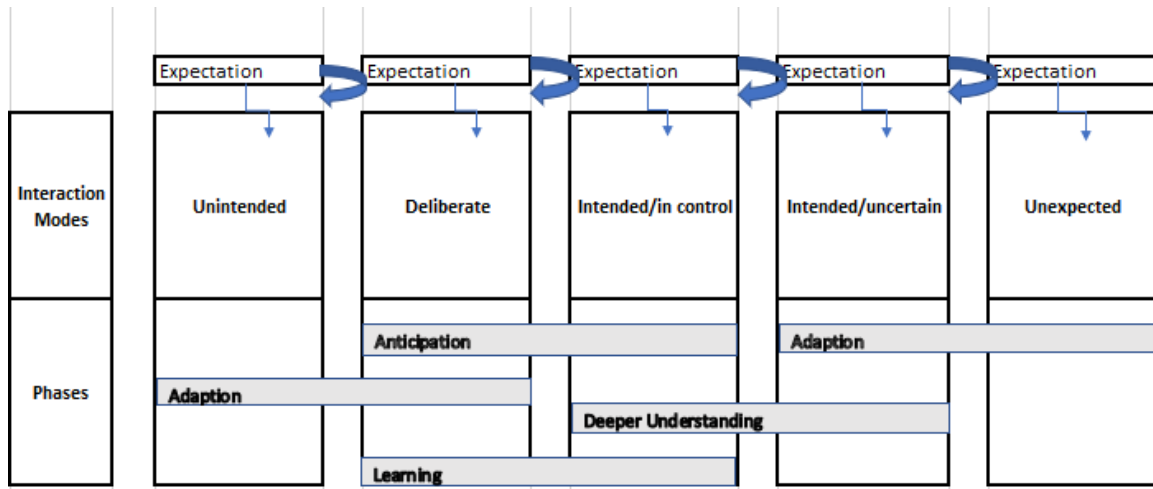
Figure 2.1: Model of Engagement: Interaction modes and phases. Adapted from Ref. [17, p. 4]

and feel sad and would feel more connect to the exhibit. The **deeper understanding** phase occurs from the intended/in-control mode to intended/uncertain mode. When in this phase, the visitor can find out some new aspect or any new unnoticed view of the exhibit [17].

So while designing the tool, we should keep in mind that the proposed tool gives the visitor time to adjust with the tool, let the visitor learn on their own pace and get used to the functionalities of the tool. Once the visitors understand the basic functionalities, we expect that they will gain the confidence to explore the tool and effective communication and engagement.

2.1.2 Contextual Model of Learning

The Contextual Model of Learning (CML) [58] is based on personal, socio-cultural, and physical context which influences visitors' experience in a museum or art gallery setting. The CML framework as shown in Figure 2.2 is divided into three sections:

Personal Context: The visitor learns by motivational and emotional cue. The visitor's learning is done by their personal interest. New knowledge is created on the basis of previous experience and preference. The visitor has choice and control over the information they gather which optimizes the ability to learn.
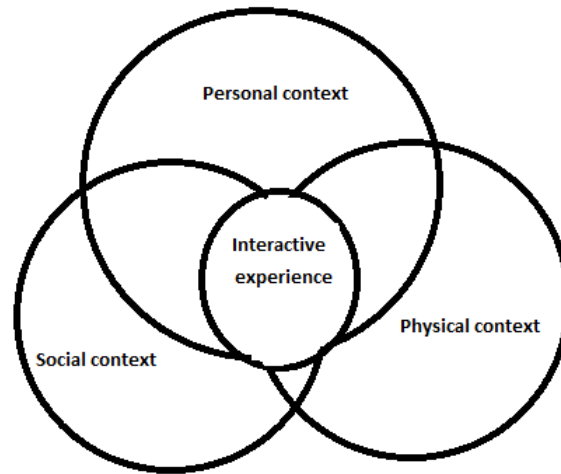
Figure 2.2: Contextual Model of Learning diagram. Adapted from [58, p. 11]

Socio-cultural Context: Learning is done here by individuals and different group members. In this case, the visitors who come in a group will use each other as tools for engaging with the exhibit. Each visitor have different motivations and come from different background. These diverse activities may affect their experience.

Physical Context: The learning process starts after the visitors get comfortable with the surroundings. The surrounding of the gallery, interaction with the exhibit impact the learning and the experience of the visitors. Also, relevant previous experience also influences the learning from a museum experience.

2.2   Art Gallery and their Components

The three main parts of an art gallery on which we will be focusing on are the **artist and their works, art curators and visitors**.

2.2.1   Artist and their works

Artist and their works are the main influencing factor around which our interactive tool will be designed. In the initial stage we have primarily divided the types of

exhibits into two major categories, **story-telling/chronological based or based on artist's choice**.

For a story-telling/chronological based exhibit the tool should suggest a pre-designed tour to the visitor for better engagement and effect. Whereas for the other category the tool should try to learn from the visitor's interest or preference to customize a tour around the exhibit. Hence, these two initial categories play an important role while designing the type of tour the tool would provide.

2.2.2 Art Curators

They are the pillars that help in designing an exhibit along with the artist. They are responsible for displaying the art in a historically coherent and entertaining way [44]. While working with them, we can understand the primary factor common to all components of a given exhibit. It may also help to think about approaches towards positively influences an increase in the engagement of viewers.

2.2.3 Visitors

In the initial stage of designing we will be focusing on the primary visitors. The motivation with which an adult visits an art gallery is quite different from that of a student visiting with their class. Hence, we should try to understand the different approaches that are used to engage different types of visitors in galleries. Another important factor to keep in mind that what a visitor remembers after a museum visit is not same as what they learn from the visit. Although they are related but they are not same. Any experience, or smell or any particular activity can leave an impression on their mind [20]. For our research, we have followed Falk's types of visitors [20] . He has categorized visitors into five groups.

Explorers: These people are curiosity driven and they are looking for something to learn. They are knowledge gatherers. Example of such visitors are art students and artists.

Facilitators: These visitors are socially motivated, and they are concerned about the overall social experience of the people accompanying them. For example, a

parent taking their child for a visit in and around a gallery to teach them about the exhibit.

Professional/Hobbyists: The purpose of the visits of these visitors are content-related. The content of the exhibit is either related to their profession or their hobby. For example, a student who is studying about the Canadian history will be interested in an exhibit telling the stories before and after the settlers arrived.

Experience Seekers: People who are serious and motivated to visit an art gallery. They consider galleries to be important destinations. For example, a tourist visiting Ottawa who considers visiting the National Gallery of Canada an important destination to see.

Rechargers: People who are primarily looking forward to having a spiritual and restorative experience in an art gallery. For example, a person roaming in a gallery for a relaxing experience or to spend some time alone.

2.3 Accessibility

Since the proposed interactive tool should be suitable for a wide spectrum of people including people with disabilities. We have explored different interactive mediums and their features to get the best out for the art galleries.

In the case of art, *eyes and ears* are the main sensory organs considered for engaging with exhibits. Therefore, it becomes difficult for the people who are blind or have low vision to enjoy art. Although there are audio devices present in several galleries, but these audio devices do not always provide a detailed literal description of the artworks. They mostly assume that the visitors have sight. To overcome such barriers, proxemic audio interfaces have been introduced in many exhibits. These interfaces include background music, sounds and verbal description. These help people with sight disabilities to have a more fulfilled experience [54]. Most galleries keep the sound and scent of the area near the exhibit neutral so that the focus does not deviate from that of the display. Effects like sound of waves or smell of smoke can enhance (or alter) a visitor's experience and their conception of the artwork can change

significantly. Again, it has been observed that as infants, human learn by touching and moving objects and gradually learn by more advanced methods such as seeing and listening [27]. Hence other senses such as smell, touch or hearing can be used to enhance the engagement of visitors in galleries [62].

The Museum of Modern Art (MoMA) main New York City campus provides services to individual who are deaf or hard of hearing, individual who are blind or partially sighted or individuals with dementia or individuals with development or learning disabilities. They provide touch tours where visitors can touch a few of the selective artifacts. They also provide services where visitors can listen to a vivid and detailed description of the exhibits or have a scheduled sign language tour [49].

2.4 Available Options

An interactive method which offers a scope of learning and helps the visitor to draw their own conclusion on the meaning of the exhibit can increase engagement of visitors [27].

2.4.1 Navigation

Information space helps people choose appropriate information by navigating through different attributes and find relation between things. In case of museums or art galleries low-tech options such as brochures or audio-tours are present for navigation around the building. Hence using tools which support the three different modes of navigation can help the visitors explore exhibits which provide little curatorial information[13].

The three different modes of navigation are: **physical navigation, social and semantic navigation, and spatial navigation**.

Physical navigation involves the movement of the visitors inside the gallery. The visitor can navigate through the gallery on their own, with the help of guides, looking into maps or through virtual guides.

Social navigation and semantic navigation usually employs choices made by other visitors to make decisions and complement semantic navigation.

In case of social navigation, choices are made by other visitors to make decisions and complement semantic navigation [13]. In case of semantic navigation, movement

from one item to another is based on semantic relationship — bigger, faster, alike [16].

Social tagging feature provides the visitor with an opportunity to browse through the tool to decide which artifact to visit. The social tags and feedback from previous visitors will help in decision making. This feature will also open an discussion forum for visitors to express their views and engage more with the exhibit. This feature will help in building the sense of community as different unknown visitors will try to communicate on the same platform.

According to Dimitar et al. [15], visitors can be can be split into two main groups based on their motivations: **Categorizers:** Visitors who use tags as navigation aid and assign tags based on some personal or shared conceptualization. **Describers:** Visitors who assign tags that describes the object best to support indexing and thus helping in search and retrieval tasks.

Tag clouds [15] can be used for social tagging systems because they visualize the information space in an intuitive way. A tag cloud interaction schema of a user navigating a tag-resource can be simplified to [15, p. 185]:

- "The system presents a tag cloud to the user for a given resource.

- The user chooses a tag from the tag cloud.

- The system delivers a list of resources tagged with the selected tag.

- The user selects a resource from the list.

- The resource is displayed and the process starts anew" [15, p. 185].

Spatial navigation on the other hand involves choosing and locating places or exhibits. It involves orientation and way findings. Visitor moves from one item to another based on the spatial relationship — above, below, under [16].

This spatial navigation relationships can be used during the designing of virtual maps to guide visitors in the gallery. While designing the virtual map, the flowchart in the Figure 2.3 may be followed.

Each room of the gallery should be represented as an indoor cell and the cell should be sectioned into **Navigable area** and **Non-navigable area**. The navigable area is the space where the visitor can roam around freely. The non-navigable area can be the place where the actual artifact, (e.g. a painting) is kept or can be the place which in general is inaccessible to the visitors. These non-navigable areas will
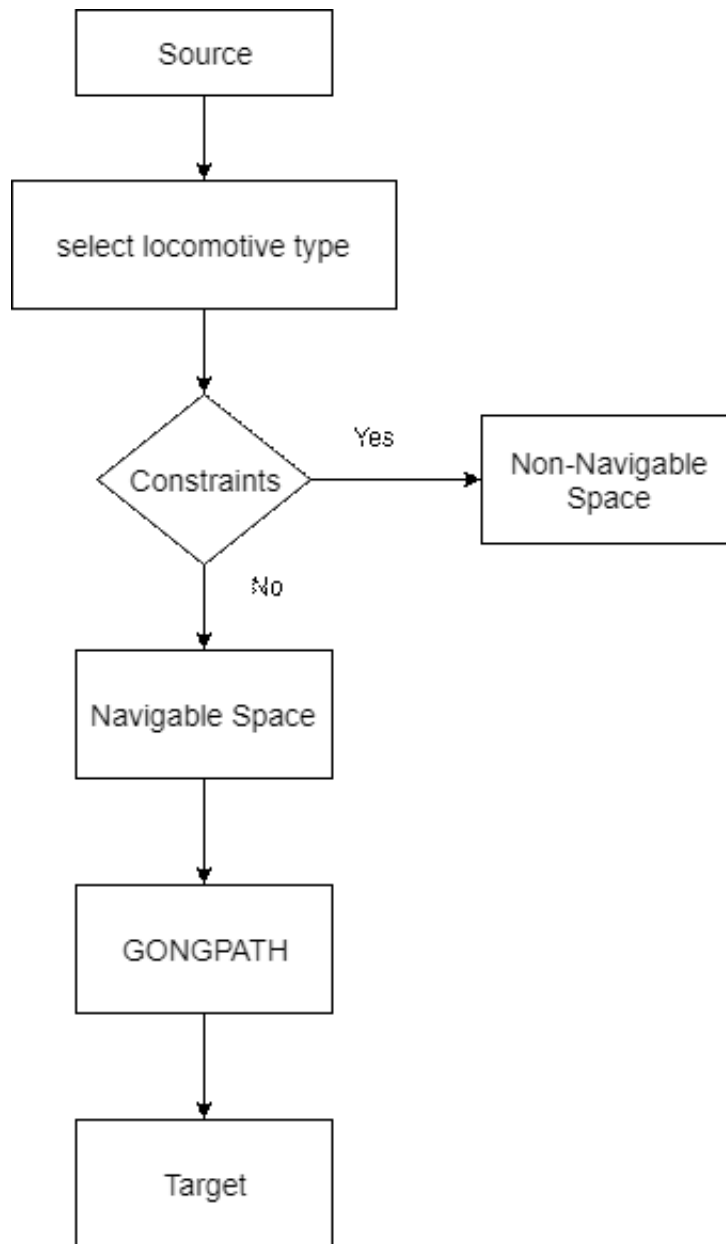
Figure 2.3: The flowchart shows how the virtual map will decide its path from the source to the target based on its surroundings. The locomotive type can be a person walking or a person on a wheelchair. Constraints may include restricted area, walls. GongPath is a navigation system whose principles can be used for indoor navigation.[33, p. 10]

be determined by the artists and the curators. The virtual map will also be able to dynamically determine navigable and non navigable space based on the constraints and the type of locomotion.

The **select locomotive type** includes two options: visitor walking or visitor on a wheelchair. If the type of locomotion is walking, the visitor is considered as walking on the floor and can cross less than 3-foot high obstacles.

If the type of locomotion is wheelchair based we have to consider the dimension of a wheelchair. The average dimension of a wheelchair according to International Standards Organization (ISO) [52] are 20 inches wide, 51 inches long and 43 inches high. The average obstacle climbing for Electric Wheelchairs is 8 inches. While deciding the path, the virtual map should consider the dimensions of the wheelchair to decide the optimal path. **Constraints** will determine navigable and non navigable spaces. They include the basic requirements for movement. It includes geometry-related constraints and physical space constraints such as height, width and length of the cell, position of the visitor, the volume of the passage spaces between rooms. It also includes spaces that are are not marked as inaccessible to visitors.

Once the navigable space is decided, the navigation path can be determined using the principles of "GongPath" [36]. This navigation system can provide intuitive navigation guidance for huge spaces containing non-convex shape and non-navigable spaces. Since the layout of an exhibit does not follow a strict measurement and has many restricted sections (area near the actual art or the art itself), this system will be beneficial to guide the visitor to their target position. Since indoor spaces are complex and partitioned by walls, the visibility field inside buildings become very important.

GongPath [36] integrates Building Information model (BIM) and an iterative algorithm to generate minimal numbers of convex spaces, to find paths for navigation. BIM used for GongPath is based on "Structured Floor Plan" [8]. In this plan, each room is defined as space and each space is always enclosed by walls and are connected to other spaces through doors, stairs and elevators. Jumphon and Soyoung [36] has defined space topology as semantic relationship among spaces. BIM can generate physical space topology based on building components and space attributes.

These relationships can be described using node graph. A space topology graph can be plotted using topology nodes (building components such as space, door, window and column) and topology link (connection between two related spaces). Although a complete indoor navigation can be generated by applying Graph theory
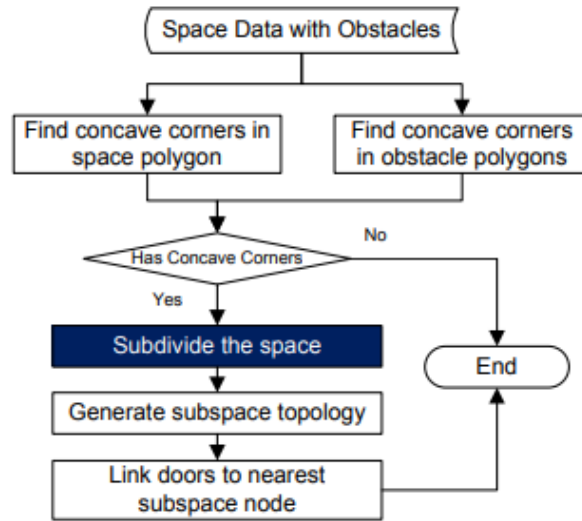
Figure 2.4: Process to generate route topology for each space [36, p. 386]

algorithm to the topology graph where distance and other attributes such as door type and space type as weight factors, the path will still be coarse and may penetrate walls and obstacles in the space.

To avoid that situation, Jumphon and Soyoung [36] propose a process to generate route topology as shown in Figure 2.4. The process begins with the verification of the space to find out whether the space is concave and contains any concave obstacles. If any concave corner is found, the space subdivided into minimal set of convex subspace using the algorithm as shown in Figure 2.5. Internal topology for routing will be created by making subspace node and connecting them. A navigable path is constructed by inserting one route node at the middle of every edge between subspaces. Lastly all the doors available in that space are connected to their nearest subspace node. The main principle of the subdivision algorithm is "to link each concave corner to the least deviated node to its opposite direction. By doing so, each concave corner will be divided into at least two convex corners" [36, p. 385]. Finally they applied path relaxation processes to remove unnecessary nodes and suggest the shortest path to the visitor.

This intersection has been used by Tagging [13] which uses both social and semantic navigation by allowing visitors to label things and places. Tools such as the Social, Location, Annotation, Mobility (SLAM) framework recognize the link between social

```
Function ConvexPartitioning (Space S, List ObsList) returns SubSpaceList
        SubSpace SA[];
        Node PF[];
        For each concave point P0 of S
            If (P0.isConvex == True) Then Next P0;
            // Create an opposite vector from P0 using a half of internal angle at P0
            Vector V = CreateOppositeVector(P0);
            // Find all free corners in S and ObsList that connect to P0 without going 'off-polygon'
            PF = FindFreeCorners(S, ObsList, P0);
            // Find the least deviated corner (PX) from V
            Node PX = FindLeastDevNode(PF, V);
            // Subdivide S with an edge between P0 and PX
            SA = S.Subdivide(P0,PX);
            P0.isConvex = PX.isConvex = True;
        Next P0
        For each Obstacle (O) of ObsList
            For each concave point (P0) of O
                If (P0.isConvex == True) Then Next P0;
                // Create an opposite vector from P0 using a half of internal angle at P0
                Vector V = CreateOppositeVector(P0);
                // Find all free corners in S and ObsList that connect to P0 without going 'off-polygon'
                PF = FindFreeCorners(S, ObsList, P0);
                // Find the least deviated corner (PX) from V
                Node PX = FindLeastDevNode(PF, V);
                // Subdivide S with an edge between P0 and PX
                SA = S.Subdivide(P0,PX);
                P0.isConvex = PX.isConvex = True;
            Next P0
        Next O
        Return SA
End Function
```

Figure 2.5: Algorithm to subdivide into convex spaces. [36, p. 385]

and spatial navigation, combining them to support group awareness and activity [13].

MobiTags, as shown in Figure 2.6, was a system which attempted to integrate so-cial, semantic and spatial navigation and was used to study how people move through different modes in an open storage museum collection. The collection in context was a small storage collection at the Johnson Museum of Art at Cornell University. Voting and tagging features were included to increase social awareness, social navigation, and engagement. It was observed that visitors liked the idea of easy access of information and having the control on the pace of information received. It was also observed that people liked the idea of tagging for semantic navigation. They also used the tagging feature to find out the relationships between different artifacts which were not clear from their physical layout. For example "hunting" tag can show all the hunting related objects from an exhibit. Visitors also reported that subjective tags such as "beauti-ful" or "scary" helped them to socially connect with earlier visitors. Again voting on
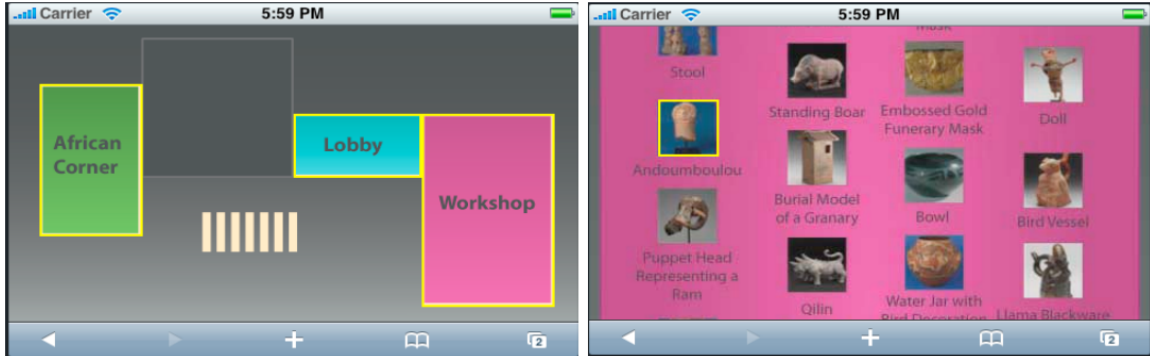
Figure 2.6: MobiTags. The left images shows the map of how different collections where spatially arranged at the exhibit. The exhibit was held on one floor of the Johnson Museum of Art, Cornell University. The Lobby case was placed outside a Workshop door present on that floor. The African Corner was place at the opposite end of the lobby some 100 feet away from the other two collections. The right image shows the thumbnails of the different art objects from the three collections. They were mostly ancient cultural artifacts such as weights, vessels,bowls, masks, and totems. [13, p. 1955]

tags gave the visitor the ability to express their opinion on a particular artifact. The map feature helped the visitors to locate any specific object in the collection as well as to find out their physical orientation. The system encouraged visitors to navigate through the physical spaces by following the maps and tags shown in the system[13].

2.4.2 Interactive Interfaces

Multimodal Interaces

Introducing multimodal interfaces gives a user opportunity to interact with the tool in different ways Since humans usually involves multiple modalities during interaction, the use of multimodal interfaces will make the interaction more natural [4]. As the motivation behind visiting an art gallery is different for every visitor, providing them with an opportunity to experience the same functionality of a tool based on their preference will help them to engage and interact more.

An example of a multimodal interactive platform is the "Digital Boardroom to Go" [55]. It is used for organizing board meetings. It has three multi-touch enabled display with a shared display. This feature can help visitors with family to have

a shared experience as well as interact with the tool individually. It also uses Microsoft Kinect and Microsoft Cortana to identify body gesture and voice command respectively [55].

User interfaces for smart environments rely on the possibility of adapting to the context as the use might try to interact with the tool under various circumstances or situations [4]. During designing of such tool, care should be taken so that the tool recognizes natural gestures and voice commands as there is no scope of user training. Usage of large screen displays for such applications makes more sense as they allow space for interaction with multiple users simultaneously [34].

Multi user Interface

The Art Lens Wall as shown in Figure 2.7 is present at the Cleveland Museum of Art is a 40 foot interactive micro-tile wall which displays 4200–4500 artworks at any given time. This wall helps the visitors to engage with the displays in a more interactive and
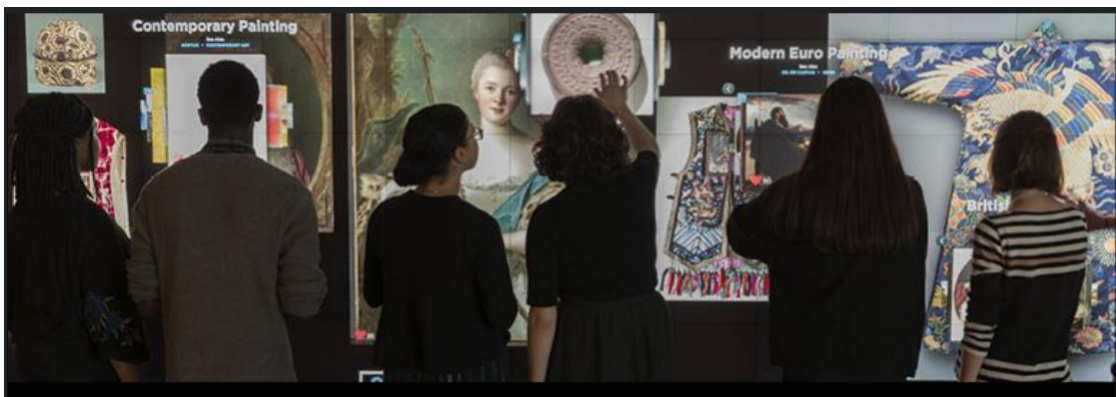
Figure 2.7: The ArtLensWall present in the Cleveland Museum of Art is an example of multimodal interactive platform. We can see in figure that the wall gives an opportunity to the visitors to interact with the artifacts individually and also as a part of a group simultaneously [48].

personal way. The visitors can download existing visitor-created tours or create their own tour on their own iOS and Android-powered devices. They can also save their favourite displays from the wall on their Art Lens application. The Wall allows multi touch so that multiple users can interact simultaneously on separate interfaces. An application content management system is also there which updates the art displays as well as keep track of the frequency with each artwork has been favorite. The

sharing and favourite frequency helps the museum staff to understand the type of display or art with which visitors are engaging [48].

2.4.3 Mobile Devices

Different art galleries have book corners where they keep different books, brochures related to the exhibit. But these corners are static and sometimes its difficult for multiple visitors to access simultaneously. It has been reported by the PEW Research Center [29] that by February 2012 21% of American readers have at least read one e-book in the previous year. In a survey that ended in December 2011 [29], some 43% of Americans age 16 and older said that they have either read an e-book in the past year or have read other long-form content such as magazines, journals, and news articles in digital format. Hence, with the growth and advancement of mobile technology in the later years, the percentage must have increased significantly. Therefore,introducing a m-Reader or mobile-reader [35] can deepen the engagement and the visitor can have a more immersive experience.

Mobile Application

There are several mobile applications that are available at art galleries. One of them is the **Canadian Museum for Human Rights Mobile app** [43]. This application can be accessed using the visitor's own iOS or Android device or on the device provided by the museum. This app has several features such as **audio guide** (provides descriptions as well as highlights of the exhibits and architecture, has text transcripts as well), **a Near Me feature** (connects to low frequency iBeacons to more than 120 Universal Access Points (UAPs) located throughout the museum, assists visitors with disabilities as well as assists visitors to experience the key exhibits), **full accessibility** (Braille marker and tactile cane strips for people who are blind or have low vision, American Sign Language and other special sign languages for people who are deaf or have low hearing ability), **an interactive panorama feature** (feature available through camera of the mobile device to relay real-time augmented reality as well as panoramic view) **interactive mood-meter** (lets the visitor share their feelings while moving through the museum space, provides feedback of the exhibit), **interactive map** (shows the location of the visitor as well as help to guide to the

visitor to their destination), **Online ticketing and membership purchase**, and **Information to plan your visit** (event calendar, description of boutique, bistro, how to make a donation and a few more options) [43].

A museum or an art gallery can primarily be classified into two types of information: **Catalogue information** and **Environmental information**. Catalogue information is the information related to the museum registry whereas environmental information is related to the surrounding to a particular artifact rather than the information on the artefact. Any piece of exhibit is usually stored in a container such as showcase or a frame. We can use Radio Frequency Identification (RFID) to locate such containers to identify any particular piece of art. Use of RFID tags and PDA can assist visitors in large groups. Suppose a large group of visitors are walking through a gallery talking among themselves or paying less attention, and they come across an important piece of the exhibition the RFID tag will send an alert to the user's PDA that they are near an important exhibit. This feature will prevent the visitor from missing an important piece at the exhibit. These tags can also be used to retrieve more information on a particular exhibit. Visitors can bring their reader close to the tag to get more information on the exhibit [59].

It has been estimated by World Advertising Research Center (WARC) that 2 billion people currently access internet only via their smartphones which is approximately 51% of the total global mobile users [26]. Hence, we can use the camera feature of the smartphone to act as a gallery guide. If a visitor point their camera to any piece of art at an gallery, image processing technology can be used to recognize the input picture and then provide multi-modal context-sensitive information on that piece of art to the user [56].

Visual Markers

Visual markers can also be used to deliver information about any artifact or an exhibit. A visitor can scan the marker using their smartphone to access a more extensive multimedia information and leave comment or feedback for the gallery. One low-cost visual marker is the use of QR codes. The codes can be used to increase interaction of visitors through quizzes, treasures hunts or for solving riddles such as identifying the correct painting at a gallery [1].

Another visual marker is Artcode which has been used for a study on *"Uncovering the Invisible"* exhibition at the University of Nottingham [1]. Once the visitor scans the code, audio clip corresponding to the display painting will start playing. This assisted the visitors to look into details of the painting and have a thorough immersive experience. Audio clips were used instead of text as reading text can distract the visitor from looking into the painting and the interaction will not be that effective. While designing such markers, we can try to mitigate issues, such as the interface for accessing the digital media, appropriate marker design and marker placement for smooth interaction [1].

2.4.4 Augmented reality

Augmented reality (AR) devices are also gaining popularity. The main three reasons that we are considering are: these devices mix storytelling with technology, they also help people with disabilities to enjoy the exhibit and self-guided tour [43]. Using this technology, we will be able to attract what they call the 'missing audience' [31] back to the art galleries. The **'missing audience'** is made up of people who are not attending the art exhibits because of their lack of time or interest. It seems that people are losing their touch from the art [31].

Augmented reality exhibits use smartphones and tablets to enhance user experience. Visitors can roam around with the device and control their experience, learn on their own pace. Usually museum or galleries keep their exhibits and displays in close environment to conserve them. If we can introduce touch experience along with several senses such as smell or taste, it can enhance the experience of the visit [9].

Lumin[42], as shown in Figure 2.8, is a mobile-tour using augmented reality (AR) and 3D mapping at Detroit Institute of Arts. The project was built in partnership with DIA, Google and mobile developer GuidiGO. This device will help the user to understand the exhibit in a new way, look into new details, know how the artifacts in display were used at that time and also to travel virtually to far way location. Lumin can also help to locate different stops inside the gallery [42].

While designing any mobile AR device, care should be taken to maintain the balance between the virtual space and the physical scene. The aim should be to enhance
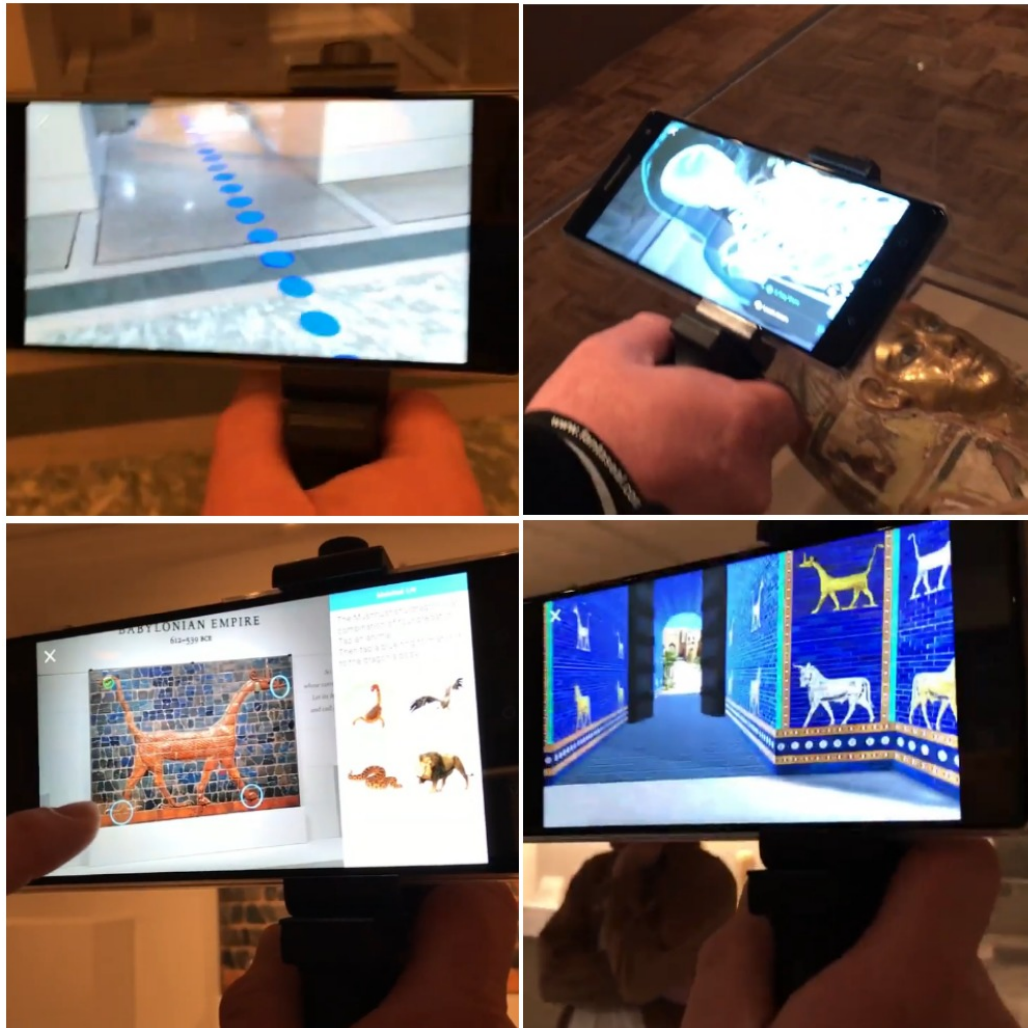
Figure 2.8: The collage shows the different features of the Lumin tool Clockwise direction: First image: Is a map which can guide a visitor around the gallery to reach their destination. Second image: X-ray view of a 2000-year-old Egyptian mummy. Third image: Virtual tour of walking through the gates of Babylon. Fourth image: Shows the game feature where the user has to match the images on the right side of the screen to the circled images on the left. All images are screen captures from the video [42]. The photo collage was made on the website at https://www.photojoiner.net/.

the interaction between the visitor and the actual exhibit with additional virtual information. **Art appreciation**, i.e. the scope given to the visitor to appreciate the original art and to share and have a discussion on the piece of art. The four steps mentioned by Feldman [7, p. 186] in art appreciation are "a brief description of the artwork, analysis of its techniques, interpretation of its meaning, and value judgements". Sometimes multimedia or interactive options can be distracting and visitors

may get more engaged with that rather than looking at the exhibit. So while designing any tool, function of mobile AR-tool as well as steps of art appreciation should be considered to facilitate the interaction between the visitor and the artifact [7].

As shown in Figure 2.9, a mobile AR-guide was developed to assist visitors in painting appreciation. The guide had an image recognition technology and the image was received through a camera lens of a 10-inch tablet PC. The study was conducted at two universities in Taipei city, Taiwan. It showed that this AR-guide was effective and the visitor believed that the additional video guide helped them to understand the background of the painting more. The visitors reported that even if they did not know much about painting, the AR-guide helped them to understand and pay more attention to the work. The text comment along with the display as well as the zoom-in zoom-out feature of the guide helped the visitors to understand the detailed description of the painting. It was also mentioned by a few visitors that the PC tablet was heavy and bulky and a more mobile-phone sized device would have been better [7].

Although AR devices provide enriching experiences, it has been observed that the users do not want to hold the devices while exploring a gallery. With the introduction of Head-Worn AR devices, visitors can utilize the functionalities of AR devices without the need to hold them [63]. A study [63] was conducted to understand the users' requirements for smart glasses museum guides. It was seen that most of the users wanted to be in control of the timings when they receive the information from the device rather than using a proactive device. There are several options by which the device can be controlled including tapping at the side of the glass, using a hand held mobile device or even voice commands. Most participants did not like the idea of voice commands as they can disturb the quiet museum environment and interfere with privacy [63].

2.4.5   Haptic Technology

Although in case of appreciating art, visual and audio senses are considered primary, recent technology advances provide informative and compelling unobtrusive haptic stimuli such as moving platforms, pin-arrays, shearing belts and balloon-based systems [40]. Using tactile sensations in mid-air, the visitors without touching the art

Figure 2.9: Mobile AR-guide.
Top picture: Visitors could point the camera of the tab at the painting. The system will recognize the painting and will provide either audio/textual information about the painting. This method will give the visitor opportunity to look at the original painting, connect with the painting, know about its background,and start an interaction with painting.
Bottom picture: The screen here is divided into two sections. The top portion has the detailed description of localized sections of the painting. It helps the visitor to gain more in-depth knowledge on the painting. This feature helps the visitor to cross-reference the descriptions of the sections. [7]. The photo collage was made on the website at https://www.photojoiner.net/.
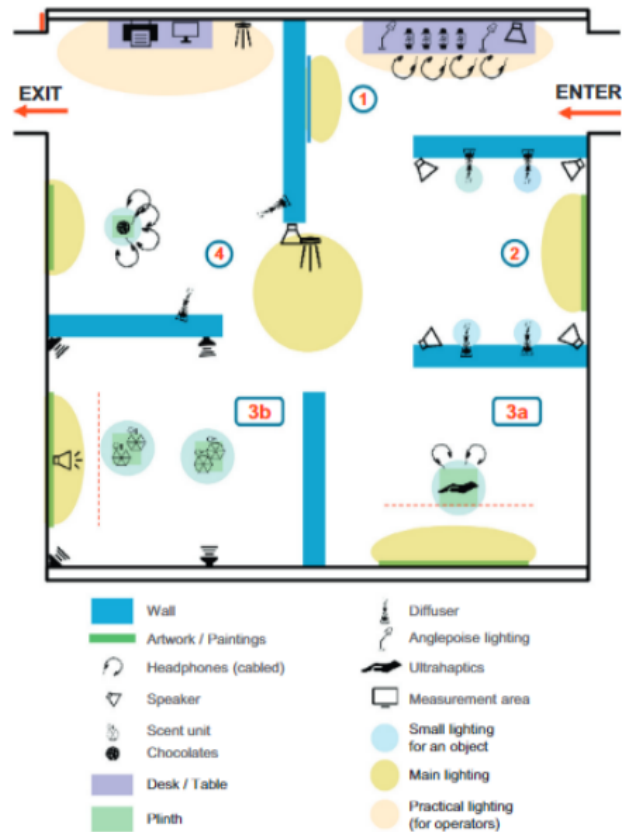
Figure 2.10: Multisensory Exhibit Layout at Tate Sensorium. "Room setup of Tate Sensorium split into different sub-spaces (design by flying object): visitors enter on the right, where they receive the headphones (1) Then they move to the room (2) to see the first painting *Interior II* (by Richard Hamilton) along side olfactory and sound stimuli. After that,they move to either (3a) to experience the *Full Stop* painting (by John Latham) along side mid-air haptic and sound or (3b) to see the painting *In the Hold* (by David Bomberg) through olfactory and sound stimuli. After swapping, visitors move to the last station (4) to experience taste sensations for the *Figure in a Landscape* (by Francis Bacon) painting" [60].

objects physically, have the opportunity to experience with the objects and prevent the decay from multiple human touch.

One such example is the **Tate Sensorium** shown in Figure 2.10, a 6-week multi-sensory exhibition at the Tate Britain art gallery in London, UK. The aim of the exhibition was to involve all senses (sight, touch, taste, hearing, and smell) to experience the exhibition. Visitors attended in a group of 4 at a time and looked at one painting at a time. After the first painting the group split into two groups of two

and one group looked at the second painting and the other group looked at the third one. The groups later swapped their location and finally moved towards the fourth painting together as a group. In addition to audio guidance for each painting, other senses were also involved during the experience such as different smells, wrist band to capture skin conductance response. Haptic feedback was delivered to the visitors through a device placed inside a plinth in front of the *"Full Stop"* painting. A synchronized sound and haptic stimuli experience were provided to the visitors and were asked to enjoy the Full stop painting during that time. The *"In the Hold"* painting different scented objects were presented and the visitors were asked to experience the smell along with the sound stimuli while interacting with the painting. It was observed that multisensory layers on top of visual appearance gave the visitors opportunity to have stronger emotional reactions. It was also reported by a few visitors that these stimuli have different effects on each individual and can be distracting for some visitors [60].

Introducing a compact, unobtrusive, easy-to-wear haptic device [41] will assist the visitor to move freely around the gallery without the struggle of carrying a bulky device. Meli et al.[41] tried to provide haptic information through a non-haptic feedback modality. For example we can make a visitor touch a virtual object to understand the texture of the actual artifact. We can introduce colour changing aspect depending on the pressure applied by the visitor on the virtual object [40].

Table 2.1 provides a summary of the features discussed in the surveyed available options.

	Category	Examples	Features and Suggestions
Navigation	Physical, Social and Semantic, Spatial	Maps, Brochures, Guide, Social Tags, Virtual map	Know the floor plan, understand the visitor's preference, Easy Guidance

Continues...

Category	Examples		Features and Suggestions
Interactive Interface	Multimodal Interface, Multiple-user Interface	Digital Boardroom, Digital Wall	using multiple methods of interaction such as voice, hand gesture.interactive within a group as well as individual interaction.
Mobile Device	Mobile Applications, Visual Marker	Canadian Museum for Human Rights Mobile app, Artcode	Guide, additional information, using hand held devices, audio-clips,can provide feedback, buy tickets
Augmented Reality	Smartphones, tablets, Head-worn AR devices	Lumin, Exhibition in Taiwan	story-telling, accessibility, self-guided tour. Balance should be maintained between virtual and physical space. Device should not be bulky. Using voice commands.

Continues...

Category	Examples	Features and Suggestions
Haptic Technology	tactile senses, haptic stimuli	exhibition at Tate Sensorium, UK	using sound, scents, easy-to wear haptic devices touch virtual objects

Table 2.1: Summary of survey available options

Chapter 3

Research Problem

While exploring different interactive options present in art galleries, the most important point that came up was to build the bridge between the artwork and the visitors. An interactive tool facilitates the interaction between the work and the visitor and provides additional information to provide an engaging experience. We want to assist future designers in their tool selection and building process. Hence we narrowed our research problem to:

To design a framework which will assist in designing/ building of interactive tools for art galleries/museums. The problem can be further divided into two sub-problems:

1. The framework should be include tools to assess accessibility issues and suggest solutions to mitigate any such issues.

2. To find influencing factors that will be used to customize the designing of the framework.

Chapter 4

Methodology

The data collection started with the interviews of art curators from different art galleries of Nova Scotia. Conducting a one-to-one semi-structured informative interview with the art curators in their office or any mutually acceptable location helped us to understand their viewpoints when they design or assist in designing an exhibit for the gallery. A face-to-face interview helped the interviewer to interpret the interviewees body language, and explore hidden meanings or understandings [57]. An ethics review was done before the study was conducted to ensure that the study meets the expectations for ethical research with human participants (see Appendix A.2).

4.1   Study Population

The study was conducted with art curators from Dalhousie Art Gallery, Art Gallery of Nova Scotia, and other art galleries of Nova Scotia. We went through the list of curators in these galleries and found out that there are only about 12 curators. Since the number of curators is limited, we aimed to try interviewing as many curators as we could for the study. Time and resource restrictions enabled interviews with only 5 curators.

We have sent out invites to the curators by e-mail. We had requested for their convenient time and place (probably their office or any coffee shop near their office). Anyone who was a curator at an art gallery of Nova Scotia was eligible to take part in the study. A detailed consent form was attached in the invitation e-mail message.

4.2   Interview

The interviews began in the participants' offices and many continued as visits to the public gallery spaces. The place was quiet enough to have and audio-record the

conversation. The interviews were semi-structured so that we could have an open-ended detailed discussion. The length of each interview were around 25–40 minutes. The interviews were audio-recorded with the participant's consent. The interview began with a set of questions and further questions were asked based on the responses.

Before the interview began, the interviewer asked the participant whether they have any concerns or need any further explanation on the study. Once confirmed, the interviewer asked the participant to sign the consent form. Only after the signature, the interview started.

The participants also had the option to stop the interview at any given time for any reason. Once withdrawn, the data collected from that interview will not be used for the study. The participants also had the right to withdraw their responses within two weeks from the day of interview.

Since most of the curator's offices are in the gallery building, we also had a tour around the gallery where the curators showed us pieces from the collection and how the artist expressed their thoughts through their work, how different paintings/sculptures were placed in the room. This helped us to understand the designing process with examples and references.

4.2.1 Privacy and Confidentiality

The participants are not identified by their names. They are only referred by their job profile and experience. This information may be enough to identify them if someone know they personally. We have used the phrase "one of our participants said" as opposed to "participant $\#x$ said". We have not used any direct quotes of the participants as the sample population is very small.

All the data (audio and paper notes) collected during the study are stored in a locked box in a locker at Dalhousie University. We have recorded the interview on laptop which is password protected. The data of the study was accessed by the research team. The audio recordings were transcribed by the lead researcher. The audio-recordings were kept to review the transcripts. The recordings were deleted 8 weeks after the completion of the interviews. The transcribed data will be destroyed one year after completion of the study.

We had the option of sharing the study results with the participants if asked. The

participants should request results via e-mail. They should send an email to the lead researcher at `oyshee@dal.ca`. Only one participant wanted to know the study result. Only the data collected from that participant was shared with them. We did not share other participants' results with them.

4.2.2 Compensation

The participant's were offered refreshment during the interview. They were also given a pin as shown in Figure 4.1 as a token of appreciation.

Figure 4.1: The design of the pin given as a token of appreciation to the participants.

4.2.3 Risk And Benefit Analysis

The risks associated with this study were minimal, and there were no known risks for participating in this research beyond being bored or fatigued. However, the participants were offered refreshment during the interview to reduce these risks. The participants were informed at the beginning of the study that they could stop the interview at any time. There are no professional risks for being potentially identifiable in the results.

4.3 Data

The data collected from the interview were qualitative in nature. We conducted a thematic analysis on the data. The responses were categorized based on their similarities. Those categorized data were further analyzed to come up with the framework.

4.4 Study Instrument

Since the interviews were semi-structured, we started with a set of (10) questions to begin; additional questions and discussions were based on the responses to those initial questions. Since the art curators are our way of communication with the artist and their work, we should try to understand how the artist want the visitors to interpret their work or how should the information about the exhibit should be made accessible to the visitors. Our aim was to start a conversation and get as much information as we can from the interviewees. We started with the question:

What is your aim as a curator?

- Increasing the number of visitors.

- Increasing the diversity of visitors.

- Increasing the quality of engagement of the visitors [12].

We wanted to find out how the curators classify different types of exhibits and how different exhibits influence their goals. As seen in the Table 2.1, the available options are customized based on visitor's inputs and preferences, we wanted to know whether the curators' aims change with the type and setting of exhibits. Hence the next question was:

Does your aim/goals change with the exhibits?

We also wanted to know if they preferred more focused or free setup for an exhibit. During our literature review, we could see that available mobile guide applications or social tag methods uses the visitor's instinct or their feedback to customize their tour. Hence, we wanted to know whether the curators have any inputs which can be implemented while designing the tools or how they want the visitors to experience the exhibit.

> **Do you want the visitors to give an overall view of the exhibit
> or just let me them explore the pieces they want to learn about?
> [A general description of the exhibit/piece of art will be given
> to the visitor. A visitor will be able to get a more detailed
> description upon showing interest.]**

As we know, sight and audio are the primary sense organs that are involved in art appreciation, we wanted to know their views on that as well as whether they use other sense organs to increase engagement in their galleries. As seen from the literature review, haptic technologies play an important role for an immersive experience at the gallery. We wanted to know their views about using other human senses for visitor engagement.

> **What other sense organs do you keep in mind while designing
> an exhibit (apart from eyes and ears)?**

Another important issue in art galleries is accessibility. It is very important to them that their exhibit becomes accessible to people with different disabilities. They try to provide additional services to facilitate their experience.

> **How do you try handling different accessibility issues?**

The end result of this research is to build a framework to facilitate future designing of interactive tools for art galleries. For this reason, we tried to the different types of interactive tools they use and how they feel about them. We wanted to know their overall view on the available devices.

> **What kind of interactive tools are used in their galleries'
> exhibits? What are the factors that influences their choice of
> interactive tool?**

The curators from galleries apart from AGNS were interviewed to get an outsider perspective. Their insights could help us to understand the views on a same exhibit across different galleries.

> **Have you seen the Maud Lewis exhibit at the AGNS? What
> do you think about it?**

Since we were using Maud Lewis's house as an example, we had a thorough discussion about that exhibit. The curators of AGNS were asked what they need the exhibit to say, how they want the story-telling to happen, what are the types of visitors they want to attract. We also tried to find out the different types of methods that are used or had been used in the past and why they have been discarded. Our aim was to capture the main essence of the exhibit and present it in a respectful manner. We also presented them with different existing methods which other galleries are using. We in no way tried to enforce any tool or tools on them. The following questions were asked only to the curators of AGNS:

What (interactive) tools are used at present for the Maud Lewis exhibit?

Are the tools effective, i.e. are you satisfied with the results you get with them?

What new features or functionality would you like in a new tool?

Would those features or functionality be for the same purpose you use the current tools for?

4.5   Benefits and Limitations

Individual interviews are a valuable method to gain insights to people's perception and can contribute to in-depth data collection [57]. In our case we had chosen semi-structured interviews. These gave us the flexibility to divert from the scheduled interview questions. Another important factor was that we conducted our interviews at the art gallery. This made the interview less formal and helped us to understand their views through examples. The study is to understand the curators' perspective and their needs. Thus, interview gives the platform for discussion and knowledge transfer. We should allow the interviewees to sum up and clarify their points at the end of each interview [2].

Since the study involved humans, it was a little biased (only the curators who have given consent will be part of the study) and the sample of curators were not a proper representation of the target population of curators. Again, the questions asked in the interview were crisp and unambiguous [30]. This reduces the chances of multiple interpretations by the interviewees.

4.6   Feedback

As we had limited time and resources, we were able to conduct 5 interviews with curators from different galleries of Nova Scotia. We did not face any risk during the interviews and all 5 participants completed their interviews. None of the participants had withdrawn their data after the interview. Only one participant requested a copy of their study result. The copy contained information collected from only their interview. As suggesting a specific devices was not nearly as helpful as discussing features that the curators think was helpful. Understanding what the stakeholders want or need guided our choice of existing device or help us to create (or adapt) our framework.

Chapter 5

Data Analysis

We collected qualitative data was collected from the interviews. We conducted a thematic analysis as shown in Figure 5.1 of the collected data. "Thematic analysis is the process of identifying patterns or themes within qualitative data" [39, p. 3352].
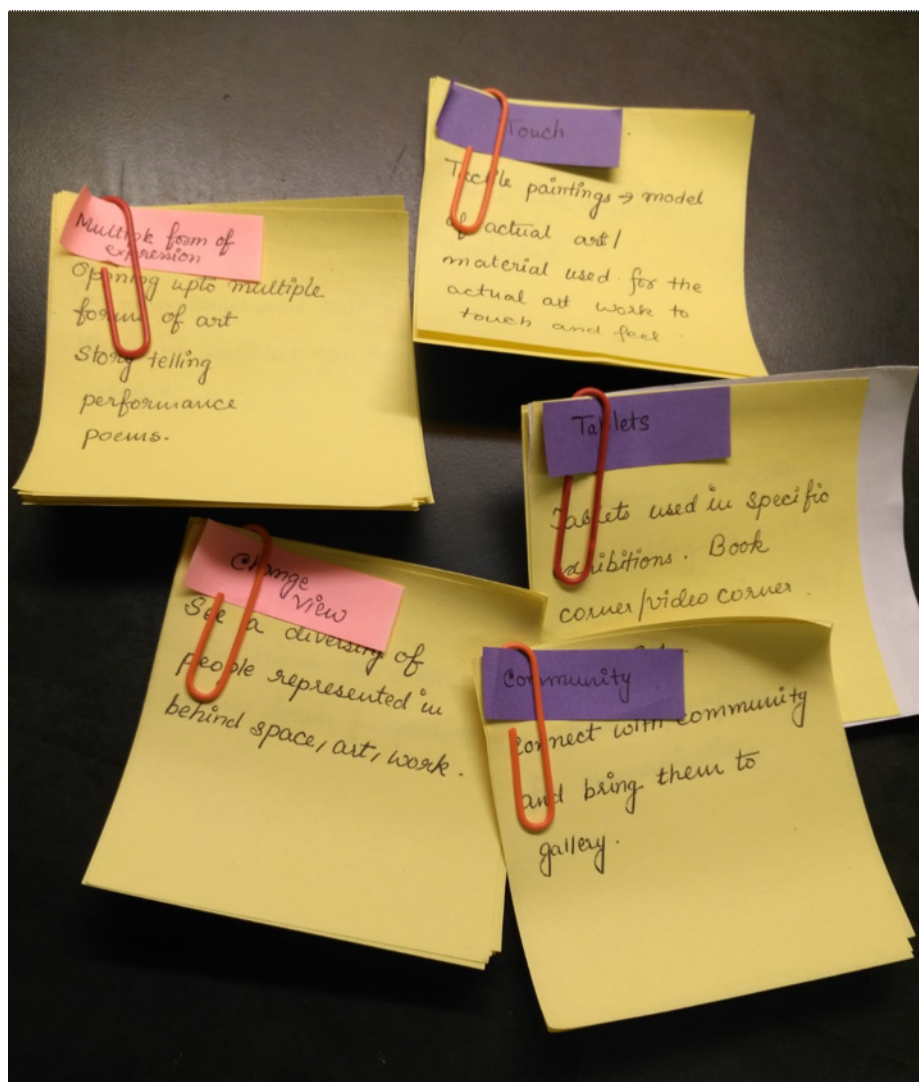

Figure 5.1: The transcribed data was sorted into groups based on similar themes.

The next step after categorizing the data by different theme was to make an affinity diagram. An affinity diagram helped us to name each of those themes and find a relation among them.

These themes and relations helped us to make the initial sketch of the framework or a platform to base our next step of research.

The data collected for general exhibitions and that for Maud Lewis exhibit were separately analyzed. In case of the general category, we have divided the data into 19 categories:

1. **One exhibit multiple experience:** 4 out of 5 participants mentioned how one exhibit can be interpreted into radically different shows/experiences. "Meaning-ful-ness" differs by visitor as they try to connect with the exhibits based on their lived experience and thoughts. Furthermore motivation differs: students visiting a gallery with their school and adults visiting on their own is different. Hence, while designing a show they have to keep in mind the different visitors and their needs.

2. **Community:** The curators expressed how they work to connect with the community and they keep trying to bring the public to the gallery. One of the curators had a background as an artist and they told how they always try to work with the community. The participants referred to 'the society' and 'the common people' as 'the community'.

3. **Change view:** One of the curators mentioned that Canadian art has been kind of narrowed down to European influence and we should try to change that. Most of the participants agreed that sometimes the exhibits need fresh perspective and there should be more diversity not only in art but also in behind space of artwork. The galleries should try to engage the audience who are in general are not well represented in art gallery visitors such as Indigenous, African, African Nova Scotian, and immigrants. The gallery space is mainly influenced by white male artists. Making space for diverse work, will draw more interest and encourage a diverse sector of visitors to visit a gallery.

4. **Multiple forms of expression:** Art is generally presumed to be visual art. But there are various other forms of art such as story-telling, performing art,

and poems. Sometimes projections, touch-pad, built-in videos are also used to express an artist's intent. Another important form of expressing is by touch. Tactile painting, touching models of actual art or touching actual art can help the visitor to engaging and interactive. Sometimes the information of a particular artifact is kept separate from the visuals by using brochures or maps. This gives the visitor a control on the amount of information they receive.

5. **Tablets:** Two of the participants mentioned that they have used tablets as a additional tool for assistance for specific exhibitions. It was also mentioned that in case of art, seeing a painting in real life is better than looking at it in book or in a tablet. Some participants also mentioned that it is not always that everyone who visits a gallery has a tablet, so there should be a facility to borrow a tablet at the gallery.

6. **Touch:** Three of the five participants encouraged the idea of 'touch tours'. They explained how tactile paintings or touching replicas of actual painting can be more engaging. The sense of touch can also help people with low vision to understand how the artifact feels, the weight, shape and texture of the object.

7. **Use of Technology:** The participants stressed on the point that using too much technology can be 'gimmick-y'. We should try to keep a balance on the amount of additional interactive tools used in the exhibit. The focus should not move from the real art and should not distract the visitor from the subject. It was also mentioned that using too much immersive experiences can make the experience of art gallery 'museum-y'. A 'museum-y' experience has a story telling approach which includes depicting a similar time-period, objects from the time-period and designing the surroundings accordingly to provide a similar immersive experience to the visitors. But in case of art, the focus is mainly on the content (such as object or painting) and the artist's intent instead of its surroundings.

8. **Smell:** Although the participants have not used smell in regular gallery setting. But it was mentioned by one of the participants that any particular smell can bring out/connect us with memories. Thus using different smells may help the visitors to connect with the exhibit based on their experience.

9. **Experience:** The aim of the curators are always to help the visitors have a meaningful experience. The experience can be pleasant or can make you uncomfortable. It can sometimes exceed expectations, raise curiosity, or tickle the sense of wonder in a visitor. The ways how visitors explore the gallery are different. Some visitors might just want to go around on their own, look around, look for pieces that attract them whereas some people will ask the guide to help them explore the exhibits, tell them everything about the pieces from the beginning. The participants want the visitors to walk away with a new question, or something meaningful to take back with them. One of the participants mentioned that people who are interested in art are also interested in stories. Hence, giving background information of a work can help the visitor to connect with it at a more engaging level.

10. **Content:** The most important factor of any exhibit is its content and what the artist is trying to express through their work. Sometimes it becomes difficult for visitors to understand the artist's intent and giving some background or historical information assists the visitors to understand the work. Knowing the stories or history behind the work can help the visitors to connect with them based on their own experiences.

11. **Visitor Type:** Different people are attracted to different types of displays and the way they approach are also different. Usually the guide/docent tries to understand the preference of the group of visitors and customize their tour accordingly.

12. **Balance between art and everyday objects:** The participants expressed that they want to bring art out of gallery spaces to the non-art spaces. Previously art was considered for the elite but with the change in perspective more and more public are getting interested in art. Helping people relate art with everyday objects or finding connections with them will bring in a more interested audience.

13. **Digital Wall:** Digital wall was a multimodal interface solution suggested by the interviewer to showcase the archived collections of the gallery.

14. **Children:** The way a tour is curated for a child is different from that for an adult. Usually the guides ask questions to understand how much the children know about the exhibits and start by sharing the stories with them. Including games and activities also keep them engaged. Also keeping small activities in the exhibit's brochures or separate kits will also attract families with young children to have a engaging time at the gallery.

15. **Sight:** Although the sight category could have been a part of accessibility, we have kept it separate as most arts are considered visual. The participants mentioned the use of fonts that are easy to read, Braille on introductory wall panels. They also mentioned a detailed descriptive tour around the gallery is also very effective in guiding visitors with low-vision.

16. **Accessibility:** One of the participants mentioned they go around the gallery in a wheelchair to understand how it feels and how the setup looks from a wheelchair and they adjusts the settings accordingly. Accessibility not only includes building ramps or building a gender neutral bathroom it also involves making additional efforts. One of the participants suggested that we can call different community members to let them know about an exhibition can also help in bringing visitors to the gallery.

17. **Customize experience/tour:** Exhibitions give the visitors the opportunity to explore and find out information on the display. They do not provide all the information at one go, rather they let the visitors engage and relate with the content based on their preference and experiences. The participants mentioned that the tour guides or docents customize their tour based on the target audience. In case of adults, they try to find out their interest and preferences to dynamically customize the tour. The tour guides are trained to understand visitors' preferences.

18. **Audio:** Sound tracks and audio guides help in creating a more immersive experience. Audio tracks can also help in providing verbal description of the exhibit in multiple languages, making it more inclusive and welcoming. One of the participants mentioned that nothing much has been done for the hearing impairments.

19. **Activities available:** AGNS Halifax has interactive painting sessions for Alzheimer's patients and their care givers.

   Tactile paintings or model of actual art/material used for the actual art has also been displayed for the visitor to touch and feel the texture, weight of the material. Visitors have also been engaged using games and quizzes.

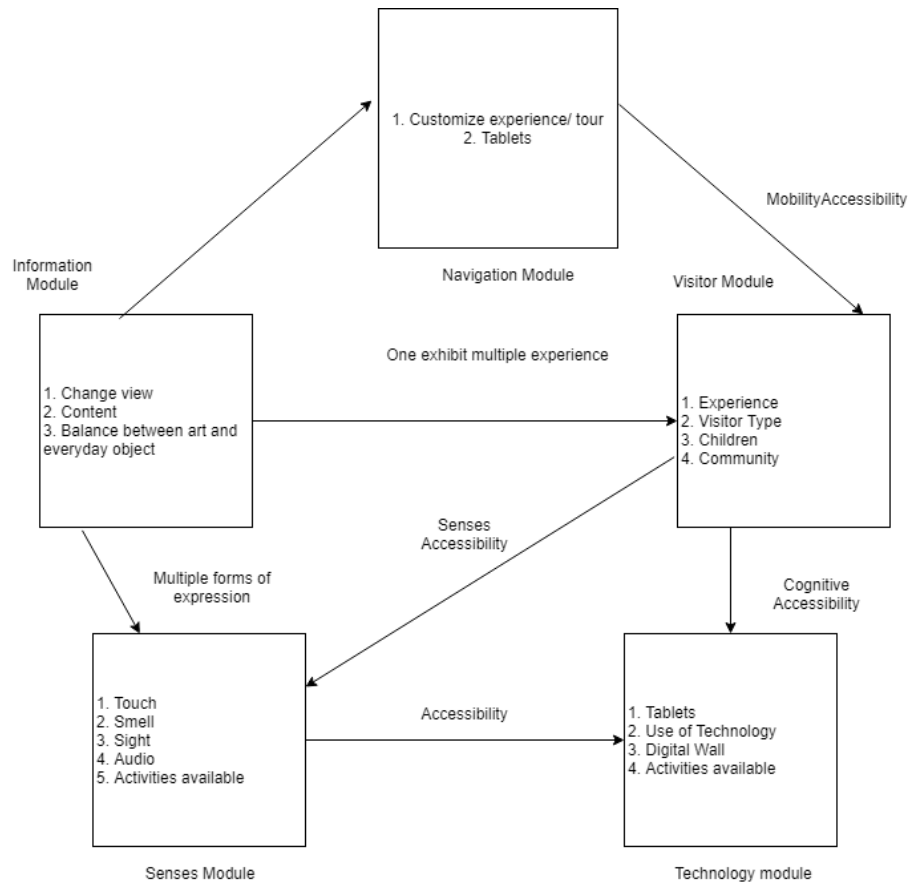The above categories were then grouped into modules based on similar themes as shown in Figure 5.2.

Figure 5.2: An overview to show the grouping of the categories and the relation between them. The figure was drawn in "draw.io". Each category was grouped based on similarities to form modules. The modules are Information, Navigation, Visitor, Senses and Technology. We have also used categories to establish the relationship between the modules. The navigation of a visitor towards an information (piece of art/object) are customizable as one exhibit can generate multiple experience for different visitors. Again navigation around the gallery involves mobility accessibility issues as well as visitor's engagement with information involves senses accessibility. Another module is technology module which involves assessing the cognitive accessibility as well as finding available and feasible resources.

Chapter 6

Framework

The proposed framework is made up of 5 modules:

1. Information Module

2. Visitor Module

3. Navigation Module

4. Accessibility Module

5. Technology Module

An overview of the framework is shown in the figure 6.1.
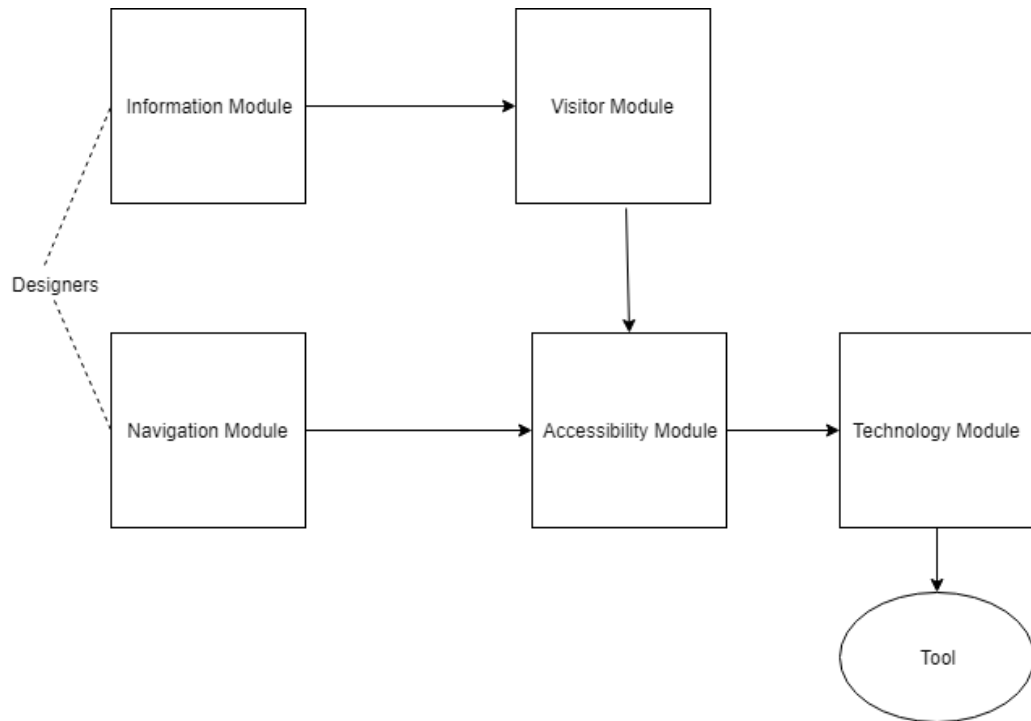
Figure 6.1: Overview of the proposed framework showing the different modules

6.1 Information and Visitor Module

6.1.1 Information Module

As we have seen in our literature review, a museum or an art gallery information can be classified into: Catalogue information and environmental information [59]. For example, information can be different paintings, sculpture etc or the environment or the setup of the exhibit as a whole to provide an immersive experience. During the data analysis phase, the participants mentioned that the gallery exhibits need fresh perspective and they should include more diverse types of exhibits including stories of Indigenous, African, African Nova Scotian and immigrants. The participants mentioned that sometimes knowing the stories or some background about the exhibit helps the visitor to connect with the exhibits emotionally. The participants also mentioned that they are trying to bring art out of gallery spaces. Artists and galleries are putting effort to showcase art in everyday objects.

From the background studies and data analysis, we could see that the information can be categorized to two categories.

One where the exhibits have a story-telling aspect and a structured guided tour of the exhibits is suggested for a better experience. For example, it may be a periodic exhibit where each painting, object or sculpture is arranged in a chronological order to show the evolution.

Another category where the route of tour does not impact the engagement and they visitor is advised to go around based on their preferences and choices. For example, sometimes an artist may paint a corner of the exhibit room a very bright colour to attract a visitor's attention.

For our framework, we have named the first category of visitor module as **Synchronous** and the second category as **Asynchronous** as shown in Figure 6.2.

6.1.2 Visitor Module

The participants mentioned how they work and try to connect with the people and the society. They mentioned how the take on different people on the same exhibit can be so radically different and the docents and the guides are trained to understand the visitor's preferences and customize the tour based on that. They also mentioned

that curating a tour for a child is different form that of an adult. The docents or the guides ask the children questions about the exhibit to know their understandings and try to communicate with the children through stories or games.

For our framework we referred to Falk's types of visitors for classifying different types of visitors for the visitor module (see §2.2.3).

6.1.3 Relationship between Information and Visitor Module

Each tour can be customized based on the visitor's preferences and interest. We have tried to establish a relation between different types of exhibits and types of visitors as shown in the Table 6.1. The suggested solutions for each types of exhibits has been taken from the data collected from the participants.
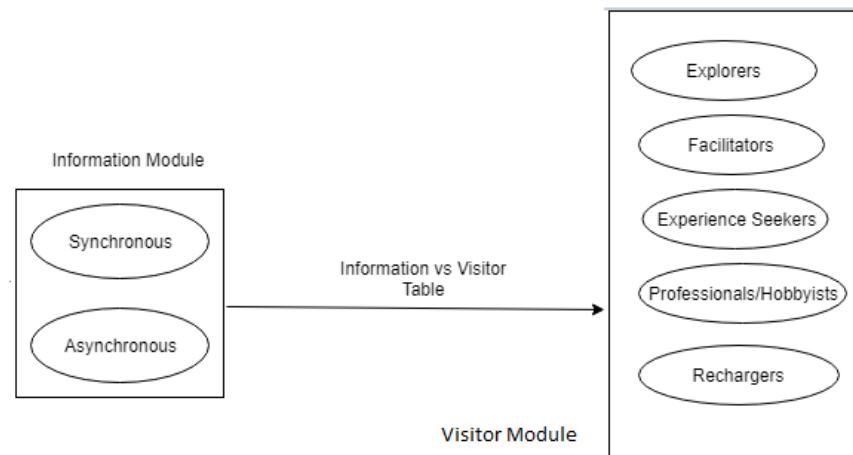
Figure 6.2: Part of the proposed framework which shows the Information and Visitor Module and the relationship between them. The figure was drawn in "draw.io"

Suggestion			
Falk's Types of Visitors		Types of Exhibits	
	Want/Need	Synchronous	Asynchronous
Explorers	These people are curiosity driven and they are looking for something new to learn. They are knowledge gatherers [20].	• A guided tour where the information is provided in the set sequence. • Touch pad, audio devices can be used to guide them around the gallery. Give out information at every point. • A tool that can act as a map to direct them around the exhibit.	• A guided tour around the gallery based on interest and preference. • Ask for feedback, and ask questions to customize the tour. • Painting a part of room in a single block of color can attract the visitors. • Find out what the visitor find attractive, impart the information accordingly.

Suggestion			
Falk's Types of Visitors		Types of Exhibits	
	Want/Need	Synchronous	Asynchronous
Facilitators	These visitors are socially motivated, and they are concerned about the overall social experience of the people accompanying them [20].	• Engage with games, quizzes, color, touch sample material. • A tool to guide a group or a crowd. Should be engaging for multiple users. • If multiple users are using virtual environment, they should be able to interact with other visitors present in the same virtual space.	• Engagement through games, quizzes, color, touch sample material. • Customized tour for each member. • The group can disperse and perform activity based on their interest.

		Suggestion	
Falk's Types of Visitors		Types of Exhibits	
	Want/Need	Synchronous	Asynchronous
		• More about engaging and imparting knowledge in the process of taking part in activities or games.	
Professional/ Hobbyists	The purpose of the visit of these visitors are content-related. The content of the exhibit is either related to their profession or their hobby [20].		• The visitor will develop a new perspective or concept, idea, or thought because of their visit to the gallery. • Understand their need. • Relation with everyday object. • Story-telling to help the visitor connect with the artifact.

Suggestion			
Falk's Types of Visitors		Types of Exhibits	
	Want/Need	Synchronous	Asynchronous
Experience Seeker	People who are serious and motivated to visit an art gallery. They consider gallery as an important destination [20].		• Diversity in types of works displayed in gallery space. • Fresh perspective. • Inclusion of people, artist from various backgrounds to be more welcoming and appealing. • People are interested in stories behind the artist's work.
Rechargers	People who are primarily looking forward to having a spiritual and restorative experience in an art gallery.		• Self-guided tour. • Virtual guide to have a lone experience. • Knowledge sharing in a passive way. • Soothing activities.

Table 6.1: Relation between different types of visitors and type of exhibits and how designing of tool differs.

6.2 Navigation Module:

We have seen in our literature review (see §2.4.1).The navigation module can be primarily divided into three parts as shown in Figure 6.3: **Physical Navigation, Spatial Navigation, and Social and Semantic Navigation**. The physical navi-
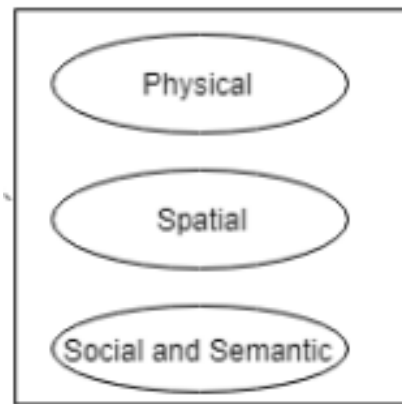
Figure 6.3: Part of the proposed framework which shows Navigation Module

gation of a visitor in a gallery involves the actual movement of the visitors inside the gallery. Accessibility issues regarding mobility has been discussed in the Table 6.2.

As discussed in the literature review, spatial navigation principles can be used to design virtual guidance system for galleries or museums. Participants mentioned that hand held devices such as tablets can be used to provide additional support during a tour. Virtual maps can be shown in tablets.

Social and Semantic Navigation principles as discussed in the literature review can assist visitors to choose their path of tour. As mentioned by the participants, they ask questions or try to understand the preferences and liking of visitors to customize their tours. Introducing tags (keywords to describe a piece of exhibit such as painting) can help the visitor to go through the available collection of artworks in the exhibit and explore them based on their interest. Introducing feedback feature also helps the visitor to connect with the exhibits as they can also introduce tags and descriptions about the exhibit which opens a platform for virtual communication with other visitors.

6.3 Accessibility Module:

Accessibility module as shown in Figure 6.4, comprises of the Senses Module (see §5.2). It also includes accessibility issues related to mobility and usage of technology (cognitive accessibility). It was one of our sub problems to try mitigating issues due to disabilities.
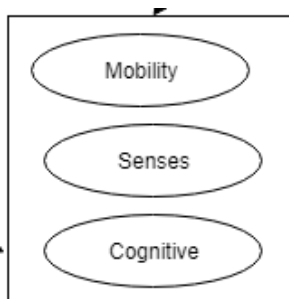

Figure 6.4: Part of the proposed framework which shows Accessibility Module

6.3.1 Mobility

Accessibility issues related to mobility has been discussed in the Table 6.2. The table 6.2 shows the issues as well as solutions related to actual physical navigation in a gallery or a museum.

Issues	Suggested Solutions
- People in wheelchairs. - Particularly short people, e.g. children - Height or level of the wall panel or the actual object.	- The information should be accessible to every level. While designing the exhibit, one should travel around in wheelchair to understand the view. - Use the suggested tool while handling a wheelchair.

Table 6.2: Accessibility: Mobility

6.3.2 Senses

In case of art galleries, sight and hearing are considered primary senses of interaction. We have tried to find out ways by which we can involve other senses to enrich the visitor's experience. Table 6.3 show different issues and their suggested solutions.

Table 6.3: Accessibility:Senses

Sight	One of the major sense organs used to appreciate art. Most of the exhibits are visual in nature.	Short-sighted, blind, color blind.	• More systematic and descriptive tour. • Touch tour, guided tour (specific objects or materials used for the art). • Braille • Fonts and color scheme that are easy to read.

Continues. . .

Sense	How it Helps	Issues	Suggested Solutions
Hearing	Some exhibits have audible components (e.g., soundtracks) for a more immersive experience. The audio portions are usually heard over headphones installed near the particular exhibit.	Short-hearing, deaf, do not the language of the audio.	- Sign language (e.g., ASL) during tours. - Introduction of more languages for the audio guides.
Touch	A touch tour can be more engaging as the visitors can feel the texture, weight, shape of the exhibit. Sometimes providing a touch tour to a short-sighted person can feel them to understand the exhibit more.	There are very few touch-oriented exhibits.	- Tours with more touch material. - Tactile sense. Replicas or actual exhibits can be touched by visitors. - Touching materials used for the actual art work.

Continues...

Sense	How it Helps	Issues	Suggested Solutions
Smell	Sometimes the smell of paint, or the smell of the materials used in the exhibit can help the visitor to connect. Smell can bring back memories.	Allergies. Have to cautious of the message the smell sends out. For example, not using the smell of tobacco for an exhibit as it might act as an encouragement to children. Too much smell and effects can turn the experience museum-y. Maintain a balance.	• The amount of smell diffused in the exhibit should be controlled. • Should be done in an closed area so that the visitors get a choice whether they want to experience or not.
Taste	Not much used in art galleries. But food can be used to create an experience.	• Might tamper with exhibit. • Messy.	Have to be very cautious so that do not interfere with the exhibit aesthetics.

6.3.3 Cognitive

While designing any tool, we should consider the following four points [11]:

- **Sharing common references:** Using common references can be of huge benefit to the accessibility community. So while designing the tool, symbols or words used should be similar to real world, which eventually help in better understanding of the tool.

- **Investigating the use of adaptive content:** The tool should have a steady learning curve which will give the users opportunity to adapt to the system. It should also try to evaluate the visitor's attention level on a particular exhibit or their browsing technique to customize the tour.

- **Reinforcing engagement and self-determination:** Introducing different activities, puzzles can help in reinforcing engagement. Again showing how much tour they have covered, what they have learned can really encourage visitors to explore and gather more knowledge.

- **Learner's production of contents:** Providing their feedback and sharing their views with others on a digital platform can make visitors feel included in the community.

6.4   Technology Module

Designing of this part of the application involves heuristic evaluation as well as following other software requirements. Due to limited time, this module was not within the scope of our research and will be add as a future work.

6.5   Framework

The above mentioned modules were finally joined in a systematic way to build the design framework as shown in Figure 6.5.
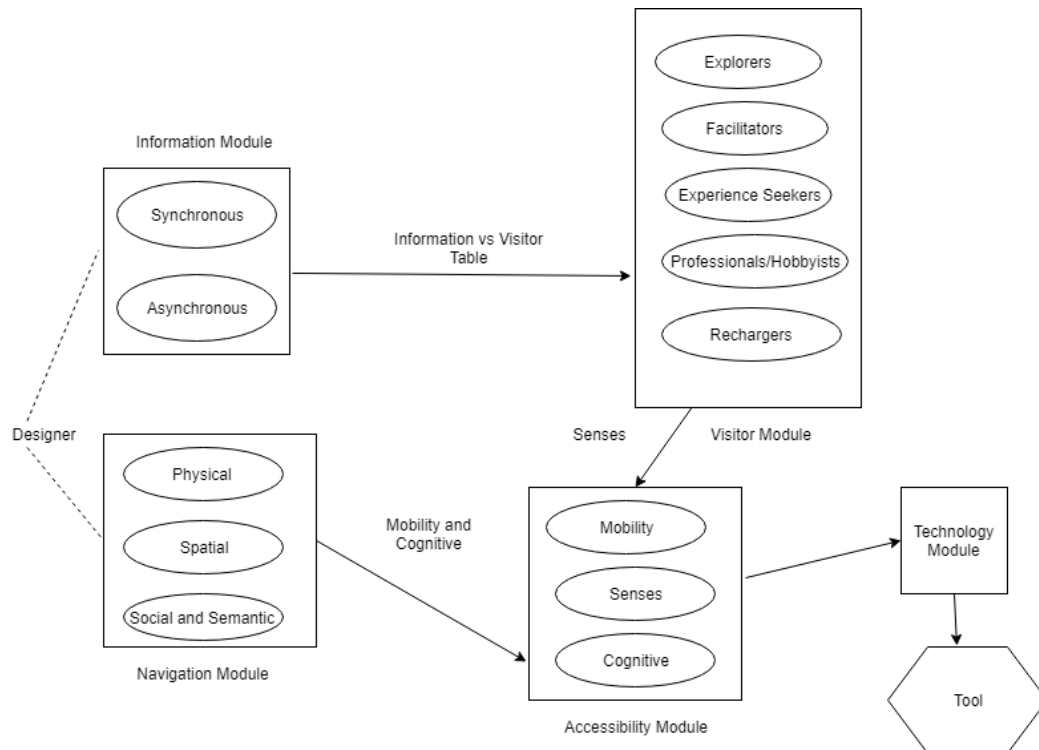
Figure 6.5: Overview of the framework which will assist in designing future interactive tools for art galleries. The figure was drawn in "draw.io"

Chapter 7

Maud Lewis

We taken the Maud Lewis exhibit at the AGNS, Halifax as a test case to assess the framework we propose. Her inspirational story, finding happiness in her paintings, simplicity and bringing out the real Nova Scotia via her works has motivated us to use her exhibit as an example. Another important driving factor was that her actual house is kept inside the exhibition room which is unique in more than one way.

7.1 Story

Figure 7.1: Maud Lewis. [47] Copyright of (c) Bob Brooks

Maud Lewis, in Figure 7.1, was a Nova Scotia folk artist born in the town of Yarmouth on March 7, 1903. As a child, she used to spend most of time the alone, as she was uncomfortable about her differences around other children. Her mother

started her painting Christmas cards and this is how she started her life as an artist. She lived with her husband Everett Lewis in a small house in Marshalltown, Nova Scotia [47]. Figure 7.2 is one of the designs drawn by Lewis.

Figure 7.2: A painting by Maud Lewis [51]

Maud married Everett Lewis and lived in their small house in Marshalltown. She had rheumatoid arthritis which made her unable to do household works and she earned by paintings. As her arthritis worsened, its effects were reflected in her work.

Although the house[47], as shown in Figure 7.3 was a very small house it showed how happy she left through her paintings. The house itself is an exhibition of Lewis's painting. After their death, the house started to deteriorate, so a group of concerned people started the *Maud Lewis Painted House Society* to save this valued landmark. After a number of years of fundraising, the Society realized that the upkeep of the house required many resources. In 1984, the house was sold to the Province of Nova Scotia and care was taken by Art Gallery of Nova Scotia. At present, fully restored house is on permanent display in Halifax at the Art Gallery of Nova Scotia.

Figure 7.3: Maud Lewis' house inside the Art Gallery of Nova Scotia, Halifax [47]

7.2 Layout

The entrance of the Maud Lewis exhibit is through a corridor where there is a small picture as shown in Figure 7.4, and an arrow to direct towards the main room.

The main exhibit room can be divided into 4 sections:

- **Art Section:** The right hand side of the room is mainly the art section as shown in the Figure 7.5. Different framed paintings by Maud Lewis with their little description are arranged around the walls.

- **House:** The house is the most unique attraction of her exhibit as it is very uncommon to see a house inside a room. By looking at the house, as shown in Figure 7.3, one can understand how small her house has been and how beautifully she had decorated every single part of her house.

Figure 7.4: A part of the wall of the corridor to enter the Maud Lewis exhibit at the Art Gallery of Nova Scotia, Halifax

- **Video Corner:** On entering the room the first left corner has a television screen displaying a documentary on Maud Lewis. A small seat is kept in front of the TV as shown in Figure 7.6

- **Book Corner:** After the house, the last left corner as shown in Figure 7.7 is the book corner. It has several brochures and books related to her life and work. Apart from this, the walls have detailed descriptive text as well as one of the walls have a chronology of her life.

Figure 7.5: The figure shows a section of the room where Maud Lewis painting are hung on the walls.

7.3 Available Options

- **Paintings:** Her paintings are hung all around the walls of the room with different sized descriptive wall panels.

- **House:** Because of the house's structure and age, visitors are not allowed to

Figure 7.6: The figure shows a section of the room where a video is playing on a TV.

enter the house, they can touch and peak through the windows to look at different angles of the house. The touch tour enables users with low-vision to

Figure 7.7: The figure shows a section of the room where several books and brochures are on display.

get a more realistic engagement with the house and its becomes clearer how small the house is.

- **Guided Tour:** The gallery has a guided tour daily around the gallery including the Maud Lewis exhibit at a fixed time. They share stories from her life, struggles, and her work.

- **Video:** A documentary video on her life plays in one corner of the room. The video is about 10 minutes long and plays in English and French alternatively.

- **Book Corner:** There are several books and brochures in that corners for more enthusiastic visitors to learn from. The books contain stories of her life, her paintings, and the restoration of the house.

- **Activity Book:** The visitors are given an activity book as shown in Figure 7.8. The book contains facts and small stories about her and her house. It also as fun games such as find different paintings based on clue, explore the house, find the trap door or an experiment space to explore their ideas of painting and also how they get inspired by her art.
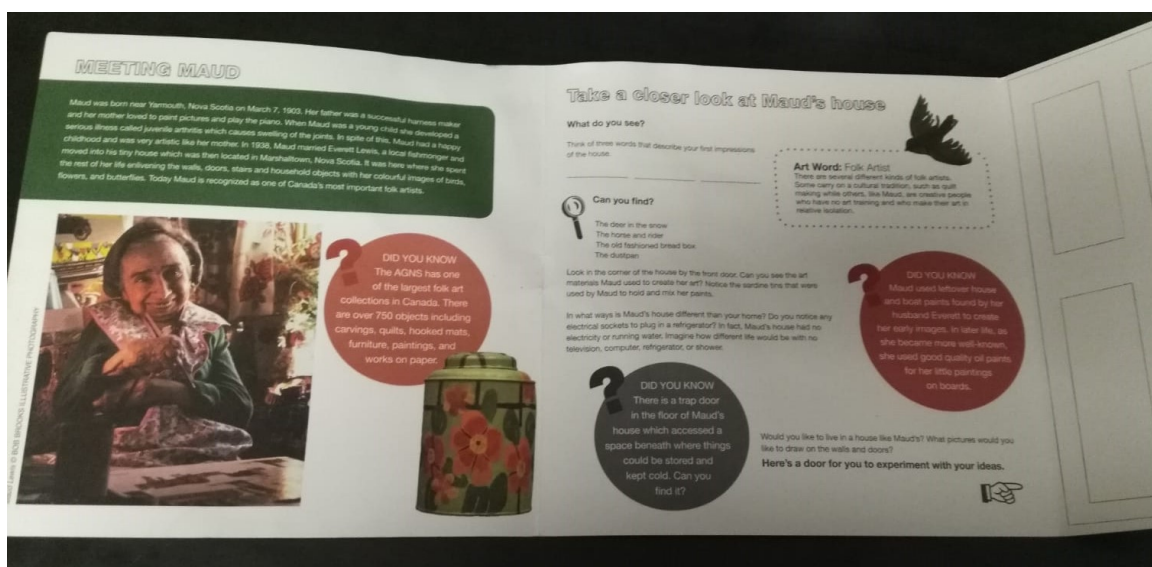
Figure 7.8: The figure shows the activity book given to the visitors.

7.4 Feedback

We have asked the curators specific questions related to the Maud Lewis exhibit at the AGNS, Halifax. The data collected from the interviews have been categorized into 8 groups:

1. **Visitors:** Visitors of the Maud Lewis exhibit can be classified into local Nova Scotian people, tourists, art enthusiasts, people who have watched the movie (*Maudie* released in 2016 and directed by Aisling Walsh [28]). Although the categories are often overlapping, there are different motivations behind the visit.

   If a person is from Nova Scotia, they hear about her in their school and grow up learning about her which often leads to a saturation in interest. This interest can again be rekindled if they become artist or interested in artist in the later part of their life.

   Again, the Maud Lewis Exhibit is one of the biggest draw of the gallery. Every year a lot of tourists visit the gallery. It might happen they have watched the movie and come, or they learn about her first time, or they consider art galleries as tourist spots.

   For a knowledgeable visitor, it shows that the exhibit has been there for a long period of time and measures should be taken to improve on the communication and engagement. The exhibition might have seen ups and down in its popularity but at present it has a sharp incline in popularity. A part of the exhibit is also be showcased in China in future.

2. **House:**

   - Many visitors would like to go inside the house and explore.Although, by seeing the house one can understand how small the house is, going inside it and actually understanding her way of life will make the understanding more vivid and lively.

   - A 360° virtual view of the house is being developed.

   - The participants mentioned how the lighting of the house was very low and had a murky environment.

- A Google Map view of the actual location of the house should also be introduced.

3. **Story:** The participants mentioned to show a realistic view of Lewis's life. She spent all her life in poverty and earned her living by painting. She never survived to see her popularity and how the values of her paintings increased over the years. The approach should be to showcase the positivity or the happiness she got from her painting despite of harsh living conditions and her worsening health. Her story is an inspiration to the society and she shows how we can find art in everyday object. She used old sardine cans as her brush holders painting the windows, stove and different parts of the house. This separates her from the traditional artist and help common people to relate to her and her work.

4. **Balance story with Art:** The Maud Lewis exhibit is more of a museum experience as one can look through the windows and actually see her studio (the house), how she painted, used brushes and colors. So caution should be taken to maintain the balance and not to get hung up on her stories. Stories should be told through her art work and how her work showed real Nova Scotia, how it changed over the years because of her health, how her paintings showed her likes and dislikes and her life.

5. **Art:** She showed real Nova Scotia through her paintings. Her paintings and their labels should be hung at an optimal height to be accessible to everyone. Visitors should have more hands-on experience and engage with similar art materials or supplies.

6. **Visual:** Work should be hung at an optimal height so that the labels and art are visually soothing. Labels at appropriate height.

7. **Available Option:**

   - Book and Video Corner
   - Have a space to appreciate art.
   - Allowed to touch the exterior of the house.
   - Video placement should be at a better location to pull more audience.

8. **Suggested Options:**

- Audio such as sounds of the highway, cars, ocean, and wind.

- Smell of salted cod, paint.

- Build a platform for communication in which her example can be used. People can share, talk and heal.

- A tablet to see more art, her pictures and her life.

7.5 Suggestion

If we feed the data collected from the interview into the framework (see Fig. 6.5 on p. 60) we came up with three suggestions to enhance the focuses, provide a more engaging and a more immersive experience for visitors as shown in Figure 7.5.
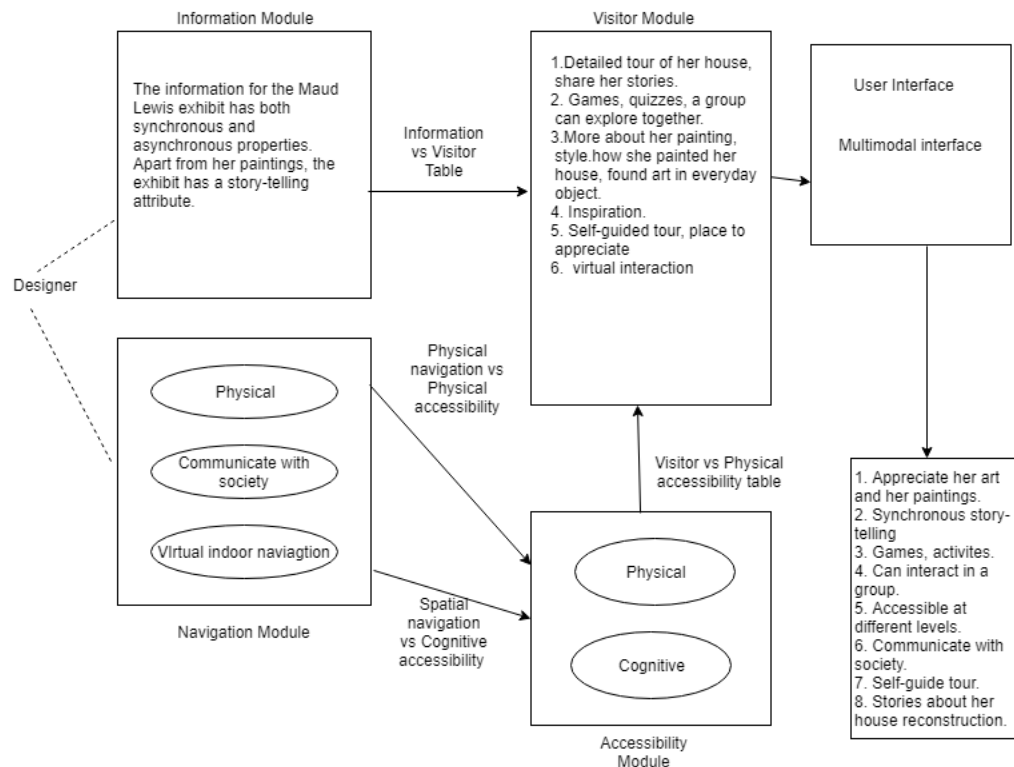
Figure 7.9: Framework showing the requirements for tools for the Maud Lewis exhibit.

A detailed description is as follows:

Information Module: The exhibit has both synchronous and asynchronous properties The participants mentioned that visitors are both interested in her story as well as her paintings. They mentioned that any proposed tool will be able to showcase the positivity or the happiness she spread through her paintings.

Another important story element is the restoration of the house. The participants mentioned that many visitors would like to go inside the house and explore the house. They also mentioned that a lot of visitors are interested in learning about the restoration story of the house. The participants mentioned that balance should be maintained so that the proposed tool does not lose focus from her art work.

Visitor Module: The types of visitors include returning visitors who are familiar with the exhibit such as people from Nova Scotia, children on a class visit, visitors who are visiting the city, art enthusiasts and people who have watched the movie and want to know more about life. These types of visitors can be fit into the Falk's types of visitors. Explorers- Art enthusiast, movie crowd; Facilitators - family visit, tourist in a group, class trip; Professional/Hobbyist - artist, art enthusiasts; Experience Seeker- art enthusiasts; Rechargers - returning visitors. These categories are not fixed and may be overlapping.

Again, as school children as well as families with children visit the exhibit games and activites should be considered while designing a tour.

Navigation Module: Navigation includes the actual movement of a visitor around the exhibit and also virtual navigation of a guidance tool.

Accessibility Module: Accessibility issues include mobility of a visitor around the gallery. Since the Maud Lewis is visual art, addressing accessibility issues related to sight is important. Audio tour, Braille introductory panels for paintings should be introduced.

Technology Module: Any tool that is introduced should not overpower the essence of the exhibit. There should be space for appreciating art. The suggested tool should be easy to use for both children and adult.

The requirement for the tools include: Space for appreciating her art and her paintings, Synchronous story-telling, Games, activities, can interact in a group, accessible at different levels, communicate with society, self-guide tour, and stories about her house reconstruction.

7.5.1   Digital Wall

- **Requirements:**   The tool should be able to provide a self-guided as well as group tour. A multi-modal digital wall can facilitate the requirements. The tool should have a story-telling attribute.

- **Solutions:**   One of the walls at the book corner as shown in Figure 7.10 has a list of the years of significant events in her life. The year are marked with a little description of the event. The book corner has several books with detailed information about her life, her art, and her house. We can use those information from the books and the wall to make an interactive wall.

  For the execution of this feature, i-Wall system [24] can used as an reference. i-Wall is an adaptable, customizable and cost-effective system built with wooden surface, conductive paint, commodity sensors, microcontrollers and video projection.

  The proposed system is adapted from i-Wall system[24] can divided into three main components as shown in Figure 7.5.1

  - **Touch Sensor:**   The touch interaction for i-Wall was implemented with TouchBoard technology, by Bare Conductive which is compatible with the Arduino Genuino software. This board has sensors that can be connected by painting with conductive paint. The years written on the wall can be replicated onto a plywood surface and be the user 'touch point's. We can also introduce Braille touch points for short-sighted visitors. Each of these touch points can be linked through the plywood via metallic nails to short wires onto the TouchBoard.

  - **Projection Mapping:**   When a user touches one of the touch points, a trigger is sent to the TouchBoard and a mapping to the necessary action

Figure 7.10: Section of the wall where important events of Maud Lewis' life are displayed in a chronological order.

can be done using the MadMapper software. Since we do not want to make the experience too museum-y and overwhelming, we will suggest projecting descriptive details and short stories. In case of short-sighted visitors, we can play audio clips over a headphone for them.

– **Animation Design:** Since our proposed system will have only texts. This component of the system will deal with the mapping of texts (curated by the gallery) and different user points. The trigger sensor of the user points will transfer the command to the laptop which eventually project the mapped text on the wall via the projector.
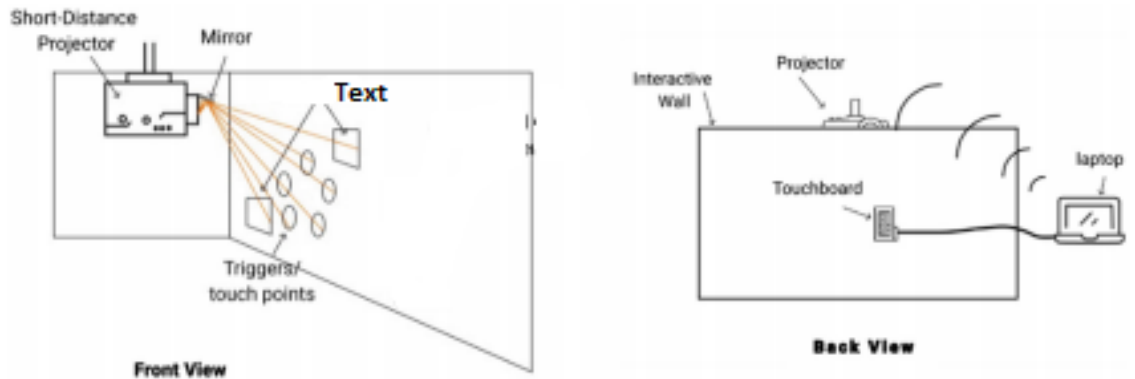
Figure 7.11: The interactive wall setup. On the left: the front of the i-Wall consists of:
(a) The plywood surface, (b) Touchpoints drawn with conductive ink, (c) A projector, (d) Projects descriptive texts near the triggered use points.
On the right: a touchboard (connected to a laptop) is mounted on the back of the i-Wall.
The setup is adapted from Ref. [24].

- **Accessibility issues:**

  - The proposed user points are paintings. So we have suggested using Braille touch points as well.

  - The suggested tool will have textual display. But we can also have audio descriptions for visitors with low vision.

7.5.2 Virtual LEGO Game:

- **Requirements:**

  - Visitors are often fascinated by the notion of a house inside a room and some of them are curious about how the house has been put together inside the room. This curiosity has led us to our next suggestion which will give the visitors control of the amount of information they receive about the house in a fun and interactive way.

  - Games, quizzes, activities.

- **Proposal:** From the data analysis, we have found out one of the main attractions of the exhibit is the house.

LEGO is a popular toy and introducing a Virtual Realtiy (VR) application which will give the visitors an opportunity to experience the building of the house as well as knowing more about the reconstruction using hand gestures.

For our suggestion, we are referencing to the VR application presented by Tran et al. [61]. Since the type of visitors is diverse and includes children, the suggested gestures should be easy to remember and perform. The gestures as shown in the Figure 7.12 are not only simple but also related to LEGO [61]. The structure that the visitors have to build will Maud Lewis's house and each step will have instructions on what part to build. After completion of each step, the system will share some stories of reconstruction. In this way the visitor will have a more immersive experience as they get to virtually experience the story of the reconstruction of the house.

A visitor will perform three main actions:

- assemble or disassemble the LEGO bricks.

- change the properties of the bricks such as rotation, switching to another brick.

- control the game's view by camera.

The hand gesture and position tracking can be implemented using the method presented by Bassily et al. [3]. The presented system uses Leap Motion controller to monitor user's hands, fingers and their positions and angles.

The proposed virtual LEGO game has been suggested by following the four different phases of Bilda's model of engagement [17] as shown in Figure 7.13.

- **Accessibility issues:**

  - Visitor usually feel uncomfortable in trying some new tool in galleries. So, we have suggested a LEGO game as they can find a common reference.

  - We have suggested using simple hand gestures so that any visitor can easily play the game.

  - A small step by step tutorial will be given to the visitors to facilitate the learning.
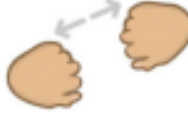
Hand	Gesture	Icon	Effect
Right hand	Point and move		Move brick
Right hand	Point and hold		Place brick
Right hand	Circle movement		Rotate brick
Right hand	Swipe		Switch menu item
Right hand	Push		Select menu item
Right hand	Fist		Open/close menu
Left hand	Fist and move		Rotate camera
Left hand and right hand	Fist and move		Zoom

Figure 7.12: Hand Gestures used for the VR Application [61]

7.5.3 Visual Marker

Maud Lewis is an inspiration to all as how she found her happiness in her paintings even in harsh conditions. Her paintings shows her journey as an artist and also how
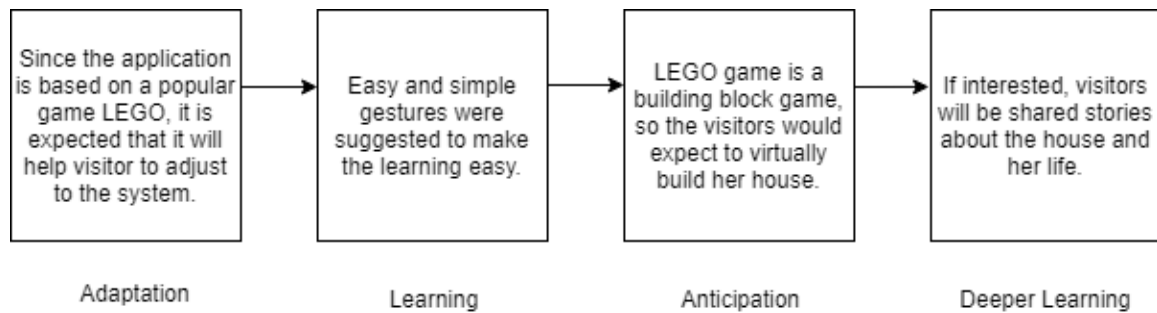
Figure 7.13: How the Bilda's model of engagement should be followed while designing the virtual LEGO game [17]

she overcame her disabilities to find art in everyday object. Her paintings are stories of how she saw the real Nova Scotia. Her stories can be used as a platform for communication.

- **Requirement:** Most of the participants mentioned that they want to connect with the society, bring more diverse crowd to the galleries, work with the society. They want people to have a meaningful experience at the gallery and connect at an emotional level.

- **Proposal:** The AGNS site in Halifax has community programs such as Autism Art [50] for children and youth ages six through early adulthood. These art sessions can help the individuals as well as their caregivers to connect over the art. Autism Art has an annual exhibition of the professional framed and installed artworks created by participants in the Autism Arts classes throughout the year. Hence this exhibit is not accessible throughout the year. Instead these paintings can then be scanned and made into visual markers. Each marker can be associated with a small audio clip describing the participants thought behind the painting or about anything they want.

These markers can be hung in a wall at the exhibit. When a visitor comes, they can scan the marker to listen to the stories. This wall will help other people on similar spectrum as well as their caregivers from different places to connect and build a sense of community. Apart from that, other people can also learn and get inspired from their stories.

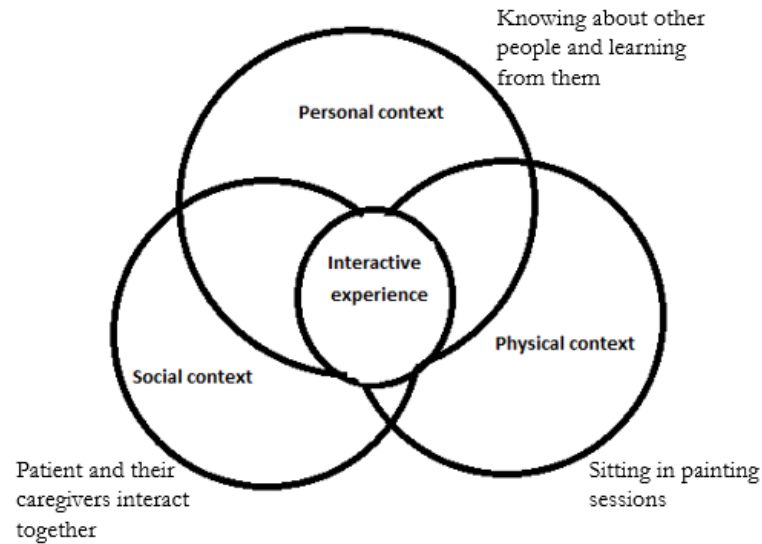The proposed visual marker can fit into the CML [58] as shown in Figure 7.14.

Figure 7.14: Context Model of Learning for Visual Marker

The motivational stories of others can help people connect with the exhibit at an emotional level and making connections with their lived experiences. The stories again builds a platform for communication between the individual and their care giver or a group of individuals to come up, learn and share their stories. The art sessions are conducted by experienced artist/art educators and they are assisted by occupational/recreational or behavioural therapist, this creates a safe environment where the individual feels comfortable to interact with the art as well as other people [50].

- **Accessibility issues:**

  - Visitors may not have a PDA to scan the visual markers. So, the galleries can lend a PDA to them for the tour.

Chapter 8

Conclusion

8.1 Limitations

We were not able to conduct interviews of a large sample population. In future, interviews can be conducted of patrons, guides/docents or other individuals who are involved in the workings of galleries or museums. We have conducted semi-structured interviews with the curators of different galleries. We could have also conducted contextual inquiry or participatory design methods[1] to collect data. It would have helped us to understand the design ideas the curators may have. Since we have interviewed only curators, the type of information collected was very restricted. Expanding the interviewee population to patrons, artists and other stakeholders of a gallery or museum can help to gathering different perspectives of designing of an exhibit.

8.2 Discussion

The aim of the thesis was to assist future designers in designing an interactive tool for art galleries. The goal of the tool should be assisting visitors to interact with the artist's work. A balance should be maintained so that the focus does not move from the actual intent.

We have suggested a framework instead of a specific tool as every exhibit is unique in its own way and every artist has different vision and motivation for their work. So a tool should be designed to meet those demands. Another important aspect of an art gallery is that all its exhibits are not permanent. Although a gallery may have a few permanent exhibits, most of the shows or displays are temporary and they are changed from time to time. Hence, any tools that are suggested should not have an elaborate setup as well as should be cost-efficient. The tool setup should not require

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[1] I thank Dr. Reilly for helping me understand this.

much time as well as it should not take much effort to pull it down.

An important distinction between art gallery and museum was observed during the data collection phase. The focus of an art gallery is the art and what the artist's work has to communicate. But in case of museum, it is not only about the objects on display but also about the overall experience. So while designing of tools for art galleries, designers should keep this factor in mind else it can lose focus from the actual art.

The framework in the Figure 6.5 addresses the research problem. The first sub-problem to assess and mitigate accessibility issues has been addressed in the Accessibility module of the framework. The second sub-problem to find out influencing factors to customize the framework has also been addressed in the Figure 6.5. The different modules shown in the figures are customized based on the requirements which eventually leads to any interactive tool(s).

For our test case, Maud Lewis exhibit, we have proposed a multi-user digital wall, an AR Lego game as well as a visual maker. An AR application was suggested for the Maud Lewis exhibit as the exhibit is both a museum and a gallery experience. It is very rare that one can actual see the artist's studio in this case her house, the paints that she used to draw, the light setting along side her works. Providing a immersive experience with sounds of cars, highway, ships or the smell of dried cod in a dimmed environment will let the visitors get a glimpse of her life and under what conditions she painted.

8.3 Future Work

Since collections and exhibitions differ between galleries, gathering information from different galleries can reveal important opportunities and understandings. So, we suggest including more galleries or museums in the study. It also involves interviewing people from gallerias outside of Nova Scotia. The interviews can be conducted over telephone. Other than semi-structured interviews, contextual inquiry and participatory design methods can also be used to get a pictorial and descriptive representation of the suggested digital aid.

A further step could be to conduct a systematic analysis of the features of available applications such as the one for the Canadian Museum of Human Rights. I single out

that application because it is so highly regarded. This analysis will help us to get an understanding of the usability of the available technological options.

Following this, implementation of prototype of suggested solutions should be done at a gallery or a gallery setting. Once a prototype is built, it can be tested at the gallery to gather user feedback. Users can be asked to fill out a simple questionnaire or be asked to take part in an interview. Feedback gathered from the testing can be used to build the actual tool and can be set up at the Maud Lewis Exhibit.

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Appendix A

Ethics

A.1 Recruitment Document

E-mail Invitation

Subject: Invitation to participate in a research project on Increasing Engagement of Visitors in Art Galleries.

Dear <Name>,

I am, Oyshee Saha Roy, a Master's student in the Faculty of Computer Science at Dalhousie University working on a research project under the supervision of Dr. Jamie Blustein. I would like to invite you to participate in a study to increase engagement of visitors in art galleries. We are using Maud Lewis's house (present at Art Gallery of Nova Scotia, Halifax, Canada) as an example for our study. The study will be a 25–40-minutes interview conducted in your office or any mutually convenient location. The aim of the study will be to get the answers of questions such as how an art curator would like the visitors to interpret a piece of exhibit, what type of visitors they want and have an in-depth discussion on the said example.

The conversation of the interview will be audio-recorded with your consent. Any written notes or audio- recordings taken during the interview will be kept in a locked box inside a locked safe at Dalhousie University. All the responses will be stored anonymously. You will have the right to end your interview at any time. If you chose to withdraw from the study, we will not use the information obtained from you anymore.

The information obtained from the interview will be only accessed by the researcher and the research supervisor. You can choose to withdraw your information from the study within two weeks of your interview. As, a token of appreciation, I will be providing you with refreshments during the interview. The ethics approval has been obtained from Dalhousie University Research Ethics Board.

If you would like to participate in the study or have any concerns, please contact me at oyshee@dal.ca or +1902-*XXX-XXXX*.

Regards,

Oyshee Saha Roy

A.2 Evidence of Approval by Research Ethics Board

Oyshee Saha Roy
Computer Science\Computer Science

Dear Oyshee,

REB #:   2019-4701
Project Title: To increase engagement of visitors in art galleries.

Effective Date: February 28, 2019
Expiry Date: February 28, 2020

The Social Sciences & Humanities Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans*. This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Sincerely,

Dr. Karen Beazley, Chair

Figure A.1: Ethics Approval

Social Sciences & Humanities Research Ethics Board
Amendment Approval

March 26, 2019

Oyshee Saha Roy
Computer Science\Computer Science

Dear Oyshee,

REB #:   2019-4701
Project Title: To increase engagement of visitors in art galleries.

The Social Sciences & Humanities Research Ethics Board has reviewed your amendment request and has approved this amendment request effective today, March 26, 2019.

Sincerely,

Dr. Karen Beazley, Chair

Figure A.2: Ethics Amendment Approval

Appendix B

Research Instruments

1. What is your aim as a curator?

   - Increasing the number of visitors.
   - Increasing the diversity of visitors.
   - Increasing the quality of engagement of the visitors [12].

2. Does your aim/goals changed with the exhibits?

3. Do you want the visitors to give an overall view of the exhibit or just let me them explore the pieces they want to learn about? [A general description of the exhibit/piece of art will be given to the visitor. A visitor will be able to get a more detailed description upon showing interest.]

4. What other sense organs do you keep in mind while designing an exhibit(apart from eyes and ears)?

5. How do you try handling different accessibility issues?

6. What kind of interactive tools are used in their galleries' exhibits? What are the factors that influences their choice of interactive tool?

7. Have you seen the Maud Lewis exhibit at the AGNS? What do you think about it?

8. What (interactive) tools are used at present for the Maud Lewis exhibit?

9. Are the tools effective, i.e. are you satisfied with the results you get with them?

10. What new features or functionality would you like in a new tool?

11. Would those features or functionality be for the same purpose you use the current tools for?

Appendix C

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Submission ID:human08
Author/Presenter(s): Oyshee Saha Roy (Dalhousie Univ.; James Blustein (Dalhousie Univ.)
Type of material: Full Paper

Publication and/or Conference Name: HUMAN'19: 2nd International Workshop on Human Factors in Hypertext
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