Chapter 8

Wise Stones: An Interactive Accessible Circuit Designed to Enhance the Experiences of Visitors with Disabilities

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Overview

Museums, now more than ever before, are committed to the inclusion of all members of society, aiming to promote similar visitor experiences for their various patrons. With the challenging mission of exhibiting and communicating humanity's common heritage, while also preserving it, the creation of an inclusive museum experience is a complex task with multiple dimensions.

This article aims to contribute to the field of accessibility in museums by discussing the three main stages of designing the *Wise Stones Accessible Circuit*, a five-year project which aimed to enhance access at the MM Gerdau Museum in Brazil by creating an interactive tactile exhibit displaying original artifacts from the museum's collection.

A participatory methodology was adopted throughout the project in which 37 professionals from multidisciplinary fields at various institutions, and 151 visitors, who performed a formal evaluation of the digital interactives, were involved. Conclusions and implications of designing accessible digital interactives, with feedback from as wide range a of visitors as possible, are presented. Although the project's main goal was to enhance the museum experience for persons with disabilities, it ended up benefitting all visitors.

Introduction

According to the International Council of Museums (ICOM), museums' social functions are at the very core of their existence — being nonprofit institutions at the service of society, and committed to social development (Desvallées & Mairesse, 2010).

In that sense, it becomes critical to have issues related to social inclusion and accessibility treated as priorities, not only because there are more than one billion people living with disabilities worldwide, but also because everyone may experience temporary impairments or age-related sensory, physical or

cognitive changes in the course of their life (World Health Organization & World Bank, 2011).

In Brazil, where this project was developed, the last census (IBGE, 2012), estimated that about 45.6 million citizens self-reported at least one of the surveyed disabilities: vision, hearing, physical, mental and cognitive. This number represents almost 23.9% of the country's population.

Assistive technologies are highlighted by Freeman et al. (2016) as having the potential to increase access and enable more inclusive opportunities and experiences for disabled patrons at museums. They are one aspect of inclusive experiences and can help museums serve a wider audience while diminishing some barriers to full access (Pillow, Banks, & Reeves, 2015; Vaz, Fernandes, & Veiga, 2018a). In addition, Andrade et al. (2016) argue that the implementation of inclusive technologies in museum exhibitions foster positive economic impacts.

The *Wise Stones Accessible Circuit* project was designed to enhance access for all visitors — disabled and non-disabled — of the MM Gerdau Mines and Metal Museum in Belo Horizonte using interactive tactile presentations of original artifacts from the museum's main collection. The exhibit uses a visitor's tactile interaction as the trigger for the presentation of multimedia content, which includes different sensory perceptual strategies such as audio descriptions, enlarged images, sign language, and text labels/descriptions.

This project was based, from the beginning, on the social model of disability, which argues that people are not disabled by their conditions but rather by the external barriers they face, many of which are created by the environment (Disabled World, 2017; Oliver & Barnes, 2010). The goal was to make visits — spontaneous and planned — to the museum accessible for as many patrons as possible. Special attention was paid to the experiences of visitors with visual impairments, considering the industry consensus that museum exhibitions remain primarily visual and therefore contribute to marginalizing this group of visitors (Cachia, 2013; Candlin, 2003; Classen, 2007; Ginley, 2013; Hayhoe, 2017; Johnson, 2018; Morgan, 2012).

This five-year project began in 2014 with an international research agreement involving the MM Gerdau, the Federal University of Minas Gerais (LavMUSEU/UFMG, Brazil), the Polytechnic Institute of Bragança (Portugal) and the University of Aveiro (Portugal), and received an award from the Ibermuseums Program in 2016. The practices of design for all (Abascal et al., 2011; Andrade et al., 2016; Smithsonian Institution, n.d.; Wyman, Timpson, Gillam, & Bahram, 2016) and participatory design methodologies (Preece, Rogers, & Sharp, 2002; Sanders, 2002; van Dijk et al., 2016), were employed through the course of the project.

In this chapter, we will present the three main stages of the project, focusing on the process of designing the interactive exhibitions; discuss the implementation of the *Wise Stones Accessible Circuit;* describe the technological approaches followed; and share some results obtained during the evaluations at each stage. The three main stages are as follows:

1. From the foundations of the project to high-fidelity prototype implementation;
2. The first iteration of the participatory design methodology, with a discussion of the re-design of a pilot exhibit;
3. The presentation of the *Wise Stones Accessible Circuit,* which comprises three new modes of access — accessibility for visitors who are visually impaired, hard of hearing and/or use wheelchairs. It also includes a website with detailed information for visitors and museum professionals.

This is followed by a discussion of the project's repercussions and the changes it has introduced to museum policy concerning inclusion for all, and the chapter ends with recommendations for the museum community and other researchers who also aim to create accessible museum experiences.

The *Wise Stones Accessible Circuit* Project

From Scratch to a High-Fidelity Prototype

The first stage of the project consisted of brainstorming sessions with museum's exhibit design, technology and education teams, as well as the administration. From those sessions, we gained in-depth knowledge about the whole collection, the multiple permanent exhibitions, and the museum's previous experience with visitors with disabilities.

Given the pervasive use of digital media in almost every exhibition, a total of 44 digital interactives in the museum were evaluated. They were classified by those that were accessible for people with visual impairments; those accessible for people who are hard of hearing; and those that were completely inaccessible.

It was noted that most pieces in the collection — even those that did not have any restrictions based on preventive conservation — were off-limits to visitor interaction. To create a high-fidelity prototype with tactile samples that would function as interaction triggers, four geological samples from the museum's collection — petrified wood, aquamarine, muscovite and flint — were made available. The intention was that the direct handling of the samples would trigger the interactive experience so that visitors could physically sense the objects while receiving information about them.

An interaction design study followed, in collaboration with various professionals in geosciences, education, and communication design, as well as some museum visitors, which facilitated the creation of a usable interaction model that would be implemented. Usability principles and human-computer interaction guidelines from Dix, Finlay, Abowd and Beale (2004), Norman (2002), and Preece et al. (2002) were employed in this process.

The implemented interaction model defined that:

- The act of picking up a sample identifies an interest in finding out more about it, while putting it back down signifies a loss of interest or lack of intention to continue accessing associated content. The adoption of this interaction language was expected to provide an instinctive mapping, where each action was associated with a specific event.

- Visitors have the opportunity to access information about one of the four samples at a time, and to find out the differences between any two of the samples, simultaneously. Whenever two geological elements are handled at the same time, contents related to both are presented, focusing on a comparison between their scientific, historical, and everyday applications.

- The samples can be handled freely, even though concerns regarding the possibility of permanent loss, by accident, for example, were broadly discussed. To prevent damage and loss, it would be necessary to ensure that the samples were correctly returned to the surface whenever a visitor leaves the exhibit. To make that easier to achieve, the regions on the surface were designed to have dimensions and shapes similar to the samples.

- Graphics and audio were both used to communicate information in the exhibits. For users with low vision, enlarged images of the pieces and accompanying text were projected on a wall. The inclusion of audio descriptions was intended to provide visually impaired visitors, elderly visitors, and people who cannot read, with the same information that was presented graphically. The audio included a detailed description of the shapes, textures, and other relevant features of the tactile samples, along with general information for identification.

- Additionally, it was designed to provide visual feedback to indicate the success of visitors' actions. Each time a sample was lifted from the surface, a light in the area corresponding to that particular geographical specimen, lit up. However, this feature was not accessible to visitors who had visual impairments including color blindness.

The system architecture that was eventually implemented resulted from a technical viability study based on the interaction model for the exhibit. It used an Arduino Leonardo microcontroller, four force-sensitive resistors, four bright actuators, and a computer to run the processing software, as well as a projector and two sound columns for the multimedia presentation (Vaz, 2014; Vaz, Fernandes, & Veiga, 2016).

The exhibit, designed based on guidelines for accessible exhibition design from the Smithsonian Institution (n.d.), consisted of the physical structure to house the interactive samples, with provisions to embed the necessary hardware. The structure was kept as simple as possible since the primary goal at this stage was experimentation and ideation to prompt feedback that would be necessary for an improved design.

Figure 1 presents a photograph of the high-fidelity prototype in operation in the main exhibition space of the MM Gerdau. The four geological samples are placed on the surface of the *Wise Stones* prototype with the images of the samples on the projected wall ahead with the phrase 'choose one sample,' written in Portuguese, below.

Figure 1: The *Wise Stones* prototype installed at MM Gerdau, with the four geological samples arranged on the surface, separated by black lines. Photo by Leonardo Miranda.

In Figure 2, a visitor is handling the aquamarine and flint samples at the same time. On the projection, the text in Portuguese informs him about their chemical compositions, places of origin, core characteristics of each and everyday uses. Only the areas of the prototype's surface corresponding to those two samples are illuminated, each with a similar color to of the object.

Figure 2: A visitor interacting with the *Wise Stones* prototype interface. Photo by Leonardo Miranda.

The objectives of the prototype evaluation were, on the one hand, to assess the positive and negative aspects of the interaction with the samples, and, on the other, trying to understand if visitors thought their museum visit was enhanced by this interactive exhibit. Other aspects of the exhibit, such as the multimedia components (images, audio and text), number of samples available to touch, and overall satisfaction (to determine whether this exhibit should be retained in the

permanent exhibition), were also evaluated. During a four-month period (April to August 2015), a total of 138 people evaluated the prototype. Of them, 9 were people who are blind, 17 were employees of the museum who had not previously participated in any phase of the project, and the remainder were visitors who happened to visit MM Gerdau during that period. The complete results of the evaluation were published in Vaz et al. (2016).

In general, the results showed that the use of the prototype pleased visitors — those who were blind and those who were sighted — all of whom rated the tactile aspects of the interaction very positively. The participants who were blind reported that their access to the collection was enhanced by the additional sensory stimuli. The majority of the participants mentioned that it was their first opportunity to handle collection objects in a museum and that this approach was very simple, pleasant, and motivating.

The duration, speed, content and presentation of the audio description proved to work well, but the graphic design and visual content needed to be reviewed, prioritizing images instead of text. All participants who were blind and half of the sighted participants suggested increasing the number of tactile geological samples available. Based on the results, we were able to conclude that interactive exhibits, like this one, are received well in the museum context, and the decision was made to proceed with a pilot study.

Exhibit Re-Design and Pilot Implementation

The pilot phase of the project aimed to develop a final version of the *Wise Stones* prototype to permanently integrate into the MM Gerdau's exhibition space. It took into account data collected from the evaluation, and also new insights generated during additional testing with visually impaired people.

Features Supported by the Pilot

The main characteristics of the re-designed exhibit are the following:

- The interaction model of the prototype would be maintained but expanded to include five samples rather than four.

- An improved interaction system was created for safety reasons — the geological samples would remain connected to the surface via a steel cable. When a sample is picked up, the movement of the cable triggers the sensor, playing the corresponding audio description and showing the associated content on the projected wall. The allowance for simultaneous interaction with two samples and obtaining comparative information side-by-side remained.

- Visitors are informed through audio and visual cues how to use the interactive system with prompts (Preece et al., 2002), and about the existence of the comparison mode. The system also provides audio feedback to alert visitors any time more than two samples are “active” at the same time (this proved beneficial when samples were not correctly placed on the surface and the interaction then didn't work as intended, which confused some visitors during prototype testing). In order to enhance the whole experience, the sound fades out smoothly between the different events.

- Even though feedback about the audio descriptions during evaluation was very positive, additional details about the physical characteristics of the samples and educational information, like forming processes, industrial uses, and surprising facts, were added.

- Several visually impaired visitors who used the prototype after its formal evaluation reported that they benefited from the enlargement of images on the screen since they could better view the colors and discern geological details. It is important to note that the World Health Organization (WHO) reports that not every visually impaired person has complete loss of vision. In fact, people with some visual perception comprise the largest percentage of people with visual impairments, so it was imperative that the revised graphic design take that into account.

Figure 3 shows the TV screen with content corresponding to the petrified wood sample. The image displayed showed intricate details that were difficult to see on the sample itself so the on-screen content also helped sighted visitors obtain more information. The updated, enlarged text provides a label with the sample's name and a brief description. This information was also presented through the

audio description — the text and audio complement each other as some visitors benefit more from one or the other, while other visitors appreciate the reminder.

Figure 3: Screen view of the petrified wood sample, with the text: "Petrified wood: it is formed when the original wood's organic remains have been replaced by mineral substances". Graphic design by Roberto Vaz.

- A flat-screen TV replaced the projector, presenting a better cost-benefit in terms of the acquisition, maintenance, and quality of content. Previously, the projection was sometimes impacted due to light sources in the room. This solution also allowed better results by allowing for customized lighting sources like directional lighting.

- Although the interaction model didn't change significantly, it was necessary to re-design the system architecture to accommodate for the changes that were made. Detailed information about this was published in Vaz, Fernandes and Veiga (2018b).

The Interactive Process of Re-Designing the Pilot Program Setup

The physical setup of the exhibit was entirely re-designed as well, in partnership with a product designer. During that phase, the Smithsonian Institution's guidelines for accessibility were followed strictly with three core goals in mind: making it accessible to the broadest range of visitors possible, completely embedding the hardware inside it, and guaranteeing an accurate operation of the triggering system with the samples attached to the surface by a steel cable. We ensured that the furniture was accessible to all visitors; that objects were displayed within viewing distance for persons of short stature, seated and standing visitors; and that the setup was cane-detectable.

Given its complexity, this stage involved multiple iterations, during which various options for the furniture were prototyped and tested with real users, before selecting the final version. Figure 4 shows photos of one of the last prototypes.

Figure 4: A low-cost prototype of the pilot setup made of cardboard, glue, and adhesive tape (left) and MM Gerdau staff and Roberto Vaz presenting it (right). Photos by Roberto Vaz (left) and Ana Cecília Rocha Veiga (right).

Since it had been decided that the exhibit would be integrated permanently within the exhibition space, the setup was designed to fit aesthetically with the other elements already in the exhibition. The focus was meant to be on the

samples, so the furniture setup was built to be neutral and dark, using lacquered, black, medium-density fiberboard. The surface was coated with durable velvet to create a pleasant tactile experience where the hardness of the samples contrasted with the surface they were on. Another factor was to ensure that the exhibit was movable and could be relocated to other museum spaces as needed.

A photograph of the final product is shown in Figure 5, where the phrase 'pick up a sample,' is written in Portuguese on the screen, inviting visitors to start interacting with the exhibit and the five geological samples displayed on the velvet surface.

Figure 5: The *Wise Stones* exhibit from the pilot phase, at MM Gerdau museum. Photos by Leonardo Miranda.

Evaluating the Pilot with Real Users

A formal evaluation of the pilot was conducted in March and April 2018 with 13 visually impaired participants — five of whom were blind while eight had low vision — who had not used the prototype before. The main goals were to study the differences, if any, in users' interaction and satisfaction with this solution; if the audio descriptions were clear and accurate in the context of what they were sensing as they were interacting with the samples; as well as understanding how to provide an enhanced visitor experience using more exhibits like this one

during future visits to the museum. The complete results of the pilot evaluation can be found in Vaz et al.(2018b).

In general, participants reacted very positively and enthusiastically to the exhibit experience. The audio descriptions helped them conceptualize the five geological samples, but two of the blind participants noted that the description of the petrified wood sample confused them because what they sensed was different — a cold mineral with the texture of a piece of wood along the edges. Based on this feedback, the audio description was revised to clarify the transformation process of wood into mineral. The participants also added that the integration of Braille labels could help them remember the names of the samples more easily without having to listen to the descriptions again, although they noted that Braille labels are not always an ideal solution given that not all blind people can read them and, if implemented, their location would need to be indicated clearly.

Regarding their expectations of more exhibits like this one for future museum visits, the majority of the participants specified that they would prefer the accessible exhibits be distributed across all three floors of the MM Gerdau so that they felt a sense of inclusion throughout the museum and would have the opportunity to visit all the exhibition spaces as sighted visitors do.

Complementary evaluations were conducted with other visitors, museum staff, and accessibility professionals, which revealed the need to expand the exhibit's accessibility for deaf visitors and visitors in wheelchairs. Figure 6 shows some photos from the pilot evaluations.

Figure 6: Visitors using the *Wise Stones* pilot exhibit at the MM Gerdau. Photos by Ana Cecília Rocha Veiga (left and right) and Leonardo Miranda (center).

Wise Stones Circuit: Ibermuseums Award and the Interactive Accessible Circuit's Consolidation

Ibermuseums is "an intergovernmental body for the promotion and articulation of public policies to support the museums of the Ibero-American Cultural Space and also provides support for different projects that help integrate, modernize and develop these institutions" (http://www.ibermuseos.org/en/about/our-role-in-the-sector/). It is supported by, among others, the Organization of Ibero-American States (OIE).

The *Interactive Interface Accessible Circuit,* consisting of the *Wise Stones Accessible Circuit*, and other accessible museum collections, won fourth place at the 7th Ibermuseums Education Award — Category II (projects in the development phase) in 2016 (https://webmuseu.org/mmgerdau-wise-stones/visitors-guide/). That year the award had, in consideration, 167 projects from 18 different countries, and the *Interactive Interface Accessible Circuit* was the only Brazilian project to receive an award. The museum was awarded $10,000 to be reinvested in the project.

With the Ibermuseums Education Award, as well as wide acceptance from people who are physically and/or visually impaired, the project was able to continue and consolidate into an *Interactive Accessible Circuit*. The project's goal,

therefore, was to be part of the museum's permanent museography, i.e., its long-term exhibition.

The first step toward the circuit's implementation was the analysis of the usability tests and interviews, in addition to the team's feedback. We then verified what had to be implemented, given that there was no longer one single exhibit, but various exhibits throughout the museum.

In the pilot exhibit, supervision by museum staff was more significant. In this new phase, the exhibits have to assure both, the user's autonomy, and the collection samples' safety. The alterations were made with that expectation in mind. Those decisions were difficult to make because when one aspect was enhanced, another was weakened. It was therefore up to the team to analyze the pros and cons and to set priorities according to the resources available at the museum, as discussed below.

The New *Wise Stones* Exhibit

The pilot exhibit's structure was maintained for the new exhibits, with the following alterations:

- Adaptation of the furniture's lower section, now hollow (shown in figure 7), to ensure access for people in wheelchairs, who can pull up directly to view the content on the surface rather than have to approach parallel to the structure.

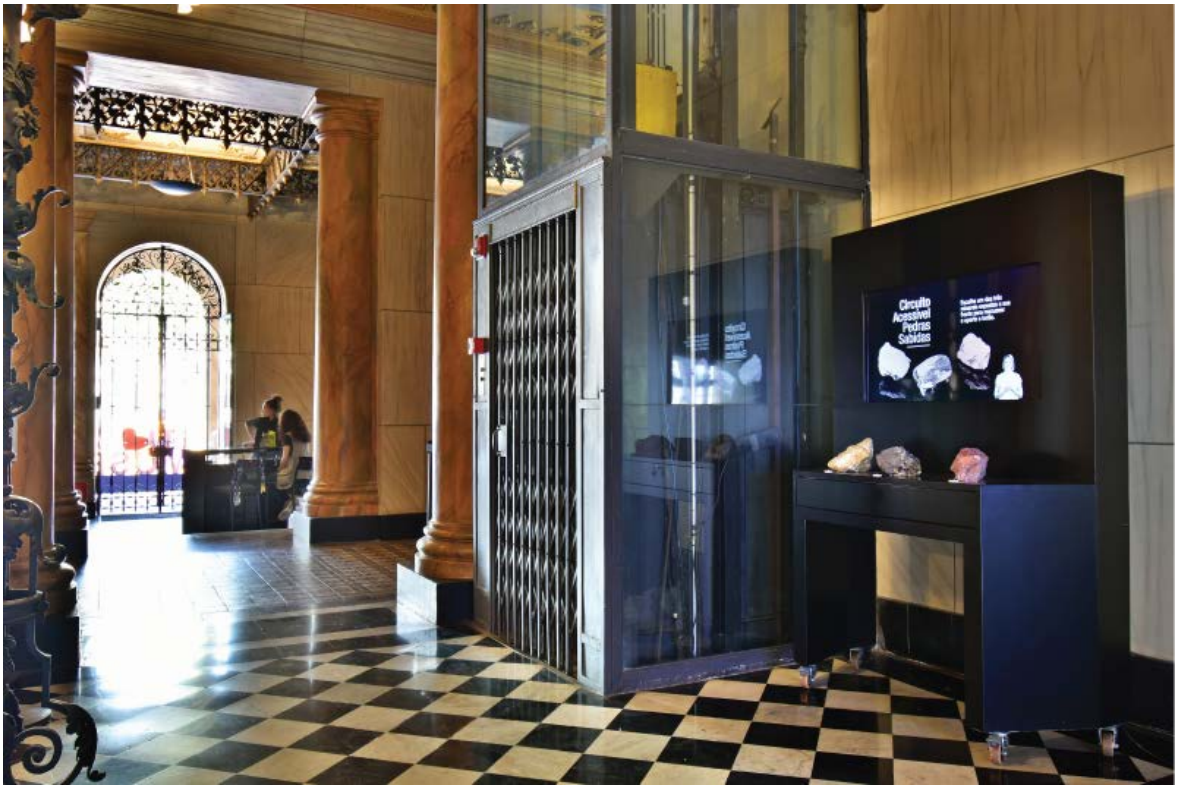

Figure 7: *Wise Stones* exhibit at the MM Gerdau Mines and Metal Museum's first floor. Photo by Leonardo Miranda.

- Minerals (samples) fixed on the exhibit, allowing the use of bigger and heavier samples than previously possible. This setup is better for the safety of visitors, who can now experience heavier samples without the risk of dropping them, and it also prevents theft. Bigger minerals discourage their removal from the surface, and their fixation also mitigates the maintenance required for the triggering system implemented in the previous version. Braille labels were also added, as presented in Figure 8.

Figure 8: Talc sample with button to start multimedia experience and Braille label. Photo by Ana Cecília Rocha Veiga.

- Buttons near each mineral start to play their respective videos on the screen. The videos contain enlarged images to show intricate details of the sample that may not otherwise be clear to all visitors, especially visitors with low vision; audio descriptions for visitors who are blind or cannot read; text on-screen for visitors who are deaf and can read in the vernacular; and sign language interpretation for visitors who are deaf and understand it. A screenshot from the video is presented in Figure 9. Although the focus for the accessible exhibits is still on serving visitors who are visually impaired, we tried, wherever possible, to meet the requirements of universal design.

Figure 9: Screenshot of the video at the *Wise Stones* digital interactive — *Quartz'* exhibit, which features enlarged images, audio descriptions, sign language interpretation, and text descriptions in Portuguese that translate to "Quartz: Huge variety of shapes and colors" and "When it is pink, it is known as Love Stone." Video from the *Wise Stones — Quartz'* exhibit.

With those alterations, part of the dynamism experienced with the pilot version was lost — previously, the media experiences were triggered automatically as soon as users picked the samples up, and comparisons between samples were possible. Now, a button press is required to start the experience. On the other hand, with those alterations, the exhibit's maintenance was made easier, human supervision (for theft prevention) is no longer necessary, and the samples can be larger. Figure 10 presents two photographs of the new *Wise Stones* exhibits. The pilot version continues to be available for mediated activities and is located in the museum's educative section.

Figure 10: *Wise Stones — Quartz* final exhibit (left) and Gibbsite (right), where text on-screen reads: "*Wise Stones Accessible Circuit* — Choose one of the three minerals in front of you to handle and press the button." Photos by Ana Cecília Rocha Veiga.

The MM Gerdau Accessible Circuit

In addition to the *Wise Stones* interactive interfaces (comprising three new exhibits and the pilot), eight new features, which were already part of the museum, were included in the development of the MM Gerdau accessible circuit. To undertake this selection, we used the survey mentioned in the *From Scratch to High-Fidelity Prototype* section earlier, which meticulously classified the museum's digital interactives according to their accessibility features.

Examples of items featured in the circuit include: minerals that can be touched, notably a 508 kg (1120 lbs) quartz druse and a meteorite; a famous Brazilian poem recited as part of the ambient sound in the *Miragens* (Mirage) gallery; and some videos/audio tracks that are not specific to certain exhibits but provide general information useful to all visitors. The circuit also features two touchable scale models — one of the large sculptures, *Língua Afiada* (Sharp Tongue), which occupies almost the entirety of one of the museum's halls (Figure 11), and another of the Liberty Square, Belo Horizonte's most famous square, where the *Circuito Liberdade* (Liberty Circuit, of which MM Gerdau is a part) is located.

Figure 11: Sculpture (left): *Língua Afiada* (Sharp Tongue) and its touchable scale model (right). Photos by Leonardo Miranda (left) and Ana Cecília Rocha Veiga (right).

The Liberty Circuit consists of a network of museums and cultural spaces at and near the Liberty Square. Operating in an integrated manner, the Liberty Circuit acts collectively through committees, one of which is the "Accessibility and Inclusion" project (Circuito Liberdade, 2017).

Considering the context in which it exists, MM Gerdau has the potential to impact the various museums that are part of its network, as well as its many visitors. As of August 2019, the number of visitors for the year was as high as 160,000 and, in the same year, the museum passed the mark of one million visitors since its opening in 2010. With the goal of widening the impact of the *Wise Stones Accessible Circuit*, sharing the knowledge obtained in the process, and encouraging similar experiences at other institutions, the team published a guidebook and website about the project.

Wise Stones **Guidebook and Website**

A *Visitor's Guide* is available on the *Wise Stones* website, and contains a description of each of the accessible circuit's features, classifying them according to their accessibility; it also contains information about visits, which are free and can be made during the museum's opening hours. In our survey, people with physical impairments heavily criticized the seasonality and temporariness of the

museum's accessible activities. Consequently, none of the features in the accessible circuit, are temporary.

The website contains not only visitor information, but also an online, bilingual guidebook (Portuguese/English, also available in PDF format as well as in print in Portuguese), aimed at museum professionals who want to replicate the project at their institutions. In addition to the information about *Wise Stones*, clippings, scientific articles, handbooks, website links and useful tools about the project's themes, such as accessibility, management, web, technology for museums, etc., are also available.

The *Wise Stones* website, therefore, opens, a new avenue for research involving the production of digital content for museums, digital accessibility, web-based writing, search engine optimization, schema and web semantics, just to name a few. The first results were published by Veiga, Vaz, & Fernandes (2019), in which they proposed a new model for web-based writing for culture and the impacts, positive and negative, that digital marketing techniques have were discussed.

The End is the Beginning: What Changed with the *Wise Stones* Project

The *Wise Stones* project contributed to the consolidation of a new, permanent accessibility policy at the MM Gerdau museum. A specific sector was structured to deal with inclusion at the museum. General improvements are being implemented gradually and specific actions, such as a course that discussed the issue of accessibility in the context of museums; an exhibition of episodes of the first Brazilian animated cartoon in sign language (with the director there); and guided visits for people with physical and sensory impairments, among other inclusive and free scheduled activities, are being promoted.

Special importance must be given to the temporary exhibition, *Fossils: From the Sea to the Conquest of Land*, which took place in 2019. The exhibition, pictured in Figure 12, had accessibility at the very core of its design, which included: a podotactile floor (also known as tactile floor markers or textured ground surface

indicators), Braille brochures and labels, tablets with audio guides, videos in sign language, and a rich collection of original fossils and replicas, both available for visitors to touch and experience.

Figure 12*: Fossils*, a temporary accessible exhibition at MM Gerdau. Photos by Ana Cecília Rocha Veiga.

Another relevant aspect of this process was the strengthening of connections between MM Gerdau and LavMUSEU/UFMG, with the museum's space used for research, internships and other integration activities. The accessible circuit forms the instructive content for many disciplines at UFMG, especially for undergraduate museology students, who go to the museum every semester for technical visits and activities. Thus, each future museologist becomes a disseminator of the knowledge gathered over the five years of the *Wise Stones* project, which continues to bear fruit toward a more inclusive and fair society.

Conclusions and Implications

Designing accessible digital interactives in museums with the aim of including all members of society is challenging, given the adaptations required to serve a diverse range of visitors with varied needs. With the opportunities to provide tactile samples of original museum objects come restrictions, often based in

conservation issues, which contribute to perpetuating the highly visual culture inherent to these institutions.

Despite the availability of assistive technologies to enhance the visitor experience (Vaz, Freitas & Coelho, 2020), like 3D (Buonamici, Furferi, Governi, & Volpe, 2015; Cantoni et al., 2018; D'Agnano, Balletti, Guerra, & Vernier, 2015; Reichinger, Fuhrmann, Maierhofer, & Purgathofer, 2016) and haptic solutions (Carrozzino & Bergamasco, 2010; Comes, 2016; Romeo, Chottin, Ancet, Lecomte, & Pissaloux, 2018), the intent of this project was to promote sensory and intellectual access to original museum pieces, rather than to their replicas.

This chapter presented the different stages involved in the creation and development of the *Wise Stones Accessible Circuit*, which aims to promote accessibility and inclusion in spontaneous visits (rather than pre-planned, scheduled ones) to the MM Gerdau for the broadest number of patrons possible, especially prioritizing visitors with visual impairments. A multisensory strategy was adopted, combining touch and sound in addition to the existing visual cues.

During the five years of this project, many lessons were learned, and some procedures that proved to work well can benefit other professionals and researchers in their own accessibility projects. These include:

- Working with a multidisciplinary team of curators, technologists, designers, educators, academics and other professionals from the museum and also from other institutions that deal with accessibility concerns, was crucial to broadening the concepts and creating integrative visions for this project. It was also important to establish a collaborative network.

- Organizing guided visits and performing formal and informal evaluations with real users during all stages allowed us to generate the most critical insights of the project. People commented on the positive and negative aspects of their experiences, what should be improved, and what their expectations were, among other aspects. Some visitors expressed to the researchers that their participation also made them feel a greater sense of inclusion and helpfulness, and that their life experience gave them something to teach others.

- Testing embryonic ideas with colleagues through simple tools like paper prototypes and simulations, like the Wizard of Oz technique (Dix et al., 2004; Preece et al., 2002), enabled the team to experiment with potential scenarios and understand some interaction errors, without expending too much time.

- Promoting seminars and staff meetings, where iconographic records and reports of the process were brought to the discussion, was vital to guaranteeing that everybody was updated with the most important stages of the project, providing each museum sector additional time to think about the changes that will need to be introduced to their future day-to-day work and to developing internal procedures.

- Making the pilot version available to be used by all visitors, as if it was the definitive version, allowed the team to observe their adherence to the exhibit; their reactions and behavior; the time they spent using it, and so on. It also allowed perception of the museum staff's engagement with it in their everyday work.

As far as limitations go, the *Wise Stones Accessible Circuit* is not fully accessible from a technological point of view, since it does not support a completely independent visit for visually impaired visitors: digital tools for visitors' orientation and mobility inside the MM Gerdau had not been contemplated. The physical accessibility of the exhibition space has to be ensured by museum staff or by visitors' companions. This limitation reveals new opportunities for research in this field.

Although the main purpose of the project was to enhance the museum experience for patrons with disabilities, it can be concluded that the result ended up benefiting all visitors.

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