

Reinventing Object Experiences with Technology

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Visitor in the *Bone Hall* viewing the AR content for the mandrill monkey on an iPad®. They see a 3D model of a fully fleshed animal superimposed over the skeleton in the case.

Introduction

In 2015, the Smithsonian's National Museum of Natural History (NMNH) released an augmented reality mobile app called *Skin & Bones*. The app provides a reimagined experience in an existing exhibition known as the *Bone Hall*. Designed in the 1960s, this permanent exhibition features a collection of skeletons with scant accompanying information. With the app, we hoped to increase the enjoyment and memorableness of the exhibition experience, more effectively communicate the organizing principles of the Hall (common ancestry and skeletal functions), and expand the narrative. The main constraint for *Skin & Bones* was to meet these goals without physically changing the displays, given their historical importance and the research value they represent to curators at the museum and elsewhere. In addition to cost considerations, preserving the exhibition was a way to provide for a niche audience that treasures a period-style exhibition.

It is not unusual for natural history museums to feature collections from another era. However, the messages conveyed by taxidermied and/or skeletonized collections and old diorama exhibits can reflect an age of trophy hunting and curiosities, and lack relevance to the issues associated with biodiversity conservation that natural science museums seek to address today. In the *Bone Hall*, we observed the disconnect in visitors, who rarely engaged with the skeletons.

Outdated exhibitions challenge museum practitioners: do we preserve the past, renovate from the ground up, or mount an intervention to meet the expectations of modern audiences? Decisions are often limited by historical precedent and structural restrictions, and more commonly by lack of resources.¹ Making use of innovative and interactive technologies is one approach to improving the object experience for exhibitions rooted in decades past,² and some museums have adopted augmented reality technology (AR) for that purpose.³ Instead of inspecting the object, then reading its label, then viewing the object again, AR allows a visitor to use a mobile device to take in all the information simultaneously in one multi-layered experience. On the digital screen, the two aspects of the object experience – observation and interpretation – are merged through AR.

The technology can overcome some of the limitations of a static collection by introducing contemporary content delivered in a novel and captivating way without the need for a

1 Kris Nesbitt, Lindsay Maldonado, and Fran Mast, “Small Changes, Big Impact: Scalable Renovations Lead to Improved Visitor Experiences,” *Exhibitionist* (Spring 2014): 42–46, www.name-aam.org/exhibition-spring2014.

2 Mark Loveland, Barbara C. Buckley, and Edys S. Quellmalz, “Using Technology to Deepen and Extend Visitor’s Interactions with Dioramas,” in *Natural History Dioramas*, eds. Sue Dale Tunnicliffe and Annette Scheersoi (Dordrecht: Springer, 2014), 87–103.

physical renovation. This provides flexibility to suit different audience preferences, both those that expect interactivity and visitors that favor period displays. Also, one of the recurring concerns of museum practitioners about mobile technology in exhibitions – that it detracts from the collections and inflicts a heads-down experience on visitors – is not the case with AR, as the virtual overlay is dependent on, and connected, to the tangible exhibition.

The Setting, Mobile App, and Visitor Study

The Setting The *Bone Hall* is a 170-foot long permanent exhibition with five connecting rooms lined with glass cases featuring over 300 skeletons arranged taxonomically. None depict particular behaviors or motion and with few exceptions, there are no images of the animals in life (fig. 1). Inside the cases are skeletons, labels, and panels with specialized anatomical terminology.

Many of the skeleton mounts predate the current museum building, which opened in 1910. They were first on view at the United States National Museum (today the Smithsonian’s Arts and Industries Building) in the 1880s (fig. 2). In the 1960s, the skeletons were combined with newer acquisitions to create the *Bone Hall*, which features some of the oldest objects on display at the Smithsonian. The exhibition has not changed since then, and in some respects, it is a time capsule.

Before our digital intervention, the majority of visitors to the *Bone Hall* walked through the exhibition making few or no stops.

3 Ayala Museum, “Diorama Augmented Reality Guides,” June 15, 2015, <http://www.ayalamuseum.org/2015/06/15/diorama-augmented-reality-guides/>; Liraz Mor, Richard M. Levy, and Jeffrey E. Boyd, “Augmented Reality for Virtual Renovation,” *Proceedings of the Second International ACM Workshop on Personalized Access to Cultural Heritage*, 2012, 15–18, <https://doi.org/10.1145/2390867.2390872>.

fig. 1. General view of the Bone Hall.

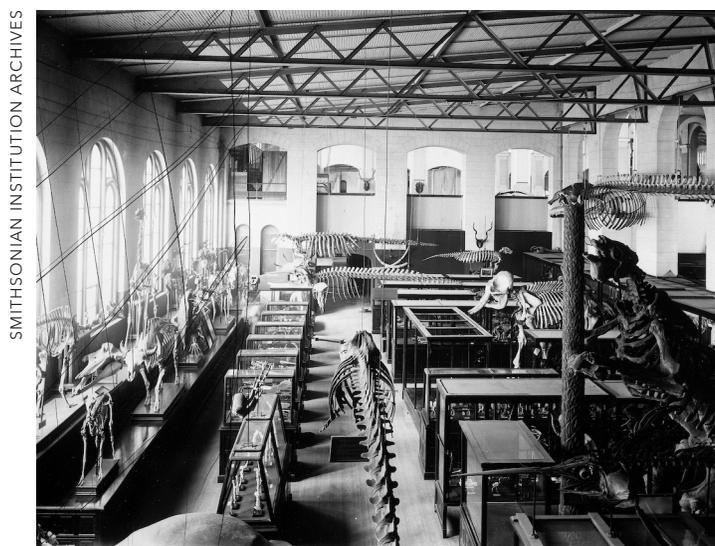
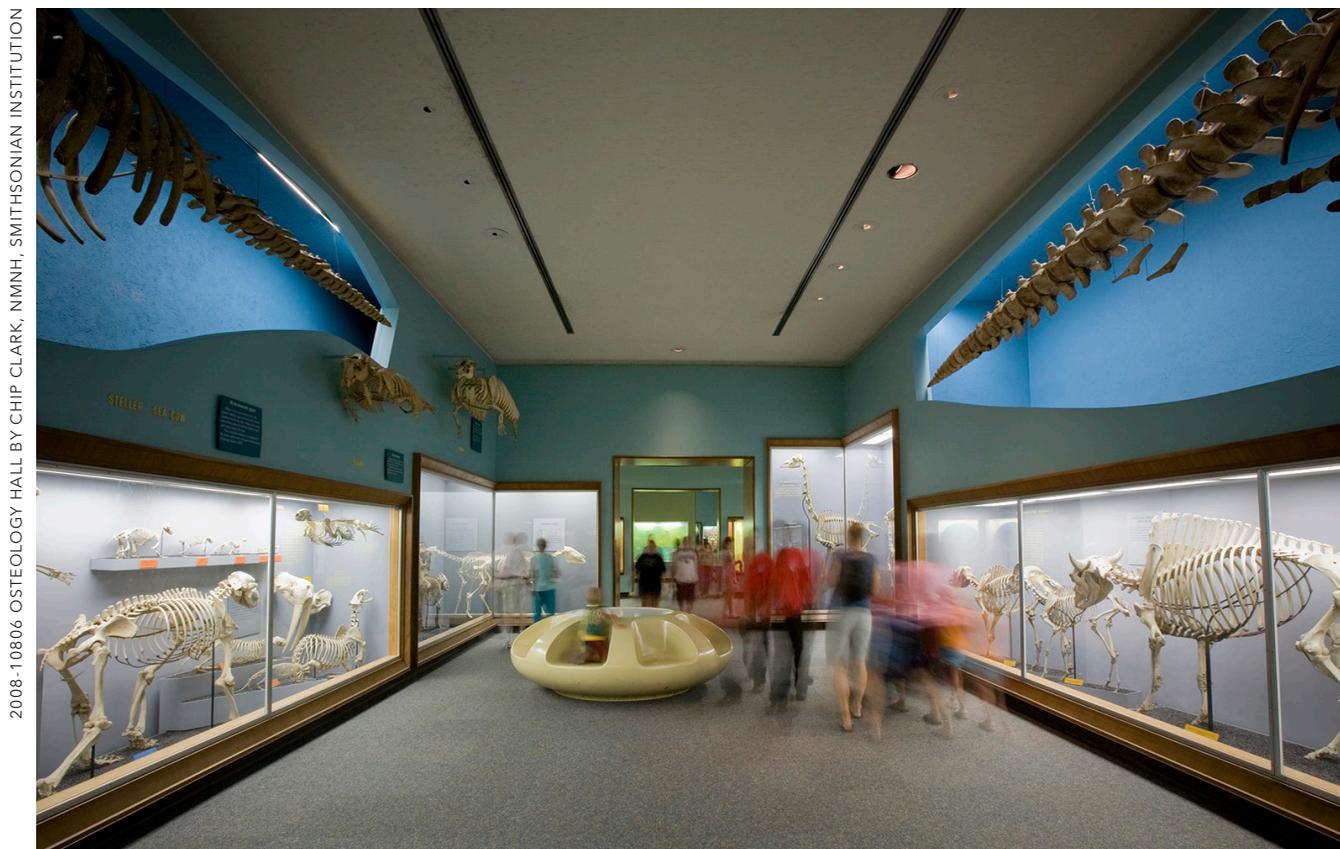


fig. 2. The exhibition *Paleontology and Comparative Anatomy* at the U.S. National Museum, late 1800s. Some of the skeletons included in this exhibition are currently on view in the Bone Hall.

Before our digital intervention, the majority of visitors to the *Bone Hall* walked through the exhibition making few or no stops.

Those who stopped did not appear to read the text panels. Consequently, the underpinning concepts that are meant to convey anatomical and evolutionary ideas were being lost to visitors.

The Mobile App: *Skin & Bones* In 2012, the Smithsonian's National Museum of Natural History began the development of a mobile app as a companion to the *Bone Hall*, aimed at improving the visitor experience. It was designed as a content-rich digital tool to bring forward the multiple stories that can be told about the skeletons on display. Even though it was primarily meant to be used at the all, all of its content can be used outside the museum.⁴

The app can be downloaded for free to iPhones® and iPads®.⁵ It features 13 animals whose skeletons are on display at the *Bone Hall*. These were selected using a variety of criteria, including the ecological, evolutionary and anatomical stories that could be told, and the connection to Smithsonian scientists who work with those animals. In total, we produced 10 AR experiences, 32 videos, and four activities.

When a user of the app selects a menu option with AR, the camera in the mobile

4 Diana Marques, Robert Costello, and Brian Alpert, "A Location Based Understanding of Mobile App User Behavior," *Museums and the Web 2017* (Cleveland, Ohio), 2017.

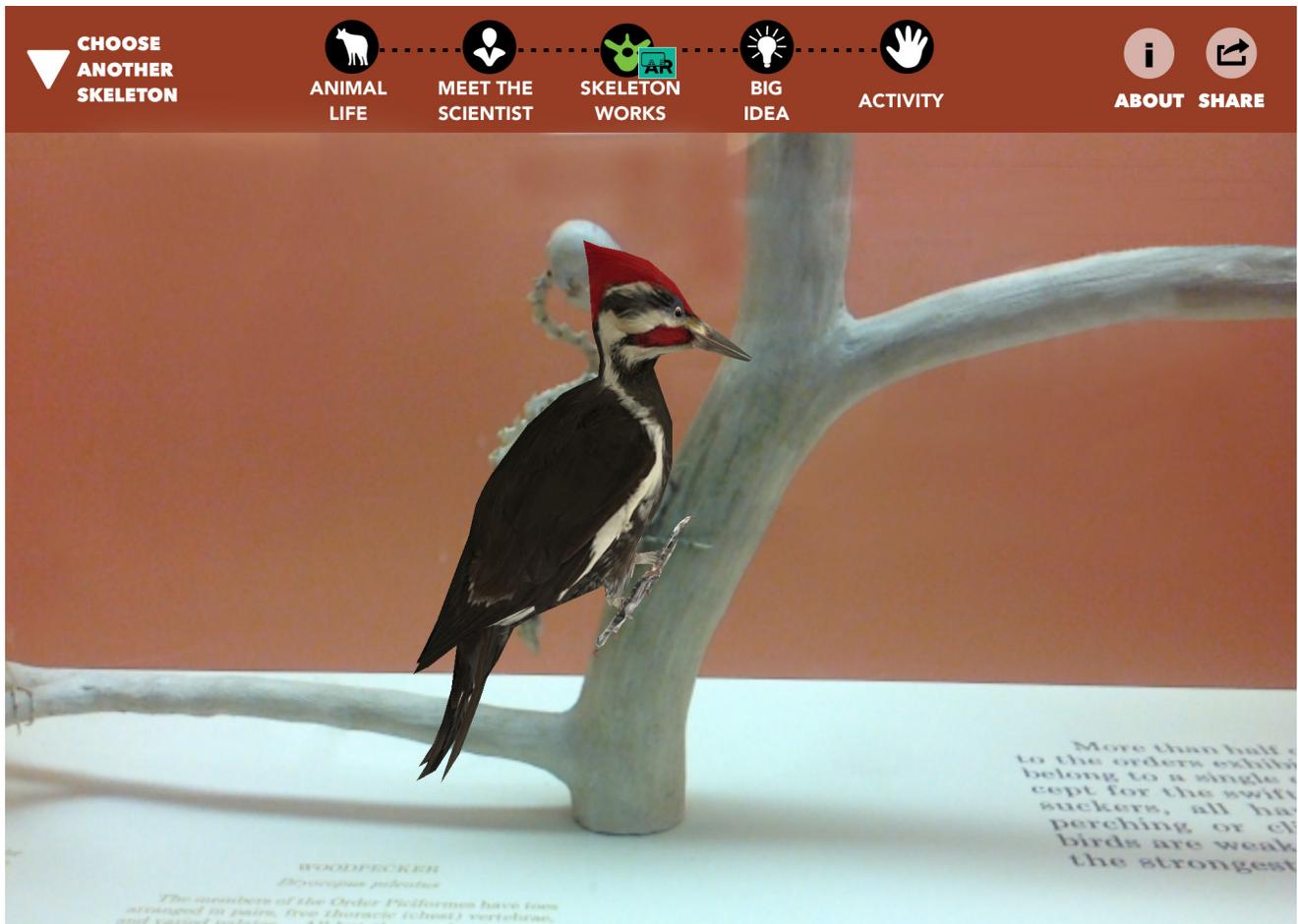
5 To download the app, go to: <https://itunes.apple.com/us/app/skin-bones/id929733243?mt=8>.

device turns on. Once it frames the skeleton, the augmented content is activated and superimposed onto the skeleton. Both static 3D models and animations are available through the AR experiences. For example, the skeleton of the mandrill monkey is skinned with a digital representation of the external anatomy of the animal (*intro image*), and the pileated woodpecker skeleton is overlapped by an animation illustrating both the feathered bird and the internal anatomy of its tongue mechanism, which is a specialized device to capture insects (*fig. 3*).

The Visitor Study In 2013, before we released *Skin & Bones*, one of the authors (Diana Marques) conducted a baseline study in the *Bone Hall* to gather information on visitor interactions with the skeletons in their analog condition. The study tracked 128 anonymous visitors who were observed, without their awareness, during their time in the exhibition. We noted each visitor's path, stopping points, stop duration, and certain behaviors that occur, such as taking a picture or calling others in their group to discuss a display. This became the control group.

Two years later, once the app was available in Apple's App Store, we collected information regarding the effects of the technology on visitors' experiences to understand if and how it changed their perceptions of the objects on view. We studied visitors using the mobile app by randomly recruiting participants in the exhibition and handing them an iPad® with *Skin & Bones*. We observed and tracked 214 people. At the end of the visit, participants were invited to fill in a self-administered questionnaire or to sit and engage in a non-directed interview.

fig. 3. This *Skin & Bones* iPad® screen grab shows a frame of the animation triggered from the skeleton of a pileated woodpecker. In the animation, the skeleton becomes fully fleshed and feathered; then, the skull is isolated to illustrate the tongue mechanism, which is adapted for catching insects.



Results

We analyzed the data collected in the two studies by looking for specific differences in the patterns of behavior. With data from the second study, we also examined the interview transcriptions to extract the perceptions of participants about visiting the exhibition with the app. Most of the interviewees revealed never having used an app in a museum before, but when asked about their level of comfort with technology, 90.5 percent placed themselves on the positive end of the scale.

Patterns of Visitor Behavior Visitors observed during the baseline study were notable for their short stay in the *Bone Hall*, with an average of three minutes and 24 seconds. The brevity of their presence in the exhibition is better illustrated by the mode of the visit duration, which was one minute and 34 seconds. In fact, only 26 percent of the individuals lingered for three minutes or more. Notably, the average visit duration increased to 14 minutes when participants used *Skin & Bones*, with most visits lasting between six and 20 minutes. The fleeting character of the visit is echoed

in the number of stops visitors made. In the baseline study, 33.6 percent of the visitors never paused to view a skeleton. Another 28 percent did make just one stop, and 36.7 percent stopped two to five times. By contrast, *Skin & Bones* users on average made twice as many stops as visitors browsing the exhibition without the app.

Looking at stop duration in the baseline study, 43.5 percent of the stops lasted less than one minute and the average duration across all stops was close to 60 seconds. Participants who used the app had an average and mode stop duration between one and two minutes.

These results – comparing the visitor behavior of the control group against the group of those using *Skin & Bones* – suggest that the introduction of AR to the *Bone Hall* was highly positive. Yet, to calibrate the results, we needed to look at data from an outgroup. We used a study conducted at a modern, permanent exhibition at NMNH, the *Kenneth E. Behring Family Hall of Mammals*.⁶ Opened in 2005, it features an extensive number of taxidermied animals, some of large dimensions similar to *Bone Hall* specimens, except with an updated look and feel. Animals are in dynamic poses in ecological settings, and audio effects and interactives are distributed throughout the space.

Stop durations in the *Hall of Mammals* averaged less than one minute, well below the stop duration of *Skin & Bones* users (which was one to two minutes). At both exhibitions, visitors stopped at about 19 percent of the displays. This coverage

6 Ioana Munteanu and Andrew J. Pekarik, "Visitor Responses and Behaviors in the Kenneth E. Behring Family Hall of Mammals at the National Museum of Natural History Smithsonian Institution Washington DC" (Washington DC: Office of Policy and Analysis, Smithsonian Institution, July 2005).

is on the low end for this metric when compared to a study by museum practitioner Beverly Serrell that examined the range of visitor behavior data across 110 exhibitions at museums of science, natural history, history, and art, and zoos and aquaria.⁷ Visitors typically view 20 to 40 percent of the displays. However, NMNH does not charge admission and it is surrounded by other free national destinations within walking distance. Visitors tend to move quickly and make fewer stops than in other museum contexts. Thus, at NMNH, this change in behavior is a significant improvement.

The rise in the number and duration of stops was expected. When viewing the *Bone Hall* exhibition with the companion app *Skin & Bones*, visitors have access to additional resources that consume more time than simply looking at the skeletons and panels. Therefore, an increase in duration cannot be directly attributed to greater interest and enjoyment. Nevertheless, the rise in the key metrics is strongly suggestive of increased engagement, which is supported by participants' comments (below). Moreover, the average session for *Skin & Bones* is quite above the same metric for other museum apps,⁸ which other data from our research suggest is correlated to the inclusion of AR.

Author Paul Marty suggests that studies that demonstrate visitors spending more time while using interactive technologies may not mean additional engagement with content, but rather more time figuring out how the

7 Beverly Serrell, *Paying Attention* (Washington DC: American Association of Museums, 1998).

8 H el ene Alonso and Jeff Hayward, "Creating Apps for in-Gallery Interpretation," *Exhibitionist* (Fall 2013): 37–41, https://www.name-aam.org/exhibition_fall2013; Elena Villaespesa, "Mobile App Analytics: a Look at How Users Engage with Tate Mobile Apps," Museum and Mobile Online Conference VI (2013).

tool works.⁹ This does not seem to apply to *Skin & Bones*, though. The great majority of participants stated that they were comfortable with technology, and our observations did not reveal any particular difficulties with using a mobile device or the app.

Visitor Perceptions Participants in the second study shared their thoughts about the kind of experiences they had with the collection in the *Bone Hall* and their impressions of AR. When asked what they would have thought about the exhibition had the mobile app not been available, they framed multiple problems associated with an outdated style of displaying information. Predominantly, participants mentioned the lack of contextual relevance and connection.

“I think it’s easy to look at a bunch of bones and forget about the animal that’s underneath, or on top I guess.”

“[I]t’s easy to blow through this exhibition and be ‘it’s a lot of bones, it’s a lot, of bones.’ Exhibition after exhibition of bones. You lose your interest you could say.”

“Bones are just sort of the same color, the same sort of thing.”

The repetitiveness and the extensive number of objects on display contributed to fatigue.

“After a while you’re tired.”

Lastly, the static and passive displays wore on visitors.

“It’s slow, a bit tiring if you’re always reading things.”

9 Paul F. Marty, “Interactive Technologies” in *Museum Informatics: People, Information, and Technology in Museums*, eds. Paul F. Marty and Katherine Burton Jones (New York NY: Routledge, 2007), 131–35.

These problems are not exclusive to the *Bone Hall*. In fact, they are common across museum settings designed to let the objects speak for themselves without making overt connections to visitors, their curiosity, and the world of their experiences. Fortunately, there are mechanisms for bridging the gap that can transform static collections into object experiences that capture visitors’ attention. Mobile augmented reality technology is one, which participants’ perceptions reflected. *Skin & Bones* contextualized the specimens by directing attention to a few curated skeletons and giving them identity.

“[Skin & Bones] has the visuals to make it more real as opposed to skeletons which dissociate you from nature, from reality.”

“If we wouldn’t have had that [Skin & Bones], we would have just blown right through, stopping at anything that caught our eye. But I wouldn’t have seen the catfish and spent any time there, but since it was on there, I saw the video on it.”

The app also introduced interaction and motion.

“It brings in a different dynamic, using the media. A different way to look at it I guess.”

“What’s good about it...is that it brings alive the skeleton that’s there.”

Rather than distracting from the collection, AR facilitated the object experience by raising awareness of both objects and the exhibition, focusing attention, and contextualizing and stimulating cognitive interests. Our goals to increase visitors’ enjoyment while preserving the historical collection were accomplished.

This kind of intervention is promising for other similar environments that under-

perform by standard measures. Beyond its proven success in repairing common problems in dated exhibitions, mobile AR is an elegant and visitor-minded solution that taps into forms of literacy other than textual, and creates two alternative modes of experience – one that preserves the legacy collections for niche audiences, and simultaneously targets the population at large, keeping up with modern demands and expectations.

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