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Preparing Dinosaurs

The Work behind the Scenes

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5 PREPARING PUBLIC SCIENCE

A woman with a child approached the windowed walls of a fossil preparation laboratory at the Southern Museum. She pointed at the man inside the walls who was spreading plaster-soaked burlap strips over a nearly finished specimen cradle and exclaimed with excitement to the child, “Look! People making fossils!” It did indeed look like Harry, a volunteer, was making fossils out of the materials around him, including wet plaster, piles of burlap, blocks of wood, a level, scissors, a razor blade, and rubber gloves. In a flipped reality of typical museum exhibits, there were no fossils in sight and there was a live human on display.

Showing visitors how workers prepare fossils portrays science as situated human action, adding nuance and complexity to the facts and objects usually on display. Unlike traditional exhibits, glass-walled labs portray science as ongoing rather than preexisting (Meyer 2011). As a result, this visitor actively constructed her own knowledge about what was happening, based on her interpretation of her own observations. Thus the display both showcased science as a process and encouraged a visitor to conduct it for herself. This approach could mislead visitors into the misconception that research workers are making *up* specimens and facts. Nonetheless, opportunities to apply scientific practices such as observing and drawing evidence-based conclusions (even wrong ones) are arguably what museums strive to provide for the public. Museum staff hope that displaying people at work can increase visitors’ interest in the exhibits as well as enrich their understanding of how research is done. Crucially, it also

shows that museums house research in addition to displays. Glass-walled laboratories seem like a rare and intriguing glimpse “backstage” (Goffman 1956) and into the “black box” of scientific practice (Latour 1987; Wylie 2020). How museum staff portray science for the public differs from how communities of practice enact their beliefs about what science is through their everyday work (as discussed in chapter 4). This chapter examines how museums present scientific specimens, work, and workers to visitors, and how museums thereby prepare a conception of science for the public.

The process of preparing displays to communicate proposed conceptions of science is dynamic, iterative, and responsive to contextual factors, which for displays include institutional culture, funding, available collections, and local interest. This process also shapes and is shaped by other knowledge-preparation processes, such as selecting and explaining objects for a nonexpert audience (i.e., preparing evidence), trying to inspire future scientists through exhibits (i.e., preparing community), and designing how objects will be displayed (i.e., preparing techniques and tools). Furthermore, this process serves as a boundary object between groups within and beyond the usual divides of research communities, including scientists, technicians, volunteers, display designers, architects, educators, institutions, and museum visitors. This chapter investigates public science from the point of view of its preparers—namely, museum staff. How the public experiences this portrayal of science is beyond the scope of this chapter, but certainly deserves further research.¹ This chapter elucidates how practitioners use displays as a medium for preparing a conception of science for public consumption. It highlights the tensions between education and entertainment, research and display, and backstage work and public performance. Moreover, it’s possible that watching relatable-looking people performing achievable-seeming research work can serve as powerful inspiration for visitors to interpret science as relevant, inclusive, and perhaps participatory.

What Museums Display

The typical and long-established narrative of museum displays presents science as facts, demonstrated by galleries full of beautiful but static

reconstructions of nature accompanied by authoritative text panels (Nyhart 2004; Kohlstedt 2005; Alberti 2008). In comparison, glass-walled exhibit labs portray science as dynamic work done by ordinary people (see figure 0.1 in the introduction). Yet, like traditional natural history dioramas (with their taxidermied animals, plastic plants, painted horizons, and/or mannequins in cultural garb), exhibit labs place glass between visitors and workers. This “fishbowl” design makes science visible though not necessarily comprehensible to visitors. For example, most display labs have brief text panels explaining their work, and a few have ways for visitors to talk to workers, but interpreting what they see is left largely to visitors’ inductive thinking. Glass-walled labs thus serve to inspire questions more than deliver answers (Meyer 2011). Glass-walled fossil preparation labs tend to spark so many questions from visitors that lab workers can easily spend more time talking than preparing fossils. As a result, several institutions have purposefully removed communication methods between visitors and workers, such as a phone or a hole through the glass (Gavigan 2009, 16–17; Noble 2016, 256–257). The balance between labs as exhibits and workplaces can be a fraught one.

Noble (2016) argues that including a glass-walled lab in an exhibit lends legitimacy to the fossils and facts on display by illustrating how they were made. This interpretation aligns with museums’ long-standing efforts to present reliable knowledge about nature. But a more important function of these labs, I argue, is that they invite visitors to reconsider their knowledge about *science*. A glass-walled lab portrays science as human work that visitors must interpret, thereby somewhat decentralizing museums’ typical presentation of finished specimens and knowledge. This approach reverses the role of an exhibit as a source primarily of facts to a source primarily of data. Being invited to make sense of what they see may explain why glass-walled labs are popular with visitors as well as why the enthusiastic visitor quoted earlier might conclude—incorrectly yet inductively—that she was watching a worker build fossils out of burlap and plaster.

How displays portray scientific specimens, knowledge, and work sheds light on museum workers’ priorities. For instance, aspects of research work that are commonly made invisible in fossil exhibits include specimen

collection and preparation, reconstruction practices (e.g., filling in gaps and sculpting replacements for missing bones), and how specimens are studied. Obscuring or omitting practices deemed the “background stuff” of fossil research (as researcher Kirk called it) may reflect the prioritization of finished, accepted knowledge. It’s also possible that the perception of fossil preparation as a separate field from research has inspired exhibit designers and even the public to consider fossil skeletons and facts to be the most worthy topics of displays. Of course, some displays do explain fossil collection and preparation through objects and text. And some exhibits discuss controversies in scientific knowledge, such as whether dinosaurs were warm or cold blooded, thereby challenging the conception of science as unquestioned facts. Many exhibits label which objects or parts of skeletons are reconstructed (although few describe how these parts are made or how repairs change how a fossil looks). These are steps to present some of the messy, laborious process of preparing evidence and knowledge, though in rather subtle ways that are easy to miss among towering dinosaurs.

Glass-walled labs are more direct. They blatantly display many things that are usually kept out of public view, such as dirt, tools, unprepared and partly prepared fossils, specimen storage containers, people at work, and typical workplace paraphernalia that visitors may not associate with doing science, including lunch boxes, headphones, informal clothes, and dinosaur cartoons taped to lab walls. These aspects arguably make exhibit labs and therefore the science they represent look more familiar, relatable, social, and *human* than other forms of museum display do.

Experiencing Authenticity

Several museum volunteers and staff members told me that visitors often ask “is this real?” about the exhibit specimens, the fossils in the glass-walled lab, and the actual lab and its workers. After all, what visitors see may not align with their previous experience of science as facts, creating dissonance as they try to meld the certainty of exhibit panels’ information and the solidity of mounted fossils with this dynamic, disorganized workspace of humans drilling away on unlabeled pieces of dinosaurs. Authenticity has long been a goal for museums (e.g., Haraway 1984; Macdonald 2002;

Lorimer 2003; Nyhart 2004; Alberti 2008; Rossi 2010; Rieppel 2012), but ironically, what authenticity means and how it is achieved is rarely explained to visitors. “Authentic” nature is displayed to the public through the invisible design processes of exhibits, which sociologist David Grazian (2015) calls the “stagecraft” of “nature-making.” For example, zoos mimic nature in the design of animal enclosures while minimizing nature’s unappealing aspects, such as poop, death, fighting, sex, and, for some visitors, mentions of evolution (Grazian 2015, chap. 1). What institutions choose to make visible and invisible about nature (extinct as well as extant) reflects their assumptions about visitors’ expectations and values, including learning and being entertained but not being offended at a zoo or museum. In the early twentieth century, museums began to display animal specimens placed in naturalistic dioramas instead of isolated and decontextualized, reflecting an underlying belief that visitors learn more by (and prefer) viewing reconstructed environments and narrative scenes (e.g., Haraway 1984; Mitman 1993; Rader and Cain 2008). Museums rarely reveal to visitors how these displays are made, probably in an effort to let the displays stand alone as representations of nature. What then do they choose to make visible about *science*?

Display labs seem inherently authentic because they contain real people doing real work with real specimens. But they are nonetheless a performance space. What happens there is somewhat controlled, designed, and censored by lab workers, exhibit staff, and museum administrators. For instance, “risky” fossil preparation tasks that are dangerous for fossils or people are conducted behind the scenes to avoid public surveillance and/or possible harm, such as from loud tools or inhalable rock dust. Scientifically valuable specimens are sometimes prepared off exhibit for security because glass-walled labs tend to be unlocked or several people have a key.²

These labs are therefore not sociologist Erving Goffman’s (1956, 69–82) “backstage” of research or museums; rather, they house a *performance* of backstage—a public version of the work that shapes fossils as data sources and exhibit objects (Wylie 2020). Similarly, exhibits of “visible storage” offer visitors views of objects arranged in crowded drawers and

shelves as if they were behind the scenes, yet which objects are on view and how they are presented are political, carefully curated decisions (Brusius and Singh 2018; Reeves 2018). Education scholar Joe Heimlich (2013, 132) points out that glass-walled labs have a “fourth wall” as stages do, but their wall is physical as opposed to imaginary (though it is transparent), and blocks contact and most sounds. These labs resemble anthropologists Sharon Macdonald and Paul Basu’s (2007) “reflexive” or “meta” exhibits in that they display a process, though these labs show the work of research rather than the work of display as reflexive exhibits do. Also, unlike many reflexive exhibits, these labs are not “spaces of enactment” for the public (Macdonald and Basu 2007). Visitors can look into labs, but can only participate in the work happening there if they become volunteers for the museum, which is a substantial time commitment. Glass-walled labs are a fascinating indicator of what institutions and workers want the public to witness—and not witness—about scientific work.

My aim is not to critique or celebrate these goals, or the resulting displays, but rather to analyze them to understand research workers’ conceptions of science, learning, and public access. The constructed authenticity of specimen displays to nature, for example, is not quite the same as that of display labs to truly backstage labs. Display labs are workplaces versus stages of simulated work, as dioramas simulate natural scenes. Work behind glass walls is not a purely public-facing demonstration (e.g., Collins and Pinch 2002, chap. 3), as are museums’ performances of historic experiments (e.g., Sibum 2000). Instead, display labs house necessary and skillful research work, which is conducted in ways deemed appropriate for public view *but* not for public view alone. Tellingly, preparators in display labs continue working when no visitors are present. Also, these labs perform the important function of showing visitors that museums do research in addition to their better-known work of displaying and storing specimen collections. Emphasizing research may make museums seem more valuable and credible to the public. Furthermore, displaying research work offers a more active, human-driven narrative of science than does a mounted dinosaur or a text panel about that dinosaur’s environment or diet. One problem, though, is that an exhibit lab’s work and workers can be just as

mysterious to visitors as a dinosaur's hidden steel frame or the epistemic debates unmentioned in text panels.

In displays of people and fossils, museum workers carefully plan what visitors will see (and not see), and negotiate compromises between best practices for fossils, lab workers, and visitors (Wylie 2020). How does this shift in display style from science as facts to science as work reflect current trends surrounding citizen science, calls for research with “broader impact” for society, and open-access journals and other portals of previously exclusive knowledge? The work and workers of research are becoming more visible to the public at the same time that the public is being invited to participate more in knowledge preparation. Exhibit labs are thus a cause and effect of museums' increasingly comprehensive and inclusive portrayal of science. Perhaps this changing mindset will alter technicians' status from invisible research worker to valued link with the public as leaders of volunteer workforces in glass-walled labs. Even if technicians are omitted from scientists' view of science (i.e., in publications), exhibit labs can make them literally the public face of science.

PREPARING SCIENCE THROUGH DISPLAY

Research Workers' Assumptions about the Public

Museum staff feel a sense of responsibility to provide good displays for the public. Preparator Brad pointed out, “If people aren't coming to your museum, what are you?” Providing people with access to specimens and scientific knowledge as well as an enjoyable visit is a role of museums that research workers embrace, even if it's not specifically part of their job. Brad conveyed a sense of urgency, for example, when he told me about displaying a ceratopsian skull recently found nearby: “The public has to know about this!” Brad and other preparators are committed to educating and engaging visitors, especially about the local environment.

Research workers particularly value displaying information about paleontological practices alongside information about dinosaurs, such as the work of collecting, preparing, and studying fossils. For instance, researcher Emily wants people to understand how dinosaurs looked and moved, and

also “how we got there,” meaning how researchers learned about dinosaurs from fossils. Researcher and collection manager Kirk agreed, and admired another museum’s exhibit for its images of preparation: “You could actually watch a video of [a preparator] grinding away rock from around the specimen to show how you do it. And they had photographic sequences to say, ‘This is what it looked like when we found it, and this is what it was like after a hundred hours [of preparation work], after two hundred hours, three hundred hours.’” Of course, research workers don’t control exhibit design, which may explain why many exhibits don’t mention paleontological practices. But, unlike research publications, at least some displays do include information about working with fossils.

Research workers appreciate exhibits as an important way to “extend the discipline” too, as researcher Frank put it. Many of the research workers I spoke with chose their careers because of powerful childhood experiences in museums like gazing up at a dinosaur with its teeth (and everything else) bared. Studies suggest that engaging in science activities outside of school, such as visiting museums, correlates with children’s interest in science careers (e.g., Dabney et al. 2012). Designing exhibits to be engaging and educational can inspire the next generation of research workers as well as other people who are informed about and supportive of science. The belief that spectacle encourages learning is old, such as the full-size models of extinct animals at London’s Crystal Palace in the 1850s (Secord 2004) and even P. T. Barnum’s exhibits of shocking, allegedly natural animals and people (Kohlstedt 2005, 598). This enduring idea is evident in today’s zoos’ offerings of entertainment experiences such as IMAX films, trained animal performances, and amusement-park-like rides as well as visitors’ expectations that animals “do something” to earn their attention (Grazian 2015, chap. 5).

Perhaps visitors’ expectation of entertainment contributes to the growing popularity of glass-walled labs in museums for topics ranging from DNA research, astronomy, archaeology, art conservation, and fossil preparation (Gavigan 2009; Meyer 2011; Heimlich 2013; Carvajal 2016). The attraction may be the novelty of seeing people inside a display case, the portrayal of science as activity as well as objects and facts, or the mystery

of typically behind-the-scenes work. Peering into a space where you don't belong also imparts an intriguing sense of spying, like in restaurants with viewable kitchens or construction sites with peepholes in their safety fences. These situations usually involve one-sided surveillance. For example, workers can't see well from the bright lab into the dark exhibit space. They also try to ignore distracting outside activity to focus on their work. The one-sidedness can make the watching feel somehow more clandestine and attractive. For fossil preparation, the strong public appeal of dinosaurs (Mitchell 1998) adds to visitors' interest in exhibit labs. One contributing factor to this appeal is dinosaurs' reputation for large size and predatory scariness—a stereotype that leaves out the vast majority of dinosaur species but nonetheless persists (Noble 2016). Preparator Carla catered to these beliefs when she selected an artist's depiction of an extinct marine reptile to tape to the lab's window above an in-progress fossil of an ichthyosaur. The picture was “not what [this specimen] looked like [in life], but it was the biggest, scariest ichthyosaur I could find” on Google image search, she told me. She decided that visitors would prefer size and fear over accuracy to the specimen in view.

Glass-walled labs are dynamic to watch, but it is not clear how well visitors understand what they are watching. Researcher Emily prefers her museum's portrayal of preparation through detailed text descriptions supported by photos, tools, and fossils instead of a glass-walled lab. She considers glass-walled labs uninformative: “All you do is stare through the glass at somebody with a drill [*laughs*] working on a specimen, but it doesn't actually explain in detail how you go about doing it, what's involved. I'm glad we did that.” It's possible that Emily is expressing the common belief among researchers that preparation is boring. But I think her primary point was that watching research work without understanding it is boring. Herein lies a trade-off between entertainment and information. Is visitors' engagement or learning more important to museums? Would museums prefer to have visitors watch workers interact with specimens or read text that describes that work? I watched volunteer William, for example, slide open a fast-food-style window in the wall of the Southern Museum's exhibit lab to talk to a group of schoolchildren clustered outside. Leaning through

the window, he asked them, “Have you been to the dentist?” He followed this unexpected question by holding up and talking about the dental drills and scrapers he uses to prepare fossils—tools that were vaguely familiar to his young audience. One child asked William, “Are you a paleontologist?” He answered, “No, but I work for a paleontologist.” William refuted this common misconception that people in display labs are scientists, though without explaining what a preparator is or that he is a volunteer. The children were astonished and impressed, and perhaps they learned that cleaning fossils is like cleaning teeth. Thus this encounter could be understood as both entertaining and educational. More important, it contained the implicit message that people who aren’t scientists can do interesting, comprehensible work for scientists, such as scraping rock from fossils with dentists’ tools.

A Right to Be Informed

How research workers talk about displaying fossils reveals their implicit conceptions of museums’ civic duty as well as of visitors’ interests and cognitive abilities. For instance, as preparator Kevin and I walked past a bipedal dinosaur mounted in the Southern Museum’s exhibit hall, he pointed at the dinosaur and said, “Somebody took his arms off.” My jaw dropped and I stared at the skeleton, shocked by the desecration and implication of theft. There was no sign explaining that this dinosaur normally had arms. A visitor would assume, justifiably, that this species had no arms. (There are stranger features of extinct species, after all.) Then Kevin continued, with deadpan humor, “It was me.” A researcher had asked to study the arms, so Kevin had removed them from the skeleton. Leaving the removal unannounced (e.g., no informative sign) and not replaced with replica arms suggests that the researcher’s access to the bones took priority over visitors’ access. Interestingly, researchers’ view of a skeleton as discrete parts—for instance, research-worthy arms—doesn’t match the more common view of a skeleton as an animal.

How research workers talk about specimen reconstruction reflects their assumptions about the public. Seemingly simple decisions of whether to fill in a gap between two fossil fragments, and, if so, how to indicate that fill to

visitors, raise complex questions of epistemology, authenticity, and responsibility. Researcher Kirk explained how ideas about visitors' comprehension of science have changed over time: "Back in the day, people used to go to great lengths to make [plaster additions] the same color as the bone. . . . Their reason was it'll confuse people if they can see that some of that's real and some of it isn't. . . . We don't think today that that's an ethical thing to do." Museum staff have long believed that reconstructed completeness, like adding plaster sculptures of missing bones to a mounted dinosaur skeleton, helps compensate for visitors' lack of "skilled vision" (Grasseni 2004) to interpret bones, which scientists and technicians acquire through years of experience. To make fossils accessible to nonexperts, museum staff try to make them look relatively familiar by centering exhibits around complete skeletons (of bone and plaster) rather than fragmentary fossils. But the problem that staff see with historical mounts, as Kirk points out, is that visitors don't know which parts of a skeleton were made by people.

By referring to this issue in terms of ethics, Kirk raises questions of visitors' autonomy and what they ought to be allowed to know. Kirk's view is that reconstruction is a choice and should be explained to the public. As he put it,

That's something that preparators have to think about when they prepare these things, is they have to make it very clear [that] these are the bits that are real, that we know about, and these are the things that we don't know about, that we don't have, and we're not going to fill them in. Or if we are going to fill them in, then we're going to make it very clear that they're add-ons.

The mainstream approach among research workers regarding reconstruction for display is that add-ons and fills must be visually distinguishable from "real" bones. Methods for distinguishing them include painting them a different color from the bones' natural color or filling gaps to just below the bone surface, leaving a shallow but visible undercut. In my experience, however, the prevalence of specimens on display without distinct reconstructed parts is high. This suggests that other museum staff, such as in education or exhibit design, may prefer uniformity and the "big picture" of a specimen, rather than the details of which parts are real and which are

built. It's also likely that many of today's mounts are historic and do not reflect current beliefs about what information to share with visitors.

These goals of a whole specimen view and visually obvious reconstructions are not mutually exclusive. Laura, a conservator and preparator, described a common way to achieve both: "Everything we do we try and make visible, and we try not to falsify anything, even if it's for display. For exhibitions they have a six-foot, six-inch rule, that the repairs that you've made should be visible six inches away, but could be invisible about six feet away. . . . The overall effect, standing back, makes it look pristine." Pristine for Laura seems to mean complete and cohesive such that a skeleton looks like it is made only of bones. But she doesn't want to hide fills and other reconstructions, which to her implies falsifying the specimen. To resolve these seemingly conflicting goals, exhibit staff consider scale: repairs to bones should look natural from a visitor's view—six feet away—but should look reconstructed from a researcher's view—six inches away.

Interestingly, this solution relies on assumptions about access (i.e., how close a visitor or researcher can get to a specimen) and experienced, skillful vision. After all, researchers know how to identify reconstructions and other artifacts of preparation work such as tool marks even at a distance. Display design incorporates the assumption that the public does not know how to "see" the distinction between fossil and reconstruction, even when they're painted subtly different colors or set at different surface heights. Visitors don't know to look for those display conventions, or, if they do notice, how to interpret the differences to mean that one part is reconstructed (and which one? Or what if the entire skeleton is a plaster cast?). The most common way of addressing this problem is through text panels. For example, preparator Paul criticized another museum for inadequately labeling a mammoth skeleton on display: "The [tusks] that they faked, they painted [them] just a little bit different color so that the average person can't actually tell that there's two different color schemes there. The signage that's being put up this week hopefully will say 'tusks, cast.'" Thus the goal of making specimens look complete and natural to nonexperts is not purely historic. It persists in today's museums, though with more transparency about which parts are (not) fossils.

PRIORITIZING ACCESS FOR SCIENTISTS OR THE PUBLIC

Protect or Display the “Real Thing”?

Research workers explain the reason why the public should know which objects are real as epistemological as well as ethical. They consider specimens to be a physical defense of scientific knowledge; therefore specimens must be educational but also honest, such as with labeled reconstructions. Kirk linked this defensive role to US culture: “Museums always need to show the real thing, if only to show that they actually have it and they’re not just making stuff up. . . . Sad to say, this is a country where people still think that they get lied to by scientists.” Museums need specimens not just to help the public learn about nature but also to win their trust and challenge science deniers, like creationists and climate change skeptics. This view reflects a conception of science as an endeavor of persuasion and argument building (Shapin and Schaffer 1985), which occurs among scientists as well as between scientists and the public. In that sense, museums’ specimen displays and collections are a bank of evidence in the service of persuasion. That evidence might be less persuasive if the specimens are partly reconstructed, especially if they are falsely presented as entirely real.

Displaying real specimens brings challenges, however. Preparator Brad portrayed his museum’s display criterion as simple: “If we can do a real specimen without destroying it, we will.” In addition to fragile specimens, they also keep most type specimens in storage because they are “too important” to subject to the risks of display (e.g., damage from mounting or visitors), and too frequently studied to justify taking them on and off display. Yet when Brad and coworkers decided to display a particular type specimen, they molded it to make a cast for the exhibit. Then the original bones could be stored for protection and study. The process of molding a fossil, though, can cause significant damage. By risking it, the staff prioritized the public’s view of this unique specimen, even while protecting the bones from display.

Furthermore, all mounted fossil skeletons are a mix of bone and reconstruction. As Brad pointed out in a joking understatement, “It’s hard to find a complete dinosaur.” Researchers try to align the realities of

specimen condition and scientific value with museums' mission to educate the public through physical evidence of scientific knowledge. Researcher Emily similarly values balancing visitors' and scientists' access to fossils. She explained that at her museum, decisions about displaying specimens or casts are based on two main variables: "A, what we actually had that was originally in the collections, and B, how fragile things were." She added, "With original material that still has ongoing research on it, you then have the problem of making it accessible to perfectly legitimate visiting researchers' requests [*laughs*]." Prioritizing a museum's own less fragile specimens saves the trouble of borrowing other institutions' fossils, while also promoting institutional pride. Of course, mounting real fossils inconveniences the research workers who must take down the specimens on researchers' demand, but the staff decided to accept that extra work because they value showing visitors real fossils.

Another option that staff members consider—and consistently reject—is displaying digital models of fossils instead of physical specimens. Researcher Henry, for instance, told me, "There are some things you can completely do with CT scanning, but . . . [if] you want to put [a fossil] on display, then you have to clean it up nicely so that people can see it." Research workers prefer physical fossils for display and only approve of on-screen models made from CT scans when they are displayed alongside the specimens themselves. These views match their preferences for fossils over images for research too (chapter 3). They fear that only seeing a fossil "on a screen" (Tobias), or even "a really great interactive or something, like a touch screen that might have a rotating specimen" (Tim), isn't sufficient to convince people that fossils—and fossil-based knowledge—are real. Perhaps most museum visitors' everyday encounters with digital and 3D images via the internet and virtual reality means they know how easily these images can be faked. In comparison, few visitors have experience with fossils. Research workers thus assume that visitors might be more skeptical of overly impressive images than of dusty, slightly crumpled, partially reconstructed bones. This assumption matches research workers' own belief that seeing "real" fossils is emotionally and epistemically powerful.

Why Have a Glass-Walled Lab?

Visitors tend to crowd around glass-walled labs with excitement and curiosity, yet many workers are ambivalent about them as work spaces. The labs' primary stakeholders—visitors, exhibit designers, lab workers, and fossils—hold diverse priorities that they must strive to balance (Wylie 2019b, 2020). Macdonald (2002) documents the complex, dynamic design process that struggled to coordinate the diverse needs and values of museum administrators, curators, physical space, budget, visitors, and objects for a new exhibit at London's Science Museum. That exhibit did not contain scientifically valuable specimens, focusing instead on common artifacts and interactive machines. Adding fossils and researchers as actors further complicates the process. The very existence of exhibit labs suggests that the public's benefit is prioritized because preparing with observers does not benefit lab workers or fossils (though it might not harm them either). But preparing fossils is also a necessary task for research rather than a mere demonstration for visitors. How lab communities create compromise between these multiple perspectives reveals their priorities and beliefs about how they ought to portray science to the public.

Fossil exhibits are designed to communicate relatively direct messages about the history and evolution of life and environments, as shown by exhibit names such as *Prehistoric Journey* (Denver Museum of Nature and Science), *Deep Time* (Smithsonian Museum of Natural History), *Dinosaurs in Their Time* (Carnegie Museum of Natural History), and *Evolving Planet* (Field Museum). In comparison, it is less clear what glass-walled labs are meant to convey to visitors. For example, London's Science Museum displays James Watt's early nineteenth-century workshop behind glass for visitors to marvel at his engineering and chemical research equipment placed alongside art objects and everyday clutter. Historian Ben Russell (2014) argues that the workshop display can portray seemingly outdated engineering research as "making," a familiar and trendy activity for today's visitors. Are glass-walled labs intended to display science as messy and human, as is Watt's workshop? This idea would address historian Steven Shapin's (1992, 28) call for teaching the public that science is collective, trust dependent, and revisable. The typical public portrayals of a single

and infallible “scientific method,” or scientists as “magic,” all-knowing practitioners, risk both “public ignorance and public idealizations” of science, Shapin (1992, 29) warns. Glass-walled labs are one way to show what Shapin (1992, 28) calls the real, “warts-and-all” work of research. Likewise, collection manager and preparator Brent trusts glass-walled labs to correct visitors’ misconceptions:

People know about preparation, if they know about it at all, . . . from scenes in *Jurassic Park* where they’re . . . just brushing away the sand and gravel from a fossil, and after two or three minutes it’s perfectly prepared. I think people will have a greater appreciation for a mounted skeleton when they realize just how much work has gone into taking the rock off the bone. . . . The only way you’re going to teach the public that is to show it to them. Seeing is believing.

For Brent, witnessing fossil preparation can convince visitors that their knowledge—such as from a science fiction movie—isn’t accurate. If this realization can improve people’s appreciation for fossil mounts, perhaps it will also strengthen their trust in fossil-based knowledge.

If the goal of display labs is to provide public access to “real” scientific work, it is not made explicit to visitors. The text panels around display labs typically describe tools and specimens, but do not explain what an observer should learn from watching the lab. The grand narrative is missing. Lab workers, for instance, complain that visitors rarely understand whom they are watching. At best, visitors assume that the workers are scientists, though they actually self-identify as preparators or volunteers. In the least informed but surprisingly common cases, visitors think that the workers are mannequins or robots. After all, visitors do not expect to see living humans inside a museum case (Noble 2016, 255–256). Also, individual preparators are not named on the text panels around glass-walled labs. Unlike researchers who are named in descriptions of their work in text panels and publications, preparators are anonymous in exhibits, even when visitors are looking right at them. And unlike docents, preparators do not wear name tags. This anonymity suggests that preparators themselves are not the primary focus of display labs; instead, I surmise that their work and perhaps generic scientific work is the primary topic presented to visitors.

For example, Noble (2016, 264) observed that visitors mainly ask preparator questions about fossils, not about being a preparator. Even though the workers and work are on display, visitors tend to ask about facts, perhaps reflecting their past experiences with fact-based exhibits along with their lack of familiarity with displays of people and processes.

A Spectrum of Labs from Demonstration Space to Research Workplace

Exhibit lab workers themselves interpret their purposes and priorities in different ways. Most communities consider their lab a research space that also happens to be on display. One exception is a fossil preparation lab located among the fossil displays at a university museum in the United States. This lab is a small space separated from the exhibit only by shoulder-high plastic walls around a workbench, thereby allowing visitors to talk to a preparator at work. It is only occasionally staffed, usually when school groups are visiting. The preparator is most often Livia, who works for the museum's education department and learned to prepare fossils as an undergraduate. This lab is distinct from the university's research preparation lab, which is across campus. The research prep lab provides the exhibit prep lab with specimens and tools as well as occasional training.

Livia's work is a balance between ideal preparation methods and the constraints of a public exhibit space. Typical air scribes, for example, are too loud and create too much dust. Instead, Livia uses a small, weak Micro Jack that buzzes quietly and is only effective for removing soft rock. Alan, the head preparator in the research lab, told me that he gives museum staff fossils that are easy to prepare and not scientifically important. These fossils therefore don't need to be prepared quickly or particularly carefully. Perhaps in accordance with the fossils' low research value, Livia uses cyanoacrylate (i.e., a permanent glue that degrades over time) to repair them. In comparison, Alan "threw out" all the cyanoacrylate in his lab and replaced it with conservation-friendly reversible adhesives (chapter 1). Thus the exhibit lab's tools, techniques, and specimens differ from the research lab's. The lab serves more as a demonstration space than a research workplace. These adapted practices allow for an open-air prep lab to operate inside an exhibit, such that visitors can see specimens and tools up close as well

as speak with a preparator. In this display lab, the museum prioritizes education and public access over best practices for fossils or research. For a similar lab inside an exhibit, Noble (2016, 336) contends that the fossils emerging from preparators' tool tips served as "instruments" to demonstrate preparation work more than they served as evidence behind the facts on display.

In contrast, the Northern Museum's preparators consider their exhibit lab a research lab that just happens to have glass walls. They have multiple lab spaces, like Livia's university does. But the Northern Museum uses all its labs exclusively to prepare research specimens. Volunteer Daniel told me that before the glass-walled lab was built, he would microsort fossils on open tables in the exhibits and talk to visitors as he worked: "People loved it." In comparison, he finds that work in the enclosed exhibit lab focuses more on specimens than on the public. "We get more work done, but I miss talking to [visitors]." Preparator Amanda agrees with Daniel regarding the lab's productivity, but dismisses talking to visitors: "I'm interested in fossils being prepared, not interacting with people, and the more you talk to people, the less fossils get prepped." She thinks that docents, trained by education staff, should talk to visitors. This view matches her identity as a preparator who works for researchers. On the other hand, she is happy for the public to watch "our setup," meaning the glass-walled exhibit lab, because "from outside people aren't going to disturb our work but they can still see what's going on." As long as being on display doesn't affect her or other preparators' work, she is open to it.

What a lab looks like reflects its workers' priority for research or display too. For example, Amanda noticed that the Southern Museum's lab, which she had recently visited, has many "display items" out for the public to see, such as finished fossils as well as photos and drawings of specimens. She thought those items cluttered up important preparation space. Likewise, I noticed that the Southern Museum preparators and volunteers leave their specimens and tools on the lab tables when they go home. While this may be a pragmatic solution to storage shortage and the large size of some specimens, it also provides something for the public to look at when no one is in the lab. Northern Museum workers, in comparison, put away

their fossils and tools when they finish, leaving the lab rather barren. On Sundays, when the Northern Museum lab is not staffed, only microscopes, tables, and chairs are visible. The exception is staff preparator Carla, who intentionally leaves out specimens in progress for visitors to see. Carla works in this lab five days a week, unlike the rotating roster of volunteers, so perhaps her status as staff and an everyday presence allows her to claim one tabletop as always hers, and hence to skip putting her work away. Carla sometimes tapes paper signs to the windows for visitors to read, as do a few volunteers. Some signs describe the specimens being prepared and others beg, “Please do not tap on the glass,” as a poignant reminder of the challenges of doing delicate, precise work while on display.

Despite facilitating the public’s view and knowledge of her work, Carla—like Amanda—considers her primary responsibility to be preparing fossils for research. Amanda even expressed some disdain for the Southern Museum’s visitor-friendly display of specimens and tools: “We don’t have that sort of thing, just a lab operation.” Amanda’s perspective may reflect our society’s greater appreciation for research than for display. At a privately funded museum whose budget relies on ticket sales, it seems counterintuitive that the Northern Museum staff would focus on research over visitor satisfaction. Indeed, these research workers perceive their display lab as a valuable opportunity for the public to watch preparators work. But they believe that a display lab should be first and foremost a lab, not just another area to show objects and information or for staff to interact with visitors.

The Southern Museum’s approach is a middle ground, with more research-focused preparation in the display lab than at Livia’s university museum, but with a stronger effort to engage with the public than at the Northern Museum. Because it is publicly funded, the Southern Museum has less financial need to attract visitors. Lab workers’ greater attention to visitors perhaps derives from the museum’s mission of public service. The Southern Museum’s lab, for instance, has a sliding window, mimicking a fast-food drive-in, to allow preparators and visitors to talk. The window locks from the inside, though; preparators choose whether to open it. The Northern Museum’s lab has no such portal. Also, the Southern Museum’s

lab has windows all around it, while the Northern Museum's lab has a small back room that visitors can't see. Workers use this room for storage and as a retreat during breaks. Amanda noticed with disbelief that the Southern Museum's lab gives preparators "no place to escape" the public. On the other hand, the Southern Museum's design offers the public more visual access. Another indicator of their different approaches are the signs about specimens. Unlike the Northern Museum's occasional informational signs alongside permanent warning signs, the Southern Museum has many homemade signs describing specimens and none asking the public to stay back (figure 5.1). These window decorations are a powerful indicator of the labs' different ideas of their purpose: to serve primarily science and scientists, or education and the public.

Display labs serve political purposes too by attracting and impressing visitors, and thus earning lab workers the museum's gratitude. Preparator



Figure 5.1

Some preparators in glass-walled labs set up signs to tell museum visitors about specimens, such as this whiteboard describing a skull and inviting questions from the public.

April said about her museum's glass-walled lab, "The public loves it, and Public Programs loves it. . . . So the biggest problem with it is staffing, . . . [access to compressed] air, and dust buildup." For the museum, the financial and educational importance of pleasing visitors outweighs the lab's not-ideal equipment and April's challenge of recruiting and training enough volunteers. Amanda explained that the Northern Museum's glass-walled lab enjoys the same admiration from visitors and the institution: "Education [Department] loves us, right, because of fossils, dinosaurs, lots of action in the lab." A disadvantage of the institution's appreciation for visitor-friendly attractions is that it causes a "flood" of demands on staff preparators' time, such as giving lab tours. Amanda considers it her responsibility to limit these requests, which she sees as detrimental to the staff's primary task of preparing fossils.

The Art of Omission

Museum staff sometimes make decisions that limit public access in order to protect research. For example, institutions typically conceal new specimens from external researchers until their own researchers have published scientific descriptions of the specimens and thereby claimed that intellectual property. So when preparators Amanda and Carla built a website to tell the public about current projects in the Northern Museum's display lab, the website's information could only be basic because most of the specimens that the lab prepares have not yet been studied. Amanda explained, "It's fine to tell [the public] that we are working on a theropod, but we can't give them too much detail." Revealing a specimen's general classification category (e.g., belonging to the suborder of Theropoda) does not threaten researchers' claims to first publication, but describing its specific features could give away important data. For the same reason, the website does not include high-quality photos of specimens. Ownership of unpublished specimens came up in my ethnographic fieldwork too, in that research workers were hesitant to allow me to photograph fossils for fear that other scientists would be able to study the specimens from the photos I publish. Displaying scientific works in progress in exhibit labs seems to conflict with the common practice of not sharing unpublished data.

The fact that researchers permit specimens to be prepared in public view—which I never heard them voice concerns about—may indicate a distinction they perceive between the public and researchers. It's fine for visitors to see an unpublished, new-to-science fossil, but not for competing researchers. This may reflect these groups' difference in skilled vision (Grasseni 2004) given that a fossil researcher is much more likely to notice a rare specimen in the lab than a nonexpert is. Likewise, nonresearcher visitors to Amanda and Carla's website may not notice the absence of the detailed information that researchers value, such as what is new about a particular fossil. But it does surprise me that research workers do not see the boundary between these groups as more porous. A researcher could potentially access an unpublished, partially prepared fossil by standing outside a glass-walled lab or finding a visitor's photo of a specimen posted publicly online. But no research worker mentioned this possibility to me. Perhaps this is not a concern because scientifically important specimens are more likely to be prepared by staff preparators, most of whom work behind the scenes (chapter 2). So blockbuster fossils might be kept out of public view coincidentally rather than to protect researchers' publication priority.

The concern—or lack thereof—about showing unpublished specimens is a reminder that a display lab is a performance space, with the actions and objects inside controlled and planned to project certain impressions to the public. This is easy to forget because the lab contains living people with real fossils, dust, snacks, and conversations. As a result, I got caught up in the exciting idea of everyone being able to watch the fossil labs that I find fascinating. Preparator Jay reminded me of the importance of controlling performance by laughing at my naivete. Early one morning at the Southern Museum, he and a collection manager, Bob, and I went to the display lab to turn over a fossil whale skull so that its underside could be prepared. It was large, heavy, and spiderwebbed by cracks that threatened to crumble it into pieces. I suggested that they wait to turn the skull until after the museum had opened so that visitors could watch their skillful handling of unwieldy fossils. Jay answered emphatically that he does this kind of work *before* the public arrives. With a jolt, I realized the implications that were obvious to Jay: damaging the skull would be terrible, but damaging it with

an audience would be worse. The image of professionalism that lab workers try to project would be as shattered as the skull. On the other hand, was the lab misleading viewers by hiding risky yet integral components of preparation work?

Lab manager Amber expressed similar concerns about preventing an embarrassing performance when the Southern Museum's Exhibits Department wanted to install a webcam to livestream the glass-walled lab's activities online. In response, Amber told me, she printed a screenshot from another museum's fossil lab webcam that showed an empty room. She brought it to the Exhibits Department staff, asking sarcastically, "Is that what you want?" No lab is staffed all the time, such as during lunch and outside museum opening hours. Volunteer-staffed labs in particular struggle to "stock the fishbowl" (Jabo 2009) with workers. Amber thought portraying that reality to the public did not reflect well on the lab or museum. It's possible that she feared an empty lab would suggest laziness or unprofessionalism, or perhaps portray the lab as just another unpeopled display space rather than a workplace. Controlling aspects of the portrayal of research work is one way in which museums prepare a vision of science for public consumption.

Exhibit labs, despite their transparent walls, are selective. Aspects of laboratory practice that are omitted can include risky tasks, loud tools, unpublished specimens, techniques requiring ventilation or compressed air systems that a lab may lack, and who the workers are (i.e., the unexplained distinctions between volunteers, staff preparators, and scientists). These omissions can make preparation appear simpler for workers and safer for fossils than it is. Of course, all displays offer selective versions of complex systems. No display can be comprehensive due to constraints of money, space, and visitors' attention spans. Rather, what displays include and don't include reveals the values and beliefs of the workers and institutions that build them. Specifically, museum workers assume that visitors should learn how science is done but not the unpleasant aspects of it, such as the perils of damaging specimens, inhaling rock dust, or gluing your fingers to a fossil. They also believe that visitors benefit from watching lab work, even a selective performance of it and even without necessarily understanding

what they see. In most museums, that benefit is subordinate to scientists' access to prepared fossils, such that scientifically significant fossils are not on display and preparators spend most of their time preparing rather than educating. In this view, glass-walled labs are spaces that house research work that, lightly edited, serves a secondary purpose as a learning opportunity for visitors to glimpse science as a process.

DISPLAYING OURSELVES

Displays as Sources of Pride

Museum workers perceive exhibits as the public version of their work, even if they are not specifically responsible for exhibits. They want the exhibits to reflect well on themselves, their museum, and science. As a result, they use exhibits as a way to influence how visitors perceive them—a process that Goffman (1956) calls impression management. For instance, preparator Kevin walked by a recently mounted cast stegosaur skeleton that was temporarily parked in the behind-the-scenes lab. He took a moment to fix a dried paint drip on its plaster vertebra. “What color is he?” Kevin wondered aloud as he mixed a few drops of gray and brown paints in a paper cup. He brushed one stroke of the paint over the drip and was satisfied with the improvement: “That’s been keeping me awake nights.” He was joking, but with a vein of truth. His interest in making the mount look its best reflects his commitment to doing good work and presenting his work well for the public.

The primary way that research workers voice their investment of identity in exhibits is about cleanliness. They are quick to spot a dusty dinosaur, and then express disapproval or even shame. Workers' concern can be explained by the fact that dust can damage fossil bone in the long term as well as their desire to have specimens appear well cared for to a public audience. One volunteer called dusty exhibits “embarrassing.” Likewise, preparator Mary hates the gravel placed beneath her museum's mounted sauropod skeleton because it “attracts dust,” is hard to clean, and therefore “always looks bad.” At the opening of one museum's new fossil exhibit, several preparators from other institutions criticized the plastic

plants placed artistically around the dinosaurs. Their complaint was that the plants' complex surfaces would take a lot of work to clean.

Cleaning large exhibit specimens is a major event for research workers and institutions because it is risky for the specimens as well as logistically challenging. Dinosaur dusting attracts visitors' attention and even press coverage, perhaps because it is so incongruous to see a human perched precariously on a ladder waving a pink feather duster between a dinosaur's ribs. Only preparator and collection manager Bill Simpson is allowed to clean the Field Museum's famous *T. rex* Sue because of the expertise required (Johnson 2015). Removing dust and cobwebs from fragile bones, often with a duster or the tube of a vacuum cleaner, requires a delicate touch, long reach, and good balance. One preparator told me that he broke the tip of a rib off an important specimen just by touching it with a duster. Another found bird droppings on a vertebra of an extremely tall dinosaur and had to leave them there because he didn't know how to best remove them at such a height, and without damaging the bones with water or chemical cleaners. This inability to clean the fossil bothered the preparator, even though no one could actually see the top of the dinosaur. Valuing good exhibits reflects research workers' hope that the public will admire their work and institution.

Looking Good

Like fossil displays, exhibit labs are a source of pride for research workers. They consider the labs and specimens as the performative "front stage" of their work, even while visitors might assume that it is the backstage (Goffman 1956). As mentioned, some staff and volunteer preparators illustrate their work for the public, such as by placing images and information about extinct animals in public view, or writing daily descriptions of their work on small, propped-up whiteboards (figure 5.1). In addition, many volunteers create personal files of their work-in-progress photos, hand-drawn maps showing bones' locations in a block of rock, and notes on their techniques and experiences with each fossil. Staff preparators do not require or even suggest this documentation in most labs, and few record this kind of information themselves. Rather, the files are more like personal reflections and memory joggers to help volunteers keep track of their work.

This informal record keeping reflects volunteers' intention to do good work in the interest of the fossil, research, their own pride, and, in exhibit labs, visitors. Disorganized or misdirected preparation work could be visible to visitors, and record keeping can help volunteers feel more confident in their practices.

Presenting themselves as competent and professional to the public is important to lab workers. Their occasional self-consciousness about preparing in public evokes Goffman's (1956) idea of impression management in that they articulate their underlying hopes for how others perceive them. As discussed before, cleanliness is one factor they especially value for workspaces as well as fossils. For example, Southern Museum volunteer Carl complained to me that while custodians regularly clean the public side of the lab's windows, where "kids put their hands and noses," the windows stay dirty on the inside and therefore never look clean. Once, an offer of media attention triggered a flurry of activity from the Southern Museum staff and volunteers to make the exhibit lab look its best: a TV news program wanted to interview a museum administrator with the lab as backdrop. When staff preparator Jay heard this plan, less than twenty-four hours before the interview, his first reaction was, "We better clean up the place." Volunteers set to work tidying the lab's tools and specimens. Lab manager Amber asked the maintenance department to collect the lab's trash, even though it wasn't the normal pickup day. Her next planning move, interestingly, was to call a woman volunteer and ask her to work in the lab during the interview. Only men were scheduled to volunteer that day and "we can't have all men," Amber told me. She saw the televised spotlight as an opportunity to portray scientific work as women's work as well as men's. The larger audience of TV news, as compared to the lab's normal visitor numbers, revealed lab workers' beliefs about how they want to portray their work and themselves.

Another high-profile event, one museum's annual Fossil Day, attracts large crowds to the glass-walled prep lab, which gives lab workers minor performance anxiety. When volunteer Jack showed off an easy-to-prepare fossil (with "good color distinction" between the soft matrix and hard bone) to other volunteers, he joked that he'd like to "save it" to prepare on

Fossil Day “so people won’t see me cursing and swearing” at a more difficult specimen. His comment captures volunteers’ motivation to perform their roles well for the public. Another of Jack’s stories that reflected volunteers’ awareness of being watched and the humor of a fishbowl workplace was when he told a group of volunteers and me that his wife teases him that he, an octogenarian, would accidentally take his nap while working in the lab. Another volunteer replied, “Then people will say, ‘There’s the fossil!’” This was a good-natured and well-received joke about Jack’s age, while also indicating how volunteers think about their exposed position as representatives of the museum and paleontology. They don’t want visitors to perceive them as messy, unprofessional, frustrated, or sleepy, and this aversion shapes their behavior.

How Exhibit Labs Prepare Science for the Public

Exhibit labs are a powerful medium for presenting research workers’ message about what science is to a public audience. There are aspects of that message that workers do not mention and may not be aware of, but that I see as crucial. Specifically, I argue that exhibit labs subtly present science as accessible and relevant to nonexperts. Labs are less narrated and labeled than fossil displays—an approach Emily criticized as less informative than her museum’s text-and-object way of explaining fossil preparation. On the other hand, leaving the display lab rather unexplained encourages visitors to pose questions and observe closely to try to answer them, such as “What are they doing?” “What is that tool for?” and “Are those people or robots?” Of course, visitors also wonder about text panels and labeled specimens, but text-directed observation may be a less engaged, less inductive learning experience than curiosity-driven observation. For example, students are more likely to remember information they learn through constructivist activities than from reading or listening to lectures (Hein 1998); this is likely true for museum visitors too. Perhaps this outcome occurs because learners are practicing skills of question formation, close observation, and theory construction. Their theories (e.g., that lab workers are “making fossils”) may not agree with lab workers’ own conceptions of their work, but encouraging visitors to practice evidence-based wondering is a powerful

contribution to visitors' understanding of how scientists do research as well as how to learn for themselves. Honing these skills is arguably more important than remembering the specific facts listed on a text panel.

Moreover, I wonder whether visitors might feel empowered by using their own logic and experiences to construct an explanation. As a result, they may be more likely to perceive science as interesting, relevant, and achievable. They could even feel encouraged to pursue science through formal or informal study, or perhaps by volunteering. How visitors perceive the conception of science that workers perform in glass-walled labs is a separate question that deserves more research. Nonetheless, these speculations would all be desirable outcomes for museums by increasing public satisfaction with museum visits as well as promoting science as accessible and important.

Technicians' active work with specimens, tools, and each other makes a better show than researchers' common low-action tasks of examining specimens, reading and writing papers, and staring at computer screens. Thus one plausible motivation for establishing glass-walled labs full of technicians and volunteers as opposed to scientists is that visible, physical research practices are more accessible to nonexperts than are the details of morphology and phylogeny that fill scientific publications. Furthermore, scratching rock off a fossil with a buzzing tool might look easy to an uninformed observer. This perception, though inaccurate, could encourage visitors to participate in research work, such as by volunteering for a museum or citizen science project. These ideas can help construct a new view of science, not as the black boxed, exclusive domain of lab-coated, PhD-holding scientists, but as enjoyable, significant, learnable work to which anyone can contribute.

The "like me" appearance of research workers on display, most of whom after all are volunteers, can further support the idea that research work is inclusive and relatable. Amber wanted a woman volunteer present for the lab's TV debut, perhaps as a role model for girls to recognize that people like them prepare fossils. Also, rather than uniforms or lab coats, lab workers tend to wear casual clothes, much like museum visitors. Staff and volunteer preparators wear old, comfortable clothes, sometimes stained by

matrix, adhesives, and plaster. They pair jeans or nylon hiking trousers with an overrepresentation of dinosaur T-shirts. Sneakers or hiking boots are standard. This performance of science, then, is costumed for the look of manual or outdoor work. One might expect an admonition from lab staff or museum administrators to “look nice” while working in public view, but I never heard anyone comment on preparators’ clothes.

Preparators’ informal, self-chosen clothes indicate their identity as creative experts. A group of volunteers in one US lab designed work aprons emblazoned with the lab’s name, but wearing them was not required or common. Staff talked about the aprons as a rather cute display of volunteer community building, implying some disdain for a desire to wear matching clothes. Wearing a uniform, even a high-status one like a lab coat, could diminish preparators’ identity as skilled craft workers by sacrificing control over their wardrobe. Similarly, workers in settings with white-collar dress codes can declare their group’s identity and power through casual clothes. For example, “computer techs could get by wearing jeans and even t-shirts. . . . Their clothing signaled that their skills were so critical to users that they could disregard fitting in as long as they kept the machines and systems running” (Barley, Bechky, and Nelsen 2016, 139). The clothing distinction between preparators and researchers is less striking than between computer technicians and their white-collar clients, because fossil researchers (men and women) most often wear jeans or slacks along with a T-shirt or collared shirt, not suits. I wonder if lab workers’ fashion choices might inadvertently help visitors imagine themselves doing scientific work as a result of watching people who look like them doing it.

Scientists and preparators alike primarily framed the labs’ mission as demonstrating a little-known and interesting-to-watch component of paleontology. No practitioners told me that the labs are walled with glass to encourage visitors to consider participating in science. For instance, I have never seen a display lab with a sign inviting people to become museum volunteers, even though an audience of lab observers seems like a prime recruitment opportunity. So it’s possible that the inclusive message that I perceive in the display of familiar, relatable people doing active, appealing work is unintentional, though certainly not misaligned with museums’

goals. Even if lab workers understand display labs as research spaces and/or educational viewing more than as advertisements for inclusive participation in science, I think these labs have the potential to achieve all three.

Including the public in research work relies on and defines science as a kind of work that benefits from diverse skills and perspectives. The locked, hidden, behind-the-scenes lab and the exclusive realm of legitimate knowledge preparation are tightly connected. Accordingly, opening research spaces could also involve welcoming nonexperts into the assiduously controlled world of scientific publications, conferences, and respected knowledge claims. If people collect, process, and analyze data, after all, they are preparing evidence and thereby contributing to the preparation of knowledge. Some researchers even recognize citizen scientists by designating them as coauthors of publications (e.g., Banfield et al. 2016; Bohannon 2016). Fossil preparators—staff and volunteer—are rarely granted authorship, but their skill, expert judgment of technologies, sense of identity in their community, pride in their work, and role as the *de facto* public face of fossil research are powerful achievements. In this frame, their invisibility in print seems less like an insult and more like a means to allow them to create their own visibility where they want it, namely as leaders in the lab, both backstage and on display.

CONCLUSION: PREPARING AN AUDIENCE FOR SCIENCE

Displays are a long-established and powerful mechanism of proposing a conception of science to the public. Traditional exhibits of inanimate objects and strongly stated facts tend to present science as passive, dehumanized, reliable, and finished. Displays of live laboratory work, in comparison, offer a view of science as active, human, ongoing, and perhaps relatable. How visitors interpret these messages merits further study, but it is likely that how practitioners prepare conceptions of science, along with how they prepare evidence, communities, and technologies, influences everyone's knowledge about nature.

How practitioners prepare a conception of science for public consumption is not always intentional. Embedded in decisions about whether to

display sculpted reconstructions, cast replicas, or “real” fossils, for example, are assumptions about what visitors can understand, will be interested in, and deserve, as well as priorities about whether specimen access is more important for the public or scientists. Research workers articulate a responsibility to share knowledge with the public about research work and nature. Traditional exhibit designs tend to omit information about how facts and finished fossils were produced and by whom; glass-walled labs have the potential to fill in that omission by offering literal—though managed—transparency, or what I elsewhere call a glass box instead of a black box around research work (Wylie 2020). What happens on display is always edited, sometimes misleading, and may not be comprehensible for visitors. Nevertheless, these labs can provide a powerful opportunity for visitors to wonder about what they’re seeing, thus inspiring them to apply classic scientific skills of posing questions, collecting evidence by observing, and constructing interpretations of their evidence. This inductive experience of an exhibit offers more open-endedness than a beautifully finished diorama or dinosaur mount, thereby requiring more cognitive labor from visitors but also encouraging their engagement and curiosity.

Displaying science as tasks as done by people whose clothing and behavior are somewhat familiar to visitors portrays science as just another kind of work. This view challenges a common perception of science as exclusive and mysterious. Telling the public that these technicians don’t have PhDs and that many are volunteers would further break down perceived barriers between nonscientists and scientists, and more strongly portray science as inclusive and accessible. Furthermore, glass-walled labs make visible the everyday actions of preparing knowledge—that is, the skillful, inseparable analysis of social and physical contexts to make informed decisions. What workers choose to perform and not perform in these fishbowl labs reflects their notions of good work, and how they behave under surveillance indicates their desires for how they want others to perceive them. I speculate and hope that inserting these windows into scientific work and communities encourages the public to learn more about science, and even participate in it as a career or hobby.

