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Virtual History

Martin Luther King's Dexter Avenue Baptist Church stands less than a block away from the State Capitol complex in Montgomery, Alabama (http://virtualglobetrotting.com/map/dexter-avenue-king-memorial-baptist-church-1/view/?service=0). Each structure in its own way represents important symbols of the civil rights movement—the Dexter Avenue church where Dr. King delivered many of his major sermons, the State Capitol the site of white power, of the segregationist Governor George Wallace, of state troopers. These two combatants in the civil rights movement were literally yards apart spatially; unlike fighters in a boxing match, who retreat to separate corners at the end of the round, these combatants had no separate corners to which to retreat. That absence of escape, that lack of reprieve, that constant reminder of white power symbolizes how King and other African-Americans had to live this conflict, reinforced by the physical proximity of this symbol of oppression. That proximity shaped the actions of civil rights activists; the church signboard that read "Jesus supported civil rights" was clearly intended for the white officials heading to the Capitol, a message aimed at those in power. "What did it mean to face your enemy at all times?" asks the historian of the civil rights movement Hasan Jeffries. "How does one negotiate this space when seeking to be an agent of change? How does one resist oppression given the proximity of white power, and how are one's actions shaped by these spatial considerations?" he asks. Space, location, distance, and proximity were important, if underappreciated, features of the civil rights movement. We know that churches like the Dexter Avenue church were important sites in the civil rights movement, but Jeffries suggests that their location in space and other considerations of proximity are rarely mentioned in histories of the movement. How activists moved through and experienced that space impacted the decisions they made.[1]

Jeffries describes this physical setting well in words, but insists that it is far preferable to see these spatial dimensions for oneself and even better to experience them, to walk up Dexter Avenue to the church and to see the Capitol rising up the hill. As this example illustrates, space is far more than just a container for historical events, a stage upon which events are enacted. Space is also more than simply the arrangement of objects. Instead, it is a cultural construction that shapes actions and events. We can consider space as a category of historical investigation, and indeed we might even speak of space as a historical actor.

While one can certainly visit Montgomery today and see the Capitol and the church in situ, there are countless other spaces of the past that have long since disappeared. Representing these spaces, and especially allowing people to experience these spaces, strikes me as one of the most important possibilities afforded by virtual reality technologies. Virtual reality describes any number of computer-generated, three-dimensional spaces with objects and people that seem very real and with whom viewers may interact as if they were real. Virtual reality systems have also been devised that allow the user to be surrounded by these images, as opposed to looking at a flat screen. Three-dimensional online worlds such as World of Warcraft and Second Life proliferate, their users "experiencing" an alternative, virtually habitable reality (and, critics contend, eschewing physical reality). Such immersive virtual reality includes important, nonentertainment applications such as flight simulations and medical simulations. Some observers, most notably Janet Murray, note that these virtual reality environments are the new sites for narrative storytelling, stories having moved from oral epic, to novel, to film, and now to virtual environments.[2] While nothing yet like the Holodeck on *Star Trek*—where participants enter into a specially fitted room and interact with physically tangible objects and people—virtual reality transports the viewer into "wholly different worlds."

Members of our larger visual culture are already experiencing "the past as virtual reality," especially via commercially produced video games. Thus, historians who wish to author virtual historical worlds will find an eager, appreciative audience. Accustomed to entering electronic virtual worlds, video gamers are drawn into virtual Civil War battle sites or a virtual Roman Colosseum, participating as foot soldiers and gladiators. In the same way that they run away from narrative story in words, those raised in a virtual culture eschew written narratives about the past and opt instead for virtual re-creations into which they feel compelled to

enter and participate. What are the affordances of this medium that are attractive for historical narrative?

The answer depends, of course, on whether or not historians insist on remaining strictly word people. The answer also depends on whether the profession wants to make the past come to life. Some historians have recently called for a "return to narrative." Rejecting jargon-laden, theoretical, and densely analytic prose, these historians have called for a return to "history as story," with real human beings and some sort of plot or moral purpose, as opposed to coldly scientific prose that seems to remove the flavor of human experience. This same narrative impulse might compel some historians to re-create the past through virtual reality technologies. Their re-creations—their virtual secondary sources—would be alive with "real" objects and "real" people with whom viewers could interact, rather than with abstractions to be monitored from a distance. Far from seeking merely an entertaining environment for video game players, these historians would instead seek to carry out the activities of the historian in virtual form: a scholarly inquiry intended to answer a problematic question, relying on primary sources, displayed as a three-dimensional virtual secondary source.

These visual historians and the consumers of their secondary sources need to immerse themselves without illusion, however. Like any other secondary source, a virtual re-creation of a past event is a constructed artifact, not the actual past itself. There is still a great deal of missing information that unsuspecting participants might easily overlook. Not all sources survive, nor can a virtual environment exactly replicate the "real reality" being modeled. Thus, despite what our senses might be telling us, a virtual re-creation is as abstract as a written narrative, only rather than being a model constructed from words it is constructed from three-dimensional images. Despite our best efforts, we can never hope to make the past truly "come to life." Virtual reality as a model for historical inquiry opens up new vistas of interpretation, but it is as limited as any other representation of the past.

Spaces of Illusion

The desire to "enter into" realistic images is an ancient impulse. Oliver Grau observes that "the idea of installing an observer in a hermetically closed-off image space of illusion did not make its first appearance with the technical invention of computer-aided virtual realities." Grau argues

that these "spaces of illusion" date at least to the frescos painted at certain villas, such as the Villa Livia, in the Roman Republic:

> Wall paintings from the late Roman Republic painted in the Second Style of Pompeii have survived that include not only mimetic but illusionary elements. Through the device of seeming to extend the wall surface beyond a single plane, the room appears larger than its actual size and draws the visitor's gaze into the painting, blurring distinctions between real space and image space. The most effective examples of these frescos use motifs that address the observer from all sides in a unity of time and place, enclosing him or her hermetically. This creates an illusion of being in the picture, inside an image space and its illusionary events.[3]

The Chambre du Cerf, which dates to 1343, and Renaissance-era villas also contained what Grau describes as "360° images," rooms containing naturalistic scenes that surround the viewer. These spaces created the illusion of immersion, efforts "to make the image appear as the source of the real." The "intention" of such spaces, notes Grau, was "to install an artificial world that renders the image space a totality or at least fills the observer's entire field of vision."[4]

In the nineteenth century, artists created panoramas, which Grau contends "represented the highest developed form of illusionism" to date; importantly, the illusionary and immersive effects were "a precalculated outcome of the application of technological, physiological, and psychological knowledge." Grau especially notes that the panorama The Battle of Sedan (1883) (www.medienkunstnetz.de/works/sedan-panorama/images/1/), a German commemoration of that decisive battle, was perhaps the most developed form of the genre and one that anticipates the virtual spaces created with computers and other digital tools. Roman and Renaissance spaces of illusion were created, apparently, as "a virtual refuge in the form of a peaceful garden,"[5] but military battles were frequently the themes of panoramas, not unlike the way in which today's video games and massively multiplayer online role-playing games (MMORPGs) seem to focus on warfare and combat.

While the word "virtual" is quite old, its digital connotations date to the 1960s. Computer scientists were already using the term "virtual" to connote "not physically existing as such but made by software to appear to do so from the point of view of the program or the user."[6] "Virtual" here did not mean simulated reality, however; it referred to the storage of memory in some form outside the physical hardware of the computer,

as on a disk. This meaning of the term was significantly altered by Ivan Sutherland. Already a pioneer in three-dimensional computer graphics, Sutherland, a computer scientist at MIT and later the University of Utah, developed one of the first virtual reality devices in the late 1960s. Dubbed "the ultimate display," it consisted of large, bulky, head-mounted goggles that projected images onto small mirrors in front of the eyes (http://design.osu.edu/carlson/history/lesson17.html). Projected over the actual surroundings of the viewer, the images were little more than a simple cube that the viewer could observe from different angles.[7] Yet Sutherland proclaimed that the technology would lead to a three-dimensional imaginary world that not only looked real but felt real as well. "The ultimate display," he wrote in 1965,

> would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate programming such a display could literally be the wonderland into which Alice walked.[8]

An important difference between Sutherland's wonderland and, indeed, subsequent developments in virtual reality and the earlier examples of "spaces of illusion" was that virtual spaces would include the ability of the viewer to affect or interact with the space, rather than just passively observe.

Sutherland's work, which seemed impractical and esoteric, drew little attention at the time. The one exception was the military, which saw the benefits of these technologies as a flight simulation tool. Throughout the 1970s and into the early 1980s, the U.S. military as well as the space program invested in these computerized simulations. Commercial application of virtual reality technologies became more commonplace in the middle of the 1980s. Although the term "virtual" had circled around computer science labs for decades, it was a former computer game programmer, Jaron Lanier, who first coined the term "virtual reality" to describe not only a specific set of three-dimensional graphics technologies but also the digital wonderland imagined by Sutherland. By the middle of the 1980s, the term was popularized in the mass media, and new applications outside of the military-industrial complex were developed, especially in entertainment. Virtual reality booths appeared at arcades and carnivals, where users donned goggles and fought imaginary battles.

Science fiction writers also popularized the concept of virtual reality. William Gibson, who coined the neologism "cyberspace," described a computer "matrix" in his book *Neuromancer*, where a user could "jack into" a computerized world by snapping an interface directly into the brain. Cyberpunk fiction writers prominently featured virtual reality themes. *Star Trek: The Next Generation*, the syndicated update of the 1960s show, featured the Holodeck, a virtual reality system that Sutherland himself would have recognized. Even outside of the relatively isolated world of science fiction, the term "virtual" was placed in front of just about everything, from "offices" to "sex," to describe a computer-mediated—albeit faux—experience.[9]

Outside these mass market spectacles, serious artists explored virtual reality as a legitimate medium, especially its interactive capabilities. The artist Toni Dove, for example, created interactive virtual narratives. One installation, *Artificial Changelings* (www.tonidove.com/af_overview_hold.html), was a large screen, surrounded by motion sensors, that created a narrative space. By stepping on electronically connected pads on the floor, a viewer moved the video images forward or backward in time, thereby shifting the direction of the narrative. By moving her arms around, the viewer could influence the pace of the narrative; by standing still, she could make the sounds and visual images also stand still. The effect was like being able to influence the sequential flow of a movie rather than merely watching the screen. This installation suggested that virtual reality could enable artists to construct meaningful interactive visual narratives outside of mindless entertainment.[10]

Virtual reality has been deployed for training situations. As noted before, the military was among the first to use virtual reality, specifically as a flight simulation tool. Army psychologists now use simulated spaces depicting urban warfare scenes as a way to help veterans with PTSD to safely confront the horrors they faced.[11] The medical profession now uses the technology as a way for interns to practice complex medical techniques and for doctors to consult in virtual examination rooms and operating theaters. Robotic surgery and surgery-at-a-distance are becoming increasingly commonplace. Air traffic controllers now gain "real" experiences of that hectic occupation before being given responsibility for real planes. In many cases, the technology is used to simulate an activity that is too risky to perform with real people and expensive objects.

The technology is useful for simulation in less dangerous occupations as well. There are many applications in science and technology,

for example. Astronomers create virtual models of planets, perhaps in preparation for landings. Engineers test new designs in virtual wind tunnels. Manufacturers, therefore, design, build, and test simulated products before committing large amounts of capital to actual construction. Chemists wed powerful microscopes with virtual reality technologies. The result is a virtual molecule that the scientist can manipulate and "explore" like an uncharted terrain. Such an approach to science sounds very much like the botanist Barbara McClintock's phrase "a feel for the organism"—that is, a level of intimacy with natural objects that yields new insights.

Architects use virtual reality spaces to design and display their work. Rather than working strictly from flat blueprints, architects imagine and model their creations with building information modeling (BIM). Instead of wood and cardboard models, architects and their clients render and experience buildings as if they were actually constructed. Many a presentation includes a virtual walk-through of the potential space for the benefit of clients. Revisions to the plan can be quickly adapted. While one may not be "immersed" in such environments, the realistic graphics allow for a certain amount of "virtual immersion."

Far beyond *Pong* and other early Atari games, video games now look more like virtual reality in that they are at once realistic, immersive, and interactive. Massively multiplayer online role-playing games (MMORPGs) such as *World of Warcraft* appear like high-tech versions of nineteenth-century military panoramas. Even if the games are not as visually immersive as the ideal virtual reality spaces, many MMORPG players enter into such games for hours at a time, their actions mimicking real-world activities and behaviors, from the consolidation of empires to organized raids to even an underground virtual economy that trades in virtual objects for real money. Critics of such online games lament the players' seeming retreat from the physical world, conjuring scenes from science fiction movies such as *The Matrix*, where the players' inert physical bodies lie in stasis "jacked into" an imaginary virtual world. Gibson's vision of cyberspace described in his science fiction novel *Neuromancer* today appears more and more a virtual reality.

Some users are deploying virtual reality to create abstract spaces as well. This application will be explored in the next chapter, but for now I wish to point out that some users are turning abstract data into virtual reality displays. In a sense, abstract graphs of numbers and spreadsheets of data can be "experienced" in three dimensions as if they were tangible,

physical objects. There are fascinating implications of this application for certain types of historical narrative, which we also explore in the next chapter.

As this brief history illustrates, however, virtual reality is as much virtual as it is reality. The dreams of Sutherland and cyberpunk novelists are as important in shaping the debates about the applications for virtual reality as the existence of actual devices. Nothing like the Holodeck exists today. Despite real, tangible advances, the technology of virtual reality is still crude and clunky by those science fiction standards. No systems have yet been developed by which users enter a digital reality that is completely indistinguishable from actual experience. Even the realistic graphics of video games are still not exact replicas of actual objects or people, and video game players know that they are still looking at a screen. Thus, advocates and designers of virtual reality technologies continue to think about applications in terms of both real and imagined potential.

While the Sutherland ideal is still far from actual reality, we might nevertheless confidently use the term "virtual reality" to describe current technologies and their applications. In my estimation, "virtual reality" describes graphics technologies with any one of three qualities. First, virtual reality systems must be "realistic," meaning either photographic realism or any variations on that theme, such as "surrealism" (real images placed in new or unexpected contexts). Second, virtual reality must be "immersive." Purists contend that the only true virtual reality is that in which the user cannot see a screen or the screen is large enough so that the user is surrounded by images. Thus, flight simulators employing giant screens or IMAX theater displays would qualify under this definition. Third, virtual reality must be "interactive." The viewer in a virtual reality environment is more than a passive observer. The viewer can manipulate the surrounding images, and his actions in that environment have consequences on the images that so surround him.

Current technologies exhibit one, some, or all of these qualities in varying degrees. None, however, approaches the verisimilitude of Sutherland's wonderland. Although the graphics might be very real, they are not fully immersive; although immersive, the graphics are not realistic and do not respond to user movements in real time. Nevertheless, we might use the term "virtual reality" to mean the realistic rendering of objects, the ability of a user to interact with these objects, and/or the illusion of being surrounded by those objects.

For a virtual reality space to be "immersive," the boundary between

real space and the image space becomes virtually indistinguishable, and we forget that we are experiencing a simulation. Janet Murray describes immersion in this fashion:

> We seek the same feeling from a psychologically immersive experience that we do from a plunge in the ocean or swimming pool: the sensation of being surrounded by a completely other reality, as different as water is from air, which takes over our attention, our whole perceptual apparatus.[12]

Immersion is as much a psychological state as it is a perceptual state; that is, the experience of immersion comes as much from our beliefs and feelings—from what our bodies are telling us—as from what our eyes are perceiving about the image we are inhabiting. Marie-Laure Ryan observes that "in a flight simulator, for instance, the usefulness of the system as a test of what a pilot will do with an actual airplane depends on its power to reproduce the complexity and stressful demands of real flight situations."[13] To feel the "stress" of the simulation, the participant must be so immersed that he experiences it throughout his body. That is, for the state of immersion to occur, the viewer's "body" must be present in the space of illusion. "In the real world," Ryan writes, "an object seen through a window may be just as real as an object that we can touch, but we experience it far less 'present' because the sense of presence of an object arises from the possibility of physical contact with it. The object and the body of the perceiver must be part of the same space." For Ryan, immersion and interactivity are deeply entwined in virtual reality spaces. Indeed, "in its literal sense, immersion is a corporeal experience, and as I have hinted, it takes the projection of a virtual body, or even better, the participation of the actual one, to feel integrated in an art world."[14] Just like our physical bodies in "real space," true virtual reality immersion occurs when we feel that we are active participants in the space we are inhabiting, not simply passive observers of a scene unfolding across our eyes. "Like Baroque frescos," observes Harry Brown, recalling those earlier spaces of illusion, "video games simulate a world beyond view, but as interactive environments, they also simulate a world that is responsive to the player, the illusion that our action as well as our vision extends into their world."[15]

Ryan states that as early twentieth-century art became more abstract and conceptual, "the eye of the mind triumphed once again over the eye of the body." Renaissance perspective painting placed the viewer

within the painting, "[immersing] a virtual body in an environment that stretches in imagination far beyond the confines of the canvas. . . . The frescos of Baroque churches blur the distinction between physical and pictorial space by turning the latter into a continuation of the former." Impressionist, Cubist, and other abstract art, in contrast, was an art of the mind, with a flat representational surface that "expelled the body from pictorial space." Virtual reality spaces, in contrast, and certain types of installation art in particular, offer "a prefiguration of the combination of immersion and interactivity that forms the [Sunderlandian] ideal of VR technology."[16] Virtual reality spaces appear more like the tactile spaces of Greek art, as understood by William Ivins:

> Tactually, things exist in a series of heres in space, but where there are no things, space, even though "empty," continues to exist, because the exploring hand knows that it is in space even when it is in contact with nothing. The eye, contrariwise, can only see things, and where there are no things there is nothing, not even empty space, for that cannot be seen. There is no sense of contact in vision, but tactile awareness exists only in conscious contact . . . . The result is that visually things are not located in an independently existing space, but that space, rather, is a quality or relationship of things and has no existence without them . . . the Greeks were tactile minded, and . . . whenever they were given a choice between a tactile or a visual way of thought they instinctively chose the tactile one.[17]

The "exploring body" of virtual reality space mimics the "exploring hand" of Greek art. Especially as virtual spaces are animated by haptic and other gestural interfaces, the movement and actions of the "body" are necessary to activate the space. Think of video game spaces, which are not simply spectacles for the eye but tactile spaces of touch, sound, and movement. Indeed, video games have become even more haptic, the body even more present, with the development of Wii and Kinect haptic interfaces. Virtual reality spaces require, and are defined by, the presence of the "body."

Bernard Frischer contends that virtual reality systems require more tools that would expand the capacity for sensory representation, beyond the visual and spatial, especially if these tools are to be of value to scholars and other researchers interested in moving "beyond illustration." So, for example, virtual reality tools for the reconstruction of archeological and other cultural heritage sites should include haptic interfaces, he argues,

not just to move objects around in our illustrations, but to provide analytical data about those objects, such as their weight and other physical properties . . . . We need sound tools, not only to populate our representations with localizable 3D sound but also to give analytical feedback about the acoustic properties of our virtual environments so that we can determine in a serious way whether, for example, the Roman Senate House with its marble floors and marble-clad walls functioned well or poorly as a place of deliberation and debate.[18]

Were we able to listen to the acoustics of a virtual re-creation, for example, our understanding of the qualities of that space would be enhanced. Sonic and haptic interfaces would situate the sensations of the body in space as important for making certain kinds of historical arguments and scholarly observations about the past.

The examples above relate to one body experiencing space. Frischer anticipates that artificial intelligence, such as agent-based modeling, will allow us to better understand how bodies circulate in space. For example, he references Jorge del Pico and Diego Gutierrez, who have reconstructed crowds entering and exiting a virtual re-creation of the Roman Colosseum. The AI figures were programmed to "understand how to enter the building and find their seat while negotiating corridors and stairs." By exploring how quickly the Colosseum could be filled and emptied, these researchers gain a greater understanding of the qualities and the experiences of a space beyond its physical properties and topographic setting. "Through this model," del Pico and Gutierrez report, "the carrying capacity of the Coliseum was more accurately gauged, and problems in the circulation route that most of the spectators had to take were identified for the first time."[19] It is not difficult to see what other kinds of historical problems might be understood by representing how bodies circulate in space, and the physiological and cultural implication of such movement. Via such tools, "space" and "the body in space" become fruitful historical categories of investigation.

What might such research mean for the representation of the past, for the work of historians? To be immersed in a space means to be surrounded not only by sights but by sounds, smells, and other sensual experiences. The senses have a history, says Mark Smith, one scholar who has helped launch a new line of inquiry into "sensual history." His program is to contextualize and historicize the senses. "The senses," writes Smith, "are historical . . . they are not universal but, rather, a product of place and, especially, time, so that how people perceived and understood smell,

sound, touch, taste, and sight changed historically. . . . [the senses are] historically and culturally generated ways of knowing and understanding."[20] Historians of the senses might find immersive, tactile, virtual spaces that invite the body into the space an effective means of representing such a "sensory history." Smith is, of course, quick to point out that even if we could replicate the smells and tactile *experiences* of the past, we could not achieve the same level of historical and cultural *understanding* of those senses: "it is impossible to experience those sensations the same way as those who heard the hammer or music, tasted the food, or smelled the dung."[21] That is, even though my nostrils can smell the smells, I cannot understand that experience the same way a contemporary did. While I might be overwhelmed by the scent of dung in a medieval space, those who actually lived in such a space might not have noticed the stench at all; they understood the sensory experience in a way I cannot. (One could argue the same thing about a text, that my reading of a text from the past cannot equate to the way contemporaries read and understood the text.) Smith is not examining the history of the senses through the lens of virtual reality, as I have here, but this "sensory turn" in history nevertheless could be fruitfully wedded to virtual spaces, especially those equipped to replicate sounds, smells, textures, touch, and other sensual experiences of the space. "Virtual history" as we will describe it here means not simply creating a visual representation of the past, but reincorporating the (virtual) body as part of that representation.

Games, Models, and Simulation

All historians engage in modeling. As the historian Mary Webb notes, a model is "any mental representation of an external phenomenon." Thus modeling refers to "the formal representation of some aspect of a problem, idea or system."[22] By this definition, every discipline employs some type of model, whether physical models, like an architect's cardboard edifice; pictorial models, like diagrams; or mathematical models. Historians, in Webb's estimation, rely on "word models": representations of the past constructed out of words, sentences, and prose. Rather than creating one-dimensional linear models, historians working with virtual reality construct models in three-dimensional space.

Part of the training of any apprentice historian involves converting primary sources into a finished word model; that is, an article or monograph. Apprentices might also learn these methods by creating a virtual reality

model. John Bonnett and his team have reconstructed in virtual form Canadian buildings long since razed. By examining fire insurance records, contemporary photographs, and other primary sources, these historians have digitally reconstructed and rebuilt the nineteenth-century urban landscape. Bonnett contends that modeling is a useful pedagogical tool for teaching the process of historical thought. Students develop the habits of mind of a historian by locating and sifting through primary sources, determining which of those sources are the most reliable, comparing those with other reliable sources, and thus piecing together reasonably accurate information about the physical structures of the buildings, which can later be composed using computer modeling tools. That process—except for the last stage—is the historical method in miniature. Students fortunate enough to be taught history in this constructivist setting learn not only about the content of the past but the method by which the historian thinks about and reconstructs that past.[23]

Instead of a word model, however, the students construct a virtual reality model, a visual secondary source. The resulting model—while re-sembling an original primary source—is in fact a secondary source since it is a visual juxtaposition of primary sources. Like all secondary sources, it is twice removed from the reality it seeks to re-create. It is the product of a set of conscious choices by historians, a product of the selection, evaluation, arrangement, and juxtaposition of primary sources. Rather than being joined together by one-dimensional chains of words, these choices are represented in three-dimensional virtual reality space.

Like all secondary sources, the finished model is a balance of posi-tive and negative information. In the finished model, there are omissions where primary source information does not exist. The historian must then weigh whether or not to make any visual inferences, a choice all historians make when they allow their word choice to fill in the gaps that sources do not reveal. But nothing in the final model is "made up" or fantasized. The structure is as faithful a re-creation as we can expect of any secondary source. Thus, a virtual reality model—before historians can label it a serious work of history—must be based on documentable and transparently available primary sources, not simply the imagination of the historian.

Virtual reality modeling, a legitimate tool of historical scholarship, resonates with many long-established methodological practices. But what is the value of the finished model so created? If it is in fact a secondary source, can a virtual reality model communicate ideas about the past?

Like other types of models, a virtual reality model would provide historians a tool with which to communicate their "understanding" of the past. The economist Paul Krugman argues that any model is an imperfect representation of some real phenomenon that nevertheless serves as a tool for understanding:

> any kind of model—a physical model, a computer simulation, or a pencil-and-paper mathematical representation—amounts to pretty much the same kind of procedure. You make a set of clearly untrue simplifications to get the system down to something you can handle. . . . And the end result, if the model is a good one, is an improved insight into why the vastly more complex real system behaves the way it does.[24]

In creating a model, the historian simplifies the "vastly more complex real system" of the past into a form that we can then use to achieve understanding and insight about that past. In the above example, the mass of documentation Bonnett uses is simplified into a virtual reality model. Krugman's definition sounds very similar to Max Weber's concept of an ideal type: a deliberate fiction that nevertheless offers some insight into a problematic subject. A virtual reality model, then, could similarly serve as a visual ideal type, a useful simplification of a complex real situation.

Very rarely do historians believe physical models and visual representations can serve as the final product of their research. Yet this is an acceptable practice in many subfields of historical research. Archeologists and art historians reconstruct physical artifacts and design reconstructions of objects as the final model. A written article is, for all intents and purposes, an illustration of the visual model. The visual model serves as a tool of understanding, more useful than a purely verbal description. Similarly, creating a virtual reality model of a Civil War battle or an ancient city would allow for a certain understanding of those historical concepts. Like a film or dramatic re-creation, a virtual reality model maintains more of the three-dimensional simultaneity lost in one-dimensional word models.

Those who create models understand that the model is an imperfect replica. However, uninitiated viewers of virtual reality replicas might be enticed by the apparent verisimilitude of the display to conclude that the technology "brings the past to life." This is a dangerous fallacy. Any reconstruction—even the most realistic and sensorially spectacular—can never replicate the actual system being modeled, because of both the limitations inherent in any modeling technique and the missing informa-

tion intrinsic to any secondary source, even a virtual reality model.[25] As with any historical model, not all evidence from the past exists, so gaps in the visual reconstruction will be unavoidable. The balance between positive and negative information basic to any secondary source might be lost on viewers overwhelmed by the positive information. Therefore, viewers need to be reminded that a virtual reality model is as abstract as a word model, even if it relies on seemingly realistic and tangible objects. Anyone who witnesses a virtual reality model of the past will have to be instructed in how to use it. Like Magritte's painting of a pipe that reads "this is not a pipe," a virtual reality model should carry a warning label that reads "this is not the past."

In addition to realistic rendering, virtual reality models invite participatory simulation.[26] Rather than just creating models of buildings or realistic renderings of battle sites, virtual reality provides immersive simulation, allowing a user to "climb into" the model and interact with those objects, making the past seemingly "come to life." While model creation is an established part of the historical method, "participation in the model" is not as methodologically accepted.

One of the defining characteristics of historical scholarship—as opposed to mere antiquarianism—is that the historian endeavors to maintain an objective stance in relation to the past. Unlike anthropologists or sociologists—who cannot help but interact with their subjects, try as they might—historians rarely have direct interaction with their subjects and the events they are studying. (There are, of course, exceptions, such as oral history projects.) Their interaction comes only through the remnants of that past as preserved in primary sources. As such, the historian is trained to separate "the past" and "history," in that the latter is a representation of the former. As a model creator, the historian learns to distinguish the model from the thing modeled.

Virtual reality makes this relationship problematic for the uninitiated viewer. Virtual reality is immersive: under ideal circumstances, viewers should forget that they are watching a digital display and should instead feel as if they are experiencing a real world. In the context of historical scholarship, this would suggest that the thing represented and the means of representation have become indistinguishable. The danger here is that in a virtual environment, the "past" and "history" blur together too easily, thus creating the illusion of a level of participation with the past that is simply not attainable.

That said, viewer immersion in a virtual reality model does possess

certain attractive features that are legitimate elements of historical think-ing. When a viewer "climbs into" a model created by a historian, that model has the potential to transform into a simulation. The interactive capacities of virtual reality allow a viewer to have some influence on the outcome of that simulation. For example, a viewer of a virtual ancient city is presented with a myriad of choices about where to proceed. Will the participant remain high above the city, maintaining an Olympian vantage point from which to observe the city? Or will she fly down into the agora and interact with street vendors? Like a reader choosing the reading path in a hypertext, the viewer/participant in a virtual reality simulation chooses the "flight path" within a three-dimensional environment created by the simulation builder (the historian). "Shifting perspectives" is an important move in any historiographic debate; a historian who wishes to suggest a new interpretation of the sources often asks the reader to shift his "point of view." This shifting of views in a virtual simulation allows the viewer/participant a means of making historiographic choices usually reserved for the author/creator.

In so participating in a virtual simulation, the participant also gains a virtual "experience" of that event. While cognizant of the virtuality of that experience, a participant in a simulation might nevertheless acquire empathy for the past. Leopold von Ranke counseled that the historian should understand the past "as it actually was." We could interpret this dictum to mean that the historian should try to gain a certain empathy with his subject: to cast off contemporary beliefs and assumptions in order to see the past through the eyes of those who lived it. Participating in a virtual reality simulation would seem to provide for this sort of Rankian empathy. Like a Civil War reenactment, a participant in a battle simulation would "experience" the past as did the actual soldiers. Like the viewer of a virtual ancient city, the Civil War participant would play an active role in the outcome of the simulation; through his interaction with virtual characters and simulated objects, his actions become an integrated part of the outcome of the model. In such cases, the warning label I noted above would have to be especially prominent; participants need to be especially wary of the balance between the Rankean empathy enabled by the simulation and the critical objectivity demanded of historians.

For my generation, historically themed video games start with *Oregon Trail*, and we have certainly come a long way from that early historical video game. Today, of course, there are a multitude of such video games, from *Civilization* to *MiG Alley* to *Assassin's Creed*, that far surpass *Or-*

egon Trail and appear very much as forms of virtual reality, in that they are realistic, immersive, and interactive. For purposes of the analysis of this book, I want to draw a distinction between "games" and "virtual reality environments," only because I wish to focus on the visual qualities and affordances of these digital spaces. Games and the ludic qualities of those spaces (while important) are not necessarily tied to their visual qualities. As Nick Montfort explains, gaming and ludic behavior can occur outside of the visualization, as in the case of interactive fiction (IF), a form of text-based gaming (http://nickm.com/if/).[27] This analysis is necessary because video games are so ubiquitous and because more and more historical narratives are moving into these environments. Indeed, we now have a generation of game players whose knowledge of the past has been shaped by video games, in the same manner that earlier generations had their historical imaginations shaped by television and, before that, by film.

A new generation of theorists wants to treat video games with the same theoretical rigor, critical appreciation, and scholarly attention as theorists of film. These advocates of "serious games" point to a host of cognitive affordances of video games. James Paul Gee, for example, asserts that a game environment is a complex "semiotic domain" and that, like a host of other such domains, learning and literacy are tied to mastery of and competence within that domain. Gee defines a semiotic domain as

> any set of practices that recruits one or more modalities (e.g., oral or written language, images, equations, symbols, sounds, gestures, graphs, artifacts, etc.) to communicate distinctive types of meanings. Here are some examples of semiotic domains: cellular biology, postmodern literary criticism, first-person-shooter video games, high-fashion advertisements, Roman Catholic theology, modernist painting, mid-wifery, rap music, wine connoisseurship—through a nearly endless, motley, and ever-changing list.

Gee thus separates the content of games (so much the focus of attention of critics) and explores their structural properties, and especially the kind of learning that occurs in such spaces. In doing so, he treats video games as a complex system of signs. As in the other domains he identifies, a person who has an understanding of and can function within such a system is identified as "literate." "If we think first in terms of semiotic domains and not in terms of reading and writing as traditionally conceived, we can say that people are (or are not) literate (partially or fully) in a domain

if they can recognize (the equivalent of "reading") and/or produce (the equivalent of "writing") meanings in the domain."[28] Leaving aside for the moment that one is slashing the throats of enemies in a game like *Assassin's Creed*, success in that game requires the kind of deep understanding and domain mastery that one would expect from competent readers or effective cellular biologists or postmodern literary critics.

Gee argues that games are "good" when they are designed according to generally recognized and accepted learning principles. Thus, effective games encourage players to take on a new identity. "Learning a new domain, whether it be physics or furniture-making," argues Gee, "requires the learner to take on a new identity: to make a commitment to see and value work and the world in the ways in which good physicists or good furniture makers do . . . [video game] players become committed to the new virtual world in which they will live, learn, and act through their commitment to their new identity." This suggests that entering into and mastering a semantic domain requires us to assume the identity of a competent practitioner of that domain. Effective games, like all effective learning, require that there be an interactive relationship between player and the world, that players act as "producers (of action), not just consumers," and that "players feel a real sense of agency and control and a real sense of ownership over what they are doing." Well-designed games encourage systems thinking, "[encouraging] players to think about relationships, not isolated events, facts, and skills. In a game such as *Rise of Nations*, for instance, players need to think of how each action taken might affect their future actions and the actions of the other players playing against them as they all move their civilizations through the ages. In our complex global society, such system thinking is crucial for everyone."[29] The key features of virtual reality—realistic, immersive, and interactive—would seem to map on to effective learning practices as well.

Representing complex systems makes video games, like other kinds of virtual reality spaces, especially useful for history. Jeremiah McCall observes that games, especially simulation games, are valuable for teaching historical thinking and understanding of the past:

> Students at all levels, and even teachers of history, can forget that the people of the past lived and operated in a multitude of physical, spatial, and intellectual systems, all of which provided the context for their lives and actions. . . . It is all too easy, unfortunately, to divorce the people of

the past from their physical, spatial, and cultural contexts . . . . The un-
derstanding of systems and contexts essential to historical interpretation
that an historical simulation game can generate goes beyond that created
by many other kinds of secondary sources. . . . It is a matter of putting
students into dynamic recreations of roles and situations from the past.
A simulation can place students at the center of complex systems where
a variety of variable factors ebb and flow simultaneously in ways that
cannot be readily represented in other media.[30]

Again, McCall is thinking structurally here about games, leaving aside,
for the moment, questions about the specific content of those games. In-
deed, critics of historical video games usually question their authenticity,
accuracy, and fidelity to the reality of the past (and McCall thoughtfully
addresses this concern by saying that these encounters with the content
of games can become moments of critical reflection for students, encour-
aging them to engage in the kind of critique of the game that one would
expect from the reader of a written account). But looked at in structural
terms, game environments, especially historical simulations, provide an
immersive space for encountering the context of the past.

Since video games and other virtual reality simulations allow a
participant the choice of determining the outcome of the simulation, it
would appear on the surface that the participant serves as the "author"
of the resulting "history." As Janet Murray contends, however, "There
is a distinction between playing a creative role within an authored en-
vironment and having authorship of the environment itself."[31] While
viewers in a virtual simulation may choose the direction and outcome
of the history, these choices are limited to those designed by the creator
of the simulation. Murray defines this second-order level of choice as
"procedural authorship," which means

writing the rules for the interactor's involvement, that is, the conditions
under which things will happen in response to the participant's actions.
It means establishing the properties of the objects and potential objects
in the virtual world and the formulas for how they will relate to one an-
other. The procedural author creates not just a set of scenes but a world
of narrative possibilities.[32]

In a virtual reality simulation, the historian is the procedural author.
This role is very similar to the one played by museum exhibit designers.
While viewers choose their own viewing paths, historians and designers

construct all the *possible* paths those viewers might choose. Museum goers navigate through a space of objects arranged by the designer. Just as a historian pencils out several rough drafts of a prose composition, historians constructing a virtual reality environment need to sketch out these possible paths, using storyboards or other visual rough drafts. Thus, while viewers have great freedom of choice, their viewing path is circumscribed, one out of many paths authored by the historian.

Thus, a virtual simulation that allows participant control over the outcome does not imply that the historian is somehow irrelevant to the narrative. Quite the contrary: as the "meta-author" of the simulation, the historian has the ultimate level of control over the outcome. How will historians choose to use the power of procedural authorship? Despite the creative potential of this meta-level of narrative control, historians may not be comfortable allowing participants in a simulation the opportunity to choose the narrative path of the history, a role traditionally held by author/historians. It is entirely possible that historians authoring virtual simulations will so significantly restrict the choices of the participant that only one choice is really possible. These historians might decide to use the technology to create only one path, only one point of view from which the participant may interact. These historians might decide to treat the virtual reality simulation like a traditional prose narrative with only one possible outcome. The participant, then, would have only the illusion of making a narrative choice, since the simulation was authored to provide only one choice.

In such cases, the simulation would again revert back to the status of a habitable model; stated another way, a model becomes a simulation only when the viewer is permitted some degree of choice over the outcome. In a true simulation, the outcome is not determined. In a flight simulation, for example, the pilot can either land the plane successfully or can crash into the runway, with other outcomes in between. Depending on those choices, there is more than one outcome, each one equally plausible, the ultimate outcome far from predetermined. What if the outcome so chosen in an historical simulation is not one that "actually happened"? What if the historian allows participants in a Civil War reconstruction to make choices that allow the South to win a decisive battle that it actually did not win? How many alternative outcomes are necessary in any simulation, and how is the historian to arrive at these? Aside from the entertainment value, are there any legitimate scholarly reasons to allow such an exploration of alternative outcomes?

The historian serving as the procedural author of an environment of choices is like the writer of a historical fiction. In a good historical fiction, the setting, the context, the environment of the past are well established and accurate even if the characters, events, and situations are made up. Wallace Stegner's *Angle of Repose* nicely conveys the context of the nineteenth-century American West even if the people and events are fictitious. As the procedural author of an interactive virtual simulation, the historian similarly needs to be mindful of the accuracy of the environment, even if the participant is allowed to make historically "untrue" choices.

Procedural authoring of virtual reality spaces also requires a flexible understanding of causation. To envision multiple paths for viewers to choose, historians need to imagine the unfolding of events "not as a single sequence of events but as a multiform plot," which Murray defines as "a written or dramatic narrative that presents a single situation or plotline in multiple versions, versions that would be mutually exclusive in our ordinary experience."[33] Rather than one linear sequence, the historian who creates a virtual interactive simulation needs to think in terms of multiple outcomes, defining causation in the past not as a single deterministic line of events but as a number of equally plausible alternative events. Like the psychohistory in Isaac Asimov's science fiction novel *The Foundation*, virtual reality presents the past as nodes of choices, forks in the road, moments when the flow of events could move in either of two directions. To the procedural author, the past starts to look less like a sentence and more like a flow chart: branching forks of "if . . . then" choices that describe a number of plausible pasts. "Like a 'Garden of Forking Paths,'" says Marie-Laure Ryan, evoking the short story by Jorge Luis Borges, "the virtual world is open to all the histories that could develop out of a given situation, and every visit to the system actualizes a different narrative path."[34]

Historians usually refer to this type of multiform, what-if narrative as counterfactual history. Counterfactual history rests on the notion that history unfolds as a sequence of choices, and video games are an excellent medium of play and exploration of those choices. Because of the principle of interactivity, players are given agency to choose and make decisions, meaning that video game spaces are counterfactual spaces. "By constructing a virtual past and granting the player agency within it," writes Harry Brown, "videogames have become the ideal medium for teaching the lesson of contingency."[35]

Unfortunately, historians tend to think of counterfactuals as merely a parlor game, not as a serious form of scholarly inquiry.[36] Niall Ferguson contends that the historian's insistence that history deal only with "what actually happened" is deeply rooted in the history of our discipline. Whether one believes history is guided along by Providence, Fortuna, the invisible hand, class conflict, progress, reason, or simple linear cause and effect, determinism runs throughout Western historiography. While it is true that historians have championed the notion of free will, they generally tend to distrust contingency and accident as an explanation for historical events. Therefore, Ferguson believes, historians are not predisposed to examine alternatives to the actual events, since any reasonable alternative would call into question the determinacy so valued by historians.

Ferguson does not believe events to be so predetermined. He draws insights from twentieth-century science, especially the ideas of uncertainty, chaos theory, and nonlinear science. In fact, he includes history among those disciplines that study "stochastic behavior" (i.e., patterned randomness). Ferguson evokes the concept of uncertainty as it pertains to quantum mechanics, which holds that the physicist "can only predict a number of possible outcomes for a particular observation and suggest which is more likely."[37] Because any physical system is exquisitely sensitive to initial conditions and because of the overwhelming number of variables that might determine the behavior of that system, it is not possible to predict the exact state of that system at any point in the future. One can only imagine a number of reasonable scenarios. If prediction is not possible, even for a physicist, how can historians claim to have uncovered the "single sequence of events" that produced "what actually happened" in history to the exclusion of all other reasonable alternatives?

A virtual simulation, therefore, need not serve merely as a high-tech parlor game: historians could participate in such counterfactual simulations in order to gain a clearer understanding of causation in history. According to Ferguson, only when historians understand that the procession of events is not governed by lawlike determinism and that events occur because of complex processes sensitive to initial conditions and subject to many variables can the historian truly understand causation. "The historian," warns Ferguson, "who allows his knowledge [from hindsight] as to which of these outcomes subsequently happened to obliterate the other outcomes people regarded as plausible cannot hope to capture the past 'as it actually was.'"[38] Counterfactuals remind historians of the indeterminate nature of causation in the past.

Counterfactual thinking is not a license, however, to dream up any alternative. If this were the case, the number of possibilities would be so vast as to make any serious simulation impractical. Further, some alternatives are more possible than others; if a virtual reality simulation is to have any credibility, the procedural author has to be aware that some outcomes are anachronistic or unrealistic. Therefore, the historian must be mindful of limits on those possibilities in any simulation he might construct. It is important for the historian to make a distinction "between what did happen, what could have happened and what could not have happened"[39] when procedurally authoring a virtual reality simulation. The best way to accomplish this is to look for plausibilities rather than mere possibilities. "In short," notes Ferguson,

> by narrowing down the historical alternatives we consider to those which are *plausible*—and hence replacing the enigma of "chance" with the calculation of *probabilities*—we solve the dilemma of choosing between a single deterministic past and an unmanageably infinite number of possible pasts. The counterfactual scenarios we therefore need to construct are not mere fantasy: they are simulations based on calculations about the relative probability of plausible outcomes in a chaotic world (hence "virtual history").[40]

Procedural authors of virtual simulations make narrative choices about which counterfactual variables to include in an environment of choices, rather than composing the one single thread of the plot as in a traditional written narrative. As the above discussion demonstrates, creating virtual models and converting them into immersive participatory simulations is not only a technical matter. The success and legitimacy of this approach ultimately depends on historians making specific historiographic and methodological choices.[41]

History on the Holodeck

How well does traditional prose history "translate" into a virtual reality environment? Is there enough isomorphism between the two mediums or are some facets of history unavoidably lost in translation? If so, which forms and types of history are preserved and which are forgotten? The virtual medium enables three general types of narrative form into which the prose of history can be translated.

Diachronic narrative: "Diachronic," which means "change through

time," suggests the procession of events, usually toward some ultimate goal. As the technology currently stands, many virtual reality displays feature this sort of event-based diachronic structure. In many video games, for example, "the quest" is the underlying narrative trope: the participant ascends through several levels in order to reach a final goal or outcome. While there may be several choices along the way—and indeed the skill of the player determines the outcome of the quest—ultimately the player wishes to arrive at some final destination that gives meaning to the entire game.[42]

Michael Nitsche identifies the "track and rails" spatial structures of many game spaces. Racing games most obviously represent actual racetracks and "reproduce the racing experience—the fast-paced, goal-oriented, and usually competitive striving to get ahead." When the path through the game space is laid in such a way as to allow the player no deviation from the track, those "players hardly notice the amazing backdrops of a track or the high-detail textures of the road . . . . They always strive forward to a destination beyond the current position." Nitsche maintains that, even when the track is not visible, the track as spatial metaphor, as structured movement through a virtual space, is nevertheless present in many video games. "So-called rail-shooters," for example, "move or guide the player along invisible tracks that allow little divergence from a given path," the invisible track tracing a linear path through the space. "Tracks thus can locate the spatiotemporal conditions for any such appearance very precisely as they restrict exploration beyond the given boundaries. They map a dramatic structure onto lines." Those lines might be bent into a twisting, winding labyrinthine narrative pattern. "Labyrinths play with the notion of hierarchy as they lack outstanding visual cues that can support orientation and instead often feature repetitive rhythms of recurring patterns."[43] Labyrinths, mazes, networks suggest a winding path through the space, but nevertheless tether the player to a path tightly determined by the game author.

Such a simulated environment appears to be teleological. For the pilot in the flight simulator, landing the plane remains the ultimate goal, even if she should crash along the way. The narrative here is structured as a series of events; the participant moves from one event to the next as she ascends the levels toward the goal. As these events occur and as the participant makes decisions, she would perceive the passage of time in the procession of those events and in the "if . . . then" choices she must make.

Again, even when these paths and tracks are not visible, in many games they nevertheless determine how the player is permitted to move through the space, and how the player moves through the space (and his actions along that path) determines the narrative structure of the game. "The focus here," concludes Nitsche, "is on the use of space that shapes possible events and their visualization. In contrast to physical space, where architects can hope to incorporate features that evoke connotations and patterns of behavior in visitors, game designers can shape the functionality available at any given location more directly and therefore determine more precisely the characteristics of the event space."[44]

This type of narrative is appropriate for certain types of historical narrative. Military history is a natural fit. Participants "take the hill" or "scatter the enemy's formation" or, more basically, "win the battle, save the Union" in these diachronic environments. Virtual diachronic narrative need not be confined to military history, however. One could create a diachronic narrative of the Underground Railroad, where users play the role of escaped slaves moving along the Underground Railroad, where they would need to "find their way toward freedom" while making choices about finding safe lodging, avoiding slave catchers, and other such "if . . . then" decisions in an attempt to reach the final goal.[45] Constructing such a virtual simulation would require the procedural author to write different plausible outcomes, as described at length above. The counterfactual method of thinking described there would be particularly necessary in these sorts of virtual diachronic narratives.

Diachronic narratives in virtual space might focus exclusively on the passage of time, even as the participant remains stationary. One of the benefits of virtual environments is the ability to alter the environment surrounding a viewer. In terms of historical narrative, a historian might procedurally author a space where the surroundings change through time. Many simulation games, such as the *Civilization* series, *The Sims*, and the *Harvest Moon* series, feature landscapes that change as swamps are drained, fields are plowed, and buildings are erected. The passage of time is depicted by the changes in the space. Much as in a novel by James Michener or Edward Rutherfurd, the viewer might begin in a muddy swamp, then watch as the swamp is drained, buildings emerge, and roads and aqueducts grow. The viewer would thus witness the birth of Rome, for example, from squalid beginnings to a grand imperial city to medieval town without moving from the same "physical" spot. In a virtual reality setting, one could stay in one place and experience the

procession of time in such a diachronic narrative. The participant might also choose to change his stationary location and thus watch the rise and fall of Rome from inside the city or at the imperial frontier. Further, the procedural author might grant the participant the ability to "speed time up" or move time backward, something like the character in H.G. Wells's *The Time Machine*, who manipulates the controls to watch time and events speed by him at a pace he determines. As with time-lapse photography, an individual could then "see" the movement of vast amounts of time, a privileged position unfortunately not granted to mere mortals. While not a direct participant, the viewer in such a virtual reality space would be permitted a high degree of historiographic choice by controlling both the narrative point of view and the pace of time.

Synchronic narrative: In this form, time is not the chief variable of the narrative. Instead, the spatial structure of human symbols, objects, and relations is the important variable.[46] The viewer/participant enters this synchronic space not with a single goal in mind, nor is there any appreciable change in the overall structure of the space. In contrast to "tracks," Nitsche describes some video game environment as "arenas," in that these spaces "provide relatively free movement in a contained space with high visibility."[47] Synchronic narratives are not event-driven but resemble a Braudelian narrative or Annales-type "thick depiction" of a three-dimensional historical space. In this sense, such a narrative seems more "anthropological" rather than traditionally "historical" since it emphasizes structure over event, stable relations over change through time.

The UCLA Urban Simulation Team (www.ust.ucla.edu/ustweb/Projects/columbian_expo.htm) has reconstructed the 1893 Chicago World's Fair, sometimes called the Columbian Exposition. As is well understood, the "White City," as it was nicknamed, was razed after the exposition ended, with only one building left standing today. Using the computational power of UCLA's supercomputer, the simulation team built virtual models of the entire exposition complex, including most of the buildings, many of which can be entered by the participant. Bernard Frischer's group at the University of Virginia has reconstructed the city of Rome from the year 320 CE (www.romereborn.virginia.edu/). The "city" in this virtual environment remains a stable set of structures within which the participant may move and interact. The goal is not teleological; that is, the viewer need not attain some specific outcome, but instead gains understanding. A viewer would still make choices: do I go here or

there? Do I want to see the city from above or in a particular location? What parts of the city would be denied to me, and how does this alter my understanding of the life of the city? In such a synchronic environment, scholarly possibilities abound. A participant could, for example, explore social spaces, such as the separate male and female spheres of the city. Thus, a synchronic space need not be simply an elaborate architectural model; it could be an environment where one could explore the symbolic relationships between people and objects that constitute social space.

Bryan Carter has developed several versions of "Virtual Harlem," a representation of the Harlem Renaissance, the most recent version of which was built using Second Life (http://slurl.com/secondlife/Virtual%20Harlem/62/35/30).[48] Designed to supplement his literature course on the Harlem Renaissance, Carter's display allows users to walk through the streets of Harlem in the 1920s or to ride a trolley car or to take a taxi to any number of buildings. Users are able to enter those buildings, such as the Savoy Ballroom, the Cotton Club, and the Apollo Theatre, and listen to music, dance, or converse with historical characters. Imagine being able to walk the streets of Harlem and enter a building in order to hear Langston Hughes read a poem; the virtual environment provides a spatial context for those texts and extends our understanding of them by allowing us to "experience" the poem in space. These virtual tours clearly require a great deal of research into the primary evidence to re-create these scenes in detail, recognizing, of course, that as with any reconstruction there would be much missing information. These interactive displays are, therefore, interesting visual secondary sources: a useful way to organize primary source material.

Using three-dimensional geographic information systems GIS mapping tools, the geographer Mei-Po Kwan explores how Muslim women in Columbus experience public space, especially after 9/11. After the terrorist attacks, Muslims were the targets of violence and abuse, against their property and against their persons. Their mosques were vandalized, many endured verbal and physical abuse, and all felt surveilled under the gaze of the security state. Because of their distinctive dress, Muslim women felt especially fearful of leaving their homes to attend to daily routines. Kwan recorded the experiences of a number of such women via oral histories and daily activity journals. She asked the women to identify and map those places where they felt especially threatened. Kwan mapped out the trajectory of daily routines, such as travel to school, to the grocery, to the mosque, and noted especially places where women

felt safe versus those areas that evoked fear.[49] One could image a three-dimensional virtual environment that maps out such "spaces of fear" and "spaces of comfort." For such a virtual space to be effective—that is, to evoke the fear and other emotions felt by Muslim women—one would need to build a virtual space such that a participant could feel the fear a building evokes. The virtual space might include areas that have been vandalized and characters that harass or stare suspiciously at the participant. A user moving through such a virtual space would eventually learn to avoid certain parts of town or stay within places that are safe so as to avoid threats of verbal or physical harm. An effective virtual environment would make the participant feel "profiled." While Kwan was looking at a contemporary phenomenon, such an approach could be used to represent many such spaces in the past.

With synchronic narratives, historians might readily translate social history into a virtual reality environment. A graduate teacher of mine once reminded us that for social history to be truly effective, the historian should be able to evoke and reconstruct the smells of his grandmother's kitchen. The social historian can procedurally author a synchronic narrative that could evoke that space (although perhaps without the smells). The medieval manor, the preindustrial household, the monastery, or the domestic spaces of 1950s suburbia can all be depicted in a synchronic virtual narrative. A participant moving through such spaces would gain the type of three-dimensional experience of, understanding about, and empathy for these spaces that well-designed historical reconstructions and reenactments evoke.

Three-dimensional immersive collage: A three-dimensional immersive collage is an arrangement of virtual objects in an abstract idea space through which a viewer might move. These virtual displays resemble certain types of museum exhibition spaces. Some museum designers arrange objects in a nonrepresentational idea space in order to discern their abstract or conceptual connections, rather than attempting to re-create the actual physical context. Objects that might not have originally appeared in the same physical space are brought together in this abstract space in order to evoke conceptual connections. For example, sculptural depictions of the human form from a variety of places and times acquire new meanings and connotations when the historian takes them from their original contexts and places them alongside one another. These virtual exhibits resemble the eighteenth-century *Wunderkammer* described in the previous chapter. The creators of those spaces sought to arrange

physical objects in an abstract space in order to explore their analogical and associative connections.

The *Wunderkammer* has recently undergone a renaissance among scholars, which is one reason we might use it as a metaphor for the kind of three-dimensional "immersive collage" I am describing here. In the 1980s, *Wunderkammer* were resurrected as the forerunners of the modern (post-Enlightenment) museum, but more recent attention has focused on the *Wunderkammer* as a premodern exercise in the spatial organization of information, an associational way to represent knowledge. Horst Bredekamp was among the first modern scholars to draw attention to the associational and analogical connections between objects in a *Wunderkammer*, and association and analogy as ways of representing knowledge are central to the observations of scholars of *Wunderkammer* such as Susan Delagrange, Barbara Maria Stafford, and Anna Munster.[50] Among these scholars, the *Wunderkammer* is a metaphor for our own digital moment, the way we experience information and represent knowledge in the digital world. "Baroque modes and devices of visual display," such as *Wunderkammer*, writes Anna Munster, "have been connected with the navigational meandering and frequent juxtapositions that comprise online experience and contemporary multimedia museal display." What Munster describes as "the postmodern image space of assemblage and bricolage" mirrors what she terms the "baroque space" of the *Wunderkammer* and provides the narrative structure of what I am referring to as a three-dimensional immersive collage: a kind of virtual reality space that does not seek to re-create an actual physical space of the past. Thus, the way we move through that space is neither diachronic nor synchronic; rather, the narrative form of the three-dimensional immersive collage is created by a viewer who meanders through associative connections between virtual objects arrayed in a conceptual space. "Both baroque and digital spaces . . . operate by creating clusters of objects, images, sounds and concepts that belong together in variation and in dissonance," writes Munster. "These clusters are not formed through arbitrary associations but emerge as the outcomes of differential connections."[51]

Further, Munster draws attention to the way in which knowledge was experienced in *Wunderkammer* as a way to understand the enactment of information in our own digital moment. "By rolling the onscreen cursor over thumbnail images of the objects" in the Smithsonian's online exhibit titled *Revealing Things*, Munster observes that "the user causes

Figure 4.1 **A Virtual *Wunderkammer***

a scrolling visual field of objects to pass across the screen. The user then unfolds further information by selecting individual images and thereby 'revealing things' . . . about the objects. But what is actually revealed," concludes Munster, tying this display back to the Baroque experience of space in the *Wunderkammer*, "is not so much things as relations."[52] In a *Wunderkammer,* the associations between objects were activated or enacted by a viewer/participant; that is, the viewer's path through the space enacted the connections, the relations between the objects. In a manner similar to the eye moving across the page, the body moving through the space of the *Wunderkammer* enacted the information. To carry forward the *Wunderkammer*-as-digital-space metaphor, the movement of (virtual) bodies in the experiential space activates the associations.

One of our projects, the Virtual *Wunderkammer* (Figure 4.1), aims to explore the conceptual connections made by the journey of a viewer through spatially arranged objects in three-dimensional virtual space. In the Virtual *Wunderkammer*, we arranged virtual objects in a digital space (created in Second Life) that invites a viewer to move an avatar through the space. As the viewer moves, she enacts connections and associations between the objects (the arrangement of the objects placed by me as the procedural author). Each of the objects in this case relates to the theme of "embodiment"; that is, each of the objects uses the metaphor of the body as a way to express ideas and concepts. So, for example, the viewer moves through a space where she might view

an image of Dürer's *Four Horseman of the Apocalypse* or an image of "blind justice" or an image of "Mother Russia." The "narrative" of the piece depends upon the path selected by the viewer and the conceptual connections the viewer makes while negotiating through the space. The space of the Virtual *Wunderkammer* was created using the same virtual reality tools as the Harlem Renaissance project described earlier. But rather than a synchronic physical space, we built the Virtual *Wunderkammer* as a conceptual, "Baroque" space that clusters objects together via association and analogy.

This secondary source is like a habitable model: viewers interact with virtual objects and can choose their own viewing path within the narrative limits imposed by the procedural author. The multidimensional syntactic connections between objects are based on their conceptual relations, not their actual relations in physical space. A viewer/participant interacts with realistic objects drawn from primary source research but placed by the procedural author into new contexts, revealing associations and analogies. The "history" in this display derives from the arrangement of the objects, not just the objects themselves. "History" in this abstract idea space reflects the concrete representation of concepts and ideas in nonrepresentational space.

A criticism of film as a medium of historical representation is that it cannot depict abstract concepts as readily as the written word because it deals in concrete images. Thinking of concepts and ideas as the arrangement of concrete objects in an abstract space is one way for intellectual and cultural historians to explore new forms of narrative expression in the virtual reality medium. For any such translation to succeed, however, the historian needs to be able to depict concepts in some sort of concrete form, a process similar to a writer's quest to find "the perfect words" to describe some interesting concept. Clearly, not all ideas and concepts could be so depicted, in which case the historian interested in the immersive properties of virtual reality might be drawn to the "pictures of ideas" described in the next chapter. It is also possible that intellectual and cultural historians might eschew virtual reality as a form of representation, viewing the medium as incompatible with their interests.

As these examples indicate, virtual reality need not be dominated by military applications. The history of the technology suggests otherwise, however. Military simulations were among the first applications of the technology. The entertainment sector has used virtual reality graphics to depict battle scenes and other violent and extreme images. As this

technology has become more commonplace, some thoughtful critics have wondered whether virtual reality will continue to retain these masculine, misogynistic characteristics. The "plots" of many video games, for example, feature violent visual spectacles; as the artist Toni Dove observes, in the virtual environment, "Narrative strategies shift away from character- and plot-driven stories to experiences that escalate physical and visual intensities."[53] Because the technology seems so physical, tactile, and visually stimulating, there is every reason to believe that virtual reality will continue to be used to create spectacles.

Does this mean that only the spectacles of the past will "translate" into virtual environments? If one believes that the medium can depict only visual spectacle, then it would appear that only the sensorially extreme events of the past—battles, riots, assassinations, book burnings—can be translated into virtual form. This would imply that only a selected portion of the past can be so translated; if the technology becomes an important medium for historical reconstructions, much of the past would be lost in translation.[54]

As my above examples indicate, however, the technology is not inherently masculine, violent, or sensorially extreme. These are, rather, choices made by designers and procedural authors, not a constraint of the technology. Virtual reality seems more "real" and less abstract than a written text, but this need not mean a descent into visual spectacle. Historians are just as likely to re-create scenes of everyday life or immersive collages as they are the battle of Gettysburg. I have been emphasizing the three-dimensional qualities of the medium—that is, the ability to depict three-dimensional simultaneous structures that written prose linearizes. Historians could apply this property of the medium to any number of problems in the past, not just the extreme events.

Conclusion

"Dad," said my oldest son, "you're a historian. You have got to play *Assassin's Creed* with me. You'll love it!" I think he meant I would appreciate the sophisticated rendering of the architecture and urban environment of medieval Syria, which I did, much more so than I enjoyed the game play. The game, as I finally told my son, is *Grand Theft Auto* set in the Middle Ages (not a popular observation on my part). That is, even though I could move through a richly detailed reconstruction of that city, the actions of my character were reduced to unrealistic

leaps across buildings and slashing the throats of my hapless victims: a "first-person slasher," I said. Now, as a game, I thought *Assassin's Creed* just fine but as history, the game reminded me of a romance novel: although the novel might be set in nineteenth-century Paris, it could just as easily be set in the Roman Empire or 1920s Berlin, since the real objective of such a novel is to describe lovemaking. That is, the historical context makes very little difference to the core plot of the novel. Video games with such "historical backdrops" proliferate and may well come to define the experience of the past of generations of video game players.

In an ideal world, professional historians would serve as the primary designers and procedural authors of these virtual spaces. It would be unrealistic, however, to assume that a historian could master all the technical requirements to construct a virtual reality display alone. This would be like one person designing, contracting, and building a sky-scraper. It would be more realistic to assume that the historian—as the procedural author—would serve as the "architect" of the virtual reality edifice, the one who conceives of and designs the structure that others construct. Unfortunately, it is just as likely that, as with many "historical" films researched by historians but ultimately designed by nonhistorians, historians working with virtual reality are more than likely to play a supporting role as consulting members of a collaborative team directed by nonhistorians.[55]

These companies are finding ready-made audiences for their products. The same general public that watches Oliver Stone movies, attends museums and reenactments, and watches the History Channel is very attracted to an immersive environment in which to enjoy the illusion of participation in the past. For those who find professional history too abstract, irrelevant, or disconnected from their own understanding of the past, the verisimilitude and concrete realism of a virtual immersive environment might invigorate interest in the past.

That "past," however, would not necessarily be "history." As my *Assassin's Creed* example illustrates, companies that design such virtual environments do not include the warning label I noted earlier saying "This is not the past but a model of the past." Rather than participating in a simulation in order to engage in a useful inquiry, the goal of these displays—aside from money-making—might be to promote a type of "nostalgic entertainment" or, as noted above, "visual spectacle." Partici-pants might be lured by the promise of agency and choice within a virtual

environment, but concerns about procedural authorship and positive and negative information might be less of an issue. Schoolteachers, wishing to find "interesting" ways of teaching history or to appeal to "visual learners," might uncritically accept these nonprofessionally produced simulations as legitimate history. The historian's understanding of the past might not be the one shared by those constructing and participating in virtual simulations.[56]

I fear, therefore, that if virtual reality is designed by nonprofessionals and marketed to the general public as nostalgic entertainment or mere voyeuristic spectacle, these visual displays would have the same professional standing as museums and films currently do. That is, professional historians would view virtual reality as interesting, necessary for an uninitiated general public, but ultimately a watered-down type of history. Such a view would perpetuate the notion that serious history is written and popular history is visual. Some historians will no doubt wish to study virtual history as a professional vocation. Like historians who study film, they might write articles or reviews of interesting applications for professional journals. These historians might write critiques of virtual simulations, assessing the accuracy, the positive and negative information, and the quality of the model-building. These historians would never dream of procedurally authoring their own virtual environment, however, for they would understand that such displays would be laughed at by "serious" historians—and never count toward tenure and promotion.

Hugh Denard and his team at the King's Visualization Laboratory developed a three-dimensional virtual model of the Theaters at Pompeii (www.kvl.cch.kcl.ac.uk/theatres_pompeii.html) as a way to secure permission for an excavation, a model improved upon after the excavation was concluded. Denard hopes that at some stage, visualizations like this might be used by scholars to "get their first exposure to the theater . . . in effect shifting the sensorium of knowledge construction from text-based artifacts to an interactive 3-D rendering that allows them to change perspective; zoom in and out of details, floor plans, and architectural features; and imaginatively explore the space to visualize how classical plays might have been performed."[57] Only when the profession treats virtual displays with the same seriousness and legitimacy as it does written monographs could virtual reality serve as a tool of historical inquiry. This will come about only when historians employ the technology for useful inquiries and scholarly communication of the kind Denard describes.

Imagine this scenario. A historian arrives at a conference as the proce-

dural author of a new simulation of a medieval village. She has created the virtual display as an expression of her understanding of the past being modeled. She knows that her simulation is a useful model: a simplification of a complex real system that nevertheless offers insight into and understanding of that real system. She has conducted primary source research, has weighed the authenticity of various forms of evidence, and is aware of previous interpretations and larger historiographic issues. The procedural author has new evidence, drawn from archival research that suggests new ways to understand gender roles in the medieval village. Her intention then is to explore the "gendered spaces" of the medieval village. The historian has procedurally authored a synchronic narrative of that village as a way to convey her new understanding to the rest of the profession.

The participants—other historians—have not arrived to be entertained. They will participate in order to assess the visual model created by the historian. They will not require any sign that reads "this is not the past" for they are well trained to know the difference between the reality of the past and the virtuality of this simulation. Once inside, the professional historians participate as if they were video game players; they are equipped with different assumptions, different reasons for participating. They bring to the simulation a sensitivity to issues of causation and are prepared to assess any counterfactual outcomes the model might permit. The audience brings to the simulation an understanding of how the social space of the medieval village has been traditionally pictured by other historians; thus their participation involves an awareness of the nuances of interpretation. They also bring along an understanding of larger historiographic themes and implicitly compare this virtual display to other displays they have participated in. Thus, these participants see not only "the past" but all the other virtual reality displays that constitute the visual secondary sources of the field. The question-and-answer session following the simulation is devoted to the new insights that the simulation revealed to the participants. There are questions about the sources, disagreements with and accolades for the new interpretation, and comparisons between opposing participant outcomes.

When the procedural author returns to her home institution, she includes this "publication" on her curriculum vita as evidence of her professional activity and, she hopes, proof of her suitability for tenure. Given the technical complexity of virtual reality, it is more than likely that she is a member of a collaborative team, but a team over which she

has ultimate design decision authority, like the director of a film or the architect of a building. In the end, the tenure committee decides that the display counts as a publication since its chief purpose was to communicate new historical insights to other members of the profession. The virtual reality display served not only as a useful model but as a vehicle for scholarly communication.

In the above scenario, the professional conference was the site for this virtual display. There will surely be other such "sites of publication" for virtual simulations, physical locations where the historian could display her work and have it peer-reviewed. Presumably conference sites would be equipped with special equipment for running virtual simulations. Large, well-endowed universities might build virtual spaces, much as they now build lecture halls, theaters, and sports stadiums. State and local governments and foundations might also build virtual reality sites in the same way they build art museums or public parks. In fact, historical museums would seem a natural site for the construction and display of virtual simulations and models. Businesses might also construct these sites in the same way they construct movie theaters. It is also likely that this virtual display will be experienced "virtually"; that is, in a "shared" immersive environment by participants in widely separated physical locations. It is also likely that virtual simulations will be displayed online. Although these displays would not be immersive, they would allow participants to view a realistic model and to participate (i.e., have the illusion of moving around) in that model. Online publication might then include virtual reality models along with more traditional prose compositions, thereby reconfiguring our notion of a "journal."

While virtual reality displays might find a home in an electronic journal, these displays seem to tug at the traditional notion of a "publication." Unlike a traditional article or monograph, a virtual simulation appears more like an art exhibition. It would be a display of "physical" objects in a specially designed space through which large audiences would move. The display might be transitory, not permanently archived, like a museum display. The simulation might be on display only for a specified length of time, after which some smaller version of the display (comparable to a museum catalog) might survive, perhaps as an online nonimmersive model. While simulations might run at major conferences, procedural authors might also have their own individual "shows" to which an audience would be invited. Again, the professional legitimacy of these forms of publication depends on the rules, practices, and as-

sumptions of the members of the discipline; they are not embedded in the technology itself.

The hypothetical historian's well-crafted display requires more than mere attention to technical matters or stimulating graphics, or even careful primary source research. These are necessary but insufficient requirements for a useful virtual reality display. Any virtual simulation also requires attentive viewers who understand that the past can never be brought to life, that the model is not the thing modeled, and that virtual reality is more virtual than reality. "This is not the past," our sign would have to read. "It is a useful device for thinking about the past."

Notes

1. Hasan Jeffries, personal correspondence, June 5, 2012.

2. Janet Murray*, Hamlet on the Holodeck: The Future of Narrative in Cyberspace* (Cambridge, MA: MIT Press, 1997).

3. Oliver Grau, *Virtual Art: From Illusion to Immersion* (Cambridge, MA: MIT Press, 2003), 5, 25.

4. Ibid., 13.

5. Ibid., 31.

6. Anne H. Soukhanov, *Word Watch: The Stories Behind the Words of Our Lives* (New York: Henry Holt, 1995), 315.

7. Ken Pimentel and Kevin Teixeira, *Virtual Reality: Through the New Looking Glass* (New York: Intel/Windcrest/McGraw-Hill, 1993), 33.

8. Mary Anne Moser, ed., *Immersed in Technology: Art and Virtual Environments* (Cambridge, MA: MIT Press, 1996), 207. See also Ivan E. Sutherland, "The Ultimate Display," *Proceedings of IFIP* 2 (1965), 506–508.

9. In addition to Pimentel and Teixeira, see Mark Pesce, *VRML: Browsing and Building Cyberspace* (Indianapolis: New Riders, 1995); L. Casey Larijan, *The Virtual Reality Primer* (New York: McGraw-Hill, 1994); Howard Rheingold, *Virtual Reality* (New York: Summit Books, 1991).

10. Toni Dove, "Artificial Changelings," n.d., www.funnygarbage.com/dove (May 14, 2002); *Body Mecanique: Artistic Explorations and Digital Realms* (Columbus: Wexner Center for the Arts, Ohio State University, 1998).

11. Bret A. Moore, "Video Game or Treatment for PTSD?" *Psychology Today*, May 24, 2010, www.psychologytoday.com/blog/the-camouflage-couch/201005/video-game-or-treatment-ptsd (accessed November 6, 2012); "Military to Test PTSD Video Therapy," *CBC News*, May 14, 2012, www.cbc.ca/news/canada/story/2012/05/14/ptsd-therapy-dnd.html (accessed November 6, 2012).

12. Murray, 98.

13. Marie-Laure Ryan, *Narrative as Virtual Reality: Immersion and Interactivity in Literature and Electronic Media* (Baltimore: Johns Hopkins University Press, 2001), 66.

14. Ibid., 67, 21.

15. Harry J. Brown, *Videogames and Education* (Armonk, NY: M.E. Sharpe, 2008), 30.

16. Ryan, 3, 4.

17. William M. Ivins, *Art and Geometry: A Study in Space Intuitions* (New York: Dover, 1946), 5–6.

18. Bernard Frischer and Anastasia Dakouri-Hild, *Beyond Illustration: 2d and 3d Digital Technologies as Tools for Discovery in Archaeology* (Oxford: Archaeopress, 2008), xiii.

19. Ibid.

20. Mark M. Smith, *Sensing the Past: Seeing, Hearing, Smelling, Tasting, and Touching in History* (Berkeley: University of California Press, 2007), 3.

21. Ibid., 121.

22. Mary Webb, "Computer-Based Modelling in School History," in *Information Technology and the Teaching of History: International Perspectives*, ed. Allen Martin, Lez Smart, and David Yeomans (Amsterdam: Harwood Academic, 1997), 213.

23. John Bonnett, "Bringing Students to a Virtual Past: Teaching Ottawa History with the 3-D Historical Cities Project," in *Construire une capitale–Ottawa–Making a Capital*, ed. Jeff Keshen and Nicole Saint-Onge (Ottawa: University of Ottawa Press, 2001), 483–502.

24. Paul Krugman, *Development, Geography, and Economic Theory* (Cambridge, MA: MIT Press, 1995), 71.

25. On the limits of models, see Krugman, 71; Rheingold, 45.

26. Rheingold, 212.

27. See Nick Monfort, *Twisty Little Passages: An Approach to Interactive Fiction* (Cambridge, MA: MIT Press, 2005).

28. James Paul Gee, *What Video Games Have to Teach Us About Learning and Literacy* (New York: Palgrave Macmillan, 2003), 18.

29. James Paul Gee, "Good Video Games and Good Learning," *Phi Kappa Phi Forum* 85, no. 2 (2005): 33–37. www.jamespaulgee.com/sites/default/files/pub/GoodVideoGamesLearning.pdf (accessed November 21, 2012).

30. Jeremiah McCall, *Gaming the Past: Using Video Games to Teach Secondary History* (New York: Routledge, 2011), 12–13.

31. Murray, 152.

32. Ibid., 152–153.

33. Ibid., 185, 30.

34. Ryan, 65.

35. Brown, 118.

36. I explore these issues in "Digital Historiography: Subjunctivity," *Journal of the Association for History and Computing* (April 2000), http://hdl.handle.net/2027/spo.3310410.0003.115.

37. Niall Ferguson, ed., *Virtual History: Alternatives and Counterfactuals* (New York: Basic Books, 1999), 73.

38. Ibid., 87.

39. Ibid., 83.

40. Ibid., 85.

41. On methods for generating counterfactuals, see Philip E. Tetlock, Richard Ned Lebow, and Geoffrey Parker, eds. *Unmaking the West: "What-If?" Scenarios That Rewrite World History* (Ann Arbor: University of Michigan Press, 2006).

42. Murray, 137.

43. Michael Nitsche, *Video Game Spaces: Image, Play, and Structure in 3D Worlds* (Cambridge, MA: MIT Press, 2008), 173–176.

44. Ibid., 188.

45. See the Connor Prairie site, www.connerprairie.org/Plan-Your-Visit/Special-Events/Follow-the-North-Star.aspx (accessed November 6, 2012).

46. For a discussion of diachronic versus synchronic narrative in history, see Marshall Sahlins, *Islands of History* (Chicago: University of Chicago Press, 1985).

47. Nitsche, 183.

48. "Virtual Harlem," n.d., evlweb.eecs.uic.edu/cavern/harlem (May 14, 2002). See also Bryan Carter, "Virtual Harlem in the Beginning: Retrospective Reflections," *Works and Days*, Vol.19, Nos. 1 & 2, 2001, 35–44. http://ucmo.academia.edu/BryanCarter/Papers/634296/Virtual_Harlem_in_the_Beginning_Retrospective_Reflections (accessed April 24, 2013).

49. Mei-Po Kwan, "From Oral Histories to Visual Narratives: Re-presenting the Post-September 11 Experiences of the Muslim Women of the USA," *Social and Cultural Geography* 9, no. 6 (2008): 6.

50. See Horst Bredekamp, *The Lure of Antiquity and the Cult of the Machine: The Kunstkammer and the Evolution of Nature, Art and Technology* (Princeton, NJ: Markus Wiener, 1995); Susan Delagrange, "Wunderkammer, Cornell, and the Visual Canon of Arrangement," *Kairos: A Journal of Rhetoric, Technology, and Pedagogy* 13, no. 2 (2009), http://kairos.technorhetoric.net/13.2/topoi/delagrange/ (accessed November 21, 2012); Barbara Maria Stafford, *Good Looking: Essays on the Virtue of Images* (Cambridge, MA: MIT Press, 1998); Anna Munster, *Materializing New Media: Embodiment in Information Aesthetics* (Hanover, NH: Dartmouth College Press, 2006).

51. Munster, 5, 6.

52. Ibid., 57.

53. Cited in Moser, 275.

54. Murray, 112.

55. See Daniel Cohen and Roy Rosenzweig, *Digital History: A Guide to Gathering, Preserving, and Presenting the Past on the Web* (Philadelphia: University of Pennsylvania Press, 2005), 56.

56. McCall's book is especially useful for raising such questions.

57. Quoted in N. Katherine Hayles, *How We Think: Digital Media and Contemporary Technogenesis* (Chicago: University of Chicago Press, 2012), 49.

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