7 SIMKNOWLEDGE
What Museums Can Learn from Video Games

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The museum looked familiar yet strangely different. The floor and pillars too shiny, the paintings and sculptures dotted along the walls of the rooms and halls bland and generic, like the sketched-in background to a dream. My companion led me into a spacious gallery, past an information desk empty except for lamps and computer screens, past vitrines holding suspiciously modern-looking automatic weaponry, and up to one of the half dozen or so tableaux on display. Within an unglazed diorama, against the illusionistic perspective of its painted backdrop, five animatronic figures in combat fatigues moved slightly yet fluidly. As we approached, they shifted into a prescripted routine, pointing, nodding, checking weaponry, sketching out a dramatic vignette from some war or war film. After a few seconds they froze, mannequins again. We circled the room, each display vivified in animatronic precision as we approached, before lapsing again into motionlessness.

"Watch this," said my companion, and opened fire with his M9. The nearest mannequin flew back, jerking, as the bullets hit, and fell to the floor crumpled – I realized with horror that it was a human body, not a mechanical device. My companion laughed and we moved, running now, to the information desk. He hit a large red button on the desk and immediately the room erupted into violent action. The mannequins leapt from their displays and headed straight for us, guns blazing. We smashed the nearest vitrine, grabbed its guns and ammunition, and dashed for cover …

This nightmarish museum is a bonus level in the popular video game *Call of Duty: Modern Warfare 2*. Playing it evoked in me an ironic vision of dire predictions of a future in which culture and science have been swallowed up by technologies of entertainment, distraction, and spectacle: an age of spectacular digital effects and interactive networked entertainment; a virtual world of shiny surface

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spectacle, filled with empty signs of cultural and scientific heritage, which have become mere tokens or props for apparently mindless violent action; intellectual or aesthetic reflection, learning, study, the communication or transmission of *meaning* all exploding in bursts of computer-driven violence. It is one vivid example of what Andrew Darley has called "digital visual culture," a culture characterized by a waning, or loss, of meaning, driven by new aesthetic forms of computer-generated imagery (CGI) in cinema and television and video games. This chapter will explore some of the implications of an emergent visual culture of digital media for museum education, and especially the popular communication of scientific ideas to a youthful audience. It will look at some examples from science museums and centers, at popular science media forms, most notably the use of CGI in science documentaries, and at computer applications, both in entertainment and in an educational context.

A key concept will be that of *simulation*. This term addresses both the pervasive sense of an emerging culture of the fake or illusory (e.g., Eco 1986; Jameson 1991; Cubitt 2001), and – in computer simulation – new modes of exploring and modeling complex natural systems. Simulation, I will argue, goes to the heart of the anxieties about, and possibilities for, new modes of communication today.

> [These visual digital forms] lack the symbolic depth and representational complexity of earlier forms, appearing by contrast to operate within a drastically reduced field of meaning. They are direct and one-dimensional, about little, other than their ability to commandeer the sight and the senses. Popular forms of diversion and amusement, these new technological entertainments are, perhaps, the clearest manifestation of the advance of the culture of the "depthless image." (Darley 2000, 76)

As we'll see, these worries are not unique to recent technological developments, and anxieties about contemporary changes in public communication of science through museums and TV documentaries are widespread, if not always expressed in the apocalyptic terms of the "loss of meaning." In both academic and popular discourse, computer-generated effects in television and cinema are generally considered as, at best, eye-catching and entertaining, but superficial, an aesthetic of the surface and depthlessness, always threatening to overwhelm the true mission of popular screen media to tell a story or transmit knowledge. From this anxious viewpoint, the potential of CGI to distract, dazzle, and seduce has to be monitored carefully: these images seem to blur carefully drawn and redrawn borders between entertainment and knowledge, running the risk of turning flagship programs and important exhibits into commercial, Disneyfied distractions. At worst, they seem dissimulating and illusory, symptomatic of a dangerous cultural trajectory toward the emptying of meaning and the waning of affect through hyperrealist aesthetics. Of particular relevance to this chapter is the often explicit insistence in theories of popular visual culture on a binary opposition between "spectacle" and "knowledge" (e.g., Jameson 1991; Mulvey 1996; Darley 2000).

This unhelpful hierarchy hides the possibility that new forms of knowledge are made possible by digital media, across science and popular screen media. This chapter will argue that the genealogy of simulation in the computer modeling of complex systems, the spectacular techniques and aesthetics of animation, and the relationships between these technocultural forms and the televisual medium of the video game suggests a more nuanced and productive way of thinking about technology, entertainment, spectacle, and knowledge in museums and science centers.

There is a rich literature on the historical precedents for recent debates and concerns about the tensions between attracting visitors' attention to museums and exhibits through novel techniques of display and the serious educational and research aims of public museums. Barbara Stafford (1994) has charted the interplay between science education and the spectacular presentation of technologies and scientific phenomena back to the eighteenth century, and other writers have discussed how new media technologies such as photography and cinema have been both embraced and resisted by museums since the mid-nineteenth century (Griffiths 2003).

A key moment was the end of the nineteenth century, when a significant shift occurred in the focus of museums in the United States from public education to popular spectacle. As the museum's role as a research institution largely shifted to the university, there was an "increasing pressure to turn museums into sites of mass popular appeal … at the expense of the notion of the museum as a research institution for everyone" (Henning 2006, 46). This shift was typified by the widespread adoption in American museums of the diorama as an exhibition technique for anthropological or natural history displays. Though familiar, even quaint, today (indeed, as our *Modern Warfare 2* example shows, it can easily serve as an archetypal signifier of museumness), at its inception the diorama was controversial. Though it addressed the problem of how to attract and keep a visitor's attention among the bewildering accumulation of artifacts in museum halls and display cases, and offered a visual cue as to the environment in which the artifact or creature originated, for some critics and curators its aesthetic and technical characteristics were too closely connected with the emergent commercial spectacle of shop window displays and arcades, as well as popular attractions such as panoramas. As Alison Griffiths puts it, the display of natural history and anthropology has always been a "site [of] complex negotiations … between anthropology, popular culture and commerce in attempting to strike the right balance between education, spectacle and profit" (2002, 47). This negotiation of the competing motives of edification and commercialism in display techniques continues today. Griffiths notes that contemporary concerns about "Disneyfication" in natural history museums echo debates in professional museum journals and popular science publications at the end of the nineteenth century on new visual technologies such as lantern slides and cinema, technologies that required "careful supervision, lest their associations with popular culture contaminate the scientific seriousness of the exhibit and institution," blurring the museums' distinction from the nickelodeon and the

sensationalist dime museum (Griffiths 2003, 376). Today, the threat of distraction from eye-catching new techniques is still felt. Chandler Screven argues that the three-dimensionality and novelty of museum "gadgetry," while offering some interest, risks "distract[ing] viewers from the main ideas, distinctions, or story line," whereas Lisa C. Roberts fears these display technologies may "overshadow the objects they were designed to set off," competing for both space and attention (quoted in Griffiths 2003, 384).

So, prefiguring more recent display technologies, the dioramas were, as Michelle Henning notes, "increasingly illusionistic," "using technical devices and three-dimensional objects." With clear resonances with contemporary displays and attractions, the aim was "to envelop the spectator, giving them the sensation of being in the scene" (Henning 2006, 47), but always running the risk of overplaying spectacle at the expense of knowledge. Visitors might, it was feared, pay attention only to the technical devices and a presentation of simplified or preformed knowledge rather than to the artifacts themselves, the intended knowledge transfer short-circuited.

Drawing on Mark Sandberg's (2003) work on tableaux in nineteenth-century Scandinavian folk museums, Henning connects these concerns to the simulational digital technologies of today:

> While the museum founders were looking for immediacy, a sense of unmediated contact with the past, many visitors seemed to enjoy the simulation *as* simulation, finding pleasure in the to-and-fro between deception and recognition. Instead of desiring an older and lost (or rapidly disappearing) reality, a good number of visitors took pleasure in that in-betweenness, a pleasure that was possible through modern spectator positions, and that dispensed with the priority of the original over the copy, reality over the representation. (Henning 2006, 57)

Concerns about visitor attention were evident across the range of museums and instructional institutions, from folk museums to zoological gardens. It is significant for my argument here to note the precise terms of these anxieties that visitors might be distracted by the techniques and apparatus of display, interaction, and illusion. There is knowledge transmission here, but it is misdirected, wrong – we learn of the devices of simulation, not of the primary object of study whether that be an animal, a people, a natural phenomenon, or an artifact. It is worth noting, however, that the science center as a distinct institution has always – since its inception in the 1960s with the Exploratorium in San Francisco – been characterized by novel interactive displays (see Pedretti 2002).

Attention to the historical precedents for the negotiation of attraction and contemplation, spectacle and knowledge, commerce and research, helps us to understand contemporary concerns about public engagement with science and natural history through museums and science centers. However, there are significant material and industrial differences attendant on the emergence of digital media,

and in their effects on exhibition design and visitor behavior. As we'll see, some of these characteristics and effects are not separable from early moments of spectacle and interaction – fears of the merging of the museum with the theme park and the retail outlet are only intensified in the vivid glare and eye-catching effects of digital media – but they do offer or promise new possibilities for engagement and interaction. Again, these innovations have been viewed with distrust as well as excitement.

Prehistoric simulation: The case of *Walking with Dinosaurs*

> *In this era of digital technology and connectivity, access to heritage is increasingly mediated through the consumption of signs, electronic images, and simulacra. In virtual heritage, an algorithmically accurate large-scale 3D model of a cathedral or castle is taken as the hallmark of authenticity*
>
> Flynn 2007, 349

In an interesting article on the implications of digital media for the modeling and display of heritage sites and museums, Bernadette Flynn identifies the processes of virtualization as a fundamental challenge to the truth status of museums, in particular the ambiguity of an artifact's historical significance when rendered as a virtual presence. The modeling of heritage sites and objects in 3D software, for example, the virtual reconstruction of a ruined cathedral, or the presentation of remote objects held in storage or at other institutions, raises important questions not only about the authenticity of any particular display for both the curator and the visitor, but also perhaps the nature of authenticity itself: "As the significance of digital images has grown, the form of the factual has become increasingly virtualized – that is to say, it has become separated from any real object" (Flynn 2007, 349).

What does it mean to have an experience of a virtual object rather than its original? Particularly if, unlike the earlier removes of photography, that experience might be more vivid, offering the reconstruction of details and luster lost over centuries? Though Flynn notes a longer historical process of mediation or separation of the artifact from its authentic context – from its isolation through vitrines, labels, new forms of lighting, through to the replacement of the artifact with its photographic depiction – digital simulation marks a new phase in this dematerialization and dehistoricization: "However, the reduction of the monument or artifact to visual simulation disrupts its connection to material evidence and thus to history" (Flynn 2007, 349–350).

We'll see later that Flynn goes on to argue that video games, rather than fully instantiating this dematerializing, virtualizing trajectory, actually offer significant ways to reconnect to the social, the cultural environments of the artifacts. The terms

"virtual" and "simulation" are key here, and while they are often used interchangeably in the context of digital media, they have distinct conceptual implications.

First, however, I will explore how the historical anxieties in popular and academic discourses around museums, science, and spectacle have been evident in reactions to specifically digital media. I will take the BBC television series *Walking with Dinosaurs* (first screened 1999), along with subsequent series that built on its success, as an extended case study. *Walking with Dinosaurs* epitomizes these anxieties and has generated intense debate among academics, broadcasters, museums curators, and scientists – and, interestingly, sustained discussion by public contributors to BBC online forums (Jeffries 2003). Criticisms of the program tended to fall into three categories that overlap in ways that go to the heart of the popular presentation and communication of knowledge in an era of digital simulation and spectacle.

The series featured cutting-edge CGI to render the appearance, movement, and behavior of dinosaurs in convincing detail. The program makers used conventional photographic media to film diverse environments, with the synthetic prehistoric animals composited into the scenes. The scenes were presented to viewers framed by familiar conventions of the television genre of the natural history documentary, complete with authoritative voice-over. The conceit of the series was not that the viewer was watching a reconstruction of, or set of speculations about, the lives of long extinct creatures, but rather that they were watching actual animals and their behavior just as if the program were about, say, zebras in Africa today. This hybrid of digital spectacle and natural history documentary proved deeply worrying for some critics and scientists for a number of reasons. Much of the criticism was expressed through interrogation of the accuracy of the scientific information, for example, the depiction of a dinosaur urinating was particularly controversial, as Michael Benton (2001), a paleontologist who acted as a consultant for the series, explained. However, it is clear that it was not so much its *accuracy* that concerned the critics as the convincing way the series presented conjecture about dinosaur behavior as fact. Or, rather, its convincing simulation of dinosaur appearance and behavior seemed to render conjecture and speculation as convincing fact through the deployment of a combination of established natural history documentary conventions and the verisimilitude of computer animation. The biologist Steven Rose, for instance, argued that

> the main problem is the inability of the programmes to distinguish known fact from interpretation and sheer speculation. These mini-sagas are presented as life stories without a shadow of uncertainty … the borderlines between fact and fiction become even more blurred. (2001, 116)

Scientists and media critics alike were suspicious of its synthetic imagery – it was a "High-tech Sooty Show" for one TV reviewer (Scott and White 2003, 317) – in particular, its obvious (and deliberate) resonance with the recent blockbuster film

Jurassic Park. The series epitomized Andrew Darley's view that spectacular entertainment and technology have a powerful tendency to override or distract from any educational or informational potential. Darley usefully sets the series within the context of the history and conventions of natural history broadcasting but, less helpfully, interprets its significance in the postmodernist binaries of surface versus depth, style versus content, and spectacle versus narrative. *Walking with Dinosaurs*, then, "falls prey to contemporary aesthetic strategies that tend to negate representation and meaning (content), promoting instead the fascinations of spectacle and form (style)" (Darley 2003, 229). For Darley, the series was a "fake documentary," a key example of a "digital visual culture" in which scientific, cultural, and historical meaning and knowledge wane with the emergence of simulational and photorealistic screen media. However, as argued throughout this chapter, the relationships between new technologies of display and the popular communication of science do not divide so neatly into a binary opposition between spectacle and knowledge, and cannot be reduced to a narrative of the waning of meaning.

A persistent criticism of the computer-generated dinosaurs in *Walking with Dinosaurs* was that the details – color, sound, feeding, speed, and so on – were speculative. The programs did not present their images as sketches, artists' impressions, or suggestions – and the natural history generic conventions of continuity editing and voice-over added to this false confidence. However, I would argue that, in the face of the convincing virtual images, the extent to which science is often always already a speculative practice is forgotten. Michael Benton countered these criticisms by pointing out the extent to which science has always relied on speculation, particularly when attending to intangible or invisible phenomena, whether these absences are due to cosmological or microscopic scale or to extinction:

> Science would be rather dull if we had to restrict ourselves to what we could see and touch, to 100% certainty. It's extraordinary that some professional paleontologists were unable to understand that reconstructing the bodily appearance and behaviour of an extinct animal is identical in scientific terms to any other normal activity in science, such as reconstructing the atmosphere on Saturn. The sequence of observations and conjectures that stand between the bones of Brachiosaurus lying in the ground and its moving image in WWD is identical to the sequence of observations and conjectures that lie between the biochemical and crystallographic observations on chromosomes and the creation of the model of the structure of DNA … in both cases, the models reflect the best fit to the facts. (Benton 2001)

While accepting the spirit of Benton's argument, I would note that the modes of visualization and speculation he refers to are not exactly the same as those deployed in popular television series. At the very least, a television program will select the behaviors and appearances about which to speculate according to their fit with its underlying narrative structure and organization, and no doubt with an eye to their attention-grabbing and spectacular appeal. As James Moran puts it, there is a gap

between the documentary's need for empirical evidence and the necessity to *reconstruct* evidence for prehistoric phenomena, a gap that "can be bridged only by speculation, a form of interpretation whose historiographic and scientific ends must be compromised by fictive means" (Moran 1999, 259). The notion of *speculation* itself is key to a full understanding of the potential of simulational media for museums, but speculation in the context of simulational media is a more complicated process – we'll return to it later.

For now, there are other processes at work, in particular the emergence of new hybrids of knowledge and popular entertainment. Debates on the mediation of historical, anthropological, or scientific knowledge on television and through new technologies in museums tend to regard the particular knowledge as quite distinct from the media technology deployed to convey it. As we have seen, new media of display generate fears that they might distract viewers or visitors from the phenomena or artifacts, whether they be dinosaurs or cathedrals, or anxieties that the focusing, editing, or selection of aspects of these phenomena and artifacts is accurate or misleading. Or, as Flynn notes and Darley fears, whether the processes of mediation and virtualization simply elide the original, authentic phenomenon altogether. But media are not simply conduits or channels (sometimes blocked) through which messages and meanings flow, more or less effectively. If, in the assessment of computer simulation and video games as new media for museums, we are to avoid assumptions of either the apocalyptic threat of virtualization and the overly simplistic thesis that in their appeal and familiarity these playful media will attract audiences and surreptitiously feed them the same old "content," then we need to draw on an approach to studying the media epitomized by Marshall McLuhan's dictum "The medium is the message." That is, at the very least, a new medium reshapes its message or, taken more literally, the message has never been separable from its mode of communication. As José van Dijck argues:

> The popularity of scientific claims is inevitably defined by the available technology and preferred aesthetics of contemporary media – media that enabled the construction of these claims in the first place. From Galileo's telescope to Etienne-Jules Marey's stereoscope, tools of visualization have moved easily between scientific investigation and entertainment … We do not illustrate science with images, we construct images and deploy media technologies to "think" science (Burnett 2004). Computer graphics and animatronics are to 21st Century physicists and paleontologists what the microscope was to 19th Century biologists: new instruments allowing for new claims, but also for a retooling of the imagination. Animated dinosaurs … are not illustrations of science – they are part of science in action. (van Dijck 2006, 20)

This last observation confirms Benton's argument that simulation and modeling is a necessary part of science, not merely the communication of its findings. However, again, the medium itself must be factored in. Here van Dijck is alluding to an important moment in the production of *Walking with Dinosaurs* that I will

use to illustrate and explore this second process. As recounted in the documentary "The Making of *Walking with Dinosaurs*," paleontologists and animators worked alongside each other to establish plausible movements for the computer-generated creatures (see Henderson 1999 for a detailed account of this process). As such, the technicians and animators, whose expertise was developed entirely within the world of media entertainment and production, collaborated in scientific work. The animators worked with paleontological models of dinosaur skeletons and physiology, but their rendering of visually convincing on-screen movement was drawn directly from the techniques of popular animation. The simulated dinosaurs moved to a sense of weight and rhythm honed in the industry of drawn animation and cartoons, yet these aesthetics actually informed scientific understanding, resonating with the paleontologists' modeling of possible planes of movement based on the mechanical affordances of fossil bones:

> Technicians sometimes refuted accepted knowledge in paleontology because their models showed a specific locomotion to be impossible. As one scientist comments in the programme, paleontologists actually learned from animation programmers because they helped "prove" how the Diplodocus walked, how it moved its arms and legs, how the animals grazed and fought … technicians help scientists establish their claims by using the very tools that turn them into attractive spectacle. (van Dijck 2006, 14)

So here we see the specific operations and implications of the overlap between animation and simulation. Animation is generally regarded as an entertainment form associated with the whimsical and fantastical, though it has a parallel history in the visualization of natural phenomena in scientific research and communication. Simulation has an analogous genealogy in scientific research and entertainment applications. *Walking with Dinosaurs* brings together CGI as animation and visual simulation with the computer modeling of complex systems and bodies – generating a new kind of hybrid or monstrous knowledge.

Significantly, both animator and scientist study the movement and behavior of living creatures as sources for their respective speculations on the movement and behavior of nonliving creatures (whether dinosaurs or monsters). At the very least, this example demonstrates that scientific knowledge and entertainment spectacle (here specifically bound up with computer simulation) are not inevitable opposites in some Manichaean cultural universe.

Video games: Beyond the interactive database

This hybridized or monstrous knowledge will be a key theme for the rest of this chapter. Before I return to it, however, some explanation of the specificity of the video game as an informational medium is needed. I will posit two main, but

overlapping, ways in which the video game as a medium becomes the message with relevance to its relationship to museums and science centers: first, in their construction and navigation of virtual space and, second, the generative operations of computer simulation.

Popular and academic attention has been focused on the spatial and navigational possibilities of digital networks and virtual media from their inception. The sense of space beyond the screen and within networks has characterized responses to Internet media and virtual reality applications. Computer and video games, in particular, have proved to be the most innovative hothouse of new forms of depiction of virtual space and new modes of interactive engagement with, or navigation of, these spaces (Manovich 2001). For museums, the virtual space of the computer game has suggested new ways of simulating inaccessible or vanished places, not only by picturing a building or an environment, but by offering the visitor/player the ability to move through the simulation and to explore it. Flynn (2007) also points out that key conventions and gameplay features from video games are very useful in managing this movement, in making it engaging. These devices include challenges and puzzles, inventories and artificial intelligence, as well as navigation:

> In entertainment-based computer games, agency or the act of doing is constituted through diverse modes of spatiality. These modes of spatiality contribute to gameplay through such strategies as constraint and concealment, challenging the player to negotiate terrain to access objects, meet avatars, find portals, and do battle … Through these sets of spatial negotiations, players become involved in the sequential unfolding of a record of signposts and metaphors embedded in the landscape. (Flynn 2007, 355)

For Flynn, this spatial negotiation provides an essential counter to the dematerializations and decontextualization of museum media, not least the most recent virtual media. The navigation of virtual space offers the opportunity to "re-enchant" the artifact or building, she suggests, as it is once more surrounded by a dynamic environment with the possibility for the visitor/player to engage with it in a simulation of the ritual or cultural dimensions initially stripped away by the museum, to feel a sense of immersion or presence: "Virtual movement has the potential to create a simulated spatiality that extends the real to a more imaginative, enchanted, lyrical relationship with spatial immersion" (Flynn 2007, 363).

Thus, the virtual spaces emerging from the commercial popular media culture of the video game offer new ways for museum-goers to commune with the absent worlds that shaped these artifacts, rituals, and processes, echoing the motives for earlier contextualizing modes of display in museums such as dioramas.

Games might be thought of as a set of media rather than as one medium. They offer a diverse range of modes of engagement, and hence of engaging with and communicating a range of different knowledges. To illustrate the significance of

this for the concerns of this chapter, I'll take two examples, one that simulates the anthropological museum and one that mediates knowledge of natural history.

At the time of writing, the British Museum's website featured a game called *Time Explorer*, an "ultimate adventure"[1] (2010). The game interface is an isometric and stylized rendering of the British Museum, similar in appearance to the popular social website for children, HabboHotel. It draws on familiar conventions of the computer game, from the initial choice of avatar to exploration of the virtual space, the accumulation of virtual objects and solving of puzzles, and the given health and time constraints. The backstory establishes the player as a "gifted young curator" setting out to "identify the exact time when natural disasters struck four great ancient civilisations," using time travel and the collection of treasure. Scores are increased by picking up "knowledge points by collecting bonus objects and facts about the civilisation." Each level is a small, highly stylized virtual architecture with emblems, characters, and puzzles denoting a particular civilization (Aztec Mexico, ancient Egypt, etc.). The Aztec level, for instance, sets a simple puzzle to construct a statue from a small number of elements, while talking to a character in the temple reveals a "bonus fact" about Aztec warriors, and – perhaps more importantly – a number of "fact points."

As a conduit for, or introduction to, anthropological knowledge, this game is limited. The stylized and abstracted environments are more akin to theme park architectonics than any reconstruction of past cultures, and the knowledge attained through playing the game would seem primarily to be knowledge of the game itself, its structure and puzzles, rather than of the civilization (knowledge is quantified and accumulated as points). At best, perhaps, we see a dynamic event in which different knowledges are woven together, even if the most salient and persistent of these might be the player's understanding and experience of computer games themselves. Moreover, *Time Explorer*, while it presents a series of virtual buildings and environments, is not a simulation in the sense of a dynamic model. Instead, its structure is closer to that of an interface/database (Manovich 2001). The player navigates a static virtual space, accessing puzzles and facts and accumulating points. This, I would argue, is a significant distinction within the broad general category of "interactives" in museum and science center display, and most of these displays, from the early CD-ROM-based applications to current touch screen interfaces, fall within the database model as they offer only a selection of text extracts or images, accessed through static menus or a simple quiz structure (see also Taylor 2010 and Witcomb 2011). Though some video games, particularly those with educational aims, have an interface/database structure, most are dynamic in their offering of nonlinear interaction with navigable spaces, more or less artificially intelligent computer-controlled characters, and simulation of environmental factors from light to the physics of friction and gravity.

Close attention to the forms of media deployed – particularly new media – is crucial for any critical understanding of their potential for museums, and the communication of knowledge is inseparable from the media of communication

themselves. However, this analysis does not in itself question the pessimistic arguments of the triumph of spectacle over knowledge. To pursue my argument in more detail, and to suggest new ways of thinking about the generative (albeit hybrid) potential of video game forms for science museums and centers, I will return to the distinction I made earlier between virtual space (now supplemented by the navigation/database form) and simulation. I will now concentrate on simulation in its more specific sense as the modeling of complex and dynamic environments or systems.

Simulation is a complex and often contradictory term (see Lister et al. 2009 for a critical account of its use in the study of new media). It is important to distinguish between two key uses of the term while noting their overlap. We have already seen how cultural and media forms characterized as diverting, commodified, or spectacular have informed debates on museums, media, and technologies of display. In this sense, video games are part of what is perceived to be a recent, digital iteration of a visual culture that revels in surface effects at the expense of meaning and "depth." However, video games are also computer media, and as such are all simulations in the computing sense of the word. Games, like other computer software such as weather or economic simulations, *model* worlds or systems – from the complexities of urban development in the *SimCity* series of games to the dynamic artificial ecologies of *Creatures* or *Spore*.

> To simulate is to model a (source) system through a different system which maintains to somebody some of the behaviors of the original system. The key term here is "behavior." Simulation does not simply retain the – generally audiovisual– characteristics of the object but it also includes a model of its behaviors. This model reacts to certain stimuli (input data, pushing buttons, joystick movements), according to a set of conditions. (Frasca 2003, 223)

It is this specific computer form of the simulation, or modeling, of dynamic systems that is of central significance here, a form that originates from scientific imperatives to model complex systems and predict a range of possible outcomes from a set of dynamic variables. These systems might be meteorological (as in weather forecasting), demographical (modeling population growth or urban development), ecological (testing the relationships between predator and prey species), or economical (predicting market growth or collapse). An early example would be the prediction, in World War I, of missile trajectories given prevailing wind speeds, a process mapped out on graph paper and informed by a printed table of ballistic variables (Woolley 1993). Simulations as informational and procedural systems offer new ways of exploring aspects of physical and cultural worlds, whether existing or speculative.

To illustrate this, we can compare *Time Explorer* with another game designed for a museum, *Be a Merchant*.[2] Playing the role of a merchant in fifteenth-century York, players start with £50 and, through a series of straightforward choices,

proceed to buy and sell goods across medieval Europe. The game's interface is engaging but simple, with predominantly still images and intermittent audio clips. Its game mechanic simulates trade, as the player buys and sells commodities at varying prices by sailing to different ports. If the player buys cheaper products and sells where they fetch a higher price, money is accumulated. The game's designer, Joe Cutting, points out the possibilities for games as simulation in this context. For him, games are great at "describing systems: a situation where one element or decision affects another. So the *Merchants* game shows a simple economic system … Games are really good at letting players explore systems and getting [*sic*] an understanding of how they work" (2013, 42).

Computer and video games have brought the scientific tools of simulation into the realm of everyday popular media, albeit repurposed for entertainment. Within computer game studies, the distinction is made between narrative and simulation as overarching media forms for explaining and exploring the world – from literature and poetry to journalism and cinema, stories have been dominant:

> unlike traditional media, video games are not just based on representation but on an alternative semiotical structure known as simulation. Even if simulations and narrative do share some common elements – character, settings, events – their mechanics are essentially different. More importantly, they also offer distinct rhetorical possibilities. (Frasca 2003, 222)

Frasca's observations open up wide conceptual terrain on the rhetorical possibilities of simulation as media, a terrain too broad to map in full here (see Aarseth 2004). I will concentrate on the questions that simulation media, such as games, raise for the popular engagement with science and technology through digital media, not least in the setting of the museum or science center. I will argue that we need to rethink the modes and possibilities of popular scientific knowledge and its objects, and acknowledge new forms of speculative and hybrid knowledge.

For Mark J. P. Wolf simulation is "subjunctive documentary," "concerned with what *could be*, *would be*, or *might have been* … the simulation documents possibilities or probabilities instead of actualities" (1999, 281).

> A simulation is certainly artificial, synthetic and fabricated, but it is not "false" or "illusory." Processes of fabrication, synthesis and artifice are real and all produce new real objects. A videogame world does not necessarily imitate an original space or existing creatures, but it exists … a simulation is real *before* it imitates or represents anything. (Lister et al. 2009, 38)

So, against the prevailing notion of simulation as inherently illusory, artificial, and fake, computer science (and some game scholars) understands the term in quite different terms. A computer model can explore, analyze, and test aspects of real – but intangible or invisible – systems in ways inaccessible to the written word, the

photograph, or the video image. However, complex systems such as climate change, demographics, or economies (like prehistoric ecologies, phenomena that cannot be seen, touched, or photographed) are simulated not to predict their future behaviors directly or absolutely, but rather to offer a field of possibilities for their future states, a field that can be manipulated by adjusting variables. There are clear connections with the debates around *Walking with Dinosaurs* in this regard (though the dynamic operations of simulation were deployed in the *making* of the programs, not – as is the case of video games – in their *consumption*). Simulation in this sense can be *speculative*; numerous variables can be adjusted to test their effect on the working of the system as a whole. A simulation can be regarded as prosthetic imagination, testing complex possibilities in what Mizuko Ito, referring to *SimCity 2000*, calls "a structured space of possibility" (1998, 303). A computer science definition of the term resonates with Ito's understanding of the popular digital media form: "a simulation produces a synthetic history of the process. Beginning with a set of initial conditions, the simulation plays through the various kinds of events which might occur."[3]

Simulacral knowledge

Before I return to the museum to make some specific observations on the relevance of this conceptual discussion for thinking knowledge communication, there is one more process that needs to be opened up. So far we have acknowledged the new (though not without precedent) hybridities of knowledge that emerge with digital media, which are exemplified by the cross-fertilization of paleontology and entertainment in the animation of *Walking with Dinosaurs*. It has been suggested that computer simulation facilitates new speculative modes of inquiry and brings to our attention intangible phenomena and behaviors. Yet it should not be assumed that computer simulation is then leading us, incrementally, through advances in programming and visualization, closer and closer to the real world. Even the most detailed and complex simulation remains a set of algorithms, a mathematical and synthetic construction, that – like Zeno's arrow – appears to get closer and closer to its target but can never reach it. Actual systems and computer models are not, as has been suggested, on a continuum, with the (achievable) goal of simulation the "actual 100 per cent implementation of the referent system" (Järvinen 2003).

Again McLuhan's assertion that the medium is the message is apposite. Computer simulation underpins a distinct set of media, with both realist (pace Järvinen) and phantasmagorical trajectories. There are serious simulations and ludicrous ones, and their open-ended structure often offers possibilities for both within the same system (Giddings 2007). Whether playful or practical, an implicit knowledge of the system is essential to play a computer game or engage with a simulational museum exhibit, but more wayward systemic knowledges also emerge. Indeed the interactive possibilities of digital media seem almost to demand a playful testing of their capabilities, a ludic tendency that can only be

encouraged by young visitors' own experience of video and computer games. The "space of possibilities" cannot always be constrained or contained by the simulation designer's intentions, and the question of what kinds of knowledge – or knowledge of what kind of object – returns.

At its simplest, this means that that images, symbols, or narrative framing of a computer simulation may not – in any particular event of play or engagement – remain as closely tied to the source system as intended. Media studies has explored countless detachments of signifier from signified in the consumption of television, cinema, magazines, and so on, but simulations add new possibilities for arbitrary semiotic and behavioral trajectories. I will explore this through an example of science education software, Mitchell Resnick's *StarLogo* program. Resnick's own analysis of the workings of *StarLogo* illustrates these operations of simulation beautifully. The program allows children to experiment with various kinds of bottom-up emergent behaviors. Drawing on techniques developed in artificial life (Alife) research, the program presents a microworld of cellular automata. Cellular automata, first developed in the translation of a paper simulation of cell colony growth (John Conway's *Game of Life*) to a computer program, are simple entities (initially a single point or cell on a screen) whose behavior is determined by a set of rules which, though simple, generate complicated and unpredictable development or behavior, analogous to cell growth, evolution, or (as we'll see later) the complex movement of animal groups. Alife and cellular automata principles underpin games such as *SimCity* (Ito 1998), to war simulations (Giddings 2007), and games featuring biological evolution itself, notably *Creatures* (Kember 2003).

StarLogo allows its young programmers to manipulate the starting positions or organization of these automata (playfully called "turtles") and then, through the program's application of simple rules of behavior, the players can watch their world unfold. The turtles are polysemic, figured as traffic jams, slime molds, or termite colonies depending on the intentions of any particular iteration of use/play. Importantly, Resnick is not concerned with exploring slime molds, traffic, and so on in and of themselves; rather, his intention is to facilitate exploration of the systems and dynamic behaviors at a more abstract level. These "microworlds are always manipulable: they encourage users to explore, experiment, invent, and revise." *StarLogo* offers "system science" microworlds, "worlds where systems thinking can hatch and grow" (Resnick 1997, 50). The knowledge generated by *StarLogo* play is not *representational* (players learn nothing specific about a termite colony or a particular city's traffic flows) but *simulational*. It is knowledge about dynamic nonlinear systems in general:

> The real world serves only as an inspiration, a departure point for thinking about decentralized systems … I am more interested in investigating antlike behaviors than the behaviors of real ants … The goal is not to simulate particular systems and processes in the world. The goal is to probe, challenge and disrupt the way people think about systems and processes in general. (Resnick 1997, 49–50)

There are echoes here of a longer, predigital philosophy of simulation, of concepts that date back to thinking about the nature of reality and artifice in classical antiquity, which were revived in the media culture of modern times, with simulation understood as "a copy without an original" (Baudrillard 1983). So the challenge for science communication here is significant: the turtles demonstrate that a simulation can explore the complexity of the world in powerful new ways, without actually simulating *anything*, or, perhaps more accurately, without reliably or closely modeling particular natural objects or phenomena. As Wolf points out, simulations can be "used to image real or *imaginary* constructs, or some *combination* of the two" (1999, 280).

A final example will, hopefully, demonstrate the relevance of this discussion for museum and science center exhibits. It is another interactive computer-based game, this time designed for the educational setting of Wildwalk, a science center in Bristol which closed in 2007.[4] Visitors would enter the installation, which was located in the final room of the center, after walking through a range of natural history and ecological displays, from living animals in vitrines to interactive screens and videos. In this smallish dark room, a data projector suspended from the ceiling projects directly down onto the floor, which is transformed into a shallow rock pool or river bed. As visitors walk across it, they can see the clear blue water around their feet. It quickly becomes apparent that this virtual water responds to the visitors'/players' footsteps, rippling and bubbling in a simulation of turbulence. The overall experience is effective, the simple device of rotating the conventional vertical orientation of the screen 90 degrees transforming the now familiar experience of the museum interactive screen into something different – a playful augmented reality in which the visitors inhabit a space that is consistent with the virtual shallows through which they paddle.

Stand still for a moment and small schools of computer-generated fish flit out from the edges of the projection. As with the rippling water, it takes a minute or so to realize that they too are responding to the movements of the visitors. They swim toward a visitor's feet, but any bodily movement sends them flitting away again. A relatively simple mechanic of motion detection and Alife algorithms – of "flocking" this time, the simulation of the complexity of flocks of birds or schools of fish – coupled with the orientation of the projection apparatus and with a playful exploratory willingness on the part of the visitors, and a simple yet dynamic virtual–actual environment is generated.

The fundamental ambiguity of computer simulation is apparent here, as the Alife processes of flocking are practically identical whether the interface is depicting a fish or birds. The general term for this particular type of automata is "boids," a thoroughly simulacral term – these are birdlike but not birds, neither fish nor fowl. Moreover, once this interactive installation enters the museum, and is entered by the museum's visitors, its communicative ambitions are not so smoothly realized. Children run through, "splashing" the virtual

water and chasing the fish. Some adults, while their children play, develop their own little games, testing the type and degree of expression needed to send the inquisitive fish darting away again beyond the edges of the microworld. Rhythms are established, the gentle swinging of arms and wiggling of fingers synchronized with the computer-generated responses of the automata as they swim in, react to the visitor, and move away again.[5] Whatever individual visitors to Wildwalk learned from this playful virtual system, it was unlikely to be any straightforward grasp of a marine environment or animal behavior, though the installation may well have been able to "probe, challenge and disrupt" the way they thought about (or perhaps perceived) natural systems and processes. They certainly responded to it as a game, engaging with the mobile entities as abstract elements, testing the system's interactivity and parameters just as a video game player must.

On the one hand then, this simulation/game is a recent example of the potential of all innovative and technically sophisticated museum displays (from dioramas onward) to distract visitors away from the "substance" of the collection and toward the novelty, mechanics, and devices of the display itself. On the other hand, like *StarLogo*'s turtles, it suggests that attention to the machinery of display is not necessarily the flattening out of meaning or knowledge by spectacular screens and surfaces. Simulation media require their own new "literacies" and, while they are not necessarily a superior way to grasp the real world's complexity compared to the more familiar linear narratives of scientific papers and television documentaries, an implicit understanding of them as media and technologies is inseparable from engaging with their rhetorical possibilities.

Moreover, both video games and interactive installations are predicated on what Flynn, referring to the video game *Grand Theft Auto* calls "a mobile and a thinking body" (2007, 359). The potential of video games is not (only) their popular appeal and engagement – it is their simulational form in and of itself as generative of emergent speculation and knowledge, and their potential for articulating bodies, minds, knowledge, and play in new, unpredictable encounters.

Notes

1 At http://www.britishmuseum.org/explore/young_explorers/play/time_explorer.aspx (accessed August 6, 2014).

2 http://www.joecutting.com/work.php?type=history (accessed August 11, 2014).

3 Definition of "simulation," Principia Cybernetica Web, at http://pespmc1.vub.ac.be/ASC/SIMULATION.html (accessed August 6, 2014).

4 For a detailed discussion of Wildwalk see Chapter 3 by Nils Lindahl Elliot in this volume.

5 For a demonstration, see http://vimeo.com/64221493 (accessed August 6, 2014).

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