Chapter 3

Video Games as Archaeological Sites

How Is a Video Game an Archaeological Site?

Video games are both artifacts and sites. It is perhaps clear to see how a video game can be an artifact; one needs only to recall the 2014 excavation of the Atari Burial Ground in Alamogordo, New Mexico, where more than thirteen hundred Atari cartridges from the early 1980s were removed from a landfill containing an assemblage of over eight hundred thousand games (see chapter 1). Understanding video games as sites is a bit more complicated. A video game is a built environment (albeit digital), something made by people for other people to use—and in some cases "inhabit" if the game is complex enough to hold one's attention for months or even years.

A video game is also an archaeological site. At the superficial level of any game set within an imagined landscape, one can observe the art and architecture placed there by a team of developers and artists. In games such as *World of Warcraft* (*WoW*), there are actual sites and examples of invented "ancient" heritage within the game: runes and ruins, ready-made material culture, and ancient artifacts to find. When one ceases to be amazed by the attention to the visual (and audio) detail in games, one can perceive the game, all of its content (material culture), and its community of players as being appropriate for archaeological study, regardless of whether or not a game contains depictions of architecture in it.

In order to better understand how a video game is an archaeological site, we first need to learn what defines a site in the real world. In meatspace an archaeological site is a place in which evidence of past activity is preserved, which may be investigated using the methods of archaeology, and represents part of the archaeological record (the body of physical evidence about the past).

When dealing with the concept of sites, one needs to address the more general concept of the archaeological record, which can generally

be defined as "the entirety of past cultural materials that have survived into the present day, but which are no longer actively engaged in a living behavioral system" (LaMotta 2012: 70). The archaeological record is formed over time and can change based on human (or another agent's) interaction with the material in the record.[1]

Vince LaMotta outlines four basic ways in which the archaeological record can become inscribed by traces of a particular activity: (1) conjoined elements of an activity are abandoned; (2) conjoined elements could be removed from one place and entered into the archaeological record someplace else; (3) waste, byproducts, and breakage; (4) modifications (LaMotta 2012: 75, 79). Several conjoined elements compose an archaeological assemblage, which can either comprise all or part of a site. The archaeological record is written in a number of ways: when the site is abandoned, moved from one place to the next, destroyed, or changed in some way, caused by any number of internal and external factors. The causation can happen via mechanical/natural changes wrought upon materials that ultimately provide us with recoverable residues (i.e., artifacts), leaving archaeologists with these artifacts to explain why people once acted to create different material realities (Barrett 2012: 146). The things we make are made for a reason, and they are also changed for a reason (although those reasons can be difficult to tease out; we cannot know for sure what was in the minds of makers and users). Archaeological sites are populated by material remains, which can be grouped together into data sets and interpreted.

LaMotta's definition of the archaeological record is a limited one, however, because (1) it restricts archaeology to sites that are no longer used, and (2) it does not account for the fluidity of time or of potential identification and uses of archaeological sites by contemporary archaeologists. Cornelius Holtorf's more liberal interpretation acknowledges that the meanings of archaeological sites and artifacts always change and cannot be fixed to a particular locus in time or space. Archaeological sites mean very different things to different people, and these meanings are equally important (Holtorf 2005). These meanings also include those emerging from the sociocultural and political baggage within the archaeologist conducting research, or of the many voices (multi-vocality) of the site's occupants past and present, something Ian Hodder defines as "reflexive methodology" (Hodder 2005). This anti-prescriptivist approach allows us to treat the recent past and even the present as archaeological, that the past and present constantly commingle, voiced by thousands of people past and present. The library I use now was built twenty years ago, and while its primary function has remained unchanged (to provide free access to people to use its resources), the

resources have changed (internet access, borrowing digital media, an entire section dedicated to Japanese comic books [manga]). The space is older, but it is also revitalized. The same can be said of video games as they are patched and modified (modded) over time to meet the needs of both old and new audiences. Archaeologists should be able to recognize and describe the modes of existence of various objects and account for the numerous connections that flow out of these streams of experience, investigating the making of objects in contemporary societies (Yaneva 2013: 131).

When we deal with the digital, the conceptual approaches and concerns involved are the same as when dealing with real-world sites. Everything tends toward a state of entropy, which is why the archaeological record is both incomplete and difficult to define. While natural/mechanical processes constantly work to erase/change the archaeological past, similar processes occur within digital media, which are by their nature degenerative, forgetful, and erasable (Chun 2011: 192). Digital media are stored (or have storage), not unlike the Earth itself (planet-sized storage). Archaeological data are locked in structures and in assemblages both underground and aboveground, just as digital data are stored. In both cases, data are gradually lost, the methods of storage imperfect. But there is also memory (an intangible archaeology), something to be interpreted when the real or virtual site is explored. Storage is finite; memory is boundless (Chun 2011: 195). There is no difference between the archaeology of the digital and the non-digital. The concepts of formation processes of the archaeological record and the methodological approaches to them are the same. Sites, like artifacts, have a history of use that continues from their origin into the present day. Sites are never not used, although they may exist in stasis until (re)discovery.

The above definitions of what makes up an archaeological site—which is part of the archaeological record and is affected by formation processes—apply to video games. I propose the following points in an attempt to further define and defend video games as archaeological sites:

1. A video game is a discrete entity where the place can be defined as the space in which the game is installed (not necessarily its installation media). The past activity is the coding that created the game. Its elements can be directly observed and manipulated, part of the record of the game.
2. Video game installation media (e.g., a tape, cartridge, or disk) is not only an artifact but also an archaeological site. Just as with real-

world sites, installation media is bounded within the confines of the physical space containing smaller entities that comprise the media, adding a level of cohesiveness to all of the digital parts that make up the overarching game. These directories, files, structures/hierarchies are all themselves discrete entities, but they combine to create a unified whole, just as a site is defined by its boundaries and the sum of its parts. The game media were created by one or more people for others to inhabit, generating a culture around those players who choose to inhabit the space of the game (e.g., the community of players in the original *MUD* in 1978). The game media become part of the archaeological record upon production and leave behind evidence in the form of material remains as well as a documented history of occupation by both developers and players.

3. The game-as-played, which is accessed via installed digital media, is also an archaeological site. The game-as-played is its own world in which one or more players interact, and which contains its own digital artifacts, either created via errors in code or created as artificial constructs to be perceived by players as actual representations of real-world things that can be manipulated in game-space. Past activity includes, at the extra-game level, updates, patches, bug fixes, mods, and expansions. At the in-game level, past activity includes the actions of one or more avatars and their effects on the game-space, whether it be moving in-game items from one place to another or the destruction or construction of something semi-permanent in the virtual world.

Archaeologists can explore these game-sites on the surface (analyzing the game media), from within (via file systems and structures), and through play (by interacting with the game-space as created by the developers). The games preserve evidence of past activity, from production to use to disposal, from installation to use to deletion, from beginning to gameplay to the final boss. The amount and nature of preserved evidence varies from game to game, as it does with real-world sites. Sometimes what remains is data rich, and other times one is left with only a trace of fleeting occupation.

One of my criteria to define a traditional archaeological site is that it can be assigned GPS coordinates. A site is a physical space of occupation, however temporary, for some purpose: a camp, a settlement, a building's footprint. But can archaeological sites exist without a specific, immutable location? In the real world, there are a handful of examples. There are sites, which have been recorded in literature (e.g., Herodotus) that might have existed at one point in time but have yet

to be found. One example of moving sites with relative locations (one must identify features in relation to the moving site's boundaries) include those that are trapped in glaciers or icebergs and sites such as the so-called "Great Pacific Garbage Patch"[2] that are big enough to see and document yet have no fixed position.

With synthetic worlds, there are a number of ways to document the locations of archaeological sites on both levels: the in-game and the extra-game. In-game, some games contain their own location systems (e.g., *Tomb Raider: Definitive Edition* 2014) where players can record X-Y coordinates on a Cartesian grid. With games featuring maps, depending on the hardware used to play the game, one can take a screenshot and then apply a regular grid over the top of it as a layer using image software (e.g., Photoshop). Other mapless games still allow for the assignment of in-game locations via textual descriptors (e.g., level name and a description of the player's surroundings); these lack pinpoint exactness, reading more like an explorer's journal entry. The usefulness of these qualitative notes becomes less clear when dealing with games comprised of vast regions to explore. But if Heinrich Schliemann could find the ancient city of Troy by way of reading the *Iliad,* then perhaps there is hope than an intrepid player could do the same based on observation, reading literature provided in-game and online, and a little luck.

Considering the loci of the physical sites of the games themselves, this could be an IP address of a game server, server farm, or local client hardware. These boxes or arrays occupy physical space and could be considered as "meta sites," the plastic-and-metal wrappers containing the game-site. Games might also be located by knowing the whereabouts of the development computer(s) or possibly the master media onto which the game's design was saved. With these game-sites come a stratigraphy of build numbers and versions, sometimes stacking on top of each other, other times replacing the code that came before—not unlike the levels of the ancient city of Troy—or using *spolia* to create new monuments and cities from the old.[3]

Just as light is both a particle and a wave, digital games are both archaeological sites and artifacts too, through no great leap in logic. A game is a place. It is also a thing. One could consider a copy of Atari's *Indiana Jones* (1982) to be a portable antiquity: a physical example of material culture that can be (and in this case intended to be) moved from place to place by people. Coins, statuettes, pots, tools are all examples of portable antiquities. As was shown in chapter 1, cartridges (and other media) are now portable antiquities, too.

The game-artifact as it existed in the past (and still does, but to a lesser extent with direct downloads taking over the market[4]) was cre-

ated by at least one person, but with the help of machines, resulting in a distributed thing, sometimes with market value, that contains within its production a history of creation, possible inscription, and has a findspot (or more than one findspot as its biography grows). The artifact of the game provides the heart (sometimes still beating) of the game-space as well as metadata, its developer-created information, a mobile inscription, a container of text-and-image. The cartridge or disk is a vessel with the wine, the stone upon which the writing was carved containing the deeper meaning born of words and syntax. It is the physical manifestation of code wrapped in layers of instructions that created the portable package, a world in itself containing a world within. Games that exist independent of physical media, accessible only through hardware connected to a network or to the internet, are digital artifacts lacking in materiality, yet they behave in the same way as their physical counterparts: the copy of *Uncharted 4* I downloaded plays exactly the same as the copy purchased at a brick-and-mortar retailer.

The final question to consider is, "When may we call what we are looking at a site?" In the real world, the archaeologist can determine the boundaries of a site through investigation of the material remains, whether a fixed border of a wall, for example, or the petering out of a distribution of flakes left behind from tool production. The archaeological record gradually transitions from site to other like the layers of the atmosphere transitioning from the Earth to space. As archaeological sites are composed of the remains of human occupation, the archaeologist must consider those things left behind to create a provisional history of the site, or at the very least a definition of the site itself.

When dealing with digital media, archaeologists such as Gabe Moshenska (Moshenska 2014), Colleen Morgan, and Sara Perry (Perry and Morgan 2015) have explored USB sticks and hard drives as archaeological sites. These containers hold a file structure composed of directories, subdirectories, and files that when taken separately are themselves artifacts. Taken together, they compose an archaeological site.

Games are no different. For older PC games, one could browse the installation directory and gradually tease out the files and contents of those files that when used together generated the game-space onscreen. As installation media has grown in sophistication, those files and their contents have become obfuscated, but all of the elements used to create the game for the player remain. These games are sites composed of artifacts working together, an electrified society of automatons.

But each game is also an artifact composed of digitally moving parts. An artifact such as the Antikythera mechanism, the world's oldest known computer dating to around the second century BCE, contains

gears, springs, rods.[5] When found in the machine, they are not themselves artifacts but are part of the artifact. When found apart from the context of the machine, these gears and springs are individual artifacts that might one day be reunited with other pieces to recreate a larger object. So it is with games: they are made from files that are not separate from the game itself (when the game is studied) but are taken as part of the game-artifact, a part of the whole. Other archaeogaming investigations might, however, focus on legacy files and snippets of code from an abandoned game, perhaps ultimately finding a way to determine the nature of what had been (or what was being) designed prior to abandonment.

In traditional archaeology, one cannot pick up a site and move it. For the game archaeologist, all sites are portable, as are the artifacts they contain. Both have multiple moving parts that all contribute to the meaning of the site they comprise. The artifacts form a network created by culture. In the case of a video game's history, its creation originates from pop culture, industry trends, and the design spec (Therrien 2012: 21). The game-site is constructed, then reconstructed, always in a state of modification. The networked pieces contribute to an emergence of a broader meaning and the creation of an interactive environment. As with any archaeological site, real or virtual, the site is a system, a network, that the archaeologist can attempt to break down into its constituent interacting agents, from whose behaviors and interactions various systems-level properties may emerge (Kohler 2012: 108). This is the definition of agent-based modeling. Pieces of the whole work together to create an interactive environment, be it the city of Athens or a digital simulation of it.

An archaeological site communicates many things and can be used in several different ways at once. Holtorf describes the uses and appeals of archaeological sites as having monumentality (big/visible = important); factual detail (conformity with educational values); commerce (commercial exploitation of sites); social order (reception that mirrors the present); identities (personal relation to the past); aesthetics (romance and scenery of ruins); reflection; aura; nostalgia; ideology; adventures; magical places; and progress (Holtorf 2005: 92–111). Take a game such as *Assassin's Creed: Unity* as a site, and you will find that all of the above uses apply equally to the synthetic as they do to the natural. In the case of open worlds—games that allow for free movement/play—video games behave even more like their real-world counterparts. In *Eve Online* there are no developer-ordained goals or a traditional endgame. Instead, players band together to create their own goals, annex their own little corner of the universe, form alliances,

foster animosities with other groups (Stanton 2015: 300–301), and create their own in-game lore (Stanton 2015: 298–300). There is no difference between the archaeological understanding of a real-world place and a video game. These sites are formed in the same way, grow and change through mechanical, natural, and human intervention, contain the same data, which lends itself to the same questions archaeologists have asked for over a century.

Perhaps most simply put, as stated in the introduction, is that video games are built environments (which can also be classed as archaeological sites). Archaeologists understand built environments to be constructed by people for people, creating a manufactured space for everyday living, working, and recreation. For many people (including myself), that includes video games—digital built environments—especially in the case of MMOs and open worlds. I give these digital spaces hundreds (sometimes thousands) of hours of my time, spend my real-world money to inhabit these environments, and build my own social networks within them (e.g., my "Carpe Praedam" *World of Warcraft* guild).[6] Some people even make a real-world living through their in-game interactions and activities (professional community managers and professional eSports players come immediately to mind). These games have become the sites for a new archaeology, one that simultaneously embraces the real with the virtual.

Landscape Archaeology in Video Games

During a spectacular flyover above the southern tip of Greenland, I looked down and instantly saw small ice floes, rocky beaches, extinct volcanoes, blue-green lakes, and glaciers. There was no evidence of humanity, at least in that small part I could see of the country (population approximately fifty-six thousand). I wondered where people might live, where they might fish, hunt, build a place to live. I also thought about where they might shop, where they might work, and scanned for clues far below.

I feel similarly when I play *No Man's Sky* or other games where I can cruise over the landscape in a ship or on a mount, watching it unfold as I make decisions on where to land based on the quests/missions that I have. It's landscape archaeology even though it's in a synthetic world, and to conduct a project within a synthetic world one must follow an established method (before ground-truthing requires on-the fly modifications). Any landscape archaeologist must create a research plan, must then select an appropriate site in which to do the work,

and then conduct a variety of activities ranging from aerial reconnaissance to remote sensing, shovel tests, field-walking, finds analysis, and more.

In order to better understand how landscape archaeology works in synthetic worlds (largely digital games, but this can be applied to all digital built environments), we need to understand the definition of a landscape and the varieties of landscape archaeologies, all of which shift neatly between the natural and the synthetic. Synthetic worlds are designed, the creators and their blueprints/code known. For the digital landscape archaeologist then, we can explore these spaces asking exactly the same questions as our natural-world counterparts. I'm willing to bet that what we find will not be that dissimilar.

In the preface to 2008's *Handbook of Landscape Archaeology,* editors Bruno David and Julian Thomas identify three broad themes of landscape archaeology (David and Thomas 2008a: 20):

1. Landscapes are *fields of human engagement* as in Heidegger's notion of dwelling. These include both explorations on conceptual *ways of approaching* and experiences of landscapes as fields of engagement, as the "in" of "being-in-the-world";
2. Landscapes are *physical environmental contexts* of human behavior (such as investigations of the tree cover or topography of the environments);
3. *Representations* of landscapes, such as in landscape art, or the identification of colonial tropes in landscape analysis of textual preconceptions, should be reflected upon.

Both natural and synthetic landscapes share these three themes: (1) for synthetic worlds, players are very much "in-the-world," completely engaged with their surroundings as they explore and play; (2) synthetic worlds do provide physical environmental contexts, which can include understanding vegetation and topography that can (and often do) dictate player behavior; and (3) synthetic worlds very much provide representations of landscapes, typically created by one or more designers based on how they conceive of landscapes, as well as how landscapes advance narrative or drive player behavior.

When we engage with synthetic worlds, we occupy a place within a place within a place, inhabiting multiple landscapes at the same time. We sit in the natural world before engaging with the synthetic. And once inside the synthetic landscape, we visit multitudes of places dotting our field of vision and beyond. The landscape beckons us in and affords us new frontiers.

Landscape archaeology seems to be preoccupied with human presence and engagement within the spaces they occupy over time (David and Thomas 2008b: 38). It doesn't matter if that space is natural or synthetic. Synthetic worlds have nearly infinite space with which players can engage, creating lived-in environments where players can spend more time than in the natural world. Players inhabit these spaces, invest time, money, and resources, and create their own culture side by side with any synthetic culture pre-built by developers and/or algorithms. Some synthetic worlds (e.g., *Minecraft* and *No Man's Sky*) offer players the chance to manipulate the landscape themselves for whatever reason, be it for entertainment or for something more practical. Create a real or synthetic garden. Dig a hole to see where it goes and what resources might lie beneath your feet.

Every landscape (natural or synthetic) can contain material remains and networks connecting agents, materials, and places. A goal of the landscape archaeologist is to connect the two (Heilen, Schiffer, and Reid 2008: 605). While this can be easy in designed games (synthetic worlds where everything has been crafted by the software developer), it becomes increasingly more difficult (and arguably more "real") in worlds where everything is procedurally generated. This is especially true when algorithms are entrusted with the task of building a world and populating it with things for the archaeologist to discover. This placement is almost random, but it bears some logic based on the landscapes discoverable within the synthetic world. The landscape shows the archaeologist where to look.

A landscape, either natural or synthetic, can be interpreted in any number of ways. A synthetic world's designers interpret their digital built environments from the perspective of narrative, player engagement, and aesthetics. From the player's perspective, the landscape exists as something to explore, as something to be traversed, and as a provider of materials for quests and recipes. In the natural world, one must also consider the landscape from the indigenous perspective(s), understanding how the landscape is a permanent resident, a host of memories, and perhaps a space of spiritual resonance (Strong 2008: 54). How do nonhuman denizens of synthetic worlds "perceive" their landscapes? For now, automatons unquestioningly operate within the constraints of a world's rules. They "see" the landscape through software instructions. They engage with that space based on parameters, acting when acted upon. It's little different than a human commuter in a rut.

Inhabiting synthetic landscapes can, over time, create a material record of that occupation through in-world crafting and building, through rubbish, but also through documentation of what came before. Players

record and photograph their creations, share them, save them. It's a rich record of space and time that the natural world will never see. It is perhaps easier to illustrate synthetic landscapes because they can be recorded during exploration and can even "instanced" for exploration by others on their own hardware; this is helpful if one wishes to have results independently confirmed by others, something not normally possible in field archaeology, which can be a destructive process leaving only data but not the primary source(s) of that data (i.e., strata).

Speaking of visualization, how does the player-archaeologist map the landscape of a given synthetic world? Some games come with built-in maps, while others tease out their mapping only through a player's progress. Other synthetic worlds have no maps at all, so players may either hand-draw their explorations or rely on memory, the latter of which most nonhuman entities do. In many games, players rarely see their world from above, but frequently at eye level. We remember how to get from one part of the forest to another through experience, or from following something, curious to see where it goes. We create a mental map, which is visual, at times aural, occasionally punctuated with memories of events that happen along the trail or traverse (see Hill 2008: 99 for research on primates and how they map their environment). We learn the game's rules for wayfinding in the synthetic wilderness and then lead others to what we've seen, or we write about it so others can follow in our footsteps. Some of these writings are literally called "walkthroughs." With an active player community (or a preserved collective memory), we also have what can equate to "tavern archaeology" in the natural world. Yannis Lolos wrote about this in *Land of Sikyon,* about approaching local Greeks in taverns and other gathering spots to share a drink and listen to stories (Lolos 2011: 6). At times these stories would provide clues to where to look for previously undocumented archaeological sites, which were then compiled into a gazetteer for future archaeologists to use as they continue to understand the history of Sikyonia. Video game archaeologists should do well to spend time with player communities on reddit and elsewhere for the same reasons as Lolos. We can learn from indigenous populations, can work together with them, and can share what we find with them.

When an archaeologist explores the landscapes within a synthetic world, they notice both presence and absence in the archaeological record (Darvill 2008: 69). The archaeologist applies filters, scanning for vegetation, animal life, water, and other topographical features, as well as evidence of current or past use and occupation. One landscape flows into the next, synthetic biomes bleeding into each other. The archaeologist looks for boundaries, for patterns, whether confronting the

landscape head-on or floating above it in a flying vehicle or in a disembodied "photo mode" provided by the game. The archaeologist can ask why some spaces are neglected and others used, and if used, how frequently and why. It is a search for an underlying algorithm or a set of landscape behaviors as designed. In most synthetic worlds, landscapes are very much characters and have their own rules on how to act, which include weather-making and resource-production. Landscapes in synthetic worlds have personalities, or at least that is how players perceive the spaces in which they occupy.

There is a haptic necessity to understanding landscapes. In order to write about landscape in an archaeological way, it must be experienced firsthand by the archaeologist.[7] What applies in the natural world is also applicable in the synthetic. Christopher Tilley articulates this in "Phenomenological Approaches to Landscape Archaeology" (Tilley 2008: 274). The more we experience a landscape in person, the more we understand its rules, which include formation processes and use by both human and nonhuman actors.

In "Object Fragmentation and Past Landscapes," John Chapman writes that "landscapes consist of a network of places, some natural, some culturally constituted, some created by human manipulation of the landscape. It is this network of places that gives human lives their meaning, through an identification of past activities and present embodiment" (Chapman 2008: 188). This also describes synthetic landscapes and the networks that run atop them: some created by human manipulation (players create networks through their own agency in a synthetic world), some culturally constituted (these networks are created in advance and by design prior to player arrival), and some natural (emergent behavior independent of player or designer agency).

So what's in a landscape then that immediately grabs the archaeologist's eye? Architecture is a start, and is one of the things most easily recognizable in synthetic worlds (McFadyen 2008: 307). Players expect architecture, and most games deliver. As part of the synthetic landscape, architecture behaves in the same way as its natural counterpart: it is recognizable, is used/reused, assists in wayfinding, and contributes to the understanding of a place's present and past. This raises an interesting point regarding determining the age of something in a synthetic world. How do we do this?

Dating landscapes in synthetic worlds varies greatly from those that are natural. This is perhaps the greatest difference between the two. In synthetic worlds, there is no real stratigraphy, and no real superposition of layers of earth, and therefore no way to assign a numerical (quantitative) date based on evidence found within the game-space (Roberts

and Jacobs 2008: 347). For most synthetic worlds, there is no geologic time. The spaces just sit there not eroding, unless you count "bit rot," the slow decay of underlying data. The archaeologist is left with software version and build numbers, which are tied to absolute dates in the natural world. But inside the game, landscapes can be made to look old (or to imply age), even though the game itself has only been playable for a few days. Even playing older games results in landscapes that look exactly the same now as they did in 1983. Little, if anything, changes.

Regardless of when they were created/accessed, these synthetic landscapes in games can provide insight into how people (and their things) move from place to place, offering glimpses into what players (or nonhuman agents) carry with them, use, sell, or discard (Summerhayes 2008: 530). In observing in-game habits of players as well as coded entities, especially in games where the landscape can vary (or can be varied), the archaeologist can begin to experiment with agent-based modeling (ABM), making modest (or radical) changes in order to run experiments to see what happens. In some cases, landscapes could be modeled after those in the natural world to assist in answering archaeological questions about earthbound places and the people who used them.

How does an archaeologist conduct landscape archaeology within a synthetic world? It's not terribly different from working in the natural world, as articulated by Thomas Richards in his article "Survey Strategies in Landscape Archaeology": first develop a research question (Richards 2008: 552). Once a research question is developed, a suitable landscape must be selected. Research problems often require a landscape to be representative of a larger area, so the distributional patterns of the surface record and associated human behavioral interpretations can be widely extrapolated. Following the selection of a regional landscape study area, the formation of its present surface characteristics needs to be considered in developing a survey strategy: geomorphology and vegetation (which affect visibility of the ground surface). Try to determine human land-use history, particularly large-scale ground disturbance activities. Determine the intensity and coverage of your initial survey. Decide on the scale of the survey and what (and how much) to sample. Decide on whether or not to conduct remote sensing or invasive subsurface testing. How will you record this data? Will there be follow-up surveys allowing for more detailed collection and analysis? At the survey's conclusion, can you develop any kind of predictive model for where one might find other artifacts or settlements?

The survey and research plan points are applicable to the archaeological investigation of synthetic worlds. Any archeological fieldwork

much be driven by research questions and a plan on how to answer those questions. For my online archaeological survey, I needed to find a site that extensively used procedural content generation, which would perhaps exhibit evidence of "machine-created culture," material remains created and organized by algorithms that would populate a synthetic landscape. *No Man's Sky* seemed to be the best fit for this need. I wanted to check distribution of sites and artifacts, to see how buildings and landscapes interacted, to look at animals and vegetation and their relationship to the landscape and these structures, and to see how these manifested in the nearly infinite worlds that could be explored. Barring a multiplayer option (which would materialize in a basic way one year after the game's initial release), I had to conduct my surveys as a lone fieldwalker and as a lone pilot. I used different levels of granularity in my surveys, less detail when flying (counting structures and times between them), and more detail when on the ground (noting artifacts, brush density). Future surveys can be undertaken in synthetic worlds that actively encourage guilds (groups of players) to survey together in the same landscape on the same server. This will also allow for specialization. Depending on the synthetic world, we can sample and "shovel test."

I mentioned noninvasive survey techniques above. Paul Cheetham covers this for natural worlds in "Noninvasive Subsurface Mapping Techniques, Satellite and Aerial Imagery in Landscape Archaeology" (Cheetham 2008: 564). Prior to starting a noninvasive survey, consider survey objectives, archaeological questions, previously remotely sensed evidence and results, current land use, former land use, underlying solid and drift geology, other local geomorphological and topographic factors, degree of access to the land, time, money, personnel, and equipment available for the survey.

Depending on how the synthetic world is constructed and what it allows players to do, it can be possible to conduct a variety of remote sensing tasks. For example, in *No Man's Sky* it is possible to orbit planets like a satellite prior to penetrating atmospheric cover for high-altitude overflight, followed by high- or low-speed travel a few meters above the deck, giving the surveyor different kinds of information about what's on the surface of the landscape and if there are any patterns to be observed. Once on the ground with the proper tool equipped, one can conduct a rudimentary form of remote sensing, which produces icons showing players where to dig and occasionally revealing underground caverns and other geologic formations. Each synthetic world has its own rules of engagement, which must be followed by players in order to successfully survey these landscapes. Depending on the hardware

and platform used to host these worlds, however, it may be possible to create modifications (mods) of tools and other equipment, which allows for bending the rules of a world in order to conduct aerial imagery or remote sensing. This raises ethical questions about whether modifying a world affects how archaeologists see the world, and how nonhuman agents operate within that world once it has been changed from its original state. Mods inject an additional level of complexity into a synthetic world, which might have unexpected/unintended results. At the same time, however, the archaeologist might be able to create a more useful digital toolkit for exploring these digital built environments instead of relying on more traditional methods that might not be the best suited for the task. To mod or not to mod recalls the decision to dig or not to dig, to use an invasive approach on the landscape in order to retrieve information about it.

When one thinks about landscapes in games, one typically considers those that contain mountains, trees, lakes, and similar things anyone would consider to be part of a natural landscape such as the ones featured in *Elder Scrolls, Dragon Age, World of Warcraft.* I propose, though, that in order to have a landscape archaeology of digital games and other synthetic worlds, the archaeologist must apply definitions and methods to any game or world, not just those that are facsimiles of recognizable natural environments.

Every game is a landscape. There is an architecture of space on the plateau of the screen, which can be measured and engaged with, that utilizes time and location in order to function. Every definition, every principle of landscape archaeology applies to games specifically, and more generally to software—anything with a graphical user interface (GUI). We are working on a micro scale, but it is easy to tell when an application's GUI nudges users down a path of activity, reacts to user agency, offers up artifacts (glitches/bugs), and is the subject of communities and cultures (e.g., Apple v. Microsoft). Most of us belong to at least one digital tribe, and we interact with that software as an indigenous population, as developers, or as users who made their pilgrimage late.

One final thought: all of the above about conducting landscape archaeology (or archaeology of any kind) within a synthetic world might sound daft, especially when we know that these are all designed environments. Think of these, however, as a proving ground for ideas on method and theory, testing on software we know that is well documented in anticipation of digital spaces that create new environments on their own. I predict that by 2020 we will finally see video games set in completely procedurally generated worlds where the cultures

that players encounter have never been considered by the game's designer(s), instead created from a complex set of rules that, when mixed together, create emergent cultures distinct from one another. We are already getting glimpses of these "machine-created cultures" (MCCs) in games such as Mark Johnson's *Ultima Ratio Regum,* and more are coming. One day we will have a Turing test for cultures to determine what is real. How will we determine that level of reality, and if a new, born-digital culture thrives, what obligations do we have to interacting with it and, ultimately, to preserving it?

Dwelling in Synthetic Worlds and Landscapes

Most of us do not live in isolation but instead reside in towns and cities, which we expect to last forever—or at least as long as we live. We expect our needs to be met through city infrastructure, that there is clean water when we need it, public safety, maintained roads, groomed parks, open space. We pay taxes and bills to keep the towns running, to keep the (street)lights on.

Most of us live in apartments, houses, duplexes, condos, dormitories, flats. These are personal spaces for us, and we expect them to give shelter (if not comfort) for as long as we need it. Because we look after our own needs and the needs of our families first, our residences must be permanent, but only so far as we need them. If I live in a house for ten years and then get offered a job in a different city, my house need only be permanent for me until the day I depart. Afterward, I don't care what happens to it. It has served my needs for the time when I was there.

We need cities to be permanent for us, too, or to at least provide the illusion of permanence during the course of our residence. We need to assume that everything will be the same each day when we rise and go to work or school and, if something needs to be repaired, that the city will maintain or improve upon things to continue the illusion of permanence. The status quo is comforting to the stable population.

To borrow from the work of Martin Heidegger, we build and dwell in the landscape. "Building" to Heidegger meant interacting with a landscape, interacting with structures, using natural resources. Building creates landscape by defining locations and spaces within it relative to human interaction.

As Heidegger wrote in 1978, "dwelling" represents how we occupy and experience a landscape. Building creates the landscape around us through our dwelling; and in turn the experience of this landscape

modulates the form of our dwelling within it. Our dwelling determines the form our building takes and by extension how the landscape is created. James Robinson wrote in his archaeology MA dissertation for the University of York, *Being and the Past,* "Dwelling (the created ideological construct of consciousness) is encoded throughout the past manifestations of Building: the material record. Therefore the ideological constructs driving and created by Building are accessible through its study." We ask the question of the past: "*Who* or what is it that Builds and Dwells?"

When we think about towns and cities and the spaces there in which we live, we bias our thoughts about permanence, the people and things that are always there. We often fail to perceive how these permanent spaces appear to the temporary visitor just passing through, maybe stopping for a time, but ultimately moving on to another destination. We fail to consider fully how a migratory population builds and dwells for a short time within a permanent space. For this group of "transhumans," nothing is permanent, and these spaces and locations become commodities to use and leave behind. Hotels are a perfect example of this, buildings with a temporary population that always changes, supported by permanent staff who keep the building in working order to support the infinite migration of families and businesspeople. This shared environment is built to serve two populations who build and dwell within it differently. For one population, the hotel is a source of employment and income. For the other, it is a place to sleep, bathe, eat, and recreate. People know about the general idea—the phenomenon—of "hotel" and what that space means. For most of the population, we visit, we use, we leave. Over time, the hotel might be sold. The building might be converted into another kind of space, or it might be destroyed so that the land underneath it can be reused. The building is semipermanent, constructed over a permanent landscape.

How then can the concepts of Building and Dwelling be applied to built digital environments, specifically video games? I have proposed that video games are archaeological sites and that landscape archaeology can be used to explore and understand them. I propose now that all video games are created as semipermanent "dreamscapes."

With notably few exceptions, any video game is an imagined space produced to be accessed by a user via hardware, which includes a screen. Through the development process, that game becomes a functional space stored in a box, bounded by rules of engagement, which the user may either follow or manipulate. The ideas from the developer(s) transmit to the mind of the user who can then react to the stimuli of the game. The interactions exist in the mind through the mediation of hard-

ware, technologically enabled dreamscapes where users can dream lucidly through the act of performing operations within a game.

I also propose that all video games from the 1970s until today have always been envisioned as semipermanent. Arcade games were played by the quarter and competed for floor space in malls and on boardwalks. To the user, the game was only as permanent as the bankroll permitted. To the developer, a game was only as permanent as its popularity. With the pace of technology and commercial competition, new games replaced the old, with the exceptions of games that became classics, expected in the spaces of arcades. Games such as *Joust* became permanent monuments within a changing landscape. When we visit Washington, DC, we expect to see the Washington Monument. When we go to the arcade, we expect to see *Pac-Man*.

The same could be said of cartridge/cassette/disk-based games. In the 1970s and early 1980s, these games were designed for relatively quick play based on player skill. It was rare to be able to save your progress. The game existed as a place to inhabit for a few minutes or hours, and then we would change the locality of play by replacing one game with another, or we would place the game on the shelf with the others to await our return, a site or monument to be revisited and engaged with. Games exist to be played. That is their grand purpose, but a purpose driven by human need: to be entertained, challenged. Cities exist to be inhabited, meeting the human need to create and to have shelter and community.

With contemporary games, their complexity and size (size not just from the perspective of landscapes but also for those games that contain infinite levels) lend themselves to a lengthy visit during each encounter. They encourage us to stay. The developers are human, and the better games do an excellent job of winning our discretionary time and money. This is by design, human-to-human. We build what satisfies us, and that which satisfies us will likely satisfy others. Game developers build spaces, which they hope will invite people in and encourage them to stay. To revisit a term from earlier, we are invited by games (and their builders) to "dwell" in these spaces for as long as they exist in their semipermanent state until the next game comes along, encouraging migration.

There are no permanent residents of games. Sooner or later players move from one game to another. At times they return to old favorites, motivated perhaps by nostalgia or through the release of a major update or new content, much like we return to places we love to remember them as they were or to visit new features recently added to the landscape. We dwell within games always with the underlying understand-

ing that we will leave. It is the commercial nature of game development to always make something new. As good as a game might be, all players will leave it to engage with something new. With video games, we are all transhuman, and we experience these places as things we are just passing through. Sometimes we have a brief stay, an overnight in a hotel. Other games encourage an extended stay. But we see new cities built, appearing every Friday, beckoning us to relocate.

With video games, we rarely see mass migration away from them (unless they are universally reviled and players abandon these places at more or less the same time). Instead, we see mass migrations to new games, drawing on the player-populations of old playscapes. The new game is the city on the hill, a shining beacon of promise and opportunity, and players leave whatever it is that they are currently engaged with, where they currently dwell, in order to have a new experience in a new place until they tire and the next new city springs up in a landscape littered with abandoned towns of dwindling populations. It's similar perhaps to people leaving their farms to work in the nearby metropolis. But then these cities get drained of their populations as other cities arise. But unlike brick-and-mortar urban centers, games are designed to be abandoned. We always quit the games we play. That functionality is built in, and we as members of a transient population expect that. We have places we love, but we cannot escape our need for a new narrative and a new place to explore and inhabit.

We very much dwell in synthetic worlds. It is a conscious act for us as players to engage with games like we do with cities. There are things to see and do, based on underlying infrastructure of mechanics and rules. We pay (most of the time) to access these spaces, a kind of engagement tax to continue to play for as long as we like, or for as long as our money lasts. Developers update the infrastructure and hope that players will stay. The more players, the healthier the economy, and the longer the game-city remains vibrant and viable. When people leave, the infrastructure of the digital built environment remains, becoming a shell of what was. Compare this to what happened with Detroit, at one time the destination for culture and industry, now overwhelmed with abandoned buildings and entire neighborhoods.

All things tend toward entropy, and entropy occurs over time driven by casual absence or conscious neglect. While cities manifest entropy in a visual way, we don't necessarily recognize the effects of abandonment on video games. For MMOs that were purpose built to house thousands (or more) players at a time, many of those that have been abandoned can still be revisited. *EverQuest* was launched by Sony Online in 1999, and all development of that MMO ceased in 2010. Play-

ers can still access the game, however, returning to see what's changed and to indulge in some nostalgia.[8] These games are ghost towns, but their contents remain buffed, shiny, and welcoming, ignorant of the decline of their own civilizations, waiting for players until modern hardware can no longer run them or until the developer decides to pull the plug on the last public server hosting the game.

Because video games are archaeological sites, they grow and change over real-time. For example, the still-popular MMO *World of Warcraft* continues to evolve with new updates and expansions and is currently in its "Hellenistic" era, perhaps having peaked in its "Classical" period of the "Cataclysm" expansion, which in effect broke the world, forcing players to rediscover familiar landscapes changed by the cataclysmic return of the dragon Deathwing. It is not possible for players to go back in time to revisit previous iterations of the game-world through Blizzard Entertainment's servers, but some players have formed archival teams for preservation and conservation of those earlier times. The most notable of these is the seven-year-old Elysium Project,[9] which maintains a server containing the "vanilla" version of *WoW* from 2004. Anyone can visit this maintained "Archaic" version of the game to actually experience what it was like to navigate the landscape before the creation of mods (modifications), flying mounts, and even entire regions in the world of Azeroth. It is the closest thing we have to time travel, and it allows us to bridge the temporal gap between past and present as we study this game.

We experience time (as Heidegger understood it) within the context of the present as well as in the past (even though we occupy the present). We can experience things as they were even though we exist thirteen years after the birth of *WoW.* We can dwell in that space now just as we could then, a conscious occupation of place. Upon its initial release, players dwelled within *WoW* as explorer-adventurers, not only interacting with the game, but also building because of it. The earliest players created guides for other players to use, built communities both within (and outside of) the game, and began the *WoW* tradition of creating "mods," free, downloadable tools for making the game easier to play.

Revisiting the vanilla version of the game today, players dwell within that landscape for additional reasons besides play: nostalgia is a driving factor for those players who started their adventures in 2004; curiosity brings other players who arrived in *WoW* later, who want to see what their beloved game used to be. Still, apart from the team of volunteer archivists who maintain this Archaic version, those who dwell there do so temporarily before leaving again for other worlds.

We are just passing through, staying long enough to form memories, continuing our migration to other places either new or familiar to us.

As players we are constant tourists in the games we inhabit. Occasionally a rare game occupies our attention, and we turn it into a kind of summer cottage, a long-term retreat until it is time for us to rejoin the real world. But for a time we dwell within the semipermanent dreamscape and explore our humanity through the grace of play.

Archaeogaming Tools and Method

What does it mean to "dig" within a game? Is there a dirt archaeology equivalent? This section outlines tools and methods as it raises issues that make archaeogaming different from more traditional fieldwork.

Tools

Meatspace field archaeologists use some (or all) of the following tools in their day-to-day on-site: shovel, trowel, screen, brush/dustpan, dental pick, pick-axe, tape measure, line level, plumb-bob, camera, computer, notebook, transit/total station, drone, as well as remote-sensing equipment and other specialized tools. Most of these tools are useless when in-world, unless a game uses these as part of its archaeology game mechanic where players can pretend to excavate and recover artifacts via their computers or consoles.

What about tools used for archaeogaming? For now it is a computer or console (likely both), a pointing device, and software for capturing screens, audio, and video. Services such as Twitch and YouTube Gaming allow the archaeogamer to live-broadcast an expedition to the public,[10] and these sites also host edited videos. Public engagement is a key to the survival of archaeology anywhere, so having a public channel for excavating in synthetic spaces is helpful.

One of the most useful tools for both traditional and synthetic archaeology? Drones. For the archaeogamer, these drones are mainly in-game flying mounts or air/spacecraft that allow one to hover over something or fly by it while taking images and video from any altitude. The benefit of in-game drones when compared to their real-world counterparts is the ability for the archaeologist to be actively in the cockpit (or saddle) as opposed to fiddling with drone controls from the ground, or relying on third-party images taken from aircraft not piloted by archaeologists.

As of 2018, the archaeogaming toolkit is not as big or as useful as it needs to be, although this is slowly changing. Archaeogaming can adopt

and adapt most of the tools from its real-world contemporaries, but it needs archaeogaming-specific software, too. Following the lead of OpenContext.org, GitHub, and other repositories, new apps/mods should be shared as open source. One benefit of doing game archaeology is that many video games are available on the Steam platform, which already has a robust modding community that creates everything from skins to tools. It is possible that these mods can be created in Steam and then mimicked for PC/Mac. Archaeologists can create these mods, or better yet they can partner with members of the modding community who can create mods based on specs provided by archaeologists. At this writing, however, one cannot mod for closed platforms such as Xbox and PlayStation. Here are a few possibilities of things that could be developed by the modding community, which could include archaeology students who are also becoming digitally literate and learning how to code:

Overlay: Traditional archaeologists apply a grid over the sites they investigate to assist with mapping and organization. The proposed digital overlay will place a grid over the screen to assist with documenting where things are on any given screenshot. Having a standardized grid can help archaeologists worldwide studying the same game to remain consistent with locations, distance, and measure, with a "smart" version of the overlay able to be tuned for scale. Even though some games do contain coordinates and complex global and local maps, many games do not. A standardized grid overlay will help.

Smart-Measure: In-world distances vary from game to game and are occasionally not to scale. Physicist and philosopher Karen Barad wonders, "What can measurements tell us or how are they useful outside of classical physics?" (Barad 2007: 342). Why measure something that is not "real" or is affected by game-created physics? I think that distance is still important: it helps provide context, regardless of the weirdness of a synthetic world's map. This app would allow you to assign a unit for a distance of measure, converting it to English/metric units for perspective. The tool can be configured to record "as-the-crow-flies" distances as well as real distances over in-world topography, much like what is available in Google Earth. Other parameters can include volume and area for a user-defined space, or guides can identify and snap to borders for a room or region.

Smart-Clock: Time works differently from game to game, and often does not reflect the passage of time in metaspace. The clock app, after parameters have been set, will keep track of both real-world time

and its passage in the virtual world, displaying both side by side. Screen- and video-captures can include this data for record-keeping purposes, much like one sees on DVD "screeners" of films. Some games offer a "speed run" option where players can time themselves completing levels or an entire game. This option provides a timer that could be repurposed for recording time/distance in a game, but having a dedicated mod will give the archaeologist more flexibility in when and how to tell time and measure it.

Probes: Much like those in the Ridley Scott film *Prometheus* (which featured archaeologists as lead characters), probes could be used to map areas of a game not yet visited by the archaeologist, reporting locations of finds or structures, possibly recording geotagged images of them as well as a video of the trip. This is no different than launching probes to other worlds not easily reached by people or sending robot-mounted cameras into tight spaces inside ancient buildings here on Earth. Game developer Hello Games sent probes into the universe it created for *No Man's Sky* to discover planets created by algorithms.[11] Mapping a game ahead of time (or borrowing maps from other players) can allow the archaeologist to make decisions on how to spend time and other resources within the synthetic world, knowing in advance where to go and what to look for.

While the above is a brief list of software to be created for archaeologists to use in synthetic spaces, some software already exists and can be adopted by video game archaeologists. For the *No Man's Sky* Archaeological Survey (NMSAS), special software was created to handle the in-game collection of survey data for an entire virtual universe (see below for a detailed case study). The NMSAS team used a version of the Federated Archaeological Information Management System (FAIMS), created by an Australia-based team at Macquarie University that makes software apps for mobile devices for archaeologists to use in the field. Other open-source software continues to evolve for data collection/recording (such as CollectiveAccess), data publication/sharing (such as OpenContext.org) as well as digital imaging and reconstruction in 3D, augmented and virtual reality (e.g., Blender and SketchFab). It is also possible to create maps in GIS software (e.g., QGIS, ArcGIS) based on game maps.[12]

Methods

As archaeologists begin to turn their attention to digital built environments, I continue to consider how to conduct archaeological survey

and excavation based on methods already proven in the natural world for traditional sites.[13] My Ur-text is Martin Carver's *Archaeological Investigation* (2009), a well-regarded how-to guide for designing, implementing, and publishing archaeological projects. I supplemented Carver's book with Steve Roskams's *Excavation* (2001) to see if I could apply his methods to "excavating" digitally. The danger of course is in trying to put techniques from the natural world to work in the digital, that this might cause me to overlook other ways for doing digital work digitally based on my research questions and the digital environment in which those questions would be asked and hopefully answered. There are many similarities shared between the natural and synthetic worlds and how to conduct archaeological investigation in them. The difference between the two is that synthetic worlds are created digitally by people (or by algorithms created by people). Both the natural and synthetic worlds are real. There is no "virtual" here.

Why Survey/Excavate Digital Built Environments?

Carver begins with an explanation of why we should conduct archaeological investigation at all. It starts with "pieces of the past, life's *disjecta membra,* the stuff. This is what we study. . . . Our first task is to appreciate why we have what we have. All these cultural remains belong to people who deserve a history, but they do not equally leave us one" (Carver 2009: 7).

Digital history, however, is even more elusive, because outside of the hardware (most of which gets deposited in dumps or recycling facilities or ultimately African "disposal" sites), the software engaged with, and the history of use by communities is completely invisible, a kind of intangible heritage. We have what we have now because users have documented what they do, but this is done informally, often on ephemeral community message boards, groups, and chatrooms, with no guarantee of preservation.

When we consider surveying or excavating a site, those sites are often either forgotten or deserted, either buried some distance under the earth or hidden in/incorporated into the modern landscape. Carver writes that "even when archaeological sites are deserted, they do not entirely die. They have a long and varied afterlife . . ." (Carver 2009: 7).

This statement is equally true with video games. Players can certainly return to old games, abandoned games, and also synthetic, shared worlds that are now devoid of players. The sites largely remain in the digital world, much like they do in the natural. When dealing with sites in the natural world, one must consider the pre-deposition of a site (subsoil, topography, culture) and post-deposition (natural and human

attrition). Human activity after the abandonment of a site can include curate behavior, vandalism, stone-robbing, cultivation, digging; natural activity includes bacterial, chemical, vegetation, burrowing animals, frost, flood (Carver 2009: 8).

We don't really see these in abandoned digital spaces, but post-deposition activities do occur. These can include bitrot (degradation of interior code) and/or degradation of physical materials exposed to the elements (or just to time). Games are reliant on hardware on which to run, and older games also relied on physical media, which served as a catalyst between the player and what is played. Just as with any other material artifact, these materials change over time. Post-deposition, the digital is just as susceptible to the whims of the environment as the natural.

Carver identifies (Carver 2009: 9, fig. 1.6) five stages for what happens to a human settlement in the natural world, each with its own factors and properties: before deposition, during occupation, at abandonment, the site gets buried, after burial. It is easy to see how these apply to traditional sites of human occupation, but how can they be mapped to the digital?

Use depends on landscape and environmental factors. A place has to be able to be occupied (or to communicate the ability that it can be occupied prior to people arriving and making use of that space). For games (and other software), one could consider this to be either the marketplace (demand creates supply, e.g., people want to play online with their friends, so companies such as Blizzard Entertainment create MMOs) or people (or companies, which are groups of people) who feel the need to carve out a niche for themselves, creating their own space(s) to inhabit. Once the space is occupied and developed, culture follows. Consider the popular MMO *World of Warcraft,* which has millions of players (four million active accounts according to Blizzard's February 2017 figures), has its own annual convention (BlizzCon), has fostered books and a feature film adaptation, and has licensed its in-game material culture to real-world companies to produce for players to buy in order to signal their love of the game to other kindred spirits.

The game is the structure inhabited by the players online, their activities preserved in massive databases hosted by the game's producers. Over time, most games are abandoned in favor of newer titles, or players find other ways to use their discretionary time and income. Populations dwindle until the game is but a shell of what it used to be. Unlike sites of human settlement in the natural world, these gamespaces do not erode, are not "robbed" of resources, and do not weather. They remain in a kind of stasis, abandoned yet timeless, ready to be

enlivened at any moment by hordes of returning players who never arrive. Following a game's abandonment, the game can be buried. As explained in chapter 1, this happened literally with the case of *E.T.: The Extraterrestrial* (Atari 1982), where unsold/returned copies of the game were trucked to a landfill in Alamogordo, New Mexico, to be dumped to make room for new merchandise. In other instances, companies retire the games they produce. They no longer sell the games and, after a period of years, cease technical and community support. The games disappear, maintained in players' memories or archived by game developers or player communities. After a game gets abandoned and then buried, it can suffer a few fates: bitrot (see above definition); disappearance, where the game and its code are lost for all time; and archaeological excavation, where recovered games are studied through either play or deconstruction.

Designing an Archaeological Project Plan for a Synthetic World

Once a game is identified as a candidate for archaeological investigation, the researcher(s) must follow protocol in creating a publicly proposed project design. "The project design must be published before work starts, and not just because this results in a better managed programme, but for ethical reasons. . . . The *project design* itself must contain a programme of long- and short-term conservation as well as programme of research" (Carver 2009: 33).

This statement is as true for synthetic sites as it is for natural ones. The project plan should be shared online publicly, especially with those user groups who actively play (or played) the game to be studied because they are that game's indigenous community. This opens it up to community critique, in effect becoming public archaeology and engaging the game's "local" population, many of which will spot mistakes and pitfalls or who might be willing to help in the research as volunteers. The plan should also identify conservation and preservation efforts for the game-site as well as for the research both pre- and post-publication. When I was organizing the *No Man's Sky* Archaeological Survey (NMSAS) in 2016, I publicly broadcast the team's reasons for investigating a synthetic universe and how we proposed to do it. Within days of posting the research plan, I was contacted by several community groups interested in conducting citizen science within the gameplay and sharing our data. We were able to work with these groups and follow their own discoveries on various community bulletin boards online and through social media. These communities also helped the NMSAS team revise its project methods during our survey period, correcting serious misconceptions about measuring distance on synthetic

worlds. As Carver says, "Archaeological project design is mandatory. . . . Researchers are bound by a contract with society" (Carver 2009: 33). In the case of games, the project design is a contract with society as well as with the player community.

Carver breaks down a field archaeologist's research agenda into three parts (Carver 2009: 47, fig 3.8): fieldwork, objective, and outcome. What are we trying to accomplish with whatever it is we're doing on-site? This is universal for both natural and synthetic sites. We excavate to see a sequence of use in order to confirm or change what we know about the site and its occupants. We survey in the site area to create a map of settlement and other features in order to determine where to dig (if we need to dig at all). We survey the area surrounding a site to map and identify other settlements in order to note changing land use or to recognize settlement/cultural patterns. We study other areas in order to compare and contrast them with what was found on-site. We can follow these same procedures in any digital built environment. Software can be mapped and even excavated, compared to earlier or later versions of itself, and compared to similar software designed to match the needs of the same user community.

At the start of any archaeological project planning, preliminary reconnaissance is key. In the natural landscape, one must visit that space to experience it firsthand, to identify its challenges, and to begin to inform yourself of how to proceed based on operating in that environment. For the video game archaeologist, this necessitates ample gameplay. Playing a game (or using any kind of software) familiarizes you with the landscape. You play where others played, and the more time spent in that synthetic environment, the better prepared you will be to conduct an archaeological survey and/or excavation of it.

Surveying the Synthetic

Before any kind of excavation can occur, a survey must be conducted, either landscape or site (or both). There are three techniques of landscape survey: cartography, surface inspection, aerial photography (Carver 2009: 65). In synthetic worlds, cartography can be done either with in-game maps, by mods (see above), or by hand-mapping during exploration. Surface inspection can be done by the player on foot in much the same way as field-walking across natural landscapes. As stated earlier, many games feature flying drones, ships, or "mounts," which allow players to see the landscape from above and even to hover at various altitudes over the surface, using the computer or console's native screen-grab features for aerial photography. Anything digital shown on a display (computer

monitor, flat-screen, television, etc.) can also be considered as a frame for a map or plan, a top-down view that can be captured and measured.

The European Landscape Convention defines a landscape as an "area as perceived by people, whose character is the result of the action and intersection of natural and/or human factors."[14] By this definition, games are landscapes. Players have agency in games, and their actions mark the intersection of their decisions upon the game-world and upon other players in a shared space. See my section on landscape archaeology in synthetic worlds for a more in-depth look at how games are landscapes that can be studied archaeologically.

Landscape survey combines geography, environment, and archaeology to explore the unknown world in deep time (Carver 2009: 86). The same is largely true in digital built environments, but the question of time (specifically deep time) is tricky. In games, deep time can perhaps be measured by version numbers, but it will not appear graphically in a visual layer on a screen. Time in games is strange, with people playing in real-time, even though that game features the rapid passing of days and seasons while no one (or thing) ages, erodes, grows, decays.

Following landscape survey comes site survey. To Carver, a site is "an area of ground in need of investigation" (Carver 2009: 89). Games also fit this definition. To Carver (Carver 2009: 89), a site survey is simply a landscape survey on a smaller scale: the area is smaller, but the focus is finer. Surveyors sense archaeological features but do not damage them. A site survey can be invasive in its exploration (e.g., shovel-testing), but these surveys attempt to leave everything intact. The objective of a site survey is to know as much about a site as possible before deciding what to do about it. The same works in digital spaces: observe, focus, and then decide next steps.

Site survey techniques in the natural world include using maps and documents, topographical mapping, surface collection, geophysical survey, and sample excavation (Carver 2009: 89). In a digital space, all games will allow for surface surveys and mapping, and some will allow for surface collection. Some might even allow traditional excavation. It all depends on the game's mechanics, or what a game allows players to do. If actual digging in a game is not possible, the video game archaeologist must consider other ways of conducting synthetic shovel tests should those be considered necessary. This is especially true when documenting material culture created by nonhuman actors/agents within synthetic worlds, placed there by algorithms. What can be determined through observation alone, and later through interaction (if ethics permit)? What do we as archaeologists introduce into a game-

world through physically interacting with that space? How might that affect future experiences in that world and with its digital residents?

Part of a site survey might include a sample excavation, which can reveal strata and other data. While some games might exhibit stratigraphy during play, this is exceedingly rare if not unique. Strata instead can be visualized between different versions of the same game, changes mapped in a software matrix, a variant of the Harris matrix. If possible, the site survey should conduct some kind of remote sensing (which some games allow as part of their mechanic). It may become apparent that digging is not necessary based on the survey/sensing results and what they say about the overarching research questions decided upon at the beginning of the project. What is appropriate in the natural world might need to be adapted for use in the synthetic world. These methods will grow and change over time, but it is imperative for all video game archaeologists to document what they did and why and what the results were. This will enable the discipline to advance and grow.

"Excavating" the Synthetic

If excavation is indeed necessary, Carver cautions that "excavation is not an unvarying ritual, but a creative study, carefully redesigned every time it's done. The methods used depend on what you want to know, the site and the social context in which you work. These are always different, everywhere" (Carver 2009: 123). So once spade is put to soil, what happens?

We can turn to Roskams's *Excavation* (2001) for details on how to conduct a successful excavation. I have flagged several details with an asterisk (*) that can be applied to excavation in a synthetic world. Pre-excavation strategies include aerial photography,* field-walking,* shovel-testing,* reading documentary material,* studying previous excavations of the same site,* performing ground-based remote sensing,* chemical mapping, coring and auguring, evaluation trenches.*

Background preparation for an excavation includes defining finance/administration,* identifying staff/support facilities,* and planning for a safe excavation.*

Site preparation includes site clearance,* site grid,* spoil removal,* shoring, de-watering, finds retrieval.*

Recording includes defining the stratigraphic unit, creating and using numbering systems,* creating a recording process and related sheets.*

The photographic record includes determining the reasons to photograph something,* photographic preparation,* and technique.*

The spatial record includes techniques,* equipment,* and drawing conventions*; types of plan*; techniques of measurement*; types of section*; piece-plotting finds.*

The stratigraphic record includes types of stratigraphic relationships,* representing these relationships,* calculating stratigraphic relationships.*

Deposit descriptions include who records and when,* computer storage of records,* deposit descriptions in relation to sedimentology and pedology, deposit color, soil particle size, compaction or consistency of deposits, inclusions within deposits, thickness and surface characteristics.

Non-deposit descriptions include masonry and brick features, timbers, inhumations, cuts, finds groups.

Excavating the stratigraphic unit includes sampling strategies for finds,* methods of collection,* troweling methods, making stratigraphic distinctions, completing the record,* checking the record.*

Stratigraphic analysis includes tidying the record*; on-site interpretations*; correlating between units,* stratigraphic nodes, and critical paths.

Prior to excavation, we need to determine what to do with the things we find. Carver stresses that a site's recovery levels are always variable, changing from site to site (Carver 2009: 124, fig. 6.10). The table is organized from general to specific, from large to small, defined in advance by how they might be discovered and how they will be collected and described. Surface finds (not collected) are followed by large finds (examples recorded and kept), visible finds (all recorded, examples kept), then sieving of samples (kept), total samples (all visible finds), and micro-sieving (done in the lab). For synthetic worlds, sieving is likely not an option (nor necessary), but in many instances examples can be documented, the smaller artifacts kept in player (or team) inventory for later analysis, everything from architecture to small finds, whatever those might be.

Regardless of the environment in which excavation occurs, stratigraphic excavation records multi-concepts: Component (grain of sand) among which are Finds (anything kept), and these belong to the following: a Context (any defined set of components—a layer, a surface—recorded with a Context card, plan, section; a Feature—any defined set of Contexts recorded with a Feature card, plan, section, photographs; a Structure defined as a set of features recorded with a Structure card, plan, photographs; a Horizon is a defined interface between truncated contexts recorded with a survey, plan, photographs (Carver 2009: 139).

These terms can be defined on a game-by-game basis. The terms are scalable.

A major component of both survey and excavation is recording the work done and what the work recovers. Each project in a synthetic world needs to determine in advance what will be recorded in writing, what will be drawn, and what will be photographed. For games and other synthetic worlds, it may also be possible/advisable to record video. All should be done before, during, and after survey and excavation to create a complete visual record. The record must include notable elements on sites.

For Carver (Carver 2009: 198, fig. 8.2), notable elements on sites are both reassessed and managed. Assemblages (artifacts and biota), chronology (stratification and dating), and spatial (contexts to features, features to structures, and structures to site) are reassessed. Management includes records (digital, context/feature cards, maps/plans/sections, photographs, and program of analysis), objects (conservation, packing/storing, program of analysis), and samples (storage and program of analysis). These elements exist equally (reassessment and management) for the archaeology of synthetic worlds but differ in their execution. For management of archaeological content from a synthetic world, any digital assets/artifacts recovered will likely include digital records (i.e., database entries), short- and long-term storage of other digital media (photos and captured video). It is unclear at this writing what digital conservation might entail for items recovered in a digital space.

Documentation, Chronology, and Location

Depending on the nature of the archaeological investigation to be completed within a synthetic world, archaeologists can follow the example Carver sets out in table 8.1 (Carver 2009: 199). Different kinds of investigations require different levels of documentation, some requiring a fine grain. For example, if one is performing a reconnaissance of a possible site, the archaeologist will keep a notebook of observations, draw a map, create digital maps from GIS points, photograph the area generally, and note surface finds. A landscape survey differs slightly, as it includes artifact photos. Excavation, however, requires a written notebook as well as context sheets and notes on features, drawn plans/maps/sections/3D plots, digital context records, coordinates, and photographs that are overviews and portraits, with assemblages noted. As above, this same methodology, this same way of organizing what to do depending on what you are doing, is scalable to digital built environments. The location of these sites is different, but the method is the same.

The purposes of documentation fall into two categories: (1) preservation of the archaeological record, and (2) analyses of recovered data. Documentation can help establish a site's chronology (absolute dating as well as a site's sequence of strata and events). For games/software, stratification is easier to read because it is identified by version and build numbers. Version 1.0 appears earlier in the record than version 2.0. The documentation allows the archaeologist to produce synthetic text on assemblage, space, and chronology—what happened, where, when. These all interrelate. So what gets collected from a site and why?

As stated above, site chronology can be divided into absolute and relative dating. Absolute dates are arrived at through scientific testing. Relative dating comes from the ordering of artifacts as well as their context. Dating is extremely difficult to accomplish within synthetic worlds when considering artifacts found within, especially when one knows the year in which the world was created (in real-time). Something might appear to be ancient yet is only (really) a few years old. Relative chronology is perhaps more important to the video game archaeologist rather than anything absolute. Or perhaps one can create a chronology based on absolute dates of discovery. In a procedurally generated game, it might be interesting to compare what is found in one site one day against another site found a few days later. Age would seem to be immaterial.

To get to any kind of dating, one needs sample artifacts/features/materials. Carver identifies five purposes for collecting samples from a site (Carver 2009: 223, fig. 9.7), and where these samples ultimately go (e.g., geologist, botanist, lab/other specialist): identification, dating, plant use, ambient conditions, chemical mapping. Depending on the nature of the synthetic world and the research question(s) being asked of it, these purposes might change. Identification remains a constant, however, asking the universal questions of "What is this?" and "To what purpose what this used?"

In both the natural and synthetic worlds, a variety of materials from sites are present. For Carver (Carver 2009: 224, fig. 9.8), each material (e.g., stone, pottery, metal, etc.) has an identifiable fabric (the kind of stone, pottery, etc.), a specific form/type/style, and a history of use (function/symbolism/discard). In a digital built environment, it is up to the archaeologist to determine the general kinds of material available for collection and to assign types, forms, and styles to them, either based on personal observation and experience within the space or in adopting the vernacular of the player community for that specific game. Contemporary games have shown seriation within types and also diversity in style between cultures within a game. Identifying in-world arti-

facts through context and then through type/style can assist in dating them or creating a biography for a particular digital artifact. It is likely, with examples of machine-created culture, that new materials, fabrics, forms, styles, and history will manifest, alien to the human experience. The archaeologist can then create a typology, updating as future discoveries yield new data.

Artifacts typically comprise assemblages, a collection of objects—either objects of the same kind spread across the site or, more typically, objects of different kinds of materials found in the same place. Assemblages are common within games. In fact, an individual game might itself be considered an assemblage of code, the sum of its parts. But most games collect disparate items together in a single space to be discovered by a player, whether it is the remains of a fallen warrior or an abandoned building. The assemblage gives the player-archaeologist context and understanding, just as it does in the natural world. When artifacts/assemblages are found, they must be documented and then (if possible/permitted) removed for conservation and additional analysis.

The care of finds from a digital space is perhaps the single major difference between conducting fieldwork in a synthetic world versus the natural one. For a traditional site with traditional artifacts, one must be mindful of foreign substances attached to an item; how to clean the object (if at all); potential risks when handling, packing, or conserving the object; how to apply "first aid"; how to pack; and where to deliver (Carver 2009: 226, fig. 9.9). For digital artifacts, the archaeologist is reliant upon photography and videography, plus inventory management both within the game and also within an external database. Any conservation or transportation occurs with cleaning and sharing the digital media that documented the artifacts found within the synthetic world. One additional option, which is finally available at a very low barrier to entry, is to create 3D scans of items found in-game, exporting the data to an open-source platform such as SketchFab, allowing these scans to proliferate online following the Jeffersonian principle of "lots of copies keep stuff safe." These 3D scans can also be sent to 3D printers for real-world visualization at various sizes, allowing the archaeologist to manipulate real-world manifestations of something only previously available (and created) in a digital environment.

Prior to their removal, all artifacts in the real world can be tagged with a specific location with X-Y-Z coordinates tied into GIS for the purposes of plotting and mapping. We know the Earth, and we have established a universal way to give everything a number, which designates a precise location to anything. At first glance, this is not the case with synthetic worlds. Modern role-playing or adventure games might

contain a relative GIS or map, which allows for occasionally specific markers for locations, objects, and players. Most games do not. One workaround to establish at least relative positions for an individual site is to take a screenshot of the site. The siting of artifacts (including structures, environmental objects, etc.) can then be mapped on a grid based on the size and shape of the display on which the screenshot was taken. The screen has an aspect ratio, and also X and Y axes. Most hardware will also tell the user the absolute pixel dimensions of the screen. Knowing these hardware basics, one can then assign basic Cartesian points to things of interest in the screen capture.

The drawback to this is that there is no Z axis for height/depth. For most games, this will not be an issue, mostly because 3D is an optical illusion for games played on a flat screen. However, with the advances in virtual reality, a more complex system of documentation must be invented in order to place the locations of objects in a truly 3D space. One possible workaround is to note the orientation of the player's eyes through the use of a compass rose, and the position of the head-tilt, then take a 2D screenshot and annotate it with regard to how the player was oriented in the real world. I think this method is both complicated and inexact, but one hopes there is a way to extract that data from the middleware that connects the VR headset to the player and also to the game.

In continuing his consideration of the space occupied by sites, Carver distills these neatly into types of field records, which are then defined by tasks, outcomes, and significance (Carver 2009: 252, fig. 10.7). For example, records of the locations of monuments can be mapped by monument type to create a plot of dated monuments, which can then show the location of monuments through time. An artifact survey creates a map by type to illustrate dated occupation areas and a sequence of occupation. The data visualization of different kinds of records for different aspects of a site provides the "why" for the survey or excavation, potentially answering the original research questions.

Carver does the same for landscape survey data (Carver 2009: 255, fig. 10.10), noting the possibility of creating a linguistic map based on placenames, or the possible location of other sites based on the mapping of artifacts gathered during surface-collection. Both the visualizations of data from site and landscape survey can apply to synthetic worlds, specifically those that use a natural-looking landscape in which players can operate. One might also be able to visualize data via maps in games that have nothing to do with adventurous navigation through perilous lands. One can still draw meaningful conclusions about landscapes and the sites they contain even when recording a digital card game or the elements of a word processor's graphical user interface (GUI). It

all boils down to the fact that we are looking for social relations in the space; function; chronological development (all re: building distribution in a settlement) (Carver 2009: 255).

In order to make the most of the artifacts found either on survey or in excavation, their pinpointed locations can help define patterns that can then be interpreted by the archaeologist, pattern-seeking through computation. Analytical routines developed by geographers have helped archaeologists to squeeze more meaning out of their patterns (Carver 2009: 258). Pattern recognition should actually be easier when applied to synthetic worlds. The natural world is messy but fractally ordered. Most games are directly designed by one or more people who apply a logic into their coding of a game-space. The algorithms within the code organize the placement of elements in a digital built environment. It seems to be a necessity to apply GIS software to any virtual world in order to view various maps of data, but it will likely be impossible to standardize such a resource because of the plethora and diversity of synthetic worlds. Perhaps the geographers' "analytical routines" can be applied to the data of any synthetic world, if their formulae are universal and not written for a specific location or even planet.

Patterns retrieved through running locations through geographer's mathematical routines could then be used to create additional visualizations of that data. Carver suggests, for example, the use of Thiessen polygons (Carver 2009: 260), which are polygons whose boundaries define the area that is closest to each point relative to all other points. They are mathematically defined by the perpendicular bisectors of the lines between all points. Carver also suggests that archaeologists can utilize Local Density Analysis and Presence Absence Analysis in order to identify patterns of settlement or of artifact creation and use (Carver 2009: 261).

For Presence Absence Analysis, archaeologists can take a page from ecologists who are mapping presence or absence of species within a particular environment, creating models for predicting the distribution of organisms from environmental data. Perhaps there are similar models for archaeology that can use the mathematics of ecological distribution, which can be applied to both the natural and synthetic worlds.

For Local Density Analysis, this looks at things such as concentrations of bones or flakes to identify sites of use or production. We could possibly use this within synthetic worlds, too, based on what we find. The mathematics/statistics should be scalable, and I will test this in my video game case studies.

One other source of pattern recognition can take a look at how human and nonhuman agents in synthetic worlds move. Carver notes that

exploring the way that centers of population interacted with each other assumes that there will be preferred pathways rather than random connections and that these pathways will themselves promote the establishment of new settlements on the route (Carver 2009: 262). This is true in the real world, but is it true in synthetic ones? In a game such as *Fallout 4,* settlements are found on roads, but also in the wilderness. In many role-playing games (RPGs), wandering monsters are more frequent off the road, but major settlements are on the routes. It depends on the game and its design, but by and large things of interest happen on pre-established routes. These routes can be created by the game's developers or, in the case of *No Man's Sky,* through procedural generation (ProcGen) where the software determines (a) if there will be creatures present, and (b) if there are, what paths they should follow based on the parameters of movement assigned to the creature depending on the kind of animal that it is and on the landscape in which that creature is situated.

During analysis of site data, there are always two analytical programs working in parallel: one working on objects, the other on contexts (Carver 2009: 272, fig. 11.4).

In the natural world, one might find a timbered house built a hundred years ago, yet made from wood hundreds of years old. There are two timelines at work: materials and the objects made from those materials. In games, sometimes this will be the same date. In ProcGen games, the material and the object made from the material are exactly the same, created mere seconds ago (even if they have the appearance of being old). In other cases, one might record when a material was mined and when it was later used to craft an object. One could also consider that a material or artifact was made on the date the game was released, or when a game was played by a player. One can argue if these dates are even important. In most cases, probably not. But in some cases, dates might be necessary if only to form a relative chronology from which to order items and to sequence elements within a game.

Sequencing of a site includes stratigraphy. This is often done through the creation of a Harris matrix. The matrix includes all the contexts, so it constitutes a total account of every stratigraphic event that occurred, or rather, those that could be observed and recorded (Carver 2009: 278). As an experiment I created a Harris-style software matrix to record the stratigraphic sequence of the game *No Man's Sky,* which treated each version of the game as a stratigraphic layer to see how one version of the game related to the next regarding functionality and bug fixes.[15] While stratigraphy is practically impossible to determine within a synthetic world, it is quite easy (if laborious) to identify and document when looking at the software from the outside in.

Seriation (the arrangement of a collection of artifacts into a chronological sequence based on characteristics such as shape, color, material, etc.), however, can (and should) be conducted within digital built environments. Sir Flinders Petrie was able to use seriation to determine that graves with the most similar pots were nearest to each other in date (Carver 2009: 280). Seriation may or may not be as Petrie described when dealing with synthetic worlds. It is dependent on the game's logic. For games that contain objects to find, one might find artifacts in many locations, which might make sense in the game but would make no sense at all in the natural world.

Continuing considerations on how to order sites, Carver shows in fig. 11.11 that different types of sites (e.g., deep urban, rural settlement) have varying levels of stratification and ways to order context (Carver 2009: 281). Most games will have none of this within the space of play. There is no need for it. Almost everything is superficial in the game-space.

Synthesis and Publication

Once the survey and excavation is complete and the features have been analyzed, it is time to synthesize the material in order to draw conclusions from the data and to create a site model. For this synthesis, Carver starts with the outcome of primary analysis, followed by a literature search, looking for ethno-parallels, then experimentation in order to create models (Carver 2009: 311, fig. 12.12). For the identity of features, for example, he recommends searching the literature about features identified on other sites, looking for features used by comparable cultures, constructing/using/disuse of replica features in experiments, in order to model the activities of the site being synthesized. Synthetic worlds perhaps provide an easier way of synthesizing data as conditions can be recreated (much of the time) and reproduced by others who also have access to copies of the same synthetic worlds. It is possible in some games to tweak a variable or condition in order to experiment, and to rerun those experiments to test a hypothesis, which falls under the rubric of agent-based modeling (ABM).

Following synthesis, it is time to publish the results. Publication is key to any archaeological project, and it is especially so for new, possibly provocative research into nontraditional areas such as the archaeology of synthetic worlds, video games, digital built environments. Carver lists eight kinds of publications, how they are presented, and for whom: field reports, lab reports, client reports, research reports, popular books, media (magazines, site guides, television), displays, and presentations (Carver 2009: 316, fig. 13.1). The latter half of these publications

is intended for the public, those who visit sites/museums, and those who have an interest in popular historical nonfiction. The other reports fulfill the responsibility of writing up the data for other researchers and for the project's sponsors. The bottom line is that the ethical project must produce similar work for distribution to colleagues and to the public as a conclusion to the original, public research plan.

The publication plan for an archaeological project set in a synthetic world would include a research report describing the investigation, findings, interpretation, and context, authored by all of the principal participants in that project. The report should be published as Open Access for maximum discoverability and use, and should be published digitally in order for the report to link to published data sets and to related digital media, including photos and video, and, if possible, a digital copy (or links to accessing) the digital site that was investigated. This will allow other archaeologists and researchers to return to the site for additional research or to test hypotheses and results as provided by the report's authors. A preliminary report should precede the final report of research to outline methods, findings, and interpretations, published immediately online.

Popular books and other public media should come second, but these should not be ignored by the archaeological team. In the case of synthetic worlds, many of these are popular spaces, and conducting archaeology within them generates enormous public interest. Public reports, interviews, etc., can draw archaeologists closer to the communities who occupy game-worlds or who actively use software, which can lead to additional support, be it financial or, perhaps more importantly, for networking purposes. The public can also raise questions overlooked by the researchers, and can critique the work, allowing the archaeologists to revise theories and reconsider results.

Carver states that "without a pre-released project design, a field archaeology project must be judged to be inept, at worst unethical. . . . A project design is therefore a consultation document that is prepared and circulated widely before serious fieldwork begins" (Carver 2009: 335). This sentiment is shared in both the natural and synthetic worlds. Both professional and community input are important prior to the start of the actual project. For synthetic worlds, archaeologists who are not directly involved in the project can critique its archaeological plan of attack, while the community can assist by providing expert/native-level intelligence on what to expect within the digital environment to be studied.

In the natural world, archaeology can appear as an inconvenience when it comes to land use. One must speak with property owners and

government representatives to acquire permission and permits, and one must also address the public. Blocking off a section of land for an excavation can cost others money and opportunity, and the archaeologist must be sensitive to those people affected by the project. In synthetic spaces, the issues are perhaps less sensitive but must still be considered, especially if work is being done in a game-space populated by other human players. Consideration of their gameplay and use of the site must be respected. Some games also have nonhuman actors/agents that should also be considered prior to embarking upon a project. How will the archaeological work interfere with their operation in the shared digital space, and are such interruptions ethical?

Carver takes a very commonsense approach to creating a project plan, taking time to consider what needs to be done and why as based on the research questions being asked (Carver 2009: 337, fig. 14.1). We need to know how big we want our survey to be prior to conducting site reconnaissance; we need to know the location, problem, and project scoping before evaluating the site; we need to evaluate what these early stages have told us prior to designing the project; we need to continually update the project design during fieldwork to adapt to the site and its environment; we need to assess the data collected prior to creating a formal analysis; we need to understand the results of that analysis prior to publication. This should be applied to any archaeological project regardless of where it takes place.

Carver offers a few "starter" questions for archaeological research projects, and these can be applied to those synthetic worlds that contain ready-made (or algorithmically generated) cultures that are alien to all prior human experience (Carver 2009: 342). How are communities and territories defined, and how are societies organized? What are the "people" like, and how are they organized? What are the gender roles (if gender is present)? What do the people in this new culture think, and what is their worldview? What do they eat; how do they make and use tools; what contacts do they have? What is their environment like? Why (or how) did things change? These are universal questions that can be put to any culture on Earth, but they can also be used on Mars or within a synthetic world. These are questions for which archaeologists seek answers, deriving those answers by following archaeological method as determined by their research plans.

Carver lays out the contents of a project design in table 14.1, breaking it down into an introduction, evaluation, research options, conservation options, and recommended integrated program (Carver 2009: 353). Completing each of these sections is essential and once done must be shared publicly for comment/critique. The original research plan

should also be included as part of the final report as a way to document if things changed during the project, and how and why.

Video Game Ethnoarchaeology

Many video games from all time periods have situated their characters and action in imaginary worlds—which Mark Wolf calls "diegetic"—where part of the game's objectives is to explore and learn about the game-space (Wolf 2014: 125). These game-worlds have space, time, and causality (Wolf 2014: 125–26). Things happen to players, and things happen because of player action.

One of archaeogaming's great potential areas of scholarship is in conducting ethnography and ethnoarchaeology within synthetic worlds. Standard ethnography is the scientific description of the customs of individual peoples and cultures. This can also be done in video games on two levels: in-game, where the ethnographer studies a particular culture as designed by the developer; and extra-game, where the ethnographer reports on a culture of players who not only play a specific game but who choose to play as a certain faction, race, and/or class. In both the real and virtual worlds, players interact with cultural systems, and archaeologists need to abide by a code of ethics regardless of which world it is that they choose to explore (Dennis 2016). For the gaming ethnoarchaeologist, the following applies to studying the entangled cultures of both worlds:

1. Cultures are the way they are because they are adapted to an external environment;
2. elements of culture are observable;
3. one can compare systems from culture to culture;
4. elements of cultural systems are interdependent;
5. different elements of cultural systems are linked to one another and explained by function;
6. we can examine links between subsystems in terms of correlation rather than simple causes. (Johnson 2010: 72–74)

Ethnoarchaeology goes one step beyond ethnography in studying people/cultures through their material remains, and it is specifically applied to modern and contemporary "living" societies. Because it is less than fifty years old, gaming culture qualifies for ethnoarchaeological study, archaeogaming being driven by that mission. As with ethnography, ethnoarchaeology requires two levels of analysis: material culture

of real-world players and the games they play (including software, hardware, as well as everything from game-related fan-created art and fiction to official documentation) and the culture created within the synthetic world itself, independent of outside forces.

Within procedural games, the ethnoarchaeologist analyzes the resulting material culture of whatever the algorithms produce. Taken liberally, this could mean that everything created in a procedural universe is an artifact, be it a planet or a pixel manipulated to create that planet. Both the pixel and the perceived world (which is really just pixels organized to convince the player of its "world-ness") appear by the grace of code. The pixels align, inherit color, position, and function, and link up to create the manifestation of a planet, or a weapon, or some kind of imagined onscreen life-form. The ethnoarchaeogamer must determine the level of granularity of study framed by research questions. What is to be studied and why?

Regardless of the answers, the material culture to be researched has been machine-created. A game's Ur-code was created by one or more people, or in the newest cases of artificial intelligence, people make the tools that are then used by machines to create the code that creates a world to explore. With procedural generation, especially in newer games, the player is an extra step removed from the developer, engaging first with whatever the algorithm creates as interpreted by the hardware running the code instead of engaging directly with the manifestation of the code itself. If you play *Uncharted: Drake's Fortune,* you can memorize what you need to do and where you need to go. The environment is always the same. In a procedural game, higher-order thinking is required both on the part of the player and whatever is being played. Depending on the hardware used, the software version, and the player, the same game will produce different outcomes, even if the end goal of the game (or a quest within a game) remains unchanged. But even now those rules are changing, with games (e.g., *Undertale*) moving the goalpost depending on player behavior at earlier points in the adventure.

What remains in these games and in-game situations is the universal issue of agency. People do things, and the game reacts, and vice versa. Without the player, in most instances, the game remains in a static state. It "waits" to be interacted with. This is no different than any real-world artifact discarded only to enter deep time until a future disturbance, sometimes at the hands of archaeologists. Archaeogaming therefore includes human behavioral ecology, which is concerned with exploring the socio-ecology of individual agents and the dynamic context that define the cost and benefits that they encounter. Bird and O'Connell write that "the individual is the nexus of human relations and is concerned

with complex behavioral strategies that underlie artifact patterns; it has much in common with agent-based approaches in archaeology" (Bird and O'Connell 2012: 54).

"Agent-based" focuses on the individual and its actions, studying how those actions combine with the other actions of individuals to create interesting, group-based behavior. In archaeology, agent-based models help archaeologists reconstruct the processes responsible for the patterns observed in the archaeological record (Kohler 2012: 111). In traditional archaeology as well as in video games, agent-based modeling deconstructs the rules down to a very fine grain, where the small combines with other individual entities to create simple actions that grow to become complex, resulting in emergent behavior. With games, the in-world mechanics operate through coded procedures, but they acquire additional meaning through player interaction. The player then actively engages as a creative agent, helping things happen. Players realize that their actions have effects not only on themselves but also in the game-space. This is not unlike what happens in the real world. As theorist Karen Barad mentions in *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning,* "Learning how to intra-act responsibly as part of the world means understanding that 'we' are not the only active beings" (Barad 2007: 391). Everything is entangled with everything else.

Archaeology takes the concepts of human agency and entanglement and includes the inanimate as well, calling it "actor-network theory" (ANT). ANT includes nature and things (anything nonhuman, such as machines and other technology) as active agents in the past, present, and future (Latour 2005). Devices are nonhuman social forces (Schut 2014: 327). Contemporary human life is completely defined by our nonhuman technology, and it is easy for humans to blame that which humans created for faults that affect the lives of those same humans. Sometimes we play the game, and sometimes the game plays us.

With video games then, ethnoarchaeology takes us further into what might be as the lines between the real and virtual blur. Anthropologist Penny Harvey says that this "new curiosity concerning other ways of relating to non-human worlds is central to the survival of our species" (Harvey 2013: 61). We must understand our interactions with things or ignore them at our peril. That study must delve into media archaeography, modes of writing that are not human textual products but rather expressions of the machines themselves, functions of their very mediatic logic (Ernst 2011: 242). Archaeogaming is central in identifying and understanding the inner dialogues of machines by virtue of the games we play on them, transferring that knowledge to the real world.

But where to begin? I attempted to tackle these issues in the *No Man's Sky* Archaeological Survey.

Archaeogaming Case Study: The *No Man's Sky* Archaeological Survey

No Man's Sky (Hello Games 2016) is not the first procedural game; it is an heir to much earlier examples such as *Elite* (Acornsoft 1984). *No Man's Sky,* however, has elevated procedural games to the next level where algorithms are used to create everything in a universe-sized universe, including photorealistic planets, plants and animals, weather, sounds, and even language. Because of the scale of the game and the fact that it would contain procedurally generated material culture, I thought this would be the first earnest candidate for in-world archaeology where archaeologists could document never-before-seen, machine-created cultures.[16] I wanted to explore emergent behavior that evolved from the complexity of such a large game; I wanted to see firsthand how material culture was created on the fly through procedural algorithms; I wanted to conduct ethnoarchaeology on beings and their habitats that were created by the software to have the illusion of having history.

To explore these ideas formally, I created the *No Man's Sky* Archaeological Survey (NMSAS) in 2016 to explore and document examples of built environments and material culture, all made from the "interpretation" of lines of code (see Figure 3.1). The NMSAS took a heuristic

Figure 3.1. Ruins in *No Man's Sky* (Hello Games). Screen capture by author.

approach to the archaeology of a virtual space, both practical and experimental, to do and to discover.

In anticipation of conducting a proper archaeological survey, which included transects (orbital and suborbital) and field-walking, I researched current survey methods used on Greece and in Cyprus, most notably the Eastern Korinthia Archaeological Survey and the Pyla-Koutsopetria Archaeological Survey. Team member Catherine Flick with L. Meghan Dennis composed a code of in-game archaeological ethics with me, which appends this book. I also partnered with the Australian archaeologists behind the Federated Archaeological Information Management System (FAIMS) to create customized survey forms for team members to use via smartphones and tablets while they played. I created several spaces for work, storage, and internal and external communication.

For anyone who wanted to follow the project online I set up a Twitter account, @nmsarchaeology, where news, images, and recorded video of our travels would post. I also set up a public Twitch channel, nmsarchaeology, so that subscribers could ride along with the archaeologists as we explored new worlds. For internal communication, I created a Slack team and included channels for general, finds, procedures, and ethics where we could have real-time discussions. Images, video, and field reports, along with procedures and other team documentation, lived on a shared Google Drive.

But all of that preparation did not account for the new universe we were about to experience. After one month of exploring *No Man's Sky,* it was clear that the game we expected was not the game the team was prepared to study, although like any good archaeologists, we improvised. The game did not ship with any maps or navigational features at the planetary or local level, and because there were no poles on any of the worlds we discovered, it was impossible to determine cardinal directions. Perhaps most damning was the lack of any kind of Cartesian coordinate system for assigning X and Y (and possibly Z) coordinates to points of interest, features, wrecks, buildings, and the like. We were unable to be exact regarding locations of things, and even if we could have been, the waypoints we discovered and logged via the *NMS* game interface were forgotten by the system itself two weeks following discovery. The only data maintained on a permanent basis by the game are galaxies, systems, planets, and moons. That changed, however, with the November 2016 release of the "Foundation Update" v1.1, which allowed for custom, permanent waypoints, along with UTM-like coordinates to record anything of archaeological interest.

At this writing, there are no active civilizations in the game. There are no surface finds other than crashed spacecraft containing discover-

able technology, and occasional "jettison pods" that dot the landscape. The only pottery to be found are static "amphoras" in ruins, and these artifacts are always the same shape and even the same disposition in the buildings in which they are found. There are no bones and no graves (other than the player's if killed by animals, ships, or the environment, and even the marker is temporary). There are animals, but no sentient life. There is nothing to interact with other than static cutscenes with four races: Korvax, Gek, Vy'keen, and Travellers. One can push buttons and solve simple math puzzles to gain locations of spacecraft wrecks, trading posts, monoliths. But the worlds are empty except for the buildings left behind by "ancients" or the ones currently in use by colonizers. In space there are space stations and trade ships.

In this game, there is nothing one could traditionally call "archaeological," things one would expect to find on a survey or excavation. But that is the point in studying games and game-spaces archaeologically. Games can be simulations, but everything within is the creation of the developer and the algorithms deployed by the developer to, in this case, populate a universe. Although the game fails to deliver on traditional archaeology, it does present the archaeologist with a number of interesting things to consider.

First, there are monoliths (different from ruins, which are explained below). These structures can be interacted with in order to teach players race-specific words as well as Atlas vocabulary (the Atlas is mysterious, almost divine technology) based on how a player answers a culturally significant question. Players learn about the history of the Korvax, Gek, and Vy'keen through these structures, and they learn a bit of the language. It is as yet unknown what happens if you answer all the questions about each race, or if answering a question correctly unlocks something else in the universe to discover. The monoliths themselves have a typology from simple rectangular prisms to cubes to spheres, and as one progresses toward the center of the galaxy, these shapes become more complex to include inverted pyramids, Atlas prisms, and more, some of which have visible mechanical parts inside. The monoliths are tied to the race of the system visited; there are no Gek monoliths on a Vy'keen world. There is robust typology in the presentation of monoliths, but their general purpose remains unknown even after "finishing" the game, and their appearance in the landscape (or underwater) remains apparently arbitrary.

Next are the shipwrecks that dot the landscape and can be found either at random or via distress beacon. When the game begins, players are at their own shipwrecks. It is possible that these wrecks also indicate other potential player starting points, but that is speculation. Each

shipwreck is marked by a banner. These banners are of different colors, have different borders, and contain a logo in the middle, also different from one banner to the next. The colors and logos signify factions, sometimes matching the dominant race of a particular star system and at other times signifying exploration on these worlds by others.

Buildings of various types dot nearly every planet visited. These buildings include trading posts, shelters, observatories, pods, factories, beacons, all of which are waypoints, which allow the player to save progress and discoveries. Every race has the same types of buildings, although they differ slightly in their design based on whether or not this is a Gek, Korvax, or Vy'keen world. Buildings are occasionally painted and occasionally have writing on them, sometimes identifiable as Arabic numerals, although whether or not they can be read as such is a mystery. What does the writing mean, if anything? When on a planet, players are rarely more than three minutes' walk from another structure or waypoint no matter where one is on a planet. The coverage is almost gridlike, and in many cases it follows a spiral design for the placement of structures to discover.

Ruins are perhaps the most archaeologically interesting, namely because they hint at age and prior civilization. Ruins can be discovered by accident, but they can always be found by solving puzzles at observatories. Solving several puzzles and several observatories does not yield a succession of more advanced ruins. Types of puzzles (three or four numbers in a four-digit puzzle or two numbers in a four-digit puzzle) seem to determine the type of ruin to be found, either a standalone structure or a two- or three-building complex.

The ruins themselves can be grouped as either "stone" or "adobe," although some ruins use both materials. Some are painted green and others red. All ruins appear to be landmarks or "plaques" or are commemorative, but they are not dedicated to a historical figure or to a deity or specific event that happened at that location. No ruins are habitations. Ruins follow a typology based on footprint, roof-covering, number of staircases, shape of the object one can interact with to learn vocabulary. Some ruins have monumental sculpture, although it is always the same: a lizard-like head on its side. Some ruins have gold spheres incised with circles and lines, and plinths for these. Players can move these spheres, and they can also be moved by strong winds.

Many ruins also have one or two flagpoles topped with flags of different sizes and shapes. The tops of the flagpoles show one of three shapes: hexagon, triangle, or spiral. In earlier versions of the game, by traveling in the direction of a flagpole (using it like a reticle), one can discover "portals," tall structures with an arch at the bottom. These

portals are exceedingly rare and allow "attuned" players to fast-travel to other worlds after entering a complex sequence of glyphs.

It remains unclear how or why ruins and portals appear where they do. Some appear on flat ground, and some appear on slopes or even underwater. Most appear in isolation, but at least one ruin has been documented mere meters away from a modern structure.

The ruins are the same throughout the galaxy and exist independently of the three factions with their own unified architecture. Ruins appear to have been built and then ruined at the same time, and they all have the same kind of pottery arranged in the same way. After seeing dozens of ruins, the arches are all identically broken (when there are arches). It is bizarre to see this kind of behavior of buildings as an archaeologist in a game, but this kind of repetition along with a kind of uniqueness to each structure makes for interesting, non-Earth, non-"real" archaeology. We can see how the algorithms decide to place the ruins and how they build the structures, and we can attempt to derive some rules based on environment, landscape, even purpose. In the real world, ruins are not placed to be ruins or are created as ruins. They were not built to teach the future anything but were instead built as practical structures for use by people at the time, with no thought given to their afterlife. In *No Man's Sky*, the ruins were built as ruins for the modern explorer with no thought given to their initial intent, to their builders, and to their first users. We are the first users of these pre-ruined ruins, and that, too, is interesting archaeologically.

After the first month of the survey the NMSAS team decided to continue exploring and documenting a flawed virtual universe. With a universe as large as *No Man's Sky* with quintillions of worlds, there may yet be planets with sentient life or Easter egg worlds with who-knows-what on them. This is very much like humanity's real-world current hunt for life elsewhere in the universe. But there is still plenty to do on every world the team explores:

1. See if the landscape affects how and where structures are placed, as well as if it determines the types of structures positioned by the game.
2. Continue to learn the languages of the Atlas and of the three races. Because language is delivered by ruins and by monoliths, does the language learned here differ from the language learned by modern speakers at space stations and in the buildings you visit?
3. Is the writing pure fantasy, or can meaning be found in it? Is it comprehensible language? If not, it is still interesting to try to determine why the game chose to decorate buildings and space stations with writing that never seems to repeat.

4. Continue to collect and keep a record of the context of banners and flags, their colors, shapes, and emblems.
5. Do a bit of "train-spotting" but with ships that come and go at a space station. Are the ships always different? Do any ships return? Can you follow a ship to see where it goes? Do all ships belong to a single faction? Do all ships contain the same cargo?
6. Study the trade market. Is there rhyme or reason to supply and demand? Is this behavior consistent from system to system and faction to faction?
7. Is there rhyme or reason to how waypoints are situated in the landscape? Is there a rule that a shelter is always a few minutes "east" of a beacon and a few minutes "south" of an observatory?

All of the above discussion focuses around conducting archaeology as archaeologists within the game environment while occasionally stepping back to determine how the algorithms are working. I also encouraged the team to be mindful of glitches as well as anomalies. There is a difference.[17]

As will be described in detail below, glitches are clearly program errors that disrupt play. Players of the unpatched, original version of *NMS* will recall the constant crashes during warps, which were fixed in later patches. On my first day of play, I got my ship stuck in a pillar of ore and had to die in order to reset the game, this time with my ship balanced atop the pillar and just enough jetpack fuel to make it to the door of the ship.

Anomalies are weird things that happen in the game that behave differently than how players might expect based on previous play. For example, I found a spinning gold sphere embedded in the pavement of a ruin. This might be a glitch, or it might not be. But it was unique to my experience. I also found ruins set on slopes that had levitating knowledge stones and stairs I could walk under. I originally thought this was a glitch, but this is actually an anomaly. The algorithms are working as intended; they just positioned the ruin in a strange place.

Glitches and anomalies are archaeologically significant when documenting the game, but they could be considered to be the "shinies" when compared with the coarseware of everything else in the universe. These common structures and material culture are just as important and yield just as much information about how the universe was built, even if it is not what we had been expecting. For this reason, *No Man's Sky* remains worthy of archaeological attention. Although it was not the game we expected, it is the game archaeologists needed at this stage of doing fieldwork in virtual worlds.

More robust, procedurally generated worlds are coming, and *NMS* is preparing us for what's ahead. With these publicly shared, massive universes to explore, the data collected by the games and their developers can provide rich insight into player and game behavior. How many ruins were discovered by players in *No Man's Sky,* and is there a distribution pattern? Are the words learned in that game all procedurally generated, meaning there are infinite lexica for the three races and for the Atlas (universal repository)? Will developers such as Hello Games release non-sensitive data (i.e., discoveries and their locations in the game) or data-mining tools to the public, or to researchers? The ethics of this kind of data collection and sharing must be considered, but I hope to see at least some information about what is out there in these virtual universes.

Conducting a Transect of a Moon in No Man's Sky

As part of NMSAS, I wanted to complete a transect of a moon in order to see what I could find as I traversed the landscape on foot, to see if field-walking was possible in a game, and if it could provide any useful information. The moon I selected, Aobandan Elemen, is one of two orbiting Gapacazuso LR474, the sole planet in the O-class system Etenqintasy, about 140,000 light years from the center of the Euclid Galaxy (the home to all *No Man's Sky* players when they begin the game). With warm weather, average Sentinel (flying robot guardians of the environment) presence, common flora, and bountiful fauna, plus its relatively small size, this moon seemed the best place to test archaeological survey/transect methods in version 1.1x, the so-called "Foundation Update" released by Hello Games in November 2016.

Methods

With version 1.1x, players could finally place their own permanent beacons as well as "signal boosters," which contain exact coordinates, allowing for proper recordkeeping. I wanted to do a long transect of a small moon to see what non-natural discoveries I could find along the route. Having played the game for a few months, I knew that it is rare that things align exactly, so I allowed myself the chance to zig and zag a little, deviating from the line by a maximum of one minute's walk from my current position in order to reach an area flagged on my head-up display (HUD). These areas appear in the game as question marks, and hovering one's pointer over them indicates travel time at one's current speed.

Prior to starting the survey, it was important to mark a start- and endpoint. I scanned the surface of the moon from space, and a "habitable base" and "abandoned building" were flagged as discoveries awaiting my arrival. These two structures mark fixed positions on the surface, and they were roughly poles apart on the equator. Because planets and moons have no poles in that version of the game (which was fixed in v1.3, August 2017), it was impossible to determine cardinal directions, so I let these structures serve as the poles of the moon's prime meridian, creating the transect to walk along. In order to mark the poles, I landed my ship at an Abandoned Building and planted a beacon and a signal booster, recording the coordinates prior to leaving. I then flew to a Habitable Base and planted another beacon and signal booster. By doing so, these two fixed points would appear on my display and allow me to see my distance traveled (in minutes and seconds) as well as the distance yet to cover (also in minutes and seconds).

Start (Habitable Base): VAER:05B9:007C:02C6:0118
End (Abandoned Building): ABST:05B9:007C:02C6:0118

To calculate distance, I used both a stopwatch and my "distance traveled" Journey entry. The game records the total distance traveled by a player on foot, measuring by "u" for "units." One unit = approximately one foot. I deduced this figure by checking my distance traveled before and after traveling for sixty seconds across a flat area on the moon. I traversed 276 units in one minute of walking. This equates to 16,560 units per hour. Assuming one travels three miles per hour, this would equal 5,520 units per mile (a mile on Earth is 5,280 feet). Unfortunately, I figured this out about two-thirds through the transect, so I was unable to record absolute distance between sites. I did, however, time my travel between sites, and one can multiply time traveled by units to arrive at distance (D = rt).

I resolved to plant a signal booster only at any sites I found along the way. Planting a permanent beacon would have confused my north-south direction, cluttering up my viewfinder with other points of interest. Planting a signal booster would give me coordinates, however, permanently tied to a structure. I opted not to plant a signal booster next to deposits of trash, feeling it would add even more clutter to the landscape. I did, however, note whenever I came upon more discarded boxes and jettison pods. For the next transect, I think I will plant a signal booster next to everything I find, not just permanent structures.

Whenever I reached a site (a non-natural feature in the environment), I took a screengrab that included the name of the moon as well

as the coordinates provided by the signal booster. I occasionally shot video of glitches and of unique (to me) animal behavior.

Research Questions

- How many built environments would I find on the transect, and of what type would they be?
- Would these structures be tied to one of the game's three races, or would there be buildings placed by different races?
- How much trash would I find along the transect, and of what type would it be?
- What kind of landscapes support different kinds of non-natural intrusions (trash, buildings, ruins, monoliths, etc.)? Can any conclusions be drawn?
- Are non-natural finds (artifacts/sites) evenly spaced apart by time, distance, or both, or is placement more or less random?
- Would there be any glitches, and if so, how would they manifest?

Environment

The climate of Aobandan Element is classed as "warm," but daytime highs were in the mid-40s C (115º F), and overnight lows in the high teens C (60s F), with frequent dust storms propelled by excessive heat (70s C, 160º F) and wind. There was zero precipitation during the seven moon-days that it took to complete the transect. The day-night cycle is twenty minutes in Earth real-time, cycling between ten-minute days and ten-minute nights bookended by very fast dawns and dusks.

The moon is hilly but not mountainous, with occasional flats that morph into modest canyonlands and simple rock arches. There is no running or standing water (or other liquid) anywhere, above- or underground. The geology is largely iron ore trapped in five kinds of rocks, with occasional crystal deposits of plutonium and quite rare chrysonite and titanium (these latter two typically found together). Plant life is limited to tall, isolated bi-leafed stalks or stalks topped with balls of vegetation. Scrub dots the landscape. Occasional plants bearing platinum or thamium9 signatures appear, typically in spaces of transition between the flats and sloping walls of red rock. Animal life varies between three types of megafauna (all peaceful), mid-sized quadrupeds (one type is carnivorous), several types of rodents (which the carnivore eats), and a human-sized "land-crab" with eight legs.

Navigating the transect was not too difficult, but occasionally I had to choose a route around steep hills or to avoid the carnivore. The most challenging environmental aspect was the excessive heat and storms, which required constant maintenance of my suit to keep me from burn-

ing up. Fortunately, overnight travel did not require any mad scrambles to find iron or platinum for immediate suit repairs.

The Transect

The following notes are organized by total time to each discovery. Whenever I stopped at a structure or rubbish site, I would stop the clock in order to make notes, restarting it only when resuming my journey. The total time to walk halfway around the moon was 140 minutes, although I spent about twice that long taking photos, video, and making notes. Time is presented in this report as hh:mm:ss. In order not to aversely affect the time between points, I walked the entire way, never engaging the "run" function and only occasionally activating the jetpack to soften landings when I had to step off of cliffs along the straight transect route.

00:00:00: Start at the Habitable Base.

00:00:39: Cargo drop (four containers requiring Atlas Pass v1 to open, health box, green cargo box)

00:04:04: two damaged machinery pods

00:10:10: "The Okpod" waypoint (EWIX prefix). This waypoint contained one shelter building with a banner featuring an orange field topped by a black square from which dropped two black vertical lines, and three black horizontal lines at the bottom. The shelter contained a multitool tech station, restore shield station, and an encyclopedia station that displayed the Gek word for "beam." The waypoint also had two "Atlas cans," one damaged machinery pod, and one health pod.

00:19:23: one damaged machinery pod

00:23:00: "Mexiguerr Crossing" waypoint (ULDI prefix). This waypoint contained one shelter with an orange-and-black banner as described above. The shelter housed a multitool tech station only. Next to the shelter was a "Quonset"-style hut, two jettison pods, and one crate.

00:25:57: "Ebuey Moor" waypoint (no permanent structures, so no coordinates recorded). This antenna was flanked by a cargo box and one suit upgrade pod.

00:28:05: one damaged machinery pod

00:33:56: one "Atlas can"

00:35:23: one jettison pod and one crate

00:42:02: "Naglet Desert" waypoint (CODIV prefix). This waypoint featured a platinum resource depot (a five-cylinder building), as well as

an orange-and-black banner as described above. The structure was surrounded by three crates, two jettison pods, and three "Atlas cans."

00:43:52: two health pods

00:49:19: one Knowledge Stone with the Gek word for "permanently"

00:49:58: one jettison pod and one "Atlas can"

00:50:11: one damaged machinery pod

00:55:20: one jettison pod

00:56:46: one damaged machinery pod

00:57:28: "Luysia Plains" waypoint (BUDUL prefix). One shelter containing a multitool tech station. Another orange-and-black banner hung outside. There was a Quonset hut and a short tower.

00:60:00: cargo drop

01:02:00: "Ruzanna Crater" waypoint (LOTE prefix). Gek observatory, the "Ticssold Reflector." There was also a Gek Knowledge Stone with the word for "idiot." Solving the observatory's puzzle yielded the location of ruins approximately thirty minutes away and off-transect. I opted to ignore the ruins during the transect, returning to them after completing the survey.

01:24:00: "H-CF5 Interface" trading post (LUBB prefix). The trading post also marked the spot of one of three glitches I found, this one being three suspended spacecraft, unmoving in the sky. Other elements moved as normal, but these ships were stuck in the air, the first time I have seen this in the game.

01:32:24: "Mepare Desert" waypoint (ENJA prefix). This waypoint contained a single shelter with a multitool tech station, outside of which stood another orange-and-black banner. A small tower and a Quonset hut stood nearby.

01:38:03: one damaged machinery pod

01:42:32: "Nodaya Plain" waypoint. No structures or crates to report, so no coordinates taken. There was an orange-and-black banner next to the antenna, however.

01:47:21: one damaged machinery pod

01:48:40: "Yevio Dale" waypoint. No structures or crates to report, so no coordinates taken. There was an orange-and-black banner next to the antenna, however.

01:55:39: "Lovars Moor" waypoint (MUPDO prefix). Two shelters and one Quonset hut. No banner. One shelter had a research specimen sta-

tion and a health station. The other shelter housed a multitool station and a shield station.

02:01:55: one damaged machinery pod

02:04:43: "Effit Moor" waypoint (ORBU prefix). Two shelters and one Quonset hut. The banner outside the shelters was NOT orange and black, but rather a black chevron on a purple field. This was the only odd banner found along the transect. One shelter contained a multitool station and a shield station. The other shelter contained a research station.

02:07:34: "Indhaudley" waypoint (PAYEM prefix). Platinum resource depot next to an orange-and-black banner as described above.

02:13:00: Drop pod. This area was glitched, as attempting to move forward caused me to spin rapidly instead of advancing. Logging out and logging in resolved the issue, and I was able to proceed along the transect route.

02:14:59: one damaged machinery pod

02:16:02: Gek plaque, "Donetuswe Landmark" (OKTI prefix). Activating the landmark revealed the Gek word for "devastation."

02:20:00: Endpoint of the transect reached.

Post-Transect

I realized dumbly that after finishing the transect I would have to walk back to my ship, or at least to a building that would allow me to summon my ship to my location. I decided to walk to the ruins I'd located via the observatory, about an hour's walk away. As I walked (about thirty degrees off-transect), I stumbled upon a few things:

"Oennyidu Tower" (Korvax transmission tower). This was the only non-Gek site/artifact/feature I discovered on this moon. Activating the tower broadcast a distress signal from a crashed ship. An empty Quonset hut stood next to the tower. No coordinates taken.

"Iwaiduc Station" waypoint (RUVA) prefix. This was a massive area featuring a Gek landing pad and Gek observatory. The landing pad connected to a commercial office crewed by "Trade Envoy Hilau." The office contained a stock transfer station, a multitool tech station, a sales terminal ("K-C-IXO"), and a weapon terminal featuring the gun "Shaodw of Yakodawaj." After speaking with Hilau, I discovered the NPC was a "SynthetiGek," a Korvax representative wearing a Gek disguise. I opted not to interfere, thus increasing my reputation with the Korvax. Solving the neighboring observatory's

puzzle pointed me to the same set of ruins I was heading toward. I summoned my ship and flew to the ruins.

"Ruins" (ULKI prefix). As with all ruins in the game, this set featured three Knowledge Stones. Words learned were all Gek, for "rare," "dampening," and "slug." The ruins themselves were a complex elevated on lofty pillars of carved rock atop which sat a Gek monumental sculpture head, a gold sphere knocked off its plinth, a flagpole topped by a triangle, and a spherical Gek plaque, "Remnants of Maviande-Aiam." Activating the plaque yielded the Gek word for "ammunition." Note that none of the above features of this ruin are unique to it (other than its name). I have seen these features in various combinations in other types of ruins.

"Koriguchi S31" abandoned Gek ship (LUPBA prefix), as identified by the Korvax radio antenna discovered earlier. The ship's banner was yellow on a blue field.

As I prepared to leave the moon, I accidentally flew over a monolith, so I landed to record it:

"Urtetuus-Foss Landmark," Gek monolith (UUJJ prefix). As with other monoliths, three Knowledge Stones were present, these offering up the Gek words for "speech," "emergency," and "balarian." Correctly solving the monolith's challenge yielded the Atlas word for "leave." This monolith was of the "sphere" type, with a blue eye open to the horizon.

Improving Methods

Future transects should plant a signal booster (containing coordinates) at every non-natural feature/artifact/site.

Record not only time between points, but also distance in units by way of the Journey feature in the menu.

Upon finishing the north-south transect, fly to the midpoint and then plant beacons to mark east-west termini for a second transect.

Immediately upon finding a banner, research it on the game's reddit pages to see if similar examples have been found, and in what context.

Record letter-forms and sigils that mark some buildings, and compare these against what others have found and have placed online.

Determine how to read the coordinate prefixes given by the signal boosters. Learn how to map these on the world's surface to look for placement patterns.

Preliminary Conclusions

Completing this short transect allowed me to do some "slow archaeology," and I was able to learn much more about this moon and its features than I otherwise would have through just a flyover. One cannot see the small crates and canisters from the air or appreciate the landscape and how it affects where things are. By far the most common non-natural find were the damaged machinery pods, followed by dump-sites of crates and boxes. A handful of building types also occurred along the transect, but not all building types were discovered (when compared to others I have seen on other worlds). There seems to be no pattern of placement or of how far things are from other things, although I was never more than ten minutes' walk from something of archaeological interest.

The most intriguing things to me when playing *No Man's Sky* as a game are the subtle differences in the procedurally generated shapes of buildings, in the words discovered, and in the names given to sites. Are these truly random, or are they tied to specific races in the game? How does the morphology and phonology work? I am also keen to learn more about the intersection of the game's three races; seeing the Korvax banner on a Gek moon was striking.

The fact that I found this much stuff over about seven Earth miles of actual walking was also surprising, and it reflects the artifact/site/feature-density I have seen on other worlds (but have not measured with as much precision) in v1.1x of the game. The density of structures was much higher in v1.0x. After visiting nearly a hundred worlds, I have found that only a handful have been devoid of non-natural intrusions/structures. Everything, however, appears to be about the same age, appears not to age, and appears to be largely unaffected by the various climates/environments on different worlds. The ruins are certainly different, appear to be older, and are actually ruined. It remains unclear who put them across the galaxy. These, too, share architectural morphology, perhaps seeded by an earlier spacefaring race.

When viewing *No Man's Sky* as its own built environment, there are still "holes in the roof," or glitches (aberrant behaviors). Observing these, one is immediately taken out of the space of the game; the illusion of immersion breaks. Seeing ships frozen in flight, seeing animals scrambling over the ground while getting nowhere, and being personally able to walk forward without spinning made an interesting walk more so. My presence on the landscape allowed me to observe these behaviors, and likely caused them just by being where I was at a certain point in time. I did nothing out of the ordinary to trigger this odd

behavior, yet there it was, the residue of the complex construct of the gaming environment.

The No Man's Sky *Archaeological Survey, One Year Later*

NMSAS stalled after the first few months of play, but the release of the "Atlas Rises" update (v1.3) in August 2017 resolved most of the game's issues for archaeologists. The survey procedure remained largely unchanged: The first step for a survey team was to choose a system in the nearly infinite galactic map into which we could warp. There are four types of stars, each with variations in the nature of the worlds orbiting them. We remained curious if the types of systems affected what we would find in an archaeological context. Following the warp, we would select a planet and then conduct a series of orbital surveys, much like what "space archaeologist" Sarah Parcak does with reviewing satellite imagery of culturally sensitive areas on Earth.[18] Following the orbital survey, we would drop our spacecraft down into the landscape to conduct a series of low-altitude transects to identify and count features, both natural and not. Then we would conduct a series of field-walking surveys in sites or over swaths of territory to look for settlement patterns, construction, waste, etc. We would also identify sites and features, marking them for a second team who would return for thorough documentation and possible excavation. For each level of the survey, we would take screen grabs and video capture to tie to custom software context sheets coded by the FAIMS project at Macquarie University (see below). At least that was the intent.

In-Game Problems at Launch (with Game Mechanics)

The archaeological sites archaeologists find are not necessarily the ones we want, and we must do our best to document the methods and results of our investigations. The game that we (and others) had hoped for had not been realized, and it was nearly impossible to do anything archaeologically meaningful in the initial versions of *NMS*:

- There was no Cartesian coordinate system (or any other kind of coordinate system) to allow us to pin a thing or place to a map.
- There was no way to determine which way is north.
- There was no way to dig/excavate or set markers or lay out a grid.
- There was no way to communicate with or see other players even if they were on the same planet.

- High-altitude orbits yielded nothing of note on the surface below, as what was found on the surface was not reflected from what we saw from orbit.
- Every two weeks, all discoveries were wiped from the game, preventing any kind of backtracking or revisiting sites of interest.

Things We Got Out of NMSAS

Because of the above issues with the game-site over the first year of play, the NMSAS team saw a 99 percent attrition rate, and it appeared at first review as if the project had been a failure. We weren't able to accomplish our goals in the digital universe, and what we found was largely contextually meaningless. We did, however, find some benefits that can now be applied to future projects in digital built environments:

1. Prior to launching NMSAS, Catherine Flick (DeMontfort University) and L. Meghan Dennis (University of York) recommended that the team and project follow a code of ethics on how to conduct ourselves and our work within the confines of an unknown universe among unknown "life forms." Our agency in the game might affect future investigation. Once the code of ethics was written by the three of us, we posted it publicly online and also emailed it to the other team members.
2. When NMSAS was announced, I was approached by Brian Ballsun-Stanton and Georgia Burnett of the FAIMS project at Macquarie University. They had created an Android app that would allow for data collection in the field via smartphone and tablet. I provided the workflow and data definitions, and FAIMS provided bespoke digital context sheets for the team to use that would update a central database in real-time. Because *NMS* lacked any kind of coordinates system or way to measure distance, we were unable to make much use of the software (which was quite good and easy to use). With the release of v1.3 of *NMS,* we should be able to renew efforts to use the software to document what we find on the survey. The software could also be changed to accommodate data from other synthetic worlds that are explored in a similar fashion to NMSAS.
3. It is likely a mixed blessing that *NMS* was released without expected functionality, as the team was able to test and modify its methods on the ground. Working in a "failed" environment also allowed me to streamline processes and reconsider when to create and launch digital field projects. We could also determine what tools we were lacking in the synthetic universe and could observe and adopt those that were created as mods in the player community.

4. Stepping outside of *NMS,* I was able to create an experimental Harris-style software matrix to track changes in the game between versions, treating each version as a stratum in order to read game stratigraphy. The methods of creating a software matrix can be applied to any digital built environment, game or not.

Lessons Learned

After one year of playing *NMS* and attempting to conduct an archaeological investigation within that space, I have taken away a handful of lessons about managing a team-based digital project set in a synthetic world:

1. Video game communities for games such as *NMS* contain thousands of citizen scientists and offer access to thousands and thousands of wiki pages, reddit threads, etc. Archaeologists must take advantage of this, involve the community in large projects, and treat this as a kind of public archaeology. The community will collect much more data than a team of archaeologists would. They will also create more mods more quickly in order to facilitate the navigation and use of a digital built environment.
2. Archaeology is social, and surveys are social events. In the natural world, no one works alone during a field season. It is a team effort. This should also be the case with digital projects. Working alone is no fun, is often thankless, and leads to abandonment of a project. Other reasons for attrition include professional and personal obligations, as well as leaving something boring for something new. Not having clear end goals or a timeline also contributes to poor morale.
3. Learn the landscape (play the game) before launching a project plan/project. No archaeologist ever showed up while a new culture was beginning. Granted, with games we work on an accelerated timeline, but we should take time to play a game in order to fully understand its mechanics and what is possible to do within that environment, developing an archaeological project plan around that instead of discovering everything we cannot do in that space.
4. Manage expectations. Don't overhype and overcommit. *NMS* failed in the beginning because too much hype led to unrealistic (and unattainable) expectations by players and the media. Later patches rolled out quietly, and over the past year have made the game quite close to what it promised to deliver in 2016. Managing team expectations is also key to project success, letting members know what is expected of them, and what the goals are, both in the short and long term.

5. Publish successes/failures (and data, media, etc.) as Open Access so that others can easily discover and use your work to advance their own. Blog/tweet regularly about the project's progress, and encourage archaeology "ride-alongs" via streaming services such as Twitch. Not doing more of this was a serious failure of NMSAS.

The (Unexpected) Future of NMSAS

I was ready to end the NMSAS project after delivering a post-mortem at the 2017 EAA meeting in Maastrict, but Hello Games released v1.3 ("Atlas Rises"), which contained much of what players (and the team) had been expecting at the game's initial release:

- Portals exist for fast travel between worlds across the universe by use of a combination of sixteen glyphs (which took me about twenty hours to find).
- Archaeologists can excavate trenches with the new Terrain Manipulator function for the multitool.
- Up to sixteen people can group up for synchronous play in the same world, which is crucial for field-walking with a team.
- We now can see where north is, and we can see units as well as time to calculate distances across the landscape (and across space).

There are also three major archaeological things to do now that v1.3 has been released:

1. With the Terrain Manipulator, all players can create their own objects and art, which can be discovered by others. This follows on the v1.2 "Pathfinder" update earlier in 2017, which allowed for base-building (and sharing) and the ability to build beacons and communication terminals that could be discovered by other players. NMSAS can now document these player-made artifacts throughout the universe.
2. With the advent of cheap and largely accessible 3D printing, players (and archaeologists) can print what they find. Thanks also to open-source tools, it is easier than ever to do photogrammetry in-world and to export to VR, granting access to spaces to people who do not play or own instances of synthetic worlds.
3. The most exciting new project stems from the fact that v1.3 was for some players a catastrophic event leading to a mass migration from one space to another. The "Galactic Hub" was a planet shared by five thousand plus players. They built bases, shared gardens, and created

a Utopian society of scientists who used that world to explore the surrounding systems and record what they found on a communal wiki. When v1.3 launched, it changed the nature of all of the planets in the universe and turned the Galactic Hub into an uninhabitable wasteland of ice. The population is migrating to a new world, leaving behind the "Legacy Hub," on which are the remains of that human society's material culture.[19] This is the first time a mass migration has occurred in a video game, and therefore it demands archaeological attention. I arrived in the Legacy Hub on September 15, 2017, set up my excavation house, and conducted a preliminary survey prior to beginning the Legacy Hub Archaeological Project (L-HAP) in October, in which the team will document and catalogue the material culture left behind by the evacuated human population.

Glitches as Artifacts

One aspect of archaeogaming is looking for "artifacts" within a gaming environment. Think of it as a bug hunt. The last thing players want to experience when exploring a virtual world is a bug or a glitch. These technical aberrations interfere with (or even halt) gameplay, and they are unwelcome intrusions into the illusion of reality. Bugs and glitches in games are common, especially in more current titles that can be overburdened by the complexity of code, of poor quality assurance testing, or a combination of both. Bainbridge recalls glitching in *World of Warcraft* as the virtual world being held hostage by real-world storms, server emergency maintenance, and even hitting the "Windows" key by accident (Bainbridge 2010: 214).

One can draw an analogue to pottery found on excavation. A lot of artifacts are grotty and common, occasionally beautiful, but all convey data to the archaeologist and form what becomes the archaeological record. "Gamifacts" are rare finds among the common environment in which they are discovered in synthetic worlds. While odd and at times entertaining, glitches taken together with their digital environments create a game history, a snapshot in time.

Take *Elder Scrolls V: Skyrim* for example. Bethesda Softworks released the game in 2011 just ahead of the holiday season (we've seen this happen before to disastrous effect with Atari's *E.T.* in 1982). Almost immediately players began complaining about some spectacular glitches/bugs, including things such as mammoths falling from the sky and dragons flying backward (see Figure 3.2). Bethesda patched the major bugs in early December: no more reverse-flying dragons, non-player

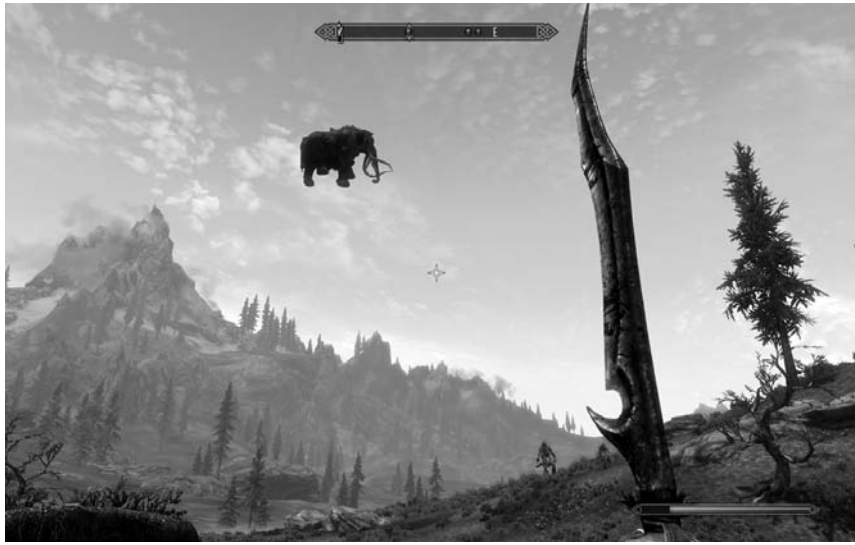

Figure 3.2. Glitch of a falling mammoth from *Elder Scrolls V: Skyrim* (Bethesda Softworks). Screen capture by author.

characters without heads, or suspended laws of physics. These massive (and massively entertaining) glitches disappeared from the game and became the stuff of game lore with evidence remaining online in images and gameplay video. These bugs are real artifacts, and the photographic, video, and anecdotal evidence are all that remains of the archaeological/archaeogaming record.

Finding a Gamifact in Elder Scrolls Online

As an archaeologist and as a player, I am always on the lookout for something out of the ordinary, something weird, something that clearly should not be part of the game. I've put in dozens of hours on Xbox One playing *Elder Scrolls Online: Tamriel Unlimited*. My level 44 avatar had been visiting eastern Coldharbour doing what one does: exploration, completing quests, farming materials, and killing enemies. I was supposed to meet a friend that evening to punch out some mini-bosses in a few delves, so I waited in the Shining Star Tavern in the Hollow City. I was early, so I had a drink and talked to the NPC clientele at the bar, a few of whom I'd seen before, but elsewhere. And then I saw Holgunn, an NPC, drinking an ale in what appeared to be "bullet time" from *The Matrix*. I stood there for a couple of minutes watching Holgunn stand still while at the same time chugging ale, almost as if his still, silent self was wishing he was drinking the place dry (see Figure 3.3).

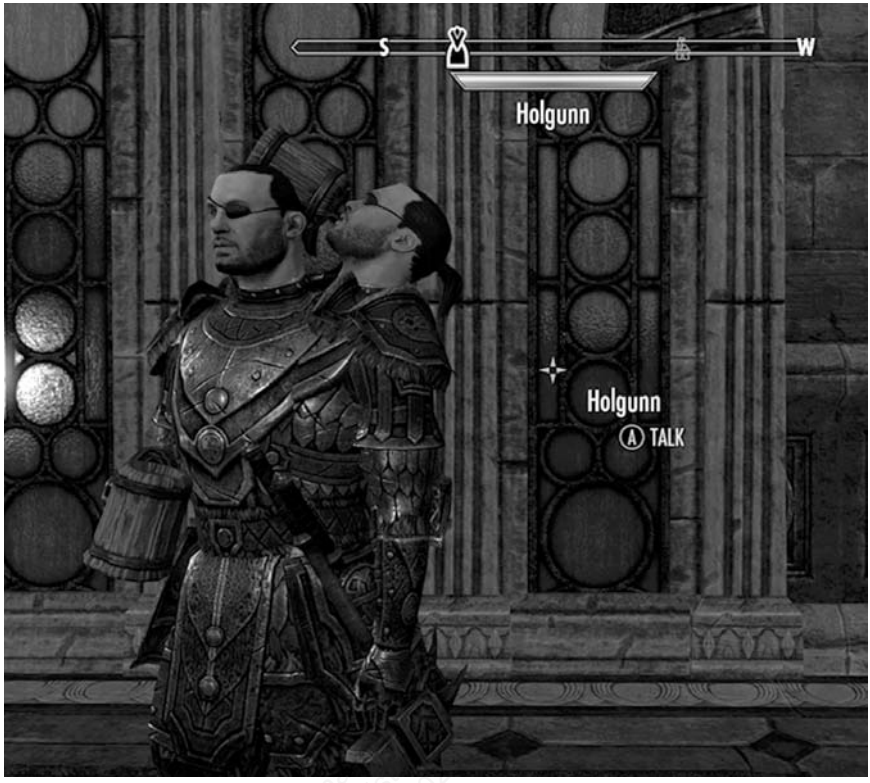

Figure 3.3. Glitch of the NPC Holgunn from *Elder Scrolls Online* (Zenimax Online). Screen capture by author.

It was a glitch. It was also an artifact. In archaeogaming parlance, it's a "gamifact." As an archaeologist, what did I do? I took several pictures. I took video. I noted the date (September 1, 2015) and the time of discovery (10:12 pm). I noted the location (Shining Star Tavern, the Hollow City, Coldharbour). I also noted the quest I was on (The Army of Meridia) because NPCs often wander off somewhere else in a game after the completion of one quest in anticipation of another. But then I wondered if this glitch could be reproduced by someone else on different hardware, PS4 and PC. Does this glitch occur only on this quest, or is it just there all the time? What code is behind this glitch?

After noting this gamifact, I visited several *ESO* discussion groups and forums, but I did not find this glitch reported anywhere. Either it is new or so subtle that no one's noticed it yet. Because the glitch is benign, it is likely that nobody cared enough to report it. As an archaeologist, I did. And when an upcoming patch is released that fixes the glitch, we will be reminded that archaeology is a destructive process.

Once we find an artifact, it is pulled from the earth, documented, filed away. Anyone who comes by later might not know that there was something special in place. So it is with glitches and patches.

The following day, I tried to reproduce the glitch. I returned to the tavern to look for Holgunn at exactly the same time as I did on the previous day, but he was absent. I forgot, however, that time is accelerated in *ESO.* The tavern in the daytime has an entirely different clientele than it does at night. It could be that Holgunn, like some, works during the day, and then relaxes with a few mugs of ale in the tavern after sundown. I checked a few times, but he was gone.

New games, just like newly discovered sites, will yield the most of these, growing more rare over time as patches fix things. These glitches are part of the game and its history, adding to the story surrounding the media, and should be recorded.

Glitches Defined Archaeologically

One of the chambers of the heart of archaeogaming lies with understanding glitch-artifacts. Some assumptions as they relate specifically to video games:

1. Video games are each their own discrete archaeological site.
2. Video games often have glitches upon their initial release.
3. Glitches, which can appear at an observable game-space and game-time, are artifacts within the game and therefore have archaeological context.
4. Glitches are artifacts created from the complexity of code.
5. Glitches are artifacts created from the entanglement of hardware, software, and platform.
6. Glitches are artifacts that temporarily exist in a quantum state.

To deconstruct:

1. As discussed earlier in this chapter, video games are each their own discrete archaeological sites. A video game is a discrete entity where the place can be defined as where the game is installed (not necessarily its installation medium, which is a whole other story). The past activity is the coding that created the game. Its elements can be directly observed and manipulated, part of the record of the game.
2. Video games often have glitches upon their initial release. A glitch can be defined as unintended functionality created by code. 1978's *Space Invaders* had one of the earliest glitches, which actually re-

mained in the game, speeding up the aliens as the player killed off rows of minions. 2015's *Rise of the Tomb Raider* has a glitch near the end of the game that "breaks" the game if a player tries to save progress prior to entering the Bathhouse Challenge Tomb.[21] Despite quality assurance (QA) testing, games ship with glitches, and those glitches remain until they are patched by the developer. If you want to see more examples of game-glitches, there are loads of websites focusing on these, but in a non-archaeological way. Search for "game glitch" and lose hours of your life to the topic.[22]

3. Glitches, which can appear at an observable game-space and game-time, are artifacts within the game and therefore have archaeological context. An artifact, such as a tool or a work of art, is something recovered by archaeological endeavor made or given shape by a person (or people), especially an object of archaeological, historical, or cultural interest. In meatspace, an artifact is often excavated. Prior to removal, its archaeological context is recorded: its relationship to its surrounding environment, its absolute location, and other metadata, including the date on which it was recovered. Following discovery and preliminary documentation (notes, measurements, in situ photography), it is removed and relocated to another place for additional study. In game-space, the glitch is the artifact (and perhaps the only class of artifact) to be observed and recorded. Everything else within the game is a deliberate creation of one or more game developers, which taken as a whole could be considered landscape archaeology as described above.[21] But glitches are true intrusions into game-space, and as such they can be classed as "significant finds."
4. Glitches are artifacts created from the complexity of code. As stated above, video games are the summation of conscious design and coding decisions, where each element a player interacts with is there for a reason. No developer deliberately creates glitches within a game s/he distributes (otherwise they would be classed as "Easter eggs").[23] A glitch is the unintended result of coding. This raises two questions: (1) is a glitch made by the code alone, (2) and if so, is it still classed as made by a person and therefore able to be called an "artifact" in the classical, archaeological sense? I propose that the answer to the second question is "yes," arguing first that the code was written by a person (or even machine-written code derived from initial human-created code) and also that by analogy people make mistakes, and the archaeological record is full of physical evidence of those mistakes (e.g., misfired pots). Complexity, when used in this context, can be considered in the mathematical sense, specifically

computational complexity, where processes having a large number of seemingly independent agents can spontaneously order themselves into a coherent system, but that the complex system contains an inherent level of chaos or noise as created by the entanglement mentioned in number 5 below. What makes glitches so interesting is that they are unpredictable attachments to nonhumans in processes of making and experiencing (Yaneva 2013: 132).

5. Glitches are artifacts created from the intersection of hardware, software, and platform. This is called "entanglement," something archaeologist Ian Hodder has written about in his book *Entangled: An Archaeology of the Relationships between Humans and Things* that explores the complexity of the human relationship with material things, demonstrating how humans and societies are entrapped into the maintenance and sustaining of material worlds (Hodder 2012). The same can be said of the maintenance of virtual worlds, where glitches are the product of the complex interrelationships between code, the code's platform,[24] and hardware used by players. It is not code alone that causes glitches (although there might be some instances where it does). Instead, it is the chaos introduced into the system by the variables of code, platform, and hardware that create these artifacts.
6. Glitches are artifacts that temporarily exist in a quantum state (i.e., they exist in a time and space that must ultimately be observed by a person, but that observation might be what actually triggers the appearance of the glitch). The classic example of a quantum state of being is the fact that light is both a particle and a wave. Things get weirder when we consider that we cannot know the state of a quark (a subatomic particle) without directly observing it but that the quark can exist in all number of states at once prior to observation. Quantum entanglement occurs when pairs or groups of particles are generated or interact in ways such that the quantum state of each particle cannot be described independently. Video games do not obey classical laws of physics when experienced as a player, even though the developer has spent time and effort to recreate a believable physics within the game-space. A glitch, then, is an aberration in which at least two states of being can be observed simultaneously: what is, and what is supposed to be. Going one level deeper, the actual game (code + platform + hardware) is subject to meatspace physics as well as quantum physics, which are operating within the twin theories of chaos and complexity, resulting in something unexpected by both player and developer alike.

These glitches, these artifacts, are destroyed (fixed) by patches and are then lost to time, living on only in the documentation of the archaeogamer as well as in the public record via media services. The memory of the glitch-artifact is preserved, but not the glitch itself, unless the archaeogamer retains an unpatched version of the archaeological site (the game). These glitches are part of the game's history and document a specific part of its development and life cycle, much like various stratigraphic levels of meatspace sites. The game's build and patch numbers equate to a time-based stratigraphy, and any glitch-artifact must be recorded not only with its game-time and game-place of observation but also with the build and/or patch number for proper contextual reference.

What can glitches tell us (if anything) about the space with which we interact? Michael J. Kramer teaches Digitizing Folk Music History, a seminar at Northwestern University. In it, he teaches the class how to hack JPEG images, turning photos of folk musicians into glitch art (Kramer 2016). By randomly deconstructing the images through a text editor, the images present new ideas of thinking about music, personality, fame, and more. Creating glitches allowed students to think about things differently. Video game glitches can do the same, offering the chance for players (and artists) to play with games in unintended ways, exploring the intersection of code and related visuals.

Artist Daniel Temkin specializes in glitch art, looking for visually interesting glitches within games and other software (Pangburn 2014). Temkin states that "the glitch aesthetic may be rooted in the look of malfunction, but when it comes to actual practice, there is often not much glitch in glitch art." Artists like Temkin tend to try to bend or break the rules inside the game-space to create glitches, using the environment in ways not intended by the developer.[25] I call this "gamejacking," which is also known as "counterplay."[26] Gamejacking is more akin to creating artifacts rather than discovering them as they are created by a game's natural errors, something that is likely disingenuous although unique at the same time.

In 2011, Temkin and his colleague Hugh S. Manon had a series of conversations about "glitch" (both a noun and a verb), fifty-six theses of which they published online (Manon and Temkin 2011), defining glitch theory and practice, defining the glitch as a real artifact in a virtual space, and exploring the formation process, which is often instant, unanticipated. The glitch-as-artifact differs from those artifacts found in the real world, which can be revealed slowly, and almost predictably, and can remain in situ until removed by the archaeologist. With glitches, they can disappear as soon as they are discovered, and it is

up to the archaeogamer to be quick in documenting the happening. This documentation will need to include a typology, something Bainbridge hinted at when playing *World of Warcraft* from a cultural perspective: glitches (of which bugs are a subset), "bugged" quests (i.e., quests that are impossible to complete for reasons other than player incompetence), "bookkeeping" glitches (i.e., the developers forget to update part of the game), and "data corruption" (i.e., dropped internet packets) (Bainbridge 2010: 215).

Glitches are not the only artifacts created by complexity/entanglement, however. I believe that in procedural games (where code creates things in game-space in a more randomized but still logical way), the complexity of code leads not only to glitches but also to unexpected elements in built environments, a "happy glitch" (one that is intellectually interesting) instead of a "sad glitch" (one that crashes the game or otherwise disrupts play).

Garbology in Video Games

World of Warcraft entertains millions of players, and has for over ten years. The game-world of Azeroth revolves around things gained by collecting, looting, buying, selling, and earning. When you think about all of the monsters/mobs/bosses slain and all of the loot dropped, there is conceivably billions of metric tons of stuff, much of it unmemorable. This junk, informally called by the player community "vendor trash" or "grays" (because of the color of the item description text), ends up either sold by players to NPC vendors, left unlooted, or dropped on the ground. Because the game has a robust inventory infrastructure, players can purchase slots for their stuff in personal and guild banks (akin to safe-deposit boxes) and/or buy increasingly large bags/packs to hold as much mobile inventory as players care to carry.

Sometimes players run out of room and must discard something, making space for a more desirable item. I leave some leather scraps on the ground where they will remain for as long as I am logged in to the game. I can travel somewhere else and return to that drop spot, and my leather scraps will still be there, untouched and unseen by animals or other players. But as soon as I log out, my trash evaporates. If only that would happen in the real world. But if it did, much of the archaeological record would be forever lost instead of locked in a sandy matrix awaiting discovery and interpretation.

Traditional archaeologists often deal in rubbish. Much of what is recovered on excavation is fragmentary bits of pottery, of bone, stone

flakes left over from the manufacture of tools and points. People break things and make mistakes, and once they come to the end of their period of intended use, their things get discarded, buried, thrown in a well, dropped down a privy hole, tossed out the back door. Pottery workshops and other areas dedicated to making consumer goods (including food) generate huge rubbish piles, which serve as literal data dumps for archaeologists interested in site economies, population, and trade. We learn much from sifting through people's trash. The field dedicated to that for modern and contemporary cultures is called garbology.

The Tucson Garbage Project was started in 1973 by William Rathje of the University of Arizona to study patterns of consumption by the city's residents. One of the insights of the project (which continues to operate years after Rathje's death) was that people lie about what they throw away. Comparing survey report data against what was actually tossed in the bin showed two different stories, one that was socially acceptable/expedient and another that demonstrated empirical actuality. Both the actual trash and the stories, however, are valuable to the archaeologist interested in how people deal with things, especially past the point of a thing's desirability. What was thrown away and why? The perceived end-of-life of an item is really just an interesting story of an object's journey into the future.

With video games, however, there is little physical evidence of anything ever having been used and discarded. In *WoW,* it is as if the Langoliers arrive to eat up the past, scrubbing it clean.[27] This is good news for the game's servers (shards), which would be overwhelmed with data, remembering where to place every discarded item from every player within the world. Over time, I imagine giant middens appearing, a Fresh Kills of Feralas or a virtual landfill in the desert of Tanaris (recalling that of Alamogordo, New Mexico).

Games with inventory systems (typically MMOs, first-person shooters, and role-playing games) must find a way to deal with player trash and unclaimed loot left by slain enemies and NPCs. In an earlier Blizzard game, *Diablo* (and its sequels), trash would gradually disappear over time. Players could leave loot on the ground, travel elsewhere, and then return to find a diminished pile. Logging out of the game would completely wipe the slate clean. Early adventure games (including Atari's *Adventure*) would leave loot on the floors of dungeons for the duration of play, but closing the game and removing the cartridge made the entire world blink out of existence. In *Dragon Age: Inquisition,* inventory that players wish to discard (instead of selling, trading, or banking) must be actively destroyed. The trash never hits the ground.

A similar trash-disposal mechanic exists in the MMO *Elder Scrolls Online.* Prior to the game's release, I had hoped that player rubbish would appear (and remain) in-game, virtual litter dropped singly or placed in piles. I wanted to see where other players had been. Because players can craft items, I wanted to look for dropped pieces made by others (identified by the character's name), drawing conclusions as to how that item came to rest at a given spot. Better yet, I wanted to see how players took items from one region of the game and transported them to others, leaving a trail of foreign trash throughout greater Tamriel. Alas, it was not to be. The questions I was asking of these open worlds are no different than those asked by archaeologists when considering how objects came to be frozen in time, prior to discovery and future movement as they continue their life cycles.

In most inventory-games (games that allow players to carry a lot of things), artifacts (and trash are artifacts) have been pre-placed by the developers (or their coded algorithms) for observation and collection. There is much for the taking, and the gaming archaeologist can decide to interpret this rubbish from within the cultural context of the game's lore or observe the higher-order thinking of the developer who made decisions of what artifacts to place, and where. How do game developers consider trash or collectibles? How do players interact with these? And how do these things impact gameplay and advancement of various narratives? Again, the questions much be asked on the in-game and extra-game levels.

But what of games that do allow players to discard inventory and that do record their placement so that players can see their own rubbish (and that left by other players) days, weeks, or months after items have been dropped? In the case of *ARK: Survival Evolved,* player rubbish (by way of abandoned, player-created structures), began occupying valuable game real estate, with some players actually becoming virtual demolition experts, blowing up the abandoned squalor to make way for new construction (Heaven 2015).

Disposing of something is a form of abandonment. We leave things behind, be they humble food scraps or broken automobiles. When considering video games and especially virtual worlds, these can be abandoned, too. The majority of video games created were done so for an audience as a form of interactive entertainment. As with other forms of entertainment media, these can be enjoyed/used and then either sold, traded, discarded, or kept unused, hibernating on a shelf or in a box.

In open worlds, these vast spaces largely remain accessible to those with the software (and sometimes hardware) to access them, long past

the sell-by date when other players have found new worlds to occupy and explore. So what happens to these abandoned worlds still populated by never-aging NPCs who might wait years to assign quests that they used to assign thousands of times a day? The landscapes and structures remain unchanged. There is no visible decay, and no sign that any time at all has passed since the last time the world was entered like a cave of forgotten dreams. The notable thing about these abandoned spaces, just as we see in abandoned archaeological sites, is the lack of life in the form of people actively using the space. The kinetic energy is gone, as is the random element of play by the invisible operators of avatars.

Occasionally though, one finds signs of life in these ghost-worlds in the form of players or explorers, not unlike the perhaps apocryphal stories of finding a hermit in a cave who still thinks there's a war on, or to meeting a fellow adventurer visiting for curiosity, excitement, or both. One recent example includes the YouTuber vinesauce's 2016 delve into the 1995 MMO game, *Active Worlds.* In the abandoned game, vinesauce encountered "Hitomi Fujiko" whom he believed to be an NPC (Hernandez 2016). The dialogue, however, was real, and the explorer had discovered one of the last players alone in an abandoned game once inhabited by tens of thousands of avatars. Like most other video games set in virtual worlds, there is no decay, no environmental takeover, just a gradual absence of people until the server ultimately is brought offline. The players take their stories with them, and all that remains are the environments built as they were intended, ready to serve their narrative purpose, albeit for a new generation of archaeologists or tourists like those who visit Chernobyl or Pompeii.

Other In-Game Archaeologies

Any archaeologist will tell you that there is much more to archaeology than excavation. There are archaeological surveys, landscape archaeology, underwater archaeology, and space archaeology (to name a few), none of which require systematic digging while attempting to identify sites, answering questions about settlement and land use, and looking at material culture of things that are not landlocked, covered with overburden. Digging is one of the oldest manifestations of the discipline (later becoming systematic excavation), yielding itself easily to media tropes and popular perception, but archaeology goes beyond the spade and trowel.

Within a digital game, especially one set in a synthetic, open world, but also to some extent any game with a graphical, interactive interpre-

tation of built or natural environments—from side-scrolling jumpers to roguelike dungeon-crawlers, procedural or fixed in their creation and layout—one has the option to conduct several kinds of archaeologies at once, both while actively playing the game as well as observing the game mechanics one level up. The fact that many games allow for any and all of the above archaeological variants again points to the fact that video games are archaeological sites and can be studied as such without a single grenade lobbed to remove ten cubic meters of digital soil.

Conclusion

This chapter attempted to demonstrate that synthetic worlds are landscapes and sites that can be studied archaeologically with gently modified methods and tools. Millions of people spend much of their discretionary time and income on video games, inhabiting these digital built environments while actively adding to game-based culture. Larger MMOs contain in-game populations that rival those of large cities, featuring constant personal and commercial interactions between players and their environments. The fact that these engagements are invisible in the natural world does not negate their importance to the archaeology of the Anthropocene. The fact that they are "immaterial" or "incorporeal" produces challenges to the video game archaeologist on how to document these spaces and the material culture they contain, which is the focus of the next chapter.

Notes

1. There are several ways of thinking about what makes a site a site, and archaeological theory continues to evolve that definition. For the purposes of this book and the material culture of the modern world, I have chosen to follow LaMotta's definitions, which appear on pp. 62–92 in the 2012 edition of *Archaeological Theory Today*, 2nd ed., edited by Ian Hodder. This book, as well as Matthew Johnson's *Archaeological Theory: An Introduction*, 2nd ed., published in 2010, are excellent overviews of the history archaeological theory.
2. *National Geographic* on the Great Pacific Garbage Patch: http://nationalgeographic.org/encyclopedia/great-pacific-garbage-patch/ (retrieved December 11, 2016).
3. Ancient monuments and other buildings made use of *spolia,* taking stone from older buildings and incorporating them into new ones. For example, Rome's Arch of Constantine (CE 315) used reliefs from second-century buildings.

4. Andy Chalk, "Analyst says digital sales made up 92% of PC game market in 2013," *PC Gamer,* August 19, 2014, http://www.pcgamer.com/analyst-says-digital-sales-made-up-92-percent-of-pc-game-market-in-2013/ (retrieved December 13, 2016).
5. Visit the Antikythera Mechanism Research Project's homepage: http://www.antikythera-mechanism.gr/ (retrieved December 11, 2016).
6. See Ducheneaut et al. 2007 for a thorough breakdown of guilds in *World of Warcraft.*
7. Stu Eve finds this necessity to hold true especially for those archaeologists equipped with technology, using what he calls "embodied GIS." For an explanation on how technology merges with real-world exploration, see his 2012 article "Augmenting Phenomenology: Using Augmented Reality to Aid Archaeological Phenomenology in the Landscape." *Journal of Archaeological Method and Theory* 19(4): 582–600.
8. https://www.reddit.com/r/everquest/comments/3368fm/to_do_list_for_returning_player/ (retrieved September 17, 2017).
9. elysium-project.org (retrieved September 17, 2017).
10. The public-facing channel for the *No Man's Sky* Archaeological Survey is twitch.tv/nmsarchaeology.
11. https://www.polygon.com/2015/3/3/8140343/no-mans-sky-space-probes-gdc-quintillion-worlds (retrieved September 17, 2017).
12. For step-by-step instructions on how to create a GIS map from an image of a game map, see https://archaeogaming.com/2018/01/28/landscape-archaeology-of-rorikstead-and-environs-in-skyrim-vr/ (retrieved February 20, 2018).
13. Prof. Bill Caraher recently published a list of archaeological project/field manuals from a variety of sites and institutions: https://mediterraneanworld.wordpress.com/2017/04/25/a-survey-of-archaeological-excavation-manuals/.
14. http://www.coe.int/en/web/landscape (retrieved September 17, 2017).
15. See Andrew Reinhard (2018), "Adapting the Harris Matrix for Software Stratigraphy," *Advances in Archaeological Practice* 6(2): 157–172.
16. Other, earlier games (such as those in the *Ultima* series) had begun to look at ethics, player action, and their effects on in-game cultures where these actions had scripted consequences (King and Borland 2004: 78). Games such as *No Man's Sky* offered the chance of facing brand new cultures with unscripted interactions based on ethical choices by the player that had completely unknown consequences.
17. Thanks to L. Meghan Dennis for pointing this out to me.
18. See Professor Parcak's TED Talk on how she uses satellites to conduct archaeology from orbit: https://www.ted.com/talks/sarah_parcak_archeology_from_space (retrieved September 19, 2017).
19. See http://kotaku.com/no-mans-sky-players-who-colonized-a-galaxy-now-have-to-1798357453 (retrieved September 19, 2017).
20. For an explanation of the glitch's history and how to avoid it, see http://www.kotaku.co.uk/2015/11/27/how-to-avoid-rise-of-the-tomb-raiders-gamebreaking-bug (retrieved February 20, 2018).

21. For twenty-five classic examples of video game glitches, watch: http://www.smosh.com/smosh-pit/photos/hilarious-video-game-glitches (retrieved December 11, 2016).
22. A comprehensive resource for understanding landscape archaeology is Bruno David and Julian Thomas, eds., *Handbook of Landscape Archaeology* (London: Routledge, 2010).
23. *Video Whizball* has the first Easter egg in a published video game, which in this case was played on the Channel F system. This predates by nearly a year the Easter egg placed in *Adventure* (1980). The egg in *Video Whizball* displays the programmer's name "Reid-Selth." It was discovered in 2004 by Sean Riddle.
24. For a definition of "platform" in this context, see the journal *Platform Studies.*
25. A good introduction to the art of glitch is by Mallika Roy, "Glitch It Good: Understanding the Glitch Art Movement," *Periphery,* December 2014, http://www.theperipherymag.com/on-the-arts-glitch-it-good/ (retrieved on December 11, 2016).
26. See Alan F. Meades, *Understanding Counterplay in Video Games* (2015).
27. Stephen King, "The Langoliers," in *Four Past Midnight* (New York: Viking, 1990).

Further Reading

Bradley, R. 2015. "Repeating the Unrepeatable Experiment." In *Material Evidence: Learning from Archaeological Practice,* edited by R. Chapman and A. Wylie, 23–41. New York: Routledge.

Castronova, E., et al. 2009. "Synthetic Worlds as Experimental Instruments." In *The Video Game Theory Reader 2,* edited by B. Perron and M. J. P. Wolf, 273–95. New York: Routledge.

David, B., and J. Thomas, eds. 2010. *Handbook of Landscape Archaeology.* New York: Routledge.

Fernández-Vara, C., et al. 2009. "Between Theory and Practice: The GAMBIT Experience." In *The Video Game Theory Reader 2,* edited by B. Perron and M. J. P. Wolf, 253–72. New York: Routledge.

Ingold, T. 1993. "The Temporality of the Landscape." *World Archaeology* 25(2): 152–74.

Nardi, B. A. 2010. *My Life as a Night Elf Priest: An Anthropological Account of* World of Warcraft. University of Michigan Press.

Rathje, W. and C. Murphy. 2003. *Rubbish! The Archaeology of Garbage.* Tucson: University of Arizona Press.

Schut, K. 2018. "*No Man's Sky.*" In *The Routledge Companion to Imaginary Worlds,* edited by M. J. P. Wolf, 425–32. New York: Routledge.