Computing Legacies

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Introduction

"The digital heritage," UNESCO points out, "embraces cultural, educational, scientific and administrative resources."[1] As simple as it may seem, such a statement has programmatic implications, and the aim of this book is to unfold a series of them. The following chapters discuss cultural, educational, scientific, and administrative cases where our computing legacies revolve around techniques of simulation. Cultural organizations (libraries, museums, archives, universities) play important roles in preserving not just knowledge but access to it, understanding of it, and context for it. The UNESCO charter on digital heritage emphasizes access but also warns about privacy, calls for a balance between the rights of creators and the interests of the public, outlines measures guarding against loss, and foregrounds continuity in digital heritage. These values are hardly controversial, though they may prove incompatible in practice.[2] Trying to respond to that broad scope, this take on digital heritage therefore sets out to look at how simulation plays a pivotal role in computer museums, university administration, computer music, and online games. Music has been radically transformed by computing, in ways that go to the core of what we think music is and does. Computing has fostered a wide range of play that in turn raises questions that challenge our notions of playing games. Museums of computing already grapple with wicked problems before one considers computer-mediated communication as part of their brief; as UNESCO warns, "the instability of the Internet is an additional risk for knowledge."[3] Higher education has embraced digital culture in unforeseen ways, not just for the delivery of courses or online collaboration but also in its administrative structures. In scenarios like these, digital culture hinges on the use of simulation as a cultural technique.

Stewardship is not the only angle here, yet in engaging notions of digital heritage, it is worth noting that our institutions of cultural memory have been severely disrupted, undermining the abilities of libraries, archives, museums, and universities to parse, collect, and interpret said heritage. One factor is the severe defunding of institutions of cultural memory in the twentieth and twenty-first centuries; another is the apparent ease of copying and duplication in digital domains, creating the illusion both of a cornucopia of new information and of redundant storage, when in fact a lot of important information falls through the proverbial cracks.[4] And digital heritage is not just whatever concerns science and technology museums, nor is it what the cloud may store (until the cloud fails).[5] As institutions of cultural memory struggle with the rapidly disappearing recent past, historiographical methods (or media archaeology as one alternative) appear to be in competition with classificatory methods from library science, and those in turn seem to compete (for resources as well as for attention) with the quantitative methods of data science and the social sciences. But the focus here will not be what to do about tweets, blog posts, or SMS messages, nor the metadata and advertising databases that encompass location and social graphs in various networks.[6] The story here is not simply the history of computing, either; in turn, the history of computing is neither the history of devices nor the history of human–computer interaction, nor the history of computer science. Instead, in considering the institutions of continuity invoked by UNESCO, I take as pivotal in digital heritage the notion of simulation, and not as metaphor but as decisive practice.

A media history of simulation promises to excavate three salient aspects: it profiles simulation as cultural technique, tracing hypothetical literacy from ancient thought experiments to computing. It discusses simulation as a theory of the digital media age—gaming and virtual worlds help debunk common sense realism as anti-speculative. And it interrogates simulation as cultural critique, despite totalizations suggesting that we already live in a simulation. The chapters of this book illustrate a cultural condition in which simulation is conceptualized not just as a particular object or technology, but as a cultural technique—a set of practices by which modeling, emulation, and serious play are constitutive in how we comprehend and relate to our mediated situation. The question of our digital heritage foregrounds the role that simulations play in the preservation of cultural memory. In this pursuit, the emphasis is less on viewpoints, histories, and perspectives

of underrepresented individuals or groups than on the way digital culture is presented and preserved, whereby our recent past itself is all too often underrepresented and misconstrued. My research design here, in other words, is not a descriptive or sociological one, but instead excavates conceptual conditions of possibility of digital culture, large parts of which are in peril of elision due to the vicissitudes of our presentist era. This is not a study of subcultural formations that purport to develop alternatives to our major institutions of cultural memory, nor is it an engagement with demographic niches or academic microclimates; the point is that the mainstreaming of digital computing, networks, and increasingly large-scale simulations raises the stakes for everyone. Rather than draw on the conventions of cultural studies, this study is influenced by a conceptual approach that in anglophone media studies is labeled "German Media Theory," despite the fact that its adherents are often neither German nor focused on theoretical discourse alone. I also rely on Bowker and Star, who exhorted researchers to reconsider the development and deployment of standards and archives as "active creators of categories as well as simulators of existing categories" that deserve attention as "spaces that are otherwise lost forever."[7] The history of simulation is interdisciplinary, drawing on informatics, the history of science, and media archaeology; in this constellation, I put an emphasis on intellectual diversity instead of a predetermined sociocultural critique.

After this introduction establishes some of the contextual signposts that situate the overall project in its interdisciplinary constellation, I will discuss what it means to consider simulation a cultural technique. As chapter 1 establishes the conceptual claims of this framework, it also reflects on the quintessentially historical role emulation plays in digital culture. The next chapter extends that approach in turning to how museums of computing grapple with the challenges of presenting and preserving the hardware and software of computing. Rather than compare the varied practices of archives, libraries, and other collections devoted to digital culture, here the focus will be on museums, because it is worth noting just when and how they devote themselves to the history of computing, including the revolutionary changes wrought by networking. Emulating the look and feel of legacy devices is also the topic of the third chapter, which discusses the sounds of retro-computing. Here we see that simulating history raises thorny questions about how to faithfully represent the past while keeping it accessible. The fourth chapter turns to the dimensions opened up by

networked interactions, particularly in online gaming. The ways in which massively multiplayer games illustrate simulation as a cultural technique range from their use in communication and training, in testing the epistemic status of models, or in simulating (counterfactual or faithful) historical events. Finally, the fifth chapter turns to the use of simulation in serious games by discussing a piece of interactive software that sought to model the administrative processes of higher education. Let me unpack by way of an introduction a little more of what each chapter sets out to do; a conclusion will then seek to pull it all together again.

It is an axiom of computing that a universal Turing machine ought to be able to run any program for any other computer that is likewise a universal Turing machine; in other words, computers can impersonate each other.[8] This idea not only lays certain theoretical foundations for computing, it also holds a promise for digital heritage, as new machines can emulate older ones. Thus, simulation has important implications for archives, museums, and the preservation of digital culture. This raises interesting issues in computer history. For example, John Walker, perhaps best remembered for his contributions to AutoDesk, created an online museum to celebrate Charles Babbage's Analytical Engine.[9] In addition to documentation, his site offers a Java emulator of Babbage's blueprints, and Walker placed a sufficient premium on the emulation's authenticity that he felt the need to compose a lengthy essay on his approach. This may strike some as odd, since in fact Babbage's Analytical Engine was never in fact built, so even the most detailed and painstaking emulator could not be authentic in a historical sense. Nonetheless, Walker's point that "in order to be useful an emulator must be authentic—it must faithfully replicate the behavior of the machine it is emulating" stands.[10] The chapter on simulation as a cultural technique analyzes in detail the motivations behind such efforts, and the museum chapter will follow suit in discussing whether the fulsome promises of simulation for musealizing preservation can in fact be fulfilled.

In simulation, we see a compound legacy of cybernetics and scenario planning as inherited by digital media from midcentury control systems research, integrating operations research, game theory, and techniques modeling feedback in complex systems. As Turkle pointed out in 2009, "Twenty years ago, designers and scientists talked about simulations as though they faced a choice about using them. These days there is no pretense of choice."[11] What held for the study of science and technology then

has only become more urgent for a rapidly expanding range of disciplines. Simulations revolutionized the sciences in nearly every possible field of study; but when scholars in media history look at simulation, they need not consider it the exclusive domain of natural and technical sciences. A profile of simulation as a cultural technique can explore controversial claims made on behalf of simulations and investigate to what extent virtual worlds and serious games may corroborate them. As the conclusion will spell out in more detail, each chapter of this project elucidates an inflection point where quantitative data become qualitative evaluations: modeling epidemics for scientific study or for entertainment, the way museums try to cope with technical aspects of our computing heritage, data mining and espionage in virtual worlds, the pivotal but constrained role for digital culture of simulating sounds (where numerical calculations turn into music), and serious gamification in higher education.

"Simulations have a particularly epistemic quality, they bring a very particular knowledge into the world."[12] This is what discussing simulation as a cultural technique seeks to elucidate. Cultivation used to invoke a relation between nature and technology that would characterize cultural techniques as mere agricultural melioration; but while this older sense of the phrase has not fully disappeared, in recent decades it was joined by a conceptual dimension that foregrounds how activities like speaking, writing, reading, imaging, and calculating are distinct from hunting, gathering, cooking, or building shelter.[13] The distinguishing aspect is an epistemic dimension—these are techniques that do symbolic work. Moreover, we acquire such techniques independently of the goals we pursue with their help, and they both need and generate media. Thus the history of cultural techniques is dependent on media as their conditions of possibility, but by the same token media are manifestations of cultural techniques. In short, "cultural techniques are practices committed to the framing of cultures and collectives and conveyed by means of the media and educational institutes."[14] We shape our tools, and thereafter they shape us.

The growing reach of simulation as a cultural technique necessitates that we "examine how electronic media is changing the ways the concept of the museum 'object' is understood both by curators and visitors."[15] This implies investigating how museum curators and historians engage with simulation techniques in museum spaces to explore not only our recollection of past computing but also what might have been if certain aspects of the history

of networked computing had developed differently. A 2014 *Museums in the Digital Age* report states that the latest in museum trends includes "content diversification, immersive experiences, and sustainable and open spaces."[16] This implies online interactions as an extension of museum presence. To that end, the museum chapter surveys different approaches to internet history, from archival forms to exploring the tense relationship between testimonials and grand historical narratives in the unraveling of the past development of networked computing. Attempts to tell the story of computing as culminating in the net we now use contrast sharply with various prior efforts to assemble computer networks as nonlinear, noncentralized means of producing nodes and hyperlinking.[17] Recent attempts to musealize the history of computing take off at a particular historical moment when the long-term ambitions for the potential of networked computation as a universalized knowledge system become increasingly overwhelmed by the commercial logic of contemporary privatized platform models. The insight that the musealization of computing took hold in the 1990s and is still accelerating is not merely subjective, but can be quantified in the number of computer museums and in the growing attendance at computing exhibits. Schools and universities are fostering that trend, as museums partner with them in didactic and pedagogical initiatives, "keeping the museum's philosophy up to date."[18] Museums are among the oldest cultural institutions, so one may be tempted to see growth as an indicator of increased prosperity accelerating an old trend. In that case, our orientation toward the past would be nothing new, and we are simply able to indulge in it more now.[19] But this is clearly an insufficient description; we can recognize in the current view of past computing a measure of the speed and force of the current rate of change in computing.

Objects from the history of computing become worthy of museum exhibits when the original phase of their nonimitative constitution is complete; if museums did not display something that is especially worthy of protection, conservation, research, communication, and enjoyment, then there would be no need for museums. This, however, means that even the most famous objects the public worships in various muses' temples are increasingly replaced by replicas to protect their irreplaceable originals; nowhere is this more evident than in museums of computing that increasingly display emulated software or hardware replicas. Mumford even complained that "the museum in America led inevitably to the baser sort of

reproduction."[20] Museums of computing save remnants of computer culture from destructive processes, but in so doing computer museums are in fact funded and motivated by that very same destructive process. The changed presence of the past is complementary to the rate of change in the presence of the future. Not even the most prosaic calculating device is exempt from aestheticization, as long as there are not too many of its kind extant. Even the most avid collector cannot stay up to date unless they start their own museum to permanentize and institutionalize the act of acquiring and conserving, researching, and communication of the digital heritage; to stop acquisition confronts one with the historicization of one's own selective activity, decreasing the probability that the collection would still be recognized in the future for its lasting value. This historicization of computing is owed to the temporal structures of the digital industries; their evolutionary processes eliminate from current use anything that is incompatible with the latest paradigms, and after a suitable moment of oblivion such relics then return as collectibles. Their special cultural function is not only a compensatory historicist interest but incorporated into didactic narratives that likewise continue to morph and update.

A notable exception to this tendency is retro-computing, which pushes beyond software emulation and hardware simulation and keeps old computing actively usable, albeit for unexpected ends. One of the most striking examples of this kind of saving digital detritus from historical obsolescence is the remarkable career in electronic music of 8-bit and other retro chiptunes. At first glance, using early digital devices for music-making seems rather odd, but it does have a significant tradition. Beyond illustrating a technique that allows one to interpret procedures of one form of communication, namely music, in terms of another type of formal structure, namely programming, computing promised twentieth-century composers an even more important objective: "the development of compositional procedures which yield musical structures that specifically exploit the logic of digital computer processes."[21] This means not only using computing to impact musical elements like pitch, timbre, rhythm, the application of rules for tonal distribution and harmonic routines, melodic conventions, contrary motion, and so on, but also a generalized model for music-making that has roots in statistical analysis of style. Notably, early experiments would involve subjective tests (asking qualified musicians about stylistic integrity, structural cohesiveness, and general musical interest of computer music

results) but also analytical tests in which the computer is asked to regard its own music as a sample and compute its probabilities.[22] While this remained an austerely academic exercise for a while, eventually it spilled over into entertainment. Chiptunes are now encountered in a range of popular genres, and for a while passed for a creative avant-garde cross-fertilizing numerous new music styles—ironically, since they were technically a kind of rear guard.

Every new technology of repetition seems to accelerate forgetting, and by the same token aids memory—and it also shows that new media generate not just hype, but also nostalgia. One example of the ubiquitous streams of audiovisual media sensurrounds is 8-bit music, the sound of retro-gaming. The role of music in games is a reliable indicator not only of technical and design progress but of aesthetic dimensions that are too often neglected in game studies. Feedback is clearly at work in how simulations reboot, respawn, and replay the sound of digital culture, as inversions and perversions of the media dialectics of attention and distraction. Such simulated sounds signify nostalgic returns to something that never was: they reflect a desire for access to hardware and software, for the right to repair and modify—in short, it is a manifestation of playful exploration. And audio, while usually relegated (both in terms of technical and financial resources expended, and in terms of what is typically front of mind for the gamer) to secondary importance, is crucial for a believable spatial and immersive simulation, so when it comes to the fore, this also inverts assumptions about simulation.

Contrary to the dubious consolations of simple time lines, culture is recursive and self-reflexive, and while there certainly are quantitative and qualitative changes over time, they do not unfold in teleological progression. Academics know this, and yet we risk predictions; even as techniques of simulation are increasingly what we rely on to offer extrapolations, scholarship in my field of digital culture has a rather mixed track record. In 2004, just as I started teaching regular courses in game studies, James Newman could still assert (in a text titled "Future Gaming: Online, Mobile, Retro") that "virtual reality and online gaming are, perhaps, the most obvious examples of false starts resulting from consumer resistance." By now, we realize that neither the online model nor the mobile model were false starts, and VR currently enjoys yet another hype cycle. Newman correctly predicted that "one possible videogame future is decidedly backward-looking"—namely

the growing attraction of retro-gaming.[23] Cultural memory can keep current (or back) any purportedly obsolete, dated, or aging aspect, and it routinely does. Computing's pasts can reboot, respawn, and replay in various ways: we witness the reentry of what progress supposedly excludes, inversions and perversions of the media dialectics of attention and distraction, even nostalgic returns to what never was (like FakeBit), the uncanny return of the repressed, and the unexpected revival of cybernetics in serious simulations.

Instead of parsing the phrase *cultural technique* in terms of a purported tension between culture and technology, between the hard and the soft sciences, a realm of future-oriented sciences of exploration and a realm of past-oriented disciplines of interpretation, the core claim in using the phrase *cultural technique* is that such divisions are misleading. Digitization "gutted the carefully cultivated distinction among media as well as cultural, technical, and life sciences."[24] Studying cultural techniques sidesteps mutual rearguard actions in the academic trench skirmishes of the culture wars, opening up to a research design that enables a rigorously historical and conceptual account of the epistemic power of images and of programmatic inscription (beyond binaries of orality and literacy) to fully account for production, storage, and transmission of rich data. This still leaves uninterrogated a suspicion that simulation is essentially technical—yet in a fundamental sense, simulation is limited neither to the computer age nor to cybernetic concepts; indeed, as a cultural technique it has ancient roots. Furthermore, simulation also functions as a critique of the real world.[25] Turkle, for instance, suggested we take the cultural pervasiveness of simulation as a challenge to develop a new social criticism: "This new criticism would discriminate among simulations. It would take as its goal the development of simulations that help their users understand and challenge their model's built-in assumptions."[26] Thus, later chapters here will to turn to controversial claims made on behalf of simulations, and investigate to what extent virtual worlds and serious games can test, corroborate, or falsify them.[27] Critical thinking means asking questions that explore assumptions—and simulations rely on making exactly that pivotal step very explicit. In the end, simulations would be incomprehensible if they were just restricted to symbols or numbers—so they are still about storytelling, which is, of course, the humanities' domain. The humanities bring not just storytelling expertise to this, but interpretive competence.

When cybernetics called for a "discipline of simulation" in the late 1950s and early 1960s, at first it meant the implementation of models by dint of electromechanical analog computing. Simulations applied computing and cybernetic theory, for example, to understanding homeostatic physiological functions at the Dynamic Simulation Laboratory run by Rockland State Hospital in the 1950s, and social scientists used role-play simulations to model international conflict resolution.[28] But scholars soon foresaw that once digital computing became fast enough to support more complex operations, it would furnish "simulation for vividness" in models that would strike observers as more clear and convincing, "simulation for deduction and exploration" that would make questions tractable or help explore them in new dimensions, and by the same token also provide for "simulation as archive," whereby models store the collected knowledge of an entire discipline. This central assemblage of a growing number of interdisciplinary contacts would all support a model that "would then itself be both archive and computer."[29] Today we consider cybernetics a historical topic, but the idea that computing ought to function as archiving is consequential for the history of technology. Indeed, companies like PIQL currently promise that they will store "immutably" first instructions to build a computer to read the archive, then the OS, then the software, until finally "you can replay the past."[30] A playful use of computing is often simply brushed aside in the history of technology and the history of media as mere gaming. Indeed, computer games struggled to gain academic acceptance and sustained attention; but while not every simulation is a game, arguably every computer game relies on modes of simulation. Many serious simulations, both analog and digital, aim directly at interactive use that is ludic and exploratory. Two chapters here address such situations, one in a detailed analysis of the higher education simulator *Virtual U*, the other asking how espionage and counterintelligence in massively multiplayer online games challenges notions of play in particular, and of collaborative computing online in general.

The use of virtual worlds and games for simulating history affords more or less accurate scenarios or help reenact historical events with their most relevant cultural dynamics.[31] Already in the eighteenth and nineteenth centuries, educators and strategists took tabletop and floor games seriously as heuristic and training tools, and painstaking battle reenactment, considering dimension and scale, agents and scenarios in great detail, operated

between analysis and synthesis, abstraction and illustration, speculative experimentation and strategic historical veracity.[32] These and more recent "serious games" are simulations that allow us to test the epistemic status of models and the pragmatic quality of their material, while affording the scaling of projection and reduction or of the spatiotemporal representation of artifacts and processes. The limits of such modeling—of abstraction, reduction, formalization—foreground that these are not just models of or for something, but structures that have their own self-referentiality, which is to say mediality. Similarly, when cybernetic models exhibit their own dynamic instead of erasing their constitutive contribution to knowledge production, they resist becoming imperceptible or anesthetic, and appear as media. This has become especially notable in computer-mediated communications.

Obviously, a lot more military war gaming takes place than ever appears in print, but even in the realm of public policy the robust tradition of scenario planning and simulation has not always yielded very detailed academic literature. Espionage and counterintelligence activities have been radically transformed by networked computing and compartmentalized SIGINT focus areas in acoustic, electronic, and other signals intelligence. These technologies of surveillance do not so much capture events as they occur but rather divert the flow of information obtained by various highly specialized means of interception through computational arrays of storage, filtering, and selection that only prepare the ground for future recall and interpretation. Smart noise techniques may mask the transmission of sensitive messages by simulating their garbled appearance elsewhere; deception jamming broadcasts false and misleading information that simulates real data. As Dourish notes, "where once nuclear and military strategists might have worried over a missile gap, they might now look at the list of the world's most powerful supercomputers and worry instead about a simulation gap."[33] It is therefore particularly interesting to see what happens when more than one intelligence agency gets deeply involved in espionage and counterintelligence inside the virtual worlds of massively multiplayer online games. The specter of systematic multinational surveillance in massively multiplayer online games forces us to contemplate how "the discrimination between play and non-play, like the discrimination between fantasy and non-fantasy, is certainly a function of secondary process."[34]

Bateson demonstrated how this leads into paradoxical metacommunication, eroding misplaced faith in the magic circle:

> By placing into question the validity of a clear line of demarcation between game and non-game, we open up the analysis of game involvement beyond the formal parameters of the game. . . . By leaving behind an either/or perspective and focusing on the specificities of the individual engagement, we open up our inquiry to a richer understanding of the feedback loop between player and game that is not normatively pre-determined by simplistic binaries.[35]

In considering the vast electronic monitoring capacities of the modern state security apparatus and the information-generating capacities of colleges and universities, digital heritage is concerned not only with the difference that computing made and makes, but with computer-mediated communication. Collated by the Internet Engineering Taskforce, the Requests for Comments (RFCs) are organized working notes that, since 1969, document the development of the internet (as initiated by Steve Crocker, and later shepherded by Jon Postel for twenty-eight years). RFC1958 reflects: "A good analogy for the development of the internet is that of constantly renewing the individual streets and buildings of a city, rather than razing the city and rebuilding it."[36] Like the mythic argonauts' boat, the internet is constantly being rebuilt. Interestingly, the RFCs also offer a sprinkling of what passes for humor among engineers. Observing that "historically clients and servers strived to maintain the privacy of their keys," although "the secrecy of their private keys cannot always be maintained," RFC7169 (from April 1, 2014) by Sean Turner proposes a certificate extension for use in certain PKIX (X.509 Public Key) Certificates, namely the "No Secrecy Afforded" extension, or NSA for short. This RFC explains that in certain circumstances, "a client or a server might feel that they will be compelled in the future to share their keys," thus compelling them to give up on forward secrecy; in other cases the certificate can be used "to indicate that their keys have in fact been shared with a third party."[37] In a sly dig at Boolean algebra, the RFC goes on to suggest that "TRUE indicates that the key has been shared with a third party, and making the extension FALSE indicates that the key may have also been shared with a third party but the signer does not want to overtly indicate that the key has been shared"—and so it is clear that the extension in fact states that keys are not secure either way. As Wendy Chun wondered, given that the internet is one of the most compromised and compromising forms of communication, why has it been bought and sold

as empowering and freeing—as a personalized medium? More recently she revisited the issue, admonishing that "to address the pressing issues posed by the many networks around us, we need to focus on modes and modalities of publicity, instead of simply and constantly defending a privacy based on outdated notions of domesticity."[38] Indeed, privacy remains an urgent discussion for media studies.

Inversely, a humorous RFC by Steve Crocker (RFC1776 from April 1, 1995) sets out to poke fun at the media theory of Marshall McLuhan in proposing that "The Address Is the Message" and suggesting that "it's not what you know but who you know, the IPng focused on choosing an addressing scheme that makes it possible to talk to everyone while dispensing with the irrelevant overhead of actually having to say anything." However, while Crocker jokes that security experts may hail this as a major breakthrough since it would render moot any questions of confidentiality and integrity, he correctly, if perhaps inadvertently, predicted that intelligence and law enforcement agencies would forget about key escrow and instead focus on metadata. Indeed, in 2014, former CIA and NSA director Michael Hayden said, "we kill people based on metadata."[39] A push beyond advertising has led to rampant exploitation of personally identifying information online, including but not limited to locations, IP addresses, and phone numbers as well as contacts. This directly impacts not only the availability and profitability of games, but also just as clearly impacts game quality.[40] The trade-offs in aiming for scale, for a new mass market, are that these models are increasingly optimizing not for extended play hours or maximum entertainment value (as the marketing for console games positioned its blockbuster titles in direct competition with cinema and television), but for secondary consumption, be it in ancillary in-game trade or in bundling and selling gamers' time (and information) to advertisers. If surveillance capitalism now drives much of the internet, this has consequences for our academic frame of reference for digital culture.

Game studies has yet to come to terms with the confessional moment of Snowden's autobiography: "It was the NES—the janky but genius 8-bit Nintendo Entertainment System—that was my real education."[41] A few reviews pointed out that "Snowden's new book *Permanent Record* is the autobiography of a gamer."[42] But is digital espionage still the great game? Once the national security data-mining dragnet reached the playing fields of elves and trolls, how does that influence the design, publication, play,

and critical reception of games? In turn, the rise of online gaming has not only changed the way we think about role-playing, but also transformed the strategy genre; networked computing also spawned virtual worlds that are not strictly speaking games but venues for congregating, exploring, communicating, and commerce. While systematic exploration and exploitation of virtual worlds by intelligence and security branches of various governments has received some journalistic coverage, the salient issues of secrecy and surveillance in virtual worlds are rarely being addressed in academia. A lesson from the history of computers is that the freedom of players to do what they want, when they want at the interface is paid for by deprivation of freedom on the back end of the system.[43] Given the necessity of real-time interaction between humans and computers, the gamer is a figure "in the loop" whose time-critical behavior must be integrated into the micro-temporal structure of the system, discretized into tiny time segments. By the same token, games also monitor players by checking whether they conform with the interface and observe the rules of the game. Massively multiplayer online role-playing games (MMORPGs) make this infrastructural dynamic explicitly thematic and therefore might help unfold such analysis. In the paranoid exploitation of networks via data mining and surveillance capitalism (dominant organizational forms for networked communication in general), we can see how this disrupts the so-called magic circle of MMORPGs. Jameson already warned about the "representational shorthand for grasping a network of power and control even more difficult for our minds and imaginations to grasp: the whole new decentered global network," but now, as Zuboff warns, "unimpeded accumulation of power effectively hijacks the division of learning in society, instituting the dynamics of inclusion and exclusion upon which surveillance revenues depend."[44] Here the form of attention is the roving paranoid surveillance focusing on metadata, hoovering up the social graph so agencies can know who connects when to whom. Finally, the simulation of administrative control by computing relies on basic cybernetic principles for its organizational shape, thus the form of attention is a recursive automation in subroutines that put the player in the loop only for certain pivotal decisions—here the attentive spotlight is on certain decisive moments that have consequences for the interaction of complex systems, black-boxing many other factors that play a crucial part.[45] In this shape, serious games seek to emulate the otherwise unmanageable interplay of data sources they model.

And this brings me to the chapter dissecting the simulation of university administration. In an era that once again touts distance education, continuous education, and flexible employment as solutions to certain social and economic problems of our time, it is hardly surprising when, among the simulation games on offer, we also encounter a serious game that sets out to construe a comprehensive simulation of higher education. So when administrators and think tanks converged on the idea of a higher-education-administration game in the late 1990s, the result was indeed telling. The chapter on the Windows title *Virtual U* analyzes the college simulator from a number of vantage points, not least from the perspective of faculty members at the largest public research university in the world, at a time when it had to undergo massive changes after the 2008 financial crisis. As I end by discussing the simulation of higher education, we are reminded that the alma mater was never supposed to be a foundry, mint, or treadmill.[46] In *Virtual U*, three trends converge: management games increasingly in use in education, training simulations developed for enterprises (from nuclear plants to military tactics), and commercial interactive entertainment software of the type that includes successful titles like *SimEarth*, *SimHealth*, and *SimCity*. To discuss *Virtual U* means engaging the "serious games" concept as well as touching on the controversies around what has come to be called gamification.[47]

Notes

Introduction

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82. The 76-bit, 29-bit, and 47-bit estimates are actually rounded down; 100,000 operators working for twice the age of the universe (13.8 billion years) can check $.87 \times 10^{23}$ settings, which is more than 76 bits. The actual number to be checked is greater than 76 bits and less than 77 bits: 1.07×10^{23} settings means 2×17 billion years. The rotor settings are also rounded down to 29 bits: 712,882,560. Divide this by $100{,}000 \times 60$ settings/sec. $\times 60$ minutes/hour = 1.98 hours. Ray Miller, *The Cryptographic Mathematics of Enigma* (Fort Meade, MD: Center for Cryptologic History, 2019), https://www.nsa.gov/portals/75/documents/about/cryptologic-heritage/historical-figures-publications/publications/wwii/CryptoMathEnigma_Miller.pdf.

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Chapter 5

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Conclusion

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