1 SAMPLES OF THE WORLD *OUT THERE*: THE SURROGATE LOGIC OF PROXIES

What, then, is contained in the *as if*?

—HANS VAIHINGER[1]

YODAVILLE

There is a small town in the desert of Arizona's southwestern edge, thirty-five miles southeast of Yuma and fewer than six miles from the US-Mexico border. The buildings in the town, mostly one story, are distributed throughout small neighborhoods and laid out across eight axes. There is one road in and out of town. The town's official name is Urban Target Complex (R-2301-West), but everyone knows the place by its nickname, "Yodaville," a name given to honor Floyd "Yoda" Usry, a now-retired colonel from the US Marine Corps. No one lives in Yodaville because Yodaville was never meant to be lived in. Instead, it is a fabricated test city, a bombing range constructed in the late 1990s to train Marine Corps pilots in attacking cities and supporting ground troops at war in urban settings. The houses and buildings of this test city are made of shipping containers and empty bomb canisters. The inhabitants are stick figures made of metal.[2]

In the early 1990s, during the intervention of the United Nations (UN) in the Somali Civil War, the US military undertook an operation in the capital city of Mogadishu. The operation ended with hundreds of Somali casualties and nineteen deaths among American special forces. Memorialized in 1999 by journalist Mark Bowden's *Black Hawk Down: A*

Story of Modern War and a 2001 Hollywood film based on that book, the battle of Mogadishu is widely regarded as a failure of the US military to prepare for a new kind of urban warfare.[3] Yodaville was built by the military to respond to the failures of Mogadishu.

In a RAND report on urban warfare from 2006, the authors begin with the American deaths in Mogadishu.[4] They draw a direct connection between the battle and the construction of Yodaville:

> The desperate October 1993 fighting on the streets of Mogadishu triggered U.S. Army development of a new type of urban training facility, *one designed to be less like the pristine villages of northwest Europe and more akin to the chaotic environments found in densely populated areas of the developing world.* The Marine Corps built "Yodaville," an innovative training site in Arizona that vividly replicates the difficulties of engaging urban targets from aircraft.[5]

The American deaths in Mogadishu (the Somali deaths go unmentioned) were partly attributable to their military training, and as the RAND report argues, this was a symptom of institutional failures of imagination in the design of training simulations. The implication is that these were not poor fighters; instead, they were people trained on untimely representations of faraway threats designed for a bygone era. The soldiers could not picture their new battleground because their references were askew. Having based their simulated fighting on the "pristine" architecture of northwest Europe, the US military was unprepared for the landscapes (to use RAND's terminology) of a "chaotic" and developing world. The remedy came in the form of a new training site that was meant to be more akin to the sites of conflict in the changing landscape of the American empire.[6]

By adjusting the environment of their training site to a not-yet-named-but-immanently-chaotic elsewhere, the military hoped that their new simulations would be commensurate with the likely arenas of future conflict and the embodied experience of targeting, attacking, and escaping those places. The look, shape, and feel of European villages were inscribed in the institutional memory of the military's training protocols, so a disaster like the battle of Mogadishu forced a rupture with the past; what followed was a new set of inscriptions.[7] The battle of Mogadishu left traces that were

archived in the building of Yodaville (figure 1.1), which acts as both a memorial to past failures and a fortification against future ones.

In the attempt to recalibrate US imperialism after a moment of breakdown, the US Marine Corps built a fake town to replicate the imagined shape, texture, and feel of an emergent enemy territory. Once built, Yodaville quickly became a *proxy* city for simulating a new kind of warfare. It was a territory for practicing the enforcement of an empire and the changing character of that empire's boundaries. As a proxy, Yodaville could represent and materialize this new enemy territory through a basic logic: by approximating emergent combat zones, the armed forces could act as if they were in combat. Soldiers could be trained and tested on surrogate targets that reflected their eventual ones, and a new standard of combat could be established, learned, and embodied.

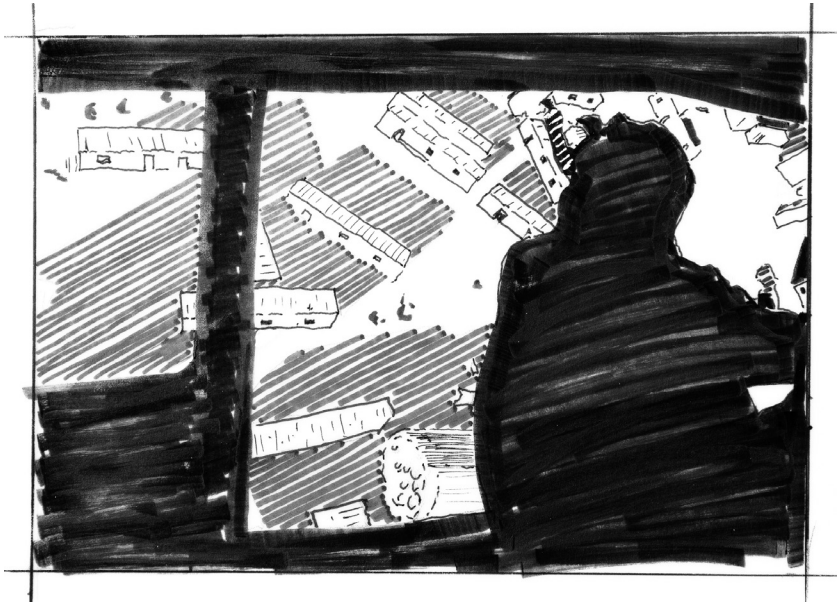

Figure 1.1

An artist's rendering of a frame from the video *Marines Fire on Yodaville* (2015), viewed on Military.com. Yodaville is seen here from behind the shoulder of a gunner aboard a US Marine Corps UH-1Y Venom gunship. The buildings (shipping containers) radiate out from the center of Yodaville. Image: R. R. Mulvin.

PROXIES

Yodaville is a proxy for any number of places in the world. This simulated town was constructed to be a flexible stand-in for many potential places (emergent battlegrounds) while still being coherently a single place (Yodaville) so that it could be used as a shared testing site for training and evaluation. Placed pointedly on the border of the continental United States, Yodaville is the materialized stand-in for a limited and controllable enemy territory. It is part of a chain of US military encampments along the US-Mexico border, it is situated within the occupied traditional territories of the Quechan and Cocopah, and it adjoins the Fort Yuma Indian Reservation.[8] As such, Yodaville is used as a stand-in while simultaneously serving as an instrument for sustained foreign and domestic occupation. By serving this double function, it embodies a very specific fantasy: "to become without becoming,"[9] meaning it can, momentarily, become a foreign war zone without risking any of its actual territorial occupations. This is the promise of proxies and the promise of creating controllable renditions of an unpredictable and unknowable world.

Proxies function as the necessary forms of make-believe and surrogacy that enable the production of knowledge. Such knowledge production relies on accessible representations of the world, and proxies are the people, artifacts, places, and moments invested with the authority to represent the world. To interrogate the use of proxies is to ask: *to whom or to what do we delegate the power to represent the world?* To answer that question, I trace the lives of long-lasting, entrenched, and thoroughly standardized delegates—proxies—and the cultural work that people undertake to act as stand-ins and keep these stand-ins viable. This includes the moments of genesis, when communities of practitioners ask themselves what they would use as a delegate for the world, and the moments, later in the lives of these proxies, when the use of alternative delegates seems unimaginable. This is the pathway by which a proxy becomes common sense. People work with proxies to produce knowledge, maintain measurement systems, evaluate performance, and engage in a series of practices that are made possible only by investing certain materials with the power to represent an unpredictable world.[10]

As a component of the internetwork of knowledge infrastructures, *proxification* is a culturally conditioned practice of consistently using some things to stand in for the world.[11] Proxies are intermediaries—they mediate between the practicality of getting work done and the collective, aesthetic, and political work of capturing the world in an instant. As Yodaville attests, the choice and development of a proxy for the world often constitute an attempt to wrangle and control the unpredictable. Every proxy comes to exist in singular ways and represents one method that experts have used to evoke a world and, by evoking a world, bring it to be. But even where proxies have idiosyncratic origins, they share in their reliance on the cultural work of standing in. Culture consists, following Marilyn Strathern, of the ways that people draw analogies between things, "in the way certain thoughts are used to think others."[12] This definition ought to orient us toward proxies as analogies, as the material for making connections (as the stuff for thinking), and the ways in which such materials both animate communities and reveal their exclusions. The cultural work of standing in, then, is the work of both analogizing and maintaining the relationship between that which *is* and that which works *as if*.

Almost like religious relics, proxies are saturated in meaning—and their further use only reinvigorates the idea that these things, these people, and these places are special: they are imbued with the power to stand in. Through the stories of three proxies that have historically evoked this enchantment—the International Prototype Kilogram (IPK), the "Lena" test image, and the standardized patient program—this book traces the ways that communities of scientific and technical professionals engage in the theatrical enactment of objectivity through the embodied use and upkeep of proxies. We will look at the guidelines for how much manual pressure to employ when scrubbing an official kilogram clean; the frantic moment when an electrical engineer tore a centerfold from a *Playboy* magazine to create a now-canonical test image for digital image processing; and the ways that medical actors (so-called standardized patients) are trained to embody the typical symptoms of diseases in order to train physicians.

By beginning with strict bodily protocols for cleaning kilograms and ending with protocols for transforming human bodies to make them better

stand-ins, this book charts a path from the eighteenth century to the near-present. It begins with a moment in which a belief took hold that the natural sciences could expose so-called invariants of nature and use them as the basis of universal standards; it ends with the twentieth-century belief that illness could be adequately codified such that it could be reproduced in a performer. These proxies are vital to the work of standardizing knowledge, and they themselves also become standardized, eventually entrenching as infrastructural and pregiven conditions for making sense of the world. But this work never happens in a vacuum: proxies shape and are shaped by the politics of representation and delegation. Test images have historically reproduced a racist and sexist visual culture that codes white femininity as a prototype; standardized patients rely on actors who wear disability as a masquerade; and these standards, in turn, shape the capacities that people have to build their own worlds.

Standardization is a process of forgetting. As Andrew Russell says, standardization is "a social process by which humans come to take things for granted."[13] Just as we could not imagine our world without its fundamental systems (including the metric system, digital image transmission, and the medical profession), it is impossible to imagine these systems without the use of their proxies. Where people share common references, to exchange knowledge and compare experiences of the world, they will produce and maintain proxies. But if the success of standardization is marked by forgetting the work of documenting the process requires one to recover the memory of how we got here. This examination is built on the idea that any notion of the "circuit of culture" ought to include practices of standardization, in addition to the conventional nodes of identity, production, representation, regulation, and consumption.[14] Standardization shows how ideas are formalized, but it also takes place in a cultural context in which those involved are themselves consumers whose identity positions bear on their work.

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What is required to take a proxy for granted? Think of Yodaville: for it to stand in for the many potential battlefields of the US military, one must

take for granted that the United States occupies the territory known as Arizona; that it can do with it what it pleases (including using it as a staging ground of simulated warfare); that the deserts of Arizona are similar enough to the deserts of other places to provide sufficient comparison; and that one soldier's performance in that desert is comparable to another's. These are the suspensions of disbelief that can transform some shipping containers outside Yuma into a durable stand-in for a world of potential battlegrounds.

We can recognize proxies all around us. When we invest something with the power to represent something else, we are engaged in the logics of surrogacy and vicarity, however minor. Cut out a template for a sewing project and you've made a ready-to-hand proxy; adjust your television or computer monitor using color bars and you've used a built-in proxy for the broadly expected formal qualities of digital screens. We have other, familiar proxies too: the proxy vote of a shareholder, a power of attorney document, and the proxy logic of representative democracy; these are all standardized and complex apparatuses for designating other human beings as our proxies in key moments of decision-making. These people, documents, and things are trusted delegates that social convention allows to serve as surrogates.

Delegation is a vital part of how institutions survive and constitutes one of the most basic relationships between people and technology.[15] For Bruno Latour, for instance, people delegate labor to nonhumans to script desired results: concrete speed bumps are delegated a function of police officers when they are enlisted with the goal of slowing down traffic.[16] But a speed bump is never only a speed bump, and neither is it only a lump of concrete made to condition behavior.[17] Delegation is a primary means of displacing social relations, and the delegate is, inescapably, an artifact of those relations.[18] Only some people possess the power to delegate core functions of the state to things, and marginalized and minoritized populations are more likely to be the targets of control: whether it's the vision of the state delegated to a security camera or a person's prospects for employment delegated to a credit score. Delegation is a political means of distributing the possibilities of living a flourishing and secure life.[19]

Delegation is a fragile process, entirely dependent on a network of trust between the delegator and the delegate (will you be a faithful representative?), as well as those with an interest in the power of a proxy to stand in for its counterpart. Through the histories of proxies, I show how people, places, and things come to be taken for granted, what happened when they were challenged, and how their trustworthiness as delegates was once again rebuilt. By building a catalog of proxies that centers on human bodies and human labor, I make the following arguments:

- *Proxies are bodily*: this is visible in the work of measurement and training that relies on finely tuned embodied and relational practices.
- *Proxies are both sticky and permeable*: though proxies are built as labor-saving devices to stand in for worldly phenomena, they inevitably carry and leave traces of their cultural milieus and the places where they've traveled.
- *Proxies rely on suspended disbelief*: the scientific and technical expertise underlying them is formed and repeated through scenes of performance, where participants must act as if a stand-in were the real thing for the purposes of getting work done.

THE MATERIAL LIFE OF STAND-INS

"All sciences must deal with the problem of selecting and constituting 'working objects,'" write Lorraine Daston and Peter Galison.[20] And proxies are no different. As simplified representations meant to be pregiven, ready at hand, easily called into action, and unquestioned, proxies are subject to many of the rules of working objects. The history of science and technology is strewn with studies of working objects, from the use of the fruit fly *Drosophila melanogaster* in genetics research, to the use of mice in biomedical research, to the use of chess in artificial intelligence testing, to the use of human surrogates in automobile crash testing.[21] All these examples are meant, ultimately, as practical solutions to the problem of needing usable models of a "too plentiful and too various" world.[22] As Steven Shapin writes, "All testimony about states of affairs stands in a metonymic

relationship to those states of affairs, and the condition of your knowing about these things—otherwise unavailable to you—is your accepting the legitimacy of that relationship."[23] A geneticist probably doesn't have any natural affinity for fruit flies but may have an affinity for the community they share with people who work with fruit flies, as well as an investment in the idea that fruit flies can stand in for (some) other living organisms: "the local and the specific are not the *point* of these experiments . . . but in order for specific findings to be *about* the atmosphere or *about* the universe the credibility of these standing-for relationships have to be accepted."[24] In other words, the legitimacy of an experiment, a model organism, or a statement about how the world works hinges on both a metonymic relationship (i.e., something stands in for something else) and the credibility of the stand-ins (i.e., someone believes it) to act for other phenomena that are not or could not be made present.

And yet: the local and the specific *do* matter, and no part of this arrangement is simple. The bonds of cultural, social, and professional norms are pulled taut every time an equivalence is made. We can examine these bonds over time and between spaces to investigate the tension between the thing standing in and the thing being stood for, or the person making the connection and the person being asked to believe it. Proxies are the product of creative decisions to design and maintain trusted delegates of a too-plentiful and various world, and a focus on the cultural labor of standing in shifts the analytic emphasis from the singular choice of a potential metonym (e.g., a fly is like other living organisms) to the training and the ongoing work that maintain proxies as credible and, ultimately, indispensable.

Proxies are instrumental to developing "group-licensed ways of seeing,"[25] and they are crucial to the ways we learn how to participate in our communities by training ourselves through common references, by coming to see problems as akin, and by taking for granted that others in our community share those references and those ways of seeing. Broadly, this process has many artifacts—tacit knowledge, canons, hidden curricula, inside jokes[26]—only some of which take the material form of common instruments for knowledge production. When Thomas Kuhn revised *The Structure of Scientific Revolutions*, he added a new focus on "exemplars" to

show how membership in a scientific community could not be explained merely through a shared set of rules. He used these exemplars to respecify what he meant by a scientific paradigm: "Shared examples of successful practice could . . . provide what the group lacked in rules. Those examples were its paradigms, and as such essential to its continued research."[27]

In a related fashion, Michelle Murphy calls particular representations of quantification like graphs of gross domestic product (GDP) *phantasmagrams*, speaking to the power of such instruments to far surpass their mere utility. The phantasmagraphic power of some quantitative practices means that they are "enriched with affect, propagate imaginaries, lure feeling, and hence have supernatural effects in surplus of their rational precepts."[28] Exemplars, working objects, and phantasmagrams, though each is distinct, are kindred ways of understanding how surrogate logics shape and bind disciplinary communities: they work through articulation, by drawing connections between things, through routine and practice, and through the shared bonds that communities form with particular problems and examples. But these concepts risk placing too much emphasis on the "objects" of laboratories and classrooms and not enough emphasis on the labor and affective commitments that proxies inspire. They also risk displacing the ways that human bodies must carry the traces of this work, either through the repetitive use of a narrow set of exemplars or the psychological and physical toll that the work might take. For instance, test images (discussed in chapters 3 and 4) are often singled out for their representational injustices on gendered and racialized grounds. But as compulsory instruments used in scientific, industrial, and classroom settings, their users often have little power to refuse their use or to question their credibility as stand-ins.

The "objectness" of working objects also appears especially brittle when we consider how many shared proxies are alive. Not just flies, rats, and mice, but living humans who work as test subjects, model patients, or make up case studies. Take the standardized patient program (discussed in chapter 5), in which laypersons are taught to embody the normal symptoms of diseases that they don't have in order to train and test physicians in diagnostic techniques. As proxies, these individuals must suppress their

own idiosyncrasies (including any actual maladies they might carry) to elevate their common status as humans with the capacity for sickness. Not only would it be dehumanizing to describe standardized patients as "working objects," it would fail to account for the ways that choosing and maintaining shared proxies entail much more than agreeing on an adequately typical exemplar. It would miss the sinuous work that analogies perform and it would erase the human labor involved in working as a stand-in. Or take a more conventional example from the world of science: chapter 2 deals at length with the protocols for cleaning and washing the IPK by hand. For more than a century, the IPK stood in for the concept of mass across the globe. In many ways, the IPK and other standard kilograms are classic working objects: platinum-iridium facsimiles of a cubic decimeter of water, they are made to be both inordinately precise and readily accessible. Yet, to be credible stand-ins, they require highly choreographed, manual cleaning with an ether-ethanol solution and a chamois cloth. This cleaning is so fundamental to the viability of the IPK as a standard that it was added to the official definition of mass within the metric system.

What distinguishes the histories of proxies in this book from histories of working objects, then, is the focus on embodied labor and performance as indispensable to the maintenance of knowledge infrastructures.[29] The cleaning of the IPK was not supplemental to the meaning of mass within the metric system; it is fundamental to what made it a viable standard. A larger set of affective and cultural practices binds people to their proxies as compulsory tools, binds communities to their shared representations, and tasks other people with the labor of making, using, and maintaining those representations.

As proxies travel to new sites and persist as "interscalar vehicles," the arbitrariness of their relationship to the world *out there* can appear in stark relief.[30] Seen in the wrong light by an ungenerous audience, what once seemed like a credible stand-in for the world starts to look threadbare, anachronistic, idiosyncratic, or outright unjust. There is no natural correspondence between shipping containers in southwestern Arizona and any potential target of the US military. It is people who must constantly reassert that correspondence, agree to it, and keep it coherent. It is also people

who must embody that correspondence, either as the workers tasked with making and maintaining standards and infrastructures or as people who must make do within conditions not of their own choosing.[31] I therefore follow an approach to infrastructural labor that is attuned to the ways that infrastructure is manifested in human practices. The knowledge labor that I trace is material and affective work, constituted in practices that, as Cait McKinney puts it, "assemble people, information, and technologies toward social goals."[32] And to follow Jacqueline Wernimont, this is an attempt to rematerialize test data, "to make it into something that one can touch, feel, own, give, share, and spend time with."[33] This is all to say that my approach is interested in the materialization of ideas in things and assumes that things are ineluctably made up of relationships.

A WORLD OF PROXIES

I live in England, but there are times that I might need to watch Canadian television. A virtual private network (VPN) can make my computer appear as if it was in Canada when contacting Canadian servers—it does this by masking my Internet Protocol (IP) address through something called a "proxy server." Because IP addresses are often a trusted stand-in for location, I can exploit a network of makeshift signifiers to bypass geofenced content (hypothetically). When Ari Luotonen and Kevin Altis published their foundational 1994 paper on web proxies, they introduced the technology through the labor-saving potential of proxies: "A proxy *allows client writers to forget* about the tens of thousands of lines of networking code necessary to support every protocol and concentrate on more important client issues."[34] This is the sense in which proxies can act as standardized infrastructure: they allow us to forget. There are other ways of establishing a computer user's location, but proxies can act as sufficient delegates when needed. Representative democracy is in some ways just such a labor-saving device. It's a technique meant to save the population of eligible voters from having to cast votes directly for each new policy of the government. In each case, it is trust that allows people to use proxies as sufficient delegates, and trust that binds people to proxies as faithful stand-ins.[35]

The work that proxies do to make systems function is invisible and easily forgotten by design. There is now a prevailing understanding of what is meant by "infrastructure" that is echoed here, where infrastructure is an expansive category that includes the taken-for-granted conditions and resources that allow the day-to-day operations of the world to take place—including not only the pipes, roads, and cables that act as conduits for information and goods, but the people, paperwork, standards, and protocols that give it all sense and shape.[36] Running a VPN and electing someone to represent your geographical district have very different stakes, and the consequences of "forgetting" about these proxies are also unequal. The project then becomes a matter of remembering and further documenting the consequences of delegating to proxies the power to represent the world. We are surrounded by proxies, but some proxies matter more than others.

Consider the Consumer Price Index (CPI) and its market basket of goods, which acts as a stand-in for consumption habits and their costs. The market basket of goods contains a selection of everyday commodities used to measure and communicate the economic changes that people feel the most, such as inflation. The CPI basket is an inordinately powerful proxy that establishes, among other things, a benchmark for wages and social program funding. It does this by measuring the current and changing costs of everything from food, housing, and medical care to clothing, cars, and education. Determining the composition of the market basket is a precise and arduous task, full of conflict and disagreement.

While fighting inflation in the early twentieth century, statisticians produced relative price indices for a "subset of goods purchased by working-class families" and then calculated the difference between the ratios of expenditure.[37] Although they agreed that the market basket of goods could act as a proxy for consumption habits (and "working class"–ness could act as a stand-in for the health of the nation), they disagreed on what goods should be included in the basket and what year should act as the baseline.[38] While proxification wasn't in question, the specific character of the proxy was. In the ongoing maintenance of the CPI basket, economists and statisticians must decide which products to track and how to measure their

costs based on a range of factors, including the place they were purchased and the time of year. They also debate how and when to replace items in the basket in order to reflect the cost of living most accurately. Here's a real question: how can one account for changes in cars every year when changes to the quality of manufacturing are difficult to separate from the clutter of marketing?[39]

When the CPI came under criticism in the 1990s, some economists argued that the difficulty of calculating it was related to the increased complexity of modern life: "a larger fraction of what is produced and consumed in an economy is harder to measure than decades ago when a larger fraction of economic activity consisted of a smaller number of easier to measure items such as hammers and potatoes."[40] This is a claim about the changing quality of American consumerism, but it's also a claim about the limits of proxification; as we graduate from hammers and potatoes to three-dimensional printers and a wide array of complex carbs, we can also see the ways that standardized proxies meet their capacities to be faithful delegates. There are few proxies with either the scope or the influence of the CPI's market basket, but without frameworks for interrogating proxies, we have very few tools at our disposal to question this vital instrument from our vantage point outside the field of economics.

The legal system is also full of proxies. From law school forward, lawyers are trained through moot courts to imagine and simulate the course of argumentation, and mock juries are regularly used to anticipate and predict the results of trials. Perhaps the most common legal proxy is the use of the "reasonable person" standard—what Mayo Moran calls "the common law's most enduring fiction."[41] The reasonable person has a number of siblings, including the "man of business," the "officious bystander," "the reasonable juror properly directed," and the "fair-minded and informed observer," all of whom form a "select group of personalities who inhabit our legal village."[42] The reasonable person is a projection of a proxy: an imagined, rational member of the community who interacts with the world in ways that judges and juries imagine that a reasonable, rational person ought to. In English courts of the late Victorian era, the reasonable person was referred to as "the man on the Clapham Omnibus"—a name that is still

a synonym for the reasonable person.[43] Because Clapham was a suburb of London and a likely site of imagined English averageness in the late nineteenth century, the analogy was concretized by situating the reasonable person (a fiction) in a definite "typical" place. As Moran writes, the "unique blend of subjective and objective qualities forms the conceptual foundation for the reasonable person and is the source of his utility."[44]

We find the reasonable person everywhere, including regulations regarding workplace harassment (part of the subject of chapters 3 and 4). The US Equal Employment Opportunity Commission's guidelines on workplace harassment state that for harassment to be unlawful, the "conduct must create a work environment that would be intimidating, hostile, or offensive to *reasonable people*."[45] It is no surprise, then, that in cases of persistent abuse, the debate often shifts from a consideration of the behavior of the accused to a consideration of the accuser's reasonableness. These are the political stakes of proxies, as they establish the standard by which a chaotic world will be adjudicated and harm might be recognized.

Yodaville may be a fabricated city in the Arizona desert, but real cities are frequently transformed into proxies for "average," "ideal," or "typical" samples of a larger population. Robert and Helen Lynd used Muncie, Indiana, as the basis of their "Middletown studies," published in 1929 and 1937, which were meant to provide a sociological portrait of life in the United States in the early twentieth century.[46] As Sarah Igo describes, the choice of Muncie for the Middletown studies was actually itself quite peculiar because the city had a disproportionately small population of African Americans and nonwhite ethnic minorities.[47] The Lynds further compromised the accuracy of Muncie as a trustworthy proxy by limiting their informants to the American-born, white residents of the city, claiming that this choice was a useful means of simplification.[48]

This decision to crop out an already misrepresented minority from their portrait of American life had long-lasting consequences. While the Lynds may have selected Muncie for its perceived middleness, this imagined feature was quickly transformed—through the press and in the reception of their research—into a new kind of cultural ideal.[49] There is often an ideological slippage between the "average," the "normal," and the "ideal,"

and in the reception of the Middletown studies, the disproportionate number of white, American-born residents in Muncie was treated as a feature instead of a bug. Instead of acknowledging this quirk as an aspect of Muncie that compromised its accuracy as a stand-in for something like "middle America," it was this whiteness that was said to make Muncie special—closer to an American ideal. This is a form of norm-swapping, where a slippage occurs when a person, place, or thing is connected to a calculated averageness, but which comes to be treated as a prototype, ideal, or expected norm. This swap happens frequently in the history of proxies, especially in cases where their prolonged use lends a kind of enchantment to a proxy.

Middletown is not alone, either. For media and communications scholars, we must contend with the fact that Paul Lazarsfeld and his collaborators also appealed to the "averageness" of certain Midwest US cities as a warrant for their ability to stand in for other places. Buried deep in the appendix of 1955's *Personal Influence*, which Lazarsfeld cowrote with Elihu Katz, is the justification of the choice of Decatur, Illinois, over seventeen other possible candidates for their investigation of opinion leaders. Lazarsfeld and Katz say that the "Middle West" of America was preferred because "that part of the country is least characterized by sectional peculiarities."[50] That is the only time that the phrase "sectional peculiarities" appears in *Personal Influence*. And I wonder about this phrase. Is the obvious inference that a place with fewer sectional peculiarities is more homogenous—and therefore easier to find and to sample stand-ins for the larger population? What are the benefits of homogeneity? And what happens when the conclusions drawn from such a place are generalized to somewhere more *peculiar* or *more sectional*? After narrowing their choices to Decatur, Terre Haute (Indiana), and Springfield (Ohio), they write a single declarative phrase, "We chose Decatur,"[51] with no further explanation.

What are the consequences of this decision, how might it have been different, and how has the field been shaped by these and similar choices of proxies? Inevitably, the choice of Decatur and the choice of Muncie leave traces, just as the choice to include or exclude particular demographics from those places had unaccountable effects. The use of a proxy always requires

that some likeness to the world is elevated and other features suppressed. Decisions about experimental settings, as well as proxies, are never epistemologically neutral—but each will be specific in its nonneutral peculiarity.[52] The task, then, is to investigate the history of proxies to recuperate the decision to choose particular places, people, and things, and to understand—at the very least—how they came to act as delegates for a larger world.

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The cultural practices I've described so far include the selection of things (e.g., baskets of goods), people (e.g., imagined rational members of the community, pretend jury members), and places (e.g., midsize American cities) that stand in for apparently "typical" or "average," and sometimes "ideal," representations of the world. This world of objects, people, and practices is not meant to point toward a global theory of proxies. Instead, it is meant to argue for local, uneven, and nonlinear understandings of the power of proxies. I advocate for an investigation of the local and peculiar conditions that shape a proxy, lend it credibility, and enable it to last. All the preceding proxies are entrenched and widely discussed examples of stand-ins that institutions, disciplines, and occupations have developed to make work possible. They are, in this way, infrastructural analogies at the core of complex knowledge systems;[53] each came about through a deliberate process of development; and each has undergone revision and repair, as both insiders and outsiders have challenged the suitability of these artifacts to act as stand-ins for a fluid and vernacular world.[54]

These proxies are "fixed points."[55] The metric system, for instance, is originally based on measurements taken at the end of the eighteenth century by French scientists trying to estimate the Earth's circumference using a meridian running from Dunkirk to Barcelona through Paris. Why? Because previous fixed points used in setting systems of weights and measures had been based on features like the arm length of a sovereign, so they were open to redefinition at a whim. Standard lengths and weights had a tendency to vary by jurisdiction, discrepancies between which were ripe for exploitation by a local and powerful elite who could impose their own

conversions. Thus, at the height of the Enlightenment, it was thought that the metric system could fix all of this by introducing a new, universal system based on a value unlikely to change: the size of the planet.

The original meter was a stand-in for a fraction of the Earth's meridian, but subsequent meters were all based on the length of the original, prototype meter, the metric system's initial fixed point. Standardized systems contain these nested references: a fraction of the Earth (an "invariant of nature") becomes the standard meter (an invariant made of metal), which becomes the meter stick in a classroom (a local, invariant reference). As a result, the proxies that enable standardization embody a conventional materialism as they are artifacts that are chosen, used, and shared by agreement, not out of natural necessity. As Martha Lampland and Susan Leigh Star write, "A great deal of work is conducted to make the standard possible, and then this must be followed up by agents committed to implementation and oversight."[56] The ongoing work to maintain fixed points continually shores up the material basis of proxies so that their legitimacy isn't called into question—and with it the legitimacy of a standard. In the case of well-entrenched fixed points, a whole world builds up around these benchmarks as references for future users.

By using benchmarks here, I want to draw on the term's origins in the nineteenth century as a noun instead of a verb. "*Bench marks*: in surveying, fixed points left on a line of survey for reference at a future time, consisting of cuts in trees, pegs driven into the ground, etc."[57] This definition (which predates its contemporary usage as a measure of computer processor speed) is especially apt because it captures the makeshift materiality of benchmarking as a process of shared representation: cuts, pegs, and lines drawn in stone are all physical traces left with the faith that such marks are useful and another surveyor will need them one day. They are highlights of everyday surfaces that become legible as representations for those who share a model of framing the world. These marks act like citations, leaving a trail of references that show where a shared reference point has traveled, who has used it, and why. They are the communal instruments that create shared understandings across space and time.

Through use, shared representations become something that can be taken for granted. Like the shorthand and inside jokes that mark you as

close to your family, friends, or colleagues, proxies—as benchmarks—must be maintained to forge the bonds of community. Like those inside jokes, there is an affective dimension to the cultural work of proxies: we recognize others through their recognition of our shared references. To question those references would not only threaten the coherence of the knowledge that we've produced using a set of proxies, it also would threaten the coherence of our community.

Again, to whom or to what do we delegate the power to represent the world? The implication of the question is that proxies are entwined in a politics of representation.[58] These politics are often obscured by the necessity and ordinariness of using stand-ins. There is an obligation to choose something, *anything*, as a fixed point, so long as it is used consistently. The idea that proxies are chosen with discretion but maintained out of necessity is a kind of "arbitrary precision" (they are arbitrary, and *then* precise). Such choices are absolutely necessary for producing scientific and technical knowledge, and the history of proxies shows how fissures in the authority of proxies are shored up through community bonds, repeated use, and the affective ties that keep people and their tools working in concert.

To take proxies for granted as benchmarks that are ready at hand, they must become ordinary. "The world must be regained every day, in repetition, regained as gone."[59] In this sense, ordinariness is an aspiration to feel some control over one's surroundings—to see some piece of the world as preordained. Proxies operate at the hinge of ordinariness in imagining and building the world as a controllable space, and the locations of their use become potential sites of struggle and refusal to accept that ordinariness. Rethinking our common proxies, as the basic reference points of knowledge infrastructures, can be a way of intervening in and reinventing the representational practices that shape standardized systems.[60] The politics of proxies demand that we understand as much as possible about their representational relationships, about the dynamic movement from the world *out there* to the world *in here*: How does something come to stand in for something else? Who gets to choose a proxy? Who gets to use it? And what it is used for? The politics of proxy representation also mean that we have to account for how proxies are maintained and who carries out that maintenance.[61]

The dichotomous thinking that insists on a boundary between *out there* (the unpredictable world) and *in here* (the controlled space of knowledge production) is an always permeable fiction. Proxies are useful because they can travel across this boundary and mediate between these imaginaries.[62] As witnesses for the world *out there,* proxies are paradigmatic media, acting as the "means by which experience is supplied to others who lack the original."[63] The division between interiority and exteriority isn't natural—it is arbitrary, political, and circumstantial; it's a division that is performed and reperformed through daily practices and institutionalized protocols. But the artifice doesn't lessen its power or its hold. As the fulcrum of the two imaginaries of *in here* and *out there*, proxies can vouch for the world of phenomena while being stable enough to also vouch for the predictable, repeatable practices of knowledge production.

REALITY PRACTICES

Return to Arizona: when Yodaville first opened in 1999, its usefulness was connected to its plasticity. In the *San Diego Union-Tribune*, a journalist wrote of the town's capacity to stand in for any number of potential battlegrounds: "For the Marine Corps, Yodaville is Mogadishu, Somalia; Port-au-Prince, Haiti; or Pristina, Kosovo. Just name a city in one of the world's trouble spots, and Yodaville can be it."[64] This notion, that one small test city in the Arizona desert could represent *any* city that the American military *might* need to fight in, reflects a common, if paradoxical, ideal often attached to the use of proxies: that they can be both universal *and* particular. It's also an invitation ("Just name a city") to imagine a limitless horizon for the pursuits of the American military. The development of Yodaville was driven by the fact that not all cities are the same (not all cities look American or Western European), but Yodaville was also built with the belief that it is possible to create a model that is sufficiently similar to enough places in the world that it could be called upon to stand in as required. Proxies exist because of this exact tension between the universal and the particular, by the need to trust models based on real things, from

which generalizable knowledge can be created. The proxy city will be just plastic enough and will have features that make it like many places, but also enough specific qualities that make it usable for a specific kind of testing, training, and standardization.[65] In this case, Yodaville is not *Anytown* in the *USA*, or *AnyVillage* in *Northwestern Europe*, but crucially, it could be *AnyCity* in the *Developing World's Trouble Spots*.

By 2006, there was less ambiguity about where the United States would be at war and less uncertainty about the cities that Marine Corps pilots would be targeting. The US armed forces had been at war in Afghanistan for five years and Iraq for three, with several other engagements and invasions on the horizon. In the Yuma Proving Ground, adjacent to Yodaville, the military built new proxy encampments called Little Baghdad, K9 Village, and Bedouin Village—places built for the purpose of practicing moving through desert towns, looking for targets, accompanying dogs, and detecting improvised explosive devices.[66] These simulation towns, like Yodaville itself, are not simple models. They are experiential engines for a technology meant to entrain bodies in the look and feel of combat and military occupation. All simulation is a form of practice and using simulated towns to train military personnel is a way of gauging preparedness and a way of encoding bodies with an analogic experience that prepares them for the actual event. The simulated towns of the Yuma Proving Ground are built to be immersive and to produce inscriptions—to get into the muscles, the retina, the senses, and the memories of the soldiers trained there.[67]

If Yodaville was built to be a portable stand-in for any number of possible targets, its usefulness was now reimagined through the reality of American warfare in the twenty-first century. During an expansion of the Yuma Proving Ground in the early 2000s, Yodaville was updated to accommodate new training requirements. According to Colonel Ben Hancock, who commanded the Air Station at Yuma in this period, the early 2000s were the busiest time in the history of the base. The reason for this activity was directly wedded to qualitative similarities between the Arizona desert and the Iraq desert, as well as the experiential similarities of simulating war in the test cities of Yuma and the real cities of Iraq and Afghanistan. What

had been a latent feature of Yodaville—the fact that it was situated in a desert—became a focal point of its potential as a stand-in for ongoing wars. In the words of Hancock, "If a pilot can drop a bomb and hit a target in Yuma, he can drop a bomb and hit a target in Iraq. . . . They got heat. We got heat. . . . It is the ideal place to train."[68]

Yodaville is functioning as a workable sample of a process (warfare in a desert) that simultaneously frames, represents, and stands in for that process and can further be used to imagine the possibilities of transforming that process. Yodaville was a site for testing and evaluating Marine performance in a situation similar enough to the actual arenas of warfare, and Hancock enunciated how blunt that commensurability could be. It is rendered as a set of test data, a "final check on whether the expert's conception of reality conforms to the physical world at hand."[69] These material similarities join war in Iraq and simulation war in Yuma.[70] Hancock's justification speaks to the way Yodaville's surrogacy for real cities was based on isolating particular characteristics (its heat, its layout, its familiarity) as useful analogs. When Yodaville stood for anywhere, its potential was immanent; when it stood for *somewhere*, its potential was realized in morbid terms.

While proxies may always have a tenuous relationship to the realities for which they stand in, they have a definite relationship to the *reality practices* of the people who make and use them. In one sense, it does not matter if Yodaville is actually like Iraq (at least, its likeness is secondary). What matters is that its users see it as similar and highlight certain of its features to create commonality. These reality practices link disparate places, things, or people in the production of standardized knowledge. The perceived likeness of Yodaville to Iraqi villages and cities becomes a condition of possibility for the production of standardized soldiers.

Hancock's optimism about the transferability of skills learned in and on Yodaville encapsulates the usefulness of test cities and highlights many of the most important aspects of proxies, including the work that they perform in producing institutional knowledge. But proxies also break down, and Yodaville is no different. Not only does it undergo constant bombardment from inert matériel and require upkeep to maintain its tattered

structures, its relationship to its real-world referents needs constant shoring up. To make the fake city seem enough like a real city takes work—both the physical, reparative work of fixing structures and the ongoing, cultural work of enunciating an analogy: how *this thing* is like *that thing*. Over time, the representational failures of Yodaville have been thrown into relief: the scale is off, the buildings don't produce realistic heat or electromagnetic readings, and "from the ground it looks like stacks of shot-up shipping containers; from the air, it looks convincingly urban." These are issues of embodied perspective that demonstrate how the standpoint from which one encounters a proxy—whether it's from the air, the ground, or through its rendering as light or radiation—changes its claim to being a veridical representation of the world (figure 1.2).[71]

The work that proxies must perform to act as sufficient surrogates of the outside world is especially complicated because they are both in and of the real world. Yodaville is a city *and* a set of shipping containers *and* a target *and* a military resource *and* a workplace *and* a classroom; it was also Mogadishu *and* Port-au-Prince, and later Mosul *and* Kandahar. Like an actor on stage, there is a suspension of disbelief that allows proxies to be both a bunch of stuff and usable surrogates. The suspension of disbelief that enables participation and appreciation of theatrical texts allows us to understand the actor as simultaneously a human, a performer, and a character. In terms of performance theory, they are *not* the character while simultaneously being not *not* the character they play.[72] Yodaville is *not* Mosul; but for the Marine Corps, it is vitally, empirically not *not* Mosul. Likewise, Yodaville is not just a bunch of shipping containers and empty bomb casings; but for the pilot who has to shoot at it, it is not *not* those things either. This is a productive contradiction and a necessary aspect of what makes proxies so useful to institutions trying to wrest the world into a system of usable samples.

Yodaville makes plain the logic of proxies and the process of making instruments that represent the world in usable ways. It operates at the nexus of a problem (i.e., American deaths in Mogadishu resulting from an apparent lack of training using properly analogous cities) and a solution (i.e.,

Figure 1.2
An artist's rendering of Yodaville as seen from the ground following its renovation. The town, made of containers, is billowing smoke as a helicopter hovers above. The image portrays a day in September 2016 during an air support exercise. Image: R. R. Mulvin.

updating the military's operative analogies to build more accurate proxies for training and evaluating pilots). Among the ways that the US military sought to remediate the damage to its reputation and self-perception as a result of the deaths of its soldiers in Somalia was a better standard, which materialized in the building of a test city and training programs surrounding that city. This is not a small thing. Yodaville is a conspicuous materialization of the US military's imagined vision of the world in the twenty-first century, and more specifically a materialization of the ways that it has most recently honed that vision. The power to represent the world as a usable proxy can be an imperial power: the capacity to lay claim to a controllable version of a chaotic and unknown exterior within a managed interior. In the case of actual military imperialism, this process is put into relief; we can see how proxies lay claim to a representation of the world as both a substitute and a preparation for laying claim to the actual world.

THE POLITICS OF "AS IF"

Proxies are the necessary and practical products of suspended disbelief. To see them this way is to see their usefulness as practical analogies. Institutions need proxies that stand in for real phenomena as if they were the real thing. In the early twentieth century, the German philosopher Hans Vaihinger published *The Philosophy of "As If,"*[73] in which he referred to the most important of these kinds of analogies as "fictions." We willingly accept fictions, says Vaihinger, because the world is otherwise too chaotic and irrational to explain and manage. His general thesis was that many important ideas, around which institutions and disciplines form, are strictly and logically contradictory.[74] Nonetheless, we accept them as true enough because they are *useful* untruths.

Vaihinger didn't think that it was necessary to reject fictions as simple falsehoods—to be a pure skeptic—but rather to understand them as the inescapable artifacts of human thought. He writes, "It must be remembered that the object of the world of ideas as a whole is not the portrayal of reality—this would be an utterly impossible task—but rather to provide an *instrument* for finding our way about more easily in the world."[75] And here, we find a glimpse of the cultural work surrounding proxies. Proxies, as fictions, are instruments that draw their power from repetition and reiteration, through the ways that they form particular habits of use and reference, and through the ways that communities affectively bond to these collective practices of make-believe. We can look to the material and cultural settings of their genesis, circulation, maintenance, contestation, and repair to understand why they persist. In other words, proxies are necessary untruths that nonetheless operate as if they are true "because it is useful for some purpose to do so." We must turn to the politics of "as if" to understand the uses and purposes of suspended disbelief.[76]

Vaihinger singles out the *homme moyen* (the average man) from the nineteenth-century work of Lambert "Adolphe" Jacques Quetelet as an especially important example of a useful statistical fiction, what he calls a "fictitious mean."[77] The nineteenth century was a boom time for the average. As William Stanley Jevons wrote in 1874, the average "enables us

to make a hypothetical simplification of a problem, and avoid complexity without committing error."[78] The average man was just one such simplification: a composite, abstract figure that represented the distribution of several attributes of the population of a given country according to a binomial curve (also known as a normal distribution, or "bell curve"), which could then come to serve as the "type" of the nation and "the representative of a society in social science comparable to the center of gravity in physics."[79] The average man, and the calculation of frequencies that came with it, was fundamental to the development of statistical science and state population management—and a building block of eugenics—in the nineteenth century and beyond.[80]

Building on his development of the average man, Quetelet undertook a lifelong study of human traits and activities, leading to the development of "moral statistics" that sought to identify the "propensity" of particular classes of people to, for example, commit crime—a criminology based in race science and statistical averages. Bolstered by the fact that the average man was, for Quetelet, both a national and a racial type, the average man became an instrument to tie a particular quantification of whiteness to a national identity and to criminalize those who were not reflected in its idealizations.

For Quetelet's early contemporaries, it was necessary that the use of the average man was only theoretical, and any suggestion otherwise was met with ridicule.[81] But for Quetelet, the average man was far from a mere fiction.[82] His great innovation was turning the assumptions undergirding normal distribution on their head: instead of thinking of statistical probabilities as the composite product of real phenomena, Quetelet imagined that if a normal distribution curve were a natural law, it could be harnessed in the production of more normal populations. The average man was not just an instrument for thinking through statistical norms, but also an instrument for making normalcy incarnate; as averageness could become a template, decisions about social management could be directed toward maximizing the reproduction of such an ideal. This is borne out in the history of the average man's journey from the domain of probability to the development of a science of populations.

The average man's legacy has lasted nearly three centuries, during which time it has continued to act as a wellspring of norms and standards. In time, the usefulness and versatility of the average man helped the concept spread to domains beyond statistical science, with particularly long-lasting and pernicious effects in criminology and medicine. With this came new disciplinary and eugenic categorizations of human physiology, ability, sexuality, and behavior.[83] But the average man was only half of the necessary scaffolding for a eugenicist project; the other half was the introduction of state practices meant to adjust and hone the attributes of actual humans in order to keep them within the bounds of normalcy.[84] "It began to turn statistical laws that were merely descriptive of large-scale regularities into laws of nature and society that dealt in underlying truths and causes."[85] As *averageness* was equated with *normalness,* and even *idealness*, the average man transcended its use as a composite calculation and became a prescriptive tool.[86]

The history of proxies is flecked with moments of incarnation, where the usefulness of proxies for conducting some limited, domain-specific task (like a sociological study of a small Midwestern city) leaks out into the wild and assumes the power and reputation of a prescriptive template. The study of proxies exposes how their users may try to portray a fiction as *only* a fiction, to hide its origins, or to obscure its definite connection with the materiality of the world *out there*. But Middletown is always also Muncie. The reasonable person incarnates as a nineteenth-century man commuting from a London suburb. Proxies are inescapably material, leaky, and porous. Seeing proxies as useful fictions does help us chart a path to their use in the day-to-day routines of professionals. But it does little to account for the phantasmagramic power that some proxies accrue when they are transformed from samples into sought-after ideals.

Instead, pragmatist and performative approaches to proxies can help to better illustrate how some useful untruths take on the role of "recipes for reality."[87] For example, in the case of the average man, what started as fictionalism (it was a useful untruth that worked as an instrument for particular calculations) soon came to look like a pragmatic phenomenon (things that were felt to be real had real effects).[88] And though we may have

outgrown the brute averages of Quetelet, the damaging effects of swapping an average for a norm persist. For instance, though anthropomorphic models have been used to test the outcomes of car crashes for nearly seventy years, it's only in the past decade that the predominant use of an "average man" model has been shown to lead to disproportionate rates of injury and fatality for people whose bodies don't conform to that model.[89] This is an obvious (and deadly) way in which averageness is made incarnate in a proxy for human bodies, with distinct and negative outcomes for anyone whose body is not captured by a dominant template.[90]

Vaihinger admitted that fictions were popular tools because they were useful instruments—but he limited himself to the usefulness of such fictions in their proper domains and the few cognate fields they might overlap with. For pragmatists, usefulness and truthfulness are more capacious: what matters is who takes an idea to be true, in what context, and with what consequences.[91] This is why the Middletown studies, for example, could go from a limited, focused study of an unnamed American city to Muncie becoming a celebrated stand-in for ideal Americanness. Despite what Robert and Helen Lynd wished, the popularity of the Middletown studies transformed Muncie from a proxy for averageness to a model of American life; the city's subsequent use and reuse reaffirmed (in circular fashion) its accuracy as an ideal template. Another way of saying this: once the average man, or the Middletown studies, or Yodaville, or any well-entrenched proxy is perceived as ideal or normal, new realties will be developed in accordance with this redefinition. As Geoffrey Bowker and Susan Leigh Star put it, "If someone is taken to be a witch, and an elaborate technical apparatus with which to diagnose her or him as such is developed, then the reality of witchcraft obtains in the consequences—perhaps death at the stake."[92] What this pragmatic perspective reveals is the productivity of fictions, the politics of representation, and the ways that power both conditions and constrains who gets to define a useful idea and for what purpose.

When we use proxies, we do not just willingly partake in the world of ideas, using and reproducing knowledge through deliberate speech acts. Participation is compulsory in a world standardized through the pragmatics of technical and scientific systems and through norms and normate

templates.[93] Here, this book often returns to gender, disability, and performance theories and the advised use of the phrase "suspended disbelief" to understand the ways that many people must engage, professionally and as laypersons, with proxies as compulsory fictionalizations of the world. Proxies are not transparent representations of the "world out there." Rather, they are representations laden with cultural baggage and they are indelibly marked by the standpoints of their production and use. The daily and standardized ways of making and maintaining analogies for life *out there* constrain—though never fully determine—the ways that we can come to understand our place in the world.[94] The move from fictionalism to pragmatism, and then to performativity, provides us with three ways of understanding proxies: as useful instruments, as analogies turned incarnate, and as the conditions of epistemic labor that must be occupied by and through human bodies. A proxy may begin as a make-believe surrogate for the world *out there,* but what happens when it starts to act not *as if,* but *as* the world? Whose labor, and whose body, is called on to maintain that fantasy?

THE SCOPE OF *PROXIES*

In a posthumously published essay, *On Truth and Lie in an Extra-Moral Sense*, Friedrich Nietzsche turns to the maintenance of coinage to explicate his understanding of truth. "Truths are illusions," he writes, "about which one has forgotten that this is what they are; metaphors which are worn out and without sensuous power; coins which have lost their pictures and now matter only as metal, no longer as coins."[95] Nietzsche's analogy contrasts elegantly with the history of proxies. Just as we might think of standards as a social process for taking things for granted or the idea that proxy servers allow one to "forget" the work they perform, Nietzsche sees truth as a conventional artifact, where the traces of its arbitrariness have been scrubbed away and forgotten—and, usefully, he turns to a standardized artifact as his exemplar.

Let's fill in the blanks of this analogy. If "truth" becomes truth through a process of naturalization—a process of forgetting—it does so by wearing down the human, conventional, and arbitrary context of its origins. This is

how norms operate: by vanishing from view, by seeming common sense, by going unmarked and unnamed. Proxies gain authority through the same process. Through wear—the result of repetition, handling, and circulation—they come to seem obvious, and (at least some of) their users become oblivious to their arbitrary origins. The source of this power is not predetermined. Some proxies function because they achieved priority and benefit from the effects of path dependence, while others work by international agreement, legal enforcement, or the entrenched power relations of gender, sexuality, race, ability, and other strata of difference that condition the selection of some surrogates over others. What follows in this book is a series of stories about proxies that foreground their histories of use, wear, and circulation, as well as the moments when communities responded to claims that a proxy's tenuous connection to the world was difficult to maintain.

Chapter 2 tells the story of the International Prototype Kilogram, which until recently was the last remaining physical artifact used as a standard in the metric system. Here, I approach the lifespan of a basic measurement proxy by examining the protocols for keeping the kilogram *clean,* as a fundamental aspect of its stability. Data hygiene, this chapter argues, is a necessary condition of maintaining proxies (and technology more generally) that need to stay coherent as shared reference points. Data hygiene is a practice visible in protocols for database management ("a clean data set") and finance ("money laundering"), as well as the larger world of hygiene within cultural texts (e.g., the "clean" version of an explicit song). As a fundamental unit in the metric system and a basic component of one of the earliest and farthest-reaching attempts at international standardization, the IPK and its associated protocols capture the messy, bodily, and makeshift aspects that animate the lives of proxies.

In the next two chapters, I undertake to tell the history of one of the most widely used test images in existence, the Lena image (also known as "Lenna"). This image was integral to the development of digital imaging techniques and practices of automated image analysis. Through repeated use, it became a central reference point in the development of digital image processing, and eventually an icon of the discipline. The image itself is a cropped 512 by 512–pixel picture of a woman in a hat, which engineers at

the University of Southern California (USC) cropped from the November 1972 centerfold of *Playboy* magazine.

Chapter 3 examines the institutional setting of digital image processing at USC. I document the environment in which the Lena image could seem like a possible solution to a range of test image problems: the need for a human face, the need for complex images, the need for new images, and to the apparent problem of an overabundance of so-called boring images. Here, I look at how all of these "needs" became cover for importing mainstream, soft-core pornography into the earliest days of networked image transmission, and examine the work that early image engineers were doing at USC on image detection and transmission.

Chapter 4 turns to the late twentieth century, looking in particular at the early 1990s, a time when the graphical World Wide Web was on the horizon. This was also a time when digital image processing was distinguishing itself from the cognate fields of optical engineering and signal processing. Following a feminist media studies approach to this history—one invested in a politics of change and a commitment to reducing and redressing injustice—this chapter looks at moments of resistance to the alienating and often abusive environments of computer science and image engineering, tying conflicts in these environments directly to the visual culture of test images. Together, chapters 3 and 4 argue that the methods of "seeing like an engineer" that produced the Lena image are a product of institutionalized, professional vision, inescapably tied to the practices of decoding and instrumentalizing women's bodies as test data.[96]

These two chapters serve two historical purposes: first, to tell the underexplored story of the earliest days of digital image processing and the attempts to get digitally processed and compressed images onto ARPANET—the direct predecessor of the internet; and second, to write the history of the creation, circulation, and canonization of a *Playboy* centerfold as a test image. I examine how gendered practices shaped image engineering labs and how the very concept of gender was performed and reencoded in image analysis practices and techniques.[97] Methodologically, the chapters draw on an archive of journals, working papers, and gray literature. This includes unofficial reports that documented the work that many engineers, students, and

workers did to contest the sexist settings of computer science and engineering throughout the 1980s and 1990s.

Chapter 5 contains a history of the standardized patient program, which began at USC (again!) in the 1960s and transformed, over forty years, into a necessary part of medical accreditation in Canada and the United States. It tells a story in which the surrogate logic of standing in was extended to include human beings as standardized proxies. In the standardized patient program, actors embody the typical symptoms of a disease and trainee physicians diagnose them while honing their bedside manner. Begun as a bridge between the dissection of cadavers and living anatomy class, the standardized patient program functioned as a "living cadaver" lesson.

Through the refinement of the program, standardized patients became a technique for training doctors in diagnosis and the emotional management of patient interaction—techniques intentionally engineered to help physicians avoid malpractice lawsuits. In spite of the fact that actual patients are both vulnerable and unpredictable, standardized patients are meant to be neither—since to be either would threaten the testing scenario they enable. Despite this, it is their shared humanity, the immanent possibility of them becoming patients, that allows them to stand in. As "patients," they act as a gauge, recording the accuracy and affect of their trainee physicians; for medical educators, they act as a consistent test scenario that can be used to compare students. Yet, unlike the kilograms and test images of the previous chapters, standardized patients talk back: they emote, they adjust, they feel pain, they are prejudiced, they mask their own traumas, and they bring with them a lifetime of interactions with the medical establishment.

Whereas the other artifacts examined in this book manifest in things like pieces of metal, paper, and pixels, standardized patients are maintained not only *through* the bodies of workers, but *within* them. Standardized patients reveal a limit for the surrogate logic of proxies, as they chafe at the ability to create predictable and reproducible testing scenarios and show how messy encoding a stand-in can be. But all proxies are messy, and each of the histories included here contains contingent, makeshift, and ritualized forms of labor that workers use to justify and maintain the use of certain materials over others. This labor aims to conceal and suppress the

arbitrary nature of scientific and technical decision-making. The messiness of standardized patients simply brings these issues to the foreground. The book concludes with a recurrent theme: the inescapable fact that the naturalization of infrastructure and standards requires a great deal of labor to be successful. The argument, I hold, is that the seams in interwoven technological systems need to undergo constant concealment to appear smooth. By looking through the lenses of artistic appropriation and through critical infrastructure studies as a form of perspectival denaturalization, I offer a methodological detour suggesting how the history of proxies might map another way of surfacing the relationships that hold technologies together.

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When issues appear with proxies, it is not in the form of some sudden, catastrophic failure; instead, issues appear *as* issues only when the fabric of communal referencing strains under the pressure of some other social demand. In the stories included here, these demands include the instability of platinum-iridium; the politics of gendered representation; the rigidity of copyright ownership; the legal consequences of bad medical care; and the capacity to speak about one's own pain.

The resolution to these problems will not simply arrive as new and better proxies. These are not merely struggles over the arbitrariness of picking one fixed point over another; they are struggles over the power to pick *any* fixed point, the ability to contest the circumstances of one's work, and the very possibilities of standardization. The power of proxy logic resides in our imaginative capacity to inscribe and realize a vision of the world and to fabricate scenarios where people, places, and things can reside in measurable comparison. The power to determine proxies, therefore, is nothing less than the power to determine the grounds of difference.[98] Who makes that difference, ultimately, is always open to debate.

Notes

CHAPTER 1

1. Hans Vaihinger, *The Philosophy of "As If,"* trans. C. K. Ogden (New York: Harcourt Brace, 1924), 93.
2. Russell W. Glenn, Jody Jacobs, Brian Nichiporuk, Christopher Paul, Barbara Raymond, Randall Steeb, and Harry J. Thei, *Preparing for the Proven Inevitable: An Urban Operations Training Strategy for America's Joint Force* (Santa Monica, CA: RAND Corporation, 2006); Geoff Manaugh, "Yodaville," *BLDGBLOG*, December 6, 2015, http://www.bldgblog.com/2015/12/yodaville/.
3. Mark Bowden, *Black Hawk Down: A Story of Modern War* (New York: Signet, 1999); *Black Hawk Down*, dir. Ridley Scott (Los Angeles: Columbia Pictures, 2001).
4. The report was commissioned by the Office of the Secretary of Defense and US Joint Forces Command.
5. Glenn et al., *Preparing*, xv (emphasis added).
6. If we think of Yodaville as an instrument in the exercise of empire, it is redoubled when we acknowledge that the Yuma Proving Ground's proximity to the US-Mexico border is a bulwark of the US occupation of that highly militarized boundary. As Audra Simpson and Lisa Ford have both argued, the layering of rationality onto a practice of make-believe is central to the logic of settler colonialism. By treating the nation and its borders as a rational and legal entity, colonial powers retrospectively justify the dispossession of territory. Audra Simpson, "The Ruse of Consent and the Anatomy of 'Refusal': Cases from Indigenous North America and Australia," *Postcolonial Studies* 20, no.1 (2017): 18–33; Lisa Ford, *Settler Sovereignty: Jurisdiction and Indigenous People in America and Australia 1786–1836* (Cambridge, MA: Harvard University Press, 2010).
7. Geoffrey C. Bowker, *Memory Practices in the Sciences* (Cambridge, MA: MIT Press, 2005).
8. The territory designations are taken from the map available at www.native-land.ca. As the site states, these designations are not meant as official/legal boundaries. Indeed, as mapmaking was crucial to European colonization and occupation, the history of boundary-drawing

is an extension of that colonial project. Here, the named territories and the reservation are offered as context for the specific emplacement of Yodaville within the history of US imperial occupation.

9. Sara Ahmed, *Strange Encounters: Embodied Others in Post-Coloniality* (London: Routledge, 2000), 132.

10. Madeline Akrich. "The De-Scription of Technical Objects," in *Shaping Technology/Building Society: Studies in Sociotechnical Change*, eds. Wiebe E. Bijker and John Law (Cambridge, MA: MIT Press, 1992), 205–224; Michel Callon, "Society in the Making: The Study of Technology as a Tool for Sociological Analysis," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, eds. Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch (Cambridge, MA: MIT Press, 1987), 83–103.

11. Greg Downey, "Virtual Webs, Physical Technologies, and Hidden Workers: The Spaces of Labor in Information Internetworks," *Technology and Culture* 42, no. 2 (2001): 209–235; Paul Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010).

12. Marilyn Strathern, *Reproducing the Future: Anthropology, Kinship, and the New Reproductive Technologies* (London: Routledge, 1992), 33.

13. Andrew L. Russell, *Open Standards and the Digital Age: History, Ideology, and Networks* (Cambridge: Cambridge University Press, 2014), 16.

14. Paul Du Gay, Stuart Hall, Linda Janes, Anders Koed Madsen, Hugh Mackay, and Keith Nagus, *Doing Cultural Studies: The Story of the Sony Walkman* (London: SAGE, 2013).

15. Mary Douglas, *How Institutions Think* (Syracuse, NY: Syracuse University Press, 1986).

16. I have simplified the causality here. Humans never act, for Latour, out of a simple desire to use technology to achieve a single, unalloyed goal, but rather in a nonreducible network of relationships with other humans and nonhumans. See Bruno Latour, "Mixing Humans and Nonhumans Together: The Sociology of a Door-Closer," *Social Problems* 35, no. 3 (1988): 298–310; Bruno Latour, "On Technical Mediation," *Common Knowledge* 3, no. 2 (1994): 29–64.

17. Latour, again: "The speedbump is not made of matter, ultimately; it is full of engineers and chancellors and lawmakers, commingling their wills and their story lines with those of gravel, concrete, paint, and standard calculations." Latour, "On Technical Mediation," 41.

18. Langdon Winner, "Do Artifacts Have Politics?" in *The Whale and the Reactor* (Chicago: University of Chicago Press, 1986), 19–39; Trevor J. Pinch and Wiebe E. Bijker, "The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other," *Social Studies of Science* 14, no. 3 (1984): 399–441.

19. Virginia Eubanks, *Automating Inequality* (New York: St. Martin's Press, 2018); Sasha Costanza-Chock, *Design Justice: Community-Led Practices to Build the Worlds We Need* (Cambridge, MA: MIT Press, 2020); Ifeoma Ajunwa, Kate Crawford, and Jason Schultz,

"Limitless Worker Surveillance," *California Law Review* 105, no. 3 (2017): 735–776; Frank Pasquale, *The Black Box Society: The Secret Algorithms That Control Money and Information* (Cambridge, MA: Harvard University Press, 2015); Stop LAPD Spying Coalition, "Location-based Policing: New LAPD Technologies, Same Racisms," September 5, 2019, https://www.citywatchla.com/index.php/2016-01-01-13-17-00/los-angeles/18377-location-based-policing-new-lapd-technologies-same-racisms.

20. Lorraine Daston and Peter Galison, *Objectivity* (Brooklyn: Zone Books, 2007), 21–22.

21. Robert Kohler, *Lords of the Fly: Drosophila Genetics and the Experimental Life* (Chicago: University of Chicago Press, 1994); Karen Ann Rader, *Making Mice: Standardizing Animals for American Biomedical Research, 1900–1955* (Princeton, NJ: Princeton University Press, 2004); Nathan Ensmenger, "Is Chess the Drosophila of Artificial Intelligence? A Social History of an Algorithm," *Social Studies of Science* 42, no. 1 (2012): 5–30; Greg Siegel *Forensic Media* (Durham, NC: Duke University Press, 2014).

22. Daston and Galison, *Objectivity*.

23. Steven Shapin, "Cordelia's Love: Credibility and the Social Studies of Science," *Perspectives on Science* 3, no. 3 (1995): 261.

24. Shapin, "Cordelia's Love," 262 (emphasis in original).

25. Thomas Kuhn, *The Structure of Scientific Revolutions*, 3rd ed. (Chicago: University of Chicago Press, 1996), 189.

26. Michael Polanyi, *The Tacit Dimension* (New York: Doubleday, 1966); Natalie Melas, *All the Difference in the World: Postcoloniality and the Ends of Comparison* (Palo Alto, CA: Stanford University Press, 2007).

27. Kuhn also introduced the term "disciplinary matrix" to explain how a network of social relationships could bind communities together. Thomas Kuhn, "Second Thoughts on Paradigms," in *The Essential Tension: Selected Studies in Scientific Tradition and Change,* ed. Frederick Suppe (Chicago: University of Chicago Press, 1977), 293–319. See also John Forrester, "If *p,* Then What? Thinking in Cases," *History of The Human Sciences* 9, no. 3 (1996): 1–25; Kuhn, *Structure of Scientific Revolutions*.

28. Michelle Murphy, *The Economization of Life* (Durham, NC: Duke University Press, 2017), 24.

29. Shannon Mattern, "Maintenance and Care," *Places Journal* (November 2018), https://placesjournal.org/article/maintenance-and-care/.

30. Gabrielle Hecht, "Interscalar Vehicles for an African Anthropocene: On Waste, Temporality, and Violence," *Cultural Anthropology* 33, no. 1 (2018): 109–141.

31. Lauren Berlant, "The Commons: Infrastructures for Troubling Times," *Environment and Planning D: Society and Space* 34, no. 3 (2016): 393–419.

32. Cait McKinney, *Information Activism: A Queer History of Lesbian Media Technologies* (Durham, NC: Duke University Press, 2020), 22.

33. Jacqueline Wernimont, *Numbered Lives: Life and Death in Quantum Media* (Cambridge, MA: MIT Press, 2019), 163.

34. Ari Luotonen and Kevin Altis, "World-Wide Web Proxies," *Computer Networks and ISDN Systems* 24, no. 2 (1994): 2 (emphasis added).

35. Markus Krajewski, *The Server*, trans. Ilinca Iurascu (New Haven, CT: Yale University Press, 2019); Fenwick McKelvey, *Internet Daemons: Digital Communications Possessed* (Minneapolis: University of Minnesota Press, 2018).

36. Susan Leigh Star and Karen Ruhleder, "Steps toward an Ecology of Infrastructure: Design and Access for Large Information Spaces," *Information Systems Research Information Systems Research* 7, no. 1 (1996): 111–134; Geoffrey C. Bowker, Karen Baker, Florence Miller, and David Ribes, "Toward Information Infrastructure Studies: Ways of Knowing in a Networked Environment," in *International Handbook of Internet Research*, eds. Jeremy Hunsinger, Lisbeth Klastrup, and Matthew M. Allen (Dordrecht, Netherlands: Springer, 2010), 97–117; Lisa Parks and Nicole Starosielski, eds., *Signal Traffic: Critical Studies of Media Infrastructures* (Urbana: University of Illinois Press, 2015); McKinney, *Information Activism*.

37. Thomas A. Stapleford, *The Cost of Living in America: A Political History of Economic Statistics, 1880–2000* (Cambridge: Cambridge University Press, 2010), 101.

38. Stapleford, *Cost of Living*.

39. In the mid-1990s, adjustments to the CPI took into account (in the case of cars) "improved corrosion protection, improved warranties, sealing improvements, stainless steel exhaust, longer-life spark plugs, improved steering gears, rust-resistant fuel injection, clearcoat paint, and more." Katharine G. Abraham, John S. Greenlees, and Brent R. Moulton, "Working to Improve the Consumer Price Index," *Journal of Economic Perspectives* 12, no. 1 (1998): 31.

40. Michael J. Boskin, Ellen L. Dulberger, Robert J. Gordon, Zvi Griliches, and Dale W. Jorgenson, "Consumer Prices, the Consumer Price Index, and the Cost of Living," *Journal of Economic Perspectives* 12, no. 1 (1998): 5.

41. Mayo Moran, "The Reasonable Person: A Conceptual Biography in Comparative Perspective," *Lewis & Clark Law Review*, 14 (2010): 1233.

42. The reasonable person's siblings come from John Gardner, "The Many Faces of the Reasonable Person," *Law Quarterly Review* 131 (2015): 563–584; "select group . . ." from *Helow v. Advocate General*, 1 WLR 2416 at 2417–2418 (2008).

43. Ellison Kahn, "A Trimestrial Potpourri," *South African Law Journal* 102, no. 1 (1985): 184–190.

44. Moran, "The Reasonable Person."

45. US Equal Employment Opportunity Commission on Harassment, https://www.eeoc.gov/laws/types/harassment.cfm (emphasis added).

46. Robert S. Lynd and Helen Merrell Lynd, *Middletown: A Study in American Culture* (New York: Harcourt, Brace, Jovanovich, 1956); *Middletown in Transition: A Study in Cultural Conflicts* (Boston: Houghton Mifflin Harcourt, 1982).

47. Sarah E. Igo, *The Averaged American: Surveys, Citizens, and the Making of a Mass Public* (Cambridge, MA: Harvard University Press, 2008), 55–56.

48. As Igo writes, in 1923, Lynd tried to explain his reasons for only including US-born whites in the Middletown studies: "The reason for this is obvious: since we are attempting a difficult new technique in a highly complicated field, it is desirable to simplify our situation as far as possible." *Averaged American*, 56.

49. Igo, *Averaged American*.

50. Elihu Katz and Paul F. Lazarsfeld, *Personal Influence: The Part Played by People in the Flow of Mass Communication* (Piscataway, NJ: Transaction Publishers, 1955), 335.

51. Katz and Lazarsfeld, *Personal Influence*, 339.

52. See Ensmenger, "Is Chess the Drosophila of Artificial Intelligence?" specifically page 6 and his comparison of artificial intelligence research to Robert Kohler's history of the use of *D. melanogaster* in genetics research.

53. Bowker et al., "Toward Information Infrastructure Studies."

54. I have mostly, here, focussed on entrenched proxies in technical, bureaucratic, and academic settings. But their presence is pervasive. While I discuss the artistic appropriation of proxies in chapter 6, Alice Christensen has reminded me of their appearance in literature, as well. Recall, for instance, the clerk (a "Prokurist"— a kind of legal proxy) in Franz Kafka's *Metamorphosis* who visits Gregor Samsa, and as proxy for his parents and boss, demands an explanation, "I am speaking here in the name of your parents and of your chief, and I beg you quite seriously to give me an immediate and precise explanation." Kafka chooses an actual legal proxy to stand in for the world *out there* at the threshold to Samsa's bedroom. Franz Kafka, *The Complete Stories*, ed. Nahum N. Glatzer (New York: Schocken, 1971), 97.

55. The term "fixed point" comes from the field of mathematics, but here, I am evoking the way that it is used to describe invariants in the process of developing a standard (a topic discussed at much greater length in chapter 2), in which fixed points become the hardened bases of a system of measurement and comparison. For a useful description of the scientific processes and debates behind setting fixed points, using the case of developing standardized thermometers, see Hasok Chang, *Inventing Temperature: Measurement and Scientific Progress* (Oxford: Oxford University Press, 2004).

56. Martha Lampland and Susan Leigh Star, *Standards and Their Stories: How Quantifying, Classifying, and Formalizing Practices Shape Everyday Life* (Ithaca, NY: Cornell University Press, 2009), 14.

57. From George William Francis, *The Dictionary of the Arts, Sciences, and Manufactures* (London: W. Brittain, 1846) (emphasis in original).

58. Stuart Hall, "New Ethnicities," in *Stuart Hall: Critical Dialogues in Cultural Studies*, eds. Kuan-Hsing Chen and David Morley (London: Routledge, 1996), 441–449.

59. Stanley Cavell, "The Uncanniness of the Ordinary," in *In Quest of the Ordinary: Lines of Skepticism and Romanticism* (Chicago: Chicago University Press, 1994), 172.

60. Berlant, "The Commons," 394.

61. Here, I am building on the work of others, including Mara Mills, Cait McKinney, Laine Nooney, and Jonathan Sterne, who offer ways of thinking of nonlinear media histories that do not efface the place of human bodies in technological cultures. See Mara Mills, "Do Signals Have Politics? Inscribing Abilities in Cochlear Implants." in *Oxford Handbook of Sound Studies*, ed. Trevor Pinch and Karin Bijsterveld (New York: Oxford University Press, 2011), 320–346; McKinney, *Information Activism*; Laine Nooney, "A Pedestal, a Table, a Love Letter: Archaeologies of Gender in Videogame History," *Game Studies* 13, no. 2 (2013), http://gamestudies.org/1302/articles/nooney; Jonathan Sterne, *MP3: The Meaning of a Format* (Durham, NC: Duke University Press, 2012).

62. In this way, proxies often function in a mediating role similar to quantum media, as described by Jacqueline Wernimont in *Numbered Lives: Life and Death in Quantum Media* (Cambridge, MA: MIT Press: 2019).

63. John Durham Peters, "Witnessing," *Media, Culture & Society* 23, no. 6 (2001): 709; Carrie Rentschler, "Witnessing: US Citizenship and the Vicarious Experience of Suffering" *Media, Culture & Society* 26, no. 2 (2004): 296–304.

64. This quote is from the June 18, 1999, issue of the paper. The article "Bombs Away at Yodaville," written by James W. Crawley, was digitized and uploaded to a Geocities site with the improbable URL of www.geocities.com/pentagon, which at the time was the home page containing information and resources on military operations on urbanized terrain. If you want to read the whole article, you might be able to view it here: https://web.archive.org/web/20020207204247/http://www.geocities.com:80/Pentagon/6453/index.html.

65. On the construction of testing scenarios, see Donald Mackenzie, *Inventing Accuracy* (Cambridge, MA: MIT Press, 1990); Trevor Pinch, "'Testing—One, Two, Three . . . Testing!': Toward a Sociology of Testing," *Science, Technology, & Human Values* 18, no. 1 (1993): 25–41.

66. Glenn et al., *Preparing for the Proven Inevitable*; Christine Hoekenga, "3:10 to Baghdad," *High Country News* (March 31, 2008), https://www.hcn.org/issues/367/17605. These place names are also repeated in Microsoft PowerPoint slides from the US Military.

67. On immersion, military training, and simulation, see Lucy Suchman, "Configuring the Other: Sensing War through Immersive Simulation," *Catalyst: Feminism, Theory, Technoscience* 2, no. 1 (2016): 1–36.

68. "Iraq War Ratchets up Work at Yuma-Area Bases," *Tucson Citizen*, March 23, 2006.

69. Pinch, "Testing," 26.

70. It is worth mentioning that Yuma, Arizona, and the surrounding desert has also been a frequent filming location, since the earliest days of the American film industry. The desert has stood in for other terrestrial deserts as well as the desert planet Tatooine in the Star Wars film, *Return of the Jedi*.

71. Glenn et al., *Preparing for the Proven Inevitable*, 38–39; Susan Leigh Star, "The Ethnography of Infrastructure," *American Behavioral Scientist* 43, no. 3 (1999): 377–391.

72. Richard Schechner, *Between Theatre and Anthropology* (Philadelphia: University of Philadelphia Press, 1985); Richard Schechner, *Performance Studies: An Introduction* (New York: Routledge, 2002); Rebecca Schneider, *Performing Remains: Art and War in Times of Theatrical Reenactment* (London and New York: Taylor & Francis, 2011).

73. Vaihinger, *The Philosophy of "As If."*

74. Vaihinger provides this example of fictions as arbitrary-but-necessary reference points: "Here we may also include all the arbitrary determinations found in science, such as, for example, the meridian of Ferro, the determination of the zero point, the selection of water as the measure of specific gravity, of the movements of the stars as an index of time. In all these cases certain points of reference are taken and lines similar to co-ordinates drawn in different directions for the determination and classification of phenomena." *The Philosophy of "As If,"* 23–24.

75. Vaihinger, *The Philosophy of "As If,"* 15 (emphasis added).

76. Anthony Appiah, *As If: Idealization and Ideals* (Cambridge, MA: Harvard University Press, 2017), 3.

77. Vaihinger argues that fictitious means predominate in disciplines that must manage "a large number of quantities that oscillate around an ideal point (e.g., meteorology and statistics)," *The Philosophy of "As If,"* 224, n2.

78. William Stanley Jevons, *Principles of Science: A Treatise on Logic and Scientific Method* (New York: MacMillan, 1874), 422.

79. Theodore Porter, *The Rise of Statistical Thinking, 1820–1900* (Princeton, NJ: Princeton University Press, 1988), 52; Lambert Adolphe Jacques Quetelet, *A Treatise on Man and the Development of His Faculties*, ed. T. Smibert, trans. R. Knox (Cambridge: Cambridge University Press, 2013).

80. Georges Canguilhem, *The Normal and the Pathological*, trans. Carolyn R. Fawcett (Brooklyn: Zone Books, 1989); Lennard J. Davis, *Enforcing Normalcy: Disability, Deafness, and the Body* (London and New York: Verso, 1995); Michael Warner, *The Trouble with Normal: Sex, Politics, and the Ethics of Queer Life* (New York: Free Press, 1999).

81. Ian Hacking, *The Taming of Chance* (Cambridge: Cambridge University Press, 1990).

82. Canguilhem, *The Normal and the Pathological*; Hacking, *The Taming of Chance*.

83. See, for instance Aimi Hamraie's history of design thinking, and the discussion of Henry Dreyfuss's user designs based on statistical averages. Aimi Hamraie, *Building Access: Universal Design and the Politics of Disability* (Minneapolis: University of Minnesota Press, 2017); Henry Dreyfuss, *The Measure of Man: Human Factors in Design*, 2nd ed. (New York: Whitney Library of Design, 1967).

84. Hacking, *The Taming of Chance*.

85. Hacking, *The Taming of Chance*, 108.

86. Davis, *Enforcing Normalcy*; Hamraie, *Building Access.*

87. Lawrence Busch, *Standards: Recipes for Reality* (Cambridge, MA: MIT Press, 2011).

88. On the idea that things that are felt to be real are real in their effects, see the Thomas Theorem, first articulated by William I. Thomas and Dorothy S. Thomas in *The Child in America: Behavior Problems and Programs* (New York: Alfred A. Knopf, 1928); see also Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences* (Cambridge, MA: MIT Press, 1999). Vaihinger was aware of the similarity of his theory to pragmatism, writing:

    > Pragmatism, too, so widespread throughout the English-speaking world, has done something to prepare the ground for Fictionalism, in spite of their fundamental difference. Fictionalism does not admit the principle of Pragmatism which runs: 'An idea which is found to be useful in practice proves thereby that it is also true in theory, and the fruitful is thus always true'. The principle of Fictionalism, on the other hand, or rather the outcome of Fictionalism, is as follows: An idea whose theoretical untruth or incorrectness, and therewith its falsity, is admitted, is not for that reason practically valueless and useless; for such an idea, in spite of its theoretical nullity may have great practical importance. (*The Philosophy of "As If,"* viii)

89. Bose et al. showed in 2011 that injury and fatality rates between people categorized as male versus female showed that "the odds for a belt-restrained female driver to sustain severe injuries were 47% higher than those for a belt-restrained male driver involved in a comparable crash." Dipan Bose, Maria Segui-Gomez, and Jeff R. Crandall, "Vulnerability of Female Drivers Involved in Motor Vehicle Crashes: An Analysis of US Population at Risk," *American Journal of Public Health* 101 (December 2011): 2368–2373. See also Caroline Criado-Perez, *Invisible Women: Exposing Data Bias in a World Designed for Men* (New York: Harry N. Abrams, 2019).

90. While the goal of Bose et al. was to demonstrate sex-specific disparities in injury prevention, we should resist the urge to sort people along dichotomous, sex-specific categories, and instead see the body-specific ways that a reliance on an anthropomorphic model based on so-called averageness has injurious outcomes for many people. Bose et al., "Vulnerability of Female Drivers."

91. Bowker and Star, *Sorting Things Out*; John Dewey, *The Essential Dewey*, ed. Larry A. Hickman and Thomas M. Alexander (Bloomington: Indiana University Press, 1998).

92. Bowker and Star, *Sorting Things Out*, 290.

93. Hamraie, *Building Access*; Rosemary Garland Thomson, *Extraordinary Bodies: Figuring Physical Disability in American Culture and Literature* (New York: Columbia University Press, 2017).

94. Judith Butler, "Performative Acts and Gender Constitution: An Essay in Phenomenology and Feminist Theory," *Theatre Journal* 40, no. 4 (1988): 519–531.

95. Friedrich Nietzsche, *The Portable Nietzsche*, trans. Walter Kaufmann (New York: Penguin Books, 1982), 47.

96. Charles Goodwin, "Professional Vision," *American Anthropologist* 96, no. 3 (1994): 606–633.

97. For some recent, like-minded work on gendering as a process within technological cultures, see Wendy Chun, *Programmed Visions: Software and Memory* (Cambridge, MA: MIT Press, 2011); Jennifer S. Light, "When Computers Were Women," *Technology and Culture* 40, no. 3 (1999): 455–483; Amy Adele Hasinoff, *Sexting Panic: Rethinking Criminalization, Privacy, and Consent* (Urbana: University of Illinois Press, 2015); Lisa Nakamura, "Indigenous Circuits: Navajo Women and the Racialization of Early Electronic Manufacture," *American Quarterly* 66, no. 4 (2014): 919–941; Rena Bivens, "The Gender Binary Will Not Be Deprogrammed: Ten Years of Coding Gender on Facebook," *New Media & Society* 9, no. 6 (2017): 880–898; Mar Hicks, *Programmed Inequality: How Britain Discarded Women Technologists and Lost Its Edge in Computing* (Cambridge, MA: MIT Press, 2017).

98. Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences*, trans. A. M. Sheridan (London: Routledge, 2002[1970]).

CHAPTER 2

1. Carolyn Marvin, *When Old Technologies Were New: Thinking about Electric Communication in the Late Nineteenth Century* (Oxford: Oxford University Press, 1988).

2. The NPL is the national measurement institute in the United Kingdom and a crucial part of the country's national measurement infrastructure.

3. Michael de Podesta, "The Measure of Science: Redefining the Kilogram," presentation, the Royal Institution, London, October 22, 2018.

4. This particular kilogram lasted 130 years, but the idea of a physical mass standard in the metric system persisted for almost 220 years.

5. de Podesta, "The Measure of Science."

6. de Podesta, "The Measure of Science."

7. de Podesta, "The Measure of Science."

8. Although the Planck constant did not previously have a fixed value (only a value that included a standard uncertainty), the new instructions for "realizing" kilograms required three sufficiently precise measurements (5 parts in 10^8) of the Planck constant using a watt balance. Once the three measurements were obtained, they were averaged out to create a new, fixed value of the Planck constant, with no standard uncertainty. Philippe Richard, Hao Fang, and Richard Davis, "Foundation for the Redefinition of the Kilogram," *Metrologia* 53, no. 5 (2016): A6.

9. Terry Quinn, *From Artefacts to Atoms: The BIPM and the Search for Ultimate Measurement Standards* (Oxford and New York: Oxford University Press, 2011), 341.