Granular Worlds: Situating the Sand Table in Media History

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We could describe the table as an "on" device; the table provides a surface on which we place things as well as do things.

–Sara Ahmed[1]

There is a pile of sand, but no history.

–Theodor Mommsen[2]

In 2021, sand was inducted into the Toy Hall of Fame at The Strong National Museum of Play in Rochester, New York. Usually, the annual inductees are commercial products of one sort or another, like Crayola crayons or the board game *Risk* (Hasbro, 1957). But sand, the curators noted, may be "the most universal toy in the world."[3]

When it is not a prominent part of the natural environment (or associated with the pleasures of the beach), adults typically find sand to be either

1. Sara Ahmed, "Orientations Matter," in *New Materialisms: Ontology, Agency, Politics*, ed. Diana Coole and Samantha Frost (Durham, N.C., 2010), p. 235.
2. Quoted in Wolfgang Ernst, "Agencies of Cultural Feedback: The Infrastructure of Memory," in *Waste-Site Stories: The Recycling of Memory*," ed. Brian Neville and Johanne Villenueve (Albany, N.Y., 2002), p. 113.
3. "Sand," The Strong National Museum of Play, www.museumofplay.org/toys/sand/

an utterly nondescript substance, a strictly utilitarian one (numerous things are manufactured from sand and silica, from concrete to glassware to silicon chips), or else a nuisance (tracked into the house or trapping a golf ball). Sand, indeed, is often associated with emptiness or the complete absence of an environment, per the desert in common Western parlance. For children, however, sand is a powerful "creative vehicle," suitable (again in the words of the museum) for "pouring, scooping, sieving, raking, and measuring." Wet sand, they note, "is even better, ready to construct, shape, and sculpt."[4]

More than a toy, sand is also a medium, an elemental substrate. As numerous commentators have observed, playing with sand may be the first creative experience of a medium many of us have.[5] Given the extent to which such testimonials have become universalized, it is worth quoting one early attempt to promote sand's virtues, Hermann von Arnswald writing to his former teacher, the German educational reformer Friedrich Froebel, on 13 May 1847:

> Might not a plane of sand be made a useful and entertaining game? By a plane of sand I mean a low, shallow box of wood filled with pure sand. It would be a kindergarten in miniature. The children might play in it with their cubes and building blocks. I think it would give the child particular pleasure to have the forms and figures and sticks laid out in the sand before his eyes. Sand is a material adaptable to any use. A few drops of water mixed with it would enable the child to form mountains and valleys in it, and so on.[6]

It is striking how much of what N. Katherine Hayles might call "media-specific analysis" is present in these sentences, from details on the actual construction of the box to the benefit (again) of adding water to the sand.[7] Notably, the children play *in* the box, sharing space with what it contains.

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4. Ibid.

5. See, for example, Jay Mechling, "Sandwork," *American Journal of Play* 9 (Fall 2016): 19–40. Jay Mechling notes that sand may fail to clear what theorist of play Brian Sutton-Smith named the "'triviality barrier,'" the threshold of attention required to take an object seriously (p. 19).

6. Quoted in Kate Douglas Wiggin and Nora Archibald Smith, *Froebel's Occupations*, vol. 2 of *The Republic of Childhood*, 3 vols. (Boston, 1900), p. 294.

7. N. Katherine Hayles, "Print is Flat, Code is Deep: The Importance of Media-Specific Analysis," *Poetics Today* 25 (Spring 2004): 67–90.

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They occupy the box but also transcend it, colossi looking downward upon their domain (as opposed to upward, toward a parent or teacher). This posture no doubt helps give rise to the pleasures of world making, the "low, shallow" box of wood opening onto wide vistas in the imagination. Froebel was convinced; he arranged the installation of public *sandgarten* throughout Berlin and from there the idea spread elsewhere, including, by 1885, the US.[8]

Sandgarten or *sandkasten* were also adapted for indoor use, the sand contained within a shallow tray. These trays were sometimes mounted, the sandbox now a sand *table*, transformed into a kind of furnishing to further domesticate the substrate. (An article in a 1900 issue of *Good Housekeeping Magazine* compares the design of a sand table to "a butler's tray.")[9] Whereas children might be content to kneel and squat, a sand table would have been a boon to adult vertebrae; it also served to elevate its contents to the level of other grown-up activities conducted at a table, including reading and writing. Sand tables were to become fixtures in a variety of settings, from childhood education (and simple recreation) to clinical therapy to the military. Indeed, the sand table as such has its systemic origins in the Prussian army, where we find numerous accounts of them being used as training devices (it is quite possible this is where von Arnswald got the idea).

But sand tables have a much older pedigree. The Egyptians spread layers of sand across flat surfaces then placed pebbles in scored columns or grooves to keep tallies and work sums. The Greeks did much the same, depositing sand atop a wooden panel with a raised border; such panels or trays could be stored indefinitely. (As Georges Ifrah tells us, the word abacus was derived from the Greek *abax* or *abacon* [table or tablet], which in turn arises from the Semitic *abq* [sand, or dust, tiny little *bits* of particulate matter].)[10] These ancient sand tables performed no actual computations but functioned as cognitive and mnemonic aids. A 1961 general readers' book with the exclamatory title *Computers! From Sand Table to Electronic Brain* testifies to what was once a pride of place in origin stories of modern computing.[11]

Outside of a narrow strain of German media studies, however, most recent narratives of the digital omit the sand table. This article seeks to restore it to computational and media history but also to eschew deterministic

8. See Alexandra Lange, "An Intellectual History of the Sandbox," *Slate*, 15 Jun. 2018, slate.com/human-interest/2018/06/history-of-the-sandbox-the-origins-of-a-playground-for-kids-and-ideas.html

9. Quoted in "Time Line of the Sand Box," *A Victorian Passage*, www.victorianpassage.com/2008/11/time_line_of_the_sand_box/

10. See Georges Ifrah, *The Universal History of Numbers: From Prehistory to the Invention of the Computer*, trans. David Bello (New York, 2000), p. 207.

11. See Alan Vorwald and Frank Clark, *Computers! From Sand Table to Electronic Brain* (New York, 1961), pp. 23–25.

renderings by offering a situated and granular account of the sand table in its own right, decoupling it from its role as a mere cameo on the way to computation. Neither as ubiquitous as maps, as visceral in impact as photographs, nor as publicly relatable as dioramas or board games, sand tables nevertheless knit together all of these media traditions: the cartographic, the mimetic, and the ludic. The table, in ways we will explore, became a platform *avant la lettre*, enabling forms of representation we associate with present-day digital capabilities: visualization, simulation, iteration, and, above all, interaction. More than this, however, sand tables also retroactively instantiate—as literal objects and infrastructure—a mode of speculative world-building typically seen as the signature of twentieth- and twenty-first-century futurology, refined in the think tanks of the Cold War and their vast reservoirs of situations and scenarios. This speculative mode persists— via the locution of the *sandbox*—as a descriptor for an open-ended, exploratory (and endlessly regenerative) game world.[12] I will return to sand, scenarios, and world-making in the final part of this article.

Sand, I will also argue, presents us with a medium that operates through processes of aggregation and dissolution, its cohesion only ever manifesting as localized pressure, the continual rub of what its researchers call tribology— the friction between grains. This friction is what activates localized stresses and forces in a manner that is very unlike digital bits, each of which is (functionally) self-identical with every other. We might say that the digital offers us its ontology *despite* its underlying materiality, whereas granular media have the capacity to mediate *through* the particulars of their materiality, which is to say the particulars of their particulates. Granular media such as sand (or salt or sugar or lentils or rice) are a subcategory of what John Durham Peters terms *elemental media*; their presence across cultures and geography suggest an alternative genealogy and an alternative ontology to the long strings of binary ones and zeros that code the global present.[13] Arguably—through their ties to basic social functions like cooking, building, trading, and playing—granular media may, as Liam Cole Young suggests, present something of an alternative ethos.[14]

As an apparatus or device, a sand table might seem rudimentary, hardly media in any technical sense at all. Yet, as I will argue, the sand table was no less sophisticated in its capacity for representation (and mediation) than

12. See Steve Breslin, "The History and Theory of Sandbox Game Play," *Gamasutra*, 16 Jul. 2009, www.gamasutra.com/view/feature/132470/the_history_and_theory_of_sandbox_.php

13. See John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago, 2015).

14. See Liam Cole Young, "Salt: Fragments from the History of a Medium," *Theory, Culture, and Society* 37, no. 6 (2020): 135–58.

contemporary sonic or visual media, just as its institutionalization within the Western military and educational establishments coincided with the eruption of nineteenth-century media technologies shortlisted as gramophone, film, and typewriter (to which we could add the telegraph, photograph, panorama, Linotype, and myriad others). Amid the wonders of recorded sound and still and moving images, the sand table invites us to consider a substrate that is a literal platform for granular world making. Ancient and elemental but also pervasive and persistent, the sand table deserves a place—a situation—in our media histories, especially those which, taking their cues from digital devices, would seek to place a premium on the virtues of interactivity. Sand, in sum, has more to offer media studies than silicon.

1

A sand table is an intentional structure that furnishes a platform for visualization and simulation. An early twentieth-century source is more prosaic: "Simply a box mounted on trestles to a convenient height, or a curbed table, partially filled with sand" (fig. 1).[15] This platform (or box) becomes a tactile space for the rehearsal of tactics, staccato words whose roots lie in haptics and arrangement. Common to this day in military settings, sand tables have also been used to teach the blind, train wilderness firefighters, conduct therapy for trauma victims, illustrate Sunday School stories to children, and play imaginative games (a sand table is part of the origin story of *Dungeons & Dragons*).

Most concretely, a sand table—by virtue of *being* a table—is what Shannon Mattern has termed an "intellectual furnishing". "I recognize these furnishings as much more than utilitarian equipment," Mattern writes of exemplars that include desks, bookshelves, storage towers for cassette tapes or compact discs, and even the modular supports of digital server racks. "Instead, they scaffold our media technologies in particular ways, inform the way human bodies relate to those media in particular ways, and embody knowledge in particular ways. They render complex intellectual and political ideas *material* and *empirical*."[16] As a furnishing, the sand table elevates—literally—what may be the oldest form of inscription we have: scratching marks and shapes in the dirt with a fingertip or stick. Its seeming simplicity notwithstanding, the table—its sides and edges, legs and trestles—must be built to fairly exacting specifications in order to bear the weight of the sand.

15. Paul Stanley Bond and Edwin Hunter Crouch, *Tactics: The Practical Art of Leading Troops in War: With Numerous Illustrations, Practical Exercises, and the New Tables of Army Organization* (New York, 1922), p. 34.

16. Shannon Mattern, "Intellectual Furnishings," *Medium*, 19 Oct. 2014, medium.com /@shannonmattern/intellectual-furnishings-e2076cf5f2de
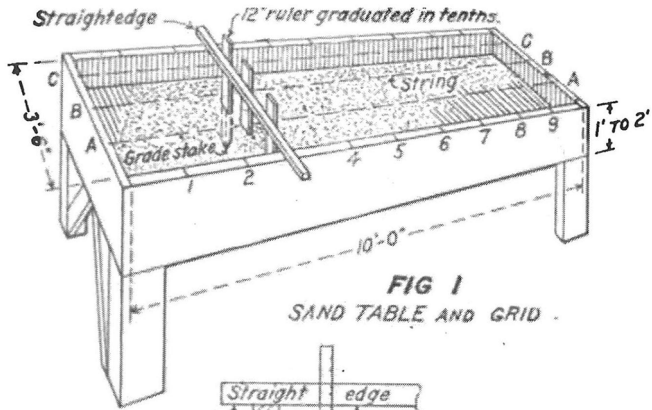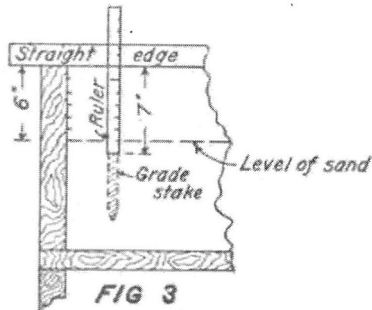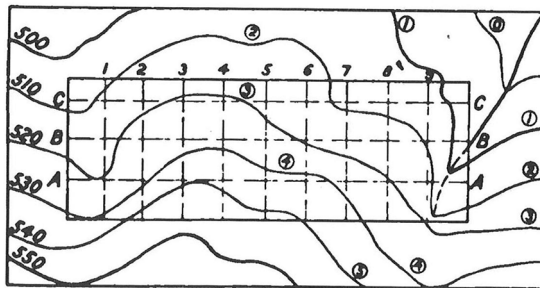
FIGURE 1.   Drawings demonstrating the construction of a sand table from Paul Stanley Bond and Edwin Hunter Crouch, *Tactics: The Practical Art of Leading Troops in War; With Numerous Illustrations, Practical Exercises, and the New Tables of Army Organization* (New York, 1922), p. 35. The schematics expose the material sophistication of this seemingly simple device.

Other forms of material complexity also manifest: sometimes the interior is lined with zinc to act as a sealant (plastic in more modern incarnations); a wire framework can be strung across the top to translate to and from the grid of topographic maps.

Everything made by sand is temporary, as countless lyrics and aphorisms remind us. For the sand table, however, this is a virtue. Over and over again, writers of military instructional manuals boasted of the ease with which the terrain could be reshaped, the hills and valleys raked smooth and made over anew—though in practice the same manuals dictated the meticulous care required to properly dress the table, the scenarios or exercises setting forth the number of hours required for their preparation.[17] Rakes, trowels, brushes, and bare hands were all used in the service of that preparation, the sand shaped and arranged until the table's contents corresponded to some real-world or imaginary terrain in a three-dimensional model. Slopes were sculpted, fields and forests marked out, and streams and rivers laid in. As per von Arnswald, the sand ("of a grade easily moulded") was typically wetted to help it hold its shape.[18]

On this improvised yet artful landscape in miniature, tactical problems would be presented to cadets. Organize a line of march from here to here, defend a crest from there to there, set an ambush in those woods beside that bridge over the stream. When those same cadets were called to arms, the sand table technique could go with them, the exercises updated to depict some real or impending situation at the front. Today there is a direct lineage from sand tables to sand-based augmented reality systems (originally developed by the Department of Defense), which offer malleable surfaces on which visual projection and haptic touch-based interfaces coexist (fig. 2).[19] An augmented reality sand table features in *Black Panther* (dir. Ryan Coogler, 2018), where

17. Military manuals illustrating how to build and prepare a sand table and set up the tactical exercises to be conducted thereon began appearing in print by the start of the twentieth century, first in Germany, then in Great Britain and the US. Perhaps the most celebrated of the English-language titles was A. W. Valentine's *Sand Table Exercises*, which went through no less than nine editions before 1938. After the Second World War still more editions appeared, responsibility for them having been turned over to A. J. D. Turner. See Archibald William Valentine, *Sand Table Exercises* (Aldershot, 1931), and T. W. Sloman, *Building and Modelling Sand Tables* (Aldershot, 1955). For a specifically US context, see J. J. Fulmer, *Use of the Sand Table* (Fort Leavenworth, Kans., 1917). Meanwhile, a 2003 manual prepared by the National Interagency Fire Center in cooperation with the US Marine Corps demonstrated the sand table's use in training recruits to combat wilderness forest fires—the lay of the land being as important a factor in firefighting as it is in a firefight; see National Wildfire Coordinating Group, *Design and Delivery of Tactical Decision Games* (2018), www.nwcg.gov/publications/468-1

18. Sloman, *Building and Modeling Sand Tables*, p. 12.

19. The so-called ARES (Augmented REality Sand Table), see Charles R. Amburn et al., "The Augmented Reality Sandtable," US Army Research Laboratory, Oct. 2015, apps.dtic.mil/sti/pdfs/ADA622471.pdf
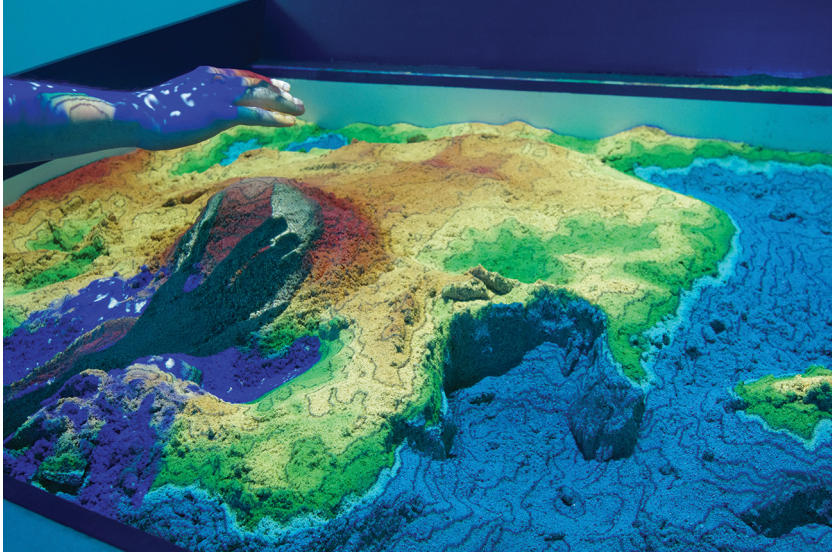
FIGURE 2. An Augmented REality Sand Table (ARES) at the Games Science Center, Berlin. Photo by Cryrill Etter.

FIGURE 3. Iraqi Army personnel using a large and elaborate sand table (actually a sand-box) to rehearse plans for an operation near the town of Muqdadiyah in March of 2011. Of particular interest is the way in which the "table" is clearly delimited as an exceptional space set off from the sand of the surrounding desert. Alamy. Licensed use.

Chadwick Boseman's T'Challa is seen using one (composed of granules of Vibranium) to rehearse a raid on a convoy of vehicles. As the company that produced the design concept explains, the sand table "takes on a very refined, unique aesthetic that remains holistic and earth-bound in its thinking and approach."[20] That a sand table figures into the Marvel Universe in such a way is—like The Strong National Museum of Play's comments about sand—a small index of the medium's place in the contemporary imagination: universal and thoroughly naturalized yet still novel and inspiring.

A sand table almost always contains more than just sand. All of the following are commonplace in descriptions of how to dress one: matchsticks, twigs, moss, cotton, lichen, glass, isinglass, wool, wire, wire mesh, sawdust, powder, paint, powdered pigments, putty, clay, chalk, tape, tacks, tin, and celluloid (good for representing water). The scenery is also augmented with models to represent roads, houses, bridges, and other built features. Finally, miniature figures (or blocks, tokens, flags, or placards) are placed to represent the disposition of friendly and enemy troops or other actors. The process of making a world from scratch forces and focuses attention on every individual element, the necessity for constant material improvisation effecting a kind of ontological flattening. Brush, fence lines, roads, buildings, a person, a cow: all require more or less equal investments of energy and imagination to render. As Susan Stewart suggests, there are no forests in a tiny tabletop world, only individual trees, fabricated from a twist of wire (let's say) garnished with some lichen—twisted and garnished one by one by one.[21]

A significant feature of a sand table is that it is an enclosure. The audience stands or is seated around it; their gaze directed inward and downward (fig. 3). At a practical level this is necessary to contain the substrate. But the sand table quickly establishes itself as a space apart, the magic circle we recall from Johan Huizinga in *Homo Ludens*.[22] The fixity of the table's borders in conjunction with the malleability of its interior combine to create a unique field of potentiality. Sand tables (and their cousins, sand trays) have long been recognized in trauma therapy for precisely this affordance: a safely bounded exploratory space. "Sand play," as it is known, is ascribed to the British pediatrician and child psychologist Margaret Lowenfeld, who also referred to it as the "World Technique" because her child patients called their

20. "Black Panther Technology Design," Perception, experienceperception.com/black -panther-fui.html

21. See Susan Stewart, *On Longing: Narratives of the Miniature, the Gigantic, the Souvenir, the Collection* (Durham, N.C., 1993), p. 59.

22. See Johan Huizinga, *Homo Ludens: A Study of the Play-Element in Culture* (Boston, 1971).

FIGURE 4.   Margaret Lowenfeld at the Institute for Child Psychology in London, employing her "World Technique" sometime in the 1930s. L0086404, Lowenfeld Archives, Wellcome Collection, Medical Photographic Library. Used by permission.

creations "worlds."[23] Using the sand contained within the tray and an assortment of toys, props, and miniature figures, a client is asked to nonverbally represent or enact emotions or events (fig. 4). Importantly, sand feels soothing and safe to the touch, inviting improvisation and expression. The hands-on, tactile nature of the activity is paramount: "traumatic memories," explains one textbook, "are encoded not only in the brain, but within the body as well."[24]

Despite appearances, a sand table is not a diorama. Both are platforms for depicting miniaturized scenes, but a diorama is spectacle or tableaux, fixed and static. At the 1939 World's Fair, the industrial designer Norman Bel Geddes exhibited Futurama, a massive artificial city of the future. Its 35,738 square feet (nearly an acre) encompassed half a million buildings (the largest among them taller than a person), a million model trees, and fifty thousand cars, some of them animatronic, on fourteen-lane expressways. Shortly

23. "The World Technique," Dr. Margaret Lowenfeld Trust, lowenfeld.org/the-world-technique/
24. Linda E. Homeyer and Daniel S. Sweeney, *Sandtray Therapy: A Practical Manual* (New York, 2016), p. 3. See also Hannah Zeavin, "War Games—Mourning Loss Through Play," in *Shared Traumas, Silent Loss, Public and Private Mourning*, ed. Lene Auestad (New York, 2018), pp. 1–13.

thereafter he took commissions to build war dioramas of equally exacting detail that were photographed in first-person perspective for *Life* magazine as renditions of battles like the Coral Sea and Kursk. But Bel Geddes's aims were documentary; notably, the basic surface material for both Futurama and the wartime dioramas was a plaster called excelsior, the same kind of compound used in taxidermy.[25] The landscape it produced—whether Russian steppes or ocean waves—was frozen in place, not unlike, in its way, a stuffed owl or ocelot. Though eventually placed on exhibit at the Museum of Modern Art, the war dioramas were conceived first and foremost as pictorial media to be experienced through *Life's* artful photography (as full-page spreads in the magazine's oversized format, they are indeed striking and immersive); Futurama, notably, featured an elevated motorized carriage that allowed fairgoers to circumnavigate the wondrous city while ensuring its skyscrapers and superhighways remained well out of reach.[26]

A sand table, by contrast, is meant to be touched (fig. 5). Instructor and pupil can reach into its interior and rearrange the elements. As Anders Engberg-Pedersen relates, the beginning of the nineteenth century saw a renewed interest in touch as a way of understanding the world, spurred in part by the writings of Immanuel Kant on what he termed *logical tact*, a kind of "cognitive touch" or feel for thought.[27] "When Kant conceives of 'logical tact,'" Engberg-Pedersen explains, "it is as a cognitive touch that immediately provides the correct concept of an empirical object or the best solution to a practical problem" (*EC*, p. 71). Etymologically and otherwise, it is but a short step from *cognitive touch* and *logical tact* to *tactics*, which is precisely what the then-contemporary innovation of the sand table taught. Tactics, in the realm of military affairs, is the space of kinetic action. Tactics must be responsive to friction, contingency, and environmental variables of the sort famously enumerated by Carl von Clausewitz, whom we know to have been versed in Kant's writings.

Tactics are intimately connected to the lay of the land, which is to say the actual material grit and *grain* of the battlefield. Sand tables teach tactics not through immersion (the kind of visceral experience we associate with

25. See B. Alexandra Szerlip, *The Man Who Designed the Future: Norman Bel Geddes and the Invention of Twentieth-Century America* (Brooklyn, N.Y., 2016), p. 237.

26. The Museum of Modern Art's press release for the exhibition of Bel Geddes's War Maneuver Dioramas, lavishing praise on their detail, declares: "It is almost impossible for the spectator not to believe he is seeing by means of the camera the actual event take place" (Museum of Modern Art, "War Maneuver Models Shown at Museum of Modern Art," 26 Jan. 1944, www.moma.org/momaorg/shared/pdfs/docs/press_archives/917/releases/MOMA_1944_0003 _1944-01-24_44124-3.pdf).

27. Anders Engberg-Pedersen, *Empire of Chance: The Napoleonic Wars and the Disorder of Things* (Cambridge, Mass., 2015), p. 71; hereafter abbreviated *EC*.

FIGURE 5.   A British military sand table from a 1932 photograph. Note the contrast between the towering figures of the men and the miniature landscape they look down upon (a bracing demonstration of what Nicholas Mirzoeff terms "the right to look"). Note also the painted backdrop (including an airplane at far left) whose mountains and sky blend seamlessly with the terrain on the table, adding depth to the illusion. Image from www.rifleman.org.uk/Land scape_Targetry.html. Used by permission.

virtual reality or first-person shooter games) but rather through the cultivation of something much closer to Kant's conception of logical tact. Officers used the sand table to inculcate the necessary "cognitive touch" in their trainees, so that in the midst of combat their well-developed logical tact would yield the correct tactical decisions. Not incidentally, sand tables accomplished this through their function as media, furnishing tangible objects and surfaces that activated (for Kant) the all-important fingertips.[28] In this the sand table would also seem to subtend David Parisi's account of the haptic subject as one that emerged to mark the intentional engineering of touch as an explicit medium for the circulation of information in and through the body. In Parisi's account, the media-archaeological spark is electricity; but sand, I would suggest, is similarly a conductor of haptic subjects.[29]

In military settings, a sand table exercise is the rare occasion that encourages discussion and dissent by those within its orbit. No small measure of the

28. To quote Engberg-Pedersen directly: "Around 1800 media offered a solution to the problem of learning how to manage space and contingency" (*EC*, p. 120). This Kittlerian pronouncement captures the confluence of philosophical discourse, changing martial realities, and the emergence of new technological platforms (certainly including the sand table) that Engberg-Pedersen sees as rewriting the habitus of war.

29. See David Parisi, *Archaeologies of Touch: Interfacing with Haptics from Electricity to Computing* (Minneapolis, 2018), pp. 4–5. Parisi describes the haptic subject as one that emerged to "both mark and steer the drastic changes touch underwent as it became increasingly an 'object-target' of scientific knowledge, engineering and design practice, bureaucratic management, therapeutic discourses, and commercial investment" (p. 4).

sand table's efficacy is gained from the ability of students to circumnavigate it, to discover fresh angles and perspectives. A twist of the body, a bend of the neck, and a new line of sight, a new grasp of the terrain may emerge—this in sharp contrast to the proprioceptive maintenance of posture that is the essence of the cadet's parade ground drill. These small, localized adjustments in position activate the strategically dominant perspectives of aerial vision that the table simulated well before the rise of actual airpower and photoreconnaissance, as has been written about by Beaumont Newhall, Paul Virilio, and others.[30] ("Visuality," as Nicholas Mirzoeff reminds us, "[is] a technique for waging war.")[31]

Rejecting accounts that seek to associate the view from above with all-seeing objectivity, Caren Kaplan offers a genealogy of what she terms aerial aftermaths, ways in which the technology and vantage of aerial observation oscillates between immediacy and belatedness, opening angles for new subjectivities that are partial and always inevitably grounded. The ways of seeing typically associated with aerial views are conducive, Kaplan reminds us, to some familiar binaries: objective versus subjective, global versus local, and remote versus intimate all figure in her list, which is, as she notes, specific to Western modernity.[32] Certainly Bel Geddes's spectacular dioramas, photographed or viewed from above, fit this description.[33] The sand table offers just such an aerial perspective, but scale, coupled with haptics, realigns the underlying binaries in some novel ways. The landscape portrayed by the table's features and terrain *appears* remote, but it is *also* always just an arm's length away, subject to an embodied encounter—and logical tact. Sand tables exchange the aerial photograph's forensic belatedness for a field of vision in and of the present, a tactile and tactical framework for interaction.

Multimedia artist Brian Conley takes up exactly this complex of issues in his performances/installations *Miniature War in Iraq* (2007) and *Miniature War in Iraq . . . and Now Afghanistan!* (2010). Conley describes the genesis of the project in his observation of tabletop wargamers and his interest in that niche pastime as a vector of critique for contemporary medial forms of participation and observation. Accordingly, he collaborated with the Kansas City Heart of America Historical Miniature Gaming Society to

30. See "The Aerial Image," a special issue of *Grey Room* 83 (Spring 2021).

31. Nicholas Mirzoeff, *The Right to Look: A Counterhistory of Visuality* (Durham, N.C., 2011), p. 277.

32. See Caren Kaplan, *Aerial Aftermaths: Wartime from Above* (Durham, N.C., 2018), p. 22.

33. See Adnan Morshed, "The Aesthetics of Ascension in Norman Bel Geddes's Futurama," *Journal of the Society of Architectural Historians* 63 (Mar. 2004): 74–99.

stage public wargames based on the two conflicts.[34] A very large sand table was constructed as the platform for the work; it featured a re-creation of a village and date-palm grove in the Zarga region near Najaf and subsequently a Baghdad neighborhood (fig. 6).

Because of its physical size, the table was actually four modular units butted together. This contrivance became integral to the rules of the game. Only insurgent players were allowed to pull the tables apart to move soldiers and vehicles that were otherwise out of reach in the interior. The US player, however, was given a participant suspended in a harness overhead, holding a model drone with one hand and with the other controlling a joystick that allowed her or him to swoop back and forth above the scene. In this way, intelligence was collected and strikes targeted. Conley describes the dynamics of the game this way:

> Players roll the dice and move the playing pieces by hand; they reach across the table, crane their necks for sightlines, crouch to measure distances, and so forth, yet all the while they tower gigantically above the fray. This tension is emphasized in the *Miniature War* video of the 2007 game in play, where all we see are the godlike hands of players reaching in from out of frame to gather up or knock over figures, upend vehicles, or dismantle buildings. The magic circle of absorptive involvement is made tangible in *Miniature War*, even as it is exaggerated to an extreme, almost caricatural level.[35]

The explicit rule differences governing play of the grounded insurgents versus the aerial Americans enact a performance of Kaplan's binaries. Above all, we see the sand table coalescing as a distinct form of media, one suitable for a variety of constituencies and situations and yet unique in its constellation of affordances—foregrounding the intentional manipulation of perspective, posture, haptics, play, and speculation, the latter both as mode of vision and a mode of the imagination.

2

Sand is a granular material. Granular materials, in the words of one researcher, "behave very strangely."[36] A more formal definition would specify

34. See Brian Conley, "Troubling the Magic Circle: *Miniature War in Iraq*," in *Zones of Control: Perspectives on Wargaming*, ed. Pat Harrigan and Matthew G. Kirschenbaum (Cambridge, Mass., 2016): 409–17.

35. Ibid., pp. 414, 416.

36. Michael Welland, *Sand: The Never-Ending Story* (Berkeley, 2009), p. 32. See also Vince Beiser, *World in a Grain: The Story of Sand and How it Transformed Civilization* (New York, 2018), and Etienne Guyon, Jean-Yves Delenne, and Farhang Radjai, *Built on Sand: The Science of Granular Materials*, trans. Erik Butler (Cambridge, Mass., 2020).

FIGURE 6.   Performance of Brian Conley's *Miniature War in Afghanistan* (2010), showing the American "drone" aloft above the sand table. Photo by Brian Conley. Pierogi Gallery, New York. Used by permission.

conglomerations of macroscopic particles that lower their entropy when they interact. Put plainly, granular materials (which would also include coffee beans, rice, sugar, salt, lentils, seeds, and popping corn) behave as though they are both a liquid and a solid, depending on their entropic state. The

associated physics are unique, as researchers have long understood. Charles-Augustin de Coulomb, best known for his study of electricity, developed laws of friction based on his study of the stability of embankments for military earthworks. Nowadays the study of granular materials demands an interdisciplinary array of physics, mathematics, materials science, and computer simulation.

Sand, too, has a scientific definition: its grains are of a diameter between 0.0625 and 2 millimeters, measured by an international standard known as the Udden-Wentworth scale. (Think of something just slightly wider than a human hair.) But mostly, sand seems defined by paradox: "Both miniscule and infinite, a means of measurement and a substance beyond measuring," as another commentator has it.[37] Sand is both sensuous and abrasive to the touch. Indeed, like the precarity of the substance itself, it is hard to know whether the materiality of sand consists more in the maintenance of these binaries or in their collapse. Sand, in still another description, is "a density that moves, circulates, shifts, translocates, and transforms."[38] Every grain is unique, yet each seems indistinguishable from all the others, at least to a layperson. An accumulation of sand is predictable in its behaviors yet difficult to control. Even the word itself, sand, is almost always understood to refer to some very large, presumably incalculable quantity of the stuff, as opposed to a single granular instance. Sand is a multiple, and we have a multitude of words for describing it in aggregate: dunes, heaps, piles, waves, and drifts, to name just some.[39] *Pace* Blake, the worlds made by sand are not in the grain but in their accumulated plenitude.

On the miniature slopes and swells of the sand table the same phenomenon that interested Coulomb is readily observable: why and how a pile of sand holds its shape—that is, holds its shape until it doesn't and a small avalanche ensues. Researchers have come to understand that the key to this question is the friction between grains, a function of what is known as tribology: the study of interacting surfaces in relative motion. We associate friction with wear and corrosion, but friction is also, of course, a stabilizing force. In particular, friction acts against gravity, which is constantly seeking to return any accumulation of sand to a higher entropic state. Wetting sand, which is routinely part of the preparation of a sand table, helps sand holds its shape by increasing its cohesion, the water drawing the grains

37. Beiser, *World in a Grain*, p. 2.

38. Quoted in David Farrier, *Anthropocene Poetics: Deep Time, Sacrifice Zones, and Extinction* (Minneapolis, 2019), pp. 24–25.

39. See *Grain*, vol. 1 of *Textures of the Anthropocene*, ed. Katrin Klingan et al., (Cambridge, Mass., 2015), p. 7.

closer together through surface tension. None of this is constant or stable, however. By contrast, the nature of the contact between any two grains is both transitory and dynamic: "As long as the contact lasts the small asperities on the surface of grains become deformed and abraded under the effect of highly concentrated forces at these points."[40]

If sand can be mobilized as media (as I have been claiming a sand table does), then it is tempting to compare individual grains to other basic media elements, like bits or pixels. We see this kinship in the colloquial term *grainy*, which is used to describe an image of insufficient resolution—so that the individual *grains* of the medium (pixels or halftone dots, say, or even the grain of a sheet of paper) become visible to the naked eye. For a digital bit—a binary one or zero—its essence consists not only in that it is singular and discrete but also that it is *symbolic*, fundamentally dissociated from its material substrate (like a silicon semiconductor). This symbolic dissociation is not a liability but the very essence of the digital. As Aden Evans suggests: "It is as *abstraction*, divorced from its concrete material meaning, drained of substance, that the bit undergirds most of the digital's extraordinary contributions."[41] This explains why digital objects routinely yield perfect copies: this inherent abstraction allows for flawless mathematical reproduction.[42]

With sand, however, the unique properties of every individual grain weigh in the balance in the overall stability of any given formation. The shape of a grain is vital. The kind of sand most suitable for modeling (*moulding*) is generally river or beach sand, which is angular in its geometries, as opposed to desert sand, which is rounded: rounded because desert wind is vastly more abrasive than running water. And as we have seen, none of these relationships and contacts are stable or constant. Put still another way, sand is not abstracted from its medium; sand, in all the material particulars of the ongoing interactions of each grain with its neighbors, *is* the medium. There is no gap, no margin of error, between the material substrate and its capacity for world making. There is no obvious way to copy a pile of sand. We can only mass another and another and another.

3

"Sand tables," as one source explains, "have been used by military planners since—well, pretty much as long as there has been both sand and military

40. Guyon, Delenne, and Radjai, *Built on Sand*, p. 81.
41. See Aden Evans, *Logic of the Digital* (London, 2015), p. 8.
42. See Kirschenbaum, *Mechanisms: New Media and the Forensic Imagination* (Cambridge, Mass., 2008).

planners."[43] While that is undoubtedly true of sand as a substrate for inscrib-ing shapes and marks, Friedrich Kittler ascribes the innovation of the sand *table* to Friedrich Karl Ferdinand von Müffling, a Prussian officer and military cartographer who served in the Napoleonic wars and was later a driver of mil-itary reforms as chief of the General Staff.[44] We know in fact that the original *Kriegsspiel* (war game) of Georg von Reisswitz was played on a sand table be-fore it was adapted to a system of modular ceramic tiles for presentation to the court of King Friedrich Wilhelm III in 1811. (Sources mention von Reisswitz's trepidation at offering common sand as part of a gift to the monarch—so he instead sought out "'more solid material'" for his game board.)[45] And it was von Müffling who subsequently canonized *Kriegsspiel*, commissioning sets for the entire army. *Sandkasten* were thus widely in use within the Prussian mil-itary establishment, and they were to remain a mainstay of von Müffling's suc-cessors, including Helmuth von Moltke (the elder) and Alfred von Schleiffen. The sand table, along with other forms of wargaming and campaign studies, constituted an officer's winter work (*Winterarbeit*)—so named to differenti-ate indoor activities from the field maneuvers conducted in more temperate months (fig. 7).

   Owing to Froebel and his followers, sand tables also enjoyed an early twentieth-century vogue in educational circles. Aids to Bible instruction in Sunday School classrooms were an especially popular application. "Even the little tots are intensely interested in the portrayal of Bible stories on the Sand Table," we are assured.[46] "To picture the story as nearly as possible," as another source has it.[47] The power of world making was surely not lost

   43. Rex Brynen, "Augmented Reality Sand Tables," *PAXSims*, 10 Aug. 2014, paxsims .wordpress.com/2014/10/08/augmented-reality-sand-tables/

   44. See Friedrich Kittler, "Ottilie Hauptmann," trans. Ilinca Iurascu, in *Operation Valhalla: Writings on War, Weapons, and Media*, trans. and ed. Iurascu, Geoffrey Winthrop-Young, and Michael Wutz (Durham, N.C., 2021), pp. 188–89; See also Kittler, "Biogeography," trans. Winthrop-Young, in *Operation Valhalla*, p. 228.

   45. Philipp von Hilgers, *War Games: A History of War on Paper*, trans. Ross Benjamin (Cambridge, Mass., 2008), p. 44. Georg von Reisswiz (the elder—not to be confused with his son, also Georg, who also published an influential set of *Krieggspiel* rules) makes mention of sand as a substrate for his game at various points in his 1812 *Taktische Kriegs-Spiel*. There is also mention of von Reisswitz's *sandkasten* in an anonymous 1874 account published in the German military journal *Militair-Wochenblatt*. See Georg von Reisswiz, *Taktische Kriegs-Spiel oder Anleitung zu einer mechanischen Vorrichtung um taktische Manoeuvres sinnlich darzustellen* (Ber-lin, 1812), and "Zur Vorgeschichte des v. Reikwik'schen Kriegsspiels," *Militair-Wochenblatt* 73, (Sep. 1874): 693–94. For discussion of *Kriegsspiel* itself, see von Hilgers, *War Games*, and Kirschenbaum, "Kriegsspiel," in *Debugging Game History: A Critical Lexicon*, ed. Henry Lowood and Raiford Guins (Cambridge, 2016), pp. 279–86.

   46. Alice Hill, *Sand Table Illustrations* (Indianapolis, 1923), p. 10.

   47. Lillie A. Faris, *The Sand-Table: A Manual for Sunday School Teachers* (Cincinnati, 1915), p. 13.

F I G U R E 7 .   "Le Jeu de la Guerre au cercle des officiers," *L'Illustration* 22 (1874): 124. French officers play an elaborate *Kriegsspiel* on a sand table in the late nineteenth century. Note the screen separating the two halves of their battlefield (to allow for hidden maneuver) as well as the additional strategic maps occupying the side tables; in the center, an official adjusts the hanging clock keeping the game's internal time.

upon these ecclesiastical advocates: one guidebook instructs teachers on how to make sheep, boats, houses, and people, as well as angels, tents, water, grass, flowers, fruit, trees, and—finally—the sun, the moon, and the stars. This is then followed by the first lesson, which is of course the Genesis story of the creation.[48] Sand trays and tables would also become a mainstay of Montessori classrooms. At the Perkins School for the Blind near Boston, a sand table was used to teach geography.[49] Few forms of media have migrated so directly and so effortlessly from the state machinery of war to childhood education (one might do worse than to name the digital computer in this regard).

   By the 1950s civilian wargame enthusiasts in both Britain and America had discovered the allure of the sand table for staging mock battles of the sort first popularized by H. G. Wells in *Floor Games* (1911) and *Little Wars*

48. See Hill, *Sand Table Illustrations*, pp. 13–25.
49. See the Perkins School for the Blind Archives, www.flickr.com/photos/perkinsarchive /14096914888/in/album-72157644862510411/

(1913). In these settings it was precisely the sand table's visibility and solidity *as* furniture that came to confer status—the rise of the table literally elevating the childish activity of playing with toy soldiers from something one did on one's hands and knees to a respectable adult level. Influential wargame designers like Don Featherstone, Jack Scruby, and Gary Gygax all owned sand tables, and each made them a point of pride. Scruby, who edited and published the *War Game Digest* magazine, offered a mail-order, typewritten, twenty-seven page introduction to the hobby that featured a photo of him and his sand table on the cover; countless readers were doubtless introduced to the concept in this way.[50]

As a furnishing, however, a sand table required an abundance of indoor space. Typically, this meant a dedicated room in a full-sized house. Featherstone admits that an extra room for a sand table was a precondition when buying his own home.[51] (Scruby adds a sexist mention of an indulgent wife as a precondition.)[52] Above all, the space needed to be able to support the weight of the table. *Dungeons & Dragons* cocreator Gary Gygax is to the point: "Baby, that sand is heavy! Better put it in the basement or the like."[53] Sand tables were thus not suitable for an apartment or flat. Gygax's own sand table was in the basement of his bungalow in Lake Geneva, Wisconsin, where it was later reconstructed by admirers.[54] Featherstone, meanwhile, elaborated on other distinctly domestic hazards, underscoring the sand's messiness, its propensity for ending up on the floor (from which it had to be swept), its potential to harbor vermin, the unpleasant odors arising from wet sand and pigments, and even appropriation by the household cat.[55] Scruby echoed the need to keep things tidy: for the suburban sand table soldier, "the broom is used as much as any other weapon."[56]

Due to the difficulty of upkeep, sand tables have mostly fallen out of favor with recreational wargamers.[57] By contrast, however, sand tables have

50. See Jack Scruby, *All About War Games*, www.scribd.com/document/46183270/All-About-War-Games-by-Jack-Scruby

51. See Don Featherstone, "Terrain," *War Games Digest* (Sep. 1960), vintagewargaming.blogspot.com/2010/03/don-featherstone-and-sands-of-time.html

52. See Scruby, *All About War Games*, p. 10.

53. Gary Gygax, "Ancient Miniature Rules," *International Wargamer* 3 (Feb. 1970): 10.

54. For Jon Peterson's footage of Gygax's reconstructed sand table, see Ethan Gilsdorf, "Gaming at the Gygax House: A Visit to the Basement Where D&D Began," YouTube, www.youtube.com/watch?v=7FxkHgBLEMY

55. See Featherstone, *War Games: Battles and Manoeuvres with Model Soldiers*, ed. John Curry (Bristol, 2014), pp. 33–34. Featherstone enthuses that a sand table provides the hobbyist with "a wonderfully realistic battlefield" (p. 33).

56. Scruby, *All About War Games*, p. 10.

57. Tabletop battles with miniature soldiers, however, remain quite popular, and the size of the table is a critical affordance for game play. This point was discussed by Ian Williams and

been employed by many of the world's militaries throughout the twentieth century and up to present day. The US Army's Dunn-Kempf rules for wargaming tank battles were frequently played out on large purpose-built sand tables at national training centers like Fort Irwin. (Soldiers stationed at this remote desert locale would push thumbnail-sized models around miniature dunes and escarpments that mimicked the surrounding terrain.) In 2006, meanwhile, Google Earth aficionados—poring over obscure areas of the app's planetary imagery—spotted an optical anomaly: several kilometers of terrain in China's remote Huangyangtan region appeared to duplicate at reduced scale a 450-kilometer swath of territory in the Karakoram mountain range, territory occupied by China in 1962 but claimed by India at the time of the discovery, some twenty-four hundred kilometers distant.[58] The Chinese terrain model stood out in part because it included glaciers, snowcapped mountains, and rivers embedded in an area whose natural geography was an arid plain. Barracks, vehicles, and other signs of military infrastructure were also visible nearby. The obvious conclusion was that this remarkable topographic *mise en abyme* was a massive sand table, visible from space and the largest ever made.

4

"Media determine our situation."[59] This is the uncompromising opening line of Kittler's *Gramophone, Film, Typewriter*. The sentences that directly follow, however, are less well-known, less ringing, and certainly less quotable. "Situation conferences were held by the German General Staff," Kittler intones, a seeming non sequitur but for the word *situation*. "Great ones around noon and smaller ones in the evening: in front of sand tables and maps, in war and so-called peace." Here the reference is to the heads of Hitler's *Wehrmacht* plotting their stratagems. Kittler then continues: "Until Dr. Gottfried Benn, writer and senior army doctor, charged literature and literary criticism as well with the task of taking stock of the situation. His rationale (in a letter to a friend): 'As you know, I sign: On behalf of the Chief of the Army High Command: Dr. Benn'" (*GFT*, p. xxxix).

Sam Tobin in "Tabled! A Table of Tables," presented at the 2022 *Generation Analog* conference on a panel entitled "Materiality and Sociality in Miniatures Wargaming."

58. For an example of the news coverage generated by the find, see Shiv Aroor, "From Sky, See How China Builds Model of Indian Border 2400 km Away," *Indian Express*, 5 Aug. 2006, archive.indianexpress.com/news/from-sky-see-how-china-builds-model-of-indian-border-2400 -km-away——————/9972/0

59. Kittler, *Gramophone, Film, Typewriter*, trans. Winthrop-Young and Wutz (Stanford, Calif., 1999), p. xxxix; hereafter abbreviated GFT.

These terse sentences are hopelessly gnomic and opaque without the benefit of Kittler's footnotes, from which we learn that "take stock of the situation" is an aphorism cribbed from writer and physician Gottfried Benn's 1947 novella *Der Ptolemäer* (*The Ptolemies*), while the signature is from a 1941 letter to F. W. Oelze, with whom Benn maintained a long correspondence. Kittler, already word processing in every way that mattered, uses his keyboard to cut and paste the two sources together, even as he cuts and pastes from the timelines of military and media history. It is, however, not sand tables but the bomb that occupies Kittler's final pages (which include an aerial aftermath photograph of Hiroshima). This is, in one sense, the book's only possible terminus given its author's obsession with martial rocketry (notwithstanding the fact that Little Boy and Fat Man were delivered by strategic bombers). But the atomic devastation of two cities on the Japanese mainland is also relevant to Kittler's penultimate discourse on codes and code breaking. The link of course is the digital computer, which was instrumental (in every sense) to both complexes of wartime scientific research. And it is cryptographic rather than atomic munitions that Kittler sees as the apex of the Cold War: he cites Truman's executive order withholding specifics about codebreaking from a congressional committee ("war-determining cryptoanalysis became a matter of ultimate classified material"), and awards Bletchley Park (locus of England's cryptoanalysis effort) the title of Annihilator (*GFT*, pp. 262; see also 261). For Kittler, it was Alan Turing even more than J. Robert Oppenheimer who could lay claim to the mantle destroyer of worlds.

Kittler's enthusiasm (some would call it bombast) may lead to questionable historical judgment, but his instinct for the zeitgeist was acute. The nexus of computation, code, and the Cold War is an enduring one for the second half of the twentieth century. Kittler's closing sketch therefore anticipates more concentrated efforts to untangle what one group of authors has called "Cold War rationality": an unwavering faith in the analytic and ultimately predictive powers of a formalized, tokenized, and algorithmically operationalized program of knowledge across many or most spheres of human interest.[60] Cold War rationality is the site of a growing body of interdisciplinary scholarship: in addition to Paul Erickson and his coauthors, Hayles, Sharon Ghamari-Tabrizi, R. John Williams, and Jill Lepore have all related important pieces of the story, whether focalized in the figures of Norbert Weiner and Herman Kahn or in the activities of the

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60. See Paul Erickson et al., *How Reason Almost Lost Its Mind: The Strange Career of Cold War Rationality* (Chicago, 2013); hereafter abbreviated *R*.

RAND and Simulmatics Corporations.[61] Broadly speaking, this scholarship is invested in rooting technologies of digital computation in worldviews that constructed and assumed—to echo still another relevant title—a "closed world" subject to the totalization of information and intelligence.[62] Their common denominator is the story of how a certain strain of mathematical theorizing came to secure massive government and private investment in actual systems and software for speculative world-building. The plot twist turns out to be this: the closed world enables and actualizes computationally endless *open* worlds, open worlds without end. Sandbox worlds, we might say.

The keystone genre for world-building is the scenario—what one writer terms "state science fiction"—or more specifically, the situation.[63] *Situation* is the word Kittler repeats in his sentences about media determinism. (In German it is *die Lage*, which can also be translated as the "scenario.") As Paul Erickson and his coauthors explain, situations were everywhere in the mid-twentieth-century behavioral and social sciences. A situation in this parlance was a bounded and controlled possibility space, a heuristic employed to reduce complex, real-world phenomena into analytically (and computationally) tractable variables. One of the preeminent situations in this specific sense were the islands of Micronesia, the remote Pacific archipelago that was simultaneously a site for American nuclear testing and a site for behavioral ethnographies of its indigenous population. The attraction of such an isolated setting was precisely that it furnished a microcosm within which any number of variables—from radiation fallout and blast effects to demographics and cultural patterning—could be studied in a contained way.[64] It was a cruel juxtaposition, as Erickson and his coauthors show, but what mattered to the researchers who flocked there was its status as an exceptional space: "Not exactly a laboratory and not exactly the real world" (*R*, p. 114).

This article has sought to demonstrate that prior to digital computation the sand table was just such an exceptional space, indeed the signature

61. See Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago, 1999); Sharon Ghamari-Tabrizi, *The Worlds of Herman Kahn: The Intuitive Science of Thermonuclear War* (Cambridge, Mass., 2005); R. John Williams, "World Futures," *Critical Inquiry* 42 (Spring 2016): 473–546; and Jill Lepore, *If / Then: How the Simulmatics Corporation Invented the Future* (New York, 2020).

62. See Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, Mass., 1996).

63. See Peter Galison, "The Future of Scenarios: State Science Fiction," in *The Subject of Rosi Braidotti: Politics and Concepts*, ed. Bolette Blaagaard and Iris van der Tuin (New York, 2014), pp. 38–46.

64. The island was, in effect, a kind of sandbox to the researchers. They use the phrases "'tiny world'" and "dollhouse" (*R*, pp. 108, 131; see also pp. 107–31).

platform of the situation. Its fusion of cartographic visualization with ludic interaction and iteration resulted, as we have seen, in a highly effective media device for constructing scenarios and exercising tactics. The sand table as furnishing is also a literal antecedent to what Theo Reeves-Evison has characterized as the "speculative infrastructures" of the second half of the twentieth century.[65] Even as field manuals published by military authorities supplied cadets with stock situations to rehearse on the tabletop, so the Cold War rationalists, working on a much grander and more grandiose scale, employed data analysis and computation to game—*sandbox*—future possibilities and possible worlds. R. John Williams describes this enterprise with admirable precision: "The capitalizable, systematic immediacy of multiple, plausible worlds, all of which had to be understood as equally potential and, at least from our current perspective, nonexclusive."[66]

The key point then is not that the Cold War's speculative infrastructures were devoted to predicting *the* future but rather that their function lay in enumerating a plurality of *possible* futures. In this the objectives would have been recognizable to the officers of the General Staff a century earlier, whose concern lay in perfecting operational plans for a wide range of contingencies and circumstances.[67] Just as the sand table was a platform that could be leveled and rebuilt with relative ease, so too were the Cold War rationalists invested in mapping and exhausting any given possibility space, something only imaginable through the technical and infrastructural capacity to massively multiply scenarios.

The situation room as most of us know it from novels, film, and TV was itself an artifact of this same tranche of behavioral and social sciences research, where it was built into the very architecture of scientific experimentation (see *R*, pp. 123–29). The brainchild of a sociologist named Robert Freed Bales, a situation room was a new kind of indoor space optimized for observation and data collection. Table and chair arrangements for subjects were augmented by microphones, cameras, and one-way mirrors or "magic walls" for the researchers. (It was, in other words, a space designed to magnify the effects of technical media.) This design became the gold

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65. Theo Reeves-Evison, "The Art of Disciplined Imagination: Prediction, Scenarios, and Other Speculative Infrastructures," *Critical Inquiry* 47 (Summer 2021): 719–46. He defines speculative infrastructures not strictly as physical systems but also "consisting of protocols, structured conversations, corporate planning exercises and other unobtrusive forms that exist as tools in the armory of governance, defense, and business management" (p. 721).

66. R. John Williams, "World Futures," p. 473.

67. Writing of the innovative nature of the German General Staff, military historian John Keegan puts it this way: "Plans [were] conceived at leisure, pigeon-holed and pulled out when eventuality became actuality" (John Keegan, *The First World War* [New York, 1999], p. 24).

standard for human-subject observation and behavioral studies. Where before the tabletop alone had been enough to define an exceptional space, now the conceit was expanded to fill an entire chamber. The situation room in the popular sense as the locus of crisis management—outfitted with maps and telephones, screens, uplinks, downlinks, and a dominant table in the middle—is a second-order instantiation of Bales's concept, brought forth from think tanks and campuses to the highest echelons of state decision-making (see *R*).

The ultimate situation to manage was of course a nuclear war. When the first atomic bomb was exploded in the desert outside of Alamogordo, New Mexico, all previous military expertise vanished in a literal flash, flattened by the shock wave. ("How many thermonuclear wars have *you* fought recently?" the colorful, corpulent Herman Kahn would ask any military brass who saw fit to question his authority.)[68] The next war could not be rehearsed and could not be gamed, at least not by conventional means.[69] So the sand table was transmuted, and the smooth glass surfaces of computer screens became the distant mirrors of the Trinity site—where the sand itself had turned to glass—furnishing the probabilistic proving ground in which thermonuclear war could be fought and refought in virtual environs.[70] "Thinking about the unthinkable" (in Kahn's famous catchphrase) was then achieved precisely through enumerating and ultimately exhausting all possible scenarios.[71] The popular movie *WarGames* (dir. John Badham, 1983) managed to evoke this in its climactic final sequence as vectors of virtual ICBMs mushroomed into brilliant bursts of light on enormous display screens, the reflections washing again and again over the faces of the denizens of the Cheyenne Mountain war/situation room (and mirrored on the faces of theatergoers in the audience).

68. Quoted in Ghamari-Tabrizi, *The Worlds of Herman Kahn*, p. 49.

69. A tiny artifact survives to offer testimony. This is a six-page typewritten document, which details the problem (and a solution involving an intermediary mapping step) for constructing sand tables of a size such as would be necessary to model a battlefield on a scale appropriate for rehearsing tactical nuclear warfare. See Henry Eaton Kelly, "The Poor Man's Atomic Sand Table," 26 Oct. 1960, US Army War College in Carlisle, Pennsylvania.

70. As Andrew Wilson relates, one of the first virtual nuclear wargames on record was fought not long after the resolution of the Cuban Missile Crisis: The Simulation of Total Atomic Global Exchange (STAGE) involved some 160,000 machine instructions. See Andrew Wilson, *The Bomb and the Computer: The History of Professional Wargaming, 1780–1968*, ed. Curry (Bristol, 2014), p. 9. For more on nuclear wargaming, see also Thomas B. Allen, *War Games: The Secret World of the Creators, Players, and Policy Makers Rehearsing World War III Today* (New York, 1987).

71. See Herman Kahn, *Thinking About the Unthinkable* (New York, 1962). See also Claus Pias, "Action, Adventure, Desire: Interaction with PC Games," in *Interactive Dramaturgies: New Approaches in Multimedia Content and Design*," ed. Heide Hagebölling (New York, 2004), pp. 138–39.

But the Cold War was never just a bipolar drama of nuclear annihilation. It was a war fought by proxy: espionage and economics but also asymmetrical military actions variously called small wars, brushfire wars, insurgencies, counterinsurgencies, and perhaps most aptly, dirty wars. Put another way, in the real world (as opposed to the simulations in *WarGames*) vectors and binary strings inevitably gave way to the grain of the local, to tribological stresses and fractures that were beyond the capacity of computers to model. (From a modeling and simulation standpoint, the physics of sand remained largely uncomputable until well into the 1980s—just as asymmetrical warfare had long been regarded as "ungameable" by the military establishment, owing to its myriad human factors.)[72] Here then is an alternate scene that could have and maybe should have come out of Kittler's media history but didn't: Lyndon Johnson in the White House situation room in early 1968, presiding over an episode from just such a proxy war.

He is studying a sand table model depicting—in something very close to real time—the state of operations at Khe Sanh, where an outpost of marines has been surrounded by some forty thousand North Vietnamese regulars (fig. 8). Johnson was obsessed with Khe Sanh, fearing the potential for a repeat of the defeat at Dien Bien Phu a decade and a half earlier that had ended France's colonial occupation. As the battle—really more of a siege—unfolded over a critical two-and-a-half-month period, an Army historian was tasked with keeping Johnson and his staff up to date. The White House sand table—a mirror image of an even larger one said to be on the ground in Saigon—was the centerpiece of these briefings, used to plot moves and countermoves. "I projected their timetable and predicted their attack to the day—a week or ten days before it happened," military-affairs journalist Thomas B. Allen claims the Army historian subsequently told him.[73]

The outpost at Khe Sanh held (albeit with heavy casualties on both sides) and was successfully evacuated later in the year. A second Dien Bien Phu was forestalled. But in the official White House photograph of the briefings, one can view the material presence of the sand table in the situation room as a kind of index of the extremity of Johnson's fixation, even as it captures the simultaneous power and impotence of the American position in Vietnam—this exacting reconstruction of a remote countryside erected in the halls of power, enclosed in a box, overlain with a grid, the president and his men towering and glowering above.

72. See Wilson, "Gaming the Ungameable," *The Bomb and the Computer*, pp. 137–57. For sand and computer simulation, see Guyon, Delenne, and Radjai, *Built on Sand*, p. x.
73. Allen, *War Games*, p. 210.

FIGURE 8.   Lyndon Johnson and some of the president's men studying a sand table depicting the siege of Khe Sanh in the White House situation room in February of 1968. Note the wire-frame grid (to aid in referencing map coordinates) and what appear to be blocks marking the positions of the combatants. Johnson White House Photographs, National Archives, ARC Identifier 192584.

The obvious correlate is to the famous Pete Souza photograph of Barack Obama and his advisors watching the Osama Bin Laden raid from a small room in the White House basement. With the exception of the military commander overseeing the mission (who remains focused on his laptop) the attention of the dozen or so figures in the photograph is singularly directed at what is clearly a large screen just out of the shot. The principals are all seated as opposed to standing, arms and hands in passive positions crossed or folded in front of them (all save Secretary of State Hillary Clinton, whose hand covers her mouth). Note, by contrast, the upright bodies in the Johnson photograph: one in the group (it looks like National Security Advisor Walt Rostow) with his finger outstretched, almost but not quite to touch, like a god; another resting his fingertips on the very edge of the table; and Johnson himself, leaning in, hands braced, gaze almost straight down.[74] He seems to be scrying. Surely there is an angle here, a posture. Surely the situation can be determined.

74. Johnson's posture in this photo perfectly embodies what Mirzoeff describes as the Medusa's all-seeing gaze, itself literalized in a twenty-first century military drone technology called Gorgon Stare; see Mirzoeff, *The Right to Look*, pp. 279–80.