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On fortification: Military architecture, geometric power, and defensive design

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Abstract
Fortification calls to mind images of high walls establishing clear lines between inside and outside and immobilizing enemies. However, even the most seemingly inert fortifications rely on subtle forms of mobility and more elaborate spatial relations. This article examines fortification as a technique of power in which warfare, the design of the built environment, and the organization of space are intertwined. Where research on fortification tends to emphasize the symbolic, sovereign aspirations of wall-building, the approach advanced here focuses on the spatial technologies and infrastructural projects of military architecture and engineering that remake space through martial means. The article follows the trajectory within military architecture by which linear fortifications became defense in depth and asks how transformations of 'depth' in contemporary warfare have come to integrate more complex, non-linear notions of space and time. By tracing the ways in which the curtain wall of Vauban's bastion fortress transformed into the radar curtain, I argue that fortification constitutes a 'becoming war' in which 'defensive' war intensifies organized violence. As such, the concept of fortification proves indispensable for understanding the reinforced boundaries and delineated pathways cutting across the global space of contemporary warfare.

Keywords
Borders, fortress, infrastructure, radar, Vauban, war

Introduction

In Paul Virilio's account of urban history, fortification forms the first cities by harnessing the power of war to organize space. Urban form is articulated through the defensive structure of the fortress: 'it was the fortress as permanent fortification that settled the city into permanence . . . the surrounding wall is linked to the organization of war as the organization of space' (Virilio and Lotringer, 2008: 20). In this recounting of urban origins, war organizes space through fortifications, and fortifications bring about the birth of cities. While doubt has since been cast on the originary role of the urban enceinte, such an account is nonetheless significant for the line of inquiry it

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opens into fortification as the relation between warfare, the design of the built environment, and the organization of space.[1] This article takes up this line of inquiry into the production of space by fortification, examining the legacies of early modern fortress design for contemporary political technologies of territorial control. My interest is in the process by which linear fortifications gave way to defense in depth and how transformations of 'depth' have come to integrate more complex, non-linear notions of space and time. Such transformations reveal fortifications to be more mobile and dynamic than the seemingly inert figure of the wall would suggest. By examining these forms of mobility, I ask how the 'defensive' and 'preparatory' techniques of fortification are making and re-making our collective world through the medium of organized violence.

While the material vestiges of earlier fortresses have often been absorbed by growing cityscapes, new modes of fortification work at multiple geographic sites, extending beyond the urban enceinte into international space and transforming the techniques by which space is defended. Fortification takes on forms that range from 'geophysical' walls along territorial boundaries to 'microphysical' controls of movements through the built environment (Virilio, 1994: 203–204).[2] Furthermore, the radar curtain—a reference to the curtain wall of the fortress—serves as a kind of fortification of airspace. This fragmented organization of space involves complex relations to time, whereby the speed and rhythm of movement are modulated in relation to projections of future risk and insecurity (Davis, 2006; Duffield, 2011; Klauser, 2010).

Despite the spatio-temporal complexities of fortification, the language of fortification has become one of installing impassable obstacles through the use of cumbersome, seemingly inert materials of stone, earth, concrete, and metal. Within this image, fortification is an architecture of creating clear lines between inside and outside and immobilizing enemies. This is fortification as the power of an older order—a state imaginary involved in theatrical and increasingly desperate attempts to display sovereign power, even with the rise of discipline and biopolitics (Brown, 2010). The rallying cry in support of these fortifications speaks in terms of declining sovereignty. Critiques of these fortifications also focus on reactions to sovereign decline. In order to trace the spatial transformations from defense in depth to contemporary warfare, I focus attention on the spatial technologies of military architects and military engineers that would redefine urban space, filter into ideas of territory, and constitute sovereignty from the ground up. As I will elaborate in detail, the designs of early modern fortress construction relied not only on the resilience of walls but also on lines of sight, the ability to survey the battlefield, and the possibility of strategic maneuver. Today, urban and border fortifications emphasize to an even greater degree visibility, detection, and tracking (Andersson, 2014, 2016; Chamayou, 2012).[3]

Rather than focus on the elusiveness of enclosure, I approach fortification as a technique of power working through a combination of modulated control by obstruction and heightened detection. This is a process of fortification that entails channeling movement through walled flows rather than strictly delimiting inside and outside (Bernes, 2013). Even the most dramatic forms of physical obstruction entail a politics of mobility, or 'kinopolitics,' focused on the management of circulations (Nail, 2016). Through this approach, I expand the analysis of boundaries to include the logistics of fortification and the underlying notions of geometry that inform how space is produced, organized, and surveilled. With a focus on the way this technique transforms built environments and martial practices, fortification is generative—it designs, builds, organizes, and reorganizes. Such a 'martial empiricism' breaks with an emphasis on the destructive capacity of war, finding in the process of design for war the creation of political dynamics, social orders, and material artifacts (Bousquet et al., 2020). Contemporary fortifications exhibit tremendous spatio-temporal complexity, creating mobile spatial controls over bodies and populations, exercised at multiple geographic scales. This article suggests fortification plays a vital, not merely theatrical, role in contemporary warfare. Fortification does not avert hostility but directs armed conflict

through design. Through the very act of guarding against the potential of future war, fortification embodies a kind of 'becoming war,' whereby its 'defensive' posture summons into being a built environment perpetually anticipating intensified violence (Bousquet et al., 2020). Where earlier work has focused on the destruction of the built environment in war (Coward, 2009), my return to theories of military architecture finds the spaces of daily life produced and transformed through designs for war.

The first section examines the conceits and contradictions of the image of fortification as monolithic and immobilizing. Departing from Brown's critique of walling as a theatrical display of waning sovereignty, it seeks to unsettle the primacy of the wall as the medium of fortified power, turning attention to the infrastructural and logistical dimensions of fortification. Fortification is not only an embodiment of sovereignty but also the planning, diagramming, and organization that supports and enables the possibility of martial power. This approach—resonant with the radical empiricism informing this special issue—focuses on the micropolitics of fortification through which spaces of war are (re)produced. The second section expands the concept of fortification to refer to an entire domain of knowledge that connects design and built form to martial-political order. It does this by returning to the discourse of fortification emerging in and through early modern warfare. If sovereignty is not a matter of control over 'impermeable' borders but a historically specific conception of space, jurisdiction, and material practices (Shah, 2012), an examination of the methods of design and architectural forms of fortification becomes indispensable to any account of power. I track the discourse of fortification from architecture into military engineering and finally into the heart of military strategy and tactics, organizing space into 'defense in depth' and supporting this strategy through geometrically defined lines of sight that provide total visibility of the battlefield. In doing so, I engage with Clausewitz's writings on defensive war to suggest that such war is not purely reactive, but rather that defensive war connotes a mode of intensified violence. The third section follows the genealogy of fortification to the practices of defending space that arise with global war, focusing on the invention of radar and its significance for geopolitics. Whereas the body of literature on global war emphasizes *unrestricted* mobility and movement across flattened global space (Chamayou, 2012; Galli, 2010; Gregory, 2011; Hardt and Negri, 2004), I seek to highlight the *modulated* mobility established by fortification. The aim here is not to suggest that contemporary fortification represents a return to earlier forms of warfare (cf. Betz, 2019: 40). Instead, fortification serves as a kind of infrastructural power, enabling certain movements while inhibiting others and in the process carving a complex geography of armed conflict into the international landscape.[4] Increasingly, the geometries of fortification, which had been defined by ideas of linear defense and defense in depth in early modern war, now gravitate toward a notion of non-linear defense, in which new combinations of obstruction and detection fortify space at multiple scales.

Imagining fortification

The image of power commonly evoked by fortification is one of a fortress raising high walls to repel plunder or invasion. In this sovereign imaginary of fortification, often premised on an image of the medieval castle, clear lines separate inside and outside. It is the immobility of the wall that guarantees security. Wendy Brown (2010) offers the most comprehensive philosophical investigation of this image of fortification. In seeking to understand its allure, Brown considers the proliferation of wall-building projects and the paradox posed by their construction at a moment when globalization is heralded as a defining force of political life. Such wall-building seeks to give physical form to sovereignty, installing impermeable lines between states and embodying a claim to absolute authority. Yet, these walls are traversed in innumerable ways: they are frequently

climbed over, tunneled under, or circumvented. The aspiration of sovereignty that they embody is equally elusive: 'one irony of late modern walling is that a structure taken to mark and enforce an inside/outside distinction—a boundary between "us" and "them" and between friend and enemy—appears as precisely the opposite' (Brown, 2010: 25). Walls not only fail to secure sovereign authority; their very presence erodes distinctions between public/private, military/police, and law/exception. Walling projects rely, sometimes implicitly, on assemblages of police, private, paramilitary, and military power, and the construction of walls, justified in terms of the preservation of 'law and order,' often involves exceptional legal measures that suspend or revoke written law.[5]

Brown provides a compelling critique of the temporal logic—the envisioned relation between past, present, and future—within this sovereign imaginary. Walls exhibit 'a markedly archaic quality' and a 'seemingly physical, obdurate, premodern signature' (Brown, 2010: 80). As tangible objects of sovereignty, walls 'seem to embody precisely the power of the "no,"' and fortifications mark an old order of power (Brown, 2010: 81).[6] The sovereign imaginary invoked draws upon an image of the past in which physical manifestations sustain decisive and unequivocal rule. This past is an age of what Gros (2010: 11) calls 'mythic war, existing only in and through stories, always situated in the mists of time, offer[ing] itself like a dream.' The past invoked here subsists in an inchoate haze, appearing when called upon and vanishing at moments of contradiction. The amorphous notion of mythic war allows one to maintain a sense that the construction of walls is a 'virtuous' endeavor. To imagine walls purely as embodiments of sovereign power conceals the racialized violence they inflict, the lines of global inequality they reinforce, and the extensive security industries that maintain them. Brown's incisive critique reveals the contradictions within this mythic register. The proliferation of walls at national borders bespeaks a nostalgia for a sovereign power that no longer exists, if, in fact, it ever did. This sovereign imaginary sees walls as an act of reclamation, enacting the military virtue of mythic war in an effort to model the future on a fabulated past.[7]

Building on critiques of this sovereign imaginary, I turn attention to the immanent logic of fortification, the precise material forms and modes of spatial governance that enable this technique of power. This is fortification as it is planned, designed, constructed, maintained, restored, and replaced. Architecture, engineering, and military strategy rely on discourses of fortification that operate in non-mythic registers and work closely with the organization of space. Where a sovereign imaginary envisions the fantastical, immanent mechanisms plan for the logistical. The violence of bordering is produced not only through totalizing assertions of sovereignty but also through the material logistics of fortifying interventions themselves. Logistics, for Virilio (Virilio and Lotringer, 2008: 20) constitutes 'the beginning of the economy of war,' and as such, the first logistical act is the construction of fortifications. Originating in military relations to space, time, and material organization, logistics is the field of technical preparations and calculations by which one establishes a supply line (Cowen, 2014: 8–13). The immanent logic of fortification envisions the creative capacities necessary for war—the series of movements, openings, and closings through which supply lines are maintained.

Where a sovereign political imaginary envisions and enacts the structural, an immanent logic produces the infrastructural. As infrastructure, fortification amplifies and modulates, it is 'a thing that facilitates other projects, a thing that expands flows, standardizes distributions, and extends political rationalities' (Fennell, 2015). This immanent logic of fortification is more spatially and strategically dynamic than its sovereign imaginary. In sovereign spatial organization, transcendent state power secures a bordered self against an invading force held 'outside.' In addition to this aspiration of sovereign enclosure, fortification also connects, enables, and subtends the entire enterprise of war. Fortification alters the built environment with a particular disposition towards the possibility of war: 'the ambition of *conducting* a war begins with the planning of its theater, or

the creation of *artificial environmental conditions*, which will form the infrastructure, the stage on which the scenario should be played out' (Virilio, 1990: 14). To fortify oneself is not to avert war but to transform one's environment for the conduct of war. This is a distinct temporal logic from the sovereign imaginary of fortification, which sought to activate a mythic past of virtuous war in the present. By contrast, the immanent logic of fortification reconstructs the built environment with possible futures of war in mind.

In this shift from structure to infrastructure and from the fantastical to the logistical, fortification appears as more than the power of walls to divide cities or decisively bound the nation-state. The tendency to focus on walls has contributed to the treatment of fortification as inert and immobilizing, reducing a complex assemblage of barriers, fences, sensors, surveillance technologies, infrastructure, and architectural knowledge to The Wall. Critiques of symbolic aspirations and concrete spatial technologies are not mutually exclusive, and in pursuit of combining them, we would be best served by thinking of fortification through its etymology as the creation of a 'strong place.' Such a process involves both the intensification of territorial boundaries, including but not limited to walls, but also the selective control of circulation. In the creation of a 'strong place,' logistical and infrastructural conditions extend the space of the border both inward and outward. The wall is only one site in a mode of fortification that emulates doctrines of defense in depth. With the extension of Border Patrol jurisdiction over the 100-mile border zone, approximately two-thirds of the United States population becomes susceptible to 'interior enforcement' (ACLU, 2018). The 'externalization of borders' describes a process by which nation-states exert influence over border procedures beyond their territory through, for instance, the adoption of biometric and other surveillance technologies, the treatment of ports and waterways as key national security sites, and the standardization of controls at international airports (Weber and Pickering, 2014: 17–19; Graham, 2011: 136–138). Fortification has come to occupy, both conceptually and materially, the interstices of war and policing and global and local space.

Architectures of defense and military engineering

To capture the spatio-temporal complexities within the design and construction of fortifications, I turn to the discourse of fortification that emerges within early modern military architecture and engineering. The aim here is neither to locate an 'origin' of fortification—one will seemingly always find an older instance of wall construction—nor to suggest that early modern Europe is the first moment of sustained reflection on fortification. Rather, the return to this moment is a matter of locating the consolidation of a discourse on military architecture and engineering, the effects of which extend to colonization, the violence of settlement, and continue to be felt in contemporary security and war.[8]

Fortifications begin to take new form following Charles VIII's invasion of Italy in 1494. Conducted with unprecedented speed due to the use of artillery to level high-walled stone fortifications, the invasion left Italian war planners defeated and in disbelief. In response, they set out to design defensive structures capable of withstanding bombardment. The innovation in artillery and ballistics 'destroyed a whole paradigm of military architecture and forced the creation of a new style of fortification' (DeLanda, 1991: 12). The result was the *trace italienne*, a design that included low ramparts, reinforced with earth to withstand cannon fire; ditches combined with walls that could not easily be scaled; and the defining feature, the angle bastion, a triangular protrusion from the walls, enabling a greater field of view (Kingra, 1993: 433). The use of multiple angle bastions around the perimeter of the fortification provided unimpeded lines of sight over the battlefield and a field of fire able to protect every part of the curtain wall. This layout embodied a material transformation of defense, mobilizing the dynamic quality of dirt to be compressed under cannon fire in

place of brittle, high walls. The iconic, star-shaped fortification of the late 16th century would serve as an international model for fortress construction (Maier, 2016: 60–65). One scholar has gone as far as to suggest that the *trace italienne* served as the defining innovation of the 'military revolution' in early modern warfare (Parker, 1976). While more recent work in military history finds such an account of the revolution in military practice reductive, subsequent studies of early modern warfare have been forced to think more carefully about the relation between military architecture and the tactics, strategy, scale, and social implications of war (Kingra, 1993; Lynn, 1991).

This transformation in fortification entailed new means of producing and disseminating knowledge of defensive architecture. At the beginning of the 16th century, fortification attracted the attention of artists, architects, town planners, political philosophers, and war planners. Manuals on warfare might devote a single chapter to the topic; such is the case in Machiavelli's *The Art of War* (2001). Albrecht Dürer's treatise on fortification (1958), credited as the earliest committed to the topic (Kruft, 1994: 100), envisioned a fortified town that was as much utopian social space as it was military installation. Whereas fortification in the early 16th century fell to the 'universal architect,' engaged in both civilian and military domains (Kruft, 1994: 112), late in the 16th century fortification became the subject matter of the specifically military architect. A discourse of expert knowledge emerged through the drafting of military treatises on fortification. Knowledge on the subject circulated through an established network of publishers, military academies, and a patronage system for military architects (Pollak, 2010: 95–100). Architects adopted a 'military perspective' disseminated through treatises on fortification (Galindo Díaz, 2014). Fortifications derived from the *trace italienne* drew praise for their geometric regularity, corresponding to ideas in philosophy about measurement and control of political space. While debate arose as to whether fortification provided an exact science of security or required the integration of these new geometric methods with practical experience in war, the *trace italienne* had nonetheless redefined the defense of space (Langins, 2004: 31). As Pollak (2010: 63) observes, '[t]he pentagonal citadel, like the head of a comet, drew behind it the whole discourse of military urbanism.'

By the end of the 17th century, fortification had been consolidated as a specialized domain of knowledge reserved for the military engineer. Examining the transformation of military architecture, DeLanda (1991: 50) suggests, 'what really inaugurated a new era for defense technology was the introduction by military engineers of mathematical knowledge in the design and construction of fortifications.' Sébastien Le Prestre de Vauban is the figure most closely associated with the innovations of the military engineer, applying and adapting theories of defensive architecture over a long military career. In the service of Louis XIV, he would engage in almost 50 sieges and construct or improve approximately 160 fortifications (Guerlac, 1986: 75; Duffy, 2016: 71). Under Louis XIV, Vauban personally oversaw the formation of an engineering corps within the French military (Duffy, 2016: 78).

The military engineer sought to emulate pure geometric form, equating mathematically defined order with effective defense. This was a matter of deriving the design for fortifications from regular polygons. A treatise on fortification detailing Vauban's method and attributed to Vauban (2003a), though more likely authored by Abbé du Fay, was accompanied by a primer on geometry, instructing the user in the elementary geometric forms necessary to apply mathematical precision to military architecture. Asymmetrical designs, resulting either from updating existing fortifications or adapting designs to uneven terrain, were deemed 'irregular' and considered inferior to their pure geometric counterparts (Vauban, 2003b: 95).[9] Vauban provided a systematized approach to siege warfare and fortification, innovating the use of statistical methods in his reports and providing a template of siege and defense that could be replicated (Guerlac, 1986: 77–78; Duffy, 2016: 96–97). His emblematic fortifications embodied a commitment to 'Cartesian reason, the role of applied science in society both for war and peace, [and] the esprit géométrique of the age' (Guerlac, 1986: 74).

This was an era in which the science of the mechanism, the clock in particular, served as the defining metaphor of political and military organization (Bousquet, 2009: 50), and Vauban's geometric mode sought to endow sieges and fortresses with an 'aspect of almost mechanical perfection' (Duffy, 2016: 72). Fortification had become the new science of security based on mathematical precision and Euclidean geometry (Bartelson, 2017: 108–117).

The geometric principles guiding this period of fortification brought about new ideas of spatial control. Within Cartesian geometry, space was rendered 'measurable, mappable, strictly demarcated, and thereby controllable' (Elden, 2013: 291). Henri Lefebvre (1991: 165) emphasizes this dimension of fortifications when he describes it as the creation of 'dominated space,' imposing 'rectilinear or rectangular form' on an existing space. By providing the means of spatial control, military architecture contributed to emerging notions of territoriality: 'Fortification determined territory in general just as pairs of integers or Cartesian coordinates were coming to define a Euclidean plane' (Maier, 2016: 67). Vauban's fortifications are credited with defining such an incipient form of state space. Over the course of his career he constructed two lines of fortresses that amounted to 'a coherent, defensible frontier' (Duffy, 2016: 85). They encircled French territory, forming a 'bastioned necklace of the kingdom' and articulating an emerging state boundary (Maier, 2016: 67; Bartelson, 2017: 112–114). The significance of this networked enceinte for both architecture and territoriality was recognized as the Fortifications of Vauban, an UNESCO World Heritage Site composed of 12 of Vauban's structures located along borders of France (UNESCO World Heritage Committee, 2009: 174). Where fortifications produced the external sovereignty of territories at 'the frontier,' infrastructural projects enabling the movement of people and commodities defined the internal space of the state (Langins, 2004: 70; Bartelson, 2017: 115; Mukerji, 2010). State space emerged through the meticulous engineering of military architectures and the application of geometries of patterned polygons to martial and political life.

We find treatises on fortification specifying the contours of space and movement within an urban system:

> They encompassed architecture and urbanism, both temporary and permanent, the fortification of cities and the layout of camps, the creation of streets and open spaces, the marshaling of the population into regular blocks, the channeling of movements through gates and bridges, the imposition of the geometrically perfect citadel on a city both receptive and hostile. Most importantly, their illustrations aestheticized the preparation and conduct of war by assimilating it to the ideal city. (Pollak, 2010: 62)

As it organized space, military architecture regulated the movements of populations and defined the telos of war as the realization of life in the ideal city. The life of the population, arising from the vitality of the city, emerged through geometries first deployed in service of the curtain wall. The modes of calculation established and refined in the discourse of fortification sought to produce a living order. Treatises on fortification included plans for streets, open spaces, bridges, and gates, situating the fortress town as a 'space of circulation' (Foucault, 2007: 13). This vital space emerged not in opposition to the wall, the engineer, and geometric power but as an outgrowth of these developments in military urbanism. Fortification established many of the mechanisms and tactics integral to spaces of circulation. In particular, the calculative logic of war-making at the time resonated with the management of life in terms of logistics (Gros, 2010: 60). Fortification had become a matter of designing the pathways for these logistical movements. Just as recent work on logistics points to the fungibility of military logics and their appropriation beyond military domains (Cowen, 2014), fortification was easily transposed from the design of battlefields to the design of urban systems.

The revolution in fortification gave physical form to a shift in military strategy and was transposed from urban space to territory. High, stone fortress walls serving as immovable, defensive

lines gave way to defense in depth, 'consisting of novel outworks that allowed the defenders to control the different outer layers, ramparts and ditches of a fortified town' (DeLanda, 1991: 50). Vauban's fortifications are noted for such outworks. The treatise on Vauban's fortifications details the design of these features, varying from larger and more ornate crownwork and hornwork to simpler, functional ravelins and tenails (Vauban, 2003b: 41–48). These freestanding features seem to reach beyond the curtain wall, waging a sort of architectural counter-attack, an assault on the enemy before they reach the main bastions. Through the network of positions beyond the main curtain, the military engineer 'gained a new flexibility in adapting his design to the terrain without imperiling the main line of defense' (Guerlac, 1986: 82). While outworks provide the clearest shift toward defense in depth, this strategic shift is evident at a number of scales in the fortifications descending from the *trace italienne*. At the scale of the fortress wall, the switch from stone to earth as reinforcement of the walls provided 'depth' against artillery—earth would compress under bombardment, whereas stone would immediately shatter. Moving to larger scales, the flexibility of depth enabled by outworks was mirrored at the strategic level: 'Even the forts and fortress cities Vauban designed were not designed to hold out forever in isolation, but to allow time for reinforcements to arrive and relieve the siege' (Maier, 2016: 56). The rigidity of earlier fortifications had been supplemented by planning for the time of reinforcement enabled through spatial depth.

Clausewitz's reflections on fortification and this new strategy of defense clarify the spatio-temporal reorganization of war. For Clausewitz (1984: 393), modern fortresses no longer serve as places of refuge for waiting out conflict, in which 'towns sought to ward off the storm clouds of war.' Instead, fortifications become decisive parts of military strategy, integral to waging war and establishing territorial claims:

> Their significance was felt beyond their walls; it contributed to the conquest or retention of the country, the successful or unsuccessful outcome of the whole struggle, and thus tended to give the war itself greater coherence. In this way, fortresses attained a strategic significance that for a time was considered so important that they formed the basis of strategic plans, which were more concerned with capturing a few fortresses than with destroying the enemy's armies. (Clausewitz, 1984: 393)

Through their strategic significance, fortresses exhibit a number of notable effects, specifically, that they reach beyond their walls and give coherence to war. In examining the effects of fortification, Clausewitz differentiates between fortress designs. A fortress that seems impregnable will be circumvented by enemy forces, whereas a 'fortress that *attracts*, and holds out against, a full-scale siege will naturally weigh much more in the scales of war' (Clausewitz, 1984: 372, my emphasis).

Reading these passages in light of recent work on the agentic qualities of weapons as material things, we find the fortress exerting complex effects on war and politics (Meiches, 2017; Chamayou, 2015; Salter, 2015). Meiches (2017: 15) provocatively suggests, '[t]he "striking power" of weapons consequently induces complex affects that befall both human embodiment and relations of desire in ways that are difficult to predetermine.' Though a response to ballistics, fortifications nonetheless have their own affective 'striking power.' Strategically valuable fortifications work at the level of an enemy's desire, exerting the force of attraction in order to weigh down one's enemies. The territorial claims enacted through fortification amount to a felt significance, reaching beyond fortress walls to define not only the fortified site but the emerging state space as a 'strong place.' Methods of strengthening urban defense could now be applied across a theater of war and ultimately extended across the entire territory.

This vital function of the fortress, as an agentic force in war, complicates lines between defense and offense. With the effects of military architecture in mind, Clausewitz (1984: 357) sets out from

the premise that 'defense in war can only be relative.' Absolute defense would amount to passivity and disengagement from war. Defense is, for Clausewitz, the more powerful position in war, and as such, must have multiple agentic qualities. He describes it as a 'shield made up of well-directed blows' and further suggests, 'A sudden powerful transition to the offensive—the flashing sword of vengeance—is the greatest moment of defense' (Clausewitz, 1984: 357). Paradoxically, the fortifications of defensive war take on their defining quality when, through precise calculation of counter-attack, they are utilized to lash out with vengeance against an enemy. Clausewitz (1984: 397) further emphasizes this dynamism when he likens fortifications, even in their most inert form, to 'blocks of ice in the course of a river's flow,' describing them through a Heraclitean metaphor of becoming. They modulate the movements of war as they are in turn composed by such movement. The fortifications of modern war are not peaceful, passive, or immobile. They strike the enemy and enable targeted blows inflicted with vengeance. Their mode of warfare reaches outward from within, enabling and intensifying conflict.

How do we think about this move from the fortress as the recuperation of the inside to a dynamic of defense within security politics? In looking to its genealogy, fortification is neither an attempt to avert war nor a reaction to impending conflict. Fortification is one pole, one site of agency, in the process of becoming war. It is a preparation for war that activates an offensive response. Such preparation for war contains an 'infernal tendency—heading toward an extreme where no one will control anything' (Virilio and Lotringer, 2008: 62). Preparation always contains the possibility, indeed the tendency, toward the use of the weapons and resources mobilized in the process. Fortification is such a preparation, decidedly not about averting or minimizing war but installing military architecture designed for the inevitability of armed conflict. By establishing defense in depth, fortification is a matter of interpellating as 'defender' and beginning to organize space and time accordingly.

The strategy of defense in depth that would first emerge around the bastion fortress and find its clearest articulation in Vauban would be complicated by changing notions of space and the decline of the bastion fortress. The next section considers how the geometry of defense in depth underwent transformations in the era of total war and asks if one can begin to speak of non-linear defense in the age of global war.

Fortified everywhere: From curtain wall to radar curtain

The military engineer of the late-19th century had a sense of coming transformations in the spatiality and material form of defensive war. Where the designs of Vauban's fortifications had once seemed uncontestable, new ideas about the relation between war and space began to gain ground. Eugène Viollet-le-Duc's enigmatic *Annals of a Fortress* stands out among these reflections. Viollet-le Duc, a prominent French architect who found himself serving as a military engineer late in his career, produced a text that is not easy to classify by genre. It is both detailed study and winding fabulation. Rather than draft an exhaustive history of fortress construction, Viollet-le-Duc wrote of a fictional site, La Roche-Pont, from its settlement over two millennia ago to future war that might be waged on its ruins. The fortified site was a composite, constructed from his experience in the defense of place. The resulting text combines Viollet-le-Duc's archival knowledge of military architecture with speculation about future warfare. In the closing pages of the text, he suggests an impending transformation in the techniques of fortification:

> And in the art of fortification we are exactly at the same point as were the men-at-arms of the end of the fifteenth century, who heaped plates on plates to protect themselves from artillery. It is time the art of fortification should be modified. In future warfare the plan of temporary fortification ought to play a

> principal part and may be made to do so. In other terms, an army ought to be able to *fortify itself everywhere*, and take advantage of every position . . . Vauban's fortresses have had their day. (Viollet-le-Duc, 2007: 379–380, my emphasis)

Viollet-le-Duc sees war outstripping the defenses of the star-shaped bastion fortress, but he cannot yet imagine the precise form of fortification that will replace it. This does not bespeak a lack of critical insight but, rather, an attunement to becoming war—an unsettled future for the shifting design, mobilization, and experience of conflict. He envisions the possibilities of the defensive mode that will accompany future warfare, understanding the dynamism of his object of study. Despite these qualifications of his claims, his provisional suggestion is of fortification that is light, mobile, and adaptable in lieu of bearing increasingly heavy and unwieldy armor. While the precise material form remains unclear, the ideal military can 'fortify itself everywhere.' Viollet-le-Duc might be read as announcing a series of transformations in the technique of fortification over the course of the late-19th and 20th centuries.

The vision of warfare in which an army can 'fortify itself everywhere' is an evocative addition to the study of global war (Chamayou, 2012; Galli, 2010; Hardt and Negri, 2004). Whereas the body of literature on global war emphasizes the unrestricted movement of conflict across territorial boundaries, close attention to fortifications of contemporary war suggests a more complex spatial arrangement. We can seize on Viollet-le-Duc's speculative endeavor to better understand the spatiality of global war—the geopolitical lines of obstruction, the defense in depth built into global space, and the heightened modes of detection that evolved out of lines of fire. Viollet-le-Duc's vision of an army able to fortify itself everywhere is echoed by Gregory's (2011: 238) notion of 'everywhere war' accompanied by the spatiality of a 'planetary garrison.' 'Everywhere,' here, does not suggest a flattening of space and a uniformity of experience, but a global 'multi-scalar, multi-dimensional' battlespace (Gregory, 2011: 239). The invocation of 'planetary garrison' notably draws on a figure of military architecture. Following the fortifications that compose this planetary garrison reveals an uneven geography of warfare in which military architecture and engineering distribute vulnerability within everywhere war along lines of fractal complexity. The geometric mode consolidated in treatises on fortification foreshadowed 'regimes of global calculation' (Elden, 2017: 300). By following the transformation of fortification as a technique of power, I bring into view the geometries and logistics by which 'everywhere war' is being waged.

Fortifications at the end of the 19th century had become cumbersome yet ineffective, leading to experimentation in design, including temporary structures, methods of reinforcement, and lines of bunkers and trenches (Hirst, 2005: 189, 205–207). My focus here will neither be on the temporary fortifications tested by engineers like Viollet-le-Duc nor on the enormous construction projects of the Maginot Line and the Atlantic Wall. Instead, I focus on the ways in which the era of total war would witness the extension of fortification from cities and specific sites to the national territory and beyond through new technologies. In particular, a material history of fortification reveals the significance of the advent of radar as itself a kind of wall:

> The next stage in the development of the wall occurred when offense technology created a new delivery vehicle, the bomber plane, forcing the fortress to dematerialize into the electronic radar curtain. The development of radar resembles the evolution of fortress design in that it relied on the application of scientific geometric thinking to the problem of maintaining a constant sweeping beam bearing on the enemy, a 'beam' of bullets in the case of fortifications, as well as a beam of radio waves in the case of the dematerialized wall. (DeLanda, 1991: 51)

I read 'dematerialization' here not as the elimination of material infrastructure—something still required by radar—but to suggest that fortification acquired a new form. Ramparts did not vanish

from the terrain of warfare; they atomized and ultimately 'dematerialized' into radar. Likewise, the geometry of the bastion fortress as a response to the ballistic capabilities of the cannon was replaced by the geometry of radar as a response to the ballistics of aerial bombardment. Where the materiality of low walls reinforced by dirt enabled the bastion fortress, the (im)materiality of the electromagnetic spectrum enabled the defense of space through radar. This newly harnessed relation to seeming immateriality redefined modes of surveying space and revolutionized sensory capacities in war. As Bousquet (2018: 74) observes, 'radar grants modern militaries a veritable sixth sense that leaves contemporary battlespaces awash with microwave and radio-wave frequencies imperceptible to the human organisms that still populate them.' Radar combines the tracking of movement with control over territory and the airspace above it. While walls may have been the most iconic fortifications of the 20th century, radar embodied an emerging logic of fortification that was re-making war.

Radar is illustrative of changes in defensive war whereby 'passive' technologies of monitoring altered the understanding of 'active' defenses employed directly in warfighting (Hirst, 2005: 216). While one should not overstate the opposition between active and passive defense (as I have suggested in my discussion of Clausewitz on defensive war), the use of radar in warfare nonetheless places new emphasis on detecting, watching, and tracking.[10] The significance of this paradigmatic shift can be made evident through public ideas about radio waves. The discovery of radio waves produced public speculation about the creation of a 'death ray.' Such a weapon would rely on an intense concentration of radio waves to attack a pilot and destroy a plane. Military officials seized on this notion, seeking to weaponize radio waves. In the UK, the Air Ministry called on the inventor Robert Watson Watt to address the possibility of a radio death ray. Watt and Arnold Wilkins calculated that radio waves would be ineffective as a weapon of counter-attack but would better serve the purposes of observation and warning: '[i]n sum, substitute radio detection for radio destruction' (Brown, 1999: 50). Guglielmo Marconi faced similar challenges in explaining the use of radio waves. Marconi, building on the work of Christian Hülsmeyer, had been one of the first inventors to suggest the idea of radar, offering the idea in a 1922 speech to the American Institute of Electrical Engineers. In a radar demonstration by Marconi years later, the event would be misunderstood and erroneously reported by journalists as a display of his 'death ray' (Galati, 2016: 10). Both cases make evident the predominant understanding of defensive technology: the projection of a radio wave must be an 'active' weapon of war. It would take the contemporaneous efforts of a number of scientists to translate the technology into an idiom that would be intelligible to military officials. Once public knowledge of radar began to catch up to the state of the technology, popular imagination suggested ways to apply it to the navigation of space in domestic life. For instance, an article in 1945 entitled 'Radar's Future' envisioned radar affixed to every ship, commercial airliner, train, and automobile (*Science News*, 1945). A sense had emerged—resonant with Viollet-le-Duc—that these 'passive' defenses could be applied everywhere. Methods of monitoring battlespace would return to the homefront as safety and precautionary measures. Multiple layers of fortification had been established beyond state territory through early warning systems, plane overflights, and submarine radar; now multiple layers of internal fortification could be added as well. The generative power of war made this new technology of detection a staple of everyday life.

The mobilization and logistics to support radar transformed the space of war, connecting a series of seemingly heterogeneous sites and spaces in a multi-scalar process of fortification. While the radar towers of Chain Home in the UK would most closely resemble linear defense, the research and development laboratory—a new organizational form in mobilization for war—facilitated research into radar and its subsequent ascent of its status as a war technology. Through the research and development laboratory, military engineers could be inserted into processes of war while

remaining physically distant from the space of the battlefield. The 1922 discoveries by Taylor and Young coincided with the founding of the US Naval Research Laboratory, where they would continue their research (Brown, 1999: 42). The MIT Radiation Laboratory (RadLab) became the heart of radar development in the United States (Buderi, 1997; Eckert and Schubert, 1990: 142). The Johns Hopkins Applied Physics Laboratory, formed from the Carnegie Institution Department of Terrestrial Magnetism Section T, brought the application of radar in the proximity fuze into large-scale production.[11] This network of laboratories directed research into a system of defense that covered the national space and transformed linear defense, first applied in the emblematic form of Chain Home, into a technology of fortification to be applied everywhere. Through radar, everywhere war could be extended to the skies.

The fortifications of military engineers reveal pathways of circulation between seemingly disconnected spaces of contemporary war. Today, the infrastructural work of the US Army Corps of Engineers provides a basis for the extension of US empire, setting regulations on property and labor and constructing infrastructure as a claim to contested territory (Khalili, 2018: 917–918). The territorial aspirations of such infrastructural projects appear most clearly in the military engineering of border walls. Examining these walling projects through a focus on military engineering reveals material circuits of war, whereby the weapons of imperial adventure are recycled into the infrastructure of border fortifications. The construction of United States–Mexico border walls since the 1980s has occurred under the guidance of the US Army Corps of Engineers. Early walls along the southern border of the United States were constructed from recycled Vietnam-era helicopter landing mats, produced in bulk as mobile landing platforms. Charged with designing an effective landing mat in Vietnam, and 50 years later, working on the design and construction of a United States border wall, the Army Corps of Engineers 'provided institutional continuities between Vietnam and the US southern border' (Hattam, 2016: 32).

The use of recycled landing mats in border walls suggests that the seemingly inert figure of the wall contains a complex material history. The claim to sovereignty performed through the construction of these walls must be understood as it emerges through its materiality, as the product of movement between 'war and wall' (Hattam, 2016: 36), and it is the Corps of Engineers that connects these seemingly distant spaces. In the materiality of the mats we witness the way in which this particular project of sovereignty is built from its own surplus. Cast-off materiel of an earlier imperial war, too physically heavy to dispose of yet otherwise functionally useless, becomes the infrastructure of a new war against migrants. As the Trump administration's plan to replace these walls proceeds, the US Army Corps of Engineers has continued its infrastructural work, testing prototypes of wall designs. If geometric power over territory and the management of urban populations first took shape in the military engineer of early modern warfare, the US Army Corps of Engineers now gives global reach to these interwoven tendencies of fortification. Hardt and Negri (2004: 49) go so far as to suggest that the engineer, through its infrastructural role in weapons development and communication, has become an emblematic figure of contemporary global warfare. Yet this global war is one tied to the logistical lines—defended spaces articulated at multiple scales and reliant on particular geographic sites. Global war may be present virtually everywhere, but it condenses and intensifies along key logistical pathways.

Through the emergence of these new defensive forms, we witness new ideas of geometry applied to warfare. With the rise of network-centric war (Weber, 2004), non-linear sciences have reshaped military doctrine and practice. Yet, this new 'chaoplexic way of warfare' has not been able to smooth out space in precisely the way it imagines (Bousquet, 2009: 185), and one should be careful not to overstate the extent to which ideas of non-linearity affect the hierarchies of contemporary war (Weizman, 2007: 212). Fortifications have not been replaced by a homogeneous space of uninhibited movement. Instead, the defense of space involves interwoven layers of

fortification—no longer linear defense or defense in depth, but *non-linear defense*. Through radar, the electromagnetic spectrum becomes both a scientific frontier and the medium through which to fortify national territory. Radar technology both extends over the entirety of the national territory and is miniaturized in the form of the proximity fuze. As research laboratories have become permanent fixtures in national defense, the logistics of fortification today involve not only a steady supply line but the ongoing development of new defense technologies—just-in-time fortifications for the everywhere war. Even the seemingly linear defense of the wall suggests curvatures and entanglements of space and time. The wall at the United States–Mexico border involves the circulation of materiel from the US invasion of Vietnam to the repeatedly colonized space of the US southwest, juxtaposing seemingly distant spaces and temporalities. If the design of Renaissance fortifications retained a lingering sense of artistry, and the design of early modern fortification found its highest expression in simple polygons, the fortifications of everywhere war have gravitated toward principles of non-Euclidean geometry.

Where the military urbanism of Vauban sought to control space through the construction of polygonal fortifications and lines of fire, the 'new military urbanism' utilizes obstruction and detection detached from linear defense (Graham, 2011: 60). Gates, fences, and walls cutting through cities resemble the securitization of state borders rendered at a different scale. The temporal logic of defense in depth, whereby the slowing of the attacker's advance grants time to the defender, is replaced by a more expansive sense of 'anticipatory action,' which includes preemption, precaution, and preparedness (Anderson, 2010). Anticipatory actions determine distributions of risk contained in possible futures and apply calculative logics to contain, ameliorate, or cancel said risk. The aim is not to avert conflict, but to guarantee a position of relative strength in any number of potential imagined conflicts. Thus, even as fortification takes a 'defensive' posture, it is always on the way to becoming war, acting against or securing a dangerous future. Fortification operates on an anticipatory logic, preparing for a future of escalating risk by marshalling resources of the past in a militarized present. In this anticipatory logic of fortification, the preparation for war turns into the medium of violence. Preparation and precaution generate their own 'maps of anticipation,' cartographies of risk and security that propel spatial organization for impending conflict (Jeganathan, 2004: 68). We find in these anticipatory logics the 'infernal tendency' by which defense lashes out in acts, always deemed counter-attacks, of vengeful aggression.

Conclusion

Fortification as a technique of power offers a way to think about the defense of space that goes beyond displays of sovereignty, focusing instead on immanent, material conditions—processes of calculation, elements of design, and mechanisms of spatial organization driven by ideas of geometric order. Such a shift in focus reveals a neglected history in which military architecture and engineering of early modern fortifications, informed by ideas of linear defense and defense in depth gave way to the fortification of space that adapts to the space to be defended. The enduring legacy of fortification appears in the complex defense of space that functions at multiple scales, utilizing an array of technologies of detection, periodically obstructing selected movements, and relying on extensive logistical networks. Following this genealogy, 'defensive' fortification is a practice of maximizing violence by other means. It names a process of anticipatory action taking form in the built environment, acting against the possibility of future risk and threat through spatial controls in cities and intensified violence at state borders. Fortification is not yet open war, but a 'defensive' approach to design in the sense that Clausewitz uses defense, as a reaching out and striking vengefully.

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Notes

1. Urban historians now tend to attribute the origin of cities to a combination of agricultural surplus, the intensification of trade, and urban defense (see Taylor, 2013: 102–111).
2. I take Virilio's writings on fortifications to be 'suggestive, rather than explanatory' (Virilio and Lotringer, 2008: 52). His conclusion that time has eclipsed space and ushered in the primacy of speed as the mode of power limits his insights into spatial organization. Nonetheless, his interjected commentaries on fortification provide provocations for thinking about the nexus of war, urban space, and social organization.
3. While my discussion of fortified borders focuses on the United States, a similar analysis applies to Europe's militarized bordering practices along the Mediterranean and the creation of fortified enclaves in Ceuta and Melilla (De Genova, 2017).
4. Walker (2010) convincingly argues for the 'international' to make reference to a world in which boundaries and borders are decisive in political life.
5. Take for instance the power of the Illegal Immigration Reform and Immigrant Responsibility Act of 1996 (IIRIRA) to waive environmental protections. This waiver power was recently invoked by the US Department of Homeland Security in the construction of new border barriers and roads in California and New Mexico (US Department of Homeland Security, 2017, 2018).
6. Such a suggestion alludes to Foucault's (1990: 12) characterization of the repressive hypothesis, which envisions 'one great central mechanism destined to say no.'
7. My thinking on the temporal logic of fortification is indebted to Stewart-Steinberg (2016) on 'reclamation' in fascist Italy. 'Reclamation' appealed to a distant past defined by military virtue and used the image of this past to mobilize social engineering projects on an enormous scale.
8. While I focus on the emergence of fortification in European warfare, I do not wish to overlook the significance of fortification in colonial war. The artillery fortress has been called an 'engine' of European imperial war in Africa, Asia, and the Americas (Parker, 2000), and garrisons were integral to the process of settler colonialism.
9. Regarding the treatise on Vauban's method of fortification, I cite it as Vauban, 2003a (the primer on geometry) and Vauban, 2003b (the text on fortification) for the sake of clear reference to the digital library that attributes it to Vauban. For a discussion of du Fay's authorship of the text, see Langins (2004: 60–62, 442).
10. Radar would later be added to weapons systems in a way that immediately contests such strong distinctions between active and passive.
11. The proximity fuze attached the 'smallest radar' directly to the weapon that the detection system had previously only directed (Brown, 1999: 174). 'Defensive' radar had been re-activated as weapon.

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