

The Early Effects of Gunpowder on Fortress Design: A Lasting Impact

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The introduction of gunpowder did not immediately transform the battlefields of Europe. Designers of fortifications only had to respond to the destructive threats of siege warfare, and witnessing the technical failures of early gunpowder weaponry would hardly have convinced a European magnate to bolster his defenses. This essay follows the advancement of gunpowder tactics in late medieval and early Renaissance Europe. In particular, it focuses on Edward III's employment of primitive ordnance during the Hundred Years' War, the role of artillery in the Ottoman conquest of Constantinople, and the organizational challenges of effectively implementing gunpowder as late as the end of the fifteenth century. This essay also seeks to illustrate the nature of the development of fortification in response to the emerging threat of gunpowder siege weaponry, including the architectural theories of the early Renaissance Italians, Henry VIII's English artillery forts of the mid-sixteenth century, and the evolution of the angle bastion. The article concludes with a short discussion of the longevity and lasting relevance of the fortification technologies developed during the late medieval and early Renaissance eras.

The castle was an inseparable component of medieval warfare. Since Duke William of Normandy's 1066 conquest of Anglo-Saxon England, the construction of castles had become the earmark of medieval territorial expansion. These fortifications were not simply stone squares with round towers adorning the corners. Edward I's massive castle building program in Wales, for example, resulted in fortifications so visually disparate that one might assume they were from different time periods.¹ Medieval engineers had built upon castle technology for centuries by 1500, and the introduction of gunpowder weaponry to the battlefields of Europe foreshadowed a revision of the basics of fortress design. However, the transformation from medieval castle to Renaissance fortress did not occur overnight. Witnessing the technical travesty of early gunpowder weaponry would hardly have

¹ For extensive discussion of these and other English castles, see R. Allen Brown, *English Medieval Castles* (London: B. T. Batsford Ltd., 1954); N. J. G. Pounds, *The Medieval Castle in England and Wales* (Cambridge: Cambridge University Press, 1990); D. J. Cathcart King, *The Medieval Castle in England and Wales* (Portland: Areopagitica Press, 1988).

convinced a European magnate to bolster his defenses. But castles could not resist the onslaught of artillery for long. Constantinople's impenetrable double walls fell to Ottoman ordnance in 1453 and from that moment on traditional medieval European defenses became increasingly obsolete. For the latter half of the fifteenth-century engineers raced to develop the mightiest fortification style possible. Expansive defensive building programs such as Henry VIII's fortification of England's southern coast illustrate the slow, cautious process that characterized the development of early Renaissance fortification. By the time the ideal formula of walls and platforms was reached, the castle had been relegated to a vestige of the past.

The final years of the fifteenth century are attractive milestones for historians of any discipline. Christopher Columbus' expeditions, the completion of the Reconquista, and Charles VIII's invasion of Italy all characterized the following hundred years. Unsurprisingly, many military historians find the foundations of the development of Renaissance warfare within the first French incursions into Italy. J. R. Hale's interpretation, which has attained widespread acceptance, points to the political circumstances of the era in both France and Italy. Both regions were reeling from centuries of political instability, and were ripe for the development of new types of weaponry. For Hale, the development of new defensive systems was a direct response to the emergence of gunpowder, and was geographically confined to Italy and France.² Thomas Arnold, in his recent survey of Renaissance war, expands Hale's geography to include Burgundy, Switzerland, and the Holy Roman Empire. In particular, Arnold focuses on non-Italian architectural innovators such as Albrecht Dürer, the German artist and engineer whose theories influenced the blueprints of many later fortifications.³ Beyond geographical constraints, however, Arnold's basic argument holds true to Hale's interpretation.

² J. R. Hale, "The Early Development of the Bastion: An Italian Chronology c. 1450–c. 1534," in *Renaissance War Studies* (London: The Hambledon Press, 1983), 6.

³ Thomas F. Arnold, *The Renaissance at War* (London: Smithsonian Books, 2005), 30–49.

Bert Hall's survey of Renaissance warfare also remains in line with Hale. He points to Pisa's first employment of a *retirata*, a freestanding emergency earthwork barrier and ditch formed behind a battered stone wall, as evidence that Italians were familiar with the dynamics of gunpowder warfare by 1500.⁴ Hall emphasizes the lagging of fortification development relative to that of offensive artillery.⁵ Indeed, the defensive capabilities of gunpowder were slow to be realized, but other recent works cite specific examples of early architectural prowess that seem to break the trend. Michael Dechert focuses on the works of Francesco di Giorgio in Naples, which, to some degree, embraced gunpowder's defensive potential.⁶ While Francesco's fortifications remained a far cry from the symmetrical star forts of the seventeenth century, early attempts at gunpowder defense provide much insight into the development of structures that truly revolutionized siege warfare.

The concept of fortification was nothing new to Renaissance commanders. For centuries, the primary mode of exerting control over a geographical area had been the castle. Charles Oman, in his pioneering, yet sweepingly general discussion of medieval warfare, classifies castles as a product of feudal relations. Defense was the base of feudalism, Oman posits, and the castle was the necessary physical manifestation of the militant political system.⁷ Later historians would refine Oman's assessment. R. Allen Brown, for example, shows that a castle's fabric reflected its location and intended function. Thus, different fortifications would serve divergent roles, based on location and necessity. For Brown, medieval castles achieved tactical, ad-hoc ends, not widespread strategic ones.⁸ Another notable view is that of Helen Nicholson, who highlights that castles were offensive rather than defensive: indeed they would protect those inside, but they would also exert political and social power

⁴ Bert S. Hall, *Weapons & Warfare in Renaissance Europe* (Baltimore: The Johns Hopkins University Press, 1997), 171.

⁵ Hall, 155.

⁶ Michael S. A. Dechert, "The Military Architecture of Francesco di Giorgio in Southern Italy," *Journal of the Society of Architectural Historians* 49, no. 2 (June 1990): 162.

⁷ C.W.C. Oman, *The Art of War in the Middle Ages A.D. 378–1515* (Oxford: Oxford University Press, 1885), 58, 68.

⁸ R. Allen Brown, *English Medieval Castles* (London: B. T. Batsford Ltd., 1954), 191.

over the surrounding countryside, subjugating the populace.⁹ Renaissance fortresses certainly retained this quality of social domination; at Siena a fortification was constructed, but was torn down by angry citizens only a few years later.¹⁰

To find the roots of military and fortification development through the Renaissance, one must consider the initial contact between Europeans and gunpowder. Edward III brought primitive ordnance along for the early battles of the Hundred Years' War, though he most likely used them for psychological effect, or, as Albertus Magnus put it, "making thunder."¹¹ By Edward's time, the crowned heads of Europe had at least some awareness of the existence of gunpowder, if not its potential role on the battlefield. Artillery may have even seen limited use in sieges before the Hundred Years' War; Walter de Milemete's 1326 *Treatise* depicts primitive cannon alongside the traditional siege armament of his era.¹² Milemete's cannon resembles a vase, suggesting a heavy East Asian influence on early ordnance.¹³ Western Europe did not drive the early years of gunpowder innovation, and thus the technology did not generate the novel acclaim that surrounded purely European creations like Gutenberg's printing press. Gunpowder, despite its potential for noise, quietly and slowly found its place on the battlefields of Europe.

The fourteenth-century introduction of gunpowder hardly produced an instantaneous universal adoption of artillery, and contemporary military architecture provides tactile proof. Magnates continued to build fortifications in the medieval style, with wall height favored over thickness and

⁹ Helen Nicholson, *Medieval Warfare* (New York: Palgrave Macmillan, 2004), 80.

¹⁰ Arnold, 52.

¹¹ Kelly DeVries, "Gunpowder and Early Gunpowder Weapons," in *Guns and Men in Medieval Europe, 1200–1500* (Burlington: Ashgate Publishing Company, 2002), 125.

¹² Walter de Milemete, *The Treatise of Walter de Milemete: De Nobilitatibus, sapientiis, et prudentiis regum*, ed. M. R. James (London, The Roxborough Club, 1913), 133–40, Accessed 14 January, 2012, <http://www.archive.org/stream/cu31924032172029>

¹³ Arnold, 30.

extensive machicolation emplacements to repel enemies at its base.¹⁴ For fourteenth- and early fifteenth-century defenders, the old system of fortification was not a problem in the face of artillery bombardment, as the first gunpowder weapons could achieve little more than preceding siege engines. During the final month of the 1375 siege of the English castle St.-Sauveur-le-Vicomte, the French employed four artillery pieces and were able to maintain reliable gunpowder supply routes from Paris.¹⁵ Froissart comments that the English took refuge in their flanking towers, indicating that the French ordnance was unable to penetrate St.-Sauveur's curtain wall.¹⁶ Indeed, the besiegers realized the ineffectiveness of attacking the walls, and instead turned their artillery to a high angle, targeting the relatively fragile wooden rooftops. The castle surrendered only a few days after two extra cannons were brought to the field, purportedly due to the fact that a stone had crashed through the roof of the English commander's quarters during the night.¹⁷

The siege of St.-Sauveur-le-Vicomte characterizes early gunpowder warfare. The French ordnance there filled the role of the trebuchet: an engine that could hurl stones high into the air so as to arch over a curtain wall, harassing the inhabitants of a fortified place. Gunpowder resulted in a successful siege at St.-Sauveur, but not due to any penetration of the castle walls. This form of victory, too, is reminiscent of the traditional medieval siege. Historians have long noted that a besieger's most reliable weapon was the threat of starvation itself.¹⁸ Dwindling victuals represented imminent death to a garrison, and the earth-shaking guns placed outside the walls of St.-Sauveur-le-Vicomte only lessened those defenders' resolve. The armament of the besieger was changing, but the basic paradigm of medieval war remained untouched.

¹⁴ Oman, "The Art of War in the Middle Ages," 57–8.

¹⁵ Hall, 56.

¹⁶ Jean Froissart, *Oeuvres: Chroniques* (Lettenhove), 8:342, cited in Hall, 57.

¹⁷ Hall, 57.

¹⁸ Oman, "The Art of War in the Middle Ages," 59.

Almost eighty years after the French took St.-Sauveur-le-Vicomte, artillery would reveal its full potential to Europe and the Near East. In 1788, Edward Gibbon recognized the decisive role of gunpowder during the Ottoman conquest of Constantinople.¹⁹ Later historians do not dissent: Charles Oman confirmed Gibbon in 1898, as did Mark Bartusis in 1997.²⁰ These writers emphasize not only the centrality of artillery in taking Constantinople, but also that the fall of the city marked the beginning of gunpowder's prominence on European battlefields. Kelly DeVries, however, challenges this thesis by considering the fall of Constantinople within the wider backdrop of Western Europe.

The Byzantines were certainly familiar with artillery by 1453, but economic conditions prevented production from reaching numbers comparable to their Eastern and Western neighbors. The Byzantines acquired most of their ordnance through gifts and lending, while the opposing Ottoman guns were home-built.²¹ It is well established that during the Siege of Constantinople, both sides employed gunpowder. What gave the Ottomans an edge, posits DeVries, was shrewd leadership, not technological superiority.²² Mehmed II's 1453 siege was not an impromptu affair. Kritovoulos recounts that the Sultan had long "prepared for greater things [...] everything contributed to the plan he had before him."²³ Some time before the campaign, the Ottoman ruler hired at least one Hungarian gun-maker who had become disgruntled with Byzantium's refusal to provide an adequate stipend. In only

¹⁹ Edward Gibbon, *The History of the Decline and Fall of the Roman Empire*, III: ch. 68, accessed January 14, 2013, <http://www.ccel.org/g/gibbon/decline/index.htm>.

²⁰ Charles Oman, *A History of the Art of War in the Middle Ages: Volume II: 1278–1485* (London: Methuen & Co. Ltd, 1924), 357–9. Mark C. Bartusis, *The Late Byzantine Army: Arms and Society, 1204–1453* (Philadelphia: University of Pennsylvania Press, 1997), 335.

²¹ Kelly DeVries, "Gunpowder Weapons at the Siege of Constantinople, 1453", in *Guns and Men in Medieval Europe, 1200–1500*, 350–2.

²² DeVries, "Constantinople," 345.

²³ Kritovoulos, "From the History of Mehmed the Conqueror," in *The Islamic World*, ed. William H. McNeill and Marilyn Robinson Waldman (Chicago: The University of Chicago Press, 1984), 316–17.

three months, the engineer had produced ordnance capable of gouging a six-foot hole in a stone wall.²⁴ Indeed, gunpowder weaponry had progressed since St.-Sauveur-le-Vicomte.

Mehmed II had the ordnance he needed to take Constantinople, and he laid siege. But he did not simply start shooting. The sultan positioned his artillery in tactical locations surrounding the city, targeting gates and long sections of wall.²⁵ Mehmed also quickly realized that maintaining his massive siege required reliable supply trains. These caravans, already armed and traveling through enemy lands, provided convenient attack forces for other Byzantine forts.²⁶ The commander even commissioned ad-hoc gun modifications, building an accurate anti-naval mortar to his own specifications.²⁷ Mehmed was keen to use his assets for multiple roles, resulting in an extremely efficient and effective fighting force on multiple fronts, which he could maintain almost indefinitely. After only fifty-five days, the Ottoman guns punctured the ancient walls of Constantinople, and the Sultan absorbed the Roman Imperial title which had existed for almost a millennia and a half.

Mehmed II's successful employment of artillery demonstrates gunpowder's potential by 1453, but does not reflect the average understanding of the technology across Europe. Almost two decades after the fall of Constantinople, in a region supposedly accustomed to gunpowder warfare, ignorant mistakes continued to doom military expeditions. In 1472, the Duke of Burgundy initiated a siege at Beauvais. His two bombards fired a shot each, and managed to blow a hole in the defenders' gate. But the besiegers ran out of projectiles after those two shots, forcing them to relinquish the siege.²⁸ Despite the clear advantage that commanders of ordnance may have expected, artillery did not exempt its owner from careful military planning.

²⁴ Michael Ducas, *Byzantine History*, in *The Siege of Constantinople, 1453: Seven Contemporary Accounts* (Amsterdam: Hakkert, 1972), 70–2, quoted by DeVries, "Constantinople", 356.

²⁵ DeVries, "Constantinople," 357.

²⁶ DeVries, "Constantinople," 358.

²⁷ Ducas, 90, cited by DeVries, "Constantinople," 360.

²⁸ Kelly DeVries, "The Impact of Gunpowder Weaponry on Siege Warfare in the Hundred Years War," in *Guns and Men in Medieval Europe, 1200–1500*, 227.

If the fall of Constantinople is to be the archetype of successful early artillery command, then the basic defensive layout should be designed to counter such an attack. Christine de Pizan, in the first decade of the fifteenth century, already had some ideas that would have benefited the Byzantines. *The Book of Deeds of Arms and of Chivalry*, Christine's revival of Vegetius' Roman legionary field manual, fits gunpowder weaponry into the familiar framework of late medieval warfare. To defend against increasingly commonplace explosive weapons, Christine suggests surrounding defensible locations with a deep ditch, building a double wall, and filling said wall with the displaced dirt. Likewise, she suggests that the walls be jagged, not straight, so as to allow for flanking fire from defenders.²⁹ A quick glance at a map of Constantinople reveals alarmingly straight double walls. Although the ancient walls were thick and high, they were obsolete in the face of Mehmed II's artillery.

Christine's commentary on defense is short. Writing during the early years of gunpowder warfare, she had a fuller grasp of artillery's offensive role. The *Architecture* of Leon Batista Alberti expands on Christine's wall design, adding several options for use against specific types of attack. Interestingly, although the architect presents a fort able to utilize and repel gunpowder weapons, he rarely conveys the superiority of cannon over traditional siege machines.³⁰ Alberti's idealized fortress is star-shaped, with relatively low walls. The walls enclose the most fortified part of the fortress, the central tower. This tower, according to the architect, should be taller than any other part of the fortification.³¹ Surrounding the walls is a large ditch, either water-filled or completely empty. Until this point, Alberti's fortress strongly resembles that of Christine.

Alberti suggests some additional armaments to bring his fortress up to date with gunpowder warfare. Possibly his most revolutionary proposition is the addition of small loop-holes at the base of

²⁹ Christine de Pizan, *The Book of Deeds of Arms and of Chivalry*, trans. Sumner Willard, ed. Charity Cannon Willard (University Park: The Pennsylvania State University Press, 1999), 105–6.

³⁰ Hale, "Bastion," 12.

³¹ Leon Batista Alberti, *The Architecture of Leon Batista Alberti*, trans. James Leoni (London: Edward Owen, 1755), 87.

walls. This would allow defenders to provide flanking fire upon besiegers located at the base of walls.³² It is necessary to note that the bases of walls were not left unprotected for the entire medieval period, only to be defended during the Renaissance. Medieval castle builders utilized wall-topping protruding stonework galleries, or machicolation, to gain a vertical vantage point against the besiegers. The introduction of gunpowder produced higher horizontal battering forces than ever, thus rendering the relatively fragile machicolation obsolete.³³ Alberti's ingenious solution not only embraces the defensive capabilities of gunpowder, but also presents a creative means to overcome the obsolescence of an almost ubiquitous fortified structure. The architect's base concept would eventually evolve into the most powerful and best remembered Renaissance defensive structure: the bastion.

Another of Alberti's influential suggestions is that the outside face of a fortress' outermost wall should be angled, not vertical. This, the architect argues, serves not only to reduce the impact of horizontal artillery missiles, but also to destabilize any attempt at siege ladder use.³⁴ This angled wall architecture is later referred to as scarping – Alberti does not use the term.³⁵ Machicolation and scarping are incompatible forms of architecture. Machicolation placed atop a scarped wall would prove useless, since the scarping angle would prevent any vertical fire from reaching the base. Thus, the architect's loop-holes become increasingly necessary. Alberti supposes that a heavily fortified central tower should provide the best possible balance of defensive and offensive capabilities. Though this architect does not give many specifics regarding his central tower, later experts would take up his concept in an attempt to improve it.

The allure of Alberti's early suggestions for fortification lies in his relatively simple structures. Princes who already had existing castle networks could not simply tear down old fortresses and put up

³² Alberti, 87.

³³ Hale, "Bastion," 9–10.

³⁴ Alberti, 87.

³⁵ Hale, "Bastion," 9.

new ones, as such a building program would prove preclusively expensive. Instead, a prince could add Alberti's structures to preexisting castles. The Castello Nuovo in downtown Naples serves as an example of castle improvement. The Angevins originally constructed the castle in 1279, though little of its original form remains extant. During the mid-fifteenth century, the Aragonese added huge barrel towers, allowing for relatively effective flanking fire from the top of one tower to its neighbor's base. A decade later, a low outer wall was added with significant scarping. This structure remains today, and its juxtaposition with the older wall reveals the sharp contrast between medieval and renaissance wall styles. The scarped wall is high enough that ladders would have difficulty stabilizing, yet low enough to act as a defensive artillery platform.³⁶ Eventually, a large ditch was added outside the scarped wall, resulting in a system of defense almost identical to Alberti's prescription.³⁷

The later years of the medieval era saw the castle's strongest point transition from the central keep to one or more gatehouses.³⁸ As has been shown, much of the initial development in gunpowder defense was heavily rooted in medieval tradition. Thus, the builders of many early artillery fortresses opted for a single strongpoint, echoing the late medieval gatehouse or early medieval keep. A strongpoint, in order to house gunpowder weapons, was usually tall and multi-tiered, with an open top for the largest guns. This layout is called an artillery tower.³⁹ Many defenders soon found the artillery tower to provide too limited a vantage point, as only distant targets were subjected to the most intense fire coming from the highest gun platform. Builders therefore adopted a new architectural form, the bastion. In comparing the two structures, Hale posits that the artillery tower represents a defensive focus, and the bastion an offensive.⁴⁰ Though the bastion would take many forms during its long life, its definition prescribes its basic function. To be a bastion, a structure must jut outwards from the fortress,

³⁶ Arnold, 48.

³⁷ City of Naples, "Castel Nuovo," accessed January 15, 2013, <http://www.comune.napoli.it/flex/cm/pages/ServeBLOB.php/L/EN/IDPagina/1372>.

³⁸ Brown, 69.

³⁹ Arnold, 46.

⁴⁰ Hale, "Bastion," 10.

and must house hidden, thickly defended flanking artillery aiming down the wall, so as to provide supporting fire to a neighboring position.⁴¹ The prestigious angle bastion came to a sharp point, putting it at odds with the lobed artillery towers. This form was quite popular with architects during the sixteenth century onwards, but was by no means ubiquitous. Transitional fortresses reveal the varied, sometimes strange schemes that late medieval and early Renaissance engineers attempted before the centralized power of the artillery tower was distributed evenly to several bastions.

Near the end of the fifteenth century, a prince with tight coffers might have opted for a *Castello Nuovo* style fortress, simply retrofitting an older castle with new technology. A prince who sought the best possible fortification, with little to no restraint on monetary expenditure, would construct a brand new fortress in the latest style. The fortress plans of the Sienese artist and architect Francesco di Giorgio present transitional takes on defensive designs.⁴² Most of his notable activity took place in Aragonese Naples between 1484 and 1497. During his short career Francesco made great strides in improving gunpowder defense. The coastal Aragonese fortress at Taranto represents his take on defensive design. The location was not new: the Byzantines and Angevins both had castles there. Francesco and the Aragonese, however, redesigned the entire site. They leveled much of what had been a traditional quadrangle castle, dug a deep ditch to allow seawater to flow around the fort, and added two large protuberances. One massive triangular structure faces the sea, while an even larger projection on the opposite side provided defense from land assault.⁴³

Some would consider it overstatement to refer to the structures at Taranto as bastions, so the term proto-bastion is appropriate. The triangular fortification jutting out into the sea is indeed very close in design to the bastion proper. Its angular shape allows for an extremely wide field of fire, but it lacks the embedded flanking guns that define the bastion. The larger structure protruding towards the

⁴¹ Arnold, 54.

⁴² Dechert, 162.

⁴³ Dechert, 168–9.

land is representative of an architectural class in between an artillery tower and a bastion. Its acute triangular shape would certainly provide an adequate vantage point, much like an elongated triangular bastion. But during its life as a battlement, the structure encapsulated a large three-tier artillery tower. Interestingly, the artillery tower was positioned between two smaller drum towers, which could provide flanking fire.⁴⁴ Indeed, the large artillery tower at Taranto shows that the ideal of mutually supportive flanking fire was present in the minds of late fifteenth-century architects. It would, however, be some time before the means of the science of fortification could achieve the ideal ends.

Francesco's proto-bastions arrived at the perfect time for Italy. He produced his treatise on architecture in 1495, during the first years of France's long period of military incursions into Italy.⁴⁵ This period saw an enormous upswing in interest in fortification technology throughout the peninsula. It was the age of the best-remembered Italian Renaissance engineers, including Leonardo da Vinci and Michelangelo. The competition for patronage drove technological innovation. A glance at Michelangelo's bastion concept sketches is evidence enough that these men imagined designs far-fetched from the medieval tradition, yet grounded enough in reality so as to attract the attention and commissions of magnates.⁴⁶

The princes who commissioned new forts, mostly Northern Italians, were quickly becoming accustomed to gunpowder warfare and realized the defensive potential of supportive fire. Patrons not only required flanking fire, but also expected aggressive, converging lines of sight far beyond the limits of the walls. Michelangelo's early sketches mix curved and angled walls, but he soon abandoned most curves in favor of diagonal lines.⁴⁷ Diagonally oriented straight walls allowed for deliberate converging fire on a distant target, whereas a curved design assigns one gun to each radial point outside the

⁴⁴ Dechert, 169.

⁴⁵ Hale, "Bastion," 19.

⁴⁶ Vincent Scully Jr., "Michelangelo's Fortification Drawings: A Study in the Reflex Diagonal," *Perspecta*, 1 (Summer 1952): 41–2.

⁴⁷ Scully, 43.

fortress. Indeed, it seems that Michelangelo eventually had lost all confidence in curved fortification design. In 1529 he was put in charge of the construction of Florence's new defense system. He immediately proceeded to iron out all the initially planned curved walls, modifying the original design proposed by Machiavelli.⁴⁸

Michelangelo's developments drove European military architecture towards star fort symmetry. One notices that much of the important innovation in fortification technology originated in Italy.⁴⁹ Indeed, sixteenth century Italian fortresses simply technologically outclassed their Northern European counterparts. Henry VIII, for example, constructed his extensive coastal defense network of "device forts" while Michelangelo was active. Henry fortified his southern coast in two stages beginning in 1539 and 1545, in response to the fluctuating threat of a Catholic military campaign in England. In 1538, Francis I of France and Charles V of the Holy Roman Empire entered into a precarious peace, which Pope Paul III hoped to mold into a Catholic alliance against the newly independent English Church.⁵⁰ At the start of his construction program, Henry VIII indulged in hiring some expensive Italian engineers, but mainly relied on homegrown English architects and his own mental "devices." Thus, angle bastions were nowhere to be seen. But while these English fortifications lacked the cutting-edge features of their Italian counterparts, their strength lay in their numbers and raw firepower. Indeed, by the end of 1540, twenty-four new fortifications had been finished and garrisoned.⁵¹ Henry's early device forts do not possess angular layouts in any respect. Most are low-lying, with heavily fortified curved gun platforms in

⁴⁸ Hale, "Bastion," 25–6.

⁴⁹ Hale, "Bastion," 29.

⁵⁰ J. R. Hale, "Tudor Fortifications: In Defence of the Realm, 1485–1558," in *The History of the King's Works*, ed. H. M. Colvin, vol. IV (Part II), (London: Her Majesty's Stationary Office, 1982), 367.

⁵¹ Hale, "Tudor Fortifications," 373.

radial, flower-like orientations.⁵² Hale, in his work on the coastal edifices, goes as far as to call the fortresses transitional in comparison to their contemporary Italian counterparts.⁵³

Why, then, should Italy have been the incubator for Renaissance defensive architecture? It cannot be that military conflict was unique to Italy, for the crowned heads of Europe had been feuding for as long as anyone could remember. Hale's position states that Italy's particular situation, a small peninsula with many small, constantly changing principalities and pinprick wars, formed a perfect incubator for the development of defensive architecture. Following the first French invasion of 1494, this preexisting process accelerated to match the power of the superior French ordnance.⁵⁴ So, the advancements in Renaissance military architecture were born of necessity.

Henry VIII constructed his fortifications out of perceived necessity, like the Italian princes. This king, however, lacked the military experience that drove the advancement of fortification technology throughout Italy. During his thirty-eight year reign, Henry only spent several months on military campaigns that tended to be ill-advised and unsuccessful.⁵⁵ The king's understanding of gunpowder fortification grew between 1539 and 1545, and the chronology of his device forts represents a microcosm of early Renaissance fortification development. The structures of the 1539 program device forts reflect an understanding of gunpowder defense that straddled medieval and Renaissance schemes. The concentric, flower-shaped, rounded designs at Forts Deal, Walmer, Saint Mawes, and Pendennis are conducive to harboring immense firepower, but leave pockets of indefensible ground at the base of each lobed gun platform.⁵⁶ This layout was typical of early artillery fortifications. Henry and his advisers were certainly accustomed to the rounded design: many existing English river defenses employed circular gun towers, as did continental fortifications such as Normandy's Mont St. Michel and the

⁵² Hale, "Tudor Fortifications," 382; Arnold, 61.

⁵³ Hale, "Tudor Fortifications," 377.

⁵⁴ Hale, "Bastion," 6.

⁵⁵ A. F. Pollard, *Henry VIII* (New York: Longman, Green and Co., 1951), 53–4.

⁵⁶ Hale, "Tudor Fortifications," 377, 383.

Aragonese-updated Castello Nuovo.⁵⁷ The reluctance of fortress designers to abandon the rounded tower design in favor of the angle bastion demonstrates the tenacity of medieval castle technology. Round towers afforded castles the advantage of mutual flanking defense and mitigated the potential destructiveness of mining, a siege strategy that sought to bore a tunnel underneath a wall's corner so as to weaken its structural integrity or completely demolish it. Henry and his designers initially saw the rounded layout as a dependable utilitarian design that could easily translate its medieval offensive and defensive advantages to the new challenge of gunpowder warfare.

Henry VIII's 1545 coastal fortification program embodies a sharp shift away from the round designs that characterized the 1539 buildup. During his abbreviated 1543–44 military campaigns in France, the king encountered the powerful, angle bastioned defenses of Francis I. Cutting-edge Italian fortifications had influenced French forts, and later, Italians themselves oversaw their construction.⁵⁸ This continental experience seems to have encouraged Henry's willingness to experiment with new fortification designs. And experiment he did: the products of his 1545 construction program were as diverse as those of the 1539 program were uniform. Fort Southsea, constructed to secure the Solent and the harbor at Portsmouth, adopted a rectangular design with two triangular bastions projecting inland and seaward. The Isle of Wight's Fort Sandown, only ten miles south of Southsea, presents a vastly divergent layout. The central keep is square and features three different varieties of bastions: semicircle, square, and angular.⁵⁹ The use of these disparate bastions on a single fort reflects the particularly English advancement of fortification design. Henry and his architects did not adopt the Italian design outright and without investigation, as the 1545 building program was a process of experimentation. By the time Henry constructed his final device fort, Yarmouth, the results of his experiment had arrived: the square fortification featured a landward arrow-shaped angle bastion in the

⁵⁷ Hale, "Tudor Fortifications," 381.

⁵⁸ Hale, "Tudor Fortifications," 384, 386.

⁵⁹ J. A. Donnelly, "A Study of the Coastal Forts Built by Henry VIII," *FORT* 10 (1982): 118.

Italianate style, allowing for a wide radius of fire, as well as flanking defense from land attack. Yarmouth still left much room for improvement, as the solitary bastion lacked any flanking fire for its own defense.⁶⁰ Later English fortifications more closely resembled their Italian counterparts. The development of fortification under Henry VIII provides insight into the slow, steady advancement that brought the medieval castle into the age of gunpowder.

Once the bastion form had developed to the point of near-perfection and diffused across Europe, it remained almost the same for centuries. The renowned French defensive expert of the seventeenth century, Vauban, made extensive use of the Renaissance bastion. The architect almost entirely relied on the generations of study that preceded him, coming to the conclusion that bastions were most effective with angles somewhere between seventy-five and ninety degrees.⁶¹ The bulk of his innovation involved rethinking the space on either side of the bastion. Vauban acknowledged the many generations of architects before him, digging large ditches outside his fortress walls. He would take the ditches a step further, though, adding floodgate systems to create temporary water-filled moats.⁶² In essence, however, Vauban's creations remained true to their mid-sixteenth-century roots.

Even the early borders of the United States of America could not have been secured were it not for the fortification developments of Renaissance Italy. The famous Fort Ticonderoga of upstate New York, built by the French in 1755, retains bastions that would have almost seemed too simple to Michelangelo.⁶³ Boston Harbor's Fort Warren, which is open to the public, retains its five angle bastions. The fortification styles developed in late fifteenth- and early sixteenth-century Italy remained current until the advent of the machine gun in the early twentieth century. Amazingly, some Renaissance defensive schemes remain effective today. The sconce, a lesser-known Renaissance German

⁶⁰ Peter Harrington, *The Castles of Henry VIII*, (Botley: Osprey Publishing, 2007), 32.

⁶¹ Paddy Griffith, *The Vauban Fortifications of France* (Oxford: Osprey Publishing, 2006), 23.

⁶² Griffith, 24.

emplacement outside the walls of a fortress, was constructed as a small earthen or masonry doughnut, serving essentially the same purpose as a modern pillbox or bunker.

Castles and their successors visually share little in common. The castle majestically stands out from its environment, its walls perpendicular to the ground and its battlements imposingly overhanging its high walls. The Renaissance fortress is a much squatter form. Its sloping walls and jutting bastions are barely discernible against its low, wide, dark silhouette. However different the two defensive measures may appear, though, their builders strove to achieve the same purpose: to defend an enclosed area, as well as the immediate surrounding countryside. Construction programs like Henry VIII's device forts that spanned both space and time demonstrate the reluctance of fortification builders to blindly adopt novel design schemes. Fortress development was not haphazard – it was the result of interplay between careful, calculated modifications and actual military experience. One must hand credit to the Italian designers of fortifications. The Italian focus on classics and liberal arts compelled theorists and architects to revive ancient treatises on fortification that led to the formulation of the angle bastion. Necessity, though, was the commanding force behind the castle's evolution into the Renaissance fortress. Princes and kings sought to maintain their lands, and the rise of gunpowder weaponry rendered much of medieval fortification obsolete. The paradigm of defense never changed, but the means to achieve it transformed completely. The longevity of early sixteenth-century innovations in fortress design stands as confirmation that the leaders, thinkers, and architects of the Renaissance truly achieved a rebirth of fortification.

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