Math and its influence on renaissance warfare

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At the turn of the 14 th century, there is a societal shift that can be portrayed as a transition from darkness to light. From the fall of the Rome Empire to the beginning of the 14 th Century, Europe was characterized to be in the " Middle Ages", an era plighted with war, disease, chaos, and little advancement in the sciences and arts. However, as Europe entered the 1300s, we see a strive for modernity, initiating the start of the Renaissance period. During this time, we see striking advancements in art, philosophy, and science. In particular, the development of science included the development of mathematics, which was attempted to apply to all aspects of life. One area frequently visited by mathematicians was warfare. Specifically, mathematicians used the principles of geometry in order to advance gunnery, fortification, and range finding and surveying.

Before the Renaissance, military tactic and troop organization was not as sophisticated. It can be characterized as knights and cavalry rushing at each other in incoherent ways with or without the support from infantry and archery (Keegan, 2011). Further, techniques and formations in order to defeat the opponent were disorganized and no strategies were consistently followed (Keegan, 2011). However, as the Renaissance began, a startling mathematical revolution transformed military strategy. In the Renaissance, army sizes became bigger than ever (Walton, 2000). Therefore, troop organization became increasingly important. Men had to begin to move more in unison and therefore, military leaders need to know to organize them properly (Walton, 2000). Thus, throughout the Renaissance period, military commanders received training in mathematics (Walton, 2000). This training, focused primarily on geometry and basic math, allowed for the commanders

to analyze how many men they had available, and what formation to best organize them in (Walton, 2000). We see the first instances in soldiers being organized in rectangular, triangular, and square shapes (Walton, 2000). Further, military leaders conducted basic math such as division, multiplication, and square roots in order to identify how many men went in each row of their designated formation (Walton, 2000). These newly acquired capabilities from leaders enhanced their army's organization and efficiency, starting a new way of mathematical combat.

As time progressed, technology and usage of weaponry advanced as history entered the Renaissance period. The invention of guns and more sophisticated artillery required the men who operated them, known as gunners, to be trained in mathematics. Gunners implemented their own mathematical rules based on proportions, called the ' Rule of Three', that allowed for them to calculate distances of their shots based on the weight of the gun powder (Walton, 2000). Further, the Renaissance also produced mathematically oriented technology that assisted gunners in doing their job more effectively. In particular, technology that was invented focused mostly on elevation, aim, and trajectory. Sophisticated quadrants, sights, and levels allowed for gunners to see where the barrel of their gun was pointing to at different elevations. These pieces of technology could be adjusted in a variety of degrees, allowing for the gunner to have a wide range of accuracy (Walton, 2000). These advancements prompted many prominent mathematicians to investigate the math behind trajectories and projectiles. Niccoló Tartaglia investigate the trajectory behind projectiles in the context of Aristotelian physics and Galileo published works on the parabolic paths of

projectiles. Both of these scientists and authors reinforced military theory and advanced the mathematical strategies surrounding warfare.

Gunners also became mathematically sophisticated in range finding and surveying. Before the Renaissance period, the most common way to measure land linearly was to lay out rope between two points and measure the distance (Walton, 2000). However, such method was not possible in the heat of war. Therefore, Gunners developed and begun to use the technique of triangulation in order to calculate the distance and elevation their weapon needed in order to shoot the most effective shot. In this method, gunners measured two fixed angles that formed with a given baseline and through subsequent calculations, were able to find the distance to that point (Hill, 1984). By implementing triangulation, gunners became increasingly accurate with their shots. Gone were the days where leaders had to estimate sizes of battle fields or measure it beforehand.

Another area that was revolutionized because of the mathematical applications was the architecture of Renaissance fortresses. In the Medieval ages, fortresses where characterized by “ high walls, towers and moats, and elements of an archetype based on plunging defense” (Bevilacqua, 2014). As weaponry got more sophisticated, militaries realized that their fortifications were inadequate. Therefore, many arrangements on fortress structures were made. One of the clearest examples on how people adjusted is seen in Leon Battista Alberti’s *De Re Aedificatoria* , where Alberti writes about how cities and fortresses should be designed for warfare. One of the first recommendations he makes is on the dimensions of the fortress walls. High Medieval walls were not capable of stopping artillery fire. Therefore, Alberti

suggested to lower them and “ make the city walls consist of two walls, 20 feet apart, the space between them filled with compacted earth” (Bevilacqua & Williams, 2014). In hindsight, the mathematical reasoning behind this was sound. The thicker the walls, the more force the walls exert back on a cannon ball, thereby increasing the chance of stopping the cannon from going through the wall. Alberti also included mathematical themes of intervals and proportions into how fortresses should be built (Bevilacqua & Williams, 2014). He recommended that round towers should be built every “ 37 and half ells” in order to increase the degrees and which artillerymen can see the enemy (Bevilacqua & Williams, 2014). At this interval of measurement, Alberti argued that the enemy would be seen from almost every angle (Bevilacqua & Williams, 2014).

Another geometrical concept that Alberti included in his work was concentricity. Not only did he believe that concentricity would reduce artillery fire, but also thought that it was the safest way to secure and design the city (Bevilacqua & Williams, 2014). In his book *De Re Aedificatoria* , Alberti suggests surrounding the citadel, the most important part of the city, in a series of concentric circles (Bevilacqua & Williams, 2014). This was believed to present invaders with the most difficulty if they were ever to get inside the walls of the city. In other applications, Alberti also believed that planning a city and fortress in concentric circles would prevent popular uprising by allowing for social classes to be separated (Bevilacqua & Williams, 2014). Alberti’s publication of *De Re Aedificatoria* clearly shows the application of mathematics in fortress design. These mathematical ideas heavily influenced renaissance architecture and military strategy.

The Renaissance period exhibited a growth in intellectual thought that catalyzed the progression of the arts and sciences in the era. Within this movement of innovation was the advancement of the military sciences through the help of mathematics. Techniques such as surveying and range finding, gunnery, and enhanced fortification of cities were all improved because of the application of mathematical principles. Although math was only applied in basic ways, its impact helped shape how military combat and strategy was conducted. It was one of the first instances in which we see math incorporated into war, but it definitely was not the last. Because of the Renaissance period, we now see flourishing partnership between warfare and mathematics.

References

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