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# INTEGRATIVE 3D RECORDING METHODS OF HISTORIC ARCHITECTURE: BURG HOHENECKEN FROM SOUTHWEST GERMANY

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INTEGRATIVE 3D RECORDING METHODS OF HISTORIC ARCHITECTURE:  
BURG HOHENECKEN FROM SOUTHWEST GERMANY

By

Aaron C. Pattee

A THESIS

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INTEGRATIVE 3D RECORDING METHODS OF HISTORIC ARCHITECTURE:  
BURG HOHENECKEN FROM SOUTHWEST GERMANY

Aaron C. Pattee, M.A.

University of Nebraska, 2016

Advisor: Effie Athanassopoulos

This research explores the methodology and application of photogrammetric and laser-scanning recording methods to a castle ruin, with the primary purpose of digitally preserving the castle. Both methods generated interactive 3D models via the combination of still images (photogrammetry) and precise laser measurements (laser-scanning), which were then combined into a single model. The case study is the medieval castle ruin *Burg Hohenecken* located in the city of Kaiserslautern in southwest Germany. The castle was active from 1212-1689, as one of over fifty castles within the region of the *Pfalz*. The inhabitants included the noble *von Hoheneck* family and various Prince Electors. *Burg Hohenecken's* duty was to protect the imperial palace in Kaiserslautern as well as the surrounding area. In addition to the 3D model, seventy letters from 1212-1560 CE concerning the correspondences of the castle were translated in order to contextualize the digital model and the castle's historical significance. The information extracted from the letters includes names and inheritances of the *von Hoheneck* family, physical locations in the surrounding environment, and construction details of the castle. These data describe a network of communication within a past landscape and provide evidence for pre-existing structures of the castle. This research contributes affirms that *Burg Hohenecken* was site

of regional significance given the many high-ranking inhabitants over the course of over 450 years—a major shift in our understanding of the history of the area.

Future work includes placing the 3D model in the *Unity* game engine allowing the castle to be virtually controlled and examined. The digital model provides an excellent opportunity to determine the function of the castle throughout the past and to potentially create virtual reconstructions of the castle from the different periods of its construction. These methods may even lead to the discovery of hidden structures. The combination of approaches from both the sciences (photogrammetry and laser-scanning) and the humanities (textual analysis) allows for a more holistic representation and preservation of this excellent example of medieval architectural cultural heritage.

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This work is dedicated to all those who have been inspired by *Burg Hohenecken* and cherish its memory.

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## Introduction

The European Middle Ages (500-1500 CE) were a period of technological innovation and philosophical development, and romanticized throughout the centuries following its conclusion in the sixteenth century. Although this time in Europe's past has been intensively studied for hundreds of years, it remains enveloped in mystery. The legends of knights and castles have a peculiar ability to seize the attention of readers and draw them back in time—a form of historical memory passed down from generation to generation. The physical structures themselves, seem to have a similar effect. Castles, though built for the purpose of defending during a time of considerable brutality, are no longer used as strategic fortresses, nor are the majority still used as residences. In fact, the vast majority of castles are ruins, hidden in forests, atop mountains, or even in the center of cities. They serve no modern function, save for a few that have been repurposed, yet they are considered vital to the cultural heritage of millions of people.

Castles no longer serve only nobles and those fortunate to reside within their thick walls and towers. They have become symbols of entire communities, centerpieces of villages, and destinations for people from all over the world. The mystery of what transpired within the walls of castles centuries before, captures the imaginations of visitors. The current conditions as ruins, leave visitors and locals with a complex decision—how best to preserve an object that is constantly decaying, yet has no function other than inspiring curiosity? Physically rehabilitating large structures can be incredibly costly. Many villages and organizations are struggling to preserve castles from further decay—dedicating thousands of hours of labor solely because they feel a cultural connection to them. Such is the case with *Burg Hohenecken*, a castle destroyed over 300

years ago, yet considered the most valuable object in the village of *Hohenecken*. Its actual monetary worth is difficult, if not impossible to determine, though its significance to the region's community cannot be measured—its worth is that of any cultural heritage site, and should be preserved as any other site would be. In the absence of a large amount of funds to physically rehabilitate *Burg Hohenecken*, the most reasonable option remaining is a digital preservation.

This thesis seeks to piece back together the puzzle of *Burg Hohenecken*'s past via a variety of perspectives. Chapters One through Three present the necessary background information to set the stage for the project, exploring the environment, social structure, history, and architecture of the Middle Ages. The information is buttressed by 70 medieval letters that I translated, revealing key details of the correspondences of the castle's inhabitants, and the surrounding areas. Chapters four and five present the digital component to the thesis, discussing previous work with photogrammetric and laser-scan technologies at cultural heritage sites, and the methods used at *Burg Hohenecken*. Chapter six concludes the project with a description of the castle's current state and future endeavors regarding its digital preservation and understanding of its regional significance.

All six chapters work together in order to demonstrate the necessity of accumulating as many perspectives as possible in order to produce a larger image of the castle's significance within its regional setting (both figuratively and literally). Environmental data, historical events, information from medieval letters, architectural statistics and features, previous research in similar projects, and a step by step workflow for generating the model all lead to a more holistic understanding of the site. The thesis

embodies the goals of digital heritage—to preserve and protect cultural heritage sites by recording and analyzing them via digital technologies and methods. This approach is fundamentally holistic by grasping at every perspective possible in order to provide insight to *Burg Hohenecken*'s past, ultimately to secure its future.

## Chapter 1—Geography, Geology, and Climate

### 1.1 Geography:

*Burg Hohenecken* is located in the region of the *Pfalz* (Palatinate) in southwest Germany on the border of the *Lorraine* (*Lothringen*) and *Alsace* (*Elsaß*) regions of France.<sup>1</sup> The castle is part of a chain of fifty-four castles constructed in the *Pfalz* between 1050 and 1285 A.D. The chain of castles resembles a network, stretching 80.1 kilometers north to south, from *Burg Montfort* to *Burg Fleckenstein* (respectively), and 64 kilometers east to west, from *Hambacher Schloss* to *Burg Kirel* (respectively). The area of the castle chain includes portions of the German states of the *Rheinlandpfalz* and the *Saarland*, as well as the French regions of *Lorraine* and *Alsace*.<sup>2</sup>

Of the fifty-four total castles, thirty-nine (including Hohenecken) are located within the *Pfälzerwald* (Palatinate Forest)—a densely forested and mountainous region consisting of the *Unterer Pfälzerwald* (the northern most section), *Mittlerer Pfälzerwald* (middle section), *Haardt* mountain range (on the eastern edge), and the *Wasgau* (the southernmost and largest portion of the *Pfälzerwald*, seen in Figure 1.2 on the left). The region's low mountains are made of *Buntsandstein* (colored sandstone, shown in Figure 1.1), with many cliff outcrops upon which dozens of castles were constructed.<sup>3</sup> The highest peak of the *Pfälzerwald* is the *Kalmit*, reaching an elevation of 672 meters (~2206 feet) in the *Haardt* mountain range.<sup>4</sup>

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<sup>1</sup> Keddigkeit, 2007, p.5.

<sup>2</sup> Rey, 2012.

<sup>3</sup> Rey, 2012.

<sup>4</sup> Schaub, 1999, p. 17.

## 1.2 Geology:

The architects of the castles no doubt used the height dominance of the red cliffs to their advantage when designing them. Each castle built on the cliffs was unique due to the different shapes and sizes of the outcrops. The *Buntsandstein* is a geologic phenomenon stretching from the Iberian Peninsula to central Poland.<sup>5</sup> It formed as a result of a continental fluvial environment in which terrestrial and subterranean rivers deposited sediments along their paths as they flowed through Europe and often changed direction.<sup>6</sup> The deposited sediments have led certain areas, especially within Germany, to be overwhelmingly composed of sandstone.<sup>7</sup>

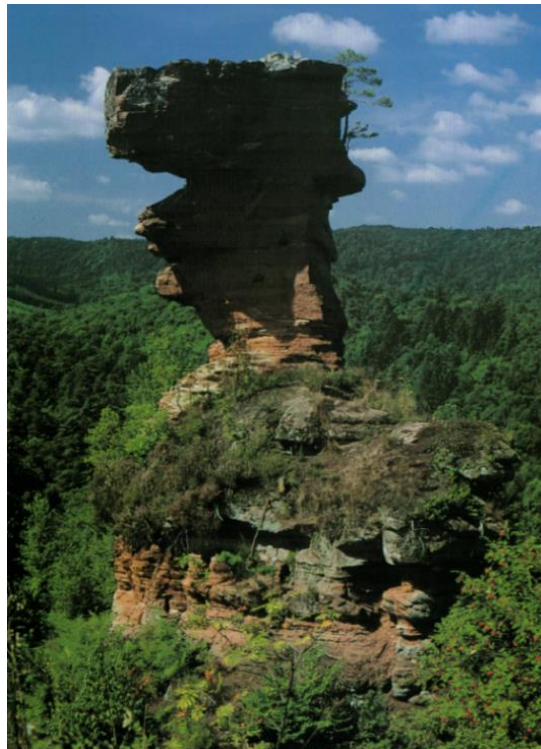


Figure 1.1: The *Pfälzerwald* and *Buntsandstein* outcrops<sup>8</sup>

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<sup>5</sup> Mader, 1985, pp.500-508.

<sup>6</sup> Mader, 1985, p.3.

<sup>7</sup> Dachroth, 1985, pp. 197-248.

<sup>8</sup> Schaub, 1999, p.17.



Figure 1.2: Layers of the *Buntsandstein*<sup>9</sup>

*Buntsandstein* formed roughly 250 million years ago above which the *Muschelkalk* (Shell bearing Limestone) is found and the *Keuper* above that. These rock strata compose the lithostratigraphy of the European Triassic Epoch (shown in Figure 1.2). In fact, the trio of rock strata is known as the *Germanic Trias Group* and gave rise to the term *Triassic*. The Triassic rock strata are exposed primarily within the southwestern areas of Germany and the northeastern areas of France. This region of the *Trias Group* is peculiar compared to the rest of the European regions because there is a continuous and comparable composition, as opposed to the general lack of uniformity elsewhere. However, within the individual layers of the *Germanic Trias*, particularly the *Buntsandstein*, are nonconforming sub-strata. The sub-strata were named after certain areas in the *Pfalz*, specifically, the areas around the *Karlstal* valley and *Burg Trifels* (known as the *Kalstalschichten* and *Trifelsschichten*, respectively).<sup>10</sup>

The stratigraphic names of the rock are of particular interest, because the first researchers of this type of rock named the strata after well-known sites in the *Pfalz*. *Burg*

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<sup>9</sup> Schaub, 1999, p.20

<sup>10</sup> Dachroth, 1985, p. 211.

*Trifels* played an essential role in the Middle Ages because it was built at the same time as *Burg Hohenecken*, and the *Karlstal* region is no more than 6.5 kilometers from *Burg Hohenecken*. The outcrop of *Buntsandstein* protrudes through the *Muschelkalk* and *Keuper* creating incredible cliffs and massive rock formations upon which many of the castles were built. The protrusions are powerful natural structures piercing the forest canopies and extending high into the sky, capturing the attention of onlookers as natural vantage points of strategic importance. From below, the cliffs dominate and act as physical representations of nature's power in the region. These cliffs create an area where nearly all of the castles within the castle chain are found (shown in Figure 1.3).



Figure 1.3: Aerial View of the *Pfälzerwald* <sup>11</sup>

The brilliant red/brown color of the *Buntsandstein* (seen in Figure 1.2) is a significant characteristic of the geology of southwest Germany and northeastern France. The color is attributed to the silt fraction of the rock formation. The rock particles are

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<sup>11</sup> Schaub, 1999, p.9.



surrounded by red-staining hematitic chromophores and the fine sand grains are coated with a continuous iron oxide film.<sup>12</sup> Nearly all of the modern houses within this area are built of the red stone, or contain elements of it as artistic aspects of the regional architecture. The castles, palaces, churches, and monasteries are also built with the red stone which is often found in a variety of different styles. The Romanesque architectural style dominates medieval structures in the region, with stones varying from coarsely, bumpily, or incredibly smoothly cut. Thus, the *Buntsandstein* has an ability to sustain different styles of masonry, despite its nature as a sedimentary rock.

The outcrop of *Buntsandstein* where both Hohenecken and Kaiserslautern are located is called the *Saarbrücker-Pfälzer Sattel* (the Saarbrücker-Palatinate Anticline).<sup>13</sup> The outcrop is characterized by a series of wave-like mountains forming an impressive border between the Palatine Forest and the flatter, non-forested areas to the north called the *Nordpfalz* through which the *Nahe* river courses. Though the area of the *Nahe* (which branches from the Rhine River) is generally flatter, it contains highlands to the north and includes pockets of dense forests. North of the *Nordpfalz* is another mountain range called the *Hunsrück*, composed of the same type of *Buntsandstein* as in the *Pfalz*. The castle chain controlled much of the area between the *Hunsrück* to the *Wasgau* (~137 kilometers). The majority of the castles are located within the *Mittlerer Pfälzerwald*, north of the *Wasgau*, but far south of the *Hunsrück*. Twelve castles are located in the *Nordpfalz* and *Hunsrück*, and two are located on flatland (*Burg Reipoltskirchen* and the *Kaiserpfalz* in Kaiserslautern). The highest peak of all the mountains in the entire area

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<sup>12</sup> Dachroth, 1985, p. 223.

<sup>13</sup> Dachroth, 1985 p. 201.

controlled by the network of fortresses is the *Donnersberg* (“Thunder Mountain”), located in the *Hunsrück* reaching an elevation of 687 meters (2253.9 feet).<sup>14</sup> The area of control is a culturally rich region consisting of numerous Celtic *Oppida* on the *Donnersberg*, for example<sup>15</sup>, countless Roman sites, ancient Germanic village sites and even older sites built by prehistoric people—Kaiserslautern is home to a 7,000 year old village, located near the location of the *Kaiserpfalz*.<sup>16</sup>

### 1.3 Climate, Agriculture, and Health:

The area of the Pfalz, though quite mountainous, is home to large lakes scattered throughout the *Nordpfalz*, and along the *Saarbrücker-Pfälzer Sattel*. These lakes are the remnants of a sea that had separated the highlands of the *Nordpfalz* from the *Pfälzerwald*. The sea provided connections to the *Nahe* and *Lauter* rivers as well as fish—particularly Pike, the fish that is featured on the crest of the city of Kaiserslautern. The sea has gradually disappeared over time, presumably a result of the changing climate and ever-growing settlements.<sup>17</sup> The High Middle Ages (1050-1250) were marked by a peculiar shift in weather patterns creating a period of relative warmth known as the Medieval Warming Period (MWP)<sup>18</sup>, lasting from 1000-1200 A.D as seen in Figures 1.4 and 1.5. This change in weather resulted in profoundly healthier and increased harvests, which led to an increase in population.<sup>19</sup> Additionally, an adequate number of animals supplemented the growth along with higher crop yields.<sup>20</sup>

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<sup>14</sup> Petry, 1988, p.79.

<sup>15</sup> Klein, 2011.

<sup>16</sup> Keddigkeit, 2007.

<sup>17</sup> Fendler, 1986, p.209

<sup>18</sup> Goosse, 2006, p.99.

<sup>19</sup> Malanima, 2010, p.3.

<sup>20</sup> Goose, 2006, p.1.

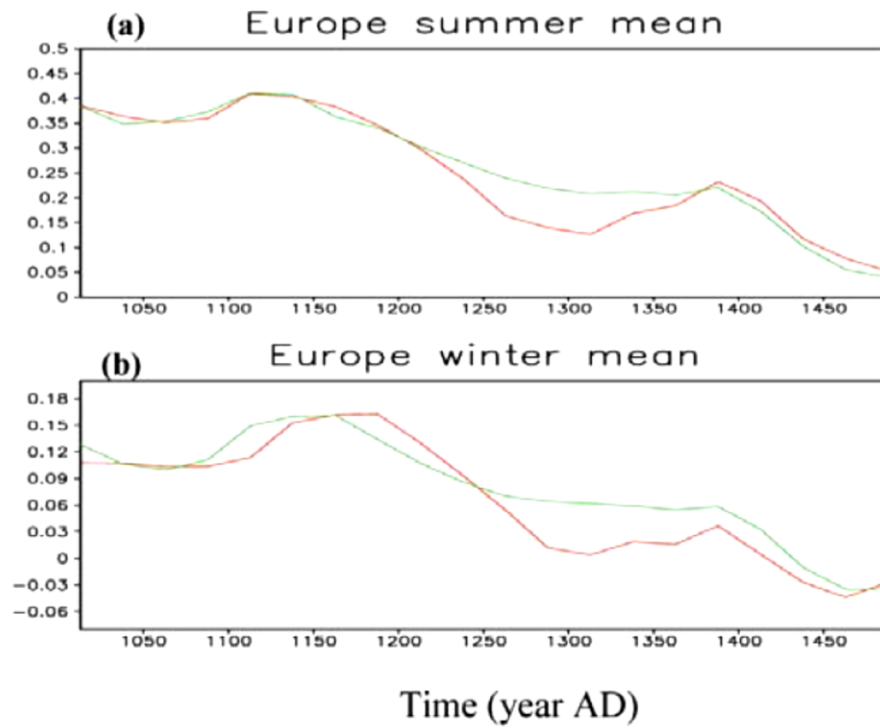


Figure 1.4: Average European temperatures during Summer and Winter from 1050-1450.<sup>21</sup>

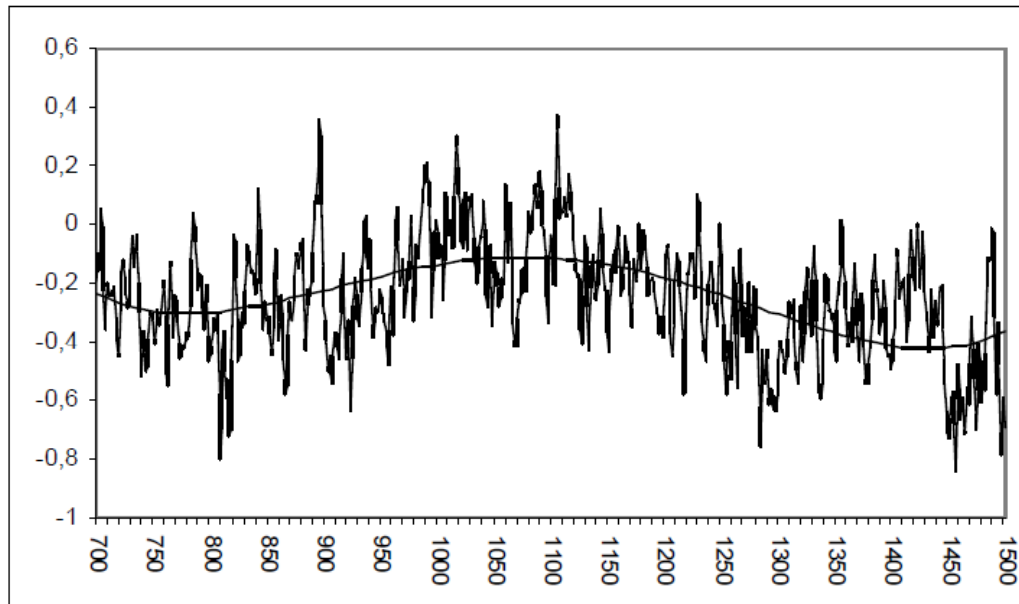


Figure 1.5: Temperature in the Northern Hemisphere from 700-1500, y-axis is the degree change in Celsius and the x-axis is the year.<sup>22</sup>

<sup>21</sup> Goosse, 2006, p.103.

<sup>22</sup> Malanima, 2010, p.16.

The actual crop yield increased linearly from 1000 until 1250—the year marking the end of the High Middle Ages. The higher yield led to a remarkable increase in Europe's population by nearly 40 million from 1050-1250 as seen in Figure 1.6. Table 1.1 directly highlights the individual growth within the modern nations of Germany, Switzerland, Italy, and Austria—all of which had been incorporated in the Holy Roman Empire during this period. At the same time, volcanic eruptions and CO<sub>2</sub> concentrations were considerably low, whereas deforestation was intense over the years 1000-1250 particularly in Germany, Belgium and the Netherlands (shown in Figure 1.7).<sup>23</sup>

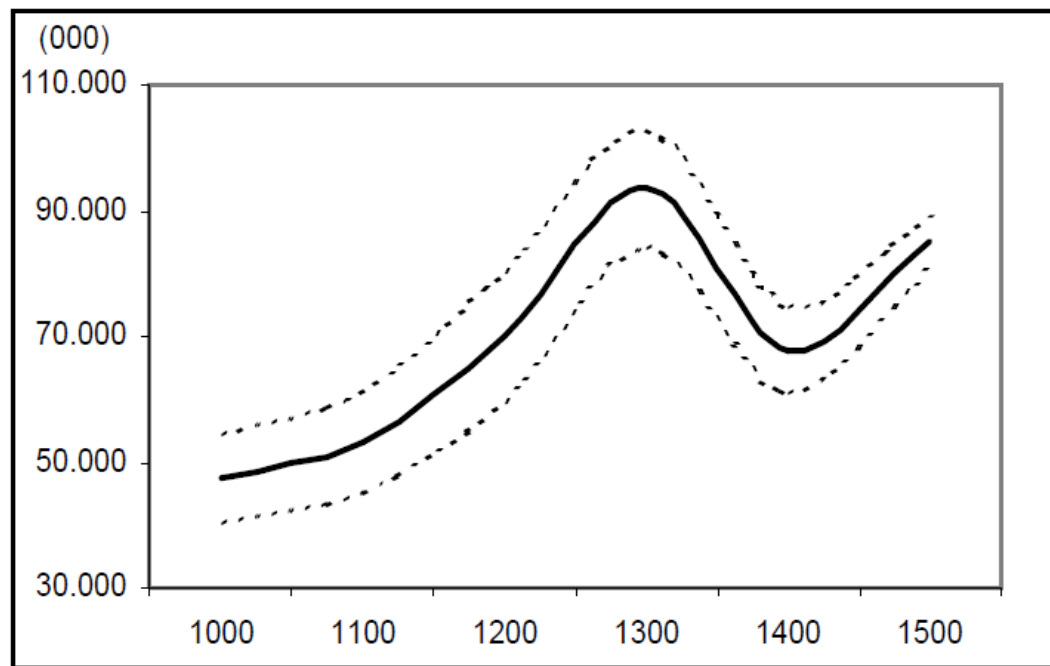


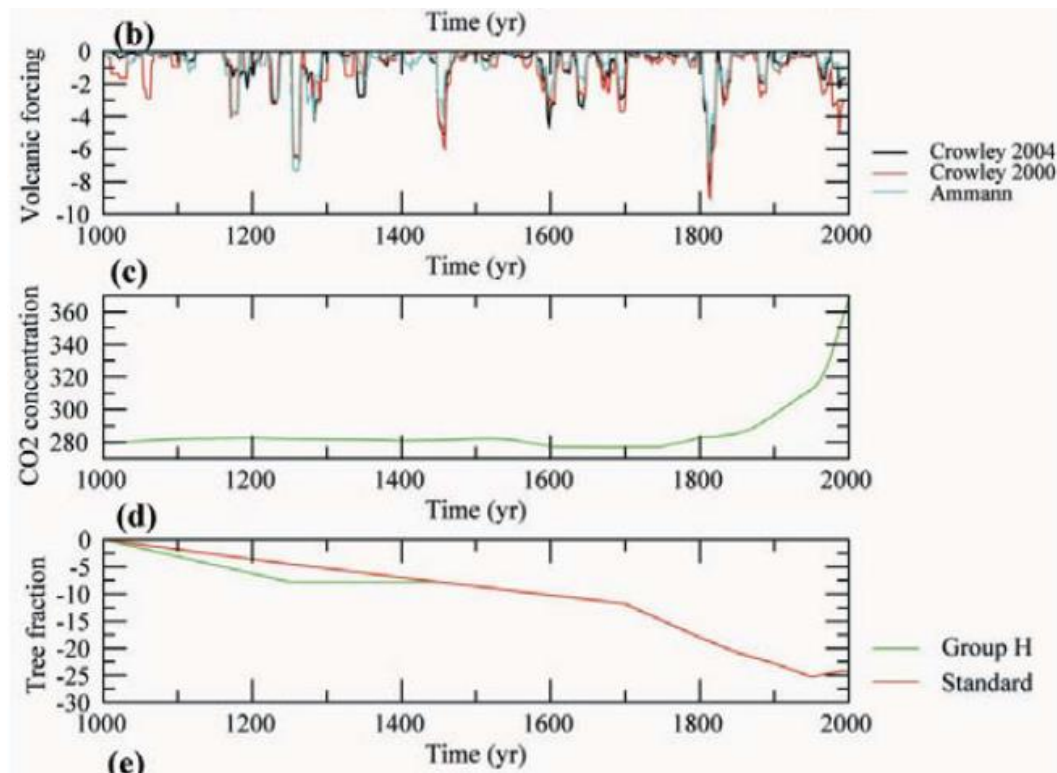
Figure 1.6: Population Growth in Europe from 1000-1500. Y-axis is the population and the x-axis is the year.<sup>24</sup>

<sup>23</sup> Goosse H, 2006.

<sup>24</sup> Malanima, 2010, p.5.

Table 1.1: Population growth in highlighted nations. Growth is represented in millions.<sup>25</sup>

	1000	1100	1200	1300	1400	1500
<b>Scandinavia</b>	1,100	1,300	1,900	2,500	1,400	1,500
<b>England (Wales)</b>	2,100	2,500	3,600	4,500	2,700	3,500
<b>Scotland</b>	580	700	900	1,000	700	800
<b>Ireland</b>	750	800	1,100	1,300	700	800
<b>Netherlands</b>	200	250	400	800	600	950
<b>Belgium</b>	600	700	1,000	1,400	1,200	1,300
<b>France</b>	8,400	10,000	14,000	16,000	12,000	15,000
<b>Italy</b>	5,800	7,000	9,900	12,500	8,000	9,000
<b>Spain</b>	2,900	3,500	4,900	5,500	4,500	5,000
<b>Portugal</b>	950	1,000	1,200	1,300	1,050	1,200
<b>Switzerland</b>	280	350	500	800	500	800
<b>Austria (Czech., Hung.)</b>	5,900	7,000	9,000	10,000	9,000	11,500
<b>Germany</b>	4,500	5,000	7,800	13,000	8,000	11,000

Figure 1.7: Volcanic forcing, CO<sub>2</sub> concentration, and tree fraction during the MWP.<sup>26</sup><sup>25</sup> Malanima, 2010, p.5.<sup>26</sup>Goosse, 2006, p.101.

A case study from the village of *Tasdorf, Landkreis Märksich Oderland* in *Schleswig-Holstein* in northern Germany demonstrates the biological effect of better harvests. The study compared the development of the skeletons of children between two periods: the High Middle Ages and the late Renaissance. The article discussed 123 skeletons from the site which had been in use from the thirteenth to the nineteenth century. The 123 skeletons were ranked in order of their preservation by examining the quality of their bones—specifically the long bones (e.g. femurs). The skeletons were then separated based upon age, x-rayed, photographed, and subjected to both light and electron microscopy. Some subjects had suffered from a variety of diseases, including, but not limited to, *rhinitis*, *sinusitis*, *osteoporosis*, *otitis media*, and *syphilis*.<sup>27</sup> The skeletons of the children from the High Middle Ages (n=47) and those from the Renaissance (n=70) were compared and findings indicated that the medieval skeletons had preserved far better than those of the late Renaissance (though six of the skeletons were inconclusive). This provides evidence the nutrition of the medieval skeletons was better than that of the renaissance children. However, of the 47 medieval skeletons, 32 (68.1 percent) died during Infant I (ages 0-6), and 14 (29.8 percent) died during Infant II (ages 7-12).<sup>28</sup> This increase in mortality is likely due to the fact some children did not survive weaning, which often lasted until the ages of five or six during the Middle Ages. There was another spike in child mortality at age eight, which is attributed to the beginning of working in the fields with heavy equipment and blades (shown in Figure 1.8). The medieval children also grew taller, on average, compared to those from the late Renaissance, as shown in Figure 1.9.

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<sup>27</sup> Jungklaus, 2010.

<sup>28</sup> Jungklaus, 2010.

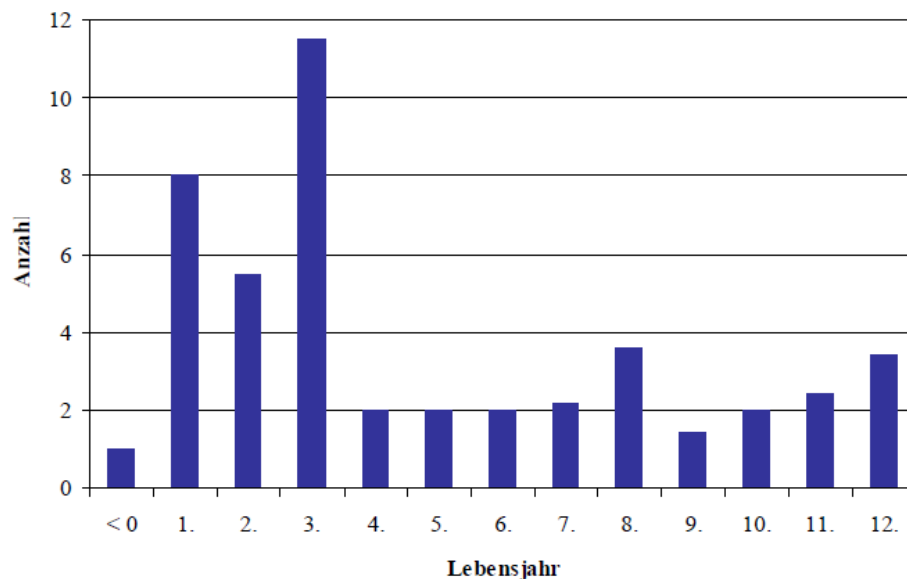


Figure 1.8: Child mortality of the skeletons from the High Middle Ages in *Tasdorf*.<sup>29</sup> The y-axis shows the number of individuals and the x-axis show the age in years.

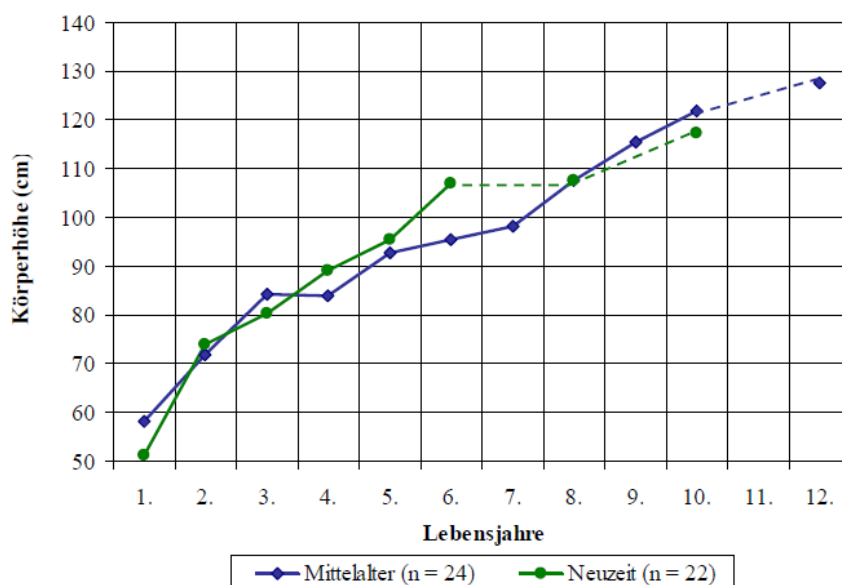


Figure 1.9: Graph demonstrating the height in cm on the y-axis and the age in years on the x-axis.<sup>30</sup> Note: *Mittelalter* means Middle Ages, *Neuzeit* refers to the late Renaissance

<sup>29</sup> Jungklaus, 2010, p.37.

<sup>30</sup> Jungklaus, 2010, p.43.

A case study of *Braunschweig*, which discussed the meat distribution among city dwellers in a large city from the High Middle Ages, found that meat production was also higher during this time.<sup>31</sup> The larger consumption of meat meant more energy and protein in the diets of the general public. The study listed all animals found to have been slaughtered for food by the people of *Braunschweig*. The list of domesticated animals included horses, cows, sheep, goats, pigs, dogs, cats, rats, chickens, and geese. The list of wild animal remains included deer, wild boar, field rabbits, ducks, singing birds, carp, and pike. The domesticated animals composed 91.6 percent of the total remains, whereas wild animals composed only 8.4 percent found throughout the portion of the city that existed during the twelfth and early thirteenth centuries. The primary animals for slaughter that provided the maximum energy per animal were the genera *Equus* (horse), *Bos* (cows), *Ovis/Capra* (goats), and *Sus* (pigs). The number of remains of these four groups is remarkably high in the twelfth century but dropped suddenly in the thirteenth century. Pigs comprised the majority of the food source for the people in *Braunschweig*. However, the pigs had relatively short lifespans since 96.5 percent of the pigs had been slaughtered under the age of 3.5 years. Though there are high numbers of *Bos* remains in the twelfth century, it does not necessarily mean they were slaughtered at the same rate as the pigs. The milk from cows was also highly energetic and a valuable commodity for workers to have access to.<sup>32</sup>

The increase in human population was not a result of warmer temperatures alone. The medical knowledge brought back from the Crusades substantially increased the quality of life by offering the people of the High Middle Ages access to new information

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<sup>31</sup> Hanik, 1995.

<sup>32</sup> Hanik, 1995.



regarding medical treatment in addition to actual hospitals. The newer medical practices, which included new surgical techniques and herbal mixtures, led to the establishment of a medical profession which previously had been the realm of the clergy.<sup>33</sup> Maintaining public health was of utmost importance to the political elite of the Middle Ages. Without healthy populations to fill the ranks of the armies or compose a strong working class, a state had no power. In order for an emperor, king, or duke to effectively signal his power and command of a country, fortresses (in the form of castles) and churches had to be built to fulfill the requirements of the empire and the Vatican.

#### 1.4 Social Structure, Gender Roles, and Medicine:

The medieval rulers did not have unlimited funds for feeding their workers (carpenters, artisans, masons, etc.) and had to ration food supplies. Food rations needed to provide maximum nourishment at the lowest cost, but it was not equal across all social groups and both sexes.<sup>34</sup> During construction projects and harvests, women would receive considerably fewer rations unless they were with child. The rations were attributed to the type of work each sex did and were completely based upon the Humor Theory.<sup>35</sup>

The Humor Theory, originally developed by Hippocrates and elaborated upon by Galen, claimed that humans were governed by four humors—Blood, Phlegm, Black Bile, and Yellow Bile. Men were said to have had an excess of blood and yellow bile, meaning that they were warm and dry (respectively), and women were to have had an excess of phlegm and black bile, meaning they were wet and cold (respectively). Thus

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<sup>33</sup> Bruhns, 2010, 138-141.

<sup>34</sup> Rippmann, 2006.

<sup>35</sup> Schneider, 2012.

the food had to be rationed not only regarding the budget but also according to Humor Theory in order to maintain a healthy balance.<sup>36</sup>

Within the peasant class outside of the noble courts, women had the duties of trimming the sheep, weaving linen, gathering nuts and berries from the forests, and harvesting honey for making mead. Other duties were considered “women’s work” due to the principles of mixing and combining. These jobs included baking bread, brewing beer, and cooking. Despite their central role in food production, they were strictly forbidden from wine making, including honey-wine (mead) notwithstanding their responsibility for collecting the honey. Only men were allowed to produce wine because, “the hot-headedness of women throughout the day was uncontrollable” and could spoil the wine.<sup>37</sup> Men were expected to perform nearly all outdoor activities, with the exception of the aforementioned gathering duties done by women, and were given rations dependent upon the strain of the activity they were performing. Plowing the fields provided men with “2.5 medium-sized breads, extra wages, and four wine rations, while workers in the wineries received no rations.” During the harvest period, the rations changed again because more people were involved in harvesting the crops than were involved in planting them. At this time, “men in the hay and wheat harvest received 1.25 medium-sized breads, with meat and wine, whilst women received no rations.”<sup>38</sup> Thus, males who were operating more difficult machinery (e.g. plows) would receive more rations. However, so-called “hot-headed males” (referring to aggressive males) were not allowed to eat meat directly, instead they had to have meat cut into small pieces and

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<sup>36</sup> Gregory, 2008.

<sup>37</sup> Rippmann, 2006.

<sup>38</sup> Rippmann, 2006.

given to them intermittently for fear their humors would become unbalanced, making them prone to cause problems.<sup>39</sup> This had been determined to be a reasonable issue by Galen, whilst working with Roman gladiators, even though *Galen* had lived nearly 1000 years prior to the High Middle Ages.<sup>40</sup>

Despite *Galen*'s fundamental role in medieval medical understanding, his works were relatively new for many people of the High Middle Ages. Before the western Europeans entered the first crusade in 1096<sup>41</sup>, the works of *Galen* and even *Hippocrates* were virtually unknown in many areas of Western Europe and the only medical knowledge consisted of simple homeopathic treatments and prayer—though most of the time, prayer was considered the major treatment. When the Europeans arrived in the Holy Land during the Crusades, they encountered the Arab scholars who had meticulously recorded many of the works of the Greek and Roman natural philosophers (i.e. *Hippocrates* and *Galen*) and contributed many of their own treatments and remedies. The Arabs first learned of these scientists prior to the Muslim invasion of the Middle East, when the Byzantine Empire (the Eastern Roman Empire, which had survived the schism of the tetrarchy in 293 and formed as an independent empire in 330 A.D.<sup>42</sup>) had ruled the region of the Near East. The newly formed crusader Kingdom of Jerusalem sought to establish peace under the rule of Baldwin I in the early twelfth century and in the process, the Christian and Muslim intellectuals traded their knowledge.<sup>43</sup>

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<sup>39</sup> Rippmann, 2006.

<sup>40</sup> Gregory, 2008, p.21.

<sup>41</sup> Riley-Smith, 2005 [1987], p.35.

<sup>42</sup> Norwich, 1999, p.13.

<sup>43</sup> Weisser, 1983.

Medieval Europe gained an incredible amount of medical knowledge from the Near Eastern physicians and scholars. The premier Near Eastern scholar of the Middle Ages was a man by the name of *Ibn Sīna* (980-1037), known to Europeans by his Latinized name, *Avicenna*.<sup>44</sup> *Ibn Sīna* was a Persian scholar who sought to unify the body and soul through medicine and rituals such as dance. *Avicenna* had revolutionized medical understanding in the Near East, and was hailed as one of the greatest medical philosophers throughout the region.<sup>45</sup> The Europeans learned greatly from his teachings, but also had similar physicians of their own. The most famous of the European medical scholars was a nun by the name of *Hildegard von Bingen* (1098-1179<sup>46</sup>). Hildegard began her studies at the convent *Disibodenberg*, located directly south of the *Hunsrück*.<sup>47</sup> She later went on to establish the convent *Rupertsberg*, located in the same area of the *Nahe* River.<sup>48</sup> She was known throughout the empire as a mystic and had sought to unify medical treatments with prayer and formed theories such as the *Kosmosmensch*, (meaning *Cosmosperson*)—a model of the ideal person who encompassed both body and mind through health and faith.

Hildegard had at one point become so influential in the medieval world that she was allowed to address the Holy Roman Emperor Frederick I *Barbarossa*.<sup>49</sup> The combination of her contributions to medicine and the medical knowledge rediscovered from the Arab scholars catapulted Europe's scientific renaissance of the High to Late Middle Ages. Across the continent, the rediscovered teachings were implemented in the

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<sup>44</sup> Weisser, 1983.

<sup>45</sup> Weisser, 1983.

<sup>46</sup> Paul, 2011, p.44.

<sup>47</sup> Petry, 1988, p.78.

<sup>48</sup> Schipperges, 1998.

<sup>49</sup> Schipperges, 1998.

monasteries and convents which served as the medieval hospitals.<sup>50</sup> *Hildegard's* influence was especially great in the area of the *Pfalz*, where she had lived.

A warmer climate, the availability of wood, the abundance of *Buntsandstein*, and a healthier population created a nearly ideal environment for the construction of castles and palaces in the region of the *Pfalz*. The construction of *Burg Hohenecken* and its inhabitants would directly mirror political, social, and natural changes over the course of nearly 500 years (1212-1689<sup>51</sup>). The House of Hohenecken and *Burg Hohenecken* began at a time when the *Pfalz* played a central role in the development of the Holy Roman Empire regarding new networks of fortifications, social and ecclesiastic reform, and nation-building.

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<sup>50</sup> Probst, 1966.

<sup>51</sup> Keddigkeit, 2002.

## Chapter 2—History of *Burg Hohenecken*

### 2.1 Europe after the Fall of Rome:

The Medieval period in Europe was a time of drastic change, transforming it from an amorphous combination of bands and tribes after the collapse of Rome to a continent governed by vast empires, kingdoms, and duchies.<sup>52</sup> The beginning of the Middle Ages is a topic of contention. It certainly began around 500 CE, during the time of the Germanic Migrations (i.e. *Völkerwanderung*)<sup>53</sup>, and ended around 1500 CE.<sup>54</sup> This period includes the age of castles that lasted from 1000-1500 CE.<sup>55</sup> The result of this metamorphosis has been chronicled by historians and storytellers alike, seizing the imagination of audiences over the centuries. Although the Middle Ages ended with the development of the Renaissance—a period of artistic innovation fueled by the resurrection of ancient Greek and Roman texts—it emerged from a shadowy time marked by brutal warfare and mass migrations, colloquially known as the Dark Ages.

The gradual collapse of the Western Roman Empire, from around 293 CE until 476 CE, created a power vacuum in Central and Western Europe in addition to vast abandoned fortress networks (the *Limes*).<sup>56</sup> The ruins of the empire were repurposed by the new rulers of Europe, who sought to replicate much of the Roman architecture, whilst adding in features of their own. These new rulers included dozens of tribes, many of whom are considered to be *Germanic*—a vague description of the people north of the Danube provided by the Romans during their conquest of Gaul, Iberia, and Germania,

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<sup>52</sup> Pirenne, 2009.

<sup>53</sup> Heather, 2009.

<sup>54</sup> Barnes, Ian. 2010.

<sup>55</sup> Krahe, 2014, p.10.

<sup>56</sup> Rogers, 2010.

and was probably derived from a single tribe named the *Germani*.<sup>57</sup> The tribes crisscrossed throughout Europe establishing new kingdoms during the *Völkerwanderung*. The tribal names do not refer directly to ethnic groups, rather, many people of diverse backgrounds joined tribal armies whose names acted more as a banner than an ethnic identity. The Franks were the most powerful tribe, establishing themselves in the modern-day areas of eastern France, Belgium, Luxemburg, the Netherlands, and Southwest Germany. Though originally a variety of smaller tribes, the Franks allied themselves under Clovis I in 509 CE, son of *Childeric*—the founder of the Merovingian Dynasty which lasted until 751 CE.<sup>58</sup> Many of the smaller tribes, particularly the Salian Franks, remained influential into the High Middle Ages (1050-1250 CE) and had a direct effect on the architecture and realm of *Burg Hohenecken* and the city of *Lautern*.

## 2.2 Creation and Structure of the Holy Roman Empire:

*Burg Hohenecken* had a significant involvement in the defense of the Holy Roman Empire (962-1806).<sup>59</sup> The history of the Holy Roman Empire begins with Charlemagne, the father of the nations of Western Europe. Charlemagne had inherited kingdoms derived from the former Merovingian territories, united them and was crowned Emperor of the Romans on December 25<sup>th</sup>, 800 CE. He played an essential part of the transfer of power from the former Roman Empire to the newly formed Frankish empire that encapsulated much of the pomp and circumstance of the Romans as well as the northern territories. After his death on January 28<sup>th</sup>, 814 CE, Charlemagne's empire first fell into civil war amongst his grandsons and ultimately disintegrated after the Treaty of

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<sup>57</sup> Heather, 2009, p.308.

<sup>58</sup> Dick, 2015, p.31.

<sup>59</sup> Zophy, 1980.

Verdun in 843 CE.<sup>60</sup> The treaty separated the empire into three distinct kingdoms: West Francia, Middle Francia, and East Francia. These kingdoms provided the foundation for the formation of the French Kingdom, the Duchy of *Lotharingia* (*Lorraine/Lothringen*), and the German Kingdom (respectively).<sup>61</sup>

East Francia became rooted in turmoil, invaded on all sides by the French, the Normans, the Hungarians, and the Vikings. It was at this time that Otto I, Duke of Saxony and King of Germany as of 936, defeated all of these invaders culminating in his victory at the Battle of Lechfeld in 955 against the Hungarians (i.e. Magyars). Seven years later on February 12<sup>th</sup>, 962, Otto was crowned Emperor and given the title *Römisch-deutscher Kaiser*—the Roman-German Emperor. Thus the empire formed was officially titled, “The Holy Roman Empire of the German Nation,” or the “Holy Roman Empire,” in short.<sup>62</sup> Henceforth, mention of the Holy Roman Empire will be given by the abbreviation HRE.

The empire consisted of a number of kingdoms, duchies, and principalities, though the boundaries of the lands and the ruling dynasties were by no means static. The constant political change within the empire caused borders to be often repositioned, resulting at times in the promotion of lands to more important positions (i.e. duchy to a kingdom), but also the relegation of lands and rulers to positions of lesser status. The hierarchy of power (in order) of the HRE is given below in English and in German<sup>63</sup>:

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<sup>60</sup> Pieper, 2013.

<sup>61</sup> Fries, 2014, p.23.

<sup>62</sup> Fries, 2014, p.23.

<sup>63</sup> Zophy, 1980.



1. The Holy Roman Emperor—*Römisch-deutscher Kaiser*
2. The Kingship of Germany—*Deutscher König*
3. The Kingship of Italy—*König von Italien*
4. The Prince Electors—*Kurfürsten*
  - A. Three ecclesiastic *Kurfürsten*:
    - i. Archbishop of Mainz—*Erzbischof von Mainz*—Arch-chancellor of the empire
    - ii. Archbishop of Trier—*Erzbischof von Trier*—Arch-chancellor of the Kingdom of Germany
    - iii. Archbishop of Cologne—*Erzbischof von Köln*—Arch-chancellor of the Kingdom of Italy
  - B. Four secular *Kurfürsten*:
    - i. The Count of the Palatinate in Heidelberg—*Pfalzgraf bei Rhein*—Arch-Steward of the empire
    - ii. The Duke of Saxony in Dresden—*Herzog von Sachsen*—Arch-Marshal of the empire
    - iii. The Margrave of Brandenburg in Havel (later in Berlin)—*Markgraf von Brandenburg*—Arch-Chamberlain of the empire
    - iv. The King of Bohemia in Prague—*König von Böhmen*—Arch-Cupbearer of the empire
5. The Kingship of Sicily—*König von Sizilien*
6. Grand-dukes—*Großherzöge*
7. Dukes—*Herzöge*
8. Sovereign Princes—*Fürsten*
9. Margraves—*Markgrafen*—ruled Marks—buffer lands along the imperial borders
10. Counts—*Grafen*
11. Barons—*Baronen*
12. Free-Lords—*Freiherren*
13. Knights—*Ritter*
14. Squires—*Edelknechten*

The Seven Prince Electors are of particular interest as they were responsible for the elections of the German kings and garnering their support was of utmost importance. The struggle to place one's own choice on the throne as King of Germany was vital, since only the King of Germany could be crowned emperor of the HRE, though he could simultaneously have multiple other titles as well; Frederick II von Hohenstaufen, for example, was King of Germany, King of Italy, and King of Sicily before elected emperor

in 1220, and then became King of Jerusalem in 1225.<sup>64</sup> The *Kurfürsten* acted as checks and balances to the power of the emperor and as emissaries to other nations. Though they were bound to the empire, their actions did not always suit the will of the emperor. The Archbishops of Cologne, for example, often took the side of the Saxon *Welfen* family—the arch enemy of the Frankish Hohenstaufen family—on many occasions during the twelfth and thirteenth centuries. The Hohenstaufen Dynasty (1025-1268 CE<sup>65</sup>) was primarily responsible for the development of fortress networks throughout the *Pfalz*.<sup>66</sup> These Archbishops personally formed armies on behalf of the *Plantagenet* family of England and the Saxon *Welfen* against the forces of the Hohenstaufen emperors and kings.<sup>67</sup> The German kings chosen by the *Kurfürsten* had to first travel to Rome to be crowned emperor by the Pope in order to hold the title. This would often prove difficult and, at times, impossible as in the case of Conrad III of Hohenstaufen (1093-1152 CE<sup>68</sup>) who attempted multiple trips to Rome but the *Welfen* instigated chaos in northern Germany as soon as he would leave, forcing him to remain in Germany and never to become emperor.<sup>69</sup>

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<sup>64</sup> Engels, 2005 [1972].

<sup>65</sup> Neuhold, 2014.

<sup>66</sup> Hotz, 1981, pp.1-19.

<sup>67</sup> Neuhold, 2014, pp.67-84.

<sup>68</sup> Neuhold, 2014, p.19.

<sup>69</sup> Neuhold, 2014, p.36.

### 2.3 Architectural Revival:

Towards the end of the Ottonian dynasty (962-1024) around the year 1000, a new style of architecture emerged, building upon the elements of Carolingian styles, yet breaking free from its distinct form. New architectural influences from the Near East and Southern Europe made their way into northern Europe as the HRE expanded its connections across the Mediterranean. The origin of Christianity in the Near East inspired many architects to look to the styles of that region, adopting Persian and Syrian sculptural aspects. This new eclectic style became known as *Romanesque*. The style combined the imperial Roman architectural grandeur with the more folk-oriented designs of the Germanic tribes. The Romanesque style spread throughout northern Europe, Byzantium, and Spain (though Spain had become more dominantly influenced by Islamic architecture).<sup>70</sup> The Romanesque style, known for its bold arches, high vaults, and thick walls proved very durable and imposing. The cathedrals in Mainz (~975), Speyer (1030), Trier (1121), and Worms (1130) are testament to this grand style of ecclesiastic architecture which paralleled the reformation of the church hierarchy in the late eleventh and early twelfth centuries.<sup>71</sup>

The reformation of the church was led by *Bernard de Clairvaux* (1090-1153 CE), considered to have been the most dominant ecclesiastic figure in Christendom during the twelfth century. *Bernard* had become the Grand Prior of the Abbey of Cluny—the model for Romanesque architecture.<sup>72</sup> He was also one of the most outspoken church leaders

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<sup>70</sup> Christie, 1982, p.244.

<sup>71</sup> Kosch, Clemens. 2011.

<sup>72</sup> Christie, 1982, p.244.

encouraging the crusades—specifically the Second Crusade (1147-1149).<sup>73</sup> His focus on education and emphasis on the relationship between Christ and the individual, paved the way for other church reformers in the centuries to come. *Hildegard von Bingen*, a contemporary and acquaintance of *Bernard*, assisted in promoting education and strengthening the foundation for church theology. Both are Roman Catholic Saints and official Doctors of the Church.<sup>74</sup>

The cathedrals of Mainz, Speyer, and Worms are a distinctive red/brown color due to the use of the *Buntsandstein* of the area. Prior to the reign of the Salian dynasty from 1024-1125, castles were primarily fortresses built mostly out of wood with stone outer walls. These structures, known as mottes (Motte and Bailey, in English<sup>75</sup>), were unable to withstand sieges very well and were falling short of the defensive requirements of the HRE.<sup>76</sup> Thus, the necessity to expand a new architectural style to these fortresses became a reality, which the empire sought to fulfill in a remarkable fashion. The Romanesque style was adopted in the construction of the new castles throughout the entire empire often built upon the foundations of previous mottes. Alongside the castles, imperial palaces of the Holy Roman Emperors were adjusted to the new style. The thick walls were perfectly suited for citadels and grand halls of emperors and kings. The Salian emperors, together with the French kings, laid an architectural foundation for Europe to be built into a bastion of Romanesque structures.<sup>77</sup> Though France had moved

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<sup>73</sup> Riley-Smith, 2005 [1987], p.43.

<sup>74</sup> Paul, 2011, pp.14,141,144.

<sup>75</sup> Barnes, 2010 [2007].

<sup>76</sup> Krahe, 2014 [2008], p.13.

<sup>77</sup> Christie, 1982, pp.246-248.

to Gothic styles in the late thirteenth century, the HRE held fast to Romanesque which reached its zenith during the time of the Hohenstaufen dynasty.

#### 2.4 Imperial Palaces—*Kaiserpfalzen*:

The Hohenstaufen emperors and kings (1138-1254) built new palaces upon the foundations of former palaces.<sup>78</sup> These imperial residences were known as a *Kaiserpfalz* and were speckled throughout Germany and Italy. These residences were used by the emperors of the HRE who would be constantly moving throughout the empire staying an average of three months in one *Kaiserpfalz*, though they would at times retreat to other residences. This process of constant movement required a large entourage of knights, servants, and mass amounts of equipment, in addition to facilities at each site to host the emperor, his family, and his staff.<sup>79</sup> Each *Kaiserpfalz* had a set of *Ministerialen* (from the Latin *Ministerialis*), who were non-nobles elected to high positions within the imperial court. They acted as the emperor's *Hofmarschallen* (court marshals), *Kämmerer* (chamberlains/treasurers), and *Mundschenke* (cupbearers, who were in charge of the court servants). The *Hofmarschallen* were responsible for the stables and grounds of the *Kaiserpfalz*—the chief of these marshals was the *Kurfürst* Duke of Saxony. The *Kämmerer* was responsible for the chambers within the palace, the organization of the servants, and assembling the décor and equipment for each room brought by the emperor—the chief of these chamberlains was the *Kurfürst* Margrave of Brandenburg. The *Mundschenke* were responsible for the feasts and testing the foods prepared for the

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<sup>78</sup> Hotz, 1981, pp.20-24.

<sup>79</sup> Andermann, 2004.

emperors and kings by tasting each dish and drink first before allowing others to indulge. A full set of these high-ranking servants had to be available at each *Kaiserpfalz*.<sup>80</sup>

The Italian *Kaiserpfalzen* have all but disappeared, and the German ones have not survived well either. The *Kaiserpfalz* in *Hagenau* (in *Alsace*, France) does not exist anymore, and the *Kaiserpfalz* in *Kaiserslautern*—of primary concern regarding *Burg Hohenecken*—has only the foundations and the remnants of one wall from the original structure. In contrast to these nearly forgotten *Kaiserpfalzen*, the ones in Aachen and *Gelnhausen* are still visible, though also not in their entirety. The *Kaiserpfalz* in *Goslar* has been magnificently preserved, still complete in the style built for the Salian emperors of the eleventh century, though it had been modified by Henry VI in the late twelfth century.<sup>81</sup> As with most structures from the Middle Ages, they were rebuilt, built upon, and repurposed at various times to better serve the needs of the regional governments.

During the time of emperor Frederick I *Barbarossa* von Hohenstaufen (1122-1190 CE), the palaces were expanded and some *Ministerialen* families were promoted to nobles. The promotion of these servants to nobility served two purposes: to have incredibly loyal subjects, owing their livelihoods to the emperor and his family, and to be positioned both as stewards within certain regions and retainers of the monarch's buildings.<sup>82</sup> As a result of Barbarossa's hierarchical promotions and the expansion of the Romanesque architectural style, massive building projects of castles were accelerated during his reign. These castles formed vast networks of defenses, often positioned and highly concentrated within mountainous or troublesome regions (e.g. the *Pfalz* and the

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<sup>80</sup> Andermann, 2004.

<sup>81</sup> Hotz, 1981, p.105.

<sup>82</sup> Andermann, 2004.

Margrave of Brandenburg, respectively). The *Pfalz* became one of the most saturated area of castles in the Kingdom of Germany, securing the empire's western border with France for nearly 500 years.

The castle chain of the *Pfalz* began under the reign of the Frankish Salian imperial dynasty (1024-1125) and continued through the Hohenstaufen dynasty (1152-1250).<sup>83</sup>

The castles were built for the following reasons: in order to protect the roads leading from the HRE to the Duchy of *Lothringen*, to protect the imperial palace in *Kaiserslautern*, and to safe guard the imperial coin mints.<sup>84</sup> These mints were located in the cities of *Kaiserslautern* and *Oppenheim*, and in *Burg Trifels*—which was also the location of the imperial regalia (scepter, orb and sword of the Emperor, known as the *Reichskleinodien*).<sup>85</sup> The modern *Kaiserstrasse* (emperor's street), which passes through *Kaiserslautern*, had originally been built by the Romans in the first century A.D. and remains in use until this day. It is a direct route from France into Germany and has witnessed the march of countless armies and invasions, including Napoleon's march east in the early nineteenth century and the allied invasion of Germany during WWII.

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<sup>83</sup> Hotz, 1981, pp.20-24.

<sup>84</sup> Keddigkeit, 2007.

<sup>85</sup> Seebach, 2009.

## 2.5 The Significance of *Kaiserslautern* and the *von Hohenneck* Family:

The city of *Kaiserslautern* is nestled in a valley between the mountainous *Unterer Pfälzerwald* to the south and flatlands to the north. The *Kaiserstrasse* passes directly through the city as does the *Lauter* River (the city's namesake, derived from the Germanic *Lûlara*, meaning "clear water"). *Kaiserslautern* was first mentioned shortly after the reign of the Merovingian King Clovis (who died in 511<sup>86</sup>). In the eighth century, the Merovingians (prior to the Carolingians) constructed a royal palace and the city was named *villa Luthra*. The city had briefly fallen from record until the latter part of the tenth century when it had been renamed *Luthara*—though it had already become a Carolingian palace in the ninth century. During the Imperial Salian Dynasty in 1086, *Luthara* acquired the control of the free city of Speyer (east of *Kaiserslautern*)—one of the most important cities in the HRE due to the power of the Bishop and the lands he controlled.<sup>87</sup> *Luthara* had been catapulted to one of the most important cities in the Palatinate and in 1152, *Barbarossa* expanded the *Kaiserpfalz* (seen in Figure 2.1).

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<sup>86</sup> Dick, 2015, p.31.

<sup>87</sup> Keddigkeit, Jürgen. 2007.





Figure 2.1: Merianstich (engraving) of Kaiserslautern from the early 17th century. Note the “Kaiserpfalz und Schloss” on the left.<sup>88</sup>

The imperial palace was erected from 1152-1158 upon the remnants of the Carolingian palace which, in turn, had been built upon the Merovingian palace, and became the residence of *Barbarossa*.<sup>89</sup> *Barbarossa*’s biographer, *Rahewin* wrote of the *Kaiserpfalz* in *Lautern* saying,

“[i]n Lautern he [*Barbarossa*] had constructed with great investment a palace out of red stone. On one side, he built a tremendous wall, and on the other side a fishpond that wrapped around like a lake, whose abundance of fish and water birds was a pleasure for both the eyes and the palate. The palace also had an animal garden located directly beside it with all kinds of stags and deer. The royal grandeur of these things captivates every visitor.”<sup>90 91</sup>

Unfortunately, *Barbarossa* most likely never saw the completion of his palace in *Lautern* because a piece of oak, dated to have been felled after 1190, was found in a recent

<sup>88</sup> Gross, 2012.

<sup>89</sup> Keddigkeit, 2007.

<sup>90</sup> Keddigkeit, 1995, p.7.

<sup>91</sup> Schauder, 2010.

excavation of one of the first buildings of the palace.<sup>92</sup> The emperor had famously died of a stroke in 1190 whilst bathing in the *Saleph* (*Göksu*) river during the infancy of the third crusade.<sup>93</sup>

The palace was quite large (though very little remains today due to the 30 Years War and WWII), consisting of a *Reichssaal* (imperial hall/court), chambers for the emperor, his family, and the associated entourages, in addition to a large stable where his knights stayed. The palace and the toll elevated *Luthara*'s status and the city was renamed *Lutra* in 1195.<sup>94</sup> The city became home to a new family of *Ministerialen* originating from *Lutra* and a small nearby village called *Hohenecken*. The family adopted the new name “*von Lautern*,” or “*de Lutra*” and within 50 years, were the *Hofmarschallen* (court marshals), *Kämmerer* (chamberlains/treasurers), and *Mundschenke* (cupbearers) at the *Kaiserpfalz* in Lautern.<sup>95</sup> Essentially, the *von Lautern* family had become one of the most powerful non-noble families in the Kingdom of Germany within the HRE. They would have chiefly served the following individuals<sup>96</sup>:

1. Henry VI (1165-1197), the son of Barbarossa
  - a. Emperor (1191-1197)
  - b. Also the King of Germany (1169-1197), Italy (1186-1197) and Sicily (1194-1197)
2. Philip von Schwaben (1177-1208), brother of Henry VI and son of Barbarossa
  - a. King of Germany (1198-1208)
  - b. Duke of Schwaben (1196-1208)
3. Frederick II (1194-1250), son of Henry VI
  - a. Emperor (1220-1250)
  - b. Also the King of Germany (1212-1220), Italy (1220-1250), Sicily (1198-1250), and Jerusalem (11225-1228)

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<sup>92</sup> Gies, 2012.

<sup>93</sup> Engels, 2005, p.126.

<sup>94</sup> Petry, 1988, pp.158-159.

<sup>95</sup> Lehmann, 1969 [1857], pp.48-49.

<sup>96</sup> Engels, 2005 [1972].

For their services to the emperor and his court, one of the sons, *Reinhardus I de Lutra* (i.e. *Reinhard I von Lautern*), was awarded the high position of *Schultheiss* (Sheriff) in *Lautern* and his brother *Heinrich I de Lutra* served as the cupbearer for the emperor.<sup>97</sup> The construction of a new castle located along the imperial road that was to become the main defense of the imperial palace and the toll was also awarded to the family as a *Reichslehen* (imperial loan—equivalent of an imperial fief). This castle, known as *Burg Hohenecken* would become the home of the *de Lutra* family (shown in Figure 2.2).<sup>98</sup> The high ranking position of *Reinhard II* (son of *Reinhard I de Lutra*) as *Reichsschultheiß* in 1217 also provided the family with the duty of protecting the new coin-mint in *Kaiserslautern*.<sup>99</sup> Due to the threat of attack, given its position near the border with France, the mint in *Lutra* would have had to be defensible, most likely placed within a fortress. The new *Burg Hohenecken* soon became home the *von Lautern* (and later renamed to *von Hoheneck*) family beginning in 1200.<sup>100</sup>

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<sup>97</sup> Lehmann, 1969 [1857], pp.48-49.

<sup>98</sup> Keddigkeit, 2002, p.378.

<sup>99</sup> Dolch, 1994, p.45.

<sup>100</sup> Keddigkeit, 2002, p.378.

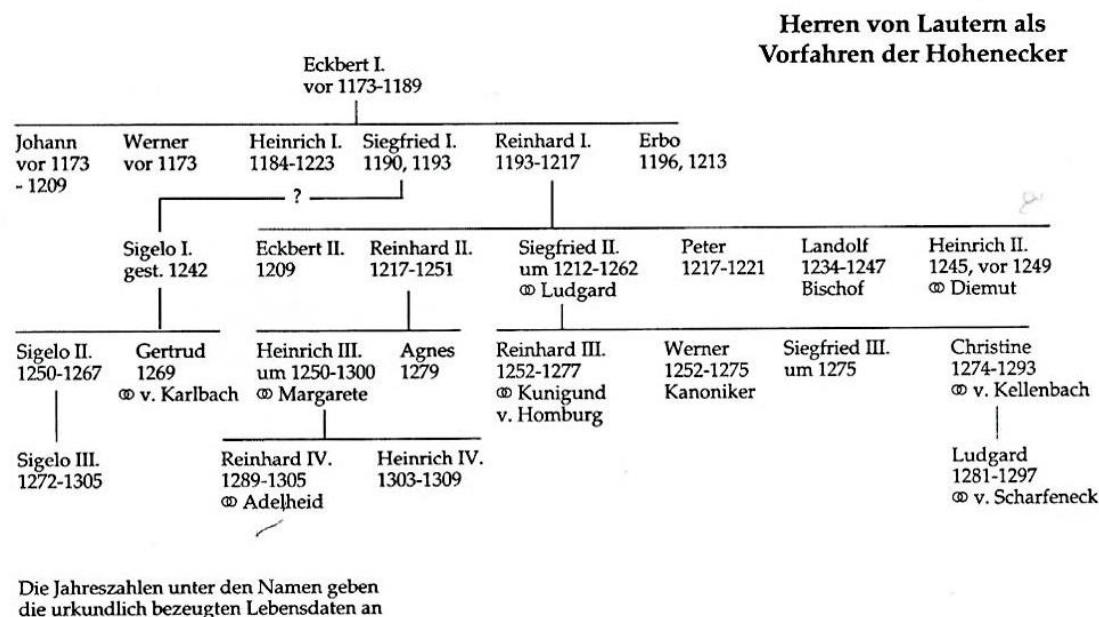


Figure 2.2: The Lords of *Lautern*—the forefathers to the House of Hohenecken.<sup>101</sup>

## 2.6 The Beginning of *Burg Hohenecken*:

Construction of *Burg Hohenecken* began prior to 1200, but after the construction of the *Kaiserpfalz* in *Lautern* in 1152, in the style of the Romanesque architecture of the tenth to thirteenth centuries, characteristic of the HRE.<sup>102</sup> Simultaneously to the construction of *Burg Hohenecken*, 23 other castles were begun between 1194 and 1210.<sup>103</sup> The imperial palace in *Lautern* had been considered the centerpiece of the network<sup>104</sup> and a variety of outposts/castles were constructed to protect it, including a settlement of Teutonic knights (in the *Einsiedlerhof*<sup>105</sup>), and eight castles: *Burg Nanstein*, *Burg Hohenecken*, *Burg Beilstein*, *Burg Wilenstein*, *Burg Wolfstein*.<sup>106</sup> Other castles located along the imperial road that crossed through *Lautern* include: *Burg Diemerstein*,

<sup>101</sup> Dolch, 1994 p.55.

<sup>102</sup> Keddigkeit, 2002, p.378.

<sup>103</sup> Rey, 2012.

<sup>104</sup> Ebhardt, 1977 [1939], p.521.

<sup>105</sup> Fendler, 1986.

<sup>106</sup> Fallot-Burghardt, 2001, p.6.

*Burg Frankenstein, Burg Wachtenburg, Burg Hardenburg*<sup>107</sup>, and *Burg Perlenberg*.<sup>108</sup>

The defense of the empire became of utmost importance during the Middle Ages in which an estimated 20,000 castles were built in the area of Germany alone.<sup>109</sup>

The massive building project was presumably sluggish between the years 1197 and 1212 due to the tumultuous end of the twelfth century and the disastrous beginning of the thirteenth. Emperor Henry VI had been murdered (most likely by his wife, Constance) in 1197 and his younger brother was left with an entire empire, which was in the midst of a massive political restructuring begun by Henry VI.<sup>110</sup> Philip had also inherited the protection of Henry's young son, Frederick II, as well as the kingship of Germany. He failed to maintain the empire, despite his efforts combating those who sought to overthrow him and it fell into civil war. Philip had extensive international connections as he was married to Irene Angelina (1181-1208), the daughter of the deposed Byzantine emperor Isaac II Angelos. Isaac's son, Alexius Angelus was determined to place his father back on the throne and convinced the Venetians to lead a crusade against Byzantium.<sup>111</sup> In 1204 the fourth crusade came to fruition and resulted in the complete devastation of Byzantium and ravaging of Constantinople, ultimately paving the way for the downfall of Byzantium until its eventual collapse at the hands of the Ottoman Turks in 1453.<sup>112</sup>

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<sup>107</sup> Rey, 2012.

<sup>108</sup> Petry, 1988, p.290.

<sup>109</sup> Krahe, 2014 [2008], p.16.

<sup>110</sup> Neuhold, 2014, pp.85-104.

<sup>111</sup> Norwich, 1999, pp.294-303.

<sup>112</sup> Norwich, 1999, pp.372-380.

The chaos of international politics at this time was a reflection of internal imperial politics. It would have been incredibly trying for the *Ministerialen* families (e.g. the *von Hoheneck* family) appointed by the Hohenstaufen Dynasty to maintain their status amidst civil war. Even being connected to an ousted emperor could invite death from the hands of the usurpers upon all servants of the former emperor. The slow dismantling of the Hohenstaufen rule became even more pronounced when Phillip was assassinated in 1208, by the *Pfalzgraf* of Bavaria who had at one point been engaged to Philip's daughter, but Philip had ended the engagement, favoring the Bohemian King *Ottokar I*.<sup>113</sup>

The mortal enemies of the Hohenstaufen dynasty, the *Welfen*, seized the opportunity to take the kingdom even before Philip had officially become king. In 1198, Otto IV, born to Henry the Lion (Duke of Saxony, first cousin and archrival of *Barbarossa*) and Matilda Plantagenet of England, was coronated by the Archbishop of Cologne as king, though without the official regalia.<sup>114</sup> The imperial regalia were held in *Burg Trifels*, a Hohenstaufen bastion that proved most troublesome to the *Welfen* considering that Henry VI had imprisoned Otto's maternal uncle Richard I Plantagenet of England *Coeur de Lion* (the Lionhearted) in *Trifels* after the third crusade.<sup>115</sup> It was during these incredibly trying times that the de *Lutra* (i.e. *von Hoheneck*) family controlled the palace in *Lautern* and were closely associated with the entourage of the Hohenstaufen kings. Otto eventually came into conflict with Pope Innocent III (the same pope who had coronated him emperor in 1209) and was excommunicated in 1210 when

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<sup>113</sup> Neuhold, 2014, p.111.

<sup>114</sup> Neuhold, 2014, p.115.

<sup>115</sup> Seebach, 2009.

he marched on Rome.<sup>116</sup> After Otto IV's excommunication, the *Kurfürsten* in Germany (among many others) became frustrated with him and elected Frederick II (son of Henry VI) as king of Germany in 1212. Though Otto remained emperor until 1215, he was eventually forced to abdicate.<sup>117</sup> Interestingly, 1215 was the same year that his maternal uncle King John I of England signed the Magna Carta.<sup>118</sup> These tumultuous years ended in the favor of the *von Hoheneck* family, because it was the Hohenstaufen dynasty to which they owed both their status as nobles and their castle.

The Hohenstaufen dynasty was again elected to the throne of the HRE with Frederick II (the son of Henry VI, and thus grandson to *Barbarossa*) as emperor in 1220. Under Frederick II's reign from 1212-1250, the construction of castles within the network of fortresses reached an unprecedented speed with the addition of six more castles in the network. The castles were all built in the Romanesque style, though not all held the power positions as imperial loans.<sup>119</sup> *Burg Hohenecken* and *Burg Trifels*—both *Reichslehen*—each received funding for further expansion after the original citadels had been built. *Burg Hohenecken* received a front tower for the coin mint, a *Bergfried* (main tower) and a new gateway at the west end.<sup>120</sup> Most of the castles in the chain are substantially larger than *Burg Hohenecken*, though each castle served a different purpose in the defense of the empire. The castle chain served its duty to protect the western border of the HRE well into the latter half of the seventeenth century.

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<sup>116</sup> Neuhold, 2014, pp.118-119.

<sup>117</sup> Neuhold, 2014, p.121.

<sup>118</sup> Breay, 2015, pp.53-58.

<sup>119</sup> Hotz, 1981.

<sup>120</sup> Keddigkeit, 2002.

## 2.7 The *von Hoheneck* Family and their Castle 1200-1300:

The following information is heavily derived from individual letters dating from 1212-1560 CE involving the *von Hoheneck* family, *Burg Hohenecken*, or both. All of the letters had been originally written in Latin or older forms of German, though some were transcribed in the nineteenth century into modern High German. I have translated each letter from the various forms of German and Latin into English to the best of my ability. The information from the letters is noted by an exact date (e.g. June 8<sup>th</sup>, 1291) and provides key insight into the correspondences of the family, locations of different sites, and materials which were traded.

The family *von Hoheneck*, first mentioned as such in 1212<sup>121</sup>, seemed to have held closely together and not followed the common fracturing pattern that plagued many noble families. The family itself was considered a fief of the HRE, as the empire had the final judgement and could override any decision.<sup>122</sup> This is perhaps due to the fact the castle had been entrusted to the entire family and that the duties of imperial sheriff, protector of the palace in *Lautern*, and governor of nearly all of the lands in between could only be managed through unity. This was also the case when dealing with the monastery in *Otterberg* (Figure 2.3), which was the dominant ecclesiastic institution in the area around *Lautern* and *Burg Hohenecken*.<sup>123</sup>

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<sup>121</sup> Keddigkeit, 2002.

<sup>122</sup> Keddigkeit, 2002.

<sup>123</sup> Steinebrei, 1992.





Figure 2.3: The monastery at *Otterberg*<sup>124</sup>

During the latter half of the thirteenth century, the Lords of *Hohenecken* continued as beneficiaries of the Cistercian monastery in *Otterberg*<sup>125</sup>, specifically in 1265 when *Heinrich III* and his wife *Margarethe* granted the monastery the rights to various lands within the fiefdom of *Hohenecken*—primarily agricultural resources.<sup>126</sup> The power of the church had truly manifested itself in the *von Hoheneck* family, considering that *Heinrich III*'s uncle, *Landolph von Hoheneck* was the bishop of Worms in the famous Romanesque cathedral from 1234-1247, and his other uncle, *Heinrich II von Hoheneck*, was a prelate in the city of Worms as well.<sup>127</sup> The *Reichsschultheiss* (Imperial Sheriff) and first cousin of *Heinrich III*, *Reinhard III*, was also involved in the transfer of

<sup>124</sup> Schwarzmüller, 2006.

<sup>125</sup> Steinebrei, 1992.

<sup>126</sup> Copy: StadtA Mainz, 13/538, Bl.141 Nr.190. Print: UB Otterberg, S.110f. Nr.146.

<sup>127</sup> Lehmann, 1969 [1857].

property to the monastery because he had to approve all transfers within the fiefdom, suggesting that he and *Heinrich III* had planned it together.<sup>128</sup> Though in return, *Reinhard III* received lands transferred from the monastery to the fiefdom of *Hohenecken* and requested official confirmation from the German King, Richard of Cornwall around 1265.<sup>129</sup> The city of *Lautern* continued to rise, becoming the site of the most lavish imperial palace, of which *Rahewin* (*Barbarossa's* biographer) noted, “In all of the various realms [of the empire], no other palace compares to it [the *Kaiserpfalz* in *Lautern*].”<sup>130</sup>

For this reason that Richard of Cornwall (1209-1272), the second son of John I of England, celebrated his wedding in *Lautern* in 1269.<sup>131</sup> Richard was not only the second highest born of the House Plantagenet (his brother was King Henry III of England), he was also the King of Germany as of 1257. The oldest surviving insignia of the city of *Kaiserslautern* dates from 1262, during the time of Richard's reign (Figure 2.4).<sup>132</sup> *Lautern* eventually reached its peak in 1276 when it was designated a *freie Reichsstadt* (free Imperial City) by King *Rudolf von Habsburg*, the successor of Richard of Cornwall as King of Germany.<sup>133</sup> In 1273, three years prior to the promotion of the city, the *von Hoheneck* family was entrusted with the keeping of *Burg Trifels* and, consequently, the protection of the imperial regalia within the same castle.<sup>134</sup>

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<sup>128</sup> Copy: LA Sp, A 14/61.1, Bl.7f. (16.Jh.); GLA Ka, S Kremer-Lamey 27, Nr. 263. Print: Mon.Pal.I, S. 318f. Nr. 69 (ungenau-unexact).

<sup>129</sup> Copy: LA Sp, A 14/61.1, Bl.23 (16.Jh.). Druck (Print): Mon.Pal.I, S. 380f. Nr.102. Regest.: Reg.Imp.VI 1, 1158 (zu 1279).

<sup>130</sup> Gross, 2012.

<sup>131</sup> Keddigkeit, 2007.

<sup>132</sup> Gross, 2012.

<sup>133</sup> Keddigkeit2007.

<sup>134</sup> Keddigkeit, 2002.



Figure 2.4: Kaiserslautern became a free city in 1276<sup>135</sup>

Both Richard's wedding and the elevation of *Lautern* to a free imperial city required a formidable defense and well-orchestrated city leadership. The House of *Hohenecken* became the primary force in establishing their castle as a strong fortress along the major imperial street along the *Saarbrücker-Pfälzer Sattel* of the *Pfälzerwald* in addition to organizing the events leading up to the wedding. In 1277, Count *Ludwig von Homburg* provided the *Prämonstratenserklöster*, a monastery of the Order of Canons Regular of *Prémontré* (Premonstratensians) located in *Lautern* (where the current *Stiftskirche* is), to one of his most trusted men, *Walter Kisteln von Dürkheim*<sup>136</sup>--the *Dürkheimer* family is one of the oldest in the *Pfalz*<sup>137</sup>. The order was strongly influenced by the Cistercians, who valued manual labor, self-sufficiency, and education. The founder of the Premonstratensians, Saint Norbert (1080-1134), had been a close friend of the Cistercian reformer *Bernard de Clairvaux*.<sup>138</sup> The *Prämonstratenserklöster* served as

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<sup>135</sup> Gross, 2012.

<sup>136</sup> HStA Mü I, Rheinpfälzer Urk. 1353 (1380-Januar-10). Pergament, Deutsch.

<sup>137</sup> Fallot- Burghardt, 2001.

<sup>138</sup> Paul, 2011.

an auxiliary to the Cistercian monastery in *Otterberg*<sup>139</sup>, providing their services within the community of *Lautern*. It is very possible that the connections with the Cistercians and Premonstratensians influenced the *von Hoheneck* family to become so heavily involved in the church. *Burg Hohenecken* had possessed a chapel of its own as early as 1269, and ecclesiastics from the monastery in *Lautern* would lead the services in the castle chapel every Sunday and holiday as of 1273.<sup>140</sup>

The family's involvement with ecclesiastic orders extended to military orders as well, specifically the *Deutschherren*—the Teutonic Knights. Originally funded by the *von Hoheneck* family in 1220, the Teutonic Knight Commandry in *Einsiedel* (~4.7 kilometers—one hour from *Burg Hohenecken* by walking) was given pastoral rights of the parishes in the nearby villages of *Ramstein*, *Weilerbach*, and *Spesbach* in 1253. The patronage of the parishes had been given to the *von Hoheneck* family by Emperor Frederick II on the 4<sup>th</sup> of July, 1215 remaining so until *Heinrich III von Hoheneck* transferred the patronage unto the “Brothers of the House of the Teutonic Knights” on the 18<sup>th</sup> of November 1260.<sup>141</sup> On the 14<sup>th</sup> of December 1277, the widow of *Reinhard III*, *Kunigund* (sister of Count *Friedrich von Homburg*), provided the Teutonic Knight Order Commandry in *Einsiedel* with more land, to which the Commandry dedicated one day of the year in honor of *Kunigund von Hoheneck*.<sup>142</sup>

The first time the family became embroiled with military affairs occurred in July of 1290, when *Heinrich III* joined forces with thirty-one other nobles from the *Pfalz* on

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<sup>139</sup> Steinebrei, 1992.

<sup>140</sup> Lehmann, 1969 [1857].

<sup>141</sup> Fendler, 1986.

<sup>142</sup> Incomplete source. Presumably from the Universitäts Bibliothek Kaiserslautern

behalf of the city of *Strasbourg* (*Straßburg*) against *Heinrich von Lichtenstein* near *Bad Dürkheim*—not to be confused with *Burg Lichtenstein* in Swabia.<sup>143</sup> This alliance was most likely a result of necessity because *Heinrich III*'s cousin, the late *Reinhard III von Hoheneck*, had been imperial sheriff of both the lands and palaces of *Lautern* and *Hagenau*—a city located 25 kilometers north of *Strasbourg*. *Reinhard*'s passing would have placed the burden of protecting the areas entrusted by the empire to the next in line of the *von Hoheneck* family. Other nobles were affected by his death, which had rippling effects throughout the entire region. On June 8<sup>th</sup>, 1291, *Heinrich von Scharfeneck*—another of the oldest noble families in the *Pfalz*<sup>144</sup>—sold lands, previously enfeoffed (i.e. awarded as a fief) to him by *Reinhard III*, in the area of *Walhaben* to the Commandry in *Einsiedel* (letter shown in Figure 2.5).<sup>145</sup>

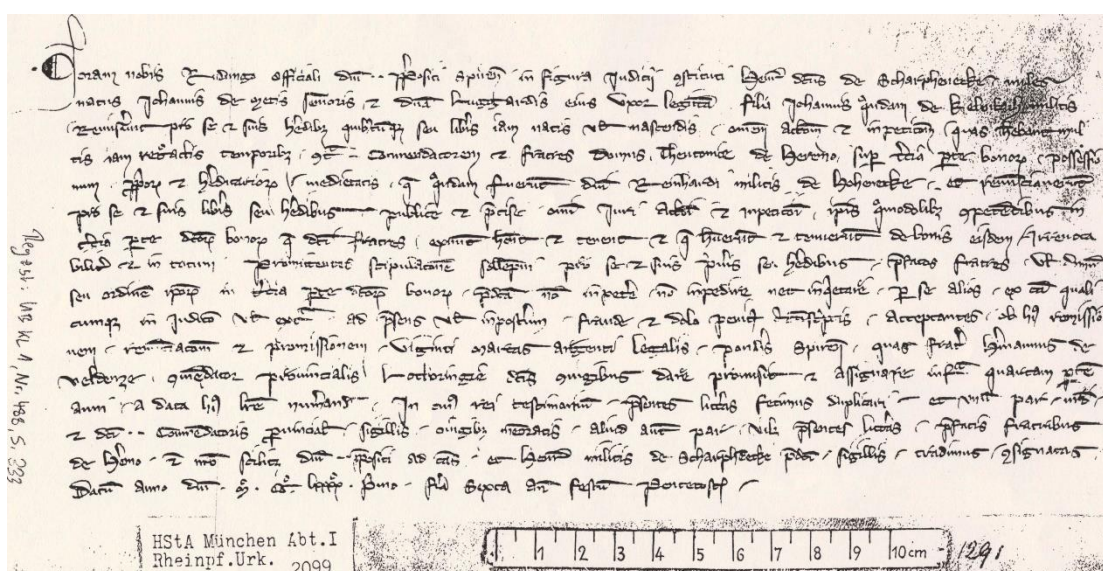


Figure 2.5: Letter describing the property sold to the Commandry in Einsiedel.<sup>146</sup>

<sup>143</sup> Wiegand, 1886.

<sup>144</sup> Fallot- Burghardt, 2001.

<sup>145</sup> Origin: HStA Mü I, Rheinpfälzer urk.2099. Pergament, Latein, 1 Presselrest. Regest.: MrhReg IV 1904 (unvollständig-incomplete). Erw. (Mentioned): Fendler, S.26 (ungenau-unexact).

<sup>146</sup> Origin: HStA München Abt. 1 Rheinpf. Urk. 2099. Regest: UB KL 1, Nr. 488, S. 333.

More lands in the area of *Walhaben* (within the fiefdom of *Hohenecken*) were sold to the Commandry in *Einsiedel* on the 9<sup>th</sup> of April, 1293 by the chamberlain of Worms, *Embrich*, with the permission of the local knight, *Johann von Kellenbach*.<sup>147</sup>

The Teutonic Knights were expanding their influence within western portions of the fiefdom of *Hohenecken*, and the Cistercians and Premonstratensians were expanding in the eastern portions. Though the lands had been sold to the three institutions, they still remained within *Hohenecken's* control, because all of those areas had originally been enfeoffed to the *von Hoheneck* family by the Holy Roman Emperors. An imperial loan could not be fractured by anyone but the emperor of the HRE though claims made by nobles often convinced emperors to take lands from one and give them to another. Selling lands to religious orders, however, placed them within the jurisdiction of the church. The Cistercians and Premonstratensians were among the chief theologians and educators in the Kingdom of Germany in the twelfth and thirteenth centuries<sup>148</sup> and the Teutonic Knights were waging continuous crusades against the Polish princes and other Slavic lands.<sup>149</sup> Thus, all three orders had the complete favor of the Vatican—the only power that held sway over the emperor.

The *von Hoheneck* family had very cleverly secured their lands by creating firm alliances with three of the most powerful institutions in the HRE, whilst maintaining good relations with both the Kings of Germany and the Holy Roman emperors. This demonstrates a remarkable effort on their behalf to secure their fief for their family.

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<sup>147</sup> Goerz, 1974.

<sup>148</sup> Barnes, 2010 [2007].

<sup>149</sup> Fendler, 1986.

Many families were divided by sons or broken up by enemies, but the *von Hoheneck* family remained unified, managing to solidify their position within the empire.

## 2.8 The *von Hoheneck* Family and their Castle 1300-1410:

The fourteenth century exemplified the brutality of the Middle Ages. The HRE experienced a constant change of emperors and dynasties, England and France had entered into a 116 year long war beginning in 1337 (The Hundred Years War)<sup>150</sup>, and the Black Death ravaged its way through Europe from 1348-1349, and again in 1369, 1374-1375, 1379, 1390, and 1407, killing approximately 25 million Europeans.<sup>151</sup> In addition to the plague and constant war, the Medieval Warming Period began to wane, ushering in 500 years of colder weather.<sup>152</sup> The Kingdom of Germany was pulled into a war between the Wittelsbach Duchy of Bavaria and the Habsburg Duchy of Austria in 1322 culminating at the Battle of *Mühldorf* (in the same year), in which the German King, *Ludwig IV von Wittelsbach*, defeated the Habsburgs with the help of the Bohemian King (and *Kurfürst*) *Johann von Luxemburg*. The victory paved way for *Ludwig*'s election to emperor in 1328.<sup>153</sup>

Directly after the battle, King Johann traveled back to his home in Luxemburg, but stopped in *Lautern*, where he held the city ransom until he was paid in full for his service at the Battle of *Mühldorf*. He demanded 10,000 pounds of Heller on October

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<sup>150</sup> Devries, 2006.

<sup>151</sup> Barnes, 2010 [2007].

<sup>152</sup> Goosse, 2006.

<sup>153</sup> Kerr, 2008.

23<sup>rd</sup>, 1323.<sup>154</sup> One Heller was the equivalent of a half penny, and ~570 Heller equaled one *Reichsmark* (Imperial Mark). The ransom was eventually paid without bloodshed and King Johann later entered the crusades in the east alongside the Teutonic Knights. He became blind in 1336 due to natural causes and continued as King until his death at the Battle of *Crécy* in 1346, fighting alongside the French against the English.<sup>155</sup>

In the same year that King Johann had taken *Lautern* ransom, *Ludwig IV von Wittelsbach*, King of Germany, confirmed the dowry presented to *Elisabeth von Leiningen* by her husband *Johann von Hoheneck* (son of *Reinhard III*). The dowry was exceptionally large, consisting of 200 Silver Marks, the castle of Hohenecken and all of its properties, the villages of *Siegelbach*, *Erftenbach*, and *Kollenbach*, both the large and small tolls in *Lautern*, as well as the farmstead and lands in *Freisbach*.<sup>156</sup> The following year, on the 3<sup>rd</sup> of February, 1324, many nobles throughout the area of the castle chain met to discuss judicial issues within the realm where certain courts had jurisdiction. The *von Hoheneck* family was not specifically mentioned, though they were certainly involved with the issues at hand. The duty of Sheriff of *Lautern* had been passed to *Nikolaus von Kindenheim*, who also served as the judge at the King's court in *Lautern*. Beside him were the members of the court including the men of the castles: *Phillip IV von Falkenstein*, *Wolfram V von Lewenstein*, *Siegfried* and *Johann von St. Alban*—all Knights—*Landolf von Wilenstein*, and *Jakob von Wachenheim*—both Squires. Also

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<sup>154</sup> Copy: HStA Mü, Äußeres Archiv 1155/1, Bl.105' (gleichzeitig). Druck: Oefele, *Rer.Boic.SS.II*, S.143b; *Const.V*, S.634 Nr.812; *Bansa I*, S.150 Nr. 150. Regest.: *Reg.Imp.VII.Johann* 68; *Reg.Bohem.III* 937; *Erben*, *Berthold von Tuttlingen*, *Anh.IV* Nr.361a. *Erw.* (Mentioned): *Lehmann*, *Klt*, S.30f.

<sup>155</sup> *Devries*, 2006.

<sup>156</sup> *Registraturvermerk*: HStA Mü I, Äußeres Archiv 1155/1, Bl.106 (gleichzeitig). Druck: Oefele, *Rer.Boic.SS.I*, S.745a-b; *Bansa I*, S. 150f. Nr.151. Regest.: *Reg.Imp.VIII.Ludwig* 665; *Erben*, *Berthold von Tuttlingen*, *Anh.IV* Nr.435. *Erw.* (Mentioned): *Lehmann*, *Burgen V*, S.55; *PG 5* (1909), S.21.



present were *Dirolf*, the mayor of *Lautern*, *Johann von Würzburg*, *Johann von Miesenbach*, *Heinrich Zangmeister*, *Johann Ulengiesser*, *Falko von Morbach*, *Berwelf von Morbach*, *Folzo von Morbach*, *Johann von Morbach*, and *Jakob Sensenschmied*—all councilmen of *Lautern*—as well as the King’s foresters (unnamed). The court decided that the all matters concerning the village of *Erlenbach* were to be handled by the monastery at *Otterberg* and the matters concerning *Morlautern* (north of *Lautern*) were to be handled by the Premonstratensian monastery in *Lautern*, except in cases in which crimes are committed on the open road, in which case the King’s court was to take responsibility.<sup>157</sup>

The open road often became the site of numerous crimes by robbers known as *Wegelagerer* (robbers who waited along the roadways—High-way Robbers). This would make traveling from one city to another quite treacherous if one were traveling alone or in small numbers. The court’s decision to make highway robberies an issue of the King’s court was a clear message that the punishments would be more severe for offenders, and would have provided protection for those traveling along the roads. The *von Hoheneck* family would have required open access to the roads in order to secure their fiefdom and remain in contact with neighboring lords.

On December 26<sup>th</sup>, 1333, *Johann von Hoheneck* formed an alliance with the Archbishop Baldwin of Trier (who was also a *Kurfürst*). Johann paid Baldwin 200 Black Silver *Turnosen*, and proved that he received an income of 20 pounds of Black Silver *Turnosen* from the lands within his control.<sup>158</sup> A *Turnose* (~4 grams) was a Capetian

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<sup>157</sup> Universitäts Bibliothek Kaiserslautern, incomplete source. No data for origin and register

<sup>158</sup> Copy: LHA Ko, 1 C/3a, Nr.1652 (Balduineum Kesselstatt). Reg.Ebfe Mainz I 2, Nr.3339 (nach Beyers handschriftlichen Regest im HStA Koblenz); Mötsch, Balduineen, Nr.1085.

French currency equivalent to 12 Black pennies. A Black *Turnose* was a silver *Turnose* with a high amount of slag—an impure coin—but still used because it was so common. Thus, 20 pounds was equal to 9.07 kilograms, approximately 2,268 Black Silver *Turnosen*. This is particularly interesting because it provides insight into the annual earnings of the *von Hoheneck* family.

After *Johann von Hoheneck* had secured his allegiance to Archbishop Baldwin, he became more involved with the Counts of *Veldenz*. The *Veldenz* family, based near the *Hunsrück*, ruled areas just north of the castle chain and was considerably more influential than *Hohenecken* throughout time, eventually merging with the houses of *Pfalz-Simmern* and *Zweibrücken*. The families of *Veldenz* and *Hohenecken* came into direct conflict when Johann was taken captive and forced to pay the Count of *Veldenz* a sum of 10 pounds Heller collected from his lands on December 21<sup>st</sup>, 1342. The agreement also included access rights to *Burg Hohenecken* for the Counts of *Veldenz*.<sup>159</sup> Despite being allied with the Archbishop of Trier, there does not seem to be any support for Johann. Johann later served as a witness during the transfer of a section of *Burg Nafelden* on the 13<sup>th</sup> of September, 1345, to the *Veldenz* family after the eldest son of *Nafelden* had died.<sup>160</sup> The castle, located in *Saarland* (west of the *Pfalz*) created a foothold for the *Veldenz* family in an area south of the *Hunsrück*. Johann seemed to be at the mercy of the *Veldenz* family at this time, and the next few years proved to be incredibly difficult for the *von Hoheneck* family.

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<sup>159</sup> Origin: V. K. B. I, 340 r. Regest: Register von Veldenz

<sup>160</sup> Origin: V. K. B. VII, 68. Regest.: Register von Veldenz

On November 26<sup>th</sup>, 1346, Charles IV of Luxemburg, the King of Bohemia, King of Germany, and eldest son of *Johann von Luxemburg* who had died at the Battle of *Crécy*<sup>161</sup> enfeoffed his great-uncle, the Archbishop Baldwin of Trier, both the castle and city of *Lautern*, *Burg Neu-Wolfstein*, and all of the lands in their area. The deposit for this fief was no less than 10,000 Silver Marks of *Mainzer* weight, which was to be yielded from the pledged properties by all those with loans within that area, specifically the inhabitants of *Burg Hohenecken*. This was written on Charles' Election Day in Bonn when he became King of the Romans (i.e. King of Germany).<sup>162</sup> Charles IV was considered one of the most powerful rulers in the history of the HRE as he was the king of each individual kingdom within the empire at the time. It was also during this time that the Black Plague enveloped Europe in 1348, causing Jewish pogroms, as they were thought to be the cause of the plague throughout the empire, which Charles made very little effort to inhibit.<sup>163</sup> After the destruction of the population and the death of his great-uncle Baldwin of Trier, Charles called an Imperial Diet (*Reichstag*)—a meeting of the rulers of all the imperial lands—in the cities of Nuremburg and Metz. The purpose of the Diet was to issue the Golden Bull of 1356 which established the *Kurfürsten* as bearing official titles (e.g. Arch-chancellor, etc.), and mandating that a minimum of four *Kurfürsten* could elect the King of the Romans which was officially renamed King of the Germans—though the two titles had been used interchangeably prior to the Diet. The

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<sup>161</sup> Zophy, 1980.

<sup>162</sup> Origin: LHA Ko, 1 A/5354. Pergament, Latein, Siegel ab, von der rot-grünen Seidenschnur ein Rest. Copy: LHA Ko, 1 C/3a, Nr.2123 (Balduineum Kesselstatt). Regest.: Rapport Kreglinger, S.256f. Nr.37 suppl.; PM 23 (1906), S.55 Nr.11; Reg.Imp.VIII 278 mit Addit. I S.831; Lüdicke 1630; Bender, Verpfändung, S.114 [Nr.5]; Mötsch, Balduineen, Nr.1906. Erw. (Mentioned): Dominicus, S.467; Rödel, Reichsgutkomplex, S. 443.

<sup>163</sup> Bönisch, 2015.

lands of the *Kurfürsten* were also made indivisible, paving the way for the creation of individual states after the Thirty Years War (1618-1648).<sup>164</sup>

After the slight re-structuring of the empire and solidification of their powers, the *Kurfürsten* began to expand their influence, often interfering with one another. On July 19<sup>th</sup>, 1369, the squire *Reinher von Hoheneck* (i.e. *Reinhard V von Hoheneck*) was called by the Archbishop *Gerlach* of Mainz to a public peace hearing on the Rhine (where Mainz is located). *Reinher* admitted to having not allowed the toll keepers *Friedrich* and *Beimond von Leiningen* as well as the Archbishop *Gerlach* and his men from entering *Burg Hohenecken*. His decision to exclude the aforementioned noblemen placed his family and his fiefdom within direct danger, but the issue was resolved by *Reinher's* trusted advisors Lord *Graf Heinrich von Veldenz* and the knight *Antilman von Grasewege* (*Burggraf*—Castle earl—in *Böckelheim*). *Reinher* agreed to pay *Gerlach* 200 Guilders, half of the brickyard at *Kaiserslautern*, and he became subservient to the Archbishop. Enemies of the Archbishop were henceforth not allowed to stay at *Burg Hohenecken* and *Gerlach* was to pay 20 Pounds Heller to *Reinher* each time that he visited. The payment was to be put towards the building and expansion costs of the castle. This is the first time that construction costs and materials (i.e. Brickyards) are specifically mentioned in the letters. *Reinher* asked all of his subjects and his younger brother *Beimond* (who was still quite young), not to take part in his affairs concerning *Burg Hohenecken* or else they will have to swear fealty to the Archbishop as well.<sup>165</sup> From the end of the Hohenstaufen

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<sup>164</sup> Fries, 2014.

<sup>165</sup> Original Letter: Staatsarchiv Würzburg, Hohenecken, NSD. 7. Nr. 126. S. 376. Transcribed Letter: Origin: München, Reichsarchiv (Mainz, Erzstift fasc. 12b). Printed: Würdtwein, Nova Subsidia 7, 374 (aus d. Kopie).--Reg.: v. Freyberg, Regesta Boica 9, 220. --Erw.: J.g. Lehmann, Burgen der Pfalz 5, 55.

dynasty in 1250 until the year 1560, *Burg Hohenecken* had been expanded various times and became a *Garnerbenburg* (castle jointly owned by more than one family) in 1369 which included an improved *Bergfried*, large farmstead and new gateway at the east end.<sup>166</sup>

Three years later on March 12<sup>th</sup>, 1372, *Reinher* suffered the loss of many of his horses at the hands of the Men of *Butscheid*—men of the Count of *Saarbrücken*. The Count agreed to compensate *Reinher* because the men had killed *Reinher's* horses while protecting the lands of his enemies. In return for the compensation, *Reinher* granted *Graf Johann II von Saarbrücken* full access to his castles *Burg Hohenecken* and *Burg Hüneburg* (in northern Alsace) for three entire years and no one was to end the agreement as long as *Johann von Saarbrücken* lived. *Johann von Saarbrücken* agreed to pay *Reinher* 7.5 Pounds of *Metzer Pfennige*, of *Saarbrückener* weight each year on two dates as recompense (*Manngeld*) for the dead horses. Though *Johann von Saarbrücken*, reserved the right to dissolve the *Manngeld* by transferring 75 Pounds of *Metzer Pfennige* to *Reinher* for lands that would be within the county of *Saarbrücken* in the following year.<sup>167</sup> *Reinher* seemed to have had a fair amount of enemies, as a result of his own makings, his alliances, or both. However, he was included on a list of noblemen in 1387 pledging their support to *Burg Lichtenberg*, the largest castle in the Kingdom of Germany.<sup>168</sup>

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<sup>166</sup> Keddigkeit, 2002.

<sup>167</sup> Origin: LA Saarbrücken, Abt. 22 Nr. 5756 (früher LHA Koblenz). Pergament, Deutsch. Erwähnung (Mentioned): Lehmann, Burgen 5, S. 55.

<sup>168</sup> Register Veldenz, Hohenecken, S. 104.

On October 19<sup>th</sup>, 1394, *Reinher* made a vitally important pact with the city of *Lautern* acknowledging the traditional peace between *Burg Hohenecken* and *Lautern*.<sup>169</sup> The two sides had grown further apart since the city and the *von Hoheneck* family had become entrenched in the feudal politics of the time. *Burg Hohenecken*'s original purpose of protecting the city of *Lautern* had been sidelined throughout the previous 80 years, especially when King Johann of Luxemburg had taken the city ransom and no mention of assistance from the *von Hoheneck* family was recorded. Despite not having the necessary forces to combat or repel a royal army, the family could have been instrumental in either preventing the capture or even securing its release. Unfortunately, there appear to be no records indicating any involvement on behalf of the *von Hoheneck* family.

The treaty, signed by *Reinher von Hohenecken*, now a knight, his brother *Beimond von Hohenecken*, a squire, and the knight *Heinrich Kemmerer von Talberg*, all members of the House of Hohenecken, formally acknowledged the traditional peace between *Burg Hohenecken* and *Lautern* (*Kaiserslautern*). It stated the following:

“The city shall never be aggrieved by *Burg Hohenecken*. The commoners of the city are allowed to have a farmstead in *Burg Hohenecken* that they can build to their liking and purpose, provided that it remain at use of the House of Hohenecken if need be. The farmstead can be used in case of emergency by both parties. Those who seek refuge in *Burg Hohenecken* must only say so to the gate guards and will be let in at any hour henceforth. The people of *Lautern* are allowed to place houses and stalls in the castle upon granted request. Each year on the day of St. Martin, *Lautern* is to pay the gate guards 4 Pounds Heller of *Lauterer* currency for their protection and aforementioned duty of helping the people of *Lautern* in times of emergency. The three aforementioned members of the House of Hohenecken have sworn all of this to the host of Saints and require

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<sup>169</sup> Transcribed letter: Kopie: StadtA Klt, Rotes Buch, Bl.36'-38 Buchst.Bbb;StadtA Klt, KB 11, Bl.256'-273'; LA Sp, F1/23, S.195-204; StadtA Klt, Urk.14 (Kopie 18. Jh.); GLA Ka, S Kremer-Lamey 28, Nr. 613. Regest: Abschrift Lehmann, Hei.Hs.430, Nr.1174 (Extrakt nach dem Roten Buch). Erwähnung (Mentioned): Lehmann, Klt, S.56f. Full Text: Origin: Aus dem Roten Buch von Lautern, 1678.

that anyone who is to live at the castle must also swear the same, lest God strike them down. The inhabitants of the castle and all of its servants are to have safe passage from the castle to *Lautern* along the imperial streets without fear of robbery. If a robbery is to occur, then the absolute punishment will be enacted by the imperial court in *Lautern* upon those guilty [as stated earlier in the letter from February 3<sup>rd</sup>, 1324]. The inhabitants of Hohenecken and the people of *Lautern* are to assist one another in wartime unless they are at war with one another, in which case, as soon as the war comes to an end, the peace treaty between the two is to be immediately reenacted. If war is to happen, then those bound in assisting their lords will not be violating their oath. Throughout wartime, the imperial streets are to remain clear and unobstructed. If *Burg Hohenecken* is ever to be sieged, then the people of *Lautern* are to assist it on their own costs and provide provisions to the inhabitants of the castle.”<sup>170</sup>

The peace pact brought *Lautern* and *Burg Hohenecken* together during a time in which there was no reigning emperor, in addition to widespread political unrest throughout Europe. On August 3<sup>rd</sup>, 1401, King *Ruprecht I von Wittelsbach*, the King of Germany and former *Kurfürst* of Heidelberg, known at that time as *Ruprecht III von der Pfalz*, enfeoffed the Toll in *Lautern* to *Reinher von Hoheneck*. *Reinher* also received the courts of both *Hohenecken* and *Espenstege*, half of the brook in *Espenstege*, the valley path in *Brende*, the *Lichtenbruch*, the small toll in *Lautern*, the guided path by *Lautern*, the population known as “the people of the empire”, a spring situated between *Lautern* and *Hohenecken* known as the *Lauter Spring*, and all of its accompanying lands.

Other fiefs included were *Burg Hüneburg*, which had been in the hands of the *von Hoheneck* family previously and all of its lands, as well as the castle in *Lautern* (both house and court) and all of its belongings.<sup>171</sup> As a *Garnerbenburg*, *Burg Hohenecken* was owned by more than just the *von Hoheneck* family. The ownership was often split three

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<sup>170</sup> Transcribed letter: Kopie: StadtA Klt, Rotes Buch, Bl.36'-38 Buchst.Bbb;StadtA Klt, KB 11, Bl.256'-273'; LA Sp, F1/23, S.195-204; StadtA Klt, Urk.14 (Kopie 18. Jh.); GLA Ka, S Kremer-Lamey 28, Nr. 613. Regest: Abschrift Lehmann, Hei.Hs.430, Nr.1174 (Extrakt nach dem Roten Buch). Erwähnung (Mentioned): Lehmann, Klt, S.56f. Full Text: Origin: Aus dem Roten Buch von Lautern, 1678.

<sup>171</sup> Entry: HStA Mü I, Oberster Lehenhof 1a, Bl.25f.

ways, one half to the *von Hoheneck* family, and the remaining two fourths to two other families or individuals. On August 4<sup>th</sup>, 1401, a local lord, *Hermann von Scharfeneck*, was awarded the fortress *Burg Scharfeneck*, and one fourth of *Burg Hohenecken* as a fief by King *Ruprecht von Wittelsbach*.<sup>172</sup>

The *von Hoheneck* family soon became very involved with the family of the *Kurfürsten* of Heidelberg. The position of emperor had been vacant since the death of Charles IV in 1378. Charles' son, Wenceslaus IV had been King of Bohemia and Germany, but was forced to abdicate as king in 1400 and was arrested by his own brother, Sigismund (who would later become emperor), in 1403. His arrest was due to his inability to maintain the empire and the princes elected *Ruprecht I von Wittelsbach* (formerly known as *Ruprecht III von der Pfalz*) as their new German King.<sup>173</sup> While *Ruprecht* was away, attempting to draw the empire back together, his son, *Ludwig III von der Pfalz* (who lived 1378-1436 CE), was appointed interim *Pfalzgraf* and *Kurfürst* of Heidelberg. On July 12<sup>th</sup>, 1404, as acting *Kurfürst*, *Ludwig* enfeoffed *Beimond von Hoheneck*—*Reinher*'s younger brother—with two parts of the castle (two fourths) and palace of *Hohenecken*, the valley under *Hohenecken*, two additional paths situated in the same valley, and the path that is called *Breidenowe* (*Breidenau*). Additionally, one fourth of *Burg Hünenburg*, and the accompanying forests and paths, the village of *Espenstege*, the forest known as *Hesseberg* and other forests (including the bushes and agricultural fields belonging to it), two parts of the toll in *Lautern*, and two parts of the guided path leading to it, as well as the people who lived in the imperial lands who were

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<sup>172</sup> Entry: HStA Mü I, Oberster Lehenhof 1a, Bl.25'

<sup>173</sup> Zophy, 1980, pp. 396, 412, 483.



known as the *Hamels* people were all enfeoffed to *Beimond*.<sup>174</sup> This was most likely a result of *Beimond* receiving official confirmation of his inheritance after *Reinher*'s death.

In 1410, King *Ruprecht* died before ever becoming emperor (the position was still vacant since 1378), and his son *Ludwig III* made no effort to seek election as the new king. Rather, the brother of the deposed King Wenceslaus the IV, (1368-1437) was elected King of the Germans the following year, in 1411.<sup>175</sup> *Ludwig III* became one of Sigismund's most trusted allies and was officially appointed as *Kurfürst* and *Pfalzgraf* of Heidelberg. *Ludwig*'s influence had become international when he married the daughter of King Henry IV of England, Blanche of Lancaster (1392-1409). Unfortunately, Blanche had died at the age of 17, and Ludwig was remarried to Mathilda of Savoy.

## 2.9 The von Hoheneck Family and their Castle 1411-1500:

A local nobleman, *Philip von Breidenborn*, who died around 1410 left a vast inheritance. This caused his son, *Johann von Breidenborn*, to seek confirmation from the Lord *Friedrich von Scharfeneck* of his inheritance. His request on May 30<sup>th</sup>, 1411, encompassed the entire loan of the *Scharfeneck* holdings, which he was to have inherited from his father *Phillip von Breidenborn*. These holdings included the *Rahmenberg* in *Lautern* between the memorial column and the castle trench, as well as an amphora of wine and 3.75 *Malter* of rye from the *Hornbacher* monastery in *Mölsheim*, the portion of the toll of Lautern that belongs the *Scharfenecker* holdings in *Hohenecken* (since the Lords of *Scharfeneck* still owned one fourth of *Burg Hohenecken*), and half of the gardens between the castle in *Lautern* and the mills on the brook-side, which he shared

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<sup>174</sup> Entry: HStA Mü I, Oberster Lehenhof 1a, Bl.62f.

<sup>175</sup> Zophy, 1980, p.483.

with *Heinrich Kemmerer* (an inhabitant of *Burg Hohenecken*).<sup>176</sup> Later in the same year, on October 28<sup>th</sup>, 1411, *Ludwig III von der Pfalz* became personally involved in *Burg Hohenecken* in conjunction with the Archbishop *Johann* of Mainz. Together they appointed a nobleman by the name of *Johann Hubenriss von Odenbach* as their trusted man in *Hohenecken*. They personally assigned *Johann Hubenriss von Odenbach* to *Burg Hohenecken* to act as custodian of their interests at the castle, only to be removed from that post by their successors, if they so chose. *Ludwig III* paid *Johann Hubenriss von Odenbach* 100 Guilders in full which *Johann* was to keep in *Ludwig's* part of the castle (*Hohenecken*) and protect it with guards and servants on his own costs over the course of the following year, until relieved of service by *Ludwig* or his successor (letter shown in Figure 2.6).<sup>177</sup>

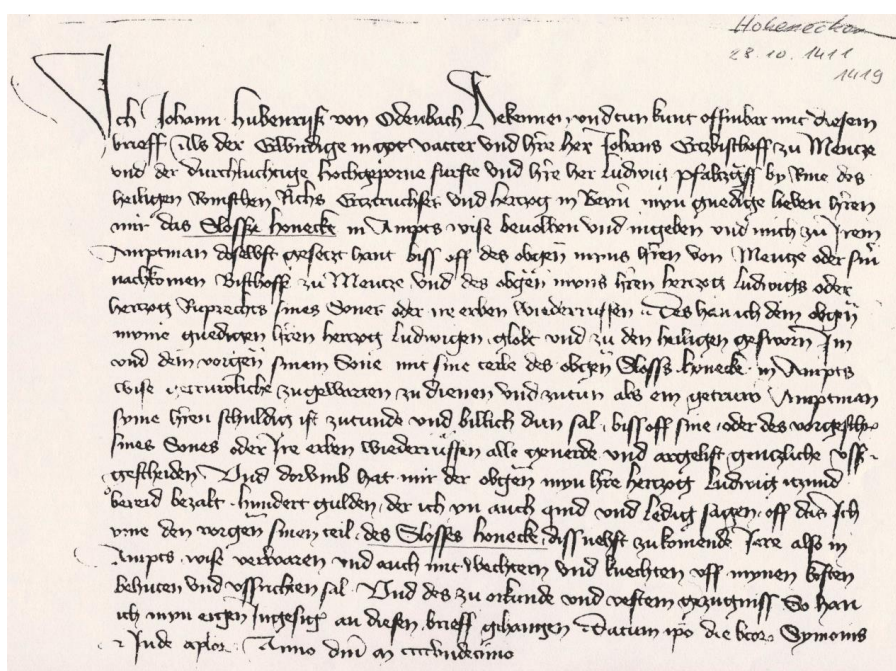


Figure 2.6: *Johann Hubenriss von Odenbach* identifies himself as loyal to *Ludwig III* and *Johann* of Mainz.<sup>178</sup>

<sup>176</sup> Copy: Hahn, BKB, Nr.111. Regest.: Reg.Breidenborn 112.

<sup>177</sup> Origin: HStA Mü III, OA Lautern 38-4-73. Pergament, Deutsch, Siegel hängt. Erw. (mentioned): Lehmann V, S.57, UB Klt II, Nr.495, Anm.2, S.402.

<sup>178</sup> Actual Letter: Origin: HStA Mü III, OA Lautern 38-4-73. Pergament, Deutsch, Siegel hängt.

The fact that a very large treasure had been kept at *Burg Hohenecken* for safe keeping by the two most powerful *Kurfürsten* in the empire, suggests the castle had been highly defensible and considered to be an incredibly safe place to store valuable treasure and perhaps even information. Considering the political schism at the time and the lack of an emperor for the previous 33 years, the identification of a castle trustworthy enough for two *Kurfürsten* to store their valuables proved very difficult. Selecting *Burg Hohenecken* as their safe haven meant the *von Hoheneck* family was considerably trustworthy during an incredibly difficult time. It also meant that *Hohenecken* would be well defended and its family would be well compensated.

The end of the chaotic political/papal schism was reached at the Council of Constance from 1414-1418. It deposed Pope John XXIII and condemned the Czech church reformer Jan Hus to be burned at the stake. Jan Hus' execution had been ordered by none other than the *Kurfürst* of the *Pfalz*, *Ludwig III*, and carried out in July 1415.<sup>179</sup> As the first major church reformer since the twelfth century in continental Europe, Hus had paved the way for later reformers like *Luther*, *Zwingli*, and *Calvin*. His execution subverted many reforms which would have benefited the church, but the empire remained unmoved. *Burg Hohenecken* and the *von Hoheneck* family continued to be loyal servants of the Archbishop and *Pfalzgraf*.

Although the *Kurfürsten* had stated their interest in *Burg Hohenecken*, they both received one-fourth share of the castle and the remaining half still belonged to the *von*

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<sup>179</sup> Backhouse, 2011.

*Hoheneck* family. This indicates the fourth previously owned by the *von Scharfeneck* family had been dissolved—though the letters do not specify this. The head of the family had also shifted from *Reinher* to his younger brother, *Beimond*, now a knight and Lord of *Hohenecken*. *Johann von Breidenborn*, the nobleman who had sought his inheritance from the *von Scharfeneck* family addressed *Beimond von Hoheneck* on April 3<sup>rd</sup>, 1417, concerning a variety of inheritances that had been given to his father (*Philip von Breideborn*) by the late *Reinher von Hoheneck*. The inheritance encompassed two parts of the toll of *Lautern*, which included:

“3 *Heller* for every two loaded wagons or carts, 2 *Heller* for each group of 3 horses of burden, 1 *Pfennig* for each of his cattle, 3 *Pfennige* for each horse, 1 *Heller* for each pig, 4 Schillings *Heller* for each group of 100 sheep and mutton (with 1 *Pfennig* for every other animal in smaller herds), a middle amount of cheese will be unlevied for the toll and the same for every 1-0.5 *Malter*, and everything that is not monetarily regulated will be unlevied by the toll as well. He also requests the lake above the village of *Siegelbach* and all of its holdings, eight bodyguards, and a farmstead in *Burg Hohenecken* by the furthest back gate on the left side.”

He also made a note in case he had forgotten anything, he would make it known.

Additionally, *Johann von Breideborn* swore fealty to *Beimond von Hoheneck*.<sup>180</sup>

Though *Beimond* was the head of the family, his relatives were also active as is evident in a letter from the 18<sup>th</sup> of November, 1424. A nobleman, *Thielman von Schartzenberg* professed to have become a man of *Graf Friedrich zu Veldenz* and to have thusly received the loans from his father-in-law *Henne von Hoheneck* and his uncle *Symond Mauchenheimer von Zweibrücken*. The loans included:

“an owed payment of 10 *Malters* of maize from *Waltherheim* to be given to the bakeries, 4 *Malters* of maize from the fields in *Sarmsheim* (another 4 *Malters* of maize from the same fields is to be given to the infirmary in *Moscheln* by request

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<sup>180</sup> Copy: Hahn, BKB, Nr.142. Regest.: Reg. Breidenborn (fälschlich-falsely addressed- zu 1407-April-3).

of the parents of *Graf Friedrich zu Veldenz*), a year's interest of 10-11 Schillings Heller to *Sarmsheim*, 2 Mo. (unclear what this refers to) of fields by *Armsheim* in *Flanheymer* measurements, an owed payment of 2 Pounds from the *Bede* (*Landbede*?—the people on the fields) in *Armsheim* and portion from a particular house on that field (which *Thielman von Schartzenberg*'s uncle, *Symond Mauchenheimer von Zweibrücken*, had paid 2 Pound Heller for)."

*Thielman* also confirmed the lifting of a debt of four Pounds that his father-in-law had owed to a castle-loan in *Landesburg* due to the damages ensued when *Henne von Hoheneck* had lost stallions and horses.<sup>181</sup> It remains unclear how *Henne von Hoheneck* was related to *Beimond*.

On November 6<sup>th</sup>, 1430, a peace treaty was written and signed regarding the three owners of *Burg Hohenecken*: the brothers *Jost* and *Johann von Hohenecken*, the *Kurfürst* and Archbishop of Mainz *Conrad von Dhaun* (also Imperial Chancellor), and the *Kurfürst* and *Pfalzgraf Ludwig III von Wittelsbach*. The relation of the brothers *Jost* and *Johann* is unclear, though it is presumed they were the sons of either *Reinher* or *Beimond von Hoheneck*. The peace treaty provided the greatest detail of all of the letters analyzed regarding the daily events of *Burg Hohenecken*. It reads as follows:

"The Imperial Chancellor, Prince Elector, and Archbishop of Mainz *Conrad von Dhaun*, the Prince Elector and *Pfalzgraf Ludwig III von Wittelsbach*, and the brothers *Jost* and *Johann von Hohenecken* profess and do so openly so that all who may see, or hear it, read that the three parties have established peace with one another as co-inhabitants of *Burg Hohenecken*. To all who loyally serve the castle, they are to with name go to the mint and from there on to the *Benderwege* (a path) until they reach the sign that directs towards *Lautern*. From there they walk up to the guesthouse near the *Rabenstock* (?), the Hesper (?) between the two paths, along the route leading to the mountain through the forest and back to the mint—this is where the peace is applied."<sup>182</sup>

<sup>181</sup> V.k.B.I, 181. Origin: Urschr. München HStA Rheinpf. Urk. Fasz. 510 Nr. 845. Regest.: Register Veldenz

<sup>182</sup> Origin: HStA Mü III, 38-4-85. Pergament, Deutsch, 4 Siegel. Copy: GLA Ka, 67/866, B1.202-204' (15.Jh.). Erw. (mentioned): Lehamn, Burgen V. S.58; Friedel, Hohenecken, S.38f.

After the castle peace treaty, the written record regarding the *von Hoheneck* family becomes very scarce with the next one over 50 years later on September 29<sup>th</sup>, 1481, in which *Johann* and *Jost von Hoheneck* formally hand over the toll of *Lautern* to the city of *Lautern* (known as *Keyerslautern* in the letter). The mayor, council, and citizens acted on behalf of the city for accepting the toll and in return, promised to pay the Lords of Hohenecken 14 *Heller* (of *Lauterer* weight) each year on the day of St. Michael, or within the 14 days after that date, in which there will be no penalty. The payment would be to the Lords of Hohenecken and their descendants who inhabited *Burg Hohenecken*, the valley of Hohenecken, and the *Espensteig* (*Espenstege*) mill. The mayor, council, and citizens accepted the offer very gratefully, agreeing to all terms.<sup>183</sup>

#### 2.10 The *von Hoheneck* Family and their Castle 1500-1560:

The sixteenth century soon brought complete disarray to the entire region through the disappearance of the warrior class of knights, the beginning of the Protestant Reformation, and the steady decline of the *von Hoheneck* family. The role of knights on the battlefield had been relegated from the main power behind an army, to nothing more than targets for ambitious sharpshooters and men operating canons. The Battle of *Crécy* in 1346 (mentioned before) marked the beginning of the end for the superiority of the mounted knight due to the effectiveness of the longbow.<sup>184</sup> Gun powder decisively brought an end to knights because it could not only be used to destroy fortresses with relative ease, but because it could also obliterate land armies more quickly than cavalry could.<sup>185</sup>

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<sup>183</sup> Medicus, Dr. W. 1900, Mitteilungen aus dem Archiv der Stadt Kaiserslautern. Pfalz Museum XVII.

<sup>184</sup> Devries, 2006.

<sup>185</sup> Jones, 2011.

The knights required many resources to train and retain their status both as elite warriors and landowners. A knight was always accompanied by his man-at-arms (upwards of 12 men), essentially an entourage of squires and pages, which placed an extra burden on his income necessary for maintaining his castle and his men. The pages were at the lowest level, serving both the knight and squires by tending to the horses and weapons. The squires served the knight directly by training with him and organizing his elite events. The entire culture of knighthood became ever more expensive as time progressed, thus forcing the knights to exact more taxes from their lands—which was often their main source of income.<sup>186</sup>

The fall of Constantinople in 1453 (whose demise can be attributed to the fourth crusade in 1204), the discovery of the New World in 1492, and the papal struggles of the late fifteenth and early sixteenth centuries, transformed Europe entirely.<sup>187</sup> St. Peter's Cathedral in Rome was demolished and re-built from the ground up beginning in 1506<sup>188</sup> and the Habsburg family had taken control of the HRE.<sup>189</sup> Frederick III, the first of the Habsburg emperors, was coronated in 1452, succeeding the late Sigismund.<sup>190</sup> The new dynasty would control the empire until its dissolution at the hands of Napoleon in 1806. The only exception was Charles VII of House Wittelsbach (1697-1745), though he only served as emperor for three years (1742-1745).<sup>191</sup>

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<sup>186</sup> Jones, 2011.

<sup>187</sup> Norwich, 1999.

<sup>188</sup> Toman et. al, 2009, p. 10

<sup>189</sup> Zophy, 1980.

<sup>190</sup> Kerr, 2008.

<sup>191</sup> Zophy, 1980, p.82.

In the 1520s, the status of knights on the battlefield had diminished and the Reformation had begun. Martin Luther had posted the 95 Theses on the church door in Wittenberg on October 31<sup>st</sup>, 1517.<sup>192</sup> The theses re-kindled many of the reforms proposed by Jan Hus more than a century prior. They ignited a series of wars to come in which the Roman Catholic Church would be split and nearly half of the HRE would secede as Protestant nations. Many knights saw the Reformation as an opportunity to gain more land and power to preserve their status; though to wage war, the knights would require even more funds. Thus began the Knights' Revolt of 1522, in which many of the castles in the castle chain played center stage in massive sieges by the Holy Roman Imperial armies against the rebel knights in their castles. Ultimately the last rebel Knight-leader, *Franz von Sickingen* (the knight who had saved Martin Luther after Luther's trial in *Worms* in 1521), was fatally injured during the siege of *Burg Nanstein* (just five kilometers from *Burg Hohenecken*) by the imperial forces in 1522, and died in 1523<sup>193</sup>

The Knight's Revolt had been quelled, and *Burg Hohenecken* had survived it fairly well, but the region was dealt another devastating blow by the Peasants' Revolt of 1525, in which many of the castles in the fortress chain were burned—including *Burg Hohenecken*.<sup>194</sup> Many knights were momentarily pardoned and conscripted into the imperial armies to suppress the Peasants' Revolt but returned from the war to burned fortresses and nearly penniless. Some castles were abandoned, though others were sold to princes and dukes who in turn renovated them to serve their own needs. The HRE had

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<sup>192</sup> Evangelische Kirche in Deutschland, 2014.

<sup>193</sup> Petry, 1988.

<sup>194</sup> Keddigkeit, 2002.



also been dealt a devastating blow by the cessation of a third of its powerful duchies and kingdoms to the Protestant cause, forcing it to raise taxes on its states.<sup>195</sup>

### 2.11 Late Period, Renovation and Destruction (1560-1689):

In 1560, *Burg Hohenecken* was expanded by *Phillip von Hoheneck*—both to repair the damages from the 1520s and as an attempt to resurrect the castle's importance (addition shown in Figure 2.7). On January 27<sup>th</sup>, 1560, Adam von Hoheneck (nephew of *Phillip von Hoheneck*) requested an inheritance from the *Kurfürst* of Heidelberg. Adam was Reeve of Heidelberg in service of the *Kurfürst* Friedrich III von der Pfalz (House of Wittelsbach, branch *Simmern-Sponheim*). Adam requested, on behalf of himself and the sons of *Philip von Hoheneck*, Adam's cousins, one fourth of *Burg Hohenecken* with all of its holdings and use, the wood of the forest for burning at their own discretion and at the discretion of the Prince Elector without hindrance from anyone. Additionally, the *Kurfürst* and the other inhabitants would be allowed to hunt the wildlife as needed without hindrance for reasons of emergency and need. Also, the House of Hohenecken was never to slight or harm the Prince Elector or his family.<sup>196</sup>

In the same year (in 1560), the castle received renaissance aspects in the form of a spiral tower, an *Aborterker*, a renovated chapel, a very large new servants' quarters (including stables), a thick outer wall, flanking towers along the wall, an extended trench in front of the east gate and the addition of a drawbridge.<sup>197</sup> It had now become a

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<sup>195</sup> Pirenne, 2009.

<sup>196</sup> GLA Ka, 67/1017, Bl.113-114' (Lehenbuch Pfalzgraf Friedrichs III. 1559-1573).

<sup>197</sup> Keddigkeit, 2002.

formidable and modern fortress, but also more expensive to maintain—far beyond the capability of the *von Hoheneck* family alone.

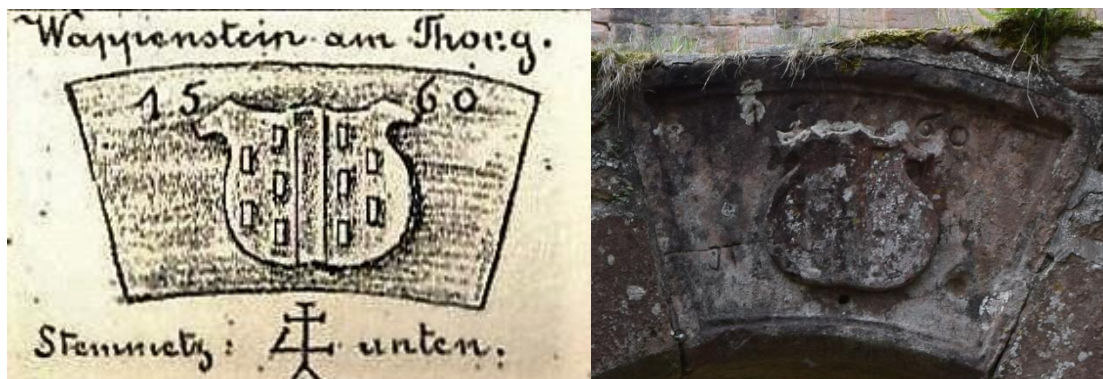


Figure 2.7: Sketch of the *von Hoheneck* crest above the front gate at *Burg Hohenecken* (on the right)<sup>198</sup>, compared to the current state of the crest (photo taken by author).

The imposing nature of the renovated castle may have been beneficial since it had not been at all damaged during the 30 Years War (1618-1648)—the most devastating war in European history prior to the World War I. The castle had been retained by the family, though one fourth had been sold to the *Kurfürst* in Heidelberg in 1481. The *von Hoheneck* family sought to remove the partial ownership of the *Kurfürst* in Heidelberg and took the matters to Emperor Ferdinand II of Habsburg. The emperor declared that the castle had been awarded as a fief only to the *von Hoheneck* family and only to be owned by the same since 1277. He thus stripped the *Kurfürst* in Heidelberg of his claim of one fourth of *Burg Hohenecken*. The full ownership of the castle was not officially granted until 1659, when Emperor Leopold I of Habsburg re-awarded the castle as a fief to the cousins Philip Franz Adolph *von Hoheneck* and *Johann Reinhard von Hoheneck*.

<sup>198</sup> Fallot- Burghardt, 2001.

The fief included all of the original lands and titles that had been given to the family in the thirteenth century, essentially a full restoration of the family's lands.<sup>199</sup>

The *Kurfürst* of Heidelberg, *Karl Ludwig* (son of *Frederick V von der Pfalz* and Elizabeth Stuart—daughter of the English King James I) was incensed by the loss of ownership of one fourth of *Burg Hohenecken* and subsequently took the castle by force in 1665. He later removed his forces in 1667 for reasons unknown. The occupation of the castle drained the funds of the *von Hoheneck* family forcing the family to sell the castle. The cousins *Philip Franz Adolph von Hoheneck* and *Johann Reinhard von Hoheneck* chose to sell it to Charles III Duke of Lothringen<sup>200</sup>, and arranged a hearing with Emperor Leopold I. During the hearing the cousins made an emotional plea stating that the family had always been loyal vassals of the HRE, surviving “forced quarters, plundering, burning, destructions, and various defilements of both the castle and the family.”<sup>201</sup> The family had always defended the lands in the best interest of the empire, but had routinely been aggrieved by the *Kurfürst* and his invading army. *Karl Ludwig* had stormed their castle, evicted their servants, and stolen much of their property without hesitation or recompense. The cousins then informed the emperor that they were in the process of selling the castle to the Dukes of Lothringen, which the emperor granted.<sup>202</sup> *Philip Franz Adolph von Hoheneck* and *Johann Reinhard von Hoheneck* essentially described the situation that hundreds of noble families had found themselves in—families who had acted within the interests of the empire for centuries, sacrificing blood and honor, only to

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<sup>199</sup> Lehmann, 1969 [1857].

<sup>200</sup> Keddigkeit, 2002.

<sup>201</sup> Lehmann, 1969 [1857].

<sup>202</sup> Lehmann, 1969 [1857].

have everything taken away. In 1668, the castle was officially sold to the Dukes of *Lothringen* for 75,000 Gulden<sup>203</sup> and the *von Hoheneck* family left their ancestral home forever.

Immediately following the sale of the castle, on August 10<sup>th</sup>, 1668, Karl Ludwig personally led his army to *Burg Hohenecken* to forcefully take it from Karl III of Lothringen. A fifty day battle with constant artillery strikes against the castle ensued. The troops of *Karl Ludwig* targeted the lower sections of the castle, avoiding the citadel which was the “imperial portion.” The troops of *Lothringen* were forced to retreat and *Karl Ludwig* left 50 men in the castle to assess the damage and clean it up. Miraculously, the Duke of *Lothringen* won the war between himself and the *Kurfürst Karl Ludwig* resulting in the transfer of *Burg Hohenecken* to *Lothringen*.<sup>204</sup>

Three years later, *Kurfürst Karl Ludwig* married off his daughter, *Liselotte von der Pfalz* to the brother of the King of France, Louis XIV. The marriage confirmed *Karl Ludwig*’s leaning towards a French alliance, distancing him from the HRE and the English. The alliance with France proved disastrous during the *Pfälzische Erbfolgekrieg* (War of Palatinate Succession) from 1688 to 1697 between King Louis XIV of France and the alliance of the HRE. *Karl Ludwig*’s death in 1690, left a void in Heidelberg which Louis XIV sought to fill, by way of his sister-in-law, daughter of the late *Karl Ludwig*. Though he officially had no legal claim to the *Pfalz*, Louis XIV pursued it nonetheless. Meanwhile, the Ottoman Turks sieged Vienna (the home of the Habsburg emperors) in the summer of 1683 with a force of over 140,000 troops. The Battle of

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<sup>203</sup> Keddigkeit, 2010.

<sup>204</sup> Keddigkeit, 2002.

Vienna was eventually won by an alliance of European forces, forming the Holy League, in September of 1683, consisting of 20,000 Polish, Austrian, and German cavalry, led by the heavily armored Polish Winged Hussars, charged into the Turkish lines—the largest cavalry charge in world history—saving Vienna and effectively repelling the Ottomans from Austria.

In 1685, Louis revoked the Edict of Nantes (from 1598) and brutally persecuted the French Protestants known as Huguenots. Many fled to Germany, though others went to England. And four years later he invaded the *Pfalz* and Rhineland after conquering *Lothringen* and subsequently captured 22 of the 54 castles in the network of fortresses in the *Pfalz*; though 29 castles had met their fate previously (mostly in the 30 Years War). Immediately following Louis' conquest, Holy Roman Imperial armies and northern protestant armies aligned themselves along the Rhine, beginning a massive, unilateral invasion of the Rhineland and Pfalz in an effort to repel the French. During the French retreat of the area, Louis XIV's forces demolished nearly all of the castles in their control. Only two castles had survived the 30 Years War and the *Pfälzische Erbfolgekrieg*, though both were burned by French forces during the French Revolution in the late eighteenth century.<sup>205</sup> The conquest and re-conquest of the Pfalz resulted in a significant loss of life and vast material destruction of the area. Cities which had been annihilated in the 30 Years War were once again ravaged and families were forced to quarter soldiers from both sides. By this point in time, *Lautern* had been destroyed on a level matched only by the fire bombings of WWII.

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<sup>205</sup> Rey, 2012.

The destruction of the castles proved to be quite simple through the use of explosives. The architecture of the *Burg Hohenecken* (at that point already partially ruined thanks to the efforts of the *Kurfürst*), along with the other decaying links in the fortress chain, had become antiquated and virtually defenseless in the late 1600s. Armies now had more mobile and more powerful canons (both artillery and handheld) capable of ruining any obsolete fortress with ease. *Burg Hohenecken* was blasted from the inside during the French retreat by the forces of General *Boufflers*.<sup>206</sup> Though most of the main walls remained upright (most notably the shield wall on the eastern side), the roofs had collapsed, the outer walls had been breached, and the pentagonal *Bergfried* (main tower) was detonated from within (shown in Figure 2.8).<sup>207</sup> Renovations would be far too costly and unnecessary now that the entire region had fallen into ruin—which included the destruction of the *Kurfürst*'s own castle in Heidelberg. *Burg Hohenecken* joined its fellow castles in solemn ruin, taking leave of its violent past, never again to be rebuilt or repurposed.

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<sup>206</sup> Keddigkeit, 2002.

<sup>207</sup> Keddigkeit, 2002.



Figure 2.27: Early twentieth century photo of Burg Hohenecken.<sup>208</sup> Note the good condition of the *von Hoheneck* crest atop the main gate.

In 1733, *Franz III von Lothringen* traded the ruin of *Burg Hohenecken* and all of its property and lands as outlined by the *Reichslehen* from the thirteenth century to the *Kurfürst* of Heidelberg. In 1806, during the Napoleonic wars, the HRE was officially dissolved via the Treaty of Vienna. Following Napoleon's defeat at the Battle of Waterloo, *Burg Hohenecken* and its properties were given to the Kingdom of Bavaria. It remained a property of Bavaria until 1948, when it became part of the new state of the *Rheinland-Pfalz* after WWII.<sup>209</sup>

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<sup>208</sup> Schwarzmüller, 2006.

<sup>209</sup> Keddigkeit, 2002.

### Chapter 3—Architectural Description and Memory of *Burg Hohenecken*

Since the late nineteenth century, there have been three documented investigations of the castle aiming to establish accurate dimensions of the various structures and the surrounding grounds. *Burg Hohenecken*'s important position within the HRE warranted its numerous construction phases. Though only two construction periods are known for sure, the letters refer to money put forth by the *Kurfürsten* designated for the upkeep of the castle and extension of structures. These expansions were done in the Romanesque, Gothic, and Renaissance styles (in chronological order). The Romanesque features have been maintained quite well and are still mostly intact (with the exception of the main tower). The Gothic features have only trace elements left after the expansion of 1560 in the renaissance style and the destruction of the castles in 1689. The investments by the *Kurfürsten* from the fourteenth to sixteenth centuries transformed *Burg Hohenecken* into a very unique castle featuring a variety of architectural styles.

As mentioned previously, prior to the twelfth century, most fortresses had been constructed of wood on hilltops with a stone wall surrounding the main structure, known as a Motte and Bailey.<sup>210</sup> This construction style dominated the HRE during the eleventh century, eventually transforming into the Romanesque structures of the late Salian and Hohenstaufen periods (1125-1254).<sup>211</sup> The production of castles out of stone was strongly influenced by Near Eastern castles encountered by Europeans during the crusades. The kingdoms of the Near East (both the Muslim lands and the Byzantine

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<sup>210</sup> Barnes, 2010 [2007].

<sup>211</sup> Krahe, 2014 [2008].



Empire) had grand stone fortresses able to withstand onslaughts of catapults, featuring strong foundations due to their sloped walls. The walls also had casemates, which were chambers within the walls used for storage and protection, and had rounded towers near the gates, allowing for more protection. The rounded towers deflected projectile strikes (ballistae, trebuchets, catapults, etc.) more efficiently than rectangular towers whilst providing defenders with a better vision of the enemy.

The Western Europeans brought this knowledge back with them and began adapting these architectural features to their own castles. The sloped walls and rounded towers soon became a feature of the Romanesque castles. The citadels were strengthened with lifted vaults and arches and the walls were built solely out of stone. Some castles were even built directly into the mountain cliff, utilizing the natural rock for foundations and walls (e.g. *Burg Hohenecken*). The mass construction of castles can be localized around the year 1225<sup>212</sup> (during the reign of Frederick II von Hohenstaufen), thirteen years after *Burg Hohenecken*'s first stage had been completed. Castles were primarily built from the eleventh to the sixteenth century, of which 14,500 remain (either in fair/complete condition or ruined). Approximately 3,600 more are assumed to have been built, because many castles have not been found or were repurposed for new construction projects. Often times they would be used as stone quarries, though sometimes people would build their homes directly against the ruins, repurposing walls and even towers. Houses are usually built in close proximity to one another in Germany, especially within cities. If a ruined castle had been divided up into a neighborhood of homes with

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<sup>212</sup> Krahe, 2014 [2008].

plastered walls, it would be nearly impossible to identify it. An additional 2,000 castles are known to have been built though neither their structures nor their foundations exist anymore. Thus, the total number of castles in the former Kingdom of Germany, in the HRE, numbers approximately 20,000.<sup>213</sup>

### 3.1 Types of Castles:

Stone castles closely paralleled the expansion of the feudal system, especially during the Hohenstaufen period in which many knights and *Ministerialen* families had been awarded *Reichslehen*. Despite the massive building projects, the castles were not evenly distributed throughout the empire. Instead, certain areas (as mentioned before) were more heavily fortified than others, specifically in the more southern regions of the German Kingdom. There existed two general types of castles: those on flatland and those on mountains. The flatland castles compose nearly 31% of all castles and were commonly built with a moat in mind.<sup>214</sup> For example, the *Kaiserpfalz* in Kaiserslautern had a large lake surrounding over half of the perimeter of its walls.<sup>215</sup> Of the remaining 69% of castles, 66% are found on hill/mountain, of which there are six variations: mountain tops, spur positions (at the edge of the mountain), hanging (on the side of the mountain), corner of the mountain, and on a mountain ridge (Figure 3.1).<sup>216</sup>

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<sup>213</sup> Krahe, 2014 [2008].

<sup>214</sup> Krahe, 2014 [2008].

<sup>215</sup> Keddigkeit, 1995.

<sup>216</sup> Krahe, 2014 [2008].

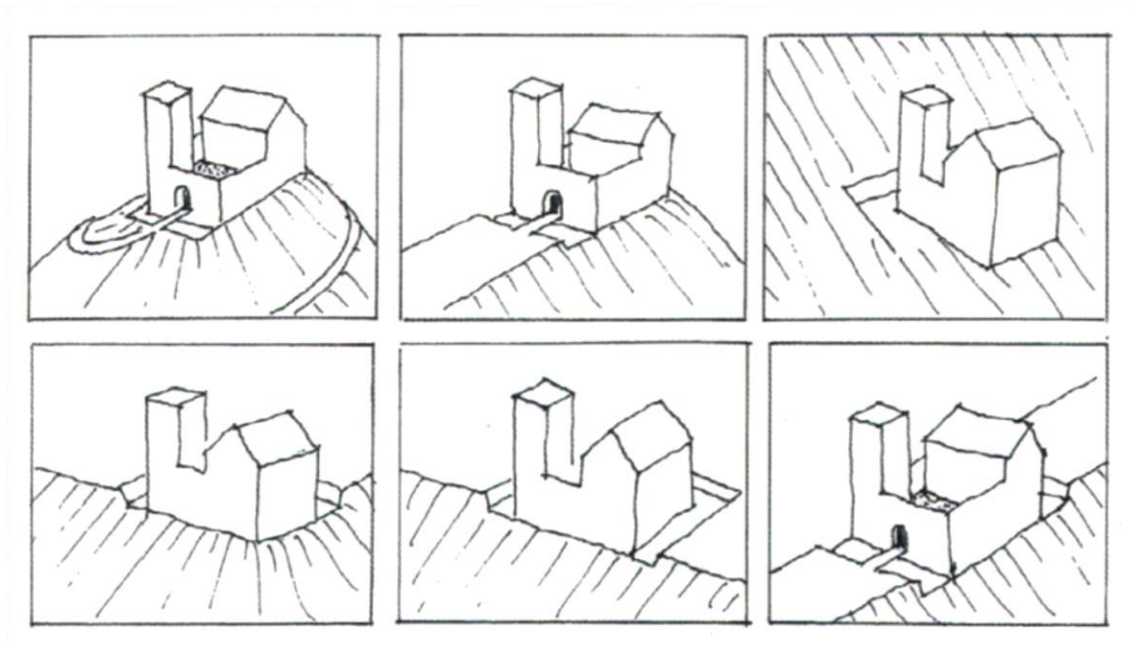


Figure 3.1: The six general types of castles. Top row from left to right: mountain-top, spur, and hanging. Bottom row from left to right: corner, edge, comb.<sup>217</sup>

Of these six types, *Burg Hohenecken* is a spur castle given its position on the end of the mountain cliff. The most defensible position was by all means the mountain top, because it provided full vision of each side, but the spur castles compose 25 % of all castles built in the Kingdom of Germany.<sup>218</sup> Construction of a castle depended strongly upon the availability and access of stone. The cliff projection upon which *Burg Hohenecken* rests is the largest consolidation of rock on the mountain and the neighboring areas. Thus, constructing the castle directly into the rock provided foundations and walls that would otherwise need to be built with imported materials (as was often the case for flatland castles).

The *Felsenburen* (Cliff-castles) like *Burg Hohenecken* were ideal fortresses in the time before canon fire due to their high positions and incredibly thick walls.

<sup>217</sup> Krahe, 2014 [2008].

<sup>218</sup> Krahe, 2014 [2008].

Approximately 40% of all *Felsenburgen* are found in the area of the *Pfälzerwald*, and were primarily begun in the earliest stages of stone-castle production. In the eleventh and twelfth centuries, only 30% of all German castles had been built, though 50% of all *Felsenburgen* ever to have been built were begun during the same time span. At the end of the thirteenth century, 75% of all German castles had been built, including 90% of all *Felsenburgen* ever to have been built.<sup>219</sup> Despite the obvious preference to build these types of castles prior to the fourteenth century, the positions on cliffs did not present the architects with many options. Each cliff has a different shape, and different amount of natural rock. Thus, the ground plan of every cliff-castle is entirely unique. Nearly one third of all *Felsenburgen*, with the exception of those built in caves, provide no evidence as to when construction had begun (about 110 castles). Given the relatively small space of a cliff upon which to build a castle, 56% were small castles (0-500 m<sup>2</sup>), 25% were single towers (0-500 m<sup>2</sup>), and only 16% were complete castles of varying size.<sup>220</sup> *Burg Hohenecken* consists of an incredible 4,250 m<sup>2</sup> castle area<sup>221</sup>, including nearly all of the features to be considered a complete castle (Figure 3.2). This places it in the category of “very large” castles with general dimensions of 2500-5000 m<sup>2</sup>—to which only 6.1% of all German castles belong. It is worth noting that only 25% of all German castles were significantly expanded during the time of their use.<sup>222</sup> *Burg Hohenecken*’s first construction phase featured only a citadel, a tower, and a large shield wall built upon the solid rock of the cliff.

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<sup>219</sup> Krahe, 2014 [2008].

<sup>220</sup> Krahe, 2014 [2008].

<sup>221</sup> Salch, 1998.

<sup>222</sup> Krahe, 2014 [2008].

### 3.2 Depictions and Blueprints of *Burg Hohenecken*:

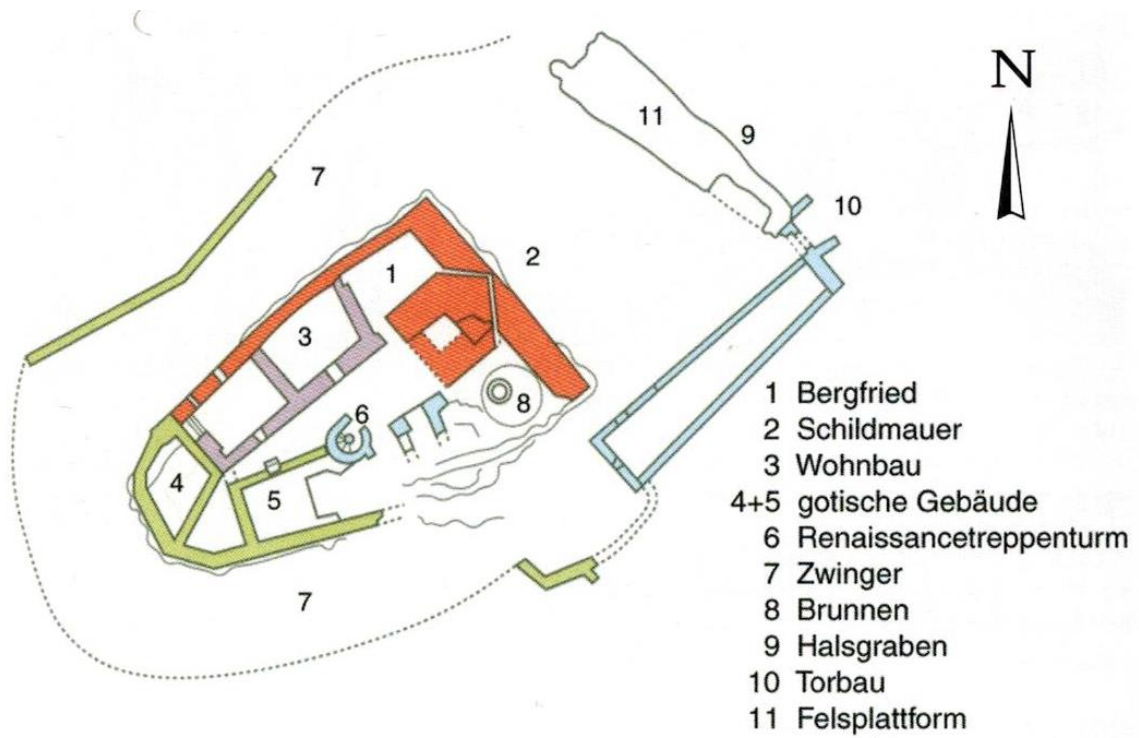


Figure 3.2: The general ground-plan of the castle 1.)*Bergfried*=main tower, 2.)*Schildmauer*=shield wall, 3.)*Wohnbau*=living quarters, 4./5.)*gotisch Gebäude*=gothic buildings, 6.)*Renaissancetreppenturm*=renaissance spiral-stair tower, 7.)*Zwinger*=outer wall, 8.)*Brunnen*=well, 9.)*Halsgraben*=trench, 10.)*Torbau*=gate structure, 11.)*Felsplattform*=cliff platform.<sup>223</sup>

<sup>223</sup> Keddigkeit, 2002.



Figure 3.3: Sketch of Burg Hohenecken.<sup>224</sup>

The earliest depiction of *Burg Hohenecken* is a sketch from 1785, labeling the castle as the *Altschloss* (the “Old-castle”, seen in Figure 3.3).<sup>225</sup> The choice of the word *Schloss* over the word *Burg* is an interesting inclusion. A *Schloss* commonly refers to a castle that served as a palace, equivalent to an English Manor House.<sup>226</sup> In contrast, a *Burg* refers to castles more generally, though labeling a castle as such infers that the structure is primarily a fortress and not necessarily the home of a high noble family. Nobles of lesser status would live in castles known as *Burgen*, whereas *Kurfürsten* or Kings would live in a *Schloss*. Considering two *Kurfürsten* had partially owned *Burg Hohenecken* during the fifteenth century and that it had been sold to the *Kurfürst* of Heidelberg in 1733, suggests that the people of the eighteenth century may have viewed it as more of a palace than simply a fortress. It may also be that people were idealizing it because the sketch was made during the era of the German Romanticism. The earliest clear depiction of *Burg Hohenecken* is a *Stahlstich* (steel engraving) made by *Johann*

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<sup>224</sup> Keddigkeit, 2002.

<sup>225</sup> Keddigkeit, 2002.

<sup>226</sup> Barnes, 2010.



*Poppel* based upon a sketch by *Richard Höfle* prior to 1855.<sup>227</sup> The *Stahlstich* was later made into a painting, presumably in the later nineteenth century (Figures 3.4 and 3.5).

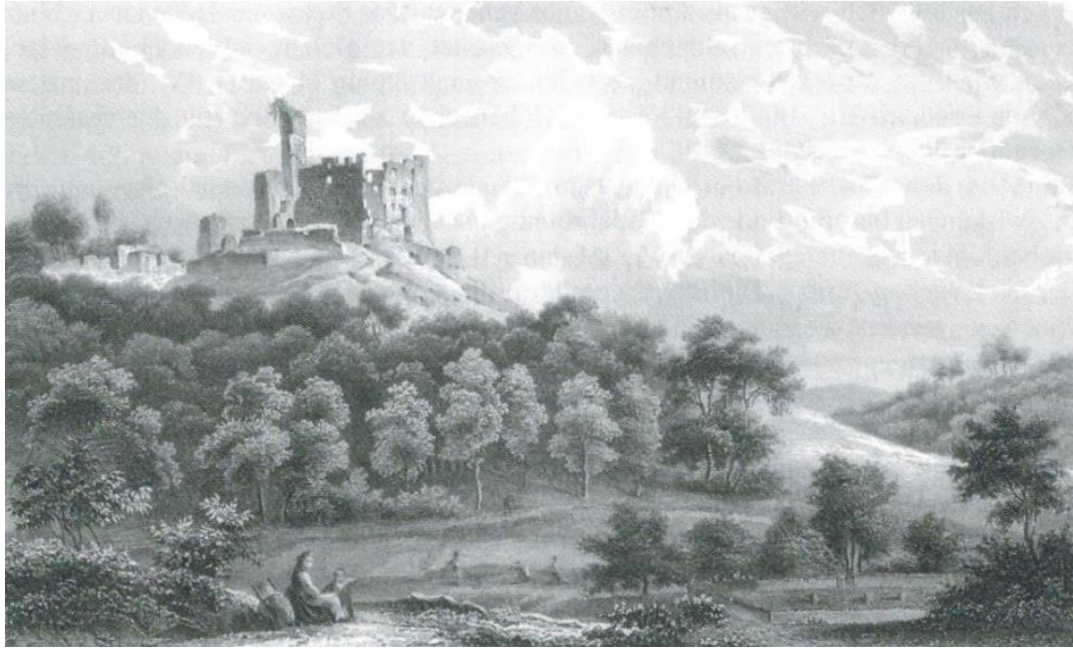


Figure 3.4: *Stahlstich* (steel-engraving) of *Burg Hohenecken* from before 1855.<sup>228</sup>



Figure 3.5: Painting of *Burg Hohenecken* derived from the steel engraving.<sup>229</sup>

<sup>227</sup> Keddigkeit, 2002.

<sup>228</sup> Keddigkeit, 2002.

<sup>229</sup> Keddigkeit, 2010.

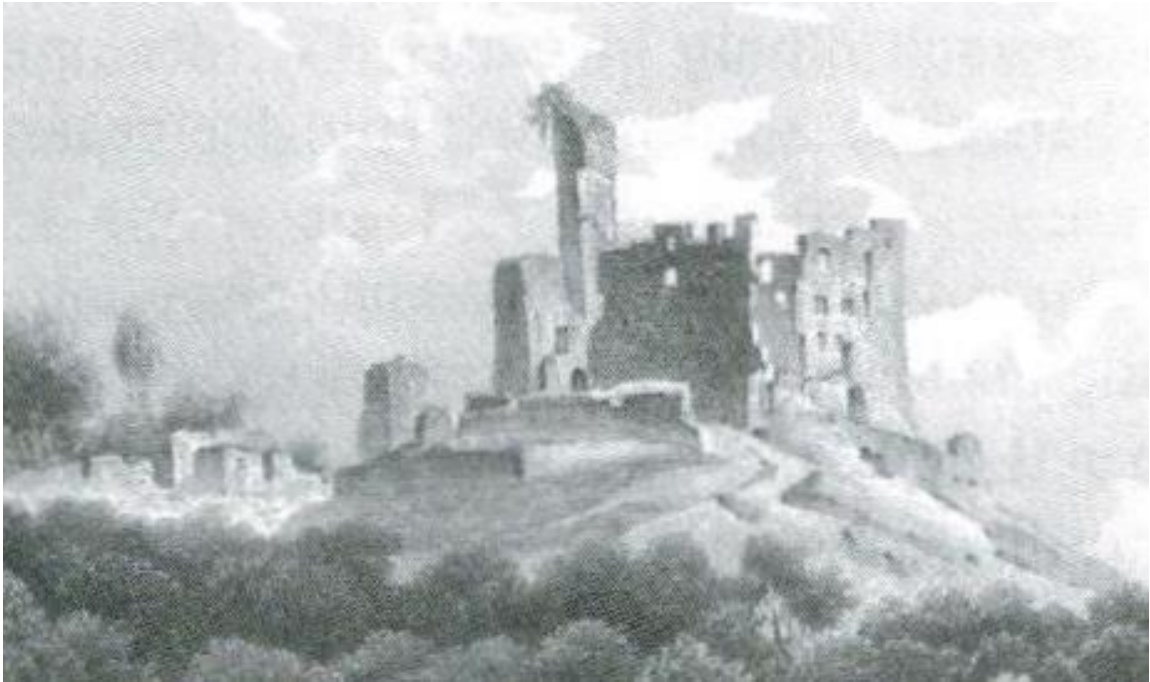


Figure 3.6: Zoomed in view of the castle from the steel engraving.<sup>230</sup>



Figure 3.7: Zoomed in view of the castle from the painting.<sup>231</sup>

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<sup>230</sup> Keddigkeit, 2002.

<sup>231</sup> Keddigkeit, 2010.



Both the *Stahlstich* and the painting depict a much higher main tower and taller citadel walls than what exist today (seen in Figure 3.6 and 3.7). They also feature the west gateway from the mid thirteenth century (on the right side of the painting at the bottom of the wall).<sup>232</sup> Two outer walls are shown (though only one currently remains) in addition to a large structure at the east end of the castle (the left side of the painting). The structure is directly in front of the trench which, until recently, separated *Burg Hohenecken* from the rest of the mountain; it was for this reason that a draw bridge had been built. The purpose of the structure on the east side is unknown because no trace of it currently exists. However, it may be that it had housed the coin mint (whose location is also unknown). Besides the structural differences of the site, the mountain side is quite bare in the painting, which is more true to the original condition of the castle. In order to maintain a proper view of its surroundings, a castle had to keep the forest neatly trimmed. Typically, this included removing every tree on the hillside. Though the primary purpose of removing vegetation was to keep a clear view, it also prevented an attacking enemy from taking refuge from the missiles from the ring wall.<sup>233</sup> The age of the structures within the castle can be determined by identifying the different architectural styles featured throughout the entire site. By examining each of the various parts of the castle and comparing them to other castles constructed around the same time, a clearer vision emerges as to how *Burg Hohenecken* may have appeared prior to its destruction.

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<sup>232</sup> Keddigkeit, 2002.

<sup>233</sup> Barnes, 2010 [2007].

### 3.3 Masonry and Walls:

The masonry of castles is a strong indicator of the period in which the castle was first begun. Many of the Hohenstaufen period castles have stones carved in a *Buckelquarder* form, as found in *Burg Hohenecken*. This type of masonry features large rectangular stones, but have curves on their surfaces that seem to “buckle” outwards. The *Buckelquarder* (shown in Figure 3.8) was aesthetically pleasing but also added to the overall surface area and weight of the stone allowing for heavier and thicker walls. The buckling of the stone would only be featured on the outer surface of the stone, whereas the other three sides would be facing neighboring stones (or two sides, in the case of cornerstones). Castle walls were rarely solid rock, unless they had been carved directly into the cliff (e.g. *Burg Hohenecken*). Instead, they often featured massive three-layered citadel walls composed of two stone walls, with a concrete-like filling in between them. The filling would often be composed of large gravel mixed with mortar, which would add to the overall thickness of a wall, yet reduce the cost of cutting stones. Citadel walls, known as *Ringmauern* (Ring-walls), were typically 1.5 meters thick, with only 15% of castles featuring a thinner wall. The *Ringmauer*, enclosing the main part of the castle called the *Kernburg* (citadel), would typically not reach higher than around 14 meters in height and would often have a causeway built into to it.<sup>234</sup>

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<sup>234</sup> Krahe, 2014 [2008].



Figure 3.8: Northeast edge of the citadel at Burg Hohenecken (photo taken by author).



Figure 3.9: View of the secondary shield-wall. Note the holes in the wall where planks used to be placed into (photo taken by author)

Causeways atop the outer wall of a castle were vital to the castle's overall defense. They would commonly be built of wood on the inside of the wall, which can be determined by holes in the masonry in which large boards would slide into. The eastern wall carved from the cliff rock at *Burg Hohenecken* still shows these holes for boards, indicating the existence of a causeway above the casemate in the wall (seen in Figure 3.9). Casemates were rooms within walls used for storage but also provided a very secure area of defense. In order to protect the defenders of a wall, the layer facing the outside would extend higher than the rest of the wall, and would include regular breaks allowing the defenders to look out whilst providing a solid shield to stand behind. These protrusions above the level of the causeway are called *Zinnen*. The tops of the *Zinnen* were sometimes covered with a roof to protect defenders from the weather and even featured stylistic elements in the form of continuous arches on the outside of the wall allowing the causeway to be wider at the top. These arches, called *Mauschikuli* (*Machicoulis*), originate from the Near East and were introduced to Europe when the crusaders returned from the Holy Land. They commonly had slots through which oils or tar could be dumped during a siege, repelling attackers more efficiently.<sup>235</sup>

### 3.4 Gates and Drawbridges:

The weakest portions of walls were the gateways. These would often be defended with a tower or *Torhaus* (a chamber within a tower above the gate), or two towers on either side of the gate, called *Flankierungstürme*—flanking towers.<sup>236</sup> The gate from 1560 at *Burg Hohenecken* features a style resembling a *Torhaus* given the extension of

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<sup>235</sup> Krahe, 2014 [2008].

<sup>236</sup> Krahe, 2014 [2008].

two minor walls perpendicular to the main wall with holes through which defenders could fire arrows or small canons. Though the upper portion of the gate no longer exists, the gate did have a drawbridge, whose foundations were still visible in the early twentieth century.<sup>237</sup> The existence of a draw bridge required either a tower above the gate or a *Torhaus* in order to defend the gate if flanking towers had not been constructed. Gates were also regularly equipped with a *Fallgitter* (*Portcullis*)—a lattice of wood or iron that would slide from above in front of the main gate. A *Fallgitter* would have only been possible if the gate had a tower above it or a *Torhaus*. *Burg Hohenecken* features the all of the requirements for a *Torhaus*, thus it may also have had a *Fallgitter*. Only 12% of all German castles had a *Torhaus*<sup>238</sup>, indicating that it was not only uncommon, but it most likely existed out of necessity.



Figure 3.10: View of the southeast edge of the citadel of *Burg Hohenecken*. Note the vertical lines where the former gate may have been (photo taken by author).

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<sup>237</sup> Keddigkeit, 2002.

<sup>238</sup> Krahe, 2014 [2008].

*Burg Hohenecken* was attacked (during the Peasants' Revolt of 1525) prior to the 1560 renovation, when the old gate was most likely located between the current servant's quarters and the citadel. The rough masonry on the southern side of the citadel shield wall from the thirteenth century (shown in Figure 3.10), provides evidence that there had existed a structure combining the *Ringmauer* of the citadel to another outer wall. This was most likely a fairly thin wall, given the approximate dimensions of five meters high and 50 cm thick. If a gate had been placed there (as is highly likely), then it would have been a simple gate without a tower above it and probably no *Torhaus*. Of all the castles yet in existence, 37% feature a simple gate—the most common style.<sup>239</sup> The fact that the castle had been relatively easily captured by peasants in 1525, presented the necessity for a major upgrade, and a *Torhaus* with a drawbridge, and holes from which to defend the gate, would have maximized the protection of the castle.

A drawbridge indicated either a moat or a trench over which to extend the bridge. Flatland castles almost always had moats of water surrounding them or were located on islands, using a river as a natural moat. Castles atop hills or mountains could not make use of rivers or water within moats, rather, they had deep trenches dug around them. Typically there were as many trenches as there were sides of the castle that could be attacked. The moats and trenches usually had bridges that partially extended across from the other side, preventing the drawbridge from extending beyond 3.5 meters in length.<sup>240</sup> The ruins at *Burg Hohenecken* show two stone foundations, still visible in the early twentieth century, upon which posts had been set. The depiction of the castle from *Julius*

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<sup>239</sup> Krahe, 2014 [2008].

<sup>240</sup> Krahe, 2014 [2008].



*Naeher* in 1887, shows extensive stonework foundations opposite the main gate. These foundations were likely a partial bridge extending across a wide trench, connecting to the drawbridge when lowered (the left-hand side of Figure 3.11).

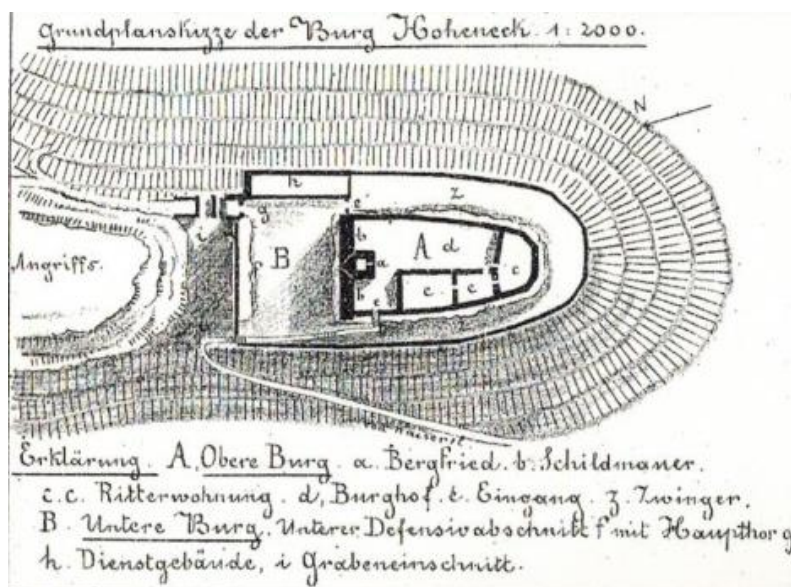


Figure 3.11: Ground plan of *Burg Hohenecken* by Julius Naeher from the 1880s.<sup>241</sup>

### 3.5 Shield Wall and Main Tower (*Bergfried*):

*Burg Hohenecken*'s most defining characteristic is its broad shield wall. The wall is 25 meters wide, 17.8 meters high, and 2.7 meters thick—a volume of 1,201.5 m<sup>3</sup> of solid cliff rock and carved stone. Shield walls are incredibly rare, found only in ~263 castles in Germany. Over half are found in the area of the Pfalz and the neighboring regions, but isolated to the southwest of Germany and northeast of France. These walls are much larger than the buildings directly behind them (in order to maximize protection) and are commonly found in spur-castles, if found at all. One third of all such walls have neither a tower, nor an accompanying gateway and only 8% have a tower located in the

<sup>241</sup> Fallot- Burghardt, 2001.

middle.<sup>242</sup> *Burg Hohenecken* 's shield-wall has a pentagonal tower in the exact middle, built into the wall, raising far above it. The shield wall and tower feature the *Buckelquarder* stone forms, from the Hohenstaufen period, thus it can be determined that the tower had been erected during that time, or slightly afterwards (at the latest). The existence of a narrow wall on the southeast part of the shield-wall, is presumably where the first gate, mentioned in 1417 had been located.<sup>243</sup> The modern gate, built in 1560, is bordered on one side by a wall, and an additional shield-wall (carved from solid rock) on the other. Two shield-walls at the same castles, indicates a necessity for high security. The fact that a coin-mint is mentioned often in the letters provides evidence suggesting as to why *Burg Hohenecken* had been so heavily fortified.

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<sup>242</sup> Krahe, 2014 [2008].

<sup>243</sup> Keddigkeit, 2002.





Figure 3.12: The massive shield-wall and Bergfried at Burg Hohenecken (both photos taken by author)

The main tower attached to the shield-wall in *Burg Hohenecken* is classified as a *Bergfried*, reaching a height of 26.7 meters (87.5 ft.). *Burg Hohenecken's Bergfried* is an incredible structure, with varying wall widths (shown in Figure 3.12). The tower is pentagonal (found in only 2% of all German castles) and the inside was rectangular. This rectangular area is 4.7 meters wide on two sides and 4.5 meters on the other two sides. The height of the inner rectangular area is 20.6 meters, providing a total inner volume of  $435.69 \text{ m}^3$  (15,386 ft.<sup>3</sup>). The *Bergfried* is connected to the shield-wall and reaches approximately nine meters above it. The position of the tower in the middle of a wall is

found in 28% of all castles with a *Bergfried*.<sup>244</sup> The area between the eastern edge of the tower is perpendicular to the inner wall of the rectangular stair/chamber area with a width of 4.7 meters. This area was built of solid stone around the outside and the concrete-like mixture of gravel and mortar (mentioned earlier) within it. It had been built so well that it withstood the demolition that had destroyed the rest of the tower. Curiously, of the 65 known castles with a pentagonal *Bergfried*, 35 are located in Western Germany, 19 in Eastern Germany, and only 11 in the middle.<sup>245</sup>

A *Bergfried* was the most defensible portion of the castle (which is why the French forces detonated it), and often contained multiple rooms. The entrance to a *Bergfried* was never at the bottom. Instead, the entry was positioned at five meters (upwards of 14 meters) above the ground, allowing the bottom area to be used for a variety of functions. This bottom chamber would oft be used as a dungeon or an area for storing precious items.<sup>246</sup> In the case of *Burg Hohenecken*, the bottom of the *Bergfried* may have been the site of the coin mint at one time, or the area where the treasure of the *Kurfürsten* (from October 28<sup>th</sup>, 1411) had been kept. These sorts of chambers were vaulted, in order to withstand the weight of the structure above.<sup>247</sup> Unfortunately, no remnants of vaulting remain at the tower. The entrance of the *Bergfried* would have been accessible via a wood staircase, allowing defenders to burn in case of an invasion, or retract, if it were a ladder. The stairs leading to the top of the tower platform (often

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<sup>244</sup> Krahe, 2014 [2008].

<sup>245</sup> Krahe, 2014 [2008].

<sup>246</sup> Krahe, 2014 [2008].

<sup>247</sup> Krahe, 2014 [2008].

covered with a roof) was accessed with wooden stairs.<sup>248</sup> Various types of *Bergfrieden* are shown in Figure 3.13.

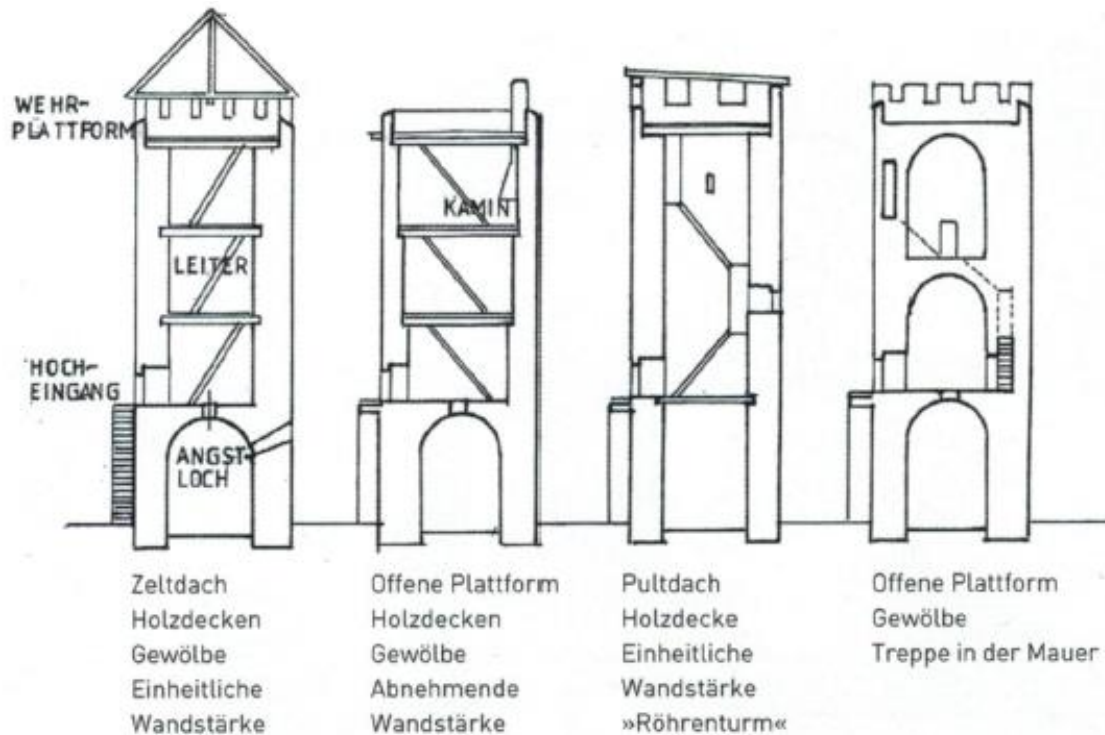


Figure 3.13: Various types of Main Towers (*Bergfried*).<sup>249</sup>

### 3.6 The Living Chambers (*Palas*):

The primary purpose of castles was ultimately to house a group of nobles. Living quarters were essential in all castles and are called the *Palas*, or palace. The word *Palas* come from the Latin word *Palatium*, meaning “a noble living quarter.” These sections are commonly not found in castles, because many were ruined in war or quarried for other buildings nearby.<sup>250</sup> Castles were also not limited to a single *Palas*. In fact, many castles like *Burg Hohenecken* had more than one living quarter. These structures were often

<sup>248</sup> Krahe, 2014 [2008].

<sup>249</sup> Krahe, 2014 [2008].

<sup>250</sup> Krahe, 2014 [2008].

rectangular in shape and are directly correlated to the position of the owner of the fief—the more living quarters at a castle, the more influential the owner was. Thus, a large set of living quarters at *Burg Hohenecken*, suggests that the *von Hoheneck* family was quite influential, and the fact that emperors Ferdinand II and Leopold I favored them over the wishes of the *Kurfürst* in the 1660s, strengthens this claim. The *Palas* was typically composed of more than one floor, but rarely exceeded three floors with a total range of 120 m<sup>2</sup> to 900 m<sup>2</sup>. The imperial palaces built by the Hohenstaufen dynasty in *Gelnhausen* and Goslar featured living quarters no more than two floors high.<sup>251</sup> *Burg Hohenecken* has three levels and a basement in the area identified as the *Palas*.



Figure 3.14: Ledges where floorboards once were (photo taken by author)

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<sup>251</sup> Krahe, 2014 [2008].



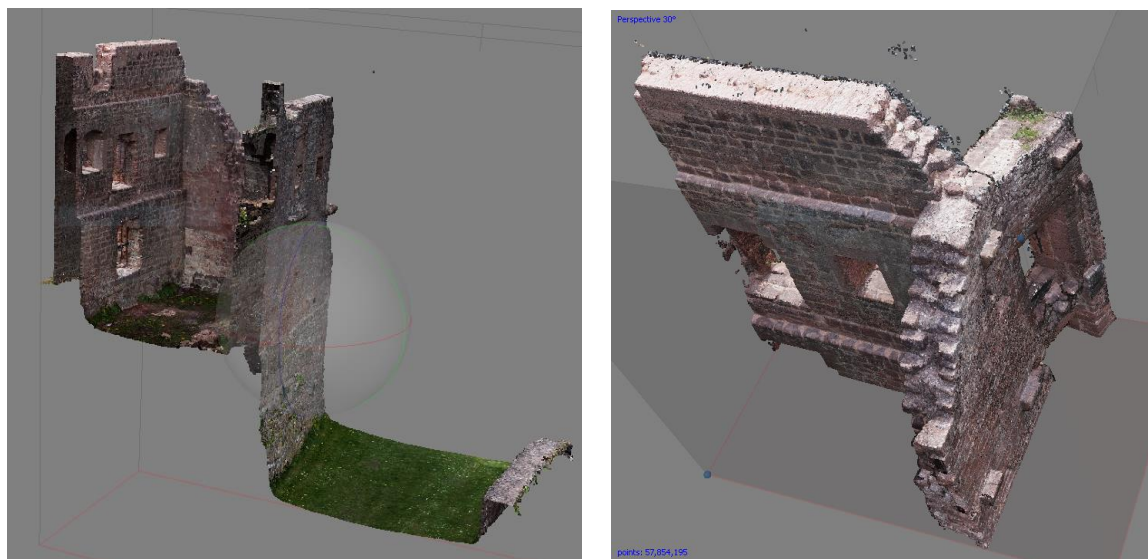


Figure 3.15: Agisoft screenshots of the Palas in Burg Hohenecken (images made by author).

A typical *Palas* was between 5-10 meters wide, given the necessity to host a variety of people during events and in order to fit a number of personal chambers.<sup>252</sup> The *Palas* in *Burg Hohenecken* is approximately six meters wide at the level of the third floor. It is possible that the western portion of the castle where the *Aborterker* (outside toilet) is located, had also been part of the *Palas*. Stones protruding from the walls where the floorboards once laid are still visible (Figure 3.14), and the inner wall facing the inner court gets progressively narrower from the first floor to the third (shown in Figure 3.15).

As the most important part of the castle, and the section in which the inhabitants would spend most of their time, the *Palas* had to fit the needs of the owners.<sup>253</sup> *Burg Hohenecken* was a *Garnerbenburg* and required enough room for multiple families. The living chambers stretched along an entire side of the citadel—found in only 18% of all castles. The *Palas* of *Burg Hohenecken* had an approximate volume of 1,254 m<sup>3</sup> (or 44,284 ft.<sup>3</sup>), given the dimensions of six meters in width, 19 meters in length, and

<sup>252</sup> Krahe, 2014 [2008].

<sup>253</sup> Krahe, 2014 [2008].

11 meters in height. These dimensions derived from the laser-scanning component of this project do not include the potential height of the top floor if the roof had been gabled above the stone work.

The weather also played an important factor in the construction of the *Palas*, because not every room was meant to be used year-round. Oftentimes the upper floor included many windows for air-flow (an example from *Burg Münzenberg* in Figure 3.16), but would only be tolerable during warm periods of time. In the winter, the inhabitants would have rarely used these upper rooms, spending most of their time in the lower chambers instead. It is worth noting that these open-air levels were built in the late twelfth and early thirteenth centuries during the Medieval Warming Period, in which the climate was warmer by an average of 1°C.

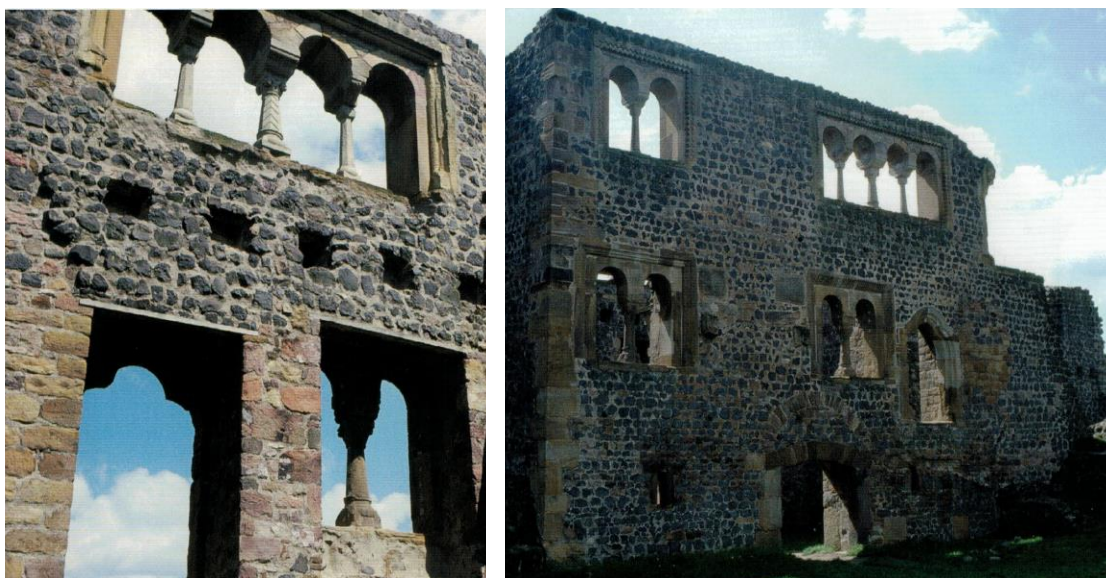


Figure 3.16: Open windows at *Burg Münzenberg*<sup>254</sup>

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<sup>254</sup> Krahe, 2014 [2008].

Windows throughout the *Palas* would have required shutters on the inside of the ornate columns found in most Romanesque castles.<sup>255</sup> These windows would have often been built with benches (like a bay window) upon which the inhabitants could sit next to the open air (shown in Figure 3.17).<sup>256</sup> Such windows are seen on the second and third levels of *Burg Hohenecken*. In winter, these levels would most likely have been unused. Other parts of the castle have considerably fewer windows, suggesting that the remaining chambers of the castle could have been usable during cold weather.

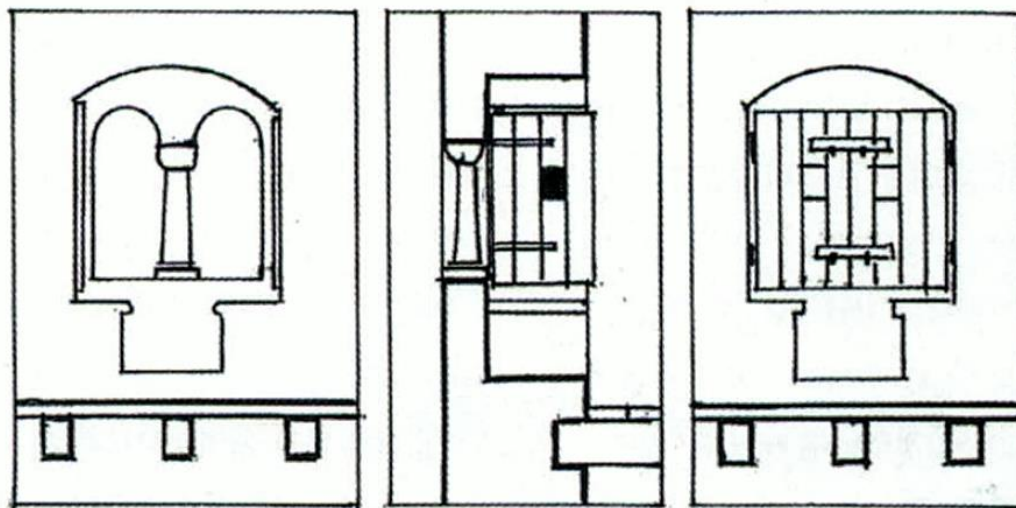


Figure 3.17: Sketch of how upper windows were kept closed during winter.<sup>257</sup>

The western portion of the castle, which could potentially have been an extension of the *Palas*, is trapezoidal and three levels high. It features a variety of entrances, a large chimney, an incredibly ornate renaissance window (from 1560), and a structure assumed to be another chimney (also from the 1560 renovation). The bottom portion of the chimney is incredibly wide, measuring approximately 2.5 meters, in a lower chamber, presumably the kitchen. This lower chamber had access to both wings of the castle, as

<sup>255</sup> Krahe, 2014 [2008].

<sup>256</sup> Krahe, 2014 [2008].

<sup>257</sup> Krahe, 2014 [2008].

well as to the inner courtyard. A curious 4.5 meter high and 88 cm wide gap located directly next to the chimney features a rectangular hole funneling through the inside of the wall all the way to the third floor. It has been presumed that this was an additional chimney, though its location close (less than 80 cm away) to the other chimney which also reaches the upper floors, suggests that its purpose was for something else. Perhaps it had been used to deliver water to the upper chambers, or even food supplies, allowing the servants to pull the food up through the walls rather than having to climb stairs each time.

### 3.7 Southern Chambers—Gothic expansion:

The southern chambers of the castle, were not directly accessible from the western trapezoidal sections (which was connected to the northern chambers on multiple levels). Instead, the southern chambers were accessible via two balconies which currently no longer exist, though the remains of a partial floor on two levels and multiple doorways exiting onto these partial floors provides evidence that they acted as miniature causeways between the three sections of the citadel. These southern chambers were built after the initial construction period, most likely in the fourteenth and fifteenth centuries, since they do not have any *Romanesque* aspects, though they do show traces of gothic style windows that had been transformed into renaissance styles later.<sup>258</sup> The 1560 renovation certainly affected this area of the castle the most, since it is the site of the spiral staircase added during the renaissance period. Unfortunately, only one part of the outer wall of the southern chambers still remains, though the foundations infer that it was not as long as the northern chambers where the *Palas* was located. The volume of the

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<sup>258</sup> Keddigkeit, 2002.



southern chambers is 675 m<sup>3</sup> (23,837 ft.<sup>3</sup>), given by a length of 12.5m, a width of 5.4m, and a height of 10m—slightly more than half the size of the *Palas*.

### 3.8 Additional Rooms and Structures:

Castles were constantly modified throughout their use, requiring skilled craftsmen to conduct the renovations. The weapons-master and the main blacksmith often had a right to a living quarter within the castle.<sup>259</sup> Castles always had a separate room for an arsenal (attended by the weapons-master) and stables for the horses. The location of the arsenal in *Burg Hohenecken* is unknown, though it may have been in one of the basement rooms of the *Palas*. The location of the stables is unknown prior to the 1560 renovation, but their location since then is either within or connected to the large rectangular building to the southeast of the citadel. This was presumably also the living quarters for the servants and the blacksmith (though he may have lived within the citadel). The building is quite large and had been gabled, as is evidenced by the tapering wall on the western side. The volume of the entire building (including the area of the gabled roof) is approximately 580 m<sup>3</sup>—less than half of the volume of the *Palas*. Thus, the servants had considerably less space than the owners of the castle, and lived outside of the citadel where they were much more prone to attack. When the *Kurfürst* sieged the castle in 1668, the areas other than the citadel were targeted, including the building where the servants most likely lived. It was also noted that the *Kurfürst* had taken the servants for himself after besieging the castle.<sup>260</sup>

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<sup>259</sup> Krahe, 2014 [2008].

<sup>260</sup> Lehmann, 1969 [1857].

Other small structures within a castle include the well-house, where the castle well was located. Having a constant supply of water was an absolute necessity for all of the inhabitants of a castle.<sup>261</sup> The well in *Burg Hohenecken* (which reached a depth of 30 meters) is located in the southeast corner of the citadel, directly to the west of the inside of the shield-wall. The current well was built in the 1970s to replace the original well—which had featured a unique arching design wrapping around the top—because the stones were stolen after WWII.<sup>262</sup>

*Burg Hohenecken* apparently had either two wells, or a well and a cistern, possibly evidenced by another structure that was discovered on the day of the photogrammetric recording (discussed later). In the outer-courtyard of the castle, a circular structure beneath the grass was found, which may have been a run-off cistern for the people living in the lower parts of the castle and for the farmstead, or it could have been an actual well, mirroring the well in the citadel. Cisterns are commonly found in castles built upon cliffs (like *Burg Hohenecken*), because the rock both filtered and preserved the water supply well into summer.<sup>263</sup>

### 3.9 Courtyards:

Each castle citadel had an enclosed area without any structures on it. This area was known as the *Burghof* (Castle court) and acted as an open space, separating the buildings from one another, but was often quite small. Only 40 % of castles have a *Burghof* that is still recognizable.<sup>264</sup> *Burg Hohenecken's Burghof* still has substantial

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<sup>261</sup> Krahe, 2014 [2008].

<sup>262</sup> Keddigkeit, 2002.

<sup>263</sup> Krahe, 2014 [2008], p. 61.

<sup>264</sup> Krahe, 2014 [2008].

remains of large stone tiles that paved the areas between the structures. It is quite small and is positioned in the middle of the citadel with structures all around it. This positioning is found in 20% of castles with a *Burghof*, making it the most common style.<sup>265</sup> The area outside of the citadel is known as the *Vorburg*, meaning, in front of the castle and is generally enclosed by an outer wall called a *Zwinger* (meaning “to force”). The purpose was to add an extra layer of defense, but also to trap enemy combatants between the walls of the castle in order to destroy them more easily. Some castles had multiple outer *Zwinger* walls, as is apparently the case in *Burg Hohenecken* from an 1855 painting, though it is not a definitive piece of evidence. *Zwinger* walls were typically built after the castles had been built, and prior to the twelfth century, they were constructed out of wood. The wall posed the largest obstacle to enemy forces and was thus in a state of constant repair.<sup>266</sup> During sieges or storms of castles, the *Zwinger* was bombarded. The siege of *Burg Hohenecken* by the *Kurfürst* in 1668 resulted in the destruction of nearly all of the *Zwinger*, leaving the castle unprotected. *Burg Hohenecken*’s position atop the mountain and the existence of a three-sided *Zwinger* suggests that it was not optimally placed in order to defend against missiles. This was typically the case for Spur-castles, which almost always had shield-walls and many-sided *Zwingers*.<sup>267</sup>

The *Vorburg* included all of the space between the citadel and the *Zwinger*. The space had to be optimally appropriated with a small farmstead, a forge, stables, storage areas, and even small shacks for protecting peasants during a siege. The farmsteads

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<sup>265</sup> Krahe, 2014 [2008].

<sup>266</sup> Krahe, 2014 [2008].

<sup>267</sup> Krahe, 2014 [2008].

typically had a large garden and a variety of animals—primarily pigs and chickens because they did not require much space. Rarely did the *Vorburg* wrap completely around the citadel<sup>268</sup>, but this is clearly the case in *Burg Hohenecken*. The general shape of the *Vorburg* was entirely reliant upon the available land surrounding the citadel. Besides the *Zwinger* walls, the *Vorburg* was also protected with additional towers, not including the *Bergfried*. These towers were placed along the wall to maximize the total area that could be seen. The towers would be in sight of one another, preventing any part of the castle from having an area un-seen by the circumventing towers. The gate-towers were generally quite large, but never reached above three stories.<sup>269</sup>



Figure 3.18: View of the Vorburg at *Burg Hohenecken* (photo taken by author)

It is possible that *Burg Hohenecken* had a gate-tower, acting as a *Torhaus*, in association with other towers surrounding the *Vorburg* (shown in Figure 3.18). There are remnants of two wall towers along the wall on the south side and the west side. Given the massive *Bergfried* in the citadel, it is highly likely that the outer wall had additional

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<sup>268</sup> Krahe, 2014 [2008].

<sup>269</sup> Krahe, 2014 [2008].

towers. The shape of the *Vorburg* in relation to the citadel suggests that there were at least five towers located on the walls. The three positions that are known to have existed are: the western tower, the southern tower, and the gate-tower/*Torhaus*. The two towers that can be presumed, given the large amount of wall and *Vorburg* space unseen by the other three towers, may have been located at the middle of the northern side of the wall and on the northeast corner of the eastern-most shield-wall. The tower on the northeast corner, may be the structure depicted in the *Stahlschnitt* from 1855. The combination of a defensive tower and a gate tower into a single tower is very likely since one third of all castles exhibit this feature.<sup>270</sup> It is worth noting that German castles did not typically have an abundance of additional towers.

### 3.10 Chapel (*Kapelle*):

The existence of a chapel was almost a necessity and the owners would have placed a high value on having one. A chapel is noted to have existed in *Burg Hohenecken* as early as 1269<sup>271</sup>, though the first construction phase had been finished in 1212. A chapel would have been built in the original structure—planned from the beginning. Not every castle had an entirely separate chapel. Instead, many had a small chapel-room or a *Kapellenerker*—an extension of the wall. The only *erker* to be found at *Burg Hohenecken* is the *Aborterker* (the toilet), though it is very possible that there were other similar structures. A sketch and photo of the *Aborterker* are shown in Figure 3.19:

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<sup>270</sup> Krahe, 2014 [2008].

<sup>271</sup> Lehmann, 1969 [1857].

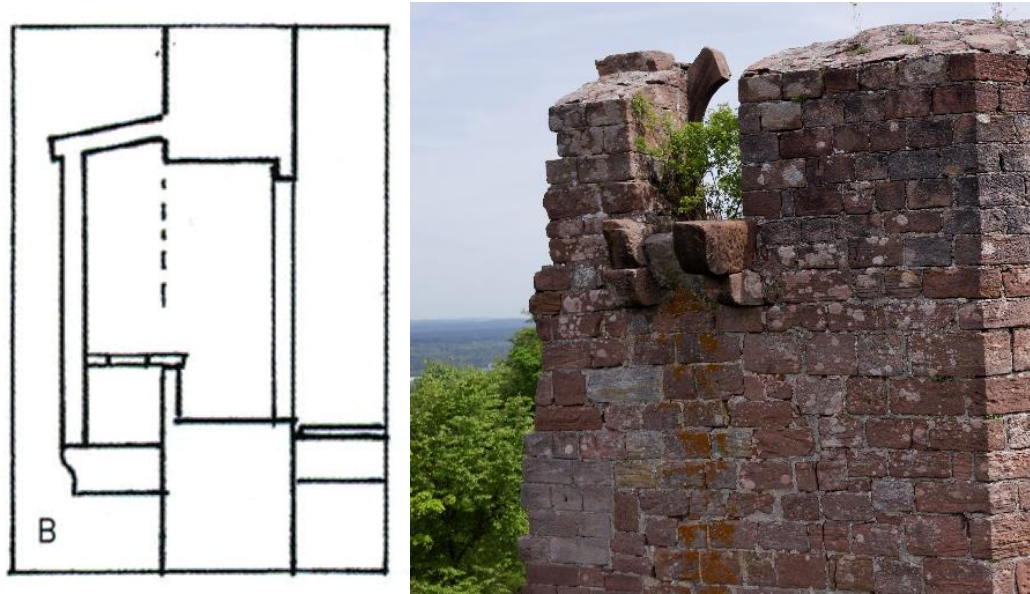


Figure 3.19: A sketch of an *Aborterker* (on the right)<sup>272</sup> and photo of the *Aborterker* at *Burg Hohenecken* (photo taken by Christian Seitz)

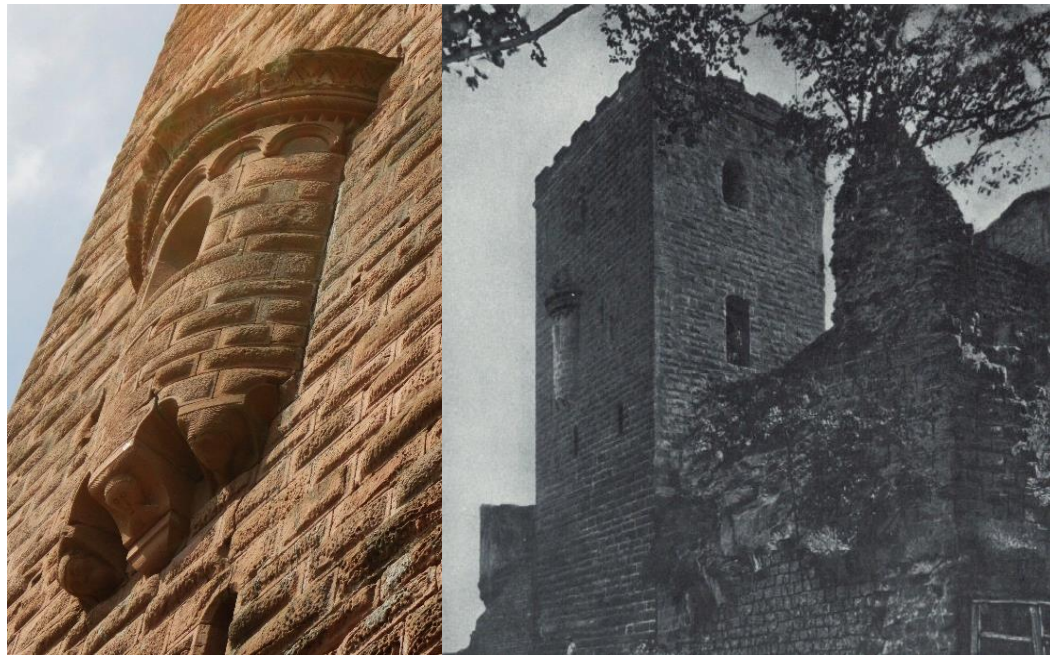


Figure 3.20: Photo of the *Kapellenerker* at *Burg Trifels* (photo taken by author) and historic photo of the same *Kapellenerker*.<sup>273</sup>

<sup>272</sup> Krahe, 2014 [2008].

<sup>273</sup> Hotz, 1981.

*Burg Trifels*, which had been renovated and expanded in 1190, at the time of *Burg Hohenecken*'s construction, features a *Kapellenerker* (shown in Figure 3.20).<sup>274</sup> Provided the fact that the von Hoheneck family had been given control of *Burg Trifels* in 1273<sup>275</sup>, it is likely that each castle would have been outfitted with similar structures. Both castles were built with *Buckelquarder* style stones carved from the regional *Buntsandstein*, are in the same geographic area, and were constructed by the same Hohenstaufen dynasty. It has been presumed that the chapel in *Burg Hohenecken* had been an entirely separate building at the southeastern corner of the citadel to the west of the well. However, this would require the building to have been built earlier than the fourteenth century, as has been proposed. It is entirely possible that the structure (of which only the foundations remain) of the southeastern corner was one of the original buildings, and that it could have been a complete chapel. If this were the case, then an excavation of that particular area would perhaps lead to the discovery of stained glass sherds, or other items—though any precious items would most likely have been raided by the French troops who occupied it in 1668-1689.

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<sup>274</sup> Meyer, 2010.

<sup>275</sup> Keddigkeit, 2002.





Figure 3.23: Inside the chapel at *Burg Trifels* (both photos taken by author).

Assuming that this structure was the elusive chapel, then its form would have been rectangular—nearly cubic—given the foundations of roughly six meters by seven meters. It potentially would have had an *erker* on one of the sides like the chapel at *Burg Trifels* (inside shown in Figure 3.22). The structure’s foundations demonstrate that each wall would have been nearly perpendicular to the cardinal directions—an incredibly important clue. Medieval chapels often faced east to west, because Jerusalem was in the east. Considering that *Burg Hohenecken* had been built during the crusades, a yearning for Jerusalem and the Holy Land was close to the hearts of many people of the time. The structure’s position directly behind the shield-wall would have given it excellent protection and the well would have provided fresh water for services. It would also be in the citadel, where 82% of all chapels are found.<sup>276</sup> Given the incredibly close connection of the *von Hoheneck* family with the Roman Catholic Church, a separate structure dedicated to housing only the castle chapel seems to be highly likely. The corners of the foundation are very large (1.5 meters by 1.5 meters), suggesting that the structure was

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<sup>276</sup> Krahe, 2014 [2008].



taller than the average height of a floor. This could mean that the structure had been vaulted (in the Romanesque style) and would have been an area of solitude.

### 3.11 Vaults and Roofs:

Vaults and roofs were common in German castles. The use of arches strengthened the overall structure by distributing the weight focused on the keystone throughout all of the stones of the arch. Arches have proven to be some of the most enduring and efficient methods in weight distribution in architecture (e.g. the Roman aqueducts). *Burg Hohenecken* does not exhibit any remains of vaulting, though it should not be assumed that it did not have any. The walls are speckled with gaps that were used for floor beams and stone which jut from the walls on the inside upon which beams were also laid. Wood was generally used for floors and roofs of castles, but it was also susceptible to burning, whereas vaulted ceilings were not (though intense fires could still destroy them). Wood floors were a relatively new stylistic element in the thirteenth century with the invention of the saw-mill, allowing for boards of the same measure to be placed next to one another.<sup>277</sup> Wood was widely available in the area because of *Burg Hohenecken's* position in the *Pfälzerwald*. A nearby lake with an old saw-mill was mentioned in variety of letters as having belonged to the *von Hoheneck* fiefdom. The roofs of the castle could have taken a variety of forms. The *Palas*, and related chambers within the citadel, would have had more elaborate roofs than the structures belonging to the servants in the *Vorburg*. They potentially would have had a *Satteldach*—a spacious

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<sup>277</sup> Krahe, 2014 [2008].

triangular roof—whereas the servants’ structure would most likely have had a *Pulldach*—a cheap angled roof.<sup>278</sup>

### 3.12 Summary of the Architectural Design:

*Burg Hohenecken* has often been described as a fortress of lesser significance than its neighbor castles *Burg Nanstein* in *Landstuhl* or the *Kaiserpfalz* in *Kaiserslautern*. However, *Burg Hohenecken*’s incredibly unique design—featuring an extremely thick shield wall and tower, large surface area (considering its position atop a cliff), and expansive living quarters—provides evidence that it was much more than a mere fortress. It was a very expensive structure, which certainly signaled both the power of the HRE and the *von Hoheneck* family within the surrounding area.

Each section of the castle was designed to optimize the use of space, though financial stability also played a key role. Materials and builders had to be local and the fiefdom had to meet the annual quota of agricultural production. The castle construction was reliant upon both the *von Hoheneck* family (who organized constructions and all of the lands) as well as every farmer and every worker in the area. Thus, the operation and stability of a fiefdom was a demanding responsibility, achieved only through constant diplomacy with neighboring lands and alliances with powerful lords.

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<sup>278</sup> Krahe, 2014 [2008].

## Chapter 4—Materials and Previous Research

Photogrammetry and laser-scanning are currently two of the most effective methods of recording cultural heritage. These data acquisition techniques aid in the documentation, identification, protection, conservation, preservation, interpretation, and even restoration of archaeological sites. The data generated from photogrammetry and laser-scanning establishes a basis for monitoring archaeological sites with purposes of preservation, conservation, and raising public awareness. These two technologies were applied in order to record *Burg Hohenecken*.

### 4.1 Photogrammetry:

Photogrammetry is a method for developing 3D models of objects or architecture by producing 3D models from 2D photographs. This technique is being rapidly adopted by archaeologists for various applications including the recording of historic architecture. It is reliant upon software that can estimate the relative orientations of individual photographs within a photo set of one scene. Recently developed software, such as *Agisoft Photoscan Pro*, uses Scale Invariant Feature Transform (SIFT), Structure from Motion (SfM), and Multi-View Stereo (MVS) in order to create 3D models.<sup>279</sup> Other software programs include *PhotoModeler*, which was used in a 2008 study of Castle Landenberg in Switzerland.<sup>280</sup> *PhotoModeler* is an older platform that uses close-range photography for the photo-sets. A high resolution camera and photogrammetric software is far cheaper than a laser-scanner with its associated software. Photogrammetry is more

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<sup>279</sup> Sapirstein, 2016.

<sup>280</sup> Püschel, 2012.

cost effective and is not nearly as logistically limited as laser-scanning because of the relatively small size of a camera compared to a laser-scanner.

The size of the site being recorded plays an essential role in how the photos are taken. Larger sites that have standing walls cannot be completely recorded at ground level. In some cases, full coverage can only be accomplished by using aerial photography.<sup>281</sup> Given the 26.7 meter high *Bergfried* and the 25 meter wide shield wall at Burg Hohenecken, it was necessary to use an aerial device for capturing photos above the height of the wall. UAVs present key benefits including fast realization of images in-flight, instant quality control on the field, more stability and flexibility than a helicopter, and are low cost compared to manned aerial vehicles (planes, helicopters, etc.).<sup>282</sup> They are described by a variety of names including Remotely Piloted Vehicle (RPV), Remotely Operated Aircraft (ROA), Remote Controlled (RC), and Unmanned Vehicle System (UVS). The device used at *Burg Hohenecken* was a UAS (Unmanned Aerial System) also known as a UAV (Unmanned Aerial Vehicle). Additionally, UAVs are separated into three general categories based upon size, weight, endurance, range, and flying altitude. The smallest are Tactical UAVs which are short-range, low altitude (a few hundred meters to five kilometers), generally low endurance, and low carrying capacity (fifty-one thousand kilometers). Strategical UAVs, are long-range, high altitude (higher than 20,000 meters), and have a much longer endurance. Special Tasks UAVs are the combat vehicles used by militaries.<sup>283</sup>

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<sup>281</sup> Püschel, 2012.

<sup>282</sup> Püschel, 2012.

<sup>283</sup> Remondino, 2011.

Tactical UAVs are the most common forms for archaeological purposes, featuring rotary wings and do not require a run-way. The capabilities of these small vehicles ranges from more common kits, carrying relatively small cameras (e.g. *GoPros*) to more complex kits which can be equipped with DSLR cameras or laser-scanners. The UAS used at *Burg Hohenecken* had eight wooden rotors, an aluminum frame with carbon fiber joints to reduce the overall weight, and was equipped with a Sony NEX full-frame camera. UAVs with laser-scanners are much heavier and generally more expensive, requiring more powerful engines than those carrying only cameras.<sup>284</sup> These systems allow for close-range and long-range photos to be taken, encompassing the entire site in one shot—which cannot be done in the absence of an aerial device.<sup>285</sup> However, UAV cameras are often auto-focusing, requiring all photos to be individually calibrated to targets or other reference points before performing any sort of metric reconstruction from the images, though this dramatically lowers the accuracy.<sup>286</sup> In the case of *Burg Hohenecken*, digital reference points were placed after the aerial photos had been aligned.

Photogrammetry is also light sensitive. Buildings present an obvious problem because they are located outside and the main light source is often the sun—which is constantly moving, albeit at a relatively slow pace depending on the time of year. This limits the photography of historic architecture to a specific amount of time. If all of the photos cannot be taken consecutively, then another day with similar conditions must be chosen in order to simulate the first day of recording as best as possible. The photos taken at *Burg Hohenecken* were done on two days, ten days apart from one another. This was

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<sup>284</sup> Remondino, 2011.

<sup>285</sup> Püschel, 2012.

<sup>286</sup> Remondino, 2011.

due to the constant rain in between the two partly sunny days in May. Thus Germany, as is the case with other northern countries, presents an additional problem due to the rapid changes in sunlight during the winter months as opposed to the summer. It would increase the rate of error if photos for a photogrammetric model were to be taken during a variety of seasons with differing availability of sunlight. The change in sunlight would create a constant change in the positions of the shadows.

The process I used for the production of a photogrammetric model follows four distinct steps in the *Agisoft Photoscan Pro* software. The software is an excellent platform for producing a model from SfM to textures. The first step is the orientation (i.e. alignment in *Agisoft*) of photos stage in which the photos are combined with one another, estimated via bundle-adjustment.<sup>287</sup> This step can be time-consuming because each photo is analyzed by the software individually in order to match one to another. The second step is the generation of the dense cloud which reconstructs the depth throughout the imagery, using techniques known collectively as MVS (Multi-View Stereo).<sup>288</sup> The third step is the production of a mesh, which maintains the surfaces of the model by interpolating them from the dense cloud. The mesh describes the surface of the surveyed scene in the form of a DSM (Digital Surface Model).<sup>289</sup> The final step is the texturing, in which the images are projected back onto the interpolated surfaces of the mesh.<sup>290</sup>

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<sup>287</sup> Sapirstein, 2016.

<sup>288</sup> Sapirstein, 2016.

<sup>289</sup> Remondino, 2011.

<sup>290</sup> Sapirstein, 2016.

Texturing can often introduce visual errors such as gaps in the data. Such errors can be remedied by capturing new photos in affected areas.<sup>291</sup>

Another photogrammetric program being developed at the Institute for Photogrammetry at the University of Stuttgart, called *SURE* (**S**urface **R**econstruction from Imagery), is a specialized software for dense image matching. It uses the MVS technique based upon a modified version of the *Semi Global Matching* algorithm (called the *tSGM*). The modification leads to a more efficient dense cloud generation, reducing RAM requirements up to 70% while accelerating the computation by 30%—crucial savings for large datasets. In contrast to *Agisoft Photoscan Pro*, it is not designed to conduct SfM. Instead, orientation data are imported from a SfM software (like *Agisoft*) into *SURE*, which then generates the dense clouds (up to one 3D point per pixel) as well as the mesh and texture. *SURE* presents an excellent method to increase efficiency and decrease computation time and memory.<sup>292</sup> This method was not used for the study of *Burg Hohenecken*, but a new model will be generated in *SURE* to compare with the model made in *Agisoft*.

Photogrammetry has been used internationally to create accurate 3D Models of Cultural Heritage since the 1990s. However, software developed prior to 2010 do not include the meshing stage, which has been included in more recent software such as *Agisoft Photoscan Pro* or *SURE*. These newer photogrammetric platforms and the availability of equipment (DSLR cameras, UAVs, etc.) has accelerated the use of photogrammetric modeling throughout the world.

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<sup>291</sup> Sapirstein, 2016.

<sup>292</sup> Wenzel, 2013.

#### 4.2 Laser-scanning (LiDAR):

LiDAR, meaning **L**ight **D**etection and **R**anging, is the umbrella term for a variety of light-based mechanisms and techniques. It is often called laser-scanning (LS) which is, in turn, another umbrella term for three separate types of scanning: ALS (Airborne Laser Scanning), MLS (Mobile Laser Scanning), and TLS (Terrestrial Laser Scanning). Each type of scanning is device specific, thus, a TLS device cannot be used as an ALS device unless its settings have been completely reformatted and repurposed in order to gather data while in motion. ALS can record very large areas (even greater than 100 km<sup>2</sup>) and provide more than five points per square meter. In contrast, TLS is generally used for much smaller areas, though it can record thousands of points per square meter. The two system are often used in conjunction with one another to provide regional data and more specific (often architectural) data.<sup>293</sup>

Laser-scanning uses light-pulses to record the distance from the light source to the object of study (shown in Figure 4.1). The *Riegl VZ-400* laser scanner, used to collect terrestrial LiDAR data at *Burg Hohenecken*, has a measurement range of 600 meters, a scan data accuracy of five millimeters (the one sigma error at 100 meters), and an efficient measurement rate up to 122,000 measurements per second. The scanner has a wide field of view of 100° vertically and 360° horizontally, using an invisible laser beam safe for operation.<sup>294</sup> The lasers are capable of passing through miniscule gaps in vegetation allowing for a more highly detailed surface recording than photogrammetry. Each time a laser pulse returns after striking an object, it is recorded as an echo. Thus,

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<sup>293</sup> Höfle, 2012.

<sup>294</sup> Data Sheet, Riegl VZ-400, RIEGL Laser Management Systems GmbH., Horn, Austria, [www.riegl.com](http://www.riegl.com).



more echoes provide a better 3D model of the area being studied.<sup>295</sup> This technique allows for precise measurements and analyses of cultural heritage sites to be made. The point clouds from TLS scans can generate position and linear measurements, top and elevation plans, cross-sections and fly-through animations, and the potential to digitally reconstruct sites.

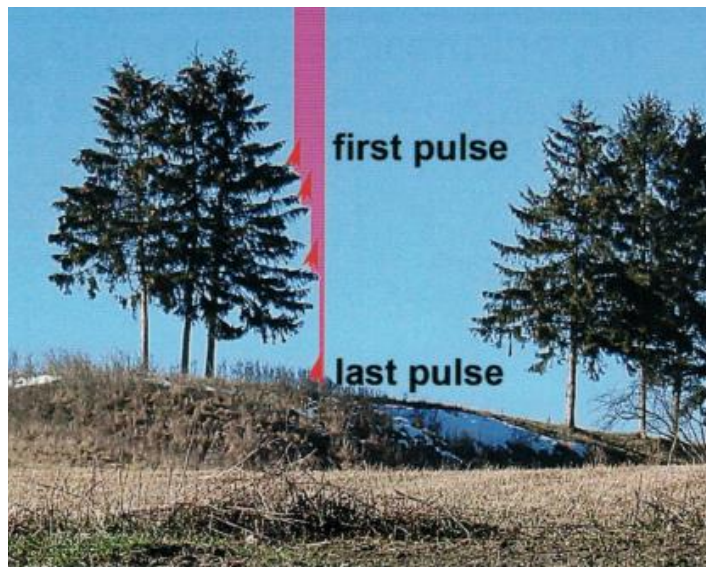


Figure 4.1: Example of laser-pulsing.<sup>296</sup>

The following examples of photogrammetric and laser-scan studies explore the application of the techniques more thoroughly and were chosen due to their similarities with the project conducted at *Burg Hohenecken*.

#### 4.3 Early Aerial Photogrammetry and Castle Models from 2004:

A study from 2004 (Kersten 2004) recorded three castles in *Celle* (Lower Saxony), *Arhensburg* and *Glücksburg* (both in Schleswig-Holstein). The goal of the study was to create virtual reality scenes of all three castles using photogrammetry and

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<sup>295</sup> Höfle, 2012.

<sup>296</sup> Bofinger, 2010.

CAD (Computer Automated Design).<sup>297</sup> All three castles were recorded from 2001-2003 using a DSLR Fujifilm FinePix S1 Pro. Only 58 photos were taken for *Arhensburg*, 274 for Celle, and 374 for *Glücksburg*. All aerial photos were taken via helicopter. Various control points placed on the castles were referenced using a *Leica* total station and connected using the software PANDA from GeoTec and the point clouds were generated using PICTRAN D from Technet GmbH. The RMS was better than five millimeters for all three models based upon manually performed measurements in PICTRAN D. Once the point clouds were completed and the accuracy had been tested, they were transferred to AutoCAD via DXF interface.<sup>298</sup> A similar amount of time was necessary for the model of Burg Hohenecken, though the processing strength was considerably higher with an i5 Processor, 32 GB of RAM, and a Geforce GTX 960 video card.

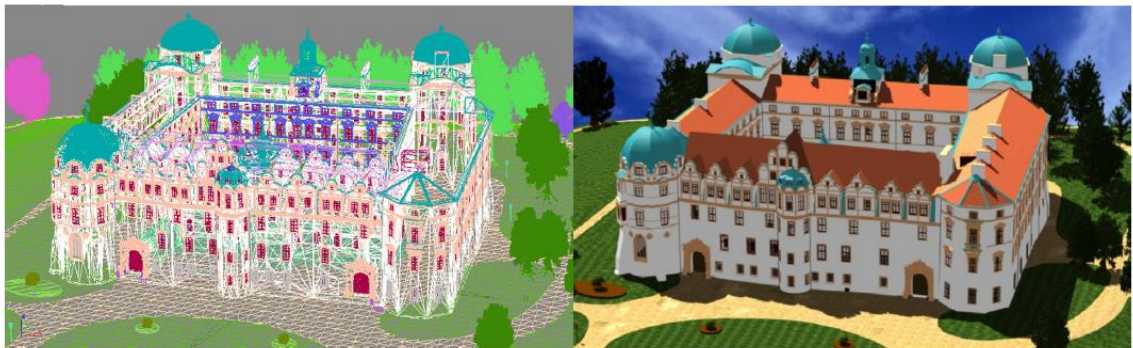


Figure 4.2: 3D model of Castle Celle.<sup>299</sup>

The generation of the models caused issues because the computers that were being used were unable to process the high amount of information efficiently. For 2004 standards, computers with twin 2.4 GHz. processors and one GB of internal RAM were high operating machines. The scenes were generated using 3D Studio VIZ/MAX, though

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<sup>297</sup> Kersten, 2004.

<sup>298</sup> Kersten, 2004.

<sup>299</sup> Kersten, 2004.

some of the layers from AutoCAD were unable to be transferred. The production time and cost of the project was immense. A total of 102 hours for processing the scenes of the three castles for a video sequence of 60 seconds. Additionally, 1350 hours—€54,000—were spent only on the production of the castle from Celle (Shown in Figure 4.2). It was shown that the production quality was very high (at the time) but was incredibly costly.<sup>300</sup>

#### 4.4 Combination of Terrestrial and Aerial Photogrammetry in 2008:

A Swiss study from 2008 (Püschel 2008) sought to combine both terrestrial and aerial photos using a highly standardized method. They opted for a UAV (Figure 4.3) rather than a manned-helicopter for the aerial photography in order to reduce the costs and for faster image capture. The UAV operated autonomously along a pre-defined path, eliminating the necessity of navigating the vehicle from the ground. All photos were taken around a radius of 25 meters from the center of the castle, and the flying height was limited to 30 meters with a camera angle of 70°. <sup>301</sup>



Figure 4.3: The helicopter UAV used at Landenberg.<sup>302</sup>

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<sup>300</sup> Kersten, 2004.

<sup>301</sup> Püschel, 2012.

<sup>302</sup> Püschel, 2012.



Figure 4.4: Real photo of Landenberg on the left and the 3D model on the right.<sup>303</sup>

The terrestrial images were also taken 25 meters away from the façade of the castle. This was done in order to maintain the same scale from the aerial photography of 1:3000—corresponding to a resolution of one centimeter. The distance limitation was not an issue in the study of *Burg Hohenecken*, because newer photogrammetric software do not require close-range photography. All of the terrestrial photos were taken using a tripod in order to avoid blurring due to the light conditions, and the auto-focus was set to manual. Two image sets were made, one in sunny conditions, and one in foggy conditions. The foggy image set was considered the best for their project because of the general lack of shadows. A total of eighteen aerial photos and nineteen terrestrial photos were chosen for the modeling process in *PhotoModeler* version 6, by Eos Systems Inc. The texture mapping was done in *Blender*—a Python-based, open-source software for 3D animation and rendering. Vegetation was eliminated using the stamp tool in Photoshop. The use of aerial photography greatly enhanced the model by reducing the required number of terrestrial photos because the entire façade of the castle could be recorded in a single photo (comparison shown in Figure 4.4). The project show-cased the use of UAVs

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<sup>303</sup> Püschel, 2012.

for modeling and texture mapping, reducing the overall cost and time for the generation of a model.<sup>304</sup>

#### 4.5 Review of UAV Photogrammetric Applications from 2011:

A more recent Italian study (Remondino et al. 2011) addresses the use of UAVs (drones) for archaeological purposes.<sup>305</sup> The paper was more of a summary describing the state-of-the-art of UAVs, providing three archaeological case studies in which drones were used to dramatically change the understanding of a site via photogrammetric models derived from aerial photography. It stressed the importance of calibrating the cameras used in UAVs either prior to the flight or afterwards. The photos from Burg Hohenecken were calibrated after the photos had been captured. This represents a shift in procedures from earlier projects which were limited to close range photography. The first case study was the *Veio* archaeological site in Italy where a four rotor drone took 100 images from a mean flying height of 35 meters. The orientation of the images (alignment) revealed 330,000 correspondences, though it was reduced to 18,000 for speed purposes, and produced a model of 40 million points.<sup>306</sup>

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<sup>304</sup> Püschel, 2012.

<sup>305</sup> Remondino, 2011.

<sup>306</sup> Remondino, 2011.





Figure 4.5: 3D Model of Copan.<sup>307</sup>

The second case study was the UNESCO World Heritage Maya Site of Copan, Honduras (shown in Figure 4.5). A UAV helicopter was equipped with a Nikon DSLR camera and flew up to 100 meters above the site (the same height limit as the study of *Burg Hohenecken*), capturing a total of 250 photos. The drone encountered a few problems with vegetation, which caused messy visualizations in the data, but the built structures were obtained correctly.<sup>308</sup> Vegetation is a source of difficulty with photogrammetry and can certainly be described as one of its limitations. Photogrammetry cannot penetrate small gaps and crevices as well as LiDAR. This requires some areas to be deleted if the coverage is too dense. More recently, Copan has been scanned using ALS in order to produce a more accurate model of the area's topography.<sup>309</sup>

The third case study concerns the *Pava* excavation area in Italy. The site is surveyed annually in order to monitor the excavation advances, compute the excavation

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<sup>307</sup> Remondino, 2011.

<sup>308</sup> Remondino, 2011.

<sup>309</sup> Von Schwerin, 2015.

volumes, and produce ortho-photos. The first flight in 2010 used a Micro-drone at a height of 35 meters, taking 40 images, which generated a DSM to be used for analyses of the excavation.<sup>310</sup> As a conclusion to the case studies, the authors discussed the stability and low cost of using UAVs compared to manned-vehicles, noting that they especially reduce the risk of injury in harsh environments. However, windy conditions and extreme vegetation continue to cause a variety of issues with UAVs.

#### 4.6 Photogrammetric Accuracy and Precision from 2016:

A recent publication (Sapirstein 2016) addressed the issue regarding accuracy in photogrammetric methods. The case study was the Temple of Hera at Olympia—a 55 x 25 meter structure with 40 partially in-tact columns *in situ* (shown in Figure 4.6). The size and intricacy of the temple presents a variety of issues for photogrammetric recording methods. Accuracy is defined in the article as the expected error, whereas precision indicates the finest measurement possible. The study did not use a UAV like many other projects have, rather, a simple boom (shown in Figure 4.8) was used in order to lift the camera into the air<sup>311</sup> (other clever adaptations include using gas balloons<sup>312</sup> and kites).

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<sup>310</sup> Remondino, 2011.

<sup>311</sup> Sapirstein, 2016.

<sup>312</sup> Drap, 2007.



Figure 4.6: Temple of Hera at Olympia.<sup>313</sup>

Given the lower accuracy of photos at long range compared to laser-scanners, it is preferable to take most of the photos for a photogrammetric model at close range as was done in this project.<sup>314</sup> The range used for the terrestrial photos at *Burg Hohenecken* was never more than three meters from the focal point. The accuracy of a photogrammetric model can be significantly increased if coded targets are used on-site. These targets (shown in Figure 4.7) can be printed via the software and are already calibrated.<sup>315</sup> They increase the measurement accuracy compared to manually placed digital markers (as was done with *Burg Hohenecken*) or automatically generated tie-points. However, the lack of physical markers increases the image calibration error by 45%. This is typically the case in models in which a variable lens with autofocus is used. Despite this short-coming, variable lenses with autofocus can be adjusted in *Agisoft Photoscan Pro* by individually calibrating each photo with different foci, rather than having them bundled together.<sup>316</sup>

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<sup>313</sup> Sapirstein, 2016.

<sup>314</sup> Sapirstein, 2016.

<sup>315</sup> Sapirstein, 2016.

<sup>316</sup> Sapirstein, 2016.



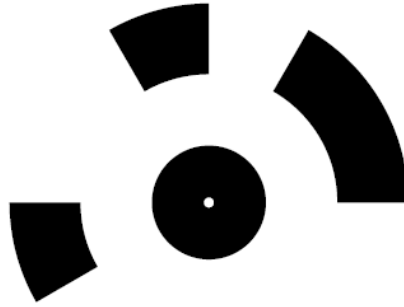


Figure 4.7: Example of an *Agisoft* photogrammetric marker



Figure 4.8: Camera raised on a boom.<sup>317</sup>

A total of 300 markers were used at the site in Olympia, and 85 stakes with a one millimeter dot were recorded using a Total Station and manually marked in the aerial photography. There were 17 batches of 50-500 photos each taken at the site, including

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<sup>317</sup> Sapirstein, 2016.

500 overlapping photos taken from the nine meter high boom. The orientation (alignment) of the photos yielded an accuracy of about one millimeter, surpassing the typical capabilities of a medium-range laser-scanner. Three dense clouds of the site were made with 15-25 million points each, with a precision of 1:8000—much higher than previous photogrammetric studies. The meshing and texturing stages revealed some empty portions due to a lack of photogrammetric data from the images, especially within crevices. The overall textures showed detail down to the individual pixel, via the averaging function in *Agisoft*, which blended the color values from respective photographs at a resolution of one millimeter per pixel (shown in Figure 4.9).<sup>318</sup>

The author noted that in the future, markers on-site should be used whenever possible, because they significantly reduce the time necessary for the generation of the 3D models. Additionally, the combination of a fixed lens, a full-frame sensor, and a significant number of targets that can be seen in every image, the precision of a photogrammetric model can reach a ratio of at least 1:50,000.<sup>319</sup>

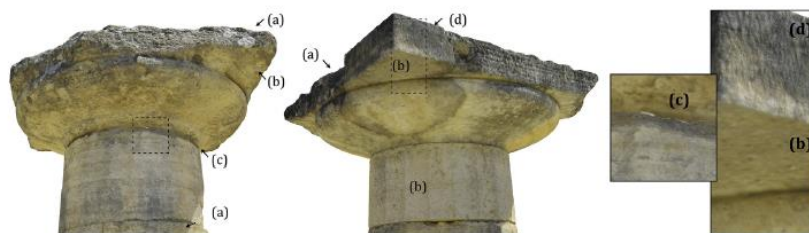


Figure 4.9: 3D models of the columns at the Temple of Hera.<sup>320</sup>

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<sup>318</sup> Sapirstein, 2016.

<sup>319</sup> Sapirstein, 2016.

<sup>320</sup> Sapirstein, 2016.

#### 4.7 Combination of Photogrammetry and Laser-scanning in 2004:

The use of photogrammetry and laser-scanning to record medieval castles has been an area of study since the early 2000s.<sup>321</sup> Most of the papers focus upon the capabilities of particular scanners and the development of the point cloud data. The adaptation of the technology to medieval castles has presented a variety of problems. A study from 2004 (Gonzo 2004) noted that “laser-scanners may be impractical for reconstructing an entire castle.”<sup>322</sup> They also noted that the location of castles atop mountains makes it difficult to find positions from which to gather all of the data. Thus, multiple scans, both terrestrial and aerial, must be made in order to gather data on an entire castle. This requires locating optimal positions that have a degree of overlap in order to align the scans. This can prove difficult due to the varying ability of laser-scanners; the further away an object is, the less reliable the data. The various walls and towers of a castle provide a multitude of blind spots, requiring an absolute optimization of the positions of the laser-scanner.<sup>323</sup> This was certainly evident at the recording of *Burg Hohenecken*.

The article stresses the importance of combining laser-scan and photogrammetric (both aerial and terrestrial) data in order to accurately record large sites. In 2004, photogrammetry’s strength was its ability to record major architectural elements and edge detection, whereas laser-scanners were considered more applicable for fine geometric details. The authors note that CAD was an essential component in previous projects (e.g. the model of *Festung Kufstein*, Austria). It was primarily used to fill gaps

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<sup>321</sup> Gonzo, 2004.

<sup>322</sup> Gonzo, 2004.

<sup>323</sup> Gonzo, 2004.

in the photogrammetric data, though until 2004, no site had been completely recorded using only photogrammetric data. In contrast, several large-scale projects had used laser-scanning to record everything, though multiple scans were necessary, combined with calibrated photos.<sup>324</sup>

At the time of the project, automated modeling techniques were dependent upon regular shapes and surfaces that do not apply to castles due to leaning walls, arched doorways, and columns. Thus, these aspects had to be modeled semi-automatically. They found that CAD was unable to patch floor plan visualizations together and instead opted for a different procedure. Aerial photos were taken by a low-flying helicopter from an average range of 120 meters and height of 65 meters above the castles, providing an accuracy of 1:6000. Additionally, terrestrial photos were taken in association to the aerial photos, taking a total of four days in two site visits. The *ShapeCapture* software was used for the calibration, bundle adjustment, and image-based-modeling of the castle, which extends over an area of 100 x 64 meters, and a height of 35 meters—very similar to the dimensions of *Burg Hohenecken*. The project found that laser-scanners were necessary for high-detail, though photogrammetry provided an adequate general model of the castle.<sup>325</sup>

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<sup>324</sup> Gonzo, 2004.

<sup>325</sup> Gonzo, 2004.

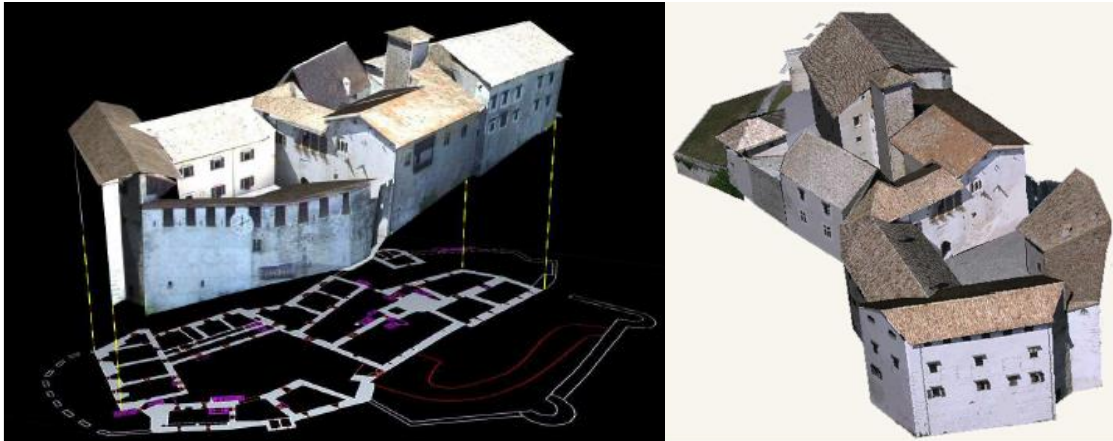


Figure 4.11: 3D Model of *Stenico* castle.<sup>326</sup>

#### 4.8 Combination of Photogrammetry and Laser-scanning from 2008:

A study from 2008 (Grussenmeyer 2008) discussed the combination of three techniques. The authors addressed the limitations of the three techniques—only photogrammetry and laser-scanning will be explained. They noted that despite having placed the laser-scanner in 19 positions—similar to the 22 laser-scan positions placed at *Burg Hohenecken*—there were still many gaps in the data. The TLS scan produced an unreliable point cloud because the combination of the scans was unable to capture most of the donjon (citadel) of the castle. A DSLR camera was used in order to record the photogrammetric data. Both systems proved to be insufficient to gather the data on the whole castle, necessitating the combination of data from both methods. In order to combine the two methods, the researchers triangulated (meshed) both models into a single model. The new model featured the aesthetics of the photogrammetric data and the measurement power of the TLS data—which was particularly important because it could penetrate much of the vegetation. The authors noted that one technique cannot be

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<sup>326</sup> Gonzo, 2004.

preferred over the other because both photogrammetry and TLS scans retrieve different data that are essential in analyzing medieval castles.<sup>327</sup> The combination of photogrammetric and laser-scan recordings was done at *Burg Hohenecken*, in order to adjust for the loss of data due to the scaffolding in the citadel.

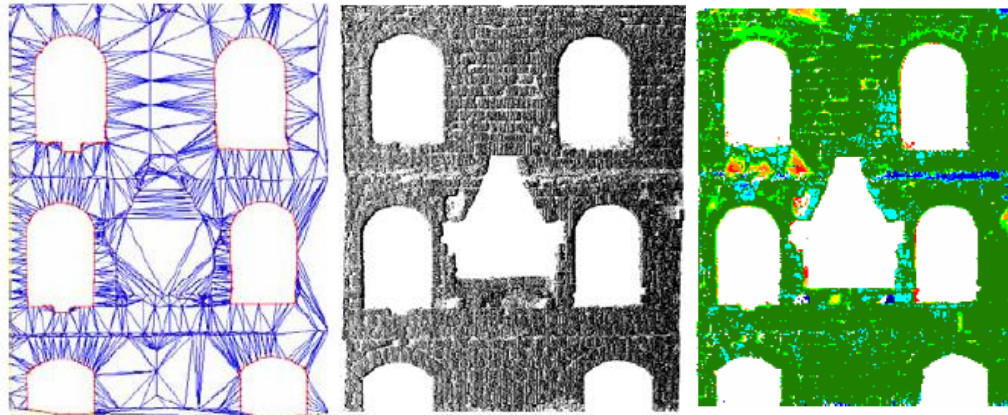


Figure 4.12: Meshes of a wall at Burg Haut-Andlau.<sup>328</sup>

#### 4.9 Discovering Hidden Structures using LiDAR from 2012:

Laser-scanning is an effective method to reveal and investigate lost sites. A recent study (Höfle 2012) discussed the adaptation of ALS to reveal hidden sites. The case study was the castle *Burg Thurant* on the Mosel River—built around 1200 CE by the *Pfalzgraf* to expand his influence in the Mosel River Valley. The Archbishops of Trier and Cologne reacted violently to the construction of the castle and built defenses in order to siege *Burg Thurant*. Of the three total structures, the positions of *Burg Thurant* and one of the castles belonging to the archbishops are known, but the third is not. Supposedly it was simply a tower, but it was demolished shortly after a truce was struck

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<sup>327</sup> Grussenmeyer, 2008.

<sup>328</sup> Grussenmeyer, 2008.

between the *Pfalzgraf* and the archbishops. Since then, the existence of the mysterious, nearly fabled, tower has been in question for some years.<sup>329</sup>

The researchers began the project with archival research for any mention of the castle including the purpose of its construction and its relation to *Burg Thurant*. The foundations of the tower were searched for using viewshed analyses from *Burg Thurant* and aerial LiDAR (ALS). Using these techniques, they related the position of *Burg Thurant* to the *Alten Burg* (the known site of one of the archbishops' defenses) and found that even the 25 meter high tower at *Thurant* would not have been able to see the *Alten Burg*, thus eliminating it as an option of where the second defense had been built. A third site, called "*Auf den Scharen*" was analyzed using the same procedures and was found to have not only been able to have viewed *Burg Thurant*, but could also see the *Alte Burg*, and much of the River Valley—an excellent location, providing evidence to how dangerous it was for the *Pfalzgraf*. The position would have been devastating to anyone in opposition seeking to maintain a toll on the Mosel River. The discovery of the tower adds to the power of LiDAR technology for archaeological purposes.<sup>330</sup> This study provides a method by which *Burg Hohenecken* can be analyzed in the future in order to discover hidden structure, including towers and the coin mint.

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<sup>329</sup> Höfle, 2012.

<sup>330</sup> Höfle, 2012.





Figure 4.13: *Burg Thurant* (on the left) and “*Auf den Scharen*” (on the right).<sup>331</sup>

#### 4.10 Laser-scan Analyses of Medieval Walls in 2015:

A study from 2015 (Bayram 2015) addressed the combination of TLS and photogrammetry. The case study was a series of walls in the *Topkapi* region of Istanbul dating to the reign of Emperor Theodosius II (408-450 CE). One of the walls was recorded using a *Faro Focus 3D* TLS over the course of seven hours and the photogrammetric data was recorded using a MP Canon 700D camera over two hours. The laser-scan model was built using the *Geomagic* software and the photogrammetric model was built using PHOTOMOD. The point cloud was a total of 10,266,068 points and the photogrammetric scale was 1:1240.<sup>332</sup>

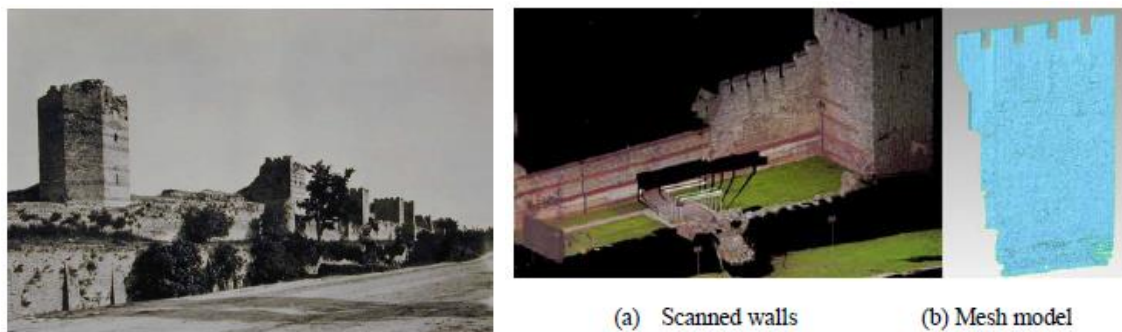


Figure 4.14: 20<sup>th</sup> century photo of the walls (on the left) and 3D model of the wall (on the right).<sup>333</sup>

<sup>331</sup> Höfle, 2012.

<sup>332</sup> Bayram, 2015.

<sup>333</sup> Bayram, 2015.



They found that the TLS data took a long time to filter and that the two models showed a variety of differences, though they did note that they did not calibrate the camera. This resulted in a substantial difference in accuracy, in which the TLS method was clearly favored. One stone marked in both models was compared and shown to change in size by 2.009 centimeters.<sup>334</sup> This demonstrates the importance of placing on-site, scaled markers for the photogrammetric data and calibrating each photo prior to the generation of a model.

#### 4.11 Summary of Previous Research:

Photogrammetry and laser-scanning present an excellent opportunity to digitally record a variety of historic sites in order to document and help preserve cultural heritage. Once the raw data have been received, the models can be processed again using up to date software. These technologies are constantly evolving and are transforming the archaeological world. The ability of photogrammetry to capture even the most miniscule details and the capability of LiDAR to locate sites beneath vegetation without physically altering them has proven invaluable for research. Combining photogrammetry with TLS in association with ALS, archaeological sites can be digitally reconstructed and incorporated into GIS.

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<sup>334</sup> Bayram, 2015.

## Chapter 5—Materials and Methods

*Burg Hohenecken* was recorded using a combination of photogrammetry and laser-scanning techniques. The laser-scanner was made available by Dr. Bernhard Höfle on behalf of the Institute of Geography at Heidelberg University. The castle was scanned using the laser-scanner first, because it was accessible before the UAS for the photogrammetric collection. This chapter explore the step by step process followed in order to produce 3D digital models of *Burg Hohenecken*.

### 5.1 Laser-scan Process:

The digital recording of the castle using laser-scanning began on the morning of April 8<sup>th</sup>, 2015 at 10:00. Prof. Dr. Bernhard Höfle (Heidelberg University), graduate student Zsófia Koma (Heidelberg University), and I drove through the forest with clearance from the *Forstamt* (Forest Service) to the castle guided by the president of the *Förderverein* (the organization responsible for the protection of the castle and castle grounds), Herr Claus Meckler. Herr Meckler provided a short tour of the castle and explained the plans for the rehabilitation of the *Nordpalas* (North palace), which was underway at the time.



Figure 5.1: The Riegl VZ-400 Laser-scanner (photo taken by author).

After we arrived at the castle, the equipment was assembled around 10:30.

Conditions were chilly atop the mountain, with low winds, and sunny. In order to organize the positions from which the scanner was to be placed, a sketch of the layout of the castle was made, marking the planned positions of the scanner. The sketch was closely followed throughout the data acquisition, though more positions were added as needed throughout the day (a computer generated image of the sketch is shown in Figure 5.2). The equipment included the following items:

- *Riegl VZ-400* Laser-scanner
- Tripod
- External batteries for the laser-scanner
- Nikon D300 Digital Camera (to be attached to the top of the laser-scanner)
- Laptop computer with *RiSCAN* (proprietary laser-scanning program associated with the *Riegl* Laser scanner)
- Mobile stand for the laptop
- Power source cable from the battery to the laser-scanner

- Ethernet cord from the scanner to the computer
- Extra external batteries for both the laser-scanner and the computer

Calibrations linking the laser scanner to the mounted digital camera were done in advance by Dr. Höfle on the day before (April 7<sup>th</sup> 2015) in order to begin the data collection immediately upon setting up the system.



Figure 5.2: Laser-scanner positions inside the grounds of *Burg Hohenecken*. Image is a superior view of the laser-scan model.

All scan positions were aligned to provide overlap between the areas being scanned. In order to best organize the positions of the scans, the 22 scans were separated into two groups: the ground level and the citadel. The ground level of the castle (the area outside of the citadel) was scanned in ten different positions (1-10). The full turn (360°) of the scanner was only used on positions one and two because they were placed in areas completely surrounded by structures of the castle. The other ground level position scans were all restricted to the area in which only castle structures were found. This option was available through the *RiSCAN* program and limited the collection of unnecessary features such as vegetation from the mountains and the village below the site. The data of the citadel of the castle was attained through twelve additional scans throughout the inner structures which included a variety of walls and, unfortunately, scaffolding on the most ornate wall (which was being repaired as mentioned earlier). Despite the presence of the scaffolding, the scans were done from different positions, providing different angles of the walls behind the scaffolding, which could be revealed by deleting the scaffolding in *CloudCompare* later. Scans 11-17 and 20-22 of the citadel were done using the full 360° capability of the scanner because of their position within rooms and the inner courtyard. Scans 18 and 19 were restricted to only the structures related to the castle because they were placed in areas with openings looking out to the surrounding forest. The acquisition of the twenty-two scan positions took roughly nine hours, of non-stop re-positioning and optimization of scanning angles. After the raw data had been taken, I began the data processing in the following week after receiving instruction of the basics of the *RiSCAN* program.

Table 5.1: Relation of total tie point per scan to tie points recognized by other scans.

Scan Position	Total Tie Points	PRCS Points	Percentage
1	155	128	82.5
2	167	143	85.6
3	157	119	75.8
4	110	87	79.1
5	145	124	85.5
6	141	121	85.8
7	180	153	85
8	169	151	89.3
9	108	93	86.1
10	151	124	82.1
11	127	106	83.4
12	50	49	98
13	156	136	87.2
14	65	61	93.8
15	100	78	78
16	36	35	97.2
17	91	80	87.9
18	63	63	100
19	44	40	90.9
20	53	52	98.1
21	114	92	80.7
22	0	0	0
<b>Total</b>	2382	659	83.27273

The processing of the scans took considerably longer than the time necessary for retrieving the raw information due to the complexity of the scans and the *RiSCAN* program, which was difficult to learn. Each scan was loaded into *RiSCAN* with the associated digital photos taken after each scan (typically six), by the DSLR camera located atop the laser-scanner. The photos provided visual context making the process of linking 21 of the 22 scans much simpler. Scan 22 has not yet been linked to the others.

Once a scan had been loaded, clearly visible points (e.g. wall corners and fence crossbeams) within the area of view taken by the respective scan position were marked as “tie-points.” These same points were then identified on other scan positions with corresponding overlaps. A range of 36-180 tie points were manually set for each scan, in accordance to all scans in which overlap had been found. For example, scan 10 shared overlapping areas with scans 1, 2, 5, 6, 7, 8, 9, 11, 13, and 21 (seen in Figure 5.3).

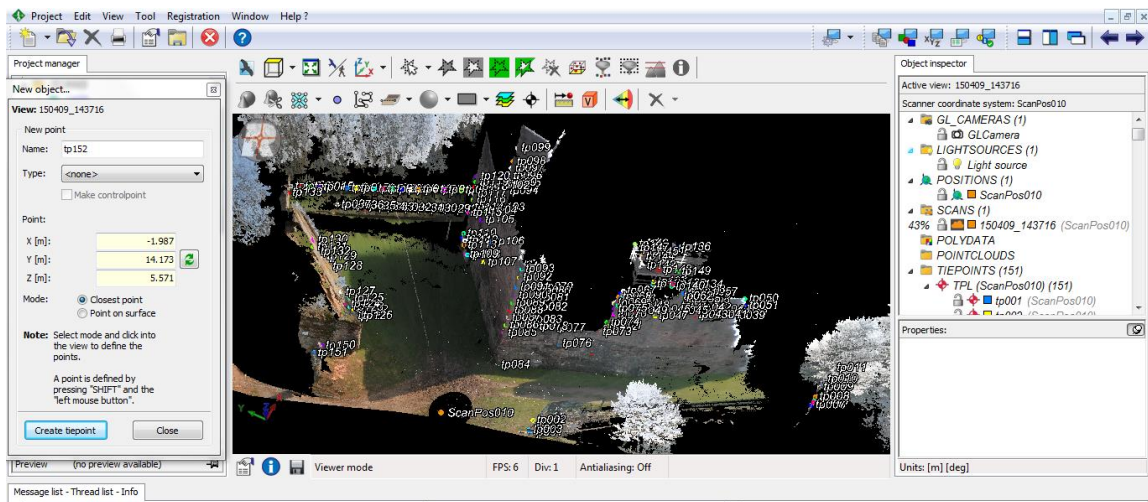


Figure 5.3: Screenshot from *RiSCAN Pro* of the Tie-point process, as seen from position ten.

The accuracy of the overlap of the scans depends upon the accuracy of the positioning of the individual tie points. Each time the same tie point had been found on two or more scans, that tie point was then categorized as a PRCS (**P**roject **o**wn **C**oordinate **S**ystem) Tie Point. A greater number of PRCS tie points increased the accuracy of aligning the scans to one another. Typically, tie points on two nearby scans (e.g. three and four) were selected simultaneously in order to retain maximum precision and increase the efficiency of the process. Roughly 83% of the total tie points placed in each scans were recognized as PRCS tie points (shown in Table 5.1). To visualize the accuracy of overlap, two or more scans were loaded in which each scan was set as a



single color rather than the actual texture. The more closely the points are in relation to one another and the general shape of the area of overlap, the more accurate the overlap is (seen in Figures 5.4 and 5.5). Placing the tie points on the scans was time consuming required roughly 18 hours.

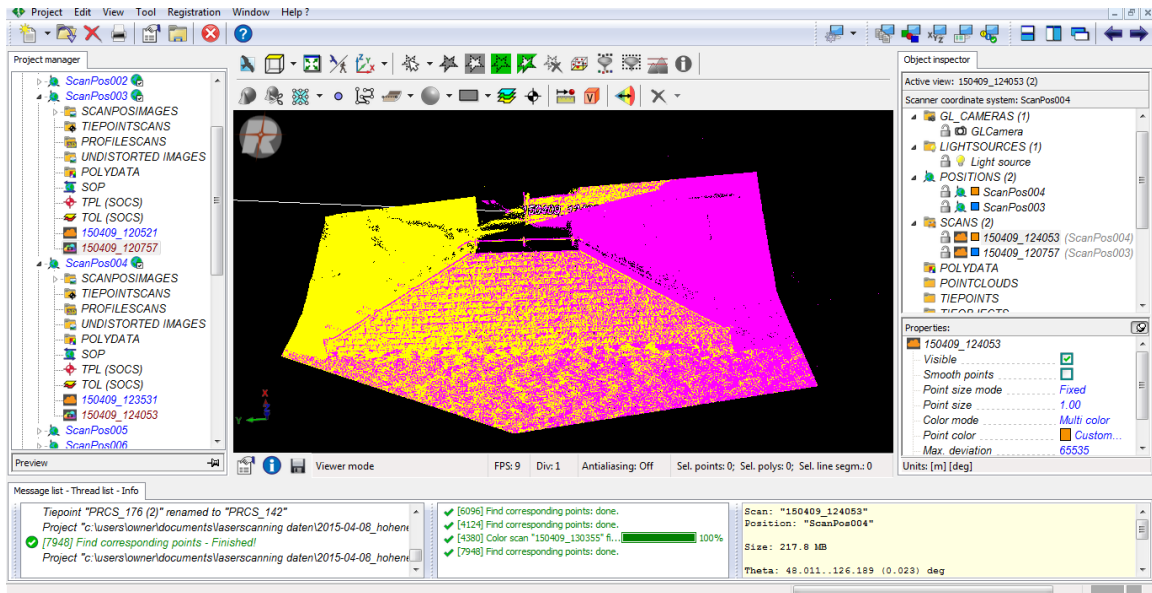


Figure 5.4: Screenshot from RiSCAN Pro, showing the overlap of scans three and four.

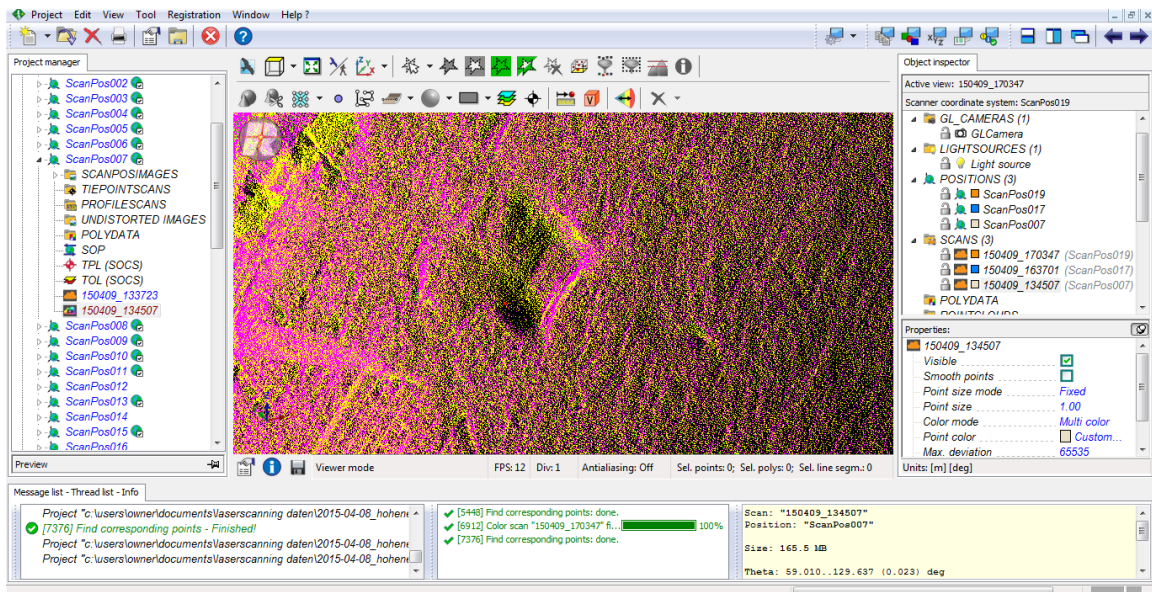


Figure 5.5: Screenshot from RiSCAN Pro, showing the overlap of scans.



Though this method is pleasant to look at, a more precise method of analysis was used in order to determine the standard deviation. Once the tie points had been placed, the scans were merged together, yielding the a merged model of the castle. Each scan was then exported as a TXT file and loaded into *CloudCompare*—an open source 3D point cloud and mesh processing software. The scans were individually trimmed in which the areas outside of the castle grounds (i.e. nearby mountains and tress) were deleted using the *Segment* tool. The trees located within the castle were all segmented out, as well as the scaffolding around the inner wall of the *Nordpalas* (seen in Figures 5.6 and 5.7).

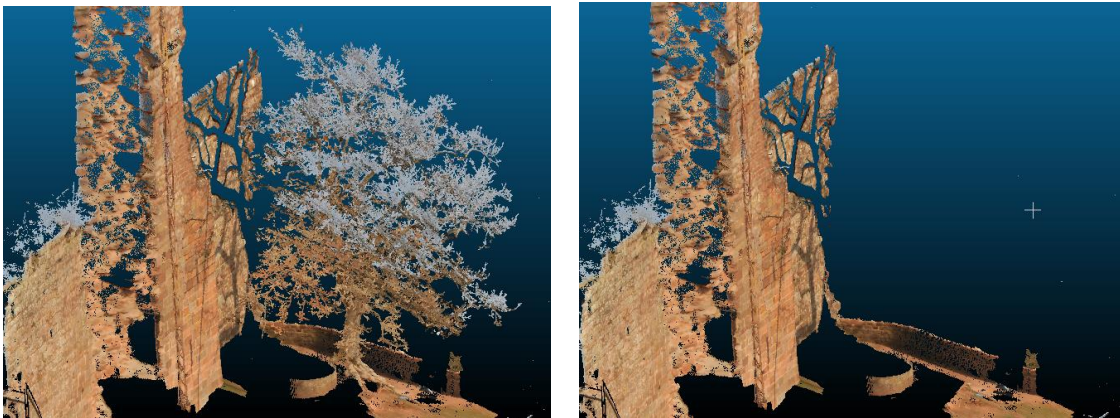


Figure 5.6: Screenshot from *CloudCompare* showing the extraction of a tree

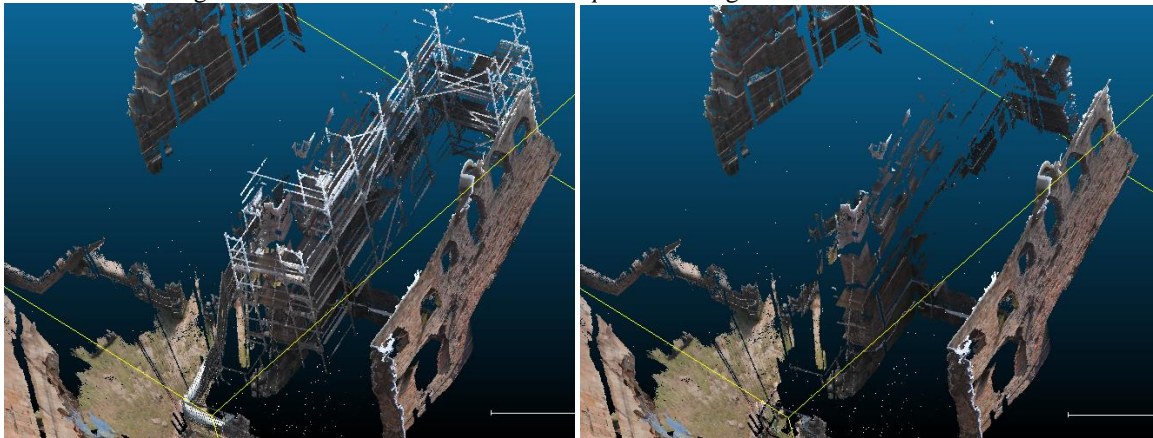


Figure 5.7: Screenshot from *CloudCompare* showing the extraction of scaffolding

After each scan had been trimmed (taking roughly 1.5-2 hours each), the *Statistical Outlier Filter* function was used in order to eliminate any extraneous objects such as insects or birds that had been recorded by the scanner. Once this had been done for each scan, the scans were merged in chunks, due to the low processing power of the laptop that was being used. Seven merges were made and each merge was subsequently decimated using the *Subsampling* tool. The objective of subsampling is to eliminate duplicate points in the merged point cloud. When two or more scans are combined, they often times have thousands of overlapping points, causing the point clouds to be denser than necessary in these areas. Thus, filtering points in overlapping areas, thins out the cloud and allows it to be more easily manipulated.

After all seven merges had been subsampled to 0.005 meters, they were merged together yielding a complete and trimmed model. The final model was then subsampled (given the overlap of the seven merges in various positions) and the *Statistical Outlier Filter* function was used again. Final touches consisting of manual trimming of vegetation from areas outside of the immediate castle grounds were then done in order to remove as many unnecessary points as possible. Upon trimming the model, it was exported as a PLY file in *CloudCompare* and imported into *Meshlab*. In order to create the mesh of the model, the *Normals* had to be set using the “Compute normal for point sets” seen in Figure 5.8.

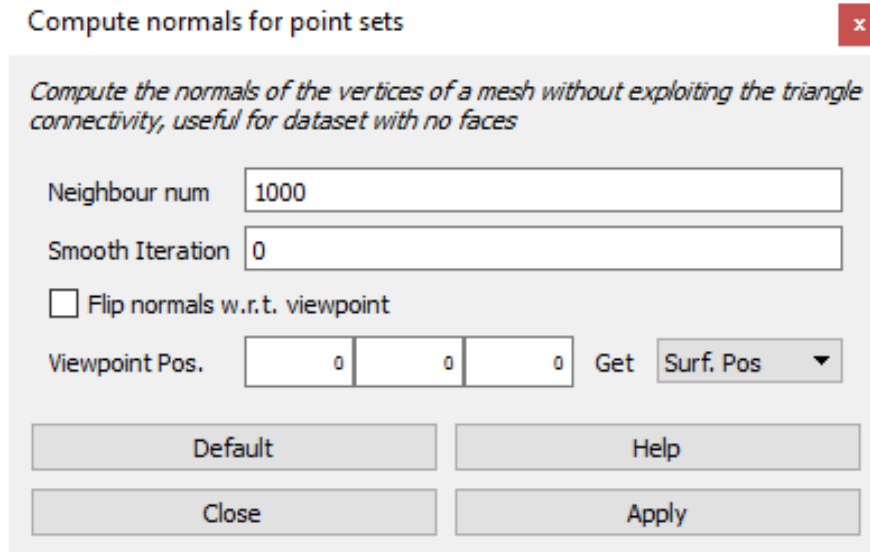


Figure 5.8: Screenshot of how to compute *Normals* in *Meshlab*.

Once the *Normals* had been calculated, the mesh could be generated using the *Ball Pivoting* method, seen below. Other methods, such as *Poisson*, did not work. The *Ball-Pivoting* meshing method generated a model with 576,803 vertices and 1,078,594 faces. The point cloud that had been imported into *Meshlab* had been previously subsampled to 0.06 meters between each point, in order to make the process work more efficiently. From the very beginning until the very end, the entire process of the laser scan model generation required approximately 90 hours.

During the processing of the laser-scan model, areas located behind walls or crevasses out of sight from any of the laser-scan positions were not recorded. These areas also included the ground directly beneath the scanner (at eighteen positions), and were only recorded when a later scan overlapped with the scan position of a previous scan. Thus, the final laser-scan model had many small gaps in places where the terrestrial scanner was unable to collect data. Unrecorded areas included the tops of walls or towers, corners and edges behind stones, or the areas blocked by scaffolding (a particular

problem that arose during the scanning of *Burg Hohenecken*). Though these areas are not completely recorded by the scanner, the different scan positions provide a variety of angles around the stones or scaffolding, limiting the total loss of points. The laser-scan model point-cloud was quite patchy in areas where scaffolding had been filtered out, requiring a method of filling the gaps. The photogrammetric model is optimal for this circumstance when combined with the laser-scan model.

## 5.2 Photogrammetric Process:

The second portion of the data acquisition of the castle began on May 8<sup>th</sup>, 2015 at 10:00 am. Christian Seitz of the Interdisciplinary Center for Scientific Computing (IWR) at Heidelberg University met me at the castle and immediately began assembling the drone and cameras. The sketch of the layout of the castle was used again in order to plan out the path of the drone. Due to the airspace restrictions of the Ramstein Airbase nearby, the drone was limited to a maximum altitude of 100 meters. Conditions were pleasant (~15° C), partly cloudy, and low winds. The equipment included the following items:

- Drone—*ArchEyeAutomatic UAS* (Unmanned Aerial System)
- Attached Sony NEX-7 DSLR camera
- Tripod with monitor
- Extra batteries for the drone
- Remote Control for the drone
- Nikon D800 Full-frame DSLR camera for some terrestrial photos
- Nikon D3300 DSLR camera for majority of terrestrial photos



Figure 5.10: The UAS from the IWR at Heidelberg University (photo taken by author).

The path of the drone focused upon areas that were not captured by the laser scanner (i.e. the tops of walls) as well as from positions that could not be photographed terrestrially. The total flight time was approximately one hour, though the entire process required 2.5 hours. The drone could fly for 15-20 minutes before its batteries had to be replaced with other rechargeable battery packs. A total of 391 photos were taken including 40 in which the entire castle was in view. The full castle photos were necessary for the Structure from Motion (SfM) alignment process. Following the completion of the aerial photography, 1,351 terrestrial photos were taken using the two DSLR cameras. The D800 Full-Frame was used only for the plaster on the inner wall of the *Nordpalas*. The D3300 was used for all other terrestrial photos.





Figure 5.11: The UAS in-flight at *Burg Hohenecken* (photo taken by author).

The terrestrial photos were taken in a particular method in which two set of photos were taken based upon the angle of the camera. The consecutive photos were shot roughly three meters apart from one another, at a distance of roughly two meters perpendicular to the walls allowing for plenty of overlap between the corresponding photos. For the first set, the camera remained aimed perpendicularly to the wall being photographed to provide data linking the base of the walls to the middle sections. Limiting the angle of the camera is of utmost importance due the potential loss of points. The photos did not reach further than 20° orthogonal to the axis of the camera. All corners were recorded hemiscircularly—a process in which the photos are taken in a semi-circle around the object at the focal point.<sup>335</sup>

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<sup>335</sup> Schaich, 2013.

The SfM (Structure from Motion) software utilized was *Agisoft Photoscan Pro* by *Agisoft LLC*. Given the large set of photos to be processed, two chunks were made: one with only aerial photos and one with only terrestrial photos. 385 aerial photos (six were blurry and eliminated) were aligned first on medium accuracy and disabled pair selection (taking ~12 hours to process). Upon completion of the alignment, the camera positions were calibrated each as individual cameras since the NEX-7 used an autofocusing lens (seen in Figure 5.10). The recalibrated cameras were optimized and 45 markers were placed in areas equally distributed throughout the area of the castle grounds which could be recognized by many different camera positions—a trial and error step in processing. Given the multi-perspective nature of the photos, the marker accuracy was set to 0.25 meters allowing for a small margin of error, yet maximizing the amount of photos in which the marker is visible in the correct position (seen in figure). The cameras positions and markers were then exported as TXT files to be imported later.

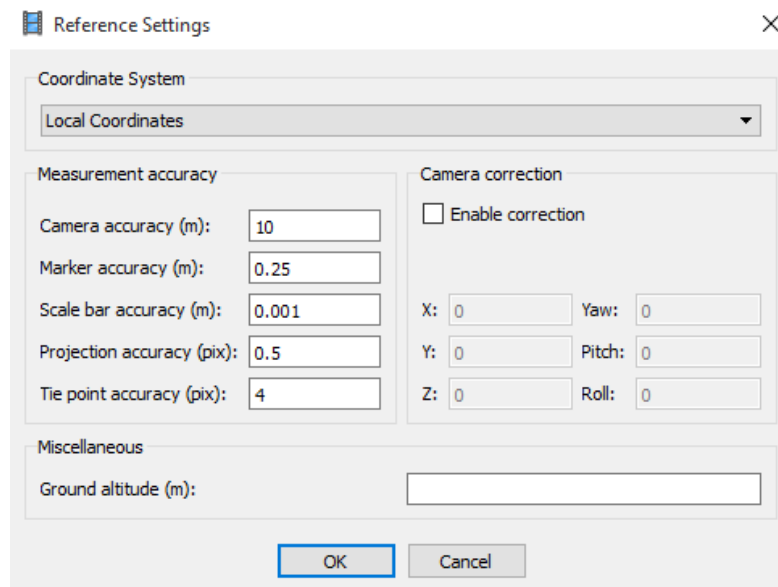


Figure 5.12: Screenshot from *Agisoft Photoscan Pro* showing camera calibration of the aerial photos.

A new chunk of photos combining both the aerial and terrestrial camera positions was made and the exported positions and markers from earlier were imported in order to diminish the time necessary for the alignment stage. Importing known positions and markers allow the software to recognize where positions already are without having to search for thousands of new points (as it does for each photo loaded). The alignment for the combined batch of photos was set to low accuracy, because 391 positions and 45 markers were already known, and pair selection was set to generic, allowing the software to narrow down the number of potential matches for each photo by using their already determined relative positions and the markers. The 1,736 photos required only 12 hours to align with this method, rather than the estimated 200+ hours for all of them to run on medium accuracy without any *a priori* information, which would require that every possible combination among all the photographs be tested by the software.

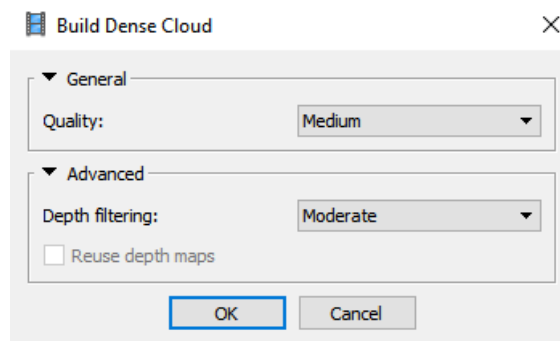
Once the alignment was finished, the aligned chunk of photos was duplicated 19 times creating 19 new chunks of 1,736 camera positions and 45 markers each. Each chunk featured the entire castle with the selection region completely around it. In order to reduce the necessary time and increase the efficiency of the dense cloud processing, the selection box was reduced to only certain regions of the castle, and each chunk was named accordingly. The names of the chunks correspond to a particular section of the castle and are as follows:

1. Halsgraben
2. Front Gate, first half of eastern wall, and first half of servants' quarters
3. Second half of eastern wall
4. Middle strip of outer courtyard
5. Western wall of servants' quarters
6. South side of shieldwall and well
7. Bergfried
8. Northern side of Shieldwall



9. Eastern side of palace
10. Inner courtyard and spiral stair
11. Spiral stair and outer stairs
12. Middle section of palace
13. Southern wall and outer stairs
14. Western side of palace
15. First half of southern chambers
16. Second half of southern chambers and southern half of western chambers
17. Northern half of western chambers
18. Western lawn
19. Missing strip from outer courtyard

Chunks 1-19 were processed independently via the batch processing function in which a variety of processes can be run consecutively, saving the project in between each process. The first batch process consisted only of the dense cloud generation for each chunk at medium quality with moderate depth filtering, requiring approximately 50 hours. Upon completion of the dense clouds, another batch process was done in which each chunk was meshed. The meshing stage is less time consuming (on average) than the dense cloud stage and required about 24 hours, though face count of is heavily dependent upon the point clouds of each chunk. The surface type was set to Arbitrary, with the dense clouds as the source data, and the face counts were set at 2-2.5 million faces or fewer per chunk. After the meshing, the textures were run via batch processing requiring roughly 24 hours as well with Generic mapping mode, Mosaic blending mode, and a texture size/count of 8192. All selection properties are shown in the figures below.



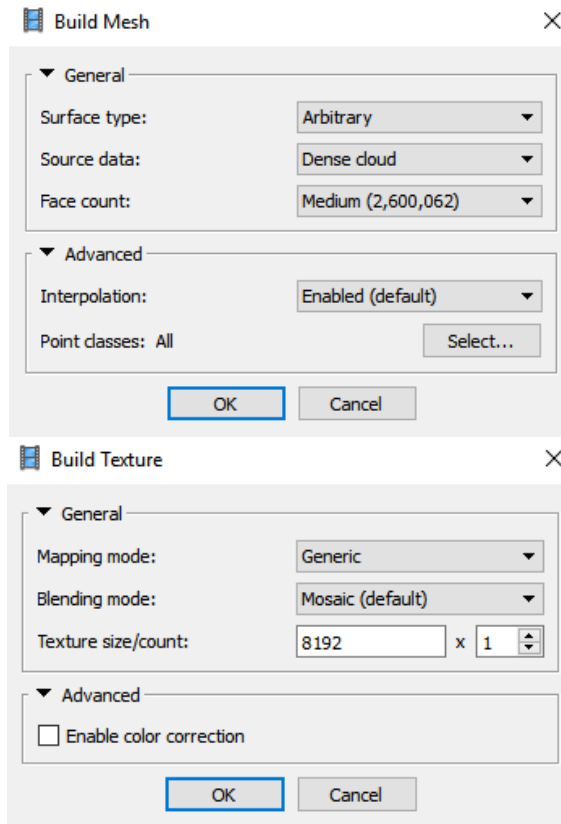


Figure 5.13: Screenshot from *Agisoft Photoscan Pro* showing Workflow and values for generating the 3D model.

Once the dense cloud, mesh, and texture had been generated for each chunk, they had to be referenced to one another. Given that no GPS positions had been recorded, a python script was used in order to reference them to each other. The script, entered into each chunk individually is as follows:

```
PhotoScan.app.document.chunk.transform.matrix = PhotoScan.app.document.chunk.transform.matrix
```

This script allowed all of the chunks to be referenced and to be merged (shown in Figure 5.14).

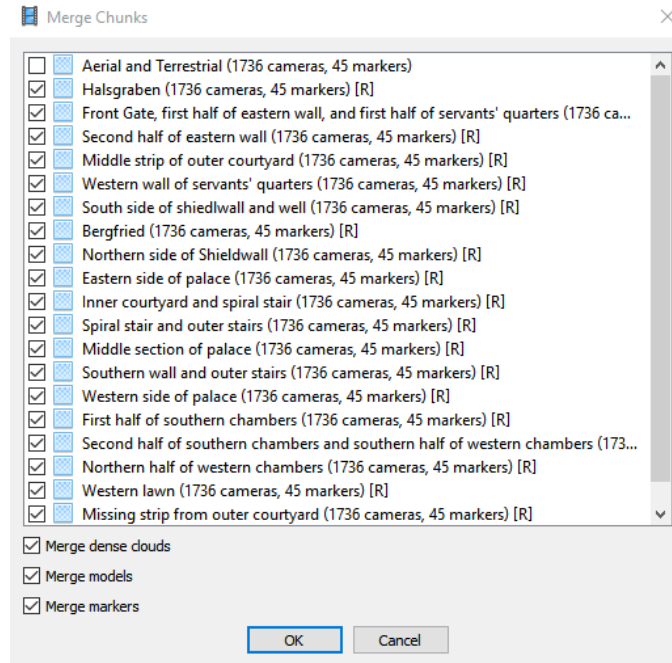


Figure 5.14: Screenshot from *Agisoft Photoscan Pro* showing the merging process of the chunks.

After the chunks had been merged and the model was complete in *Agisoft*, it was exported as an OBJ file with 18 associated texture JPGs. The merged dense cloud consisted of 273,100,963 points, and the mesh was comprised of 18,467,092 faces and 9,342,174 vertices. At 1.425 GB, the model was too large and it was imported into *CloudCompare* for segmentation of extraneous parts and vegetation. All trees and portions of the mesh that were floating in free space were trimmed, reducing the model to 1.269 GB. In order for the model to be hosted on *Sketchfab* (a website for displaying 3D models online), the model has to be decimated to 50 MB or less.

The decimation process was done in *Meshlab* using the *Quadratic Edge Collapse Decimation (with texture)* function (seen in figure). The target number of faces was set to 375,000 which yielded a model just under 50 MB limit at 48,280 KB. The model was

archived along with its MTL file and 18 texture JPGs and uploaded to *Sketchfab* (as an archive).

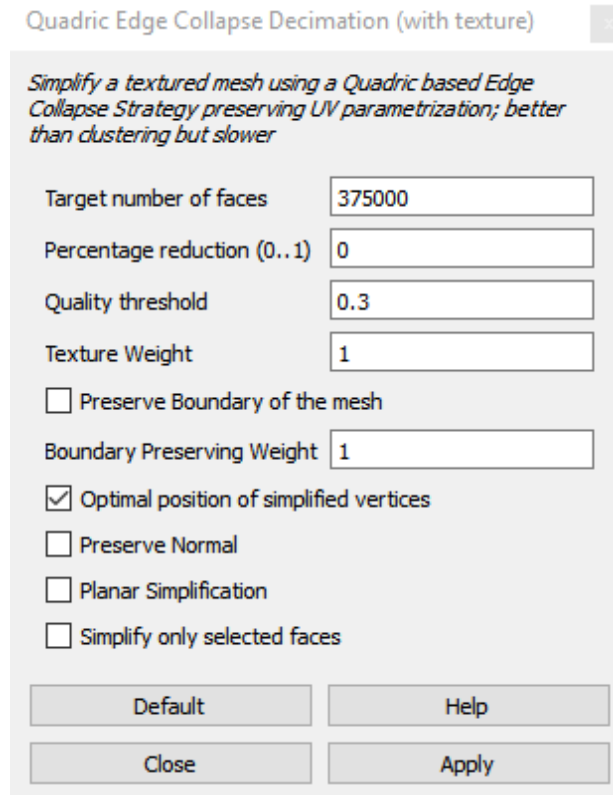


Figure 5.15: Screenshot from *Meshlab* showing decimation procedure for photogrammetric model.

### 5.3 Combination of the Models:

Once both the laser-scan and photogrammetric models had been processed, they were opened simultaneously in *Meshlab* to be aligned. The laser-scan model (shown in Figure 5.16) was set as the reference layer to which the photogrammetric model (shown in Figure 5.17) would be scaled.



Figure 5.16: Screen-shot of the laser-scan model of *Burg Hohenecken*.



Figure 5.17: Screen-shot of the photogrammetric model of *Burg Hohenecken*.

Both models were then put in the same viewing position and selected to be scaled to one another (shown in Figure 5.18). Eight corresponding points were then selected on each model in order to align them.

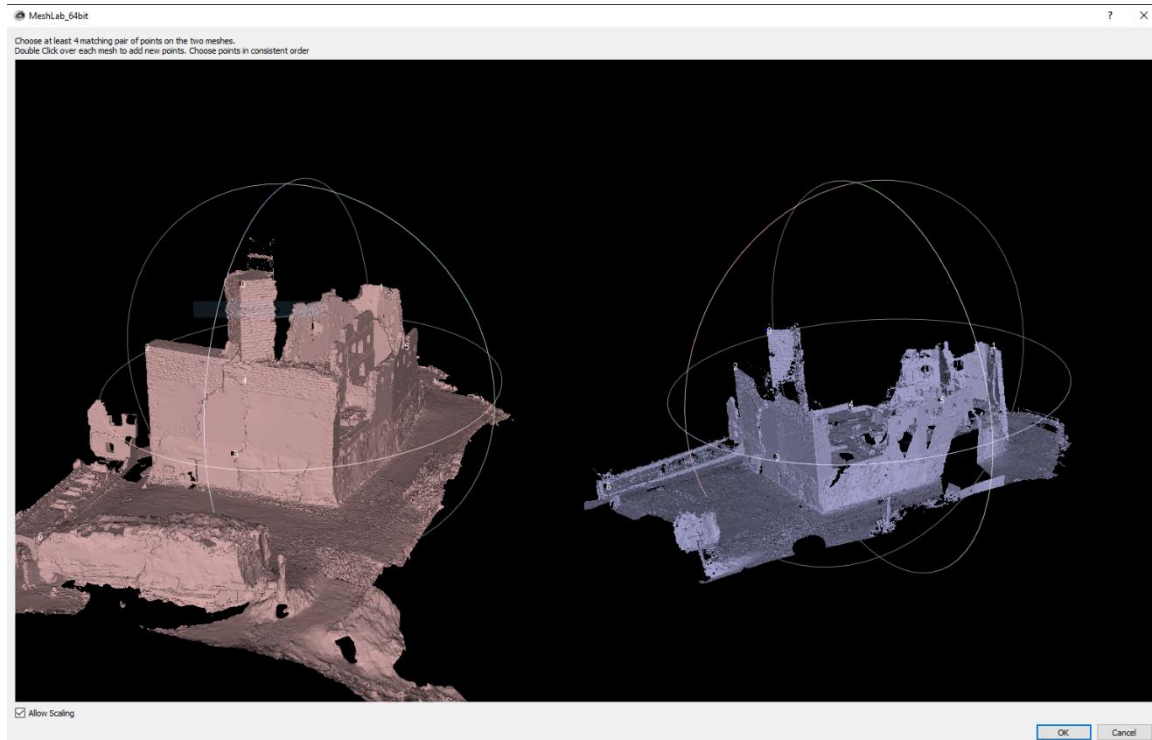


Figure 5.18: Screen-shot of the alignment phase. Photogrammetric model is on the left and the laser-scan model is on the right.

The laser-scan model was decimated considerably low in order to load it alongside the photogrammetric model (which had also been decimated). Unfortunately, this resulted in a significant loss of data in certain places. Upon placing the corresponding points, the alignment was then processed, yielding a single model, with an average error of 0.016 meters. The aligned model successfully filled in gaps from both individual models (shown in Figure 5.19).

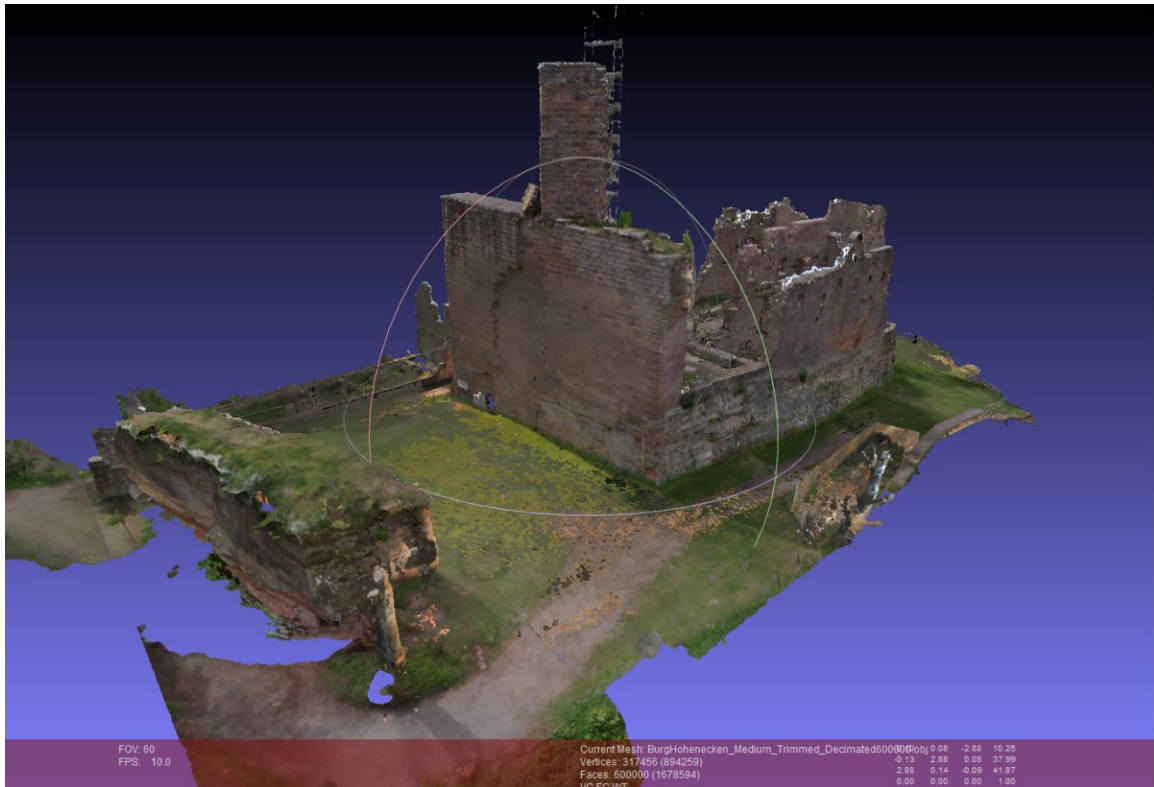


Figure 5.19: Aligned and scaled model of *Burg Hohenecken*.

#### 5.4 Summary of Materials and Methods:

The aligned model of incorporating both photogrammetric and laser-scan techniques has yielded the most accurate model of *Burg Hohenecken* to date. The model was processed over the span of eleven months from beginning to end. Future models following this methodology will take significantly less time, now that the process is more familiar. Modifications in the future included the use of coded markers for the photogrammetric process, and Ground Control Points (GCPs) for geo-referencing within the Global Navigation Satellite System (GNSS).

## Chapter 6—Conclusions and Outlook

*Burg Hohenecken* is a castle dear to the hearts of many people. It is a symbol of the Middle Ages ever present within the landscape of the northern *Pfälzerwald*. Once representing the identity of the *von Hoheneck* family, the castle now represents the identity of the village of *Hohenecken*. Providing in-depth descriptions of the environment, history, and architecture of *Burg Hohenecken* is fundamental to creating a holistic picture of its past and place within the region. It has affected the lives of thousands who treasure it as a symbol of their heritage and seek to preserve it for future generations. The decay of the castle remains an urgent problem. An entire level has all but disappeared since the 1920s and the citadel walls are leaning more each year—threatening collapse. A scaled digital model with highly detailed textures is not only one step towards raising awareness for this magnificent piece of cultural heritage beyond the region of the northern *Pfälzerwald*, but also for recording its current state before any further decay.

### 6.1 Chapter by Chapter Review:

Each chapter presents a different perspective of *Burg Hohenecken*'s past, its present status, and the application of recording methods. Chapter One focuses on the environment of the *Pfälzerwald*, particularly the large outcrops of *Buntsandstein* and topography of the area. The condition of the land is vital towards understanding the construction of the castle and its relevance in history. Densely forested areas were important defensive resources for the HRE because they blocked the advance of large armies. Though trees can be felled, a network of castles is much more resilient, controlling vital routes through the empire. The construction of dozens of castles during



the period of the Hohenstaufen reign was in part made possible by the Medieval Warming Period when the population of the HRE grew by tens of millions, significantly improving harvests and health. Due to the favorable climate, the people of the medieval HRE grew taller, survived to adulthood at higher rates, and were generally healthier than the people in the centuries immediately before and after. The social structure was simultaneously changing, and medical knowledge was advanced from the rediscovery of Roman, Greek, Near Eastern, and Western European texts. All of these factors transformed the area of the *Pfälzerwald* both socially and physically.

The historical significance of *Burg Hohenecken* was covered in detail in Chapter Two, which provided an outline of the history of the HRE enhanced by information from the 70 translated letters regarding *Hohenecken*. The letters provide insight into the lives and correspondences of the *von Hoheneck* family and their fief. They document trade, the location of important sites (castles, natural springs, paths, etc.), and the lives of the common folk who are otherwise unmentioned. The integral connections that the *von Hoheneck* family had with the Catholic orders (Cistercians, Premonstratensians, and Teutonic Knights) are unattested beyond the letters. They indicate the mutually beneficial relationship the family maintained with the regional monasteries. Using the known history of the region and HRE in combination with the information from the letters, an entire world of the past can be reconstructed and analyzed. The letters mention a variety of structures and sites lost for centuries: the location of the coin-mint, pathways to and from the city of *Lautern*, and funds designated for expansions of the castle. It is likely that the castle did not experience major expansions beyond those from 1200 and 1560. Instead, the castle was consistently modified throughout its use. This is not to say that

*Burg Hohenecken* was a perpetual construction site, but that there were multiple periods of construction throughout its past.

The architecture of the castle discussed in Chapter Three, demonstrates the uniqueness of *Burg Hohenecken*. As an imperial loan, the castle was built completely out of stone in the Romanesque architectural style. It is a spur-castle built atop a cliff, yet its dimensions place it within the category of “very large” castles—in contrast to most clifftop castles which are considerably smaller. The *Buckelquarder* style stones make the walls thicker and heavier than walls of other masonry types. *Burg Hohenecken* possessed a variety of different structures and features, including: two outer-walls, a drawbridge, a shield wall, a gigantic 87.5 foot pentagonal tower, a large area of living chambers, servants’ quarters, a chapel, and a farmstead. The fiefdom of the *von Hoheneck* family spanned a vast territory of the northern *Pfälzerwald* with access to main roads, lumber, and plenty of rock from which to carve stones. The castle in conjunction with the entire fief was a network which worked within the larger network of castles—each with their own microcosm.

Chapter Four explored previous research involving digital modeling of castles, including photogrammetric and laser-scanning for 3D—the methods used to generate the 3D model of *Burg Hohenecken*. The discussion of UAVs was of particular importance because the elevations of the main tower and the upper citadel could not be reached effectively without a drone. The planned flight path of the drone at *Burg Hohenecken* captured 391 photos of the tops of walls, interiors of windows, and photos of the entire site. The interiors of the windows had previously not been seen in such high detail. Combining terrestrial and aerial photos allows for every surface of the castle to be

captured and processed within the final model. Generating the model in conjunction with laser-scan data allowed for the model to be accurately scaled. Combining photogrammetry with laser-scanning had been done before (as shown in chapter four), though the studies demonstrated the obstacles encountered with laser-scanners. Laser-scanners are considerably heavier and costlier than photogrammetric equipment, and are not nearly as flexible in recording large structures, such as castle ruins. However, the measuring capability of a high resolution laser-scanner (e.g. the *Riegl VZ-400* used at *Burg Hohenecken*) provided the most accurate measurements of the site to date. Laser-scanners also present an opportunity to discover lost sites using aerial data of the topography of an area. This is a method that will be used at Burg Hohenecken in the future in order to determine the location of the hidden structures.

Chapter Five expanded on the information presented in Chapter Four, focusing on the material and methods used at *Burg Hohenecken* and the process followed in order to generate the 3D model. Each step is described in detail so that the same workflow can be reproduced at other research sites with similar environmental settings and availability of equipment (i.e. access to both a high resolution laser-scanner and UAV). The capabilities of the various software are also noted in order to demonstrate the strengths of some software as opposed to others.

## 6.2 Project Significance and Contribution to Historical Preservation:

Preserving the cultural heritage of the Pfalz lies at the very center of this project. *Burg Hohenecken* has been deteriorating since its partial destruction in 1689, though more damage has occurred in the past 90 years than in the centuries after it was partially destroyed. Photos from the 1920s show entire levels of the castle that no longer exist.

Building plans from the late nineteenth century indicate wall foundations that have left no visible trace on the site today, save for a short portion of the foundations on the northern side of the castle. The ornate well was completely dismantled and each piece removed after WWII, and one of the two remaining Romanesque window columns had to be replaced because it had deteriorated. The walls are leaning ever more, and the *von Hoheneck* crest atop the main gate has nearly disappeared—within just the last ten years. There is extensive graffiti, and visitors sometimes take stones from the castle as keepsakes. Water seeping through the cracks in the tops of walls freezes and expands, causing the apical portions of the castle to tear apart. Roots from trees and other vegetation have ripped stones apart from one another and the southern wall of the servants' quarters has already begun to collapse.

The local organization formed in 2007 for the preservation of the castle (the *Förderverein*) has made a great effort to rehabilitate the castle by re-mortaring the tops of the walls and maintaining the grounds keeping the vegetation at bay; had they not intervened, more of the citadel might have decayed within the last five years. The *Förderverein* has made tremendous strides raising tens of thousands of euros and hundreds of hours of volunteer time to preserve the castle<sup>336</sup>, but the city of *Kaiserslautern* (to which the castle belongs) is financially strained. The *Förderverein* was completing a rehabilitation of one wall of the citadel and raising a flag atop the main tower (*Bergfried*) of the castle<sup>337</sup> during the recording in spring of 2015. The rehabilitation consisted of a new “crown” of stones atop the inner wall of the palace

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<sup>336</sup> Kruse, 2015.

<sup>337</sup> Kruse, 2015.

above the double Romanesque windows. Photos from the 1920s provided the evidence as to how the castle had once looked. Water had been seeping between the stones for decades, freezing, expanding, and destroying the walls from within. The new stones provide a buffer and offer protection for the most ornate wall left in the castle. The project cost 56,000 euros, requiring stones that had been gathered from a local house that had been demolished, and a crew of highly specialized stone masons in addition to hundreds of hours of volunteer work by the 75 members of the *Förderverein*. 20,000 euros were provided by the *Deutsche Stiftung Denkmalschutz* (German Foundation for Memorial Protection), 20,000 by the city of Kaiserslautern, and 16,000 from the *Förderverein*—which had gathered funds from a summer festival at the castle and benefit concert.<sup>338</sup> The rehabilitation was greatly beneficial and potentially saved the entire wall, though the scaffolding proved inconvenient for the recording of the castle.

The city fully realizes the importance of *Burg Hohenecken*, but lacks the funds to properly support it like castles in more affluent cities (i.e. Heidelberg). Thus, a state-of-the-art digital model and highly-detailed report of the history and significance of every aspect of the castle is critical to future efforts to promote *Burg Hohenecken* beyond the region of *Kaiserslautern*. The castle has traditionally been viewed as no more than a fortress in the forest, though this thesis demonstrates that it was of much greater importance. It played a central role in the defense of the HRE and served as the residence of multiple prince electors and the noble *von Hoheneck* family. *Burg Hohenecken* has always been near to me since I was a child, when my grandparents and parents would

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<sup>338</sup> Luttenberger, 2014.

take me to the ruins to explore. Despite having seen larger (e.g. *Burg Lichtenberg*) and more prominent castles (e.g. *Burg Trifels*), Burg Hohenecken has always been like a dear friend or family member. My admiration for the castle is shared by the village of Hohenecken and the surrounding areas of Kaiserslautern.

Building the digital model of the ruins has changed my perspective on the site. The castle has always been a source of inspiration, but when the structure is stripped from the landscape that accompanies it, it loses much of its mystique and becomes just another building. The intangible dimension of the castle is inextricably linked to the environment, a dimension that is lost when the background is the gray screen of *Agisoft Photoscan Pro*, rather than the lush temperate rain forest of the *Pfälzerwald*. Viewing the castle objectively meant investigating it as though an outsider would. Having seen the castle annually over the course of 20 years, it was difficult to separate the feeling of being at a site that was always a childhood centerpiece. However, in a computer program in which it can be virtually analyzed in 3D, new aspects of the architecture reveal themselves. The drone captured very clear photos of a former cistern, or possibly a well, that is obscure from the ground. Water was a vital resource, and the nearest spring identified in the letters was nearly 1.5 kilometers away<sup>339</sup>. The castle was already known to have had a well in the inner court, but another well in the outer court would have been advantageous. The overall layout of the castle was also revealed.

Both the photogrammetric and laser-scan models revealed where additional towers may have been located. Towers along the outer wall were typically placed so that

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<sup>339</sup> 1401, Aug. 3--King Ruprecht feoffs Reinhart of Hohenecken the Toll of Lautern. Entry: HStA Mü I, Oberster Lehenhof 1a, Bl.25f.

nothing was outside of the line of sight. For all angles of the castle to have been appropriately visible, a minimum of five wall towers would have been necessary, including a three story tower over the front gate, which previously had a drawbridge<sup>340</sup>. Though these seem to be hypothetical, an old steel etching from the eighteenth century depicts the castle with another level where the chambers are located, a tall tower that is no longer there, and a second outer wall (Figures 3.4 and 3.6). The tower's existence would have been necessary in order to maximize visibility, and the second outer wall—which was uncommon in the German Middle Ages—is specifically mentioned in a letter from 1430. Combing all sources of information has completely changed the interpretation of the castle as a mere fortress.

The realization that *Burg Hohenecken* was a site of regional significance given the many high-ranking inhabitants over the course of over 450 years, is a major shift in our understanding of the history of the area. Piecing together the communication networks and using the information in the letters has revealed the medieval landscape, something that has been all but lost considering that the land around *Burg Hohenecken* has been altered. Many of the lakes have been drained and the fields covered with houses by both the state and the nearby air base. Any detail of the former landscape is limited to the memories of those who yet remember it before WWII, and those memories are quickly fading.

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<sup>340</sup> Keddigkeit, 2002.

### 6.3 Future Research and Long-term Outlook:

Geo-referencing and placing all of the locations from the letters in GIS using aerial LiDAR data (ALS) is the next step for this research. This process will allow the landscape to be visualized rather than just imagined. The viewshed, buffering, hydrology, and predictive modeling functions of GIS will be useful in recreating the former landscape. The viewsheds of the castle from three different positions (the top of the main tower, the highest windows of the citadel, and from the outer wall) should cover a wide range of the surrounding valley from a variety of different heights. The view from atop the main tower (*Bergfried*) will provide the maximum height from which the inhabitants of the castle could have seen. The highest windows of the citadel (from the northern *Palas* and western *Palas*) demonstrate what the inhabitants were able to see from their own living quarters and what implications this may have (i.e. looking out toward the former lake). A viewshed from the outer-wall (*Zwinger*) will provide evidence of what the defenders of the castle could have been able to see whilst on watch, particularly, movement in the surrounding valley. The viewshed from the *Bergfried* will also help determine the height of a nearby ruin, *Burg Perlenberg*, which presumably functioned in the same way that *Burg Scharfenberg* did with *Burg Trifels*—a watch-tower. *Burg Perlenberg* stood watch over the imperial street from *Landstuhl* to *Lautern* and may have been the site of the coin-mint of *Hohenecken* because many coins have been found there, and a local *Saga* tells the story of its evacuation and subsequent burying of a vast treasure. Directly on the imperial road was the Teutonic Knight Order in *Einsiedel* which was at one point connected to *Burg Perlenberg* via an underground



tunnel. Both were constructed shortly after Burg Hohenecken in the early thirteenth century.<sup>341</sup>

A buffer of the areas surrounding the known imperial roads (e.g. the *Kaiserstrasse*) and their intersections with lands in the *von Hoheneck* fiefdom will demonstrate where the areas of least protection were located. High-way robbers (*Wegelagerer*) were a serious problem in the Middle Ages. They would often hide near the streets, waiting to strike small groups of travelers. Locating the most likely areas where robbers could be out of sight of the view of the defensive towers relative to the imperial roads would determine whether or not these roads were indeed well protected. Additionally, the existence of former lakes and the extent of the surrounding forests would affect the availability of hiding spots for robbers.

Conducting a hydrologic analysis of the area within a three kilometer radius will help determine where the lakes were to be found and where water would naturally drain—especially important given the amount of rain in this area. During the Middle Ages, this area of the Palatinate Forest (*Pfälzerwald*) would have been very wet—nearly swampy—making the land difficult to traverse with a large caravan. The topographical limitations of the terrain would have required roads that were very efficient and preferably well protected. Identifying where each lake was will be relatively simple because those areas are consistently flooding as nature strives to take back what it had lost, but marking the boundaries of the lakes may be an impossible task. The Museum of Natural History of the Pfalz (*Pfalzmuseum für Naturkunde*), located in *Burg Lichtenberg*

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<sup>341</sup> Petry, 1988, pp. 89, 290, 381.

has extensive information on the landscape of the past—particularly information regarding the location of water. Additionally, old maps from the local historical institute depict former lakes. An analysis of the path of least cost in addition to a predictive model of the area based upon the previous aquatic surrounding (hydrology) and the viewshed analyses may provide evidence as to the locations of main roads and side paths. Building on the success of integrating historical and digital technologies, future work will combine historical data of roads and lakes with the GIS data.

Creating reconstructions of the castle from the two main phases of its construction (1200 and 1560) using *Autodesk 3ds Max* (a computer automated design software), can allow for a more accurate analysis of its position within the landscape throughout time. However, reconstructed models are at risk for inaccuracies. Hypothetical structures must be noted as such, to prevent any misunderstandings of how the castle may have appear. Fictional structures can significantly alter the interpretation of the site. Thus, all structures must be annotated, including those know to have existed (i.e. the third story of the citadel in the photo from the 1920s). The locations in the letters will be geo-referenced in GIS allowing the landscape to be visualized rather than imagined solely via text, thus reconstructing the past landscape utilizing medieval sources and incorporating the 3D model in the reconstructed network. This virtual environment of the Middle Ages can then be added into the *Unity* game engine, allowing viewers to virtually tour the castle without actually being at the site. This would allow *Burg Hohenecken* to be examined throughout the world, raising both awareness within the general public and digitally preserving it.

The memory and preservation of *Burg Hohenecken* will be an ongoing process involving a variety of digital methods and technologies. Constructing a model of *Burg Hohenecken* using state-of-the-art technology creates an opportunity to recreate the network. The project shares the goals of digital heritage—to preserve and protect cultural heritage sites by recording and analyzing them via digital technologies and methods.

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