2015

Broaching the subject: the geometry of Anglo-Saxon composite brooches

Anna Luella Isbell
University of Iowa

BROACHING THE SUBJECT: THE GEOMETRY OF ANGLO-SAXON COMPOSITE BROOCHES

by

Anna Luella Isbell

A thesis submitted in partial fulfillment
of the requirements for the Master of Arts
degree in Art History in the
Graduate College of
The University of Iowa

May 2015

Thesis Supervisor: Professor Robert Bork

Graduate College
The University of Iowa
Iowa City, Iowa

CERTIFICATE OF APPROVAL

____

MASTER'S THESIS

____

This is to certify that the Master's thesis of

Anna Luella Isbell

has been approved by the Examining Committee for the thesis requirement for the Master of Arts degree in Art History at the May 2015 graduation.

Thesis Committee: ____
Robert Bork, Thesis Supervisor

____
Björn Anderson

____
Wallace Tomasini

I would like to dedicate this thesis in honor of my parents, Richard and Luella Isbell, and in memory of my grandmother, Bettye Jo Isbell. You all supported me throughout my life and in my decision to pursue my passion for art history. Thank you for your unwavering faith in my abilities and for your emphasis on the importance of education.

ACKNOWLEDGEMENTS

I would like to express my gratitude and appreciation to my advisor Professor Robert Bork, who has been a brilliant mentor for me. He inspired my research in geometrical analyses of art and encouraged me to pursue my interest in early medieval metalwork. His guidance has caused me to grow as a scholar and made me a better writer in the past two years. I would also like to thank Professor Björn Anderson and Professor Wallace Tomasini, for taking the time to serve as my committee members and for offering their wisdom.

Furthermore, I wish to thank my parents for their endless love and encouragement. Words cannot express how grateful I am to my mother and father for all of the sacrifices that they have made on my behalf. Their prayers and support for me have sustained me thus far. I would not be where I am today if not for their unwavering love and faith in me. My friends who supported me in my studies, and encouraged me to never give up in my pursuit of knowledge deserve my thanks as well.

ABSTRACT

The various surviving disc and composite brooches provide proof of the skill and craftsmanship of Anglo-Saxon metalsmiths. Surprisingly, no one has conducted a full geometrical analysis of these brooches to discover the design process preceding the casting and decoration. This thesis endeavors to rectify this through a geometrical investigation of the sophisticated geometrical planning principles used by Anglo-Saxon craftsmen in the creation of these elaborate brooches. Through the use of simple geometrical constructions, smiths were able to create works of great beauty and sophistication. Closer inspection reveals that Anglo-Saxon smiths produced all the composite disc brooches in this study using similar processes of planning. In order to plan out the compositions of each brooch, master smiths would only need a compass, a straightedge, and some material on which to write. Each brooch reveals the same kind of coherent geometry, sharing traits and patterns; with proportions tend to be governed by a series of modular association.

Although the master smiths or designers of the composite brooches used simple tools to create the composition, the figures in this thesis were created using the Vectorworks CAD program. This significantly expedited the analytical process and allowed for exact measurements. Despite using the computer program to replicate the planning process, all the figures can be recreated with just a compass and straightedge. While a complete geometric study of all the composite disc brooches needs to be done, this study examines five of the best preserved and well-crafted of that type, ranging from some of the simplest to the most elaborate, as an introduction to the subject.

PUBLIC ABSTRACT

The glittering and gleaming artifacts that can be found in Anglo-Saxon archaeological sites capture the imagination, conjuring up images of a warrior culture that displayed its wealth through wearable objects. Although many people still believe that creativity and learning were largely lost during the so-called "Dark Ages," standards of craftsmanship remained high and works of art were expertly planned and executed. This is especially apparent in the jewelry of the Anglo-Saxons, more specifically their composite inlaid brooches.

These items of prestige not only demonstrate the desire for public displays of importance in society but also exhibit the talent and skill of the Anglo-Saxon goldsmiths. Such craftsmen worked for years to hone their craft and undoubtedly designed their works in advance so as to not waste precious materials. The different facets of the brooches' construction and planning show how these Kentish composite brooches are intricate works of art and reflect their importance to the Anglo-Saxons. Surprisingly, no one has conducted a full geometrical analysis of these brooches to discover the design process preceding the casting and decoration. This thesis endeavors to rectify this through a geometrical investigation of the sophisticated geometrical planning principles used by Anglo-Saxon craftsmen in the creation of these elaborate brooches.

TABLE OF CONTENTS

APPENDIX A: LIST OF TABLES

APPENDIX B: LIST OF FIGURES

INTRODUCTION

This thesis describes the sophisticated geometrical planning principles used by Anglo-Saxon craftsmen in the creation of elaborate brooches, which rank among the most impressive specimens of early medieval metalwork. These techniques have been little studied to date, and the art of the Anglo-Saxons and other migratory, "barbaric" peoples of Europe remains poorly understood more generally. Many people still view artworks of that period as products of the so-called "Dark Ages," in which creativity and learning were supposedly minimized by greater physical needs in a struggle for survival. Such views lead to misconceptions about the design of artwork at the time, causing some to believe that pieces were created without a solid plan or guide. While the art did not have a template as such, each piece was thought out ahead of time and some reflect workshop practices.

While certain facets of classical learning were admittedly less apparent in Britain after its abandonment by the Roman Empire, standards of craftsmanship remained high during this time. The design and manufacture of illuminated manuscripts, sculpture, and jewelry attest to this fact. Artisans were especially careful in creating symbols of prestige, such as the renowned disc brooches. Such attention to detail reflects the fact that Germanic art has a long history of skilled artistry. Indeed, several Germanic peoples co-existed with the Romans in England, serving as both mercenaries and craftsmen in England even before the advent of Anglo-Saxon rule.

By the fifth and sixth centuries, many people of German heritage resided on the island. The Venerable Bede, writing in 731 CE about the settlement of England during the preceding centuries, stated that "those who came over were from the three most

formidable races of Germany, the Saxons, Angles, and Jutes."[1] He maintained that these heathen conquerors pillaged and devastated all settlements, overrunning the whole of the island.[2] While Bede's account provides a wealth of information and paints a picture of the various skirmishes between these groups, there was no single invasion of the land by Germanic peoples. Instead, their population steadily increased after the island's break with Rome as more mercenaries were needed for defensive purposes, and as others arrived by ship on some of the unmanned coasts.[3] Whether the Anglo-Saxons invaded or immigrated more peacefully, they came to stay. Since they were primarily pagan, little Christian art was produced in England between the Roman exodus and the beginning of the island's reconversion to Christianity in the late sixth century. It was at that time that Pope Gregory I sent St. Augustine and other missionaries to convert the heathens of the island.[4]

The effort to convert the Anglo-Saxons coincided with the production of some of the most intricately designed artifacts from the early medieval period. These include illuminated Bibles, such as the *Lindisfarne Gospels*, and elaborate metalwork objects of personal adornment, exemplified by the brooches that will occupy center stage in this thesis. Although few written sources exist from the pre-Christian period, many documents from the monasteries and Christian missionaries have survived, giving

---

[1] Venerable Bede, *Bede's Ecclesiastical History of England,* trans. A. M. Sellar (London: George Bell and Sons, 1907), 63.

[2] Ibid, 64. He also tells of how a descendant of the Romans won a great battle against these invaders with the help of God. His book provides a wealth of information for those interested in the foundation of the Church in England and the subsequent conversion of the various peoples who lived there.

[3] Richard Muir, *The National Trust Guide to Dark Age and Medieval Britain: 400-1350* (London: George Philip/The National Trust and the National Trust for Scotland, 1985), 16.

[4] George Henderson, *Vision and Image in Early Christian England* (Cambridge: Cambridge University Press, 1999), 17-18. Pope Gregory sent Augustine and his colleagues in part to convert the Anglo-Saxons, but also to bring the heretical practices of the British Christians in line with those of the Roman papacy, which they refused. See, Bede, *Ecclesiastic History of England;* and, Henderson, *From Durrow to Kells,* 9-10.

scholars valuable insight into the meanings and use of these objects. Despite this proliferation of literary and documentary sources, however, information about the working techniques and design processes of craftsmen remains scarce.[5] The original manuscript of *The Anglo-Saxon Chronicle* spans the timeframe from the advent of the first invasions of England to the year 1154. As such, it is one of the most comprehensive firsthand accounts of the Anglo-Saxons. Unfortunately, that manuscript only provides historical context for the period and does not shed light on the art of the time. Few documents offer any evidence for the actual making of metal artifacts, and instead, focus on the stories of prestigious smiths and artists, or center on the aspects of ownership and uses of the objects.[6] Compounding this problem, few examples of Anglo-Saxon workshops or smithies survive, even as archaeological traces. Therefore, knowledge about the planning and creation process must be discovered using later-written sources and from the works of art themselves. It is only through careful observation and geometrical analysis that these aspects of the objects can be revealed.

Historiography:

The amount of scholarship on Anglo-Saxon design techniques remains minimal, measured against the larger literature on the physical production and crafting of artifacts. However, several studies by eminent scholars have shown that geometric analysis can successfully reveal the planning process involved in Anglo-Saxon art, in media ranging from illuminated manuscripts to jewelry. Rupert Bruce-Mitford, for example, completed extensive work dissecting the proportions and layout of manuscript pages, concluding that these patterns were carefully charted before they could be painted onto the vellum.

[5] Leslie Webster, *Anglo-Saxon Art: A New History* (New York: Cornell University Press, 2012), 8.
[6] Elizabeth Coatsworth and Michael Pinder, *The Art of the Anglo-Saxon Goldsmith* (2002), 3.

Scribes used compasses and rulers/straightedges to plan these compositions. Those two tools would also be instrumental in the designing process of other art, such as jewelry. Essentially, the same design principles and processes of unfurling and twisting geometry cross many mediums of Anglo-Saxon art.

This can be seen in the work of Robert D. Stevick, who has studied manuscripts, stone crosses, and jewelry. His book, *The Earliest Irish and English Book Arts,* examines the layout of seventh-century manuscripts and their geometric construction. His research clearly illustrates the precision of the drafting process and how its steps can all be linked back to a single measure or simple shape, such as a square. By providing step-by-step instructions for the compositions, Stevick successfully communicates his ideas and proves the correlating relationships between the different parts of the pages' designs.[7] In his figures, Stevick illustrates how the layout of the manuscript pages is established through the use of basic constructive geometry. Through this, the scribe utilizes simple shapes and ratios in order to create the compositions.[8] Although many of the books and pages Stevick examined are Hiberno-Saxon in origin, these same principles can be applied to Anglo-Saxon manuscripts.

Stevick has also shown that the same sort of designing processes were used in the design of Irish high crosses.[9] These crosses and illuminated manuscripts pulled from the already established traditions and motifs found in metalwork. Ironically, the metalwork

---

[7] Robert D. Stevick, *The Earliest Irish and English Book Arts: Visual and Poetic Forms Before AD 1000* (Philadelphia: University of Pennsylvania Press, 1994), 6.

[8] The word 'geometry' will be used quite a bit in this thesis. It is important to note that the medieval ideas of geometry and mathematics are not the same as they are in the present day. Medieval people employed ratios and basic shapes to plan art out as a series of steps instead of using precise measurement systems or arithmetic formulas to figure out the composition. For a full explanation of the medieval design methods and geometric methods, see Doran, "Mathematical Sophistication of the Insular Celts," 259-289; and Stevick, *The Earliest Irish and English Books*, 1-14.

[9] Robert D. Stevick, "Shapes of Early Sculptured Crosses of Ireland," *Gesta* 38 (1999): 3-21.

that influenced book arts has not been studied as comprehensively. Stevick's article "The Form of the Tara Brooch" shows how its form was conceived as a series of rounded arcs and straight lines.[10] As arguably the most famous brooch from Western Art History, the Tara Brooch has been studied extensively by medieval scholars. Despite its fame, no one had fully investigated its geometrical design and spatial relations until Stevick published his article in 1998.

Few articles and books address the geometrical designs and proportional relationships involved in composing the fabulous and famous round brooches of early medieval England. Derek Hull's book *Celtic and Anglo-Saxon Art: Geometric Aspects* from 2003 addresses the Kingston brooch briefly but does not fully investigate the ratios in its design and their relationship to one another.[11] Instead, he focuses on how the brooch consists of concentric circles that have different types of symmetry. As such, Hull's brief examination considers the geometric nature of the decoration within the different circles but not how the concentric circles were conceived. In other words, his interest lies more in the appearance of the ornament rather than in the details of its conception. Hull's book also addresses the same geometric designs that appear in illuminated manuscripts.

The idea of studying both book arts and metalwork together is appropriate since the intricacy of line found in the spirals and interlace of books like the *Lindisfarne Gospels* can also be seen in examples of metalwork. Much of the scholarship on Anglo-Saxon

---

[10] Robert D. Stevick, "The Form of the Tara Brooch," *The Journal of the Royal Society of Antiquaries in Ireland* 128 (1998): 5.

[11] Derek Hull, *Celtic and Anglo-Saxon Art: Geometric Aspects* (Liverpool: Liverpool University Press, 2003), 55-58.

Still, Hull does write about the different symmetries of the concentric circles. His examination is a step in the right direction but must be taken further.

metalwork focuses on the establishment of ecclesiastical centers as patrons, creation of illuminated manuscripts, important burials like Sutton Hoo, or on metalwork in general terms, with little attention to design and geometry. Similarly, there are a number of broad overviews for Anglo-Saxon art that briefly address the importance of personal adornment and the mediums of gold, silver, and bronze.[12] These mostly concentrate on social significance and cultural values, which are important for understanding the creation of the pieces. These publications use a socio-cultural methodology that complements my more technical methodology of design analysis.

Overall, recent publications that consider Anglo-Saxon jewelry and explore it in its own context are rare. The subject appears more often in scholarship on early medieval Irish metalwork when exploring exchange with the Anglo-Saxons. Some scholars have conducted research on the way that Anglo-Saxon metalwork styles became entrenched in the Irish tradition but they disagree on how this was done.[13] Other scholars focus only on the technical and stylistic aspects in relation to how they were integrated into Irish metalwork.[14] Ironically, these publications provide much of the bulk of the information

---

[12] For more information on the socio-cultural importance of brooches as prestige items, please see: Niamh Whitfield, "The 'Tara' Brooch: An Irish Emblem of Status in Its European Context," in *From Ireland Coming: Irish Art from the Early Christian to the Late Gothic Period and Its European Context*, edited by Coum Hourihane, (Princeton, NJ: Princeton University Press, 2001), 211-247.

Elizabeth Coatsworth and Michael Pinder. *The Art of the Anglo-Saxon Goldsmith: Fine Metalwork in Anglo-Saxon England: its Practice and Practitioners* (Woodbridge, UK: Boydell Press, 2002), 227-234.

T. D. Kendrick, *Anglo-Saxon Art to A.D. 900* (London: Methuen & Co. Ltd., 1938), 62-73.

[13] Françoise Henry, *Irish Art in the Early Christian period to AD 800* (London: Methuen, 1965), 171.

James Graham-Campbell, "The Lough Ravel, Co. Antrim, Brooch and Others of Ninth-Century Date," *Ulster Journal of Archaeology* 36/37 (1973/1974): 55.

Henry and Graham-Campbell disagree on this. Francoise Henry claims Anglo-Saxon items were brought into Ireland where they were first copied and then transformed to create new style. However, she does not have archaeological evidence to support this. Graham-Campbell rejects this though as he believes that the development of Hiberno Saxon style occurred in Northumbria via monasteries like Lindisfarne. He cites the absence of Anglo-Saxon objects in Ireland as flaw of Henry's thesis.

[14] Niamh Whitfield, "Filigree Animal Ornament from Ireland and Scotland of the Late-Seventh to Ninth Centuries: Its Origins and Development," in *The Insular Tradition,* ed. Catherine E. Karkovet al. (New York: State University of New York Press, 1997), 211-244.

on techniques of Anglo-Saxon metalsmiths, including a wealth of knowledge on the techniques of the Anglo-Saxons that is not easily found in writings that focus solely on Anglo-Saxon art. One exception is *The Art of the Anglo-Saxon Goldsmith* by Elizabeth Coatsworth and Michael Pinder, from 2002. Coatsworth and Pinder offer an overview of archaeological evidence for goldsmiths, their place in society, the influences on their art, the techniques used, and the design process. Despite their in depth examination of the topic, only a few pages mention any sort of geometrical analysis and their illustrations are basic. Therefore, the process needs to be expanded to include the individual types of jewelry that were made in such workshops, such as the composite brooches created in the late sixth to mid-seventh centuries. The geometrical studies in this thesis will produce more detailed figures and will more fully explain the process.

Of the research that focuses solely on Anglo-Saxon jewelry, most dates to the 90's or earlier. These include Ronald Jessup's *Anglo-Saxon Jewellry* from 1950, Richard Avent's 1975 archaeological report *Anglo-Saxon Disc and Composite Brooches*, and the 2000 book *The Quoit Brooch Style and Anglo-Saxon Settlement: A Casting and Recasting of Cultural Identity Symbols* by Seiichi Suzuki.[15] Although Suzuki's book does not include disc brooches, it provides an excellent framework for studying organization of a brooch type and its design, comparing decorative motifs, and investigating the quoit

---

Raghnall Ó Floinn, "Irish Metalwork: The Anglo-Saxon Connection," in *Anglo-Saxon Irish Relations before the Vikings*, ed. James Graham Campbell and Michael Ryan (Oxford, UK: Oxford University Press, 2009), 231-252.

Several of Niamh Whitfield's essays and articles deal with different components, studying them carefully to determine where techniques and styles originated. Raghnall Ó Floinn's essay reviews the evidence of interaction and influence between the Irish and Anglo-Saxons through close examination of archaeological finds and their designs.

[15] Jessup, Ronald. *Anglo-Saxon Jewellry.* London: Faber and Faber, 1950.

Avent, Richard. *Anglo-Saxon Disc and Composite Brooches,* vol. 1 and 2. Oxford: British Archaeological Reports, 1975.

Suzuki, Seiichi. *The Quoit Brooch Style and Anglo-Saxon Settlement: A casting and recasting of cultural identity symbols.* Woodbridge, UK: Boydell Press, 2000.

brooch's meaning in a socio-cultural context.[16] Her inferences on the importance and prestige connected to brooches during the Migration Period can also be applied to other brooch forms. Jessup and Avent's publications agree with this assessment in their brief writings about the socio-cultural aspect of disc brooches in some of their publications. Avent's publication focuses more on dividing the different round brooch brooches into classifications based on their construction and decoration. Therefore, disc brooches are split into several typologies that are then divided even further into classes. He also documents the different types of filigrees and cloisonné shapes. Overall, his work creates a system for recognizing and cataloguing the brooches.

Instead of focusing on the socio-cultural meanings or the classifications of these brooches, this thesis provides a valuable perspective through its examination of the geometry within composite brooch design in an effort to show how the craftsmen began formulating the compositions of their brooches. The study is not meant to be a comprehensive look at the geometry of these brooches but rather, an introduction to the possibilities that such studies can offer to the discourse surrounding early medieval intellectual and technological developments. Indeed, this thesis will open the doors for further exploration on the properties of design and creation of Anglo-Saxon metalwork. The primary aim of this work is to study the geometric designs of the composite brooches' compositions in depth, not to comprehensively discuss the various external influences on their styles, the place of the workshop, or the techniques utilized. While some information on these subjects will be provided to more fully appreciate the work

[16] Seiichi Suzuki, *The Quoit Brooch Style and Anglo-Saxon Settlement: A casting and recasting of cultural identity symbols* (Woodbridge, UK: Boydell Press, 2000), 1-7.
Made in the early Anglo-Saxon period, quoit brooches are characterized by a round band around an empty center. The surface of the band is usually highly decorated. Decorations include a variety of zoomorphic and geometric motifs achieved through punching and chip-carving.

and to grasp the compositional challenges, readers are advised to seek out other sources for more knowledge. That having been said, a brief explanation of the different type of round brooches will be helpful in order to fully understand the different components of the composite brooch type.

Types of Brooches:

Unsurprisingly, there are several types of disc brooches as well as brooches organized into other categories. Keystone brooches are considered the simpler of the brooch types as they are cast in one piece. A prime example of this would be Avent's brooch 109 from Dover that now resides in the British Museum (Fig. 1). The center of all of these brooches is made up of a circular setting with a stone or shell inlay that can be either flat or raised. The raised inlay usually has a round garnet, or less typically white shell or white paste, in the center. Several T-shaped or wedge shaped settings branch out from this core. Typically, these settings are separated by animal ornament in the simpler keystone brooches and another style of setting in the more complicated examples. The more complex settings will be either circular or T-shaped and made of stone or the same white material as the center piece. Animal ornament decorates the spaces in-between the two types of settings.[17] In comparison, the plated disc brooches contain two separate pieces: a silver back-plate and a gold front-plate. Both parts are cast and fit together afterwards to form one piece like in brooch 153 in Avent's classification (Fig. 2). The gold-front typically has a central setting like those in the keystone brooches, which is usually encircled by a cloisonné ring. Three or four triangular cloisonné settings emanate out from that ring with their pinnacles pointing towards the rim of the brooch. Halfway

[17] Richard Avent, *Anglo-Saxon Disc and Composite Brooches,* vol. 1 (Oxford: British Archaeological Reports, 1975), 1.

between each of those triangles lie a satellite medallion so that four of them are placed between the rim and the central setting. Panels with filigree decorate the areas in the middle.[18] These were added to the gold front-plate after it was joined to the silver back-plate. As such, the keystone and plated disc brooches can be similar in appearance.

The rarest classification of round brooch is that of the composite disc brooch. Richard Avent only catalogues fifteen examples in his rather comprehensive archaeological report *Anglo-Saxon Garnet Inlaid Disc and Composite Brooches*.[19] That number was later expanded in Michael Pinder's article "Anglo-Saxon Garnet Cloisonné Composite Disc Brooches: Some Aspects of their Construction" from 1995, where he lists eighteen examples.[20] Found primarily in Kent, these brooches tend to be thicker than the other two types and typically combine three round plates. These three plates consist of a gold or bronze front-plate; a silver, gold, or bronze back-plate; and a middle-plate in between the two that can be made of bronze or copper. The back-plate is soldered onto the middle-plate and the gold rim of the top plate folded over to fix the back and front-plates together.[21] Panels of filigree and cloisonné inlay cover the front-plate. Like the other two types of disc brooches, these also have a central boss, usually made of white shell encircled by a garnet cloisonné ring.[22]

The different facets of their construction and the planning show how these Kentish composite brooches are intricate works of art, which reflects their importance to the Anglo-Saxons. Surprisingly, no one has conducted a full geometrical analysis of these

[18] Avent, *Anglo-Saxon Disc and Composite Brooches*, vol. 1, 1.
[19] Ibid, 48-55.
Most of the measurements and data on provenance will come from this two volume publication.
[20] Michael Pinder, "Anglo-Saxon Garnet Cloisonné Composite Disc Brooches: Some Aspects of their Construction," *Journal of the British Archaeological Association* 148 (1995): 15.
[21] Ibid, 8-9.
[22] Ibid, 1.

brooches to discover the design process preceding the casting and decoration. Indeed, the construction of these brooches is only rudimentarily covered by Avent. Unfortunately, most of the scholars tend to focus on the stylistic details and how they reflect the broader trends in Anglo-Saxon garnet inlaid metalwork. This focus on jewelry in a more generalized sense, while using composite brooches as brief examples, pervaded much of early medieval scholarship during the twentieth century.[23] It was not until Michael Pinder published his article that the manufacture of the composite brooch was truly investigated in depth. In "Anglo-Saxon Garnet Cloisonné Composite Disc Brooches: Some Aspects of their Construction," Pinder discusses the major components that make up the composite brooches and divides each into typologies. By describing the construction of the brooches, he provides a structural survey that had been previously ignored in the scholarship. Thus, it is now known that the rims were soldered to the base-plate before any of the garnets could be inlaid and that a paste made of calcite adhered the garnets to their gold-foil-covered cells.[24] Yet, his article does not delve into the planning process that occurred before manufacture could begin.

Towards a Geometrical Understanding of the Composite Brooch Design:

The smiths who designed the composite brooches needed to plan them out beforehand, just as the scribes who created the *Lindisfarne Gospels* and other masterfully designed illuminated manuscripts of the period would have planned their compositions. Vellum would have been too costly for this process, and so another option was essential to the process. It is likely that Anglo-Saxon craftsmen used wax tablets or bone fragments

[23] For examples of this, see: T. D. Kendrick, "Polychrome Jewelry in Kent," *Antiquity* 7 (1933): 429-452; or Ronald Jessup, *Anglo-Saxon Jewellery* (London: Faber and Faber, 1950), 114-119, pls XXIV-XXVII.

[24] Pinder, "Anglo-Saxon Garnet Cloisonné Composite Disc Brooches", 7-8.

to plan out preliminary designs. This inexpensive system allowed the smiths, sculptors, and scribes of the time to sketch out their ideas in preparation for the permanent object. Wax tablets could also be reused once the artist was finished with the design by heating the wax and then flattening it back out.[25] Bones were easily acquired and could be thrown away when done. It is important to note that these were not just simple designs, but rather, multifaceted plans requiring a compass and straight edge to prepare compositions based on intersections and proportions. While this may seem uncomplicated at first glance, the ways that those tools were used are not instinctual and would have required detailed training, just like the actual metal working techniques utilized in the manufacture of these intricate works of art.

To some, the designs of these brooches may seem rather simple. After all, are they not just rings and circles put together haphazardly? In truth, they require much thought and planning. The brooches employ specific proportions that fill the designs in such a way that each brooch resembles the others without following the same proportions or design. The circles are not arbitrarily sized for each one has a specific size determined by the preceding circle or line. Often, the brooches can be divided into multiples of two or three and thus four, six, eight, and nine. Division into fifths and tenths happen less but, nevertheless, occurs at least once. The relationship of these proportions is not accidental. This leads to the conclusion that the brooches were seriously and fully thought out before any of the decorative material could be applied to the actual metal plates. Even so, the models in this study show the ideal forms of the brooches. When working with metal, there is always a chance for departures from the accuracy in plans. In general, the brooches tend to be surprisingly precise for designs copied into cast gold and bronze with

[25] Janet Backhouse, *The Lindisfarne Gospels* (Oxford: Phaidon, 1981), 31.

cloisonné inlay. Truly, even the pieces with less "exact" renderings show sizes and proportions that are accurately set. It is typically the roundness of the circles that is in question.[26] In some cases, the centers of the circles are not oriented according to the rest of the plan. Despite any inaccuracies, the designs of these brooches show a remarkable amount of skill and forethought. It is this preliminary process of planning the composition that remains a mystery to scholars and that this thesis hopes to uncover.

[26] Robert Stevick, "The Forms of the Monasterevin-Type Discs," *The Journals of the Royal Society of Antiquaries of Ireland* 136 (2006), 132.
In this way, the composite brooches share some of the same traits and display some issues similar to the Monasterevin Discs. Photos taken from raking angles can also introduce distortions that must be understood and controlled prior to geometrical analysis.

CHAPTER I: COMPLEXITY IN DESIGN AND MEANING

Although rare, brooches made of precious metals have been found in the Kentish area. It is important to stress that these brooches and the brooches in this study belonged to members of the elite and that the non-elites wore brooches with plates of iron or bronze instead of gold or silver.[27] All of the eighteen documented examples were found in the graves of wealthy women or of unsexed skeletons, on or near the shoulder or neck.[28] The evidence provided through burials supports the accepted idea of women fastening their cloaks with a single brooch in the middle of the breast or wearing the brooches somehow suspended.[29] Many brooches are thought to have been worn as part of a pair. However, the composite brooches are rather heavy and so most likely functioned more as special decorative symbols of prestige instead of everyday jewelry. By the sixth century, the Anglo-Saxons undoubtedly valued their brooches highly as visible manefestations of social rank.[30]

During the fifth century, gold and silver were rarely if ever used for brooches. This shifted during the late sixth and seventh century as a fashion for gold use spread into Southern England from the east and the south. This new use of precious metal helped to give the brooches more meaning. Evidence for the connection with the East can be found

---

[27] Gale R. Owen-Crocker, *Dress in Anglo-Saxon England* (Rev. ed. Woodbridge, UK: The Boydell Press, 2004), 37.

[28] Pinder, "Anglo-Saxon Garnet Cloisonné Composite Disc Brooches", 6.

Avent's report states that only the Kingston brooch was located between the neck and right shoulder. All the others were found on the chest of the deceased. Although Pinder writes that the placement was closer to the neck, contents of graves can be shifted and it is more likely that the brooches were placed on the sternum. Quite a few of the skeletons are identified as female but some remain unrecorded. No record exists of a composite brooch being found in a male grave.

[29] Howard Williams, *Death and Memory in Early Medieval Britain* (Cambridge: Cambridge University Press, 2006), 67.

While pairs of brooches sometimes held up peplos-like garments, this was not always the case.

[30] Avent, *Anglo-Saxon Disc and Composite Brooches*, vol. 1, 3.

This value extended past the brooches' function as a fastening device. After some were passed down as heirlooms, their clasps broke and so they were given a secondary function as pendants or were repaired.

in references to Byzantine gold coins of the *nomisma* variety from *The Chronicle of Hugh Candidus* as early as the seventh century.[31] It is possible that this trade with the East transpired through the Anglo-Saxons' engagement with the Frisians, who controlled much of the trade in the Baltic Sea before the ninth century and the advent of Viking power.[32] The Anglo-Saxons likely obtained silks, gold and violet manuscripts, and metal objects from the East through the Frisians by the early seventh century.[33] Gold and silver also made their way to England via France. The Byzantine emperors gifted riches to the Frankish kings during this period and the gold coins that made up these subsidies travelled across the English channel due to Kent's relationship and proximity to the Frankish kingdom.[34] The "superior" metalwork from Kent reveals this access to the wealth and styles of France.

The growing connection between Kent and continental Europe resulted in changes to Kentish jewelry beyond the material. Round brooches had been made in Kent from the late fifth century, and although their Jute neighbors wore saucer brooches, the introduction of key decorative features from the Franks helped to shape the new Kentish disc brooches.[35] The first keystone garnet disc brooches date to the second quarter of the sixth century, roughly half a century after the introduction of similar forms on the continent. Still, the Anglo-Saxon smiths cannot be accused of simply copying the forms

---

[31] C. R. Dodwell, *Anglo-Saxon Art: A New Perspective* (1982), 155.

[32] Georges Duby, *The Early Growth of the European Economy: Warriors and Peasants from the Seventh to the Twelfth Century* (New York: Cornell University Press, 1974), 103-104.

[33] Dodwell, *Anglo-Saxon Art: A New Perspective*, 157.
Indeed, the Codex Amiatinus has a several violet pages illuminated with imitation gold. This reveals that the Anglo-Saxons were already adopting Byzantine styles by the early eighth century when that manuscript was produced.

[34] Webster, *Anglo-Saxon Art: A New History*, 63.

[35] Avent, *Anglo-Saxon Disc and Composite Brooches,* vol. 1, 6.

or stylistic elements of Frankish jewelry. The Kentish kingdom was well established and bursting with activity by the seventh century, with its own aesthetics.[36]

The influence of the Franks can also be seen in the interlace decorating many of the brooches. Interlace examples can be found in early pagan Anglo-Saxon England using both abstract and zoomorphic forms from as early as the early seventh century. The prototypes of interlace emerged in Roman art (Fig. 3).[37] The non- zoomorphic Roman plaitwork was often used as a border on mosaic pieces. This type of design was readily adopted and then expanded on by Germanic peoples, who developed even more intricate patterns.[38] The Anglo-Saxons interlace derived from the two main European traditions: Style I and Style II.[39] Of the two, Style II would have the most lasting impact on Anglo-Saxon composite brooches. Developed on the continent, this type of interlace entered England through ties with the Franks in the sixth century. By the early seventh century, it had become a staple of Anglo-Saxon decoration as exemplified by the gold and garnet shoulder clasps from Sutton Hoo (Fig. 4). Anglo-Saxon craftsmen would not have been able to master the art of interlace intuitively. These types of patterns have to be planned out well in advance just like in the illuminated manuscripts of the time.

While Christianity reappeared throughout England at this time, its impact of it on these brooches is not as overt as it is in manuscripts. The Augustinian Christian missionaries successfully spread Roman and Mediterranean artistic traditions in conjunction with the Christian faith, resulting in some jewelry with southern stylistic

[36] Webster, *Anglo-Saxon Art: A New History*, 66.

[37] Carl Nordenfalk, *Celtic and Anglo-Saxon Painting: Book Illumination in the British Isles 600-800* (New York: George Brazeller, 1977), 14.

[38] Lloyd Laing, *European Influence on Celtic Art: Patrons and Artists* (Dublin: Four Courts Press, 2010), 64-66.

[39] Ernst Kitzinger, *Studies in Late Antique Byzantine and Medieval Western Art*, Vol. II (London: The Pindar Press, 2003), 802.
The question of when and where these styles developed is still being hotly debated.

flair. However, the composite brooches mostly adhere to the so-called “barbaric” motifs and craftsmanship of their Germanic heritage. Evidence of this Germanic legacy manifests itself in the garnet inlay, geometric patterns, and interlacing Style II ornamentation.

The delicate craft of goldsmithing requires a great deal of skill for fine, detailed work. Most of the equipment necessary for the craft is portable and the stationary pieces are only used for certain techniques.[40] Characterized by abstracted, non-figural ornamentation, the use of dynamic line, and geometric patterns, the metalwork of the Anglo-Saxons represents the larger aesthetics of the culture. Kentish craftsmanship, in particular, is renowned for its delicate decoration and superb handling of cloisonné.[41] According to Coatsworth and Pinder, the Anglo-Saxons did not differentiate between different types of smiths, using the term to refer to all metalworking craftsmen.[42] This could indicate that smiths had a broader knowledge of different metals and did not work in gold or copper alloy exclusively. Still, it is likely that some only worked in fine metals while others completed more traditional “blacksmith” work with iron and bronze.

During the sixth century, smiths cast the faces of the brooches to include settings that they filled with garnets. By the end of the century, the smiths began to do that same work by hand in order to create more elaborate designs out of the gold cells, or cloisons.[43] It is likely that goldsmiths did not own their gold or silver and that the metal was provided by their patrons. This could be in the form of ingots, old coins and jewelry, or raw material. The recycling of previously worked material required the smith to refine the

[40] Coatsworth and Pinder, *Art of the Anglo-Saxon Goldsmith*, 24.
[41] T. D. Kendrick, *Anglo-Saxon Art to A.D. 900* (London: Methuen & Co. Ltd., 1938), 62.
[42] Coatsworth and Pinder, *Art of the Anglo-Saxon Goldsmith*, 3.
[43] Ibid.

substance in order to remove any impurities.[44] Once that occurred, the metal could be recast. There are no existing moulds that were used to cast Anglo-Saxon brooches. Due to the lack of examples, archaeologists posit that the moulds were made of biodegradable material such as sand or clay.[45] After the plates had been cast and put together, the decorations could be added.

One of the most significant decorative techniques used by Anglo-Saxon smiths was that of filigree. Filigree is most often thought of as being small wires or filaments of metal affixed to a surface as delicate embellishment. Typical filigree is composed of either twisted wires, tiny beads, or sometimes both that are soldered to the surface of an object. This technique allows a craftsman to create intricate, raised designs. Often, craftsmen use precious metals, such as gold and silver, which are more malleable and easier to melt. Ironically, those same characteristics cause gold and silver to be simultaneously easier and harder to make into filigree. On the one hand, the smith can melt down those metals and shape them without much trouble. However, he must then be extra vigilant to not heat the beads too much or they will simply run off the surface on which he wishes to place them. Although most consider filigree to include the small beads of metal, there are numerous techniques that are considered filigree. These include beaded wire, round twisted wires, twisted beaded wires, and combinations of the above.[46] In order to avoid confusion, the term granulation is often used in reference to small beads of metal affixed to the surface.

---

[44] Coatsworth and Pinder, *Art of the Anglo-Saxon Goldsmith*, 34.

[45] Ronald Jessup, *Anglo-Saxon Jewellery* (London: Faber and Faber, 1950), 42.

[46] Niamh Whitfield, "The Filigree of the Hunterston and 'Tara' Brooches," in *The Age of Migrating Ideas: Early Medieval Art in Northern Britain and Ireland,* ed. R. Michael Spearman and John Higgitt (Edinburgh: National Museums of Scotland, 1993), 120-121.

The amount of detail work on these brooches astounds most viewers. For not only is filigree placed on the front of the pieces but on the edges and surfaces of the stud cells. Using filigree in this manner can also be found in much of Anglo-Saxon and Germanic metalwork, both of which translated the practices of antique sources.[47] This influence from Germanic metalwork appears in how the smiths attached the filigree. Instead of placing it directly on the surface of the brooch, craftsmen soldered the filigree to small plates of gold-foil, which were then pasted to the brooch.[48]

The Anglo-Saxons brought the techniques for garnet inlay with them when they migrated to England and there are many continental examples the same technique. The garnets in each brooch were an integral part of the design and manufacture of the composite brooches. Different types of cloisonné were utilized by Anglo-Saxon craftsmen. Gold foil backing enhanced the color of the garnets and created an effect similar to enamel.[49] The deep red color was achieved by cutting the garnets into thin sheets and placing them on a gold background. In other words, small pieces of gold foil behind each garnet caused the stones to appear more luminous by reflecting the light shone on them and by deepening the color of the stones (Fig. 5). Although extremely thin with a thickness of 10 to 20 microns, the tiny foil pieces assist in the awe-inspiring effect of the brooches. Without them, the garnets would lack the luster for which these objects are famous.[50] Cutting the garnets was time consuming and difficult as they are brittle

---

[47] Niamh Whitfield, "Motifs and Techniques of Celtic Filigree: Are They Original?" in *Ireland and Insular Art: A.D. 500-1200*, ed. by Michael Ryan. (Dublin: Royal Irish Academy, 1987), 75.
[48] Whitfield, "Motifs and Techniques of Celtic Filigree, 77.
[49] Jessup, *Anglo-Saxon Jewellery*, 49.
[50] Coatsworth and Pinder, *Art of the Anglo-Saxon Goldsmith*, 141-142.

stones that fracture easily. Some still debate on whether the garnets were cut especially for each brooch or were paired down from garnets cut at an earlier time.[51]

The various surviving disc and composite brooches provide proof of the skill and craftsmanship of Anglo-Saxon metalsmiths. Close examination of these wearable pieces of art offer evidence of how the designs were conceived and then manufactured. While a complete geometric study of all the composite disc brooches needs to be done, this thesis will examine five of the best preserved and well-crafted of that type. The Kingston Down brooch exemplifies this, as it is the largest and arguably most impressive of the composite brooches. However, the other four examples show a remarkable amount of skill as well and are equally able to show the design process. The complex methods of crafting these works of art required skill and dexterity in addition to a wide variety of raw materials that needed to be processed before the brooch's creation.[52] Most scholars have been fascinated by the manufacture of the metals, stones, and panels that were married in these works of art. The amount of scholarship on the processes like purification, stone cutting, and smelting shows the increased interest in the steps before the production of the brooch could be underway. However, these inquiries can only go back so far, and few have considered the sheer amount of work that must be done before the smith even touched his tools or the materials. After all, he must have a design for his creation before embarking on the crafting process itself.

---

[51] Coatsworth and Pinder, *Art of the Anglo-Saxon Goldsmith*, 145.
[52] Ibid, 86.

CHAPTER II: THE BROOCHES AS A STEP BY STEP PROCESS

The designs of each brooch reveal the same type of coherent geometry, sharing traits and patterns.[53] All are circular discs containing tiers of concentric circles and four satellite medallions. The figures in this study show a surprisingly complex mode of design from Britain's so-called "Dark Age." Through the use of simple geometrical constructions, smiths were able to create works of great beauty and aesthetic sophistication. The disc brooches' proportions tend to be governed by a series of modular association. Closer inspection reveals that Anglo-Saxon smiths produced all the composite disc brooches in this study using similar methods of planning.

Geometrical analysis helps illuminate the design process between the different tiers of frames and the typical placement of the four satellite medallions. Although the final products may differ slightly from the idealized geometry shown here, the purpose of this study is to show the likely steps of the design process.[54] Although the perfect geometry of the designs may not always line up completely with the actual brooches, this sort of geometrical imprecision is not unheard of. Indeed, such differences in proportions from the original designs occur in many mediums throughout history, including jewelry and architecture.[55]

The various surviving disc and composite brooches provide proof of the skill and craftsmanship of Anglo-Saxon metalsmiths. Although the master smiths or designers of the composite brooches used simple tools to create the composition, the figures in this thesis were created using the Vectorworks CAD program. This expedited the analytical

---

[53] Robert Stevick, "The Forms of the Monasterevin-Type Discs," 112.

[54] Further investigation into the actual geometry on the physical objects will have to be completed at a later date.

[55] Robert Bork, *The Geometry of Creation: Architectural Drawing and the Dynamics of Gothic Design.* Burlington, VT: Ashgate, 2011, 11.

process significantly and allowed me to be exact in my measurements. Despite using the computer program to replicate the planning process, all the figures can be done using a compass and straightedge. Close examination of these wearable pieces of art offer evidence of how the designs were conceived and then manufactured. While a complete geometric study of all the composite disc brooches needs to be done, this study will only examine five of the best preserved and well-crafted of that type, ranging from some of the simplest to the most elaborate.

The Faversham Brooch:

One of the earlier examples of a composite brooch from Faversham, labeled as brooch 169 in Avent's book, demonstrates the steps of design in an easy to follow manner (Fig. 6). Avent's belief that this example is the earliest of the composite brooches stems from its similarities to Class 1 of the plated disc brooches.[56] Since no record of its find site or date of discovery exists, dating for the brooch relies heavily on stylistic details and design elements. Sadly, the brooch is missing the filigree and stone settings, so even that is made rather difficult.[57] However, it is most likely from the late sixth century. Despite the lack of settings, there is no evidence for a forceful removal of those pieces, which simply adds to the mystery of its origins and condition.[58]

With a diameter of 4 cm, this brooch may seem rather unassuming due to its size.[59] Yet, it is the small size that makes these brooches so impressive. The detail work requires careful handling and a skilled eye. The faultless construction of the gold cloisons and the

---

[56] Avent, *Anglo-Saxon Disc and Composite Brooches*, vol. 1, 62-63.

[57] Avent, *Anglo-Saxon Disc and Composite Brooches*, vol. 2, 44.
Although the provenance of the brooch remains unknown, it is now owned by the Ashmolean Museum in Oxford, England.

[58] Pinder, "Anglo-Saxon Garnet Cloisonné Composite Disc Brooches", 16.

[59] The diameter of this particular brooch is roughly equivalent to the diameter of two pennies. That comparison really drives home how incredibly intricate the details must be to fit on such a small surface area.

silver back-plate reveals the time and effort put into the creation of ornamental, wearable items of prestige. And worn it was, for it has abrasions on the sides, showing lots of use. Still, the form of the brooch remains intact and can be further examined to determine the geometrical framework involved in its creation.

The basic shape of the brooch is marked by a gold rim that encircles a border with T-shaped cloisons intersected by four smaller satellite circles. The radius of each of those circles equals the width of the border. Four triangles lie in-between the satellite circles and both the triangles and the circles connect to another circle in the middle of the brooch. That band contains more T-shaped cloisons and some other more irregular shapes. Inside that border is yet another circle.

The composition begins by drawing a horizontal line at 180 degrees which is then bisected at a 90 degree angle with a vertical line (Fig 7). These two intersecting lines effectively divide the composition into four equal quadrants, labeled 1-4 respectively. Next, a red circle with a radius of 1.000 radiates out from that center point.[60] This shows the measurement of the inner portion of the border encircling the brooch and intersects with the centers of the satellite medallions. The length of the vertical and horizontal lines of the axis to the perimeter of the circle shows the diameter of this circle. Each has effectively been cut in two by the intersecting line, revealing the radius, or half of the diameter.

Four diagonal lines emerge from the center point at 45 degrees in each quadrant, splitting the red circle into eight equal pieces. Next, four red lines form a square around the red circle by connecting the four diagonal lines, with each side equal to the diameter

[60] The units used in the following steps will be simply in reference to the proportions to make the steps more clear than using the actual measurements in centimeters.

of the red circle. The central axes divide the large red square into four smaller squares of the same dimensions, so that there is one in each quadrant. The diagonal lines split each one so that the composition is divided into eight equal wedges. Orange diagonal lines bisect the red 45 degree angled lines from the other direction, creating a diamond within the red circle and marking the perimeter of the cloisonné ring around the center of the brooch. The distance from the center to this intersection is ½ the red diagonal line.

Yellow lines connect corners in all four quadrants, excluding those connected to the center point. Lines from the top left corner of quadrant 1 simultaneously attach to the lower right corners of both quadrants 2 and 4. These lines intersect with the central axis, marking a halfway point between the center and the perimeter of the red circle at .500, or ½ the radius of the red circle. Similarly, lines sprout from the lower left corner of quadrant four to the upper right corners of quadrant one and three. These lines are mirrored on the right half of the composition so that the lower right corner of quadrant three connects to the upper left corners of quadrants two and four while the upper right corner of quadrant two joins with the lower left corners of quadrants 1 and 3. All these yellows lines unite to form an unequal eight pointed star that encompasses the central axis. The four points of the star along the central axis outline the four triangular protuberances from the center ring of cloisonné.

Green lines emerge from the points of intersection between the red diagonals and the yellow lines in each quadrant, forming a square in the middle of the composition. Each side measures 1/3 of the diameter of the red circle. The red diagonals divide each quadrant into two isosceles triangles, mirroring the red square in yet another way. The distance from the center of the axis to the corner of the green square is 1/3 the red

diagonal of the large red quadrants. The width of the square supplies the measurement of a diameter for another circle within it, also marked in green. As such, the radius of this circle is .333, 1/3 of the radius of the red circle. Another green circle is placed to the left so that is touches both the green square and the red circle. The diameter of the left green circle is marked by a green line through the center that connects the intersecting point of the orange diamond and the yellow lines of the star.

The point where the two green circles touch becomes the source of a blue diagonal line that extend downwards in the 45 degree angle until it reaches a yellow line of the star (Fig. 8). A vertical blue line then comes out of that intersection to meet the central axis. The distance from this new point to the intersection of the two green circles becomes the diameter for a small blue circle that has a radius of .111, or 1/9 of the red circle's radius. Therefore, three of these small blue circles fit inside each of the green circles resulting in the red circle having nine across the horizontal axis. This small blue circles also help to figure out the measurements of the central concentric circle that occurs within the imperfect octagon in the center of the yellow star. With a radius of .444, this circle is equivalent to 4/9 of the red circle.

Meanwhile, the center line of the green left circle also delineates the exterior point for a violet circle marking the cloisonné border around the central medallion. As such, its radius is equal to double that of the green circles at .667, or 2/3 of the red circle's radius. Each green circle can also be split in half so that distance between the center and the perimeter of the violet circles becomes the diameter of a fuchsia circle (Fig. 9). They can also be found using a set of diagonal and vertical lines once more. A fuchsia line descended diagonally from the point of intersection between the two small blue circles in

the right side of the left green circle. That line meets with the perimeter of the green circle and another fuchsia line extends upwards. The distance from the perimeter of the red circle and that point of intersection of the fuchsia line and the central axis becomes the radius of a fuchsia circle. That radius then measures .167, or 1/6 the radius of the red circle. Another two fuchsia circles are place to the right of the first. Next, fuchsia circles radiate out from the meeting point of the horizontal line of the central axis with the red circle on either side of the composition. As such, the radii of these circles extend .167 past the red circle, creating a boundary for the next circle. With a radius of 1.167, this pink circle is 7/6 of the red circle and marks the outer edge of the cloisonné border that intersects with the satellite medallions. Therefore, the small fuchsia circles reveal that the size of the cloisonné ring around the whole brooch is equal to the radius of the fuchsia circles.

The four points along the central axis where it intersects with the red square provide midpoints for four more circles marked in light blue (Fig. 10). Their proportions are again found through the application of diagonals and verticals. A light blue line joins the orange diagonal with the intersection of the two small blue circles in the right side of the outer green circle. A vertical light blue line then connects the orange diagonal to the central axis. This subdivision reveals that a whole blue circle is equal to the radius of the light blue circle that radiates out from the intersection of the central axis and red circle so that the radius of the light blue circle is .222, or 2/9 of the red circle's radius. Three more light blue circles are placed on the other intersections of the red circle and central axis. The radii of the light blue circles extend outward past the red square and even past the light pink circle, while the portions facing inwards toward the center point mark the

rounded sections of the triangles coming off of the inner border. The outermost points of the small light blue circles are joined by an ice blue circle that encircles the rim around the outer border. With a radius measuring 1.222, this circle is found by simply adding the radius of the small light blue circle to the radius of the red circle so that 1.000 plus .222 equals 1.222, or 11/9 of the red circle's radius. Once this is established, the designer would want to place the four satellite medallions that occur on the diagonal lines. Using the intersections of the red circle and diagonal lines as center points, four satellite lime green medallions are inscribed upon the composition. Their radii are the same as those of the fuchsia circles at .167 or 1/6 of the red circle's radius, showing repetition in the design.

The ratios found in Brooch 169 reveal that the planning process of the design was methodical and meticulous. The divisions formed by the numerous shapes and lines form relationships to one another and each fluidly leads into the next. Largely ignored before now due to its missing polychrome inlay and filigree panels, the brooch still provides value data concerning its layout and proportions.

The Amherst Brooch:

Avent's Brooch 178, or the Amherst Brooch, has a more complex design and still retains most of its glass and garnet inlays (Fig. 11). The brooch was found in 1843 and dates to the late sixth or early seventh century. Comparison with the metal in contemporary coinage puts its creation date at some time before 620 CE. Due to its find date, very little record exists detailing its excavation and placement. At 6.2 cm in diameter, it is roughly 1.5 times larger than the Faversham Brooch.[61]Despite the difference in size, they are similar in their construction of a gold front and a silver back.

[61] This is roughly three nickels across.

This lavish example, made of imported gold and garnets, also shows the use of other materials. The greens and blues are made of glass paste and there may have been shell inlaid in one of the circles at one point. The cells holding the stones and glass paste are made of gold, suggesting that the brooch was created for a wealthy client. Several similar brooches, like the Monkton Brooch, were constructed with copper-alloy cloisons, which could indicate a less affluent patron.[62]

The circular shape of the brooch is marked by a nielloed rim. The next ring contains alternating right side and upside down stepped cloisons that are each separated by two garnets with a gold diagonal line through the center. The next concentric circle consists of four satellite medallions with diameters equal to the width of the ring. A quatrefoil resides in each medallion with lines of gold connecting the cloison to the rim of the medallion in a cruciform shape. The area around the quatrefoil in the medallion is inlaid with garnet. On either side of each medallion are gold panels with three tiers of filigree. The tier closest to the rim of the brooch has mostly C-scrolls with two of the panels decorated with S-scrolls instead. The middle tier contains filigree circles. The last tier has both S-scrolls and C-scrolls. Although Jessup calls the filigree "uncertain and bungled,' it is not unskillful enough to warrant such insults.[63] While the filigree of the Amherst brooch may not be considered the same class as the Kingston brooch, it still exhibits a fair amount of skill. The next ring of cloisonné surrounds center of the composition. This ring contains eight triangular cells filled with green glass that radiate out from the center

---

[62] David A. Hinton, *Archaeology, Economy and Society: England from the Fifth to the Fifteenth Centuries* (Oxford: Routledge, 2002), 22.
While this could mean that the Monkton brooch was made for someone who could not afford the extravagance of gold cloisons, it is also because it was manufactured later than the Amherst brooch. As the seventh century preceded, England lost some of its contact with the East so gold and garnets were more difficult to obtain.
[63] Jessup, *Anglo-Saxon Jewellery*, 117.

of the composition. In-between each of the eight triangles are two bands of garnets that frame an upside down stepped cloison, which most likely would have contained garnet or glass paste. The center of the next ring is missing but may have been inlaid with white shell. Finally, the very center of the brooch is contained by a thick gold barrier that encloses a quatrefoil like those in the satellite medallions. The overall effect is that of a lavish ornament full of radiating circles and spinning forms that delight the eye.

The designing process begins in the same manner as before by drawing a central axis (Fig. 12). First, a horizontal line is drawn using a straightedge. A vertical line bisects the horizontal one so that the composition is split into four quadrants, again labeled 1-4 in a clockwise fashion. Although the symmetry of the brooch's imagined geometry is absolute, the designs on the surface of each quadrant are not always an exact mirror image of its neighboring quadrants. The point of the intersection between the two lines becomes the center point of the entire composition. The 90 degree angles formed by the bisections are then divided in half by red lines angled at 45 degrees, dividing the composition into eighths.

A red circle radiates outward from the center point until its radius measures 1.000.[64] This marks the outer border of the gold filigree work, encircling all parts of the brooch except for the outer ring of cloisonné. In order to discover the other concentric circles, the designer maps out one of the quadrants. In this instance, quadrant 4 will be used as the example. An orange square is placed in the quadrant so that its top and right sides correspond to the central axis. It fits in-between the red circle's perimeter and the central axis so that its sides are 1.000, the same as the radius of the red circle. An orange line

[64] Again, this is analogous to a system of proportions in order to convey the process. This is not the exact measurements in centimeters. However, these proportions can be matched to the actual measurements of the brooch.

emerges from the upper left corner until it reaches the lower right corner, dividing the square into two triangles. Two more lines come out of the upper left and upper right corners until they meet in the center of the bottom of the square, forming a V. All these lines will be useful in the process of finding the proportions for the other concentric circles.

A yellow vertical line emerges from the point of intersection between the orange line splitting the square in two and the right diagonal of the V until it meets the central axis. The distance from this point to the center of the composition is .333, or 1/3 of the radius of the red circle. This forms the radius of a yellow circle that radiates from the center of the composition. The center for another yellow circle can be found through another yellow line extending from the intersection of the left line of the orange V and the red diagonal. That line marks the center of the left yellow circle, which fits between the first and the red circle. The midpoint of the yellow circle also marks the radius of another circle, delineated in green. As such, the radius of this green circle is equal to the diameter of the yellow circle, or 2/3 the radius of the red circle. The distance of .667 from the center of the axis, this circle shows the outer border for the ring of cloisonné around the central rings. The rest of the design will reveal that most of the other concentric circles are also fractions of the red circle in thirds, sixths, and ninths.

As the red circle has already been divided into thirds, it can now be split into smaller units. A green diagonal line emerges at a 45 degree angle from the intersection of the two yellow circles until it touches the right orange line of the V. From that point, a vertical line surges upward to the central axis. That marks the radius of a green circle with a radius of .111, or 1/9 of the red circle. Therefore three small green circles fit into each

yellow circle. They are then repeated across the entire length of the horizontal axis. These ninths will help determine the perimeters of the concentric circles through the use of more diagonals like those in the orange square. First, a blue line inscribed at a 45 degree angle emanates from the center of the outermost green circle on the left until it touches the red diagonal in quadrant 4 (Fig. 13). Another blue line goes up vertically from that point until it reaches the central axis at a distance of .444 from the center. This creates the radius for a blue circle that constructs the outer border of the missing ring. The radius of the ring matches the proportions of the central medallion in Avent's Brooch 169 as it is also .444, or 4/9 of the red circle's radius. The inner border's radius does not present itself yet, and is one of the last steps in the design's production. However, the circle around the quatrefoil in the central circle can be found at this time. A diagonal line extends down from the intersection of the left side of the larger blue circle and the central axis until it meets the interior of the yellow circle. The blue line that extends upwards marks a radius measuring .167 from the center, or 1/6 of the red circle's radius. [65]

Now that the proportions of the concentric circles have been ascertained, the perimeter of the brooch must be planned out. By drawing a violet line at a 45 degree angle from the center of the left yellow circle to the diagonal orange line and then a vertical line from that point, the designer finds the center of the violet's circle's radius, or ¼ of the yellow circle. This point serves two functions. First, it provides the center for a violet circle with a radius equal to ½ that of the yellow circle at .167, or 1/6 of the red circle. The radius of each yellow circle becomes the diameter for a violet circle. This violet circle is, therefore, the same size as the center blue circle. Two more violet circles

[65] The radius of the inner border of the missing ring is simply the radius of the outer border minus that of the blue circle around the center. This is equivalent to .277, or .444 – .167. Still, finding that at this point in the design's creation would be more difficult than later in the process.

are placed so that their centers are at the intersection of the red circle and horizontal line of the central axis, extending past the red circle by .167. A larger violet circle radiates out from the center point of the composition until it reaches the exterior points of the two outer small violet circles. This new circle has a radius of 1.167, which is the same as 7/6 of the red circles. The center of the first violet circle inscribed within the left yellow circle also marks the perimeter of a fuchsia circle with a radius of .833, or 5/6 of the red circle's radius. This circle does not correspond to any of the bands and instead marks the centers of the four satellite medallions.

Next the perimeter of the whole circle must be found (Fig. 14). A pink line emerges at a 45 degree angle down from the left intersection of the fuchsia circle and the central axis until it reaches the violet diagonal line. From there, a pink line extends vertically until it touches the exterior of the violet circle. The distance from this point to the red circle marks the radius of a pink circle equaling .250, or ¼ the radius of the red circle. Another one of these pink circles is placed on the right side of the composition so that it mirrors the original. The outer points of the two pink circles supply the dimension of a larger pink circle that encompasses the whole brooch. With a radius of 1.250, this large pink circle is equal to 5/4 the red circle.

Now that the radius of the whole brooch has been determined, various other aspects of the design must be taken into consideration (Fig. 15). The satellite medallions occur between the large green circle and the red circle. The intersection of the red diagonal lines and fuchsia circle with a radius of .833 marks the centers of the satellites. From there, ice blue circles spread outwards until they have radii of .167, or 1/6 of the red circle's radius. They are also equal to the small center blue circle and the small violet

circles, showing the repetition of proportions in the brooch. The two satellite medallions on the right side of the brooch are bisected both vertically and horizontally by lime green lines that illustrate the cruciform shape in each medallion. Lime green circles also surround the quatrefoil shaped cloisons within the satellite medallions. These lime green circles have radii of .111, or 1/9 the radius of the red circle.[66]

Other cloisons can also be found geometrically (Fig. 16). The triangular shaped protuberances from the missing ring are easily explained. Lilac lines emerge from the point of intersection between the vertical axis and the top of the large green circle until they connect to the points of intersection with the bottom red diagonals with the same circle. Both those points then join to the points of intersection with the horizontal axis and the circle. Two more lines unite those points with the intersections of the upper diagonals and the circle's perimeter. The last two lines connect the upper diagonal points with the point of intersection of the vertical axis and the bottom of the circle. All these lines form an equal eight pointed star within the boundaries of the large green circle. These points reveal the basis for the triangular designs in the inlaid cloisonné border around the center of the brooch. The intersections of the lilac lines with the center axis also form the perimeter of a light blue circle that marks the inner portion of the missing ring within the cloisonné border.[67]

That same border also contains pyramidal or step shaped cloisons between each triangle. Those can be bisected by white lines that divide the eighths made by the red

[66] The quatrefoil shape of the cloisons can be determined using four smaller circles with diameters equal to the radius of the lime green circle. Their radii are .056, or 1/18 of the red circle's radius. Each black circle intersects with the other three in order to form the shape of the quatrefoil. These quatrefoils can be found in this way but this could have just as easily been done free hand. Therefore, it does not show up in the figures.

[67] This is the ring that was difficult to determine when designing the other concentric circles earlier in the process.

diagonals in half, thus splitting the composition into sixteenths. The lines not only bisect the cloisons but they also travel along the lines that connect the step cloisons to the border or the large blue circle. This is repeated in the exterior cloisonné border as well so that the placement of those stepped cloisons have been determined by the combination of the central axis, red lines dividing the composition into eighths, and the white lines forming sixteenths.

The Kingston Down Brooch:

While the two previous brooches appear to follow the same rough scheme, the Kingston Down brooch, or Avent 179, follows a slightly different plan (Fig. 17). Most likely made in the first quarter of the seventh century, it has captured the fascination of all those who have seen it since its discovery in 1771 by the Reverend Bryan Faussett. His excavation of a large burial mound at a place called Kingston Down in Kent revealed the grave of a woman inside, who had the brooch placed between her neck and left shoulder. Although the bones of the woman were in poor shape, the overall condition of the brooch is rather remarkable. Only a few of the inlaid pieces are missing and it still contains all the filigree panels except for part of one. Those filigree panels contain Style II animals that turn their heads in order to bite their own backs.

With a diameter of 8.55 cm, the Kingston Down brooch is the largest and arguably most impressive of the composite brooches, showing a mastery of the goldsmith's craft.[68] The composition of the brooch can be divided into fourths, with each containing a satellite medallion. Made of a solid silver disc covered with gold, the surface of the brooch is decorated with filigree panels and gold cloisonné cells inlaid with garnets,

---

[68] Avent, *Anglo-Saxon Disc and Composite Brooches,* vol. 2, 48.
This is roughly four nickels across. So it is a rather impressive display of wealth and noticeable when worn.

colored glass, white shell, and millefiori.[69] The garnets are sliced so thin that one can see the chequerboard patterned gold foil behind them.

Seven concentric circles form the basis of the design, radiating out from the center. Each band appears to be roughly the same width as the previous one so that the different rings are systematic to the naked eye. At the center of the brooch lies a domical shape that contains three semicircles at equal intervals. Each semicircle contains a blue glass T-shaped inlay that contrasts vividly with the garnet around it. The gold band around the dome separates it from a ring of white shell placed in four equal segments divided by gold. The third circle repeats the motifs of the center with ten semicircular designs containing T-shaped cloisons of blue glass that are surrounded by garnets. The exterior border of that ring touches the four satellite medallions and also intersects with four bands of cloisonné that follow the same angle as the gold that divided the shell inlay. Therefore, each satellite medallion is separated from the next by these bands of garnets. Small panels of filigree fill in the space between the garnets and the medallions, forming the fourth concentric circle.

Next, the fifth ring, formed of garnet inlay with eight T-shaped cloisons, intersects with the straight lines of garnets and the middle of the medallions. A rhombus shaped cloison filled with a darker garnet marks each cross section of the ring with the four straight lines. The four satellite medallions contain both garnet and blue glass. The center of each one has a circle of white shell with two triangular pieces of blue glass coming off it so that the tips touch the exterior border of the medallion. Two pieces of garnet lie on either side of the triangles and they are separated by a blue glass T-shaped cloison. The sixth concentric circle's outer border touches the outermost points of the satellite

[69] Hull, *Celtic and Anglo-Saxon Art: Geometric Aspects* (2003), 55-58.

medallions. It is similar to the fourth ring in decoration but with a larger arc length. Lastly, a garnet and blue glass ring encircles the rest of the composition. It echoes the other inlay designs in having semicircular frames of gold that contain blue glass T-shaped inlay. Each one of the semi-circles is also separated by two more pieces of garnet that lie on either side of yet another blue glass T-shaped cloison. Thus, the decoration of the entire brooch connects with previous parts, forming obvious relationships.

The design process also shows this interconnected nature of the brooch (Fig. 18). First, the designer created a central axis by inscribing a horizontal line and bisecting it vertically. The intersection of these two lines provides the centerpoint for the brooch. The central axis splits the whole composition into four equal sections, labeled 1 though 4 as in the previous examples. Each section is then divided by red lines at 45 degree angles that separate the composition into eight equal wedges. Now, the designer can place the tiers of concentric circles. A red circle radiates from the centerpoint until it reaches the outer borders of the satellite medallions. This circle has a radius of 1.000, encircling the rest of the composition, including the four satellite medallions. By halving this circle, a smaller red circle with a radius of .500 can be found which surrounds the band of cloisonné around the ring of white shell.

The other concentric bands on the brooch now need to be placed on the design using the radius of 1.000 as a starting point. That radius will be used to create an orange square in quadrant 4 with sides of the same dimension. A 45 degree diagonal orange line divides the square and bisects the red diagonal already going through it. Two more orange lines emerge from the top corners of the square until they meet at the center of the bottom line, forming a V. The right orange line intersects with the orange 45 degree diagonal, creating

a point from which a vertical yellow line extends upwards until it reaches the top of the square. This marks a distance of .333 from the center of the circle, or 1/3 the radius of the large red circle. That distance becomes the radius of a yellow circle that outlines the white shell ring around the boss. Another yellow circle is placed to the left of the first so that it touches both the original and the large red circle. Its midpoint is delineated by a yellow line that extends downwards until it reaches the intersection of the red diagonal line and the left line of the orange V. That midpoint then reveals the radius of a green circle that surrounds the first band of filigree, overlapping the satellite medallions. With a radius of .667, this circle is 2/3 of the large red circle.

The use of subdivision through the application of diagonals and straight lines can also be employed to find the dimensions of the center boss. The intersection of the red diagonal in quadrant 4 with the yellow center circle creates a point from which a blue vertical line emerges until it touches the top of the orange square, or the central axis. This marks the radius of a blue circle measuring .236 from the centerpoint of the composition. This same circle reveals the dimensions of the gold ring around the central cloisonné boss.[70] A blue 45 degree line emerges from the intersection of the two yellow circles until it reaches the red diagonal line's intersection with the blue circle. The vertical line that emerges from that point determines the radius of another blue circle. With a radius of 1.67, this blue circle is 1/6 of the large red circle and marks the boundary that separates the inlaid boss and its gold rim.[71] Thus, six of the concentric circles have been planned.

---

[70] Although the measurements of that circle can also be found using $.167\ x\ \sqrt{2}$, that sort of math was most likely not employed by the early medieval craftsman.

[71] In order to find the radius of the gold rim, the radius of the boss must be multiplied by the square root of two to reach .236. Therefore, the rim cannot be found until the radius of the boss has been determined if one is going to use pure mathematical formulas.

Now the relationship between the last concentric circle and the large red circle's radius of 1.000 must be found. A diagonal violet line emerges at a 45 degree angle from the point of intersection between the green circle and the midpoint of the left yellow circle until it reaches the orange diagonal line (Fig. 18). A violet vertical line then expands upward from that point of intersection until it reaches the central axis, marking a point .833 from the center of the composition. That measurement develops into the radius of a violet circle around the middle ring of garnet cloisonné. The radius is, therefore, 5/6 of the red circle's radius of 1.000. That same point created by the vertical violet line marks the radius of a fuchsia circle with a center at the intersection of the red circle and the central axis (Fig. 20). The radius of that circle is equal to 1.000 minus .833 at 1.67. This is the same value as the radius of the boss and is also 1/6 of the red circle. The fuchsia circle extends past the red circle by the length of its radius. Another fuchsia circle with the same dimensions is repeated on the right side of the brooch so that it mirrors the first. The outermost points of these two fuchsia circles create the diameter of a large fuchsia circle that encircles the whole brooch, marking the outer rim. With a radius of 1.167, it is 7/6 of the red circle. This is the last of the concentric circles in the composition.

Lastly, the dimensions of the satellite medallions must be determined. In order to discover this, the center of the medallions must be found first. The intersection of the smaller red circle with the horizontal axis provides the point from which a pink diagonal line emerges. It extends down to the orange diagonal line. From there, a vertical pink line materializes until it connects with the central axis. This intersection marks the radius of a pink circle that is .750 from the center of the composition. That radius is equal to ¾ of the

large red circle's radius and supplies the halfway point between the two red circles. While this pink circle does not outline any of the bands in the brooch, it marks the center of the four satellite medallions and the center of the middle band of cloisonné so that it bisects the four diamond shaped garnets on the central axis.

Now that the designer has already discovered the centers of the four satellite medallions, adding them to the composition plan is simple (Fig. 21). Four ice blue circles radiate out from the intersection points of the pink circle and red diagonals until they touch both red circles. With radii of .250, these ice blue circles are proportionally ¼ of the red circle and 1/3 of the pink circle. The ring inside of the satellite, marked in lime green, is then equal to half the ice blue circle with a radius of .125, or 1/8 of the red circle.[72] The two triangular protuberances that extend out of the lime green ring to the ice blue circle can be found by drawing light blue lines from the intersections of the ice blue circles and the red diagonals to the intersection of the pink circle and lime green rings. And so, the major points of the composition have been planned.

The Milton North Field Brooch 1:

Of course, there were multiple composite disc brooches that had simpler designs while being fairly large. At 7.4 cm in diameter, Avent's Brooch 182, or the Milton North Field brooch, is only slightly smaller than the Kingston brooch and yet, less complex in certain ways (Fig. 22).[73] Found on the breast of a skeleton in 1832, it lacks the gold cells of the other examples so far. The gold front has bronze cloisons instead and gold filigree panels. Although the center is now much decayed, it may have held an ivory or white

[72] Lastly, the size of the inlaid round garnet needs to be found. While one would think that it should correspond to half the size of the ring in lime green, it is slightly smaller than that. With a radius of .056, it is equivalent to 1/18 of the red circle, not 1/16. This raises more questions than it answers
[73] Avent, *Anglo-Saxon Disc and Composite Brooches,* vol. 2, 49.

shell boss at one time. The ring of cloisonné around it contains three rows of inlaid glass jewels in the shape of irregular pentagons. The four bands that come off the rings at equal intervals contain a double row of the inlay.[74] In-between the four bands are four satellite bosses that were most likely set with the same material as the central boss. On either side of each satellite boss are spaces for filigree containing ropelike intertwining animals. Unfortunately, two of the interlacing filigree panels are missing. The bosses overlap slightly with a two row border of inlay that encircles the composition. Quite a bit of the cloisonné in this band is also gone. While the decoration on the brooch is damaged, none of that has harmed the overall shape or changed the geometrical composition. Therefore, the damage is only superficial and does not impact this study.

The designer would have begun creating the composition much the same as the other examples in this study. Like before, he would have drawn a straight horizontal line at 180 degrees and then bisected it with a straight vertical line, creating a central axis (Fig. 23). The four quadrants made by the intersecting lines are again labeled 1 through 4 in a clockwise fashion. A diagonal line splits each quadrant in half, dividing the composition into eighths. The diagonal lines also divide each satellite medallion in half, showing the symmetry inherent in the quadrants. With this part planned out, the actual pieces of the composition can now be sketched.

First, a red circle radiates outward from the center point until its radius equals 1.000. This marks the intersection between the gold filigree panels and the outermost cloisonné ring of the brooch. The circle also overlaps the four satellite medallions, touching the outer edges of the missing inner portions. This measurement will form the basis for most of the concentric circles in the brooch, and this can be easily seen in the way the brooch

[74] Harold, Peake, *The Archaeology of Berkshire* (London: Methuen & Company Ltd., 1931): 134.

is broken into thirds. In order to do this, an orange square with sides measuring 1.000 is placed in quadrant four so that its top side overlaps the central axis. A diagonal line bisects it from the upper left corner to the lower right corner. Half-diagonals are also placed in the square forming a V shape so that the half-diagonal from the upper right corner intersects with the first orange diagonal. A yellow vertical line emerges from that intersection until it reaches the central axis. This new point of intersection is .333 from the center, which forms the radius of a yellow circle at the center of the composition. Another yellow circle is placed to the left between the first and the red circle so that the yellows circles are 1/3 the size of the red circle around the gold panels. The center of the second yellow circle can be found by a yellow line extending from the intersection of the red diagonal and left orange line of the V to the top of the yellow circle. The midpoint of the left yellow circle is then .667 from the center of the composition. This becomes the radius of a larger yellow circle that is 6/9 or 2/3 the size of the red circle. Nine green circles with radii of .111 are placed across the horizontal line of the central axis to show how the red circle can be split into ninths.

These nine green circles help show the dimensions of the concentric circles in the design with the help of subdivision (Fig. 24). A blue line emerges diagonally from the left side of the center green circle until it connects to the 45 degree angle orange diagonal line. Another blue line extends vertically from that point to the central axis where it marks a point .556 from the center of the composition. This also provides the radius for a blue circle that marks the outer boundary of the cloisonné rings around the center. With a radius measuring .556, this circle is 5/9 of the red circle. Not only does this circle delineate the cloisonné ring but it also touches the perimeter of the rings of the satellite

medallions, setting their measurements. That same blue diagonal line from the left side of the center green circle then passes through that blue circle. Another vertical blue line comes out of the intersection of the two until it stops at the central axis .444 from the centerpoint. That, in turn, becomes the measurement for the radius of another blue circle, which is 4/9 of the red circle's radius. That circle marks the boundary between the outmost tier of garnets and the other two. This separation is due to the outer tier's rectangular shaped pieces and a bronze border.

A vertical violet line rises from the intersection of the red diagonal with that smaller blue circle, determining the width of the first tier of cloisonné. This circle, marked in violet, has a radius of .393 and separates the first and second tiers of the irregularly shaped cloisonné.[75] Next, the measurement of the center boss must be laid out with another violet circle. It can be found through the application of subdivision as well. The intersection of the red diagonal with the first violet circle provides the point for another vertical line. That line meets with the central axis at .278 from the center, which determines the radius of the center boss. That value is equivalent to half the radius of the border of the cloisonné ring.

Now that the basic concentric circles have been inscribed, the radius of the whole brooch must be found. In order to do this, a series of steps must be undertaken (Fig. 25). The designer focuses his attention back on the left yellow circle marking 1/3 of the red circle. A fuchsia line emerges at a 45 degree angle from the intersection of the yellow line and the central axis until it reaches the orange diagonal line. Another fuchsia line extends vertically from that point, subdividing the radius of the left yellow circle and

[75] Its radius also corresponds to the value of .556 except that .556 is now divided by the square root of two so that it equals .393.

providing the endpoint for a smaller circle. This smaller circle is placed with its centerpoint on the intersection between the central axis and the red circle so that it overlaps the first while its radius simultaneously extends out from the circle. Also delineated in fuchsia, it has a radius of .167, or 1/6 the largest red circle. This same process is repeated on the right side of the brooch. The outermost points of these small fuchsia circles provide the measurement a large fuchsia circle that marks inner border of the brooch's rim. With a radius of 1.167, or 7/6 of the largest red circle, it is not quite equal to the dimensions of the whole brooch even though it appeared as if it would solve the radius of the whole brooch. This hypothesis appears plausible due to the brooch designer's propensity to use multiples of three. This is not only seen in the yellow, blue, and green circles but in a pink circle that marks the halfway point between the large yellow and red circles. With a radius of .833, it is 5/6 of the red circle and marks the centers of the satellite medallions. However, that trend of using thirds, sixths, and ninths does not provide the size of the brooch as a whole.

The dimensions of the brooch can be supplied, instead, through use of diagonal and vertical lines (Fig. 26). The midpoint of the green circle directly to the right of the center green circle becomes a point from which an ice blue line emerges until it reaches the red circle. From there, a vertical ice blue line comes forth to the central axis. That point of intersection becomes the marker for the radius of an ice blue circle that radiates out from the intersection of the red circle and central axis. As such, the radius is .196, which cannot be found applying fractions of three.[76] The two ice blue circles with this radius are placed with the same centerpoints as the small violet circles, encircling them. Their

[76] That radius can also be found through the application of the square root of two, much like the outer violet circle. It is the radius of the center blue circle divided by the square root of two, or $.278/\sqrt{2}$.

outermost points create the perimeter of a larger ice blue circle that marks the outer rim of the brooch. Its radius of 1.196, equivalent to the sum of the red circle's radius and the radius of the small ice blue circle, is the radius of the whole composition.

While that find is important, the satellite medallions still need to be planned. Using the intersection of the pink circle and the red diagonal as a centerpoint, four lime green circles are inscribed to illustrate the border of the rings around the missing satellites. The radii of these circles are the same as that of the center boss at .278, or ½ of .556. The centers of the satellites, marked in light blue are equal to the small fuchsia circles at .167, or 1/6 of the largest red circle. This design contains a more complicated set of ratios that do not all correspond to each other. Therefore, the subdivisions are sometimes the only way to find some of the proportions.

The Milton North Field Brooch 2:

Another brooch from Milton North Field Abingdon, Avent's brooch 183, differs from brooch 182 in its central fitting type, arrangement of some of its rings, and its circular settings (Fig. 27).[77] However, it shares some key characteristics, providing some evidence of production from the same smithy or, at the very least, similar workshop practices. Like the previous brooch, it is rather simply designed, is made of a gold front with a silver back, and contains bronze cloisons. Both brooches are roughly the same size

---

[77] The high-resolution image of brooch 183 provided by the Victoria and Albert Museum displays several subtle optical distortions, most notably slight biasing of all the raised medallion centers in the same direction, and the slight asymmetry of the outer frame of the brooch along the same axis. These suggest that the image was shot at a slight raking angle, although the aspect ratio was corrected so that the whole brooch fits perfectly into a circle. The images of brooch 183 in this thesis have been further rectified with Photoshop, so that the centers of the raised medallions appear properly centered with respect to their frames, just as they would in a view from directly above. These rectified images provide an adequate basis for the geometrical analysis undertaken here. However, the same results were found with an untouched photograph of a lower resolution. As such, the work here can be replicated without relying on Photoshop in any way. For reasons of image quality, the photograph from the Victoria and Albert Museum was used in the figures to better show the details and craftsmanship of the decoration.

with brooch 183 having a diameter of 7.8 cm in comparison to the 7.4 cm of brooch 182.[78] This example may have been discovered in 1832 with the other Milton North Field brooch, but the records are scanty at best. Brooch 183 also has no record of the sex of the interred or its position when found. Still, it is probable that it was found in the grave a woman and that it, like the others, was worn on the breast.

The brooch, itself, only contains five rings. Each ring has a different width, with the filigree panels being the largest. The very center circle of the brooch most likely contained a round piece of garnet at one point. Unfortunately, whatever was placed in that cloison has been lost. That empty spot is surrounded by a thin ring of white shell that rises from the surface of the brooch, adding to the three-dimensional aspect. A bronze cloison frames that shell ring, separating it from three tiers of garnet inlay around it. The first tier, made up of rectangular pieces, is separated from the next two by a bronze frame. The two outer tiers are composed of irregular pentagon shaped that fit together seamlessly so that the cloisons interlock. Four arms emerge from that ring at equidistant intervals until they reach the outer border. They consist of two rows of the same irregular pentagon shaped cloisons as two outer tiers of the garnet ring. In any case, the area between each arm of the cross contains filigree panels with two a ribbon-like, intertwining animals. Both animals are facing a white shell boss in the middle of the gold panel. Inside the shell rings are small round garnets encircled by bronze borders. The filigree panels are then surrounded by the last ring of garnets that consists of two rows of the same irregular pentagon shaped cloisons as before. While this design is certainly not

---

[78] Avent, *Anglo-Saxon Disc and Composite Brooches*, vol. 2, 49.
This is roughly three U.S. quarters across. So it is rather large in size, making it noticeable when worn. However, it lacks the impressive visual intricacy of the Kingston Brooch.

as involved as the Kingston Down brooch, it still required planning ahead of time by using geometry is order to interlock all of the components.

To begin, the designer divides the composition into eight equal wedges in the same manner as the previous examples (Fig. 27). The horizontal line of the central axis is labeled zero so that the radius of every circle will be measured out from that centerline. Once the composition has been divided into eighths, a red circle radiates from the center until it reaches the frame around the panels of gold filigree. With a radius of 1.000, this circle will provide a system on which the other concentric circles will be based.[79] Next, the designer uses that radius to provide the dimensions of an orange square in quadrant 4. Like the examples before this, the square is bisected by an orange diagonal line from the top left corner to the bottom right corner, which is then intersected by half diagonals in the shape of a V. That point of intersection provides a position from which a yellow line emerges until it meets with the top side of the orange square. That marks a point of .333 from the center of the composition, or 1/3 of the radius of the red circle. Another yellow circle is placed to the left of the first. The midpoint of that circle can be found through the use of a vertical line that extends upwards from the intersection of the left orange line of the V and the red diagonal until it reaches the top of the yellow circle. That same point reveals the radius of another circle, also shown in yellow. The radius of the larger yellow circle equals .677, or 2/3 of the red circle's radius.

Although the first four brooches were created using system of thirds, sixths, and ninths, the Milton North Field Brooch 2 differs slightly. While, it still makes use of those proportions, as exemplified by the 1/3 and 2/3 circles, certain concentric circles follow a

[79] Of course, the designer could have done these steps in a different order. He could have found the radius of the border of the cloisonné rings first tier and then used that to find the whole radius of the cloisonné ring.

wholly dissimilar set of proportions. By treating the red circle as ten green circles, the designer was able to find several of the concentric circles. First, a blue 45 degree angle line is drawn from the center of the third green circle to the left of the centerpoint to the perimeter of the left yellow circle (Fig. 28). That point provides a starting point for a blue vertical line that bisects the radius of the left yellow circle. That, in turn, supplies the radius of a blue circle with the value of .800, or 4/5 (8/10) of the red circle. It almost passes through the centers of the satellite medallions but is not precise enough. That will be found at a later juncture. Once the blue circle has been inscribed, the innermost portion of the brooch can be examined.

A violet line extends upwards from the intersection of the blue circle and red diagonal in quadrant 4, setting the perimeter for a violet circle. The radius measures .586, or .400 multiplied by the square root of two.[80] That circle marks where the border of the center ring of cloisonné meets the filigree panels. The points of intersection between that circle and the four red diagonals are then connected by straight fuchsia lines that form a square (Fig. 29). A fuchsia circle radiates out from the center of the composition until it touches the sides of the square so that it has a radius of .400, or 4/10 of the red circle's radius.[81] A pink vertical line connects the intersection of the red diagonal and the fuchsia circle to the central axis and supplies the dimensions for a pink circle. At .283 from the center, this circle marks the ring of white shell around the missing center medallion.[82] Another pink vertical line emerges from the intersection of that first pink circle with the

[80] This can be found using that equation but it is simpler to find the radius using subdivision. By finding that radius and then subtracting it from the radius of the red circle, one can find the width of the filigree panels so that 1.000 - .586 = .414.

[81] This measurement equals 2.674cm in the actual brooch. The radius, therefore, is 1.337cm.

[82] In the brooch, the white shell ring measures 1.892 in diameter. The radius of the shell ring can also be found by dividing .400 by the square root of two to equal .283.
It may be noted that the circle is off a bit. That is not an error in the geometry, and fault lies with the execution of the design when creating the brooch.

red diagonal to determine the radius of another. This one has a radius of .200, or 1/5 of the red circle's radius, and marks the center medallion's border.

Now that the concentric circles have been planned out, the border of the whole composition must still be determined. In order to do so, an ice blue diagonal line emerges from the point of intersection between the large yellow circle and the central axis until it reaches the orange diagonal line. From there, another ice blue line extends to the central axis to show the radius of an ice blue circle that radiates out from the point of intersection of the red circle and central axis. Another one is added on the right side of the composition so that it mirrors the first. The radii of those circles are equal to .167, or 1/6 of the red circle. Because of this, the radius of the whole brooch can now be found (Fig. 30). An ice blue circle measuring 1.167 in radius combines the red circle and radii of the ice blue circles. In other words, the large ice blue circle is 7/6 the red circle. Thus, the designer has finally found the radius of the whole brooch.

Lastly, the centers of the satellite medallions can be discovered by finding the midpoint between the red circle (1.000) and the border of the cloisonné ring marked in violet (.586). This midpoint of .783 becomes the radius of a light blue circle. Not only does the circle intersect with the satellite medallions but it also overlaps the intertwining filigree ornament where portions of the zoomorphic figure intersect. The shell rings of the satellites are marked in lime green circles that measure .146 in radius or 1/8 the radius of the whole brooch. A black circle reveals the dimension of the bronze frame for the garnet inlay. With a radius of .073, it is equivalent to 1/16 of the whole brooch.[83] And so, all the

[83] Although more work could be done in regards to the geometry of the filigree panels, that is beyond the scope of the present thesis.

major components of the brooch have been planned out in an easy to follow manner with interlocking proportions.

CONCLUSION

The connection between art and geometry can be traced for thousands of years. From Greek temples to illuminated manuscripts and Gothic cathedrals, the two have been intertwined. The proportional linkage of lines and circles found in the composite disc brooches of the Anglo-Saxons are just one aspect of this long history. This thesis' investigation of composite disc brooch design allows scholars to truly consider the roles of geometry, ratio, and preplanning in Anglo-Saxon metalwork in order to show the importance of the objects to their society. Unsurprisingly, much work had to be done before the metal was purified or the garnets cut. Before any of the actual metalwork could be completed, a design had to be made. These no lost plans were most likely done on either wax tablets or bone fragments.

Once the composition had been carefully planned, work could begin. It is possible that the designers of the brooches were completely separate from the actual smiths. Workshops could have divided the various parts of the construction as well: one craftsman cutting the garnets, one creating the gold filigree panels, one casting the different plates, and another fusing the cloisons to the front-plate and placing the garnets within them. This distribution of labor could explain the derivation from the ideal geometric plans. It would also explain why the intertwining animal panels do not always correspond to the concentric circles. Although many have their own independent geometry, some do have intersections align with the main concentric circles. Such geometric coherence would argue for united conception and execution, further confusing the debate surrounding Anglo-Saxon workshop practices.

While the designs of composite disc brooches may seem simple at first, craftsmen made conscious choices when drawing the ratios in the composition. Many of their

geometrical schemes can only be determined from the methods of production, which establish the side-to-side symmetry of the brooches. As these figures and studies illustrate, the planning must have been meticulously completed before the construction of the actual brooches. Craftsmen designed each composite brooch as a series of steps that reflected the proportions of earlier steps in the construction. While not all the proportions of each case study match the others, the result and effect is much the same. This reveals the design process in a way that has not been considered by other scholars. Therefore, it is important to study these brooches not only in terms of their decoration, meaning, and production, but the design process that reflects all of them. These brooches represent variations on a small set of geometrical themes, which appear to have been applied in terms of ratios instead of measurements with a ruler. This supposition is due partially to the differences in scale between the examples. The overall sizes are in no way standardized. Even brooches with very similar compositions, such as the two Milton North Field brooches, display this with their .4 centimeter difference in size.

Despite the dissimilar sizes and levels of decoration, many of the brooches share key elements, such as the use of 7/6 as the proportion for the outermost rims of the Faversham Brooch, Kingston Down Brooch, and Milton North Field Brooch 2. Even then, the other two brooches use that proportion in the inner boundary of the rim so that each brooch at least uses the ratio of 7/6 in some way. In order to discover whether all composite brooches follow the same scheme laid out here, future research will need to be done. Future work would widen the scope of the project to encompass all eighteen examples, providing high resolution photographs of each and a step-by-step explanation of their geometrical elements. It would also need to include error analyses that would

reveal where the craftsmen went astray in trying to implement the already developed design. Despite more work needing to be done, there are several basic conclusions that can be made thus far.

Each brooch begins in basically the same manner with a central axis drawn. From there, the designer inscribed the first circle with a diameter of 2.000 and a radius of 1.000 (Table 1). The circle is divided into fourths by the central axis. Diagonal lines then emerge from the center of the composition to extend outwards past that first circle. These divide the composition further; into eighths. A square is placed in the lower left quadrant so that its sides equal 1.000. A diagonal line bisects it from the opposite direction from upper left corner to the lower right corner, forming an X with the first diagonal. Next two lines from the upper corners of the square connect in the bottom center in the shape of a V. These lines help in dividing the first circle into thirds. From there, the steps can differ. Some brooches are split into ninths while others are divided into tenths or sixths instead. Once these proportions are established, the other concentric circles are easily found. The relationship between these proportions change depending on the number of concentric circles.

Similarly, the satellite medallions can be determined once those concentric circles and the midpoints of the medallions have been placed in the composition (Table 2). The relationship between the ratios based on the first circle and the connections of subsequent circles shows the similarities based in the designs of all five composite disc brooches. While this study only provides a guide for five of the eighteen known brooches, it begins a course of study previously unexplored by scholarship. If the designer were so inclined, he could begin with a different circle and then based the ratios of the others on it.

However, that would only change the order of the steps and not the actual ratios and proportions that have been demonstrated throughout this research. This gives evidence that the Anglo-Saxon craftsmen were employing a set vocabulary of ratios. As such, they used constructive geometry without implementing a scale of measurement or using numerical calculations.[84]

It is possible that the different proportions may have had some sort of significant meaning. Alternatively, the designer or even the patron could have arbitrarily chosen them during the process of design due to aesthetics. Unfortunately, no documents survive that explain the meaning behind the compositional decisions in these brooches so neither supposition can be proved. Patrons most likely only supplied the materials and did not intervene in the design process. It is feasible that the cross formed out of four bands of inlay represents the growing popularity of Christianity but it could just as easily have another meaning.[85] This cruciform shape is found on all but the Faversham Brooch in this study and is integral to the designs of the other four brooches. Despite the uncertainty surrounding the symbolism of numbers or the meaning behind motifs, the similarities in the brooch designs are clear. The various technical similarities shared with other composite brooches suggest that both Milton North Field brooches were created in Kent, revealing a possible reason for their design similarities.[86]

---

[84] Robert D. Stevick, "The Form of the Tara Brooch" (1998): 14-15.

[85] Rupert Bruce-Mitford, "The Sutton Hoo Ship-Burial: Comments on General Interpretation," in *Aspects of Anglo-Saxon Archaeology: Sutton Hoo and Other Discoverie* (London: Victor Gollancz Limited, 1974), 26-35.

Bruce-Mitford discusses the possibilities and points to instances of pagan evolution of the cruciform motif. Since the brooches in this study are from a time when Christianity was gaining strength in England, the meaning behind their cruciforms is unclear. The designers could be pulling from either Pagan or Christian tradition, or both.

[86] Avent, *Anglo-Saxon Disc and Composite Brooches,* vol. 1, 55.

Further examination of composite disc brooches' geometry could lead to the discovery that many were planned in roughly the same manner with just slightly different ratios. As such, this thesis merely begins the conversation on the geometry of the composite brooch type. The five examples in this study show a process that can be replicated with a sequence of continuous steps that unfold the composition. These brooches are evidence of a highly skilled and well-trained collection of smiths and designers who took great care with their work. This continued even when gold and high quality garnets became scarcer in Britain. Despite the lack of high-grade materials, smiths continued to create remarkable pieces of wearable art that publically demonstrated the owner's prestige and wealth. Although these designs involved fairly simple layouts, the designing of these brooches was an involved, logical process that required skill and forethought. Because of this, the compositions needed to be planned by an individual with the knowledge and training required to lay out the composition. This education would allow the designer to form a design based on coherent geometry in which each concentric circle is related to every other by ratios obtained through their subdivision.

As mathematician and anthropologist, Walter Sizer once wrote, "more precise geometric constructions also enter where society values precision."[87] The importance of prestige items is, therefore, reflected in the geometrical aspects of the composite disc brooches. The development of geometric constructions and their application occur as an effect of the most significant aspects of a society and its daily life. The brooches are a result of connected, logical derivation executed with a compass and straightedge. Using

---

[87] Walter S. Sizer, "Mathematical Notions in Preliterate Societies," *Mathematical Intelligence* 13, no. 4 (Fall 1991): 59.

Although the Anglo-Saxons had access to writing, not all members of society were literate. Undoubtedly, many craftsmen did not write and did not perform complex mathematics. However, they still managed to produce art that contained a wealth of geometric forms.

the tools of their time, Anglo-Saxon craftsmen were able to plot compositions using coherent geometry.[88] This aspect of design is often overlooked despite its ability to reveal the intellectual achievements and their conceptions of patterns and shapes. The Anglo-Saxon composite disc brooches effectively reveal this in their overall plans.

[88] Robert D. Stevick, "The Ancestry of 'Coherent Geometry' in Insular Designing," *The Journal of the Royal Society of Antiquaries of Ireland* 134 (2004): 6-7.
Although Stevick connects this idea to Insular design in several mediums with a focus on Irish design, it still applies to Anglo-Saxon brooches and metalwork.

APPENDIX A: TABLES

From Rim to Center	First Circle or Outer Rim	Second Circle	Third Circle	Fourth Circle	Fifth Circle	Sixth Circle	Seventh Circle	Eighth Circle
Faversham Brooch	1.167 or 7/6	1.000	.666 or 2/3	.444 or 4/9	N/A	N/A	N/A	N/A
Amherst Brooch	1.250 or 5/4	1.167 or 7/6	1.000	.667 or 2/3	.444 or 4/9	.277 or .444 - .167	.167 or 1/6	N/A
Kingston Down Brooch	1.167 or 7/6	1.000	.833 or 5/6	.667 or 2/3	.500 or ½	.333 or 1/3	.236 or .167 x √2	.167 or 1/6
Milton North Field Brooch 1	1.196 or 1.000 + (.278/√2)	1.167 or 7/6	1.000	.556 or 5/9	.444 or 4/9	.393 or .556/√2	.278 or .556 x 1/2	N/A
Milton North Field Brooch 2	1.167 or 7/6	1.000	.586 or .400 x √2	.400	.333 or 1/3	.283 or . 400 / √2	.200 or 1/5	N/A

Table A1: Comparison of Proportions for Composite Brooches' Concentric Circles

	Circle Marking Midpoint	Satellite Rim	Inner Portions	Quatrefoils
Faversham Brooch	1.000	.532 = 1.000 x 1/6	N/A	N/A
Amherst Brooch	.833 = 1.000 x 5/6	.167 = 1.000 x 1/6	.111 = 1.000 x 1/9	.056 = 1.000 x 1/18
Kingston Down Brooch	.750 = 1.000 x 3/4	.250 = 1.000 x 1/4	.125 = 1.000 x 1/8	N/A
Milton North Field Brooch 1	.833 = 1.000 x 5/6	.278 = .556 x 1/2	.167 = 1.000 x 1/6	N/A
Milton North Field Brooch 2	.783	1.46 = 1.167 x 1/8	.073 = 1.167 x 1/16	N/A

Table A2: Comparison of Proportions for Composite Brooches' Satellite Medallions

APPENDIX B: FIGURES

Figure B1: Keystone Garnet Disc Brooch, Avent corpus 109, Anglo-Saxon, 6th-7th century CE, gilded silver with green glass, garnet, and white paste, Diameter of 3.35 centimeters. The British Museum, London, England.

Figure B2: Plated Disc Brooch, Avent Corpus 153, Anglo-Saxon, 6th-7th century CE, gilded silver with gold front-plate, Diameter of 4.5 centimeters. The Ashmolean Museum, Oxford, England.

Figure B3: A small part of The Great Pavement, Roman, c. 325 CE, mosaic. Woodchester, Gloucestershire, England.

Figure B4: Shoulder clasps from the Sutton Hoo ship burial, Anglo-Saxon, early 7th century CE, millefiori glass, gold, and garnet, 12.7 centimeters in length when clasped, width of 5.4 centimeters. From Mound 1, Sutton Hoo, Suffolk, England. The British Museum, London, England.

Figure B5: Detail of the Kingston Down Brooch showing gold foil behind garnet inlay, composite brooch from Kingston Down, Avent corpus 179, Anglo-Saxon, c. 600-625 CE, 8.55 cm in diameter, gold front and back. City of Liverpool Museum, Liverpool, England.

Figure B6: The Faversham Brooch, composite brooch from Faversham, Avent corpus 169, c. 6th century CE, diameter of 4.0 centimeters, gold front with silver back. The Ashmolean Museum, Oxford, England.

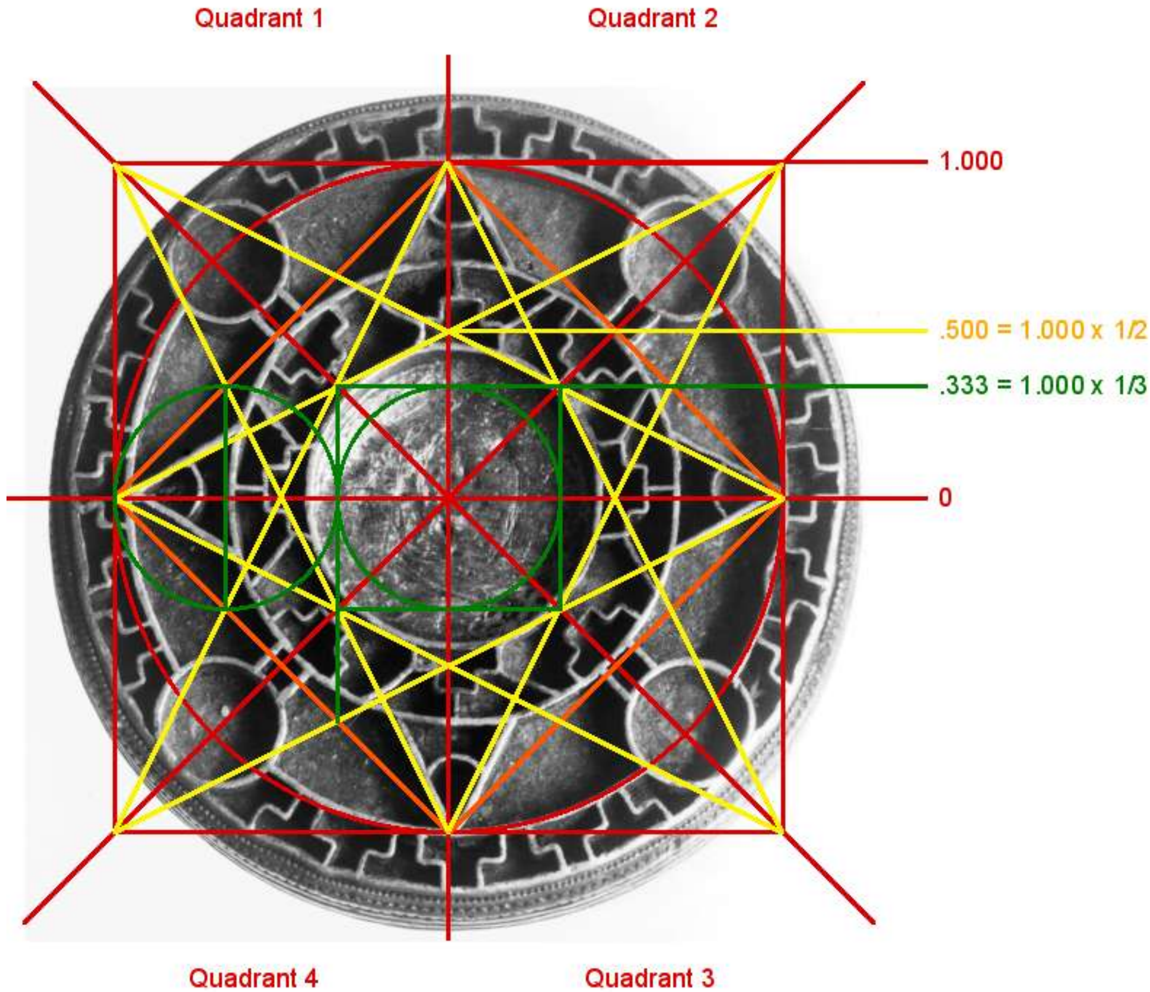

Figure B7: The Faversham Brooch showing steps 1-8.

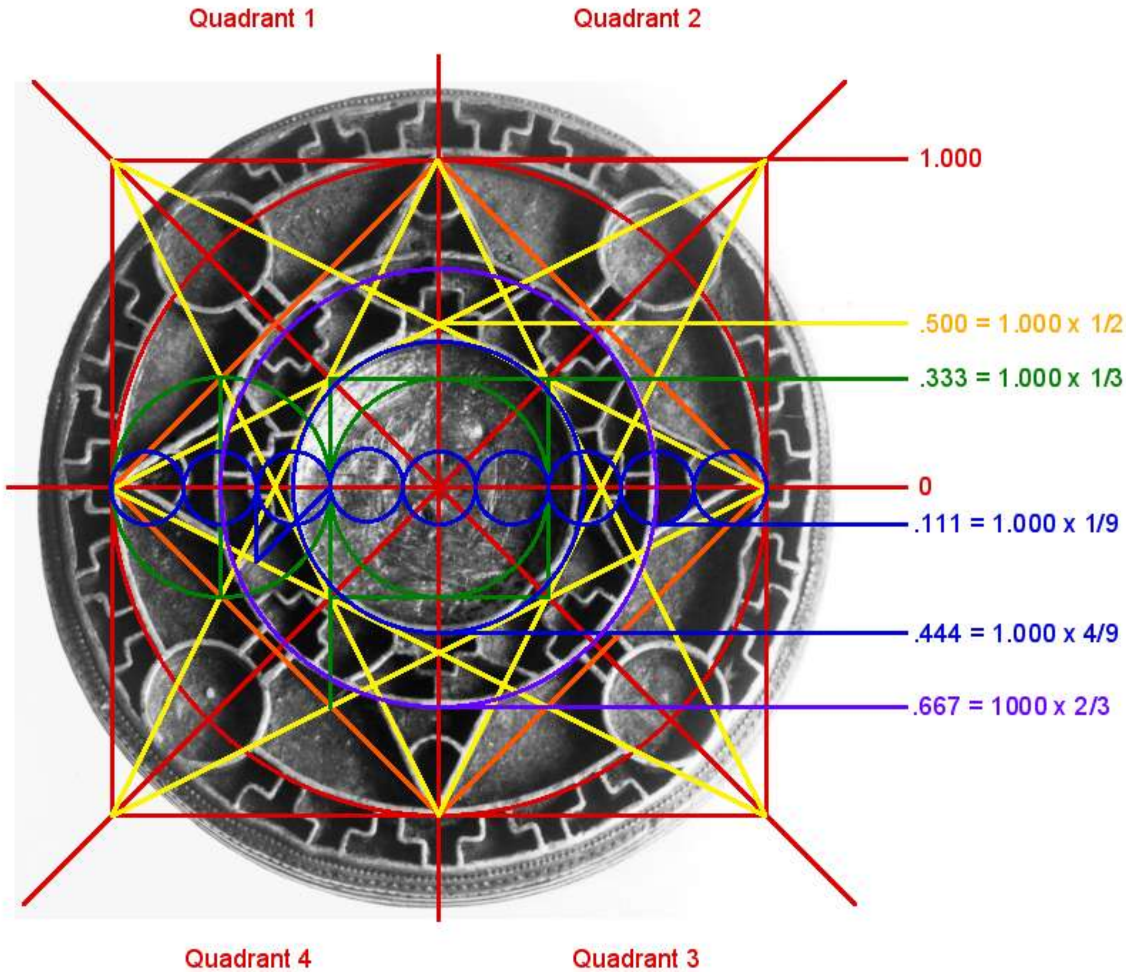

Figure B8: The Faversham Brooch showing steps 9-12.

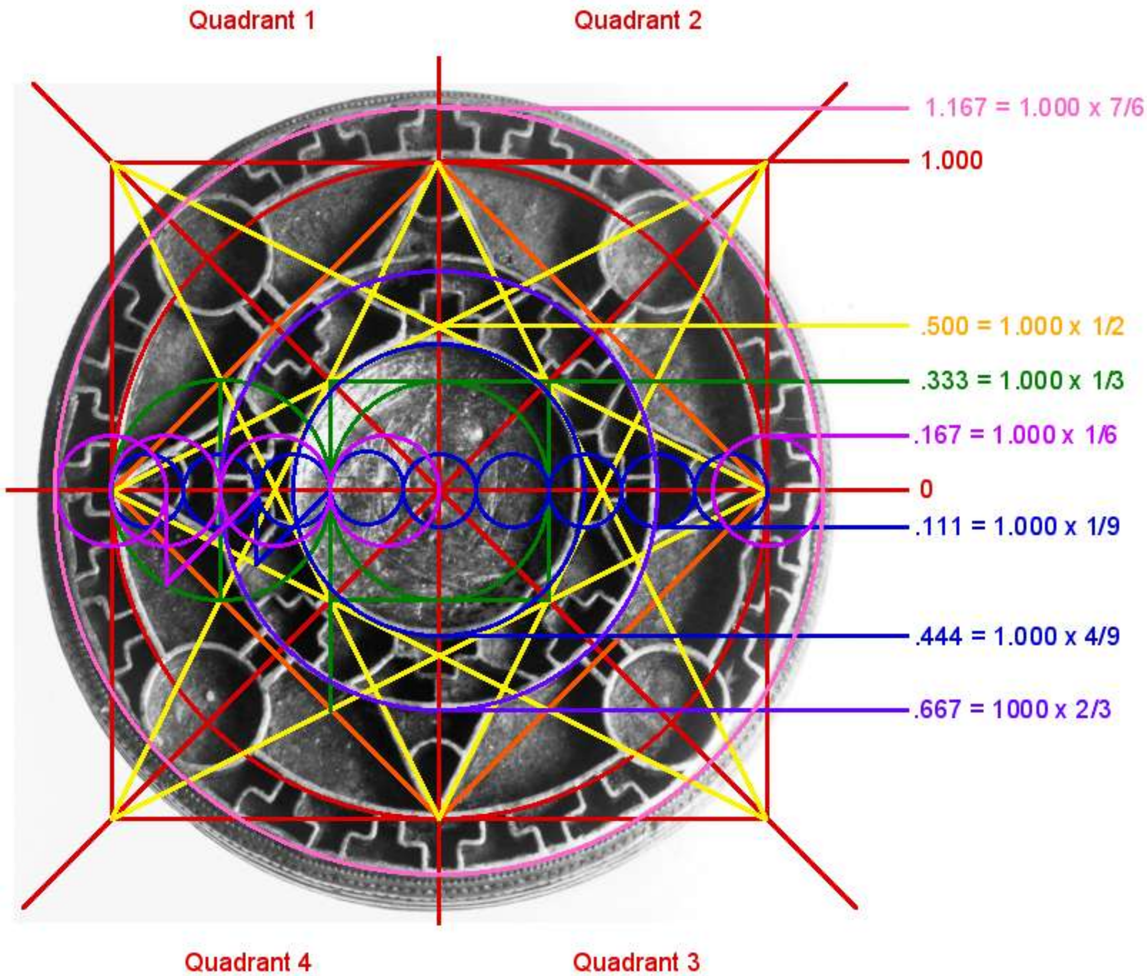

Figure B9: The Faversham Brooch showing steps 13-15.

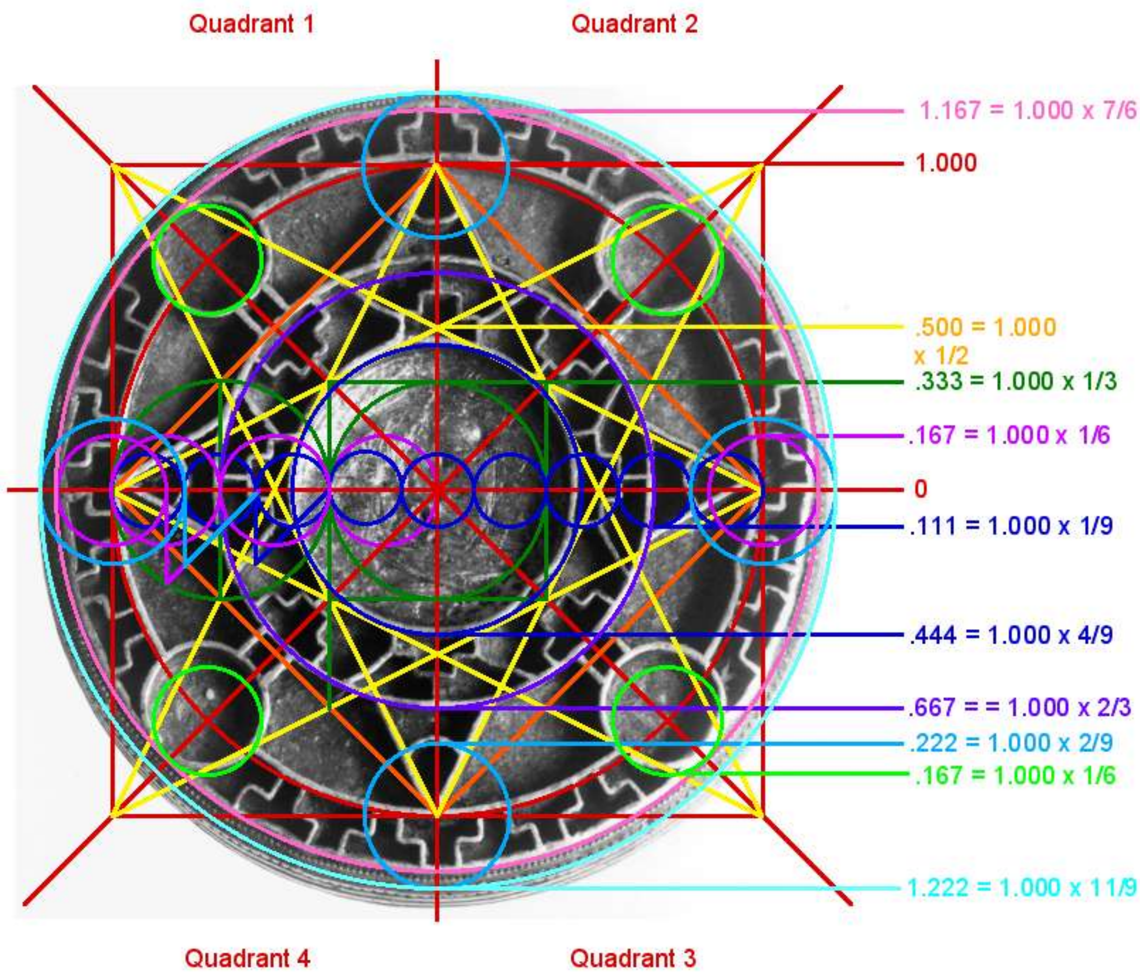

Figure B10: The Faversham Brooch showing steps 16-19.

Figure B11: The Amherst Brooch, composite brooch from Sarre, Avent corpus 178, c. 6th-7th century CE, 6.2 cm in diameter, gold front with silver back. The Ashmolean Museum, Oxford, England.

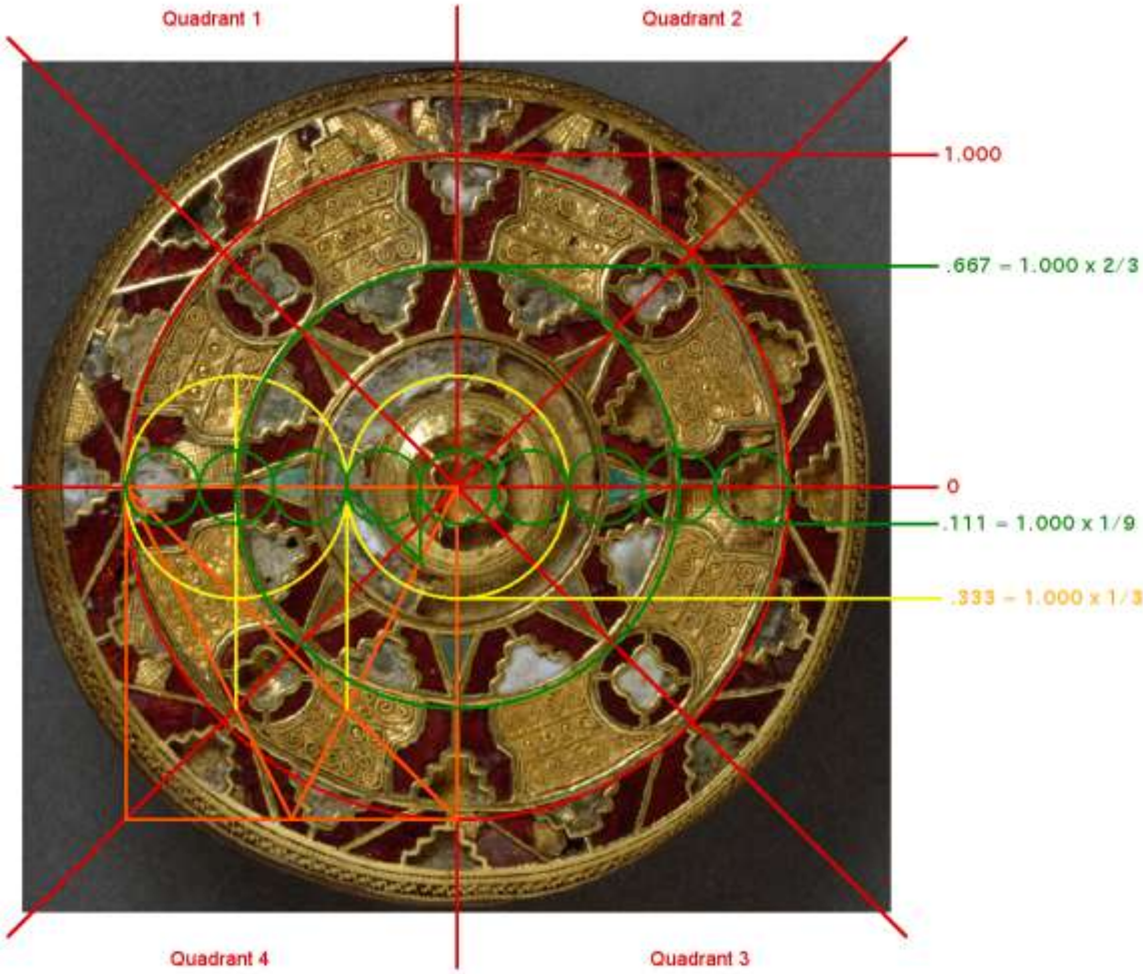

Figure B12: The Amherst Brooch showing steps 1-12.

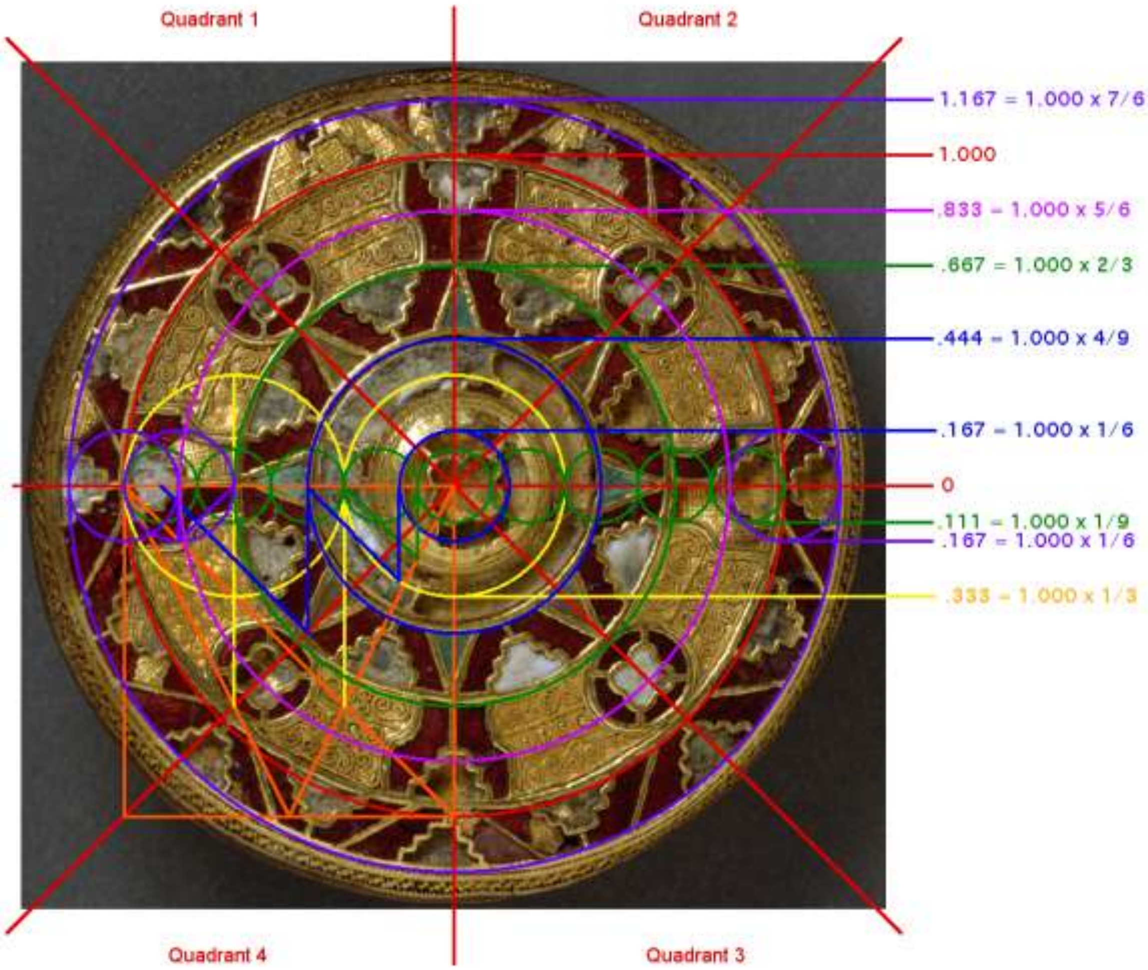

Figure B13: The Amherst Brooch showing steps 13-21.

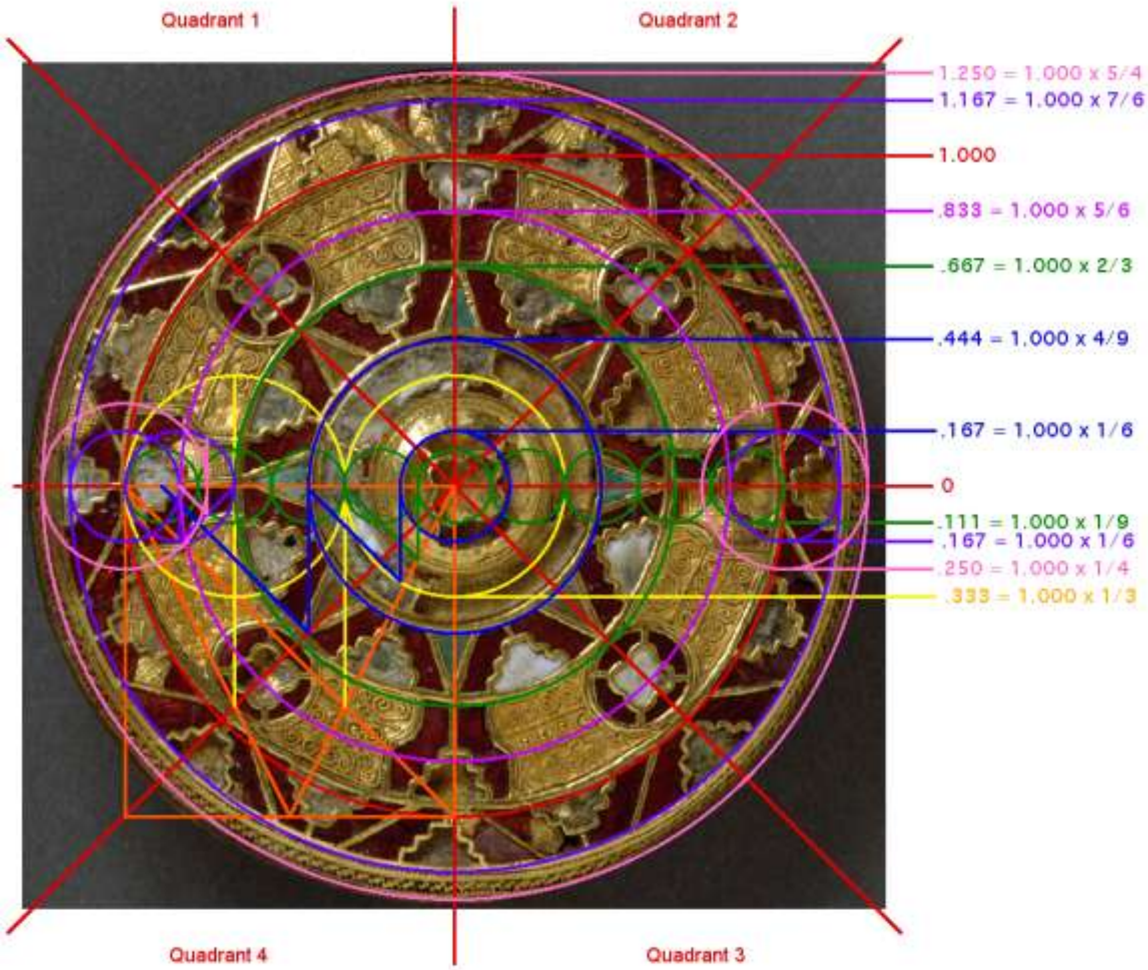

Figure B14: The Amherst Brooch showing steps 22-26.

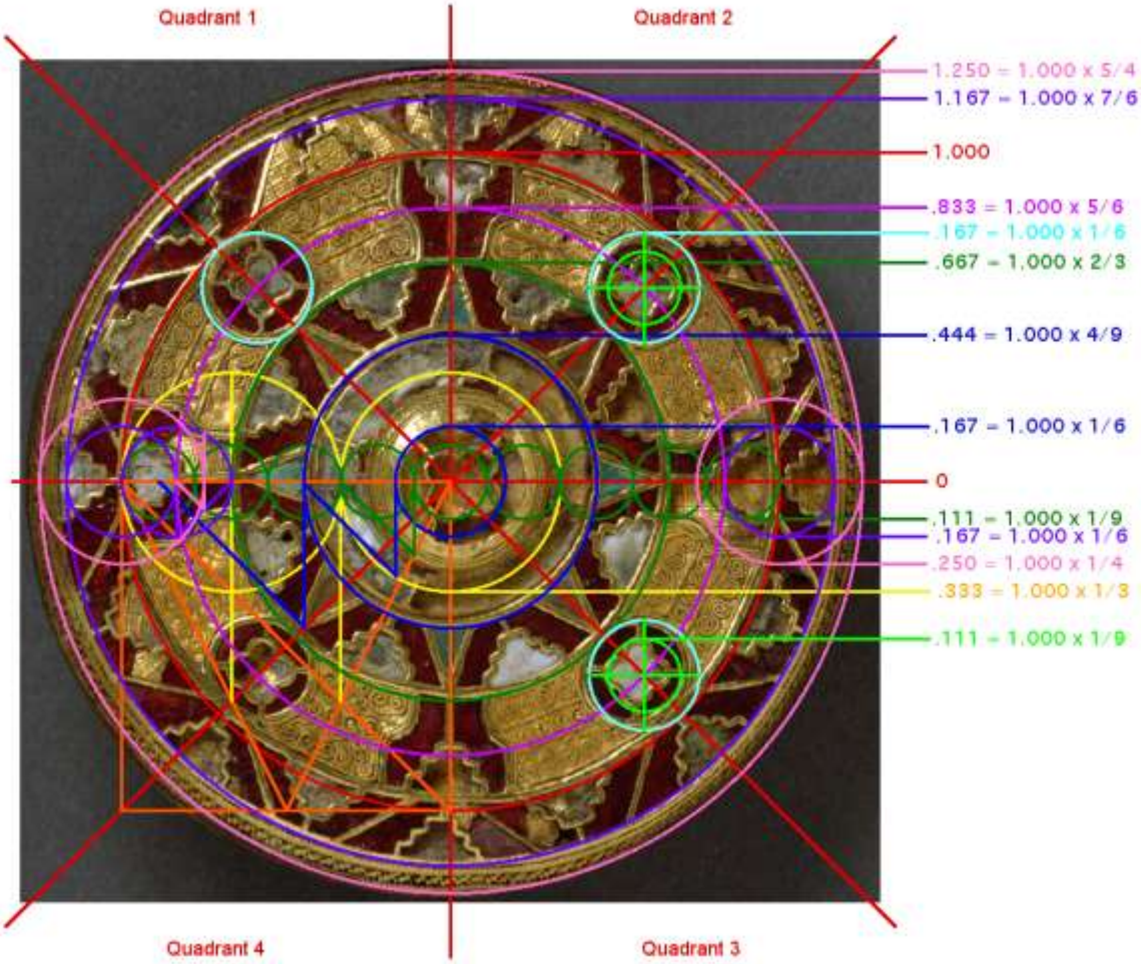

Figure B15: The Amherst Brooch showing steps 27-29.

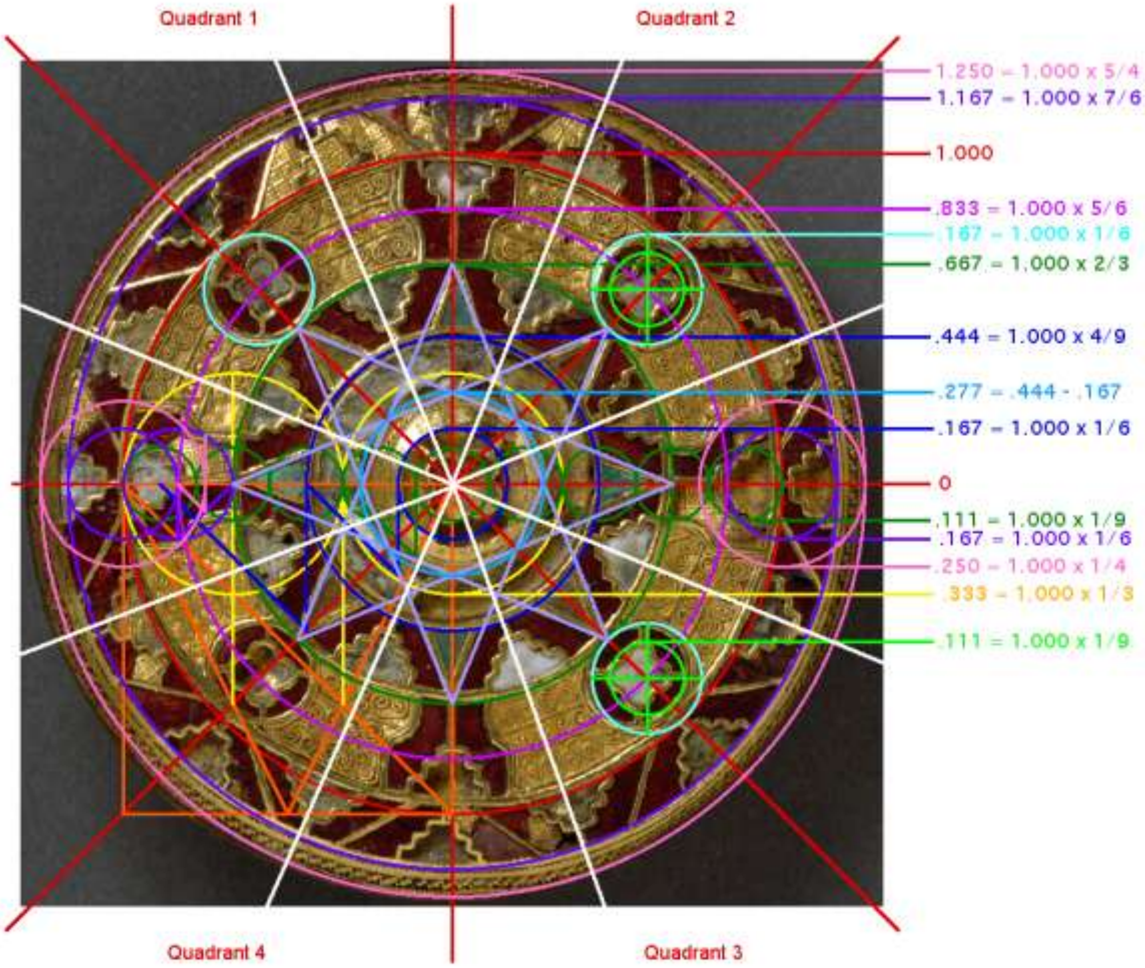

Figure B16: The Amherst Brooch showing steps 30-32.

Figure B17: The Kingston Down Brooch, composite brooch from Kingston Down, Avent corpus 179, Anglo-Saxon, c. 600-625 CE, 8.55 cm in diameter, gold front and back. City of Liverpool Museum, Liverpool, England.

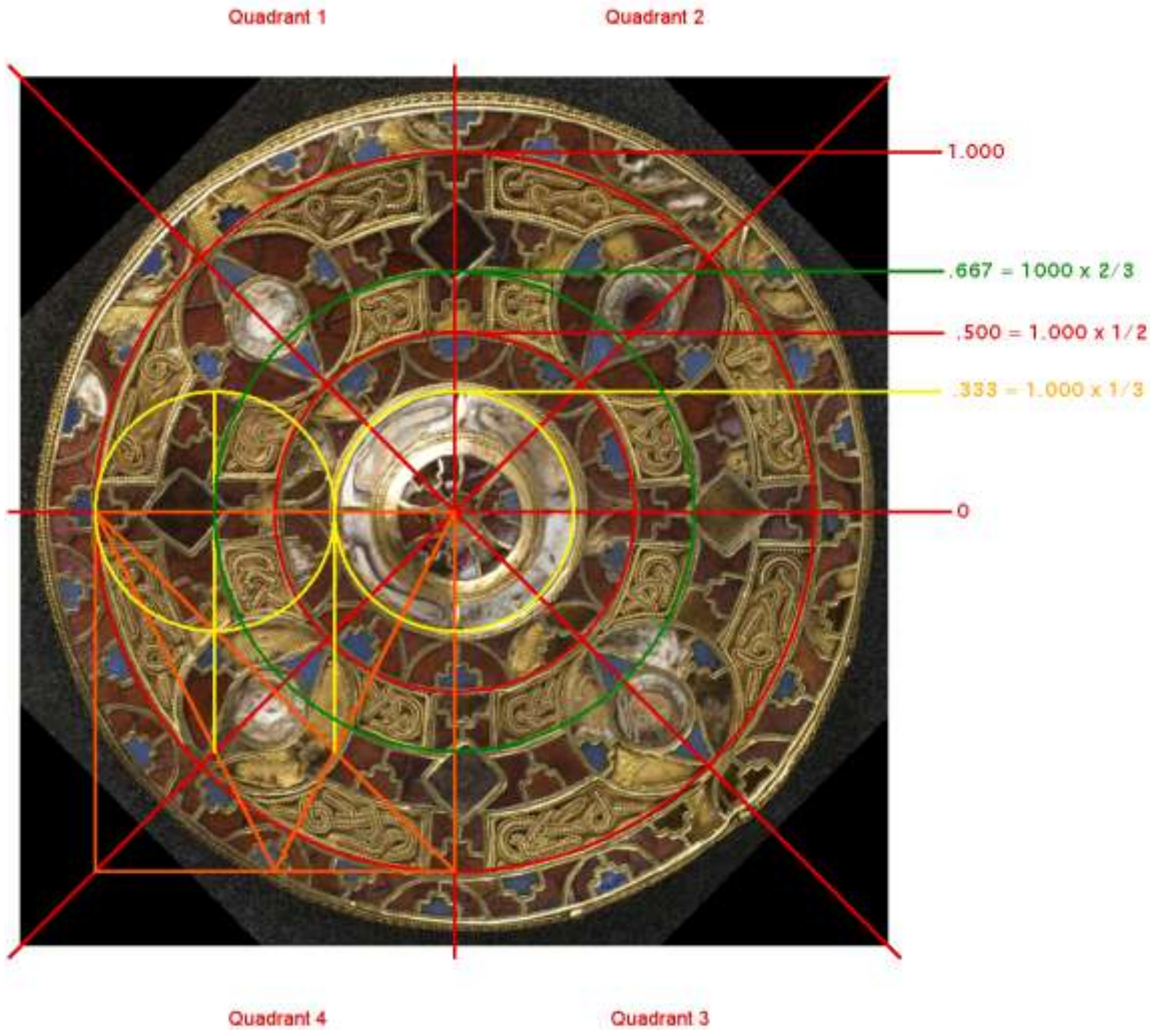

Figure B18: The Kingston Down Brooch showing steps 1-11.

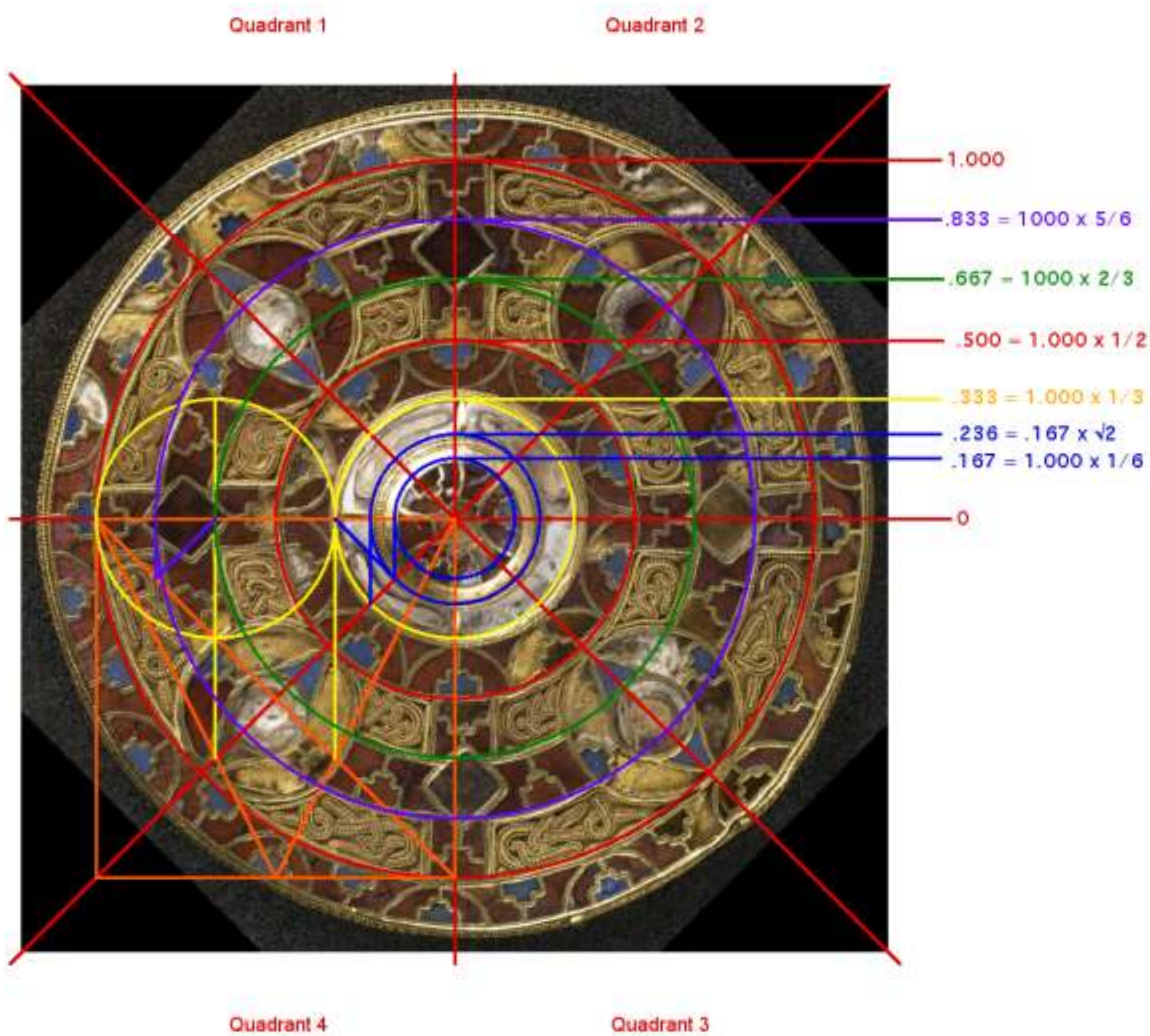

Figure B19: The Kingston Down Brooch showing steps 12-16.

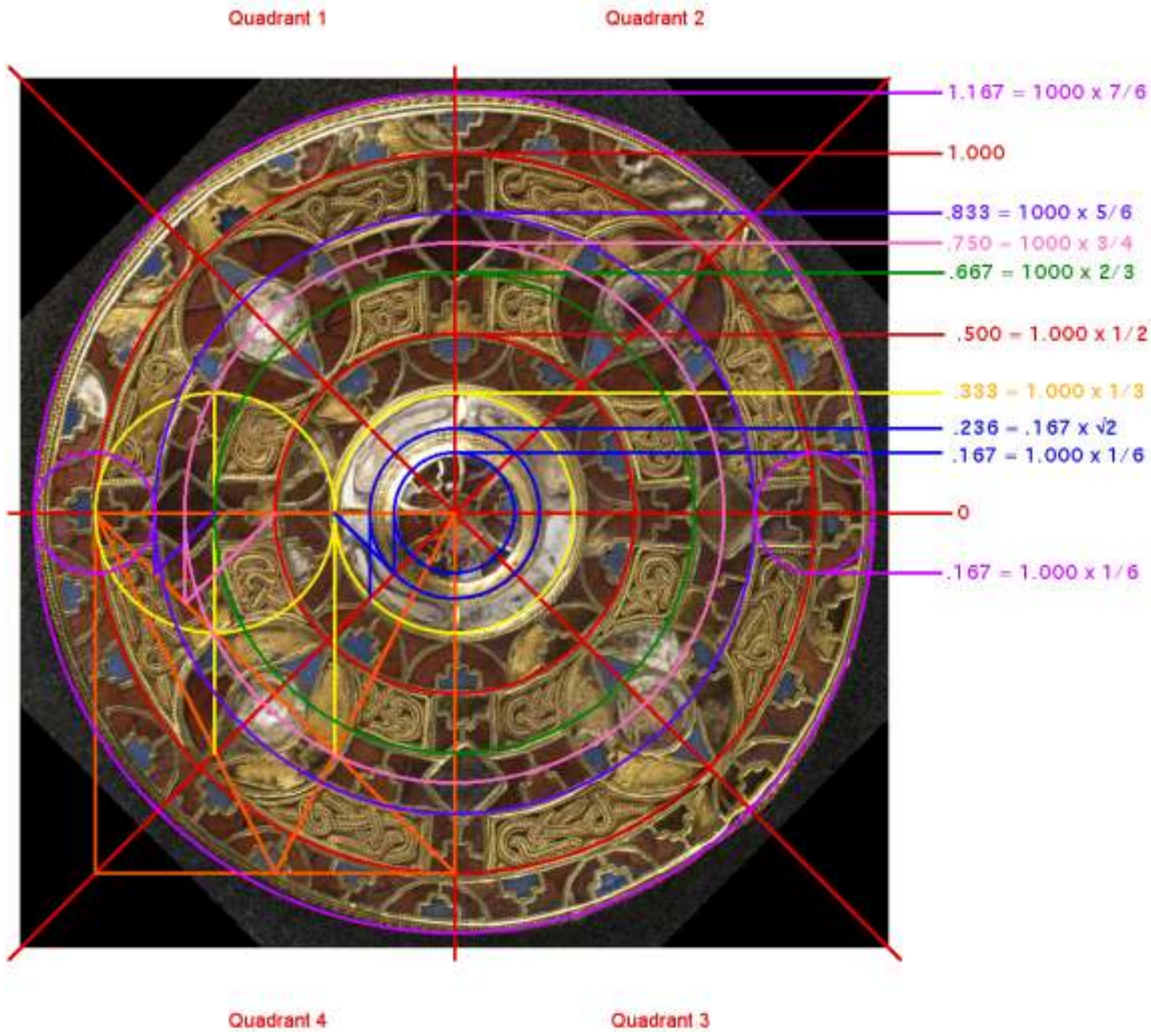

Figure B20: The Kingston Down Brooch showing steps 17-21.

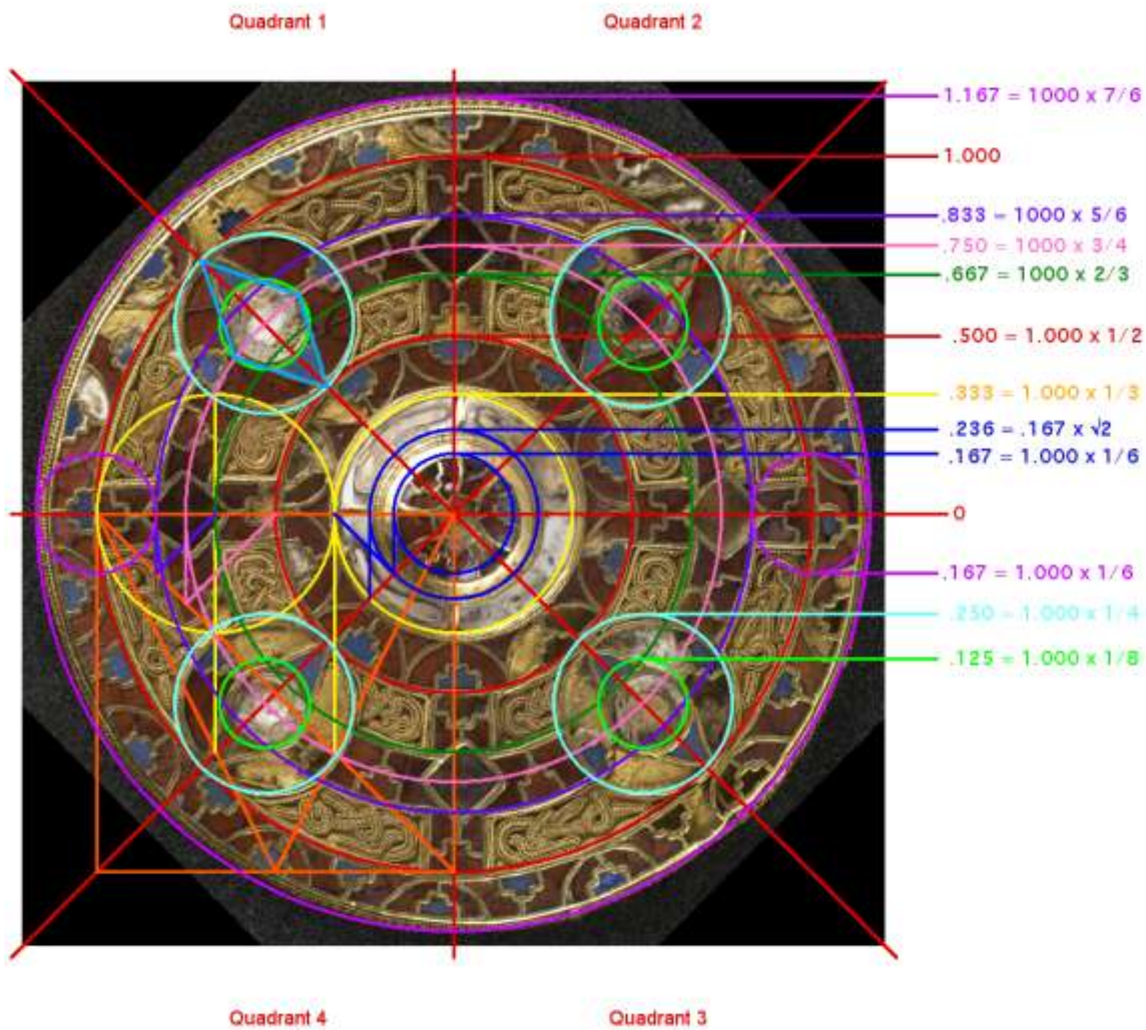

Figure B21: The Kingston Down Brooch showing steps 22-24.

Figure B22: Composite brooch from Milton North Field, Abington, (Milton North Field Brooch 1), Avent corpus 182, c. 6th-7th century CE, 7.4 cm in diameter, gold front with silver back and bronze cloisons. The Ashmolean Museum, Oxford, England.

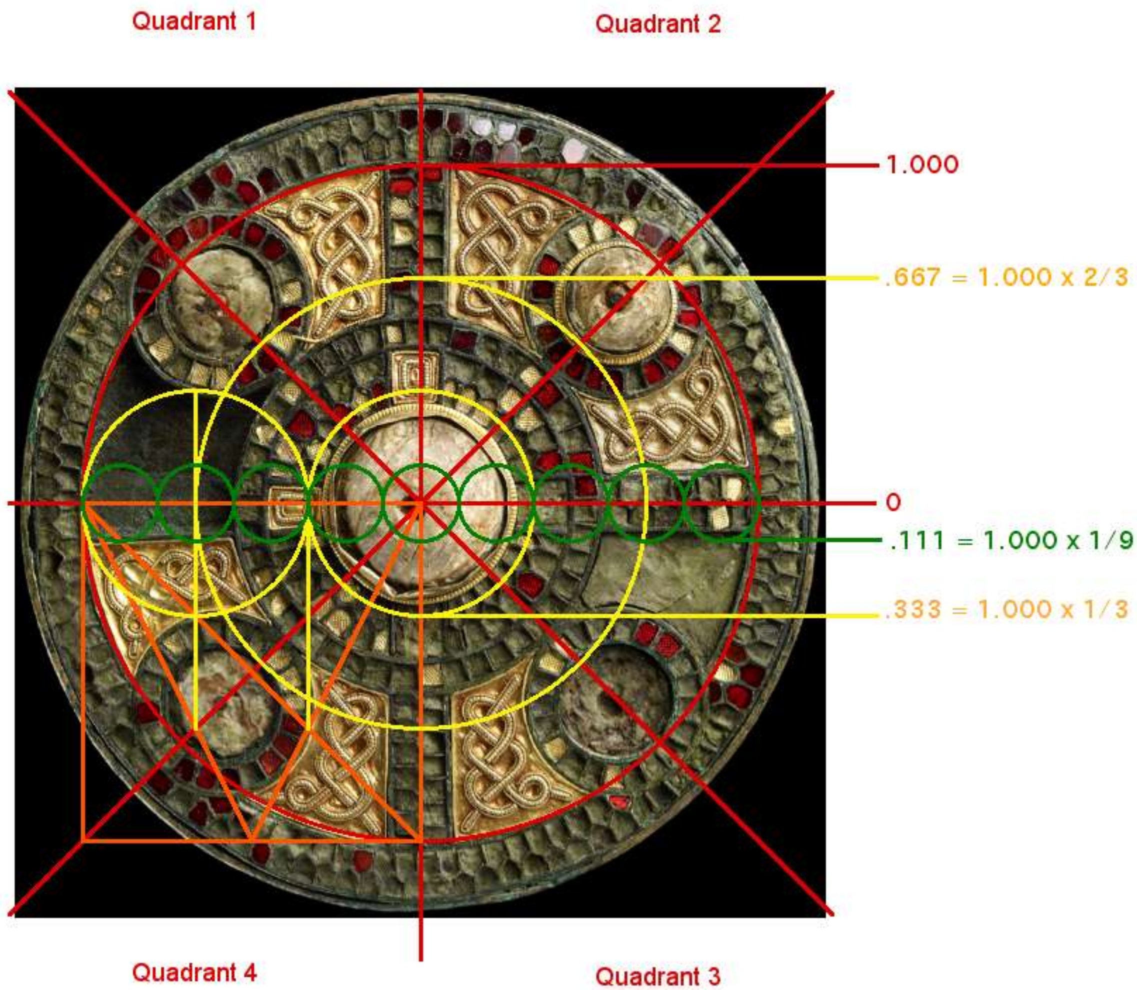

Figure B23: Milton North Field Brooch 1 showing steps 1-11.

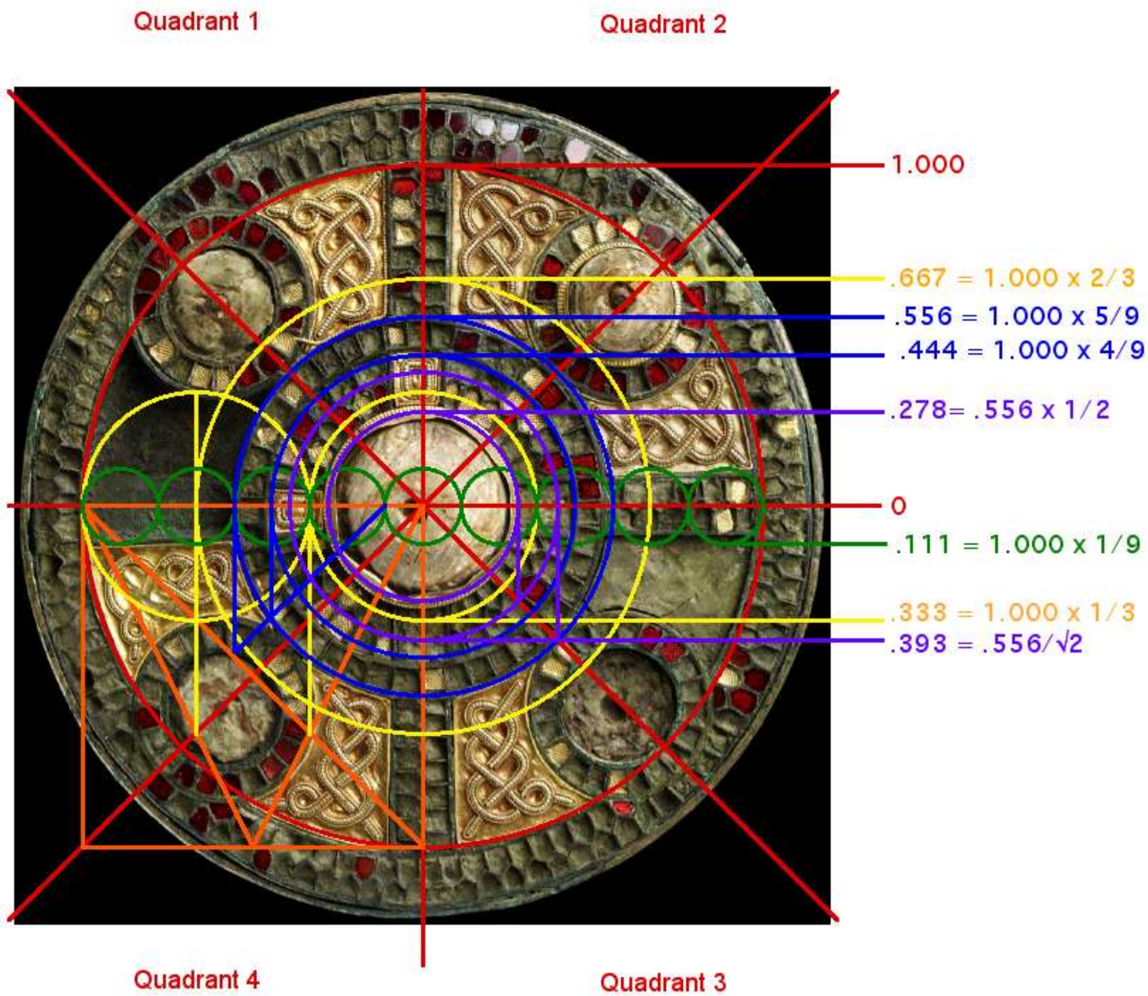

Figure B24: Milton North Field Brooch 1 showing steps 12-19.

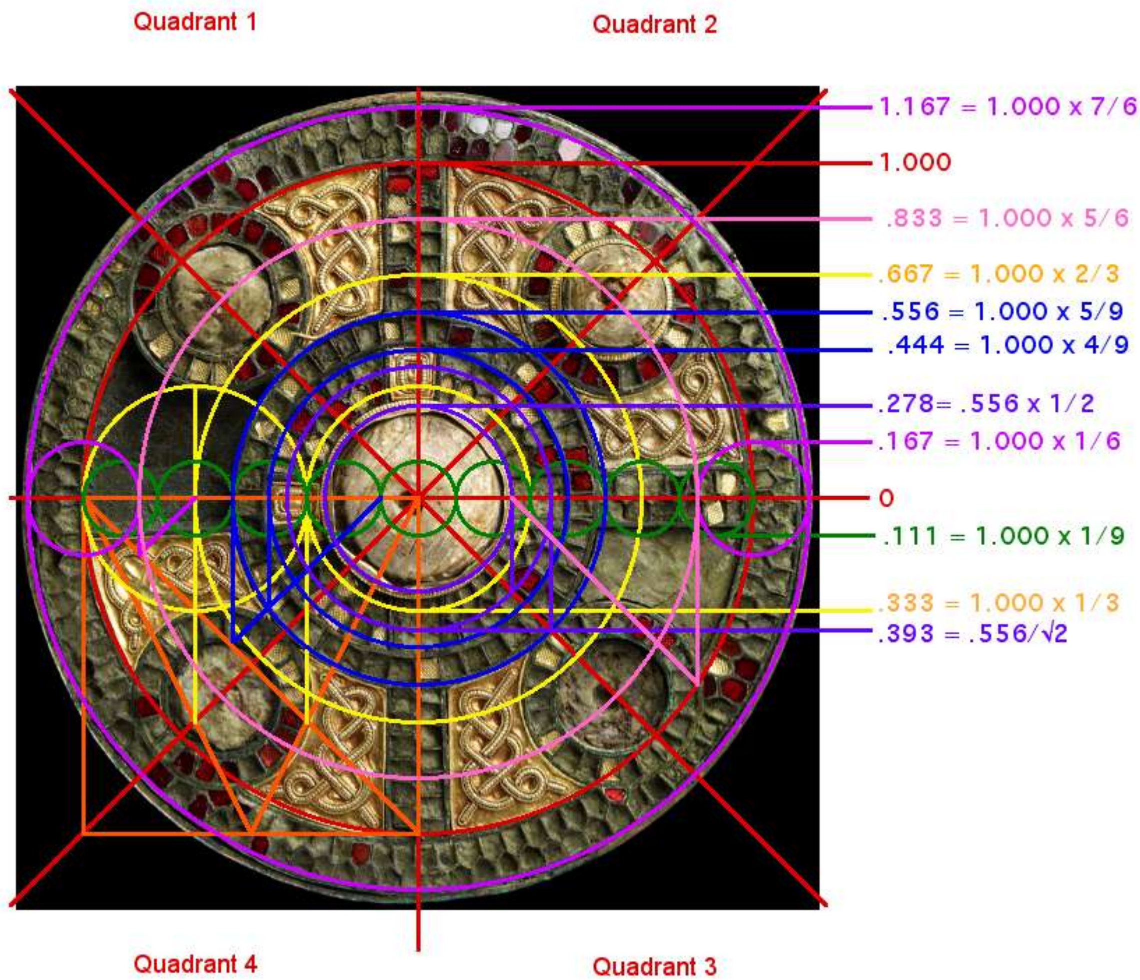

Figure B25: Milton North Field Brooch 1 showing steps 20-24.

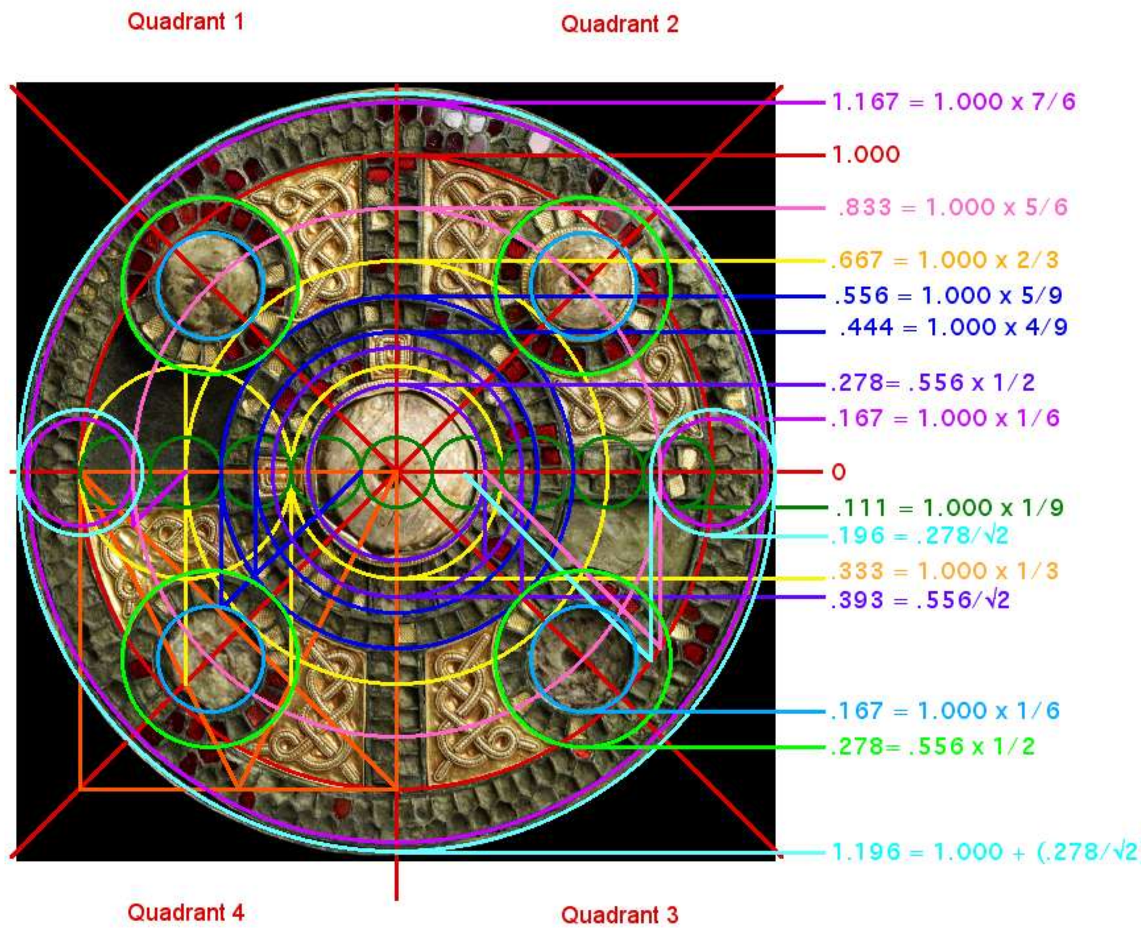

Figure B26: Milton North Field Brooch 1 showing steps 25-28.

Figure B27: Composite brooch from Milton North Field, Abington (Milton North Field Brooch 2), Avent corpus 183, c. 6th-7th century CE, 7.8 cm in diameter, gold front with silver back and bronze cloisons. The Victoria and Albert Museum, London, England.

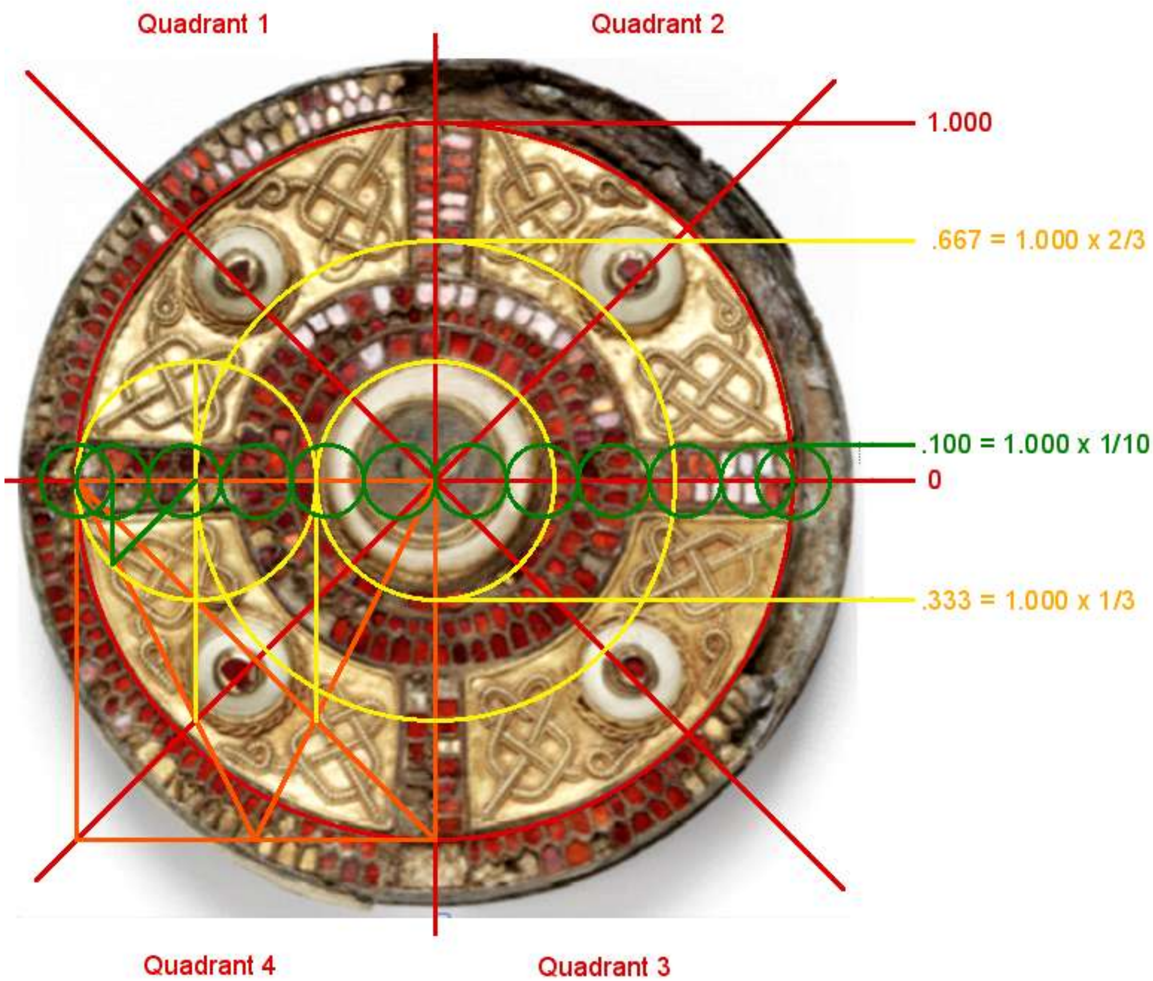

Figure B28: Milton North Field Brooch 2 showing steps 1-10.

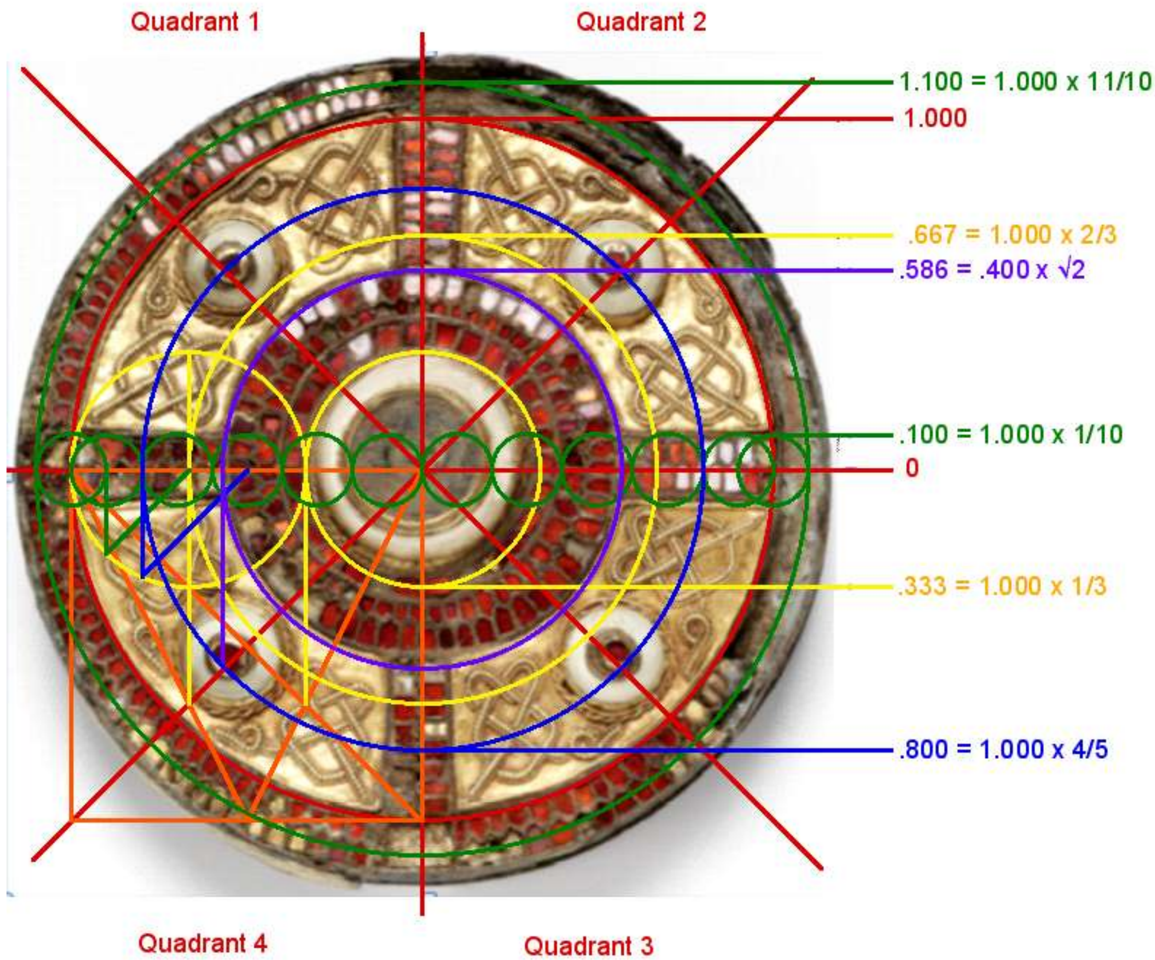

Figure B29: Milton North Field Brooch 2 showing steps 11-14.

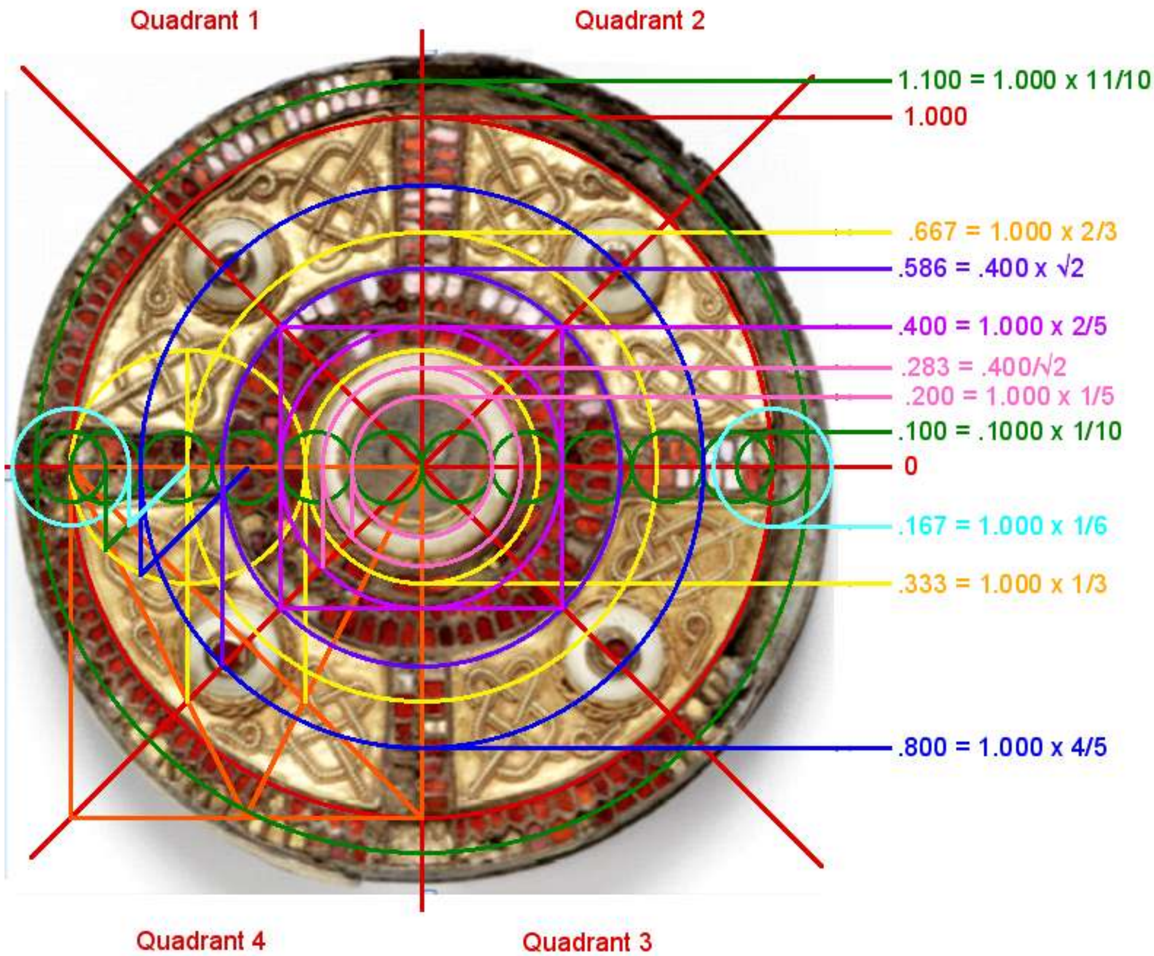

Figure B30: Milton North Field Brooch 2 showing steps 15-23.

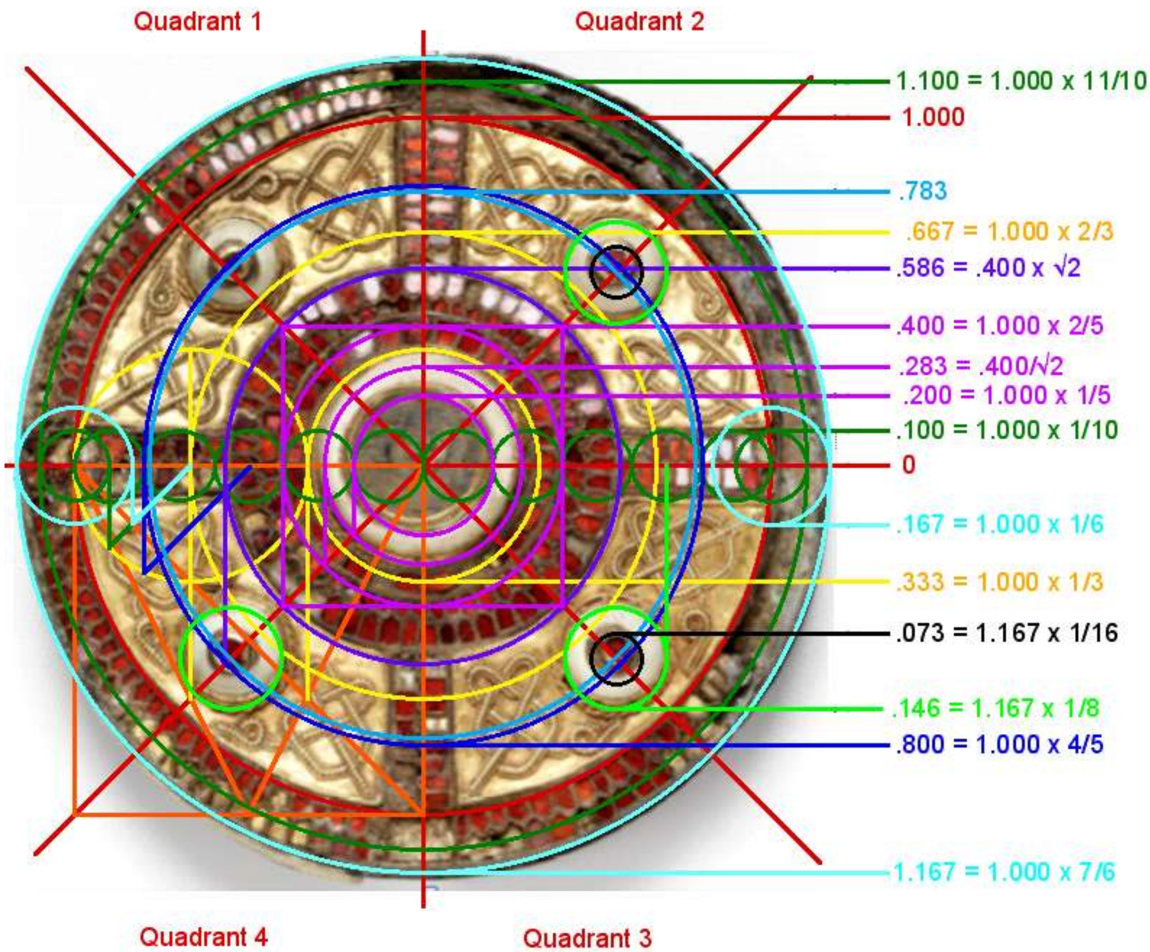

Figure B31: Milton North Field Brooch 2 showing steps 24-27.

BIBLIOGRAPHY

Adams, Noël. "Rethinking the Sutton Hoo Shoulder-Clasps and Armour." In *Intelligible Beauty: Recent Research on Byzantine Jewellery*. Edited by C. Entwistle and N. Adams. 83-112. London: British Museum Research Publication, 2010.

Allen, John Romilly. *Celtic Art in Pagan and Christian Times.* London: Methuen and Co, 1904.

Arnold, C.J. *An Archaeology of the Early Anglo-Saxon Kingdoms.* London: Routledge, 2006.

Backhouse, Janet. *The Lindisfarne Gospels*. Oxford: Phaidon, 1981.

Bede, Venerable. Bede's Ecclesiastical History of England, trans. A.M. Sellar (London: George Bell and Sons, 1907), 63.

Bork, Robert. *The Geometry of Creation: Architectural Drawing and the Dynamics of Gothic Design.* Burlington, VT: Ashgate, 2011.

Brooks, Nicholas. "Historical Introduction." In *The Making of England: Anglo-Saxon Art and Culture AD 600-900*, edited by Leslie Webster and Janet Backhouse, 9-12. Toronto: University of Toronto Press, 1991.

Coatsworth, Elizabeth and Michael Pinder. *The Art of the Anglo-Saxon Goldsmith: Fine Metalwork in Anglo-Saxon England: its Practice and Practitioners.* Woodbridge, UK: Boydell Press, 2002.

Dodwell, C. R. *Anglo-Saxon Art: A New Perspective*. Ithaca, NY: Cornell University Press, 1982.

Doran, Brent. "Mathematical Sophistication of the Insular Celts: Spirals, Symmetries, and Knots as a Window onto their World View." Proceedings of the Harvard Celtic Colloquium 15 (1995): 259-289.

Duby, Georges. *The Early Growth of the European Economy: Warriors and Peasants from the Seventh to the Twelfth Century*. New York: Cornell University Press, 1974.

Evans, Angela. "Metalwork and sculpture." In *The Making of England: Anglo-Saxon Art and Culture AD 600-900*, edited by Leslie Webster and Janet Backhouse, 21-34. Toronto: University of Toronto Press, 1991.

Geake, Helen. "Burial Practice in Seventh- and Eighth-Century England." In *The Age of Sutton Hoo: The Seventh Century in North-Western Europe*, edited by M. O. H. Carver, 83-94. Woodbridge, UK: Boydell Press, 1992.

Graham-Campbell, James. "The Lough Ravel, Co. Antrim, Brooch and Others of Ninth-Century Date." *Ulster Journal of Archaeology* 36/37 (1973/1974): 52-57.

Henry, Françoise. *Irish Art in the Early Christian period to AD 800.* London: Methuen, 1965.

Henderson, George. *Vision and Image in Early Christian England.* Cambridge: Cambridge University Press, 1999.

Henson, Don. "Appendix 5: Chronology of Anglo-Saxon Material Culture." In *The Origins of the Anglo-Saxons*, 213-223. Norfolk, England: Anglo-Saxon Books, 2006.

Hinton, David A. *Archaeology, Economy and Society: England from the Fifth to the Fifteenth Centuries.* Oxford: Routledge, 2002.

Hull, Derek. *Celtic and Anglo-Saxon Art: Geometric Aspects.* Liverpool: Liverpool University Press, 2003.

Jessup, Ronald. *Anglo-Saxon Jewellry.* London: Faber and Faber, 1950.

Kendrick, T. D. *Anglo-Saxon Art to A.D. 900.* London: Methuen & Co. Ltd., 1938.

______. "Polychrome Jewelry in Kent," *Antiquity* 7 (1933): 429-452.

______. "The Kingston Brooch." *Antiquaries Journal* 19, no. 2 (1939): 195-196.

Kilbride-Jones, Howard E. *Zoomorphic Penannular Brooches*. London: The Society of Antiquaries of London, 1980.

Kitzinger, Ernst. *Studies in Late Antique Byzantine and Medieval Western Art,* Vol. II. London: The Pindar Press, 2003.

Laing, Lloyd. *European Influence on Celtic Art: Patrons and Artists.* Dublin: Four Courts Press, 2010.

______. *The Archaeology of Celtic Britain and Ireland: C.AD 400-1200.* Cambridge, UK: Cambridge University Press, 2006.

Muir, Richard. *The National Trust Guide to Dark Age and Medieval Britain: 400-1350.* London: George Philip/The National Trust and the National Trust for Scotland, 1985.

Nieke, Margaret R. "Penannular and Related Brooches: Secular Ornament or Symbol in Action?" In *The Age of Migrating Ideas: Early Medieval Art in Northern Britain and Ireland*. Edited by R. Michael Spearman and John Higgitt, 128-134. Edinburgh: Alan Sutton Publishing, 1993.

Nees, Lawrence. *Early Medieval Art*. Oxford: Oxford University Press: 2002.

Nordenfalk, Carl. *Celtic and Anglo-Saxon Painting: Book Illumination in the British Isles 600-800.* New York: George Brazeller, 1977.

Ó Floinn, Raghnall. “Irish Metalwork: The Anglo-Saxon Connection.” In *Anglo-Saxon Irish Relations before the Vikings,* edited by James Graham Campbell and Michael Ryan, 231-252. Oxford, UK: Oxford University Press, 2009.

______. “Secular metalwork in the eighth and ninth centuries.” In *The Work of Angels: Masterpieces of Celtic Metalwork, 6th-9th centuries AD,* edited by Susan Youngs, 72-124. Austin, TX: University of Texas Press, 1989.

Owen-Crocker, Gale R. *Dress in Anglo-Saxon England*, Rev. ed. Woodbridge, UK: The Boydell Press, 2004.

Owen-Crocker, Gale R. “Measuring Wealth by Metalwork in Anglo-Saxon Graves.” In *De Re Metallica: The Uses of Metal in the Middle Ages,* edited by Robert Bork, 15-29. Aldershot, UK: Ashgate, 2005.

Peake, Harold. *The Archaeology of Berkshire.* London: Methuen and Company Ltd., 1931.

Pinder, Michael. “Anglo-Saxon Garnet Cloisonné Composite Disc Brooches: Some Aspects of their Construction.” *Journal of the British Archaeological Association* 148 (1995): 6-28.

Richardson, Hilary. “Celtic Art.” In *An Introduction to Celtic Christianity*, edited by James P. Mackey, 359-385. Edinburgh: T&T Clark, 1989.

Richter, Michael. “The English link in Hiberno-Frankish relations in the seventh century.” In *Ireland and northern France: AD 600-850,* edited by Jean-Michael Picard, 94-109. Dublin: Four Courts Press, 1991

Schoenfeld, Edward and Jana Schulman. “Sutton Hoo: An Economic Assessment.” In *Voyage to the Other World: The Legacy of Sutton Hoo,* edited by Calvin B. Kendall and Peter S. Wells, 15-28. Minneapolis, MN: University of Minnesota Press, 1992.

Sizer, Walter S. “Mathematical Notions in Preliterate Societies.” *The Mathematical Intelligencer* 13, no. 4 (Fall 1991): 53-60.

Stevick, Robert D. “Shapes of Early Sculptured Crosses of Ireland.” *Gesta* 38 (1999): 3-21.

______. “The Ancestry of ‘Coherent Geometry’ in Insular Designing.” *Journal of the Royal Society of Antiquaries of Ireland* 134 (2004): 5-32.

______. *The Earliest Irish and English Book Arts: Visual and Poetic Forms Before AD 1000.* Philadelphia: University of Pennsylvania Press, 1994.

______. “The Form of the Tara Brooch.” *The Journal of the Royal Society of Antiquaries in Ireland* 128 (1998): 5-16.

______. “The Forms of the Monasterevin-Type Discs.” *The Journals of the Royal Society of Antiquaries of Ireland* 136 (2006): 112-140.

______.“The Plan of the Evangelist Portrait Pages in the “’Book of Mulling.’” *Journal of the Royal Society of Antiquaries of Ireland* 121 (1991): 27-44.

______. “The Shapes of the Book of Durrow Evangelist-Symbol Pages.” *The Art Bulletin* 68, no. 2 (1986): 182-194.

______. “The 4x3 Crosses in the Lindisfarne and Lichfield Gospels.” *Gesta* 25, no. 2 (1986): 171-184.

Suzuki, Seiichi. *The Quoit Brooch Style and Anglo-Saxon Settlement: A Casting and Recasting of Cultural Identity Symbols.* Place and shit, 2000.

Tait, Hugh, editor. *Jewelry: 7,000 Years*. New York: Harry N. Abrams, 1986.

Webster, Jane. “Creolizing the Roman Provinces.” *American Journal of Archaeology* 105, no. 2 (April, 2001): 209-225.

Webster, Leslie. *Anglo-Saxon Art: A New History*. New York: Cornell University Press, 2012.

Whitfield, Niamh. “Filigree Animal Ornament from Ireland and Scotland of the Late-Seventh to Ninth Centuries: Its Origins and Development.” In *The Insular Tradition,* edited by Catherine E. Karkov, Michael Ryan, Robert T. Farrel, 211-244. New York: State University of New York Press, 1997.

______. “More Thoughts on the Wearing of Brooches in Early Medieval Ireland.” In *Irish Art Historical Studies in Honour of Peter Harbison*. Dublin: Four Courts Press, 2004.

______. “Motifs and Techniques of Celtic Filigree: Are They Original?” in *Ireland and Insular Art A.D. 500-1200,* edited by Michael Ryan, 70-108. Dublin: Royal Irish Academy, 1987.

______. “The Earliest Filigree from Ireland.” In *Pattern and Purpose in Insular Art: Proceedings of the Fourth International Conference on Insular Art held at the National Museum and Gallery, Cardiff 3-6 September 1998,* edited by Mark Redknap et al., 141-156. Oxford, UK: Oxbow Books, 2001.

______. “The Filigree of the Hunterston and ‘Tara’ Brooches” in *The Age of Migrating Ideas: Early Medieval Art in Northern Britain and Ireland,* ed. R. Michael Spearman and John Higgitt, 118-127. Edinburgh: Alan Sutton Publishing, 1993.

______. “The ‘Tara’ Brooch: An Irish Emblem of Status in Its European Context.” In *From Ireland Coming: Irish Art from the Early Christian to the Late Gothic Period and Its European Context*, edited by Coum Hourihane, 211-247. Princeton, NJ: Princeton University Press, 2001.

Williams, Howard. *Death and Memory in Early Medieval Britain.* Cambridge: Cambridge University Press, 2006.

Woolf, Greg. "Beyond Romans and Natives." *World Archaeology* 28, no. 3 (Culture Contact and Colonialism (Feb., 1997): 339-350.