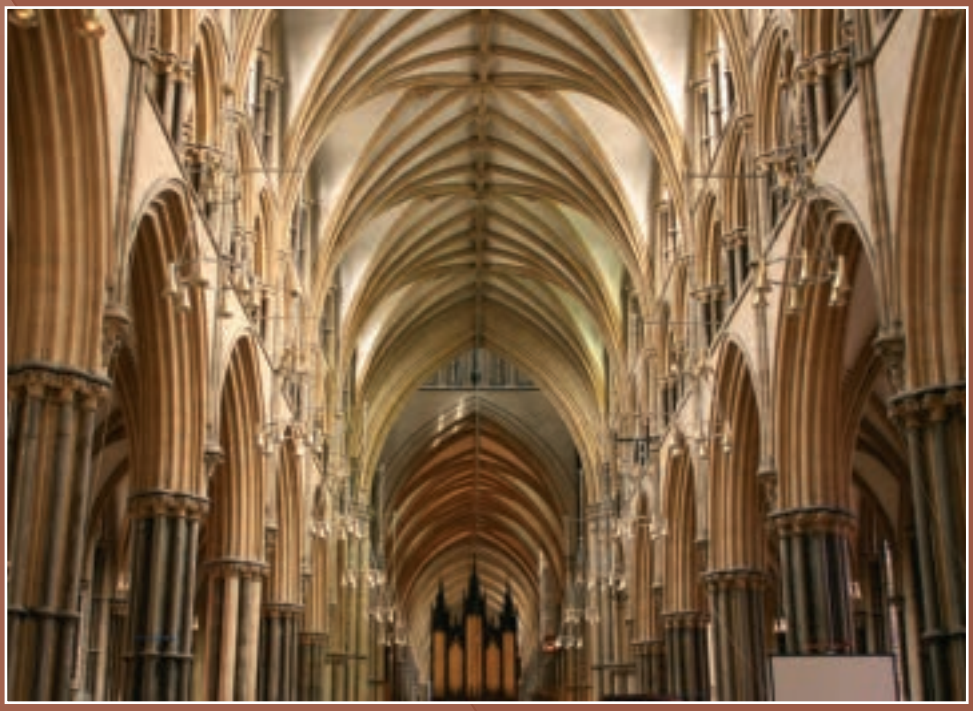
PETER LANG

Architecture as Cosmology

LINCOLN CATHEDRAL AND ENGLISH GOTHIC ARCHITECTURE



JOHN SHANNON HENDRIX

Architecture as Cosmology examines the precedents, interpretations, and influences of the architecture of one of the great buildings in the history of architecture, Lincoln Cathedral. It analyzes the origin and development of its architectural forms, which were to a great extent unprecedented and were very influential in the development of English Gothic architecture and in conceptions of architecture to the present day. *Architecture as Cosmology* emphasizes the relation of the architectural forms to medieval philosophy, focusing on the writings of Robert Grosseteste, Bishop of Lincoln (1235–53). The architecture is seen as a text of the philosophy, cosmology, and theology of medieval English culture. This book should be useful to anyone interested in architecture, architectural history, architectural theory, Gothic architecture, and medieval philosophy.

John Shannon Hendrix is Professor of Architectural History at the University of Lincoln. His previous books include *Architecture and Psychoanalysis, Aesthetics and the Philosophy of Spirit, Platonic Architectonics,* and *Architectural Forms and Philosophical Structures,* all published by Peter Lang, and *The Relation Between Architectural Forms and Philosophical Structures in the Work of Francesco Borromini in Seventeenth-Century Rome* and *Robert Grosseteste: Philosophy of Intellect and Vision.*

Architecture as Cosmology

PETER LANG
New York • Washington, D.C./Baltimore • Bern
Frankfurt • Berlin • Brussels • Vienna • Oxford

JOHN SHANNON HENDRIX

Architecture as Cosmology

LINCOLN CATHEDRAL AND ENGLISH GOTHIC ARCHITECTURE

PETER LANG
New York • Washington, D.C./Baltimore • Bern
Frankfurt • Berlin • Brussels • Vienna • Oxford

Library of Congress Cataloging-in-Publication Data

Hendrix, John.
Architecture as cosmology: Lincoln Cathedral
and English Gothic architecture / John Shannon Hendrix.
p. cm.
Includes bibliographical references and index.
1. Lincoln Cathedral. 2. Grosseteste, Robert, 1175?–1253.
3. Architecture, Gothic—England. 4. Architecture and cosmology—England.
I. Title. II. Title: Lincoln Cathedral and English Gothic architecture.
NA5471.L7 H46 726.609425'34—dc22 2010030793
ISBN 978-1-4331-1316-1 (paperback)
ISBN 978-1-4539-0517-3 (eBook)

Bibliographic information published by **Die Deutsche Nationalbibliothek**.
Die Deutsche Nationalbibliothek lists this publication in the "Deutsche
Nationalbibliografie"; detailed bibliographic data is available
on the Internet at http://dnb.d-nb.de/.

Photo by author with kind permission of Lincoln Cathedral.

This book is dedicated to the memory of my father, John David Hendrix,
and the memory of my mother, Margaret Shannon Hendrix.

Contents

Illustrations

Acknowledgments

I would like to acknowledge the University of Lincoln, in particular Nicholas Temple, Head of the School of Architecture; the Rhode Island School of Design, in particular Margaret Lewis, and the Professional Development Fund, for a grant to photograph the cathedrals and churches; Roger Williams University, in particular Stephen White, for travel funds; Lincoln Cathedral, in particular Nicholas Bennett, the Archivist, and the masons of the cathedral; Lincoln Academy; and colleagues in England for their support, in particular Nader El-Bizri. All photographs are by the author with permission from the cathedrals and churches. Marta Bustillo, in the Visual Resources Center at the Rhode Island School of Design, digitally enhanced some of the photographs. The photographs are published with kind permission of Lincoln Cathedral, with kind permission of the Dean and Chapter at Canterbury, by permission of the Vicar and PCC of Beverley Minster, with kind permission of the Dean and Chapter of Bristol Cathedral, by kind permission of the Dean and Chapter of Norwich Cathedral, with kind permission of the Dean and Chapter of Hereford, by permission of the Chapter of Chester Cathedral; by kind permission of the Dean and Chapter of Southwell Minster, Nottinghamshire; by kind permission of the Vicar of Sherborne, Canon Eric Woods; by kind permission of Christ Church, Oxford; by kind permission of the Dean and Chapter of York; by permission of Ottery St. Mary, Tewkesbury Abbey PCC, Wells, Salisbury, Exeter; Durham, Winchester, Worcester, St. Mary Redcliffe, Peterborough, Oxford Divinity School, Bath Abbey, and Westminster Abbey (exterior). Permission was requested from King's College Chapel, Ely and Gloucester. I would like to thank Caitlin Lavelle and Jackie Pavlovic at Peter Lang for the production of this volume.

1
Introduction

I am a Professor of Architectural History at the University of Lincoln in England. For several years I have been researching and writing about the architecture of Lincoln Cathedral, its influence in the development of English Gothic architecture, and the relation between the vocabulary forms of the architecture and the geometrical cosmologies of Robert Grosseteste, Bishop of Lincoln 1235–53. I have given many lectures and presentations on the subject, at the University of Lincoln and elsewhere. I have taken hundreds of photographs of the cathedral and thirty other cathedrals and churches in England, supported by a Professional Development Grant from the Rhode Island School of Design, where I am an adjunct professor. The research was carried out under the direction of Nicholas Temple, Head of the School of Architecture at the University of Lincoln. Input for the project has been received from other colleagues in England, including the Archivist of Lincoln Cathedral, Nicholas Bennett; members of Lincoln Academy, and masons at Lincoln Cathedral; and other architectural historians at Lincoln and other universities. The project is supported by Lincoln Cathedral and the University of Lincoln. No archives exist of the medieval building fabric, so interpretations are based on the built work, and the writings of previous scholars. All available recent scholarship, including publications of the British Archaeological Association, is taken into consideration. Any controversy about the dating of the parts of the cathedral, and any information resulting from recent archaeological work which is relevant to the project, is addressed in the text.

This book examines the architecture of Lincoln Cathedral, one of the great buildings in the history of architecture, in the context of English Gothic architecture. Lincoln Cathedral is profoundly influential in the development of forms and ideas in architecture. Amazingly, there is no good book in print on the architecture of Lincoln Cathedral. This book proposes to make the architecture of the cathedral familiar to readers, and to convey the importance of the architecture of the cathedral in the history of architecture. The book is intended for anyone who is interested in architecture, Lincoln Cathedral, and

medieval culture. A goal is to explain the relevance of English Gothic architecture to contemporary architecture and contemporary concerns, as well as to do justice to the beauty and complexity of English Gothic architecture in its own right.

The aim of this project is to establish the importance of Lincoln Cathedral in the origin and development of English Gothic architecture. This study examines precedents for the architecture of the cathedral, the circumstances of its building, the new architecture which emerges at Lincoln between 1190 and 1250, and the architecture in relation to the culture of the time period, including the theology, philosophy, and epistemology, as particularly evidenced in the writings of Robert Grosseteste, Bishop of Lincoln, 1235–53. The extraordinary importance of the architecture of Lincoln Cathedral in the history of architecture has not been established before this project. Beyond the enormity of its influence, what is most significant about the architecture of the cathedral is the invention of an architectural vocabulary, in a departure from the French style of Gothic architecture, which had never been seen before, and which subsequently became the defining vocabulary of English Gothic architecture. In particular, the ridge pole, the tierceron (non-structural rib), the lierne (or a precedent for the lierne rib, the segmented ridge rib), the flying rib, the conoid springer vault, triradial vaulting, double syncopated arcading, and the bundled and ribbed umbrella column and vault, all originate in some form or are developed at Lincoln. Some of the vocabulary can be explained in part by related precedents and parallels, while some of the vocabulary has as yet no explanation at all.

The aim of this project is to provide an explanation, by examining the precedents and parallels, by interpreting the architectural forms in relation to the culture, and by revealing how the architectural forms are related to a geometrical catechism of the structure of matter which was the focus of the new scientific philosophy developed by Robert Grosseteste and the Oxford School. The main forms of English Gothic architecture are not just decorative, but play an important role in representing the understanding of the structure of the physical and metaphysical worlds, the structure of being, on the part of the medieval culture of England. English Gothic architecture, beginning at Lincoln Cathedral, is intended to function as a catechism or *edificium* for the geometrical structure of matter, and for the relation between the material or sensible world and the intelligible world, that is between man and God or reason and faith, as it is understood through the mechanisms of intellect and perception, and translated into architectural forms.

The survey of English Gothic architecture is divided into four sections, based on periods established by Thomas Rickman in the *Attempt to Discriminate the Style of Architecture in England* in 1815. The periods are Early English (1180–1250), Decorated (1250–90), Curvilinear (1290–1380), and Perpendicular (1380–1540). The divisions are used just for convenience; the limitations of the categories are discussed in due course. The development of English Gothic architecture throughout the Middle Ages, from 1180 to 1540, is relatively homogeneous and consistent. Almost all of the architecture contributes to the same campaign, the same particular use of vocabulary elements, with surprising and innovative variations, and the same expressive intentions. Consistently throughout the development of English Gothic architecture, there is an intention in the architecture which can be traced back to the precedents at Lincoln Cathedral: the intention to express an idea through the juxtaposition of non-structural geometries with the structural geometries of the architecture. The characteristic "handwriting" of English Gothic architecture, the linear networks, surface patterns, geometrical articulations, and spatial interpenetrations, contribute to the creation of an architecture in which form contradicts function, resulting in a poetic expression. In order for architecture to be art, its form must contradict its function, as architecture, unlike the other arts, can never be free and independent from its function.

The cathedrals and churches of English Gothic architecture represent some of the greatest achievements of architecture as art in the history of architecture, and some of the most poetic expressions in built form. All of the buildings contribute to an expression of a coherent idea, representing the theology, philosophy, and epistemology (Scholasticism) of medieval England. There is no doubt that the buildings are intended as catechisms, as three-dimensional models for didactic purposes, to represent and communicate to everyone basic ideas about man, God, and being. The buildings are models of the structure of the universe, conceived in terms of a geometrical substructure of matter which can be related to the cosmology of Robert Grosseteste, *De lineis, angulis et figuris* (*On Lines, Angles and Figures*), written at the beginning of the thirteenth century. The buildings enact the role of *lux spiritualis*, the spiritual light of God, as it is transformed into *lumen spiritualis*, reflected spiritual light, into the physical world, which is then transformed into matter, in reflection, refraction and rarefaction, in lines, angles and figures, that is, geometry and mathematics.

The geometrical and mathematical structure of the buildings, the intelligible or conceptual structure as opposed to the physical structure, enacts the

formation of matter through light, so that the buildings are models of the understanding, in the developing natural or scientific philosophy, of the physical structure of the cosmos. Such an understanding began with the work of Robert Grosseteste at Oxford and Lincoln. It was the product of a synthesis of Catholic theology (in particular the Neoplatonic theories of light from St. Augustine to Pseudo-Dionysius); Neoplatonic philosophies filtered through works such as the *Liber de Causis*, *Theology of Aristotle*, and the writings of the Greek and Arabic commentators on Aristotle; and Neoaristotelian concepts as they conformed to Catholic and Neoplatonic concepts. The result was the beginning of natural or scientific philosophy, the beginning of the "Oxford School," the beginning of the "Franciscan School," and the beginning of the "Great Synthesis."

The extent to which Grosseteste's writings constitute the beginnings of modern science, as argued by Alistair Cameron Crombie in *Robert Grosseteste and the Origins of Experimental Science 1100–1700*, in their experimental or empirical methodology, is subject to debate. It is much easier to see their legacy in the architecture of the cathedrals, in a unified cosmology and a philosophy of intellect and perception made visible in built form. The closest relation between text and Gothic architecture can be found in the writing of the Abbot Suger in France (the *Libellus Alter De consecratione ecclesiae sancti dionysii*), which refers to the metaphysical concepts of Pseudo-Dionysius in relation to a description of the building project at the Abbey Church of St. Denis in the twelfth century. The interest in Pseudo-Dionysius was continued by Grosseteste, with translations and commentaries of the work of Pseudo-Dionysius during Grosseteste's bishopric at Lincoln. It is not an over-estimation to say that the beginning of the thirteenth century in England was a pivotal period in the course of Western civilization, a true renaissance which established the groundwork for cultural expression for the next three hundred years, leading up to the "Renaissance" itself, which in reality is as much defined by cultural, economic, and political shifts as by radical developments in cultural expression. In fact, this survey of English Gothic architecture hopes to contribute to a picture of continuity between the cultures of the late Middle Ages and the Renaissance, in terms of relations between church and state, and philosophical outlooks.

The buildings are models of the structure of the universe; they express an idea through an intelligible structure which is juxtaposed to the physical, sensible form. Robert Grosseteste, in works such as the *Commentary on the Posterior Analytics*, distinguished between the *species sensibilis*, sensible

perceived form, and the *species apprehensibilis*, intelligible form, in the processes of perception. The intelligible form is the form as understood in order to be perceived; it is illuminated in the *oculus mentis*, the mind's eye, by the *lux spiritualis*, spiritual light. In order to see the intelligible form clearly, a person must develop his or her intellect through their will, *solertia*. The lowest form of intellect, *virtus cogitativa* (from the *nous hylikos*, or material intellect, of Aristotle's *De anima*, also called the *nous pathetikos*), is intellect which is completely connected to sense perception and the material world. In order to cleanse the lens of the *oculus mentis* and see the intelligible form, intellect must be developed from the *virtus cogitativa* to a higher form of intellect, *virtus intellectiva* (from the *nous poietikos*, poetic or creative intellect, of the commentators on Aristotle), which is in part freed from connection with the physical world and sense perception.

The *virtus intellectiva* operates in part based on the participation of *intelligentia*, divine intelligence (from Aristotle's concept of active or universal intellect in the *De anima*), which is the source of the *lux spiritualis* which illuminates the *oculus mentis*. The English Gothic cathedral was designed to facilitate this ascension in intellect from the physical to the spiritual. As the eyes of the worshipper gradually turned away from physical existence and material necessity (as in the structural and functional requirements of the building), they began to focus on the geometrical patterns, spatial juxtapositions, and all the elements enacting a geometrical and mathematical intelligible structure of being. They were able to focus on the intelligible structure because of the *lux spiritualis* in the *oculus mentis*, which was represented in the architecture by the light through the stained glass windows, which were the *oculus mentis* of the building. The architecture thus led the worshipper through an intellectual ascension towards God and *intelligentia*, in a process of purification through the hypostases of being. The ascension was facilitated by the Scholastic characteristics of dematerialization, compartmentalization, and subdivision, exercises designed for the development of higher intellect, and which formed the compositional bases of the architecture.

Such concepts of the structure of the universe, being and intellect, permeated the culture of medieval England, and from 1180 to 1540 contributed to a homogeneous cultural expression, particularly in the architecture of the cathedral. The architecture of the cathedral developed as a response to the *zeitgeist* of the era; there was little concept of individual artistic expression or creativity. The result is a lasting representation, in built form, of the theol-

ogy, philosophy, and epistemology of a civilization in the Middle Ages in England.

The first chapter seeks to explain the architecture of Lincoln Cathedral in relation to architectural and theoretical precedents at Durham Cathedral and Canterbury Cathedral, which constitute both the beginnings of Gothic architecture and the origin of the distinctive forms of English Gothic architecture. The architectural precedents are considered in both their technical formations and their expressive intentions. The rib vault, considered by some historians to be the most fundamental element of Gothic architecture, was possibly invented at Durham. There is debate among historians as to what caused the invention of the rib vault, whether it was purely a technical necessity or whether it conformed to concepts of dematerialization, Scholastic compartmentalization and divisibility (as in the *summa*), surface texture, or an intelligible structure distinct from the physical structure of the building. The rib vault forms the basis for what appears later at Lincoln.

The chapter discusses some of the theories of architecture associated with the emergence of the rib vault, and pointed arch vault, beginning with Paul Frankl, and including Heinrich Wölfflin, Gottfried Semper, Marc-Antoine Laugier, Eugène-Emmanuel Viollet-le-Duc, and Willi Drost. There is a discussion of the debate over the roles of Platonism and Aristotelianism in Gothic architecture, and the extent to which cultural epistemologies extended to the masonry of the cathedrals. There is a long discussion of a letter written by Robert Grosseteste, quoted by John Harvey in *The Medieval Architect*, which links craft and masonry to ideas about the archetypal design of the cosmos, the understanding of divine intelligence, the structures and relationships of the church and clergy, and the dialectic between the perceived form and the intelligible form, which is a model for the relation between human intelligence and divine intelligence. The discussion widens to concepts outlined by Grosseteste in the *Commentary on the Posterior Analytics*, with references to other writers such as Plotinus and Marsilio Ficino, and the *Metrical Life of Saint Hugh*, the biography of Hugh of Avalon, Bishop of Lincoln 1192–1200. The discussion then moves to the symbolic role of the stained glass window, in particular the Dean's Eye and Bishop's Eye at Lincoln Cathedral.

The building of the east end of Canterbury Cathedral is outlined, as chronicled by Gervase of Canterbury. The innovations of William of Sens are described, initiating the departure from French Gothic architecture and the beginnings of the particular characteristics of English Gothic architec-

ture, including the use of materials, a syncretic approach to composition, the dematerialization and divisibility, and the contradiction of structural logic. William the Englishman, who succeeded William of Sens at Canterbury, introduced even more syncretism and departure from precedent. It is believed that Geoffrey de Noyers, the master mason at Lincoln, had worked at Canterbury. There follows a discussion of the writings of Anselm of Canterbury, Archbishop of Canterbury, who is sometimes called the "Father of Scholasticism." The discussion focuses on the concepts of mystical light in the *Monologion*, and the dialectic between the sensible and intelligible, reason and faith, in the *Oratio ad sanctum Nicolaum*, with references to Plato, Plotinus, Pseudo-Dionysius, Nicolas Cusanus, and the writings of Grosseteste.

A brief history of Lincoln Cathedral follows, and a description of the architectural elements in relation to the precedents at Durham and Canterbury, in particular the ridge rib, diagonal ribs, triradial ribs, tierceron and lierne (segmented ridge rib), syncopated double arcading, and crocketing. The precedents at Durham and Canterbury established the groundwork for the explosion of a new architecture and a new set of architectural forms at Lincoln, which should be seen as a "handwriting" of Scholastic ideas in linear networks, layered treatments, spatial interpenetrations and geometrical articulations, and which should be seen as in turn establishing the basic vocabulary for the development of English Gothic architecture.

The next chapter includes a brief history of Lincoln, the building of the Norman cathedral by Bishop Remigius, and the rebuilding of the cathedral in the Gothic style begun by Bishop Hugh of Avalon. The research builds upon the work of architectural historians G. H. Cook, A. F. Kendrick, Christopher Wilson, Paul Frankl, Nikolaus Pevsner, John Harvey, Peter Kidson, Folke Nordström, John Baily, and Peter Draper. The chapter includes a chronology of the completion of the parts of the cathedral, and a description of Saint Hugh's Choir, with a discussion of the debate over the chronology of the building of the choir. During the bishopric of Grosseteste at Lincoln, it is probable (though debatable) that Saint Hugh's Choir, the nave and chapter house were vaulted, the tower was rebuilt, the Galilee Porch was completed, and the central portion of the west front was completed. There is a description of the transepts, the rose windows, the nave, the west front screen façade, crossing and tower, and chapter house. The originality of the architecture has been established by a number of historians, including Eugène Emmanuel Viollet-le-Duc, George Gilbert Scott, Edmund Venables, and J. H. Parker.

An important part of the interpretation of the architecture is a challenge to the interpretations of Paul Frankl and Nikolaus Pevsner: Frankl's attribution of the architecture to "Gothic Mannerism" or "akyrism," and Pevsner's attribution to the "visionary genius" of Geoffrey de Noyers, his "sense of play" and "experiment in vistas." The interpretation also challenges Pevsner's continual description of the vaulting in English Gothic architecture as purely decorative, and seeks to redefine the term "mannerism" in a way that would be applicable to the architecture. The interpretation considers important themes from Erwin Panofsky's *Gothic Architecture and Scholasticism*: the "urban professionalism" of the time, the diffusion of knowledge from the university and clergy to the artisans and masons, the importance of the *manifestatio* in the underlying structure of both the *summa* and the cathedral, and the principles of transparency and "progressive divisibility" as they are applied to architecture. There is a discussion of the relation between the architectural forms and images in contemporary illuminated manuscripts, representing the hierarchical structure of the church, and a discussion of Byzantine and Early Christian precedents for the vaulting.

There is a brief discussion of the optical theory of Robert Grosseteste, or his theories of perception and intellect, in relation to the vaulting, which are more thoroughly discussed in the subsequent chapter. In particular there is a discussion of the *lux spiritualis*, or spiritual light, in relation to Pseudo-Dionysius and the Abbot Suger, as it is manifest in the architecture, and the *species apprehensibilis* of Grosseteste, the intelligible form in perception, and the *virtus intellectiva*, or higher form of intellect in which divine intellect participates, as they are manifest in the architecture. The architecture of the cathedral is seen as a catechism of the relation between the sensible and intelligible, and between reason and faith. There is a discussion of Greek and Arabic influences on Grosseteste, and the theory of perception of Plotinus.

The architecture of the cathedral is seen as entailing a purposeful disjunction between form and function, between the visual organization of vocabulary elements and the logical structural system. In the architecture of the cathedral, which constitutes the beginning of the English Gothic, it is a demonstrative geometry which is the driving force of the architecture. The geometries are generated in relation to architectural precedents and structural purposes, but ultimately they are departures from both of these, and their intended function is a didactic one: they are intended as catechisms for a structural model of matter and being based in geometry, mathematics, and optics. This would explain their radical novelty and innovation, which was so influ-

ential to subsequent architectural developments. The architecture of the cathedral introduces a new element into architectural design: the forms of the architecture depart from their structural necessity, in a disjunction between form and function, for the purpose of expressing an idea.

The next chapter considers the origin of the vocabulary elements of the architecture of Lincoln Cathedral, which become the main vocabulary elements of English Gothic architecture, in relation to the writings of Robert Grosseteste. It explains how the vocabulary elements were formed to create an architecture which is a catechism or *edificium* of the understanding of the structure of matter, intellect, and being. The chapter begins with a brief biography of Grosseteste, describing his career and writings, his role as the first Chancellor of Oxford University, chief supporter of the Franciscan School, and Bishop of Lincoln 1235–53. His influence on Duns Scotus, John Wycliffe, Roger Bacon, and John Peckham is briefly discussed, and the importance of his work to Albertus Magnus and Thomas Aquinas in the Great Synthesis. Grosseteste wrote the first Latin commentary on Aristotle, and wrote the first scientific cosmology since the *Timaeus* of Plato. The principal writings of Grosseteste which are discussed are *De Luce* (*On Light*, c. 1215), *Commentary on the Posterior Analytics* (of Aristotle, c. 1230), *De lineis, angulis et figuris* (*On Lines, Angles and Figures*, c. 1235, the cosmology), and Grosseteste's *Hexaemeron* (c. 1235). The scholarship on Grosseteste builds upon the work of Grosseteste scholars James McEvoy, Alistair Cameron Crombie, Richard William Southern, and Daniel Angelo Philip Callus.

There are obvious parallels between the geometries which Grosseteste used to describe the substructure of light and matter and the geometries of vocabulary forms of the architecture at Lincoln Cathedral, some of which have no precedent. The *De Lineis* describes lines of light, which form matter, in geometrical terms. Rays of light emanate in cones, and are refracted and rarefacted to form various geometries, which correspond to the substructure of matter, as in the *Timaeus* of Plato. The *De Lineis* is the first scientific cosmology written since the *Timaeus*, and plays a key role in the beginnings of a new scientific or natural philosophy at the beginning of the thirteenth century in England. The geometries of refracted and rarefacted light as described by Grosseteste correspond to the vocabulary elements of the vaulting at Lincoln Cathedral, which appear for the first time without precedent: the ridge pole, tierceron, lierne (actually a segmental ridge rib), conoid springer vault, and bundled umbrella vault. The *species* (*eidos*) or visible form of matter is projected by light in straight and bent lines, over convex surfaces

(as in the piers at Lincoln), concave surfaces (the vaults), in acute or obtuse angles (formed by the tiercerons and liernes), and reflected off of concave surfaces, so that it is diffused and refracted, or multiplied, as in the arch tracery or Y-tracery, triradial vaulting, and double syncopated arcading, in what Erwin Panofsky, in *Gothic Architecture and Scholasticism*, would call the "principle of progressive divisibility" of the *manifestatio* of Scholasticism. The *virtus* (power) of the *species* is amplified in shorter lines (the liernes), and projected in three dimensions in the form of cones (as in the conoid springers in the nave, or non-structural rib-cones in the chapels behind the west front, or the umbrella vault in the chapter house).

The role of the stained glass window is explained in relation to Grosseteste's theories of the *lux spiritualis* (spiritual or immaterial light) and *lumen spiritualis* (reflected or material light), and the relation between the light of the stained glass window and the geometry and mathematics of the vaulting and elevations is discussed in relation to Grosseteste's theories of the *species sensibilis* (sensible form as perceived) and the *species apprehensibilis* (intelligible form illuminated by the *lux spiritualis* in the *oculus mentis*) in perception. There is a discussion of Grosseteste's scholarly interest in marginalia symbols, to reinforce his interest in the role that geometry plays as a mediator between the sensible and intelligible, as it is enacted in the architecture, along with number symbolism. The architecture of the cathedral should be seen as a microcosm of the structure of the cosmos, a catechism of the transformation of archetypal forms to sensible forms, and an *edificium* and facilitator for the ascent on the part of the viewer from the *virtus cogitativa*, material intellect, to the *virtus intellectiva*, active or creative intellect, all in relation to the traditions of classical philosophy, both Plato and Aristotle, and Christian theology, which Grosseteste synthesizes. Grosseteste's concept of intellect originates in the *De anima* of Aristotle, Book III, where a universal, active intellect is distinguished from a material intellect (*nous hylikos*); in the commentators on Aristotle, productive intellect (*nous poietikos*) is distinguished from a potential intellect (*nous pathetikos*). For Grosseteste, the cosmic, active intellect or divine intellect (*intelligentia*) makes forms intelligible to the human, potential intellect (*virtus scitiva* or *cogitativa*), in the *virtus intellectiva* (*nous poietikos*), and the *intellectus in habitu* (*dianoia* or discursive reason), as light makes forms visible through geometry and mathematics. Clearly the architecture of the cathedral can be seen as an *edificium* of this process.

The chapters on the development of English Gothic architecture examine details of twenty-five cathedrals and churches in England, seen in relation to Lincoln Cathedral. The survey is the result of extensive documentation, more than six hundred photographs of the details of the buildings, 108 of which are included in the text. It was necessary to include all of the buildings and details in order to explain the continuous and homogeneous project of representing in the architecture the ideas, beliefs, and theological and philosophical structures of medieval England.

The chapter "Early English" examines architectural developments at Wells, Ely, Hereford, Lichfield, Winchester, Beverley, Chester, York, Worcester, Salisbury, Southwell, Lincoln, Gloucester, and Westminster Abbey. The first phase of building at Wells was contemporary with the first phase of building at Lincoln, and the two buildings represent radically different departures from the architecture at Canterbury, but each equally defining a distinctive English Gothic architecture, Wells more in its homogeneity and Lincoln more in its syncretism. Ely Cathedral is the earliest to show the influence of Lincoln, in the detailing of the west front and the Galilee Porch, in particular the syncopated double arcading. The vaulting of the retrochoir at Hereford Cathedral shows the influence of Lincoln, in the vaulting of the Consistory Chapel in particular. The vaulting of a choir aisle at Lichfield Cathedral (restored) displays an early example of the ridge pole, a key element of the architecture at Lincoln. Tiercerons also appear in the vaulting of the south transept at Lichfield as early as 1220.

The eastern part of Winchester Cathedral, the Lady Chapel, shows the influence of Lincoln in the early thirteenth century. The syncopated double arcade occurs at Beverley Minster, along with Purbeck shafts and openwork arcading on the Lincoln model, reflecting the membrification and subdivision of the Scholastic composition. Vaulting in the chapter house at Chester Cathedral is based on Lincoln vaulting, while the vaulting in the chapter house vestibule at Chester goes back to Durham and Peterborough. The elevations of the south transept of York Minster, begun around 1220, are similar to Lincoln and Beverley, as are the elevations of the retrochoir of Worcester Cathedral, built in the 1220s; the vault of Worcester retrochoir is a tierceron vault derived from Lincoln. The motifs of the retrochoir elevations are continued into the choir at Worcester.

The architects of Salisbury Cathedral, Elias of Dereham and Nicholas of Ely, incorporated Lincoln motifs into the new design in the thirteenth century, combining them with themes from Wells. The rib vaulting in relation to

the elevations can be seen as a catechism of the geometrical cosmologies of Grosseteste, in the emanation of the *lux spiritualis* into matter, as can the elevations of the east transepts. The screen façade at Salisbury shows the influence of those at Lincoln and Wells. The choir of Southwell Minster, begun in 1234 by Archbishop Walter de Gray, is based on the Lincoln vocabulary, though a triforium is absent. The presbytery of Ely Cathedral was built under Bishop Hugh of Northwold, a friend of Robert Grosseteste. The presbytery is seen as an intermediary in the development from the Lincoln nave, by Alexander the Mason, to the Lincoln Angel Choir, by Simon Thirsk.

The vault of the Ely presbytery is a copy of the Lincoln nave vault. It is possible that the vault of Saint Hugh's Choir at Lincoln, the "crazy vault," as it is called, was rebuilt in the 1240s, after the collapse of the tower in 1237 or 1239. The vaulting, probably from an earlier design, perhaps by Geoffrey de Noyers, introduced the ridge pole, tierceron, and triradial vault, in the only major asymmetrical vaulting in a Gothic cathedral. The original vaulting of the south cloister walk at Wells Cathedral is believed to date from 1240. It is a "lierne star" vault, perhaps one of the earliest uses of the segmental nonstructural rib, separating the form of the vault from its function, and constituting an architecture of linear surface texture. The nave vault of Gloucester Cathedral, completed around 1242, is a Lincoln-style tierceron vault. A tierceron vault also appears in the west cloister walk of Westminster Abbey, designed by Henry of Reyns between 1245 and 1255. The architecture of the choir, transepts and chapter house of Westminster Abbey, begun by Henry of Reyns and completed by John of Gloucester and Robert of Beverley, synthesizes French influences with influences from Lincoln, especially in the detailing, and tierceron vaulting. The chapter house of Westminster Abbey is based on the Lincoln chapter house, with the bundled umbrella column and vault, combining them with French tracery.

In the next chapter, the Decorated period introduces variations to the Early English motifs. The Chapel of the Nine Altars at Durham Cathedral can easily be read as a catechism or *edificium* of the Celestial Hierarchies and the formation of the material world in the terms of Grosseteste. In the mid-thirteenth century, similar diapering or reticulation appears at Lincoln, Westminster Abbey, and Hereford Cathedral, corresponding to the geometrical subdivision and compartmentalization of Scholasticism, the cosmological geometries of Grosseteste, and the "handwriting" of linear patterns. The nave of Westminster Abbey, begun in 1253, again combines Lincoln and French influences, with a Lincoln-style tierceron vault. By now it is clear that the

architecture of Lincoln Cathedral is being appropriated to represent a national identity.

The stairwell to the chapter house at Wells, begun in 1255, contains elements of the Lincoln vocabulary—Purbeck shafts, ridge pole, transverse ribs. The Angel Choir of Lincoln, begun in 1256 by Simon Thirsk or Richard of Stowe, combines the Lincoln nave with the Ely presbytery, with an increased amount of architectural and sculptural detailing, and arcading and bar tracery which creates a transparency that enacts the relation between the *lux spiritualis* and the intellect of the worshipper. The transparency can be seen as both a physical transparency and a conceptual or phenomenal transparency, between human intellect and divine intellect. The nave elevations of Lichfield Cathedral, begun in 1258 by William FitzThomas, combine influences of Lincoln and Westminster Abbey. The chapter house of Salisbury Cathedral, constructed between 1263 and 1279, is also on the model of the Lincoln chapter house, with sixteen ribs forming a cone at the center blooming into the vault, corresponding to the rarefaction of light in the formation of matter. The vault of the nave of Lichfield Cathedral, complete by 1293, was a copy of the Lincoln nave vault. The vault of the nave of Westminster Abbey is a tierceron vault based on the Lincoln nave vault. The vault of the Lady Chapel of Chester Cathedral is also based on the Lincoln nave vault.

The architecture of the chapter house at York Minster, from between 1275 and 1290, represents significant departures from the Early English style. It includes overhanging canopies and foliate corbels which can be seen as "pendants," a motif developed later in the Perpendicular period. While the forms are a departure, the overlapping and undulation of the arcade can be seen to be products of spatial experiments carried out at Lincoln. The vault of the chapter house at York is a centralized tierceron and lierne vault. At Exeter Cathedral, the vault of the Lady Chapel shows the influence of Lincoln. The Bishop of Exeter at the time, Bishop Quivil, was present at Lincoln Cathedral in 1280 for the consecration of the Angel Choir. The vaulting at Exeter is an elaboration of Lincoln vaulting; the profusion of tiercerons suggests the fan vault to come; the excessive membrification follows the principles of Scholasticism. Vaulting in the retrochoir aisle at Exeter presents a syncopated composition which refers back to vaulting at Lincoln. It is possible that masons at Exeter had worked at Lincoln.

The "leaves of Southwell," the carved foliage in the chapter house at Southwell Minster, reflect a humanist concept of the human mind as a microcosm of the cosmos, in a synthesis of the human mind and nature which

can be found in natural philosophy and the writings of Grossseteste. The vault of the chapter house is a centralized lierne star vault. The architecture of the Decorated period begins to display a kind of mannerism which has its roots at Lincoln; it can be seen as a rhetorical or poetic language with a tropic vocabulary, as can the vocabulary elements invented at Lincoln. The chapter concludes with a summary of the relation between those vocabulary elements and the tropic elements of a cosmology.

The next chapter, "Curvilinear," begins with a discussion of the historical classifications of English Gothic architecture, citing definitions and dating of the Curvilinear and Perpendicular by Thomas Rickman, John Harvey, Christopher Wilson, Edmund Sharpe, and Paul Frankl. The main concern, which will also be discussed later, is the distinction between Curvilinear and Perpendicular, as they are formally distinct but overlap chronologically. The Curvilinear period begins in the last decade of the thirteenth century. The vault of St. Mary Undercroft of St. Stephen's Chapel in Westminster Palace, designed by Michael or Thomas of Canterbury, established an important precedent for the development of lierne vaulting, a defining motif of the Curvilinear and Perpendicular. This chapter examines architectural details at York, St. Mary Redcliffe, Wells, Norwich, Bristol, Lichfield, Exeter, Canterbury, Lincoln, Salisbury, Worcester, Tewkesbury Abbey, Southwell, Ely, Gloucester, Beverley, Ottery St. Mary, Chester, Winchester, Durham, and Westminster Abbey.

The lierne vault in the transept of St. Mary Redcliffe in Bristol represents a new level of detachment of the vault pattern from the vault structure. The chapter house at Wells combines the Lincoln model with Curvilinear tracery, combining geometrical and organic forms, as an elaboration of a geometrical understanding of forms in nature. At the turn of the century, the flying ribs which appear in Bristol Cathedral can be related to the tiny flying ribs in the Easter Sepulcher at Lincoln, and to the experiments in spatial vistas attributed to Geoffrey de Noyers at Lincoln. The flying rib constitutes an intelligible structure visibly separate from the structure of the building. Vaults in the Eastern Lady Chapel and choir at Bristol are lierne vaults with conoid springers, tiercerons and transverse ridge ribs, as developed from Lincoln. The liernes of the choir vault at Bristol have an organic structural quality, as an intelligible organism, blurring the line between sensible and intelligible form. In the north transept at Lichfield, overlapping planes in the elevation are developments from experiments at Lincoln and in the Early English style, and the vault is a Lincoln-style tierceron vault. The elevations of the Exeter

choir, between 1300 and 1310, can be seen as Decorated variations of Lincoln nave, with stonework grilles.

The nave vault at Bristol, reconstructed in the nineteenth century, is a Lincoln-style tierceron vault. The flying rib appears again in the antechamber of the Berkeley Chapel in Bristol Cathedral, designed by William Joy in 1310. Here the architecture has become a mannerist mock-up of itself, displaying openly the disjunction between form and function which allows the architecture to express an idea, a metaphysic, outside its physical presence. The nave elevations at Worcester, from around 1320, are based on the nave elevations of Lincoln. The pulpitum of Lincoln, from the same time, represents an early example of the use of the ogee arch and carved decoration associated with the Curvilinear style. The pulpitum at Exeter, designed by Thomas Witney, incorporates ogee arches, cusping and crocketing, and a lierne vault. The nave vault of Tewkesbury Abbey combines the lierne patterns of St. Mary Redcliffe with the thick ribs of Exeter to create a catechism of the vault of the cosmos, as an architectonic texture in the form of a "net" vault. The vault of the Lady Chapel at Lichfield is a Lincoln-style vault with longitudinal ridge rib, transverse ribs and tiercerons. The pulpitum at Southwell Minster contains flying ribs, ogee arches and crocketed gables, and fragments of architectural vocabulary elements which produce a tropic, mannerist composition, a literary or poetic architecture.

The Lady Chapel at Wells, by Thomas Witney, is a composition based on the Lincoln vocabulary (umbrella column, ridge rib, tierceron, lierne), with a domed vault with liernes forming an eight-pointed star pattern, similar to patterns found in contemporary illuminations, as a representation of the celestial vault. The adjoining retrochoir, by William Joy, contains clusters of Purbeck piers, influenced by Lincoln. The arcade of the Lady Chapel of Ely, perhaps designed by John Ramsey, is composed of nodding, cusped ogee arches and crocketed gables in the Curvilinear style, the undulating surface forming a kind of epigenetic landscape: organic surfaces formed by underlying geometrical matrixes, as described by Robert Grosseteste in treatises on natural philosophy such as *De Natura Locorum*, applying the geometrical cosmology of *De lineis, angulis et figuris* to natural phenomena. The vault of the Ely Lady Chapel is a Lincoln-style tierceron vault with lierne star patterns, resulting in a crystalline organic intelligible form. The elevations of the choir of Ely, designed by John Ramsey, feature ogee arches and curves, and arches with rippling cusped borders, transforming Platonic geometries into organic forms, blurring the line between inorganic and organic, between geometry and na-

ture. The vault is a lierne star vault, based on vaulting at Lincoln and St. Mary Undercroft, accommodating the intellectual ascension of the worshipper through intelligible forms, but with increased sensuality.

The octagonal crossing at Ely, designed by Alan of Walsingham, topped by the timber lantern designed by William Hurley, is the most elaborate *edificium* of the Curvilinear style, consisting of a geometrical and material progression from the material to spiritual, through the hypostases of being, and the progression from the *virtus cogitativa* to the *virtus intellectiva*, to the origin of the *lux spiritualis*. The vault of the North Porch of St. Mary Redcliffe is a centralized tierceron vault taking on the appearance of a crystalline organic form, merging the sensible and intelligible forms of the architecture. The remodeled south transept of Gloucester, from 1331 to 1336, is seen as the first manifestation of the Perpendicular style, with its vertical paneling and mullions, and tracery, derived from the exterior elevations of St. Stephen's Chapel, but with Curvilinear elements such as ogee arches and cusping. The vault in the Gloucester transept is a lierne net vault developed from the Lincoln vocabulary, taking on the form of an organic structure based on underlying geometrical and mathematical proportions.

The choir vault of Wells, built by William Joy between 1333 and 1340, introduces a geometrical net pattern which displays a dematerialization through surface texture and the membrification of Scholasticism, in the "principle of progressive divisibility." The vaulting pushes the mannerist disjunction between form and function, enacting the intelligible form in relation to the sensible. The lierne star patterns in the choir aisle vaults suggest a crystalline form or cosmic diagram. The Percy Tomb at Beverley Minster, designed by William de Malton, is a masterpiece of the Curvilinear style, with nodding ogee arches, cusping and crocketing. The choir arcade of Lichfield was rebuilt in 1337 in the Lincoln style, with Curvilinear stone grillwork, as at York, Worcester, and St. Mary Redcliffe. The nave vault of St. Mary Redcliffe is a development of the transept vault there, with liernes zigzagging, folding and undulating across an uneven vault surface, suggesting the matrixes of vectors in the epigenetic or topographical landscape, or the *virtus* of natural forms described in geometrical terms by Robert Grosseteste in his treatises on natural philosophy, cosmology, light, the heavenly bodies, and meteorological phenomena.

Between 1337 and 1367 the elevations of the choir and presbytery of Gloucester were covered with Perpendicular paneling, and densely textured lierne net vaulting was designed by William Ramsey, taking to an extreme

the vault as intelligible structure, surface texture, and catechism of Scholastic membrification, and creating a stupefying effect, suggesting the negative theology of Pseudo-Dionysius. The choir and nave vaults of Ottery St. Mary were designed by William Joy between 1338 and 1342, showing the influence of the Wells choir vault. William Joy's nave vault at Exeter is a Lincoln vault with the tiercerons increased in size and density. The vaulting suggests organic form, but as in any architecture, the forms can never be organic, they can only symbolize the organic, allegorically, because of their inability to be separated from structural function, or the representation thereof. William Joy's screen façade at Exeter is in the tradition of Lincoln and Wells. The vault of the south transept of Chester, from around 1350 (restored) is a Lincoln-style vault, as is the nave vault at Worcester.

The first full fan vault in English Gothic architecture was constructed in the Gloucester cloister between 1351 and 1364, attributed to Thomas of Cambridge. The fan vaulting can be seen as a logical consequence of the development from the Lincoln tierceron vault, as it consists of conoids of tiercerons with liernes applied to the surface. The fan vaulting merges the geometrical and organic, the human mind and nature, or the human mind and the divine mind, with underlying geometrical matrixes, in a cognitive or intelligible structure. The original nave vault of York Minster, replaced by a timber reproduction in the nineteenth century, is a simplified version of the Lincoln tierceron vault. Tierceron and lierne patterns fluctuate, as do the concave surfaces of the vault, resulting in a form in between structure and surface pattern, and in between intelligible form and sensible form. The vault was painted to symbolize the vault of the cosmos, the celestial intelligence. A more complex version of the vaulting appeared in the choir and retrochoir of York between 1361 and 1370, continuing the fluctuating, "in between" phenomenon.

Lierne vaulting in the central portal of Winchester Cathedral, begun in 1360, recalls the vault in the North Porch of St. Mary Redcliffe. Openwork arcading in the presbytery at Norwich recalls the treatments of Geoffrey de Noyers at Lincoln and William the Englishman at Canterbury, in their dematerialization and subversion of structural logic. The vault of the Prior's Kitchen at Durham, designed by John Lewyn between 1366 and 1374, recalls Islamic vaulting at Córdoba and Isfahan; Islamic influences could also be found at Lincoln and Ely. The vault at Durham is part of a series of experimental vaults designed in the late fourteenth century, using the tierceron and lierne vocabulary to create crystalline organic patterns. Vaults in the tran-

septs at Worcester also appropriate the Lincoln vocabulary. The choir and nave of Westminster Abbey, completed by Henry Yevele, beginning in 1375, are copies of the Lincoln nave, for the purposes of nationalistic representation. The lower part of the west front of Westminster Abbey, by Henry Yevele, displays the transformation from the Curvilinear to the Perpendicular.

It has been seen that the Curvilinear and Perpendicular overlap, as elements of the Perpendicular appear in the early fourteenth century. The Perpendicular style is dominated by vertical lines, linear patterns, repeated cusped panels, the lierne rib, and overlapping ogee curves forming reticulated patterns. The Perpendicular, the subject of the final chapter, is the last period or style in the continuous development of English Gothic architecture from the precedents at Durham, Canterbury, and Lincoln.

The choir vault at Tewkesbury Abbey, from between 1375 and 1390, is a Lincoln-style tierceron vault with lierne star patterns composed of curved liernes, which are segments of ogee arches, blurring the distinction between organic and inorganic, structure and pattern, sensible form and intelligible form. The vault in the crossing at Tewkesbury is a centralized lierne vault in the form of a mandala, a cosmological catechism with octagons and squares and a figure of the sun in the center, symbolizing emanation and creation, and synthesizing Christian theology and classical philosophy. The vaulting in the crossing tower of Lincoln Cathedral synthesizes the Lincoln vocabulary elements—conoid springers, tiercerons, liernes, ridge ribs, and membrification in compartmentalization—to form what could be read as a catechism of the celestial hierarchies, a diagram of the order of the church (*imago generalis ecclesiae*), the vaulting of the cosmos, or an epigenetic or topological landscape with an underlying matrix of geometrical vectors.

The vaulting of the nave of Canterbury Cathedral, designed by Henry Yevele or Thomas Hoo, contains ridge ribs, tiercerons, and lierne lozenges added to a quadripartite vault. The vaulting of the cloisters at Canterbury, designed by Henry Yevele and Stephen Lote, combines conoid tierceron springers with sprays of fan vaulting and liernes forming cusped rosettes. The Founder's Chantry at Tewkesbury Abbey contains an early model of the fan vault, with vaulting ribs as applied decoration, and Perpendicular grilling. The Beauchamp Chantry at Tewkesbury Abbey features fan vaults with pendants in its lower and upper levels. The pendant becomes a defining vocabulary element of the Perpendicular style, as in the vaults at Oxford, Cambridge, Windsor and Westminster Abbey. The pendant can be seen as a development of hanging corbels, as in the York chapter house, the gradual

minimalization of responds in elevations, or the removal of the umbrella column from the umbrella vault. The pendant is a hanging vaulting corbel with no support, defying structural logic, as in experiments at Canterbury and Lincoln. The contradiction of structural logic allows the architecture to be an *edificium* of a metaphysic, as a *manifestatio* of Scholastic thought, in the dialectic between reason and faith.

The west cloister walk of Worcester Cathedral, built by John Chapman between 1435 and 1438, contains vaulting composed of the Lincoln vocabulary: conoid tierceron springers, ridge pole, transverse ribs, and lierne octagons. The choir vault of Sherborne Abbey, designed by Robert Hulle in 1445, is the first full-span fan vault. The vault of the Norwich nave, perhaps designed by Robert Everard or Reginald Ely, contains zigzagging liernes and lierne star patterns, in what can be read as a model for the emergence of material form from patterns of light. The choir vault at St. Mary Redcliffe, from around 1450, is a regularized version of the nave vault there, displaying orthogonal Perpendicular geometries in contrast to irregular or organic Curvilinear lines. The vaulting of the presbytery of Peterborough is a lierne net vault similar to the St. Mary Redcliffe choir vault, a surface texture rather than a structural system, or representation thereof. The nave vault of Winchester Cathedral, designed by Robert Hulle, is a stellar lierne vault with zigzagging liernes, as in St. Mary Redcliffe nave or Norwich nave, based on the Lincoln vocabulary.

The remodeling of the crossing of Gloucester Cathedral between 1450 and 1475 by Robert Tully, features mid-air stone ogee arches set on flat four-centered arches, supporting pendant conoid springers of a lierne net vault. The arches appear to be a development of the flying rib, continuing experiments in spatial juxtapositions and inverted structural systems which began at Canterbury and Lincoln, but with a Perpendicular vocabulary. The Lady Chapel at Gloucester is a Perpendicular "glass cage" with a complex lierne net vault as in the choir there, a dense surface texture in contrast to the Perpendicular geometries below it. The crossing vault at Bristol Cathedral is a centralized lierne star vault, the pattern of which is continued in the transepts, with tiercerons and lierne diamonds, appearing as matter unfolding from an intelligible geometrical structure. The crossing vault at York Minster is also a centralized lierne vault, where the lines appear to respond to forces created by the building, in a dynamic process suggesting an epigenetic landscape. The choir vault at Norwich consists of lierne star patterns and tiercerons which spring from the peaks of window heads in the clerestory, or hang

from the vault like pendants, creating the effect that the elevations are suspended from the vault. The nave vault of Sherborne Abbey, designed by William Smyth, interweaves tiercerons, lierne patterns and fans, in a summation of the vocabulary of English Gothic vaulting.

The choir screen in Winchester Cathedral is a development of the treatment of the arcades in York chapter house and Ely Lady Chapel, with cusping, crocketing, ogee arches and miniature pendant vaults in canopies. The vault of the Divinity School of the Bodleian Library at Oxford University is a pendant lierne vault designed by William Orchard in 1478. The vault is divided by bundled transverse ribs which appear to be almost flying ribs; spandrels between are decorated with openwork tracery. William Orchard also designed the vault of Christ Church choir at Oxford University, a pendant lierne net vault, with similar transverse ribs suggesting flying ribs, and pendants attached to the transverse ribs as secondary corbels. The crossing vault at Salisbury is a centralized cusped lierne net vault; the crossing vault at Wells, designed by William Smyth, is a centralized fan vault. The nave and choir vaults of St. George's Chapel at Windsor Castle were designed by William Vertue and Robert Janyns. The vaulting is composed of tiercerons and lierne stars, with cusping and decorative tracery.

Bishop Alcock's Chapel in Ely Cathedral, designed in 1488 by either Adam Lord, Adam Vertue or Robert Janyns, features a fan vault influenced by St. George's Chapel, with pendant cusping, and an undulating canopy screen filled with crocketed gables, ogee arches, and filigree tracery. The composition combines the recognizable vocabulary elements into an unprecedented form filled with overlappings and spatial inconsistencies, pushing the vocabulary of the English Gothic beyond any recognizable geometrical structure. The vault of Bishop Langton's Chapel at Winchester features tiercerons, zigzagging liernes, and cusped tracery. The vaulting in the retrochoir or "New Building" of Peterborough was designed by John Wastell, designer of the vaulting of King's College Chapel at Cambridge University. The vault at Peterborough is composed of steep conoid sections of fans decorated with tiercerons and reticulated tracery in the Perpendicular style. The vaulting of Henry VII's Chapel at Westminster Abbey was designed by Robert Janyns Junior in 1503, and perhaps constructed by Robert and William Vertue, who designed the fan vaults at Bath Abbey. The vault in Henry VII Chapel is a pendant fan vault with crocketed flying ribs, or ribs with pendant cusping, developed from William Orchard's vaults at Oxford. The ribs of the Henry VII Chapel vault dissolve into lines of pendant cusping