Chapter 1

Urbino's Mathematical Humanism and the Reduction Compass

Barocci's development of new artistic methods did not arise merely from a particularly sensitive response to the climate of the Counter-Reformation; rather, Barocci had certain distinct cultural and technological advantages over his peers. A degree of provincial isolation afforded by Urbino preserved techniques from the High Renaissance, particularly the use of life and extensive preparatory drawings, which fell into relative disuse in the cosmopolitan capital of Rome, and later Florence. Nonetheless, the riches of the local mathematical and scientific culture of Urbino are important to note, especially the influence of a number of prominent scholars with documented contact with Barocci and his family.

Of course, "science" as an organized practice did not exist in Barocci's time.[44] If the Counter-Reformation led to a demand for control and re-elevation of the work of a painter, Barocci's response was richly informed by concrete influences in his hometown of Urbino, where he came of age, and to which he later permanently returned after a few important early years in Rome. One need only glimpse the view of Urbino's ducal palace in the background of so many of Barocci's paintings to sense the artist's pride in his city. However, by looking more carefully, we can better understand the ways in which the culture of Urbino impressed itself upon Barocci.

Artful Mathematics, Mathematical Arts

Urbino was a center of advanced natural philosophy in Barocci's time.[45] A number of thinkers of world-wide importance worked there, for the Dukes and their voracious appetite for knowledge secured a hospitable environment for numerous mathematicians. These individuals included Federico Commandino (1509-1575), the first great figure of the late century.[46] A translator of Euclid, Heron and Ptolemy, he was the *caposcuola* who trained most of the younger mathematician. In Samuel Edgerton's words, Commandino was "the first professional to publish a mathematical analysis of linear perspective in a text intended solely for fellow mathematicians."[47] His seminal text, *Planisphaerium Ptolemaei commentarius*, was published at a crucial time in Barocci's training, and Commandino continued with optical topics, including a Latin translation of Euclid's *Elements*.[48]

Closer in age to Barocci was Francesco Paciotto (1521-1591), an important architect who worked both in Turin and the Spanish Netherlands for projects of mutual interest to the duke of Urbino.[49] Paciotto was an expert in surveying and helped acquire ancient poliorcetic texts. Guidobaldo del Monte (1545-1607) was Commandino's successor as

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[44] Park and Daston (2006).
[45] For the sciences in Urbino see in general, Gamba and Montebelli (1988, 1989).
[46] Rose (1975); Meli (1989): 397-403.
[47] Edgerton (1991), 165.
[48] Commandino (1558; 1575). There was furthermore talk of publishing Leonardo of Pisa's *Practica geometriae* and Luca Pacioli's *Summa*; c.f., Baldi (1707).
[49] For Paciotti, see Promis (1863), 361-442; Verstegen (2010).

caposcuola. Guidobaldo was a minor noble and a friend from birth of the Duke Francesco Maria II, and he was even named after the Duke's father, Guidobaldo II. Guidobaldo continued the pursuit of scientific perspective, not intended for the layman, in his *Perspectivae Libri Sex* of 1600.[50] The work is commonly acknowledged as the most rigorous perspective treatise of the Renaissance that proves perspective according to standards we can recognize today.

What was the social position of these thinkers? One interpretation is that the mathematicians sought to distinguish themselves socially by focusing their efforts on non-utilitarian thinkers – the purity of their objects of study translated to their elevated social position.[51] One could call this an interpretation of mathematics as *sprezzatura*, in accord with Baldassare Castiglione's famous ideal of comportment for Urbino's courtiers. Yet the exhausting efforts of a Commandino – and also a Barocci – did not seek to conceal effort. Rather, as Alexander Marr has pointed out, they pursued in all things precision (*esquisitezza*).[52] Such labor was not antithetical to nobility or social distinction.

Both Commandino and Guidobaldo del Monte had demonstrable ties with the Barocci family. The Commandino and Barocci families lived next door to each other in Urbino, and Commandino, as will be explained below, surely knew Barocci's brother Simone. A member of Barocci's school may have painted the posthumous portrait of Commandino in the style of the *uomo illustro* **(Fig. 9)**.[53] Moreover, Simone Barocci worked closely with Guidobaldo as well; the tangible evidence of this friendship is a portrait of Guidobaldo by Barocci himself **(Fig. 10)**.[54] A lost portrait by Barocci of Paciotto is recorded in an early inventory.[55]

Finally, there are subsequent personalities who worked into the seventeenth century and would have had less formative influence but still contributed to the scientific atmosphere of Urbino. Among them are Count Giulio Thiene (1520-1588), the poet Bernardino Baldi (1553-1617), Giambattista Clarici (1570-1620), the architect Muzio Oddi (1569-1639) the theologian Ludovico Vincenzi (married to Muzio's sister) and Peter Linder of Nuremberg.[56] Most of these mathematicians were younger, but they may have had some contact with Barocci. Ludovico, for example, corresponded with his brother Guidobaldo in Milan about Barocci's commissions for Milan Cathedral.[57] According to an old story, Baldi was given drawings lessons by Barocci.

These interactions and circumstances are not random; generations of the Barocci family (including Federico's brother and father) tellingly constructed scientific instruments and clocks. Barocci's great-grandfather, Ambrogio Barocci established the Barocci family in Urbino when he moved to the city to work for Federico da Montefeltro

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[50] Del Monte (1600/1984).
[51] Biagioli (1989).
[52] Marr (2010), 223.
[53] Workshop of Federico Barocci, *Portrait of Federico Commandino* (Urbania, Museo Comunale); Cleri and Paoli (1998), no. 25, 18, list the author as Cesare Maggeri.
[54] Federico Barocci, *Portrait of Guidobaldo del Monte* (Rome, Galleria Nazionale now transferred to Uffizi, Florence); Olsen (1962), no. 57, 204-5; and Museo Civico, Pesaro; Gamba (1998), 2:88.
[55] Zezza (2009), 264: "*fece ancora un ritratto del s. r. conte pacciotto.*" A copy of the original is in the Casa Raffaello, Urbino.
[56] For Thiene, see Promis (1874), 672-675; for Clarici, 734-6.
[57] Sangiorgi (1982).

at the Palazzo Ducale. Ambrogio was a master carver and worked extensively in and around Urbino. He was extremely successful and was even eventually voted to the magistrate. Ambrogio bought the family house in 1486 on the via dei Fraticelli (now via Barocci) in which the painter's ancestors would proceed to all live. Emblematic of the family's early ties to Urbino's scientific interests are the tens of panels that Ambrogio Barocci carved for the exterior of the Palazzo Ducale. Based on drawings of scientific machines conceived by Francesco di Giorgio, the carvings illustrated jointly Duke Federico Montefeltro's celebration of scientific knowledge and the Barocci family's participation.

Ambrogio's son (and Federico's grandfather) Marcantonio was a jurist, but the Baroccis by and large adopted highly skilled professions. Barocci's father, Ambrogio the Younger, was a gem engraver, sculptor, and clockmaker. He established the Barocci name in the manufacture of scientific instruments. Ambrogio the Younger trained his son Simone (the brother of Federico), in addition to his nephews Giovanni Battista and Giovanni Maria (d. 1593) in the art of precision craftsmanship. Federico's cousins were slightly older than he, and they achieved their own fame when Federico was still a young man. Giovanni Maria is most famous for making a watch for Saint Philip Neri (1563) and a gear clock for Pope Pius V (1570).[58] Simone, however, seems to have been the most praised of the three. He is known for various projects but especially for working with both Commandino and Guidobaldo on innovative scientific instruments. Muzio Oddi writes how Simone collaborated with both mathematicians on the perfection of the reduction compass, a story recounted below.

Federico Barocci thus grew up in a heady theoretical and technical environment. He never practiced as an instrument maker, but mathematics and mechanics surely affected his artistic practice to a much greater extent than it did for most of his contemporaries. When Barocci was a young man, he was taught perspective, spent time in the ducal collections in Pesaro and came under the protection of the Cardinal Giulio Feltrio della Rovere. It is hard to imagine that the young Barocci was unaware of Commandino's works. Just as Barocci was completing one of his first mature works, *The Martyrdom of Saint Sebastian* (1557; Urbino, Cathedral), Commandino would have been compiling his commentary on Ptolemy's *Planisphaerium (Federici Commandini ubrninatis in planisphaerium Ptolemaei commentarius* (1558).[59] Within the commentary, Commandino attacked the proof of perspective with the vigor of a mathematician, rejoining a debate that had floundered since Piero della Francesca.

Pittore Scientifico?

One of the most obvious ways in which to gauge the scientific commitments of a Renaissance painter is through their interest in problems like perspective. Although Barocci often had architectural backdrops for his compositions, we see an active perspective construction in only a few of his works, most notably in the *Flight of Aeneas from Troy* (1589, Villa Borghese), with its rendition of Bramante's *Tempietto* from San Pietro in Montorio in Rome.[60] The building is utilized here to provide a suitably classicist

[58] Morpurgo (1974); Panicali *(*1988).
[59] Commandino (1558/1993).
[60] Olsen *(*1962), 190-182; Emiliani (1985), 2:230-237; (2008), 2:58-*70.*

backdrop and was worked out in full detail in a separate study (Uffizi 135A); **(Fig. 11)**.[61] The perspective is constructed with authority but it is almost unique in Barocci's oeuvre.[62] There is also some record that Barocci created scenography in 1588, and he probably approached this with ability as well.[63] But these works exhaust Barocci's attention to perspective. Perspectives were no longer of absorbing interest to the most advanced painters in Italy, for by the late sixteenth century, perspective, especially in the form of architectonic *quadratura* decoration, had become a specialty craft. Cigoli, a leading painter and expert on perspective, was an anomaly for the time.[64] Further, as a painter primarily of easel pictures rather than frescoes, Barocci would have had even less opportunity to paint perspectives.

Barocci's primary biographer Bellori, however, notes that Barocci learned perspective from his cousin (actually his father's cousin) Girolamo Genga. Vasari describes the expertise of both Girolamo and his son Bartolomeo for making *archi trionfali*, and Girolamo's frescoes for the Villa Imperiale employ very advanced *quadratura*.[65] Indeed, the involvement of perspective specialists in Urbinate ephemeral architecture is shown again and again, leading us to believe that perhaps there was as much of an interest in perspective in these arches as in other artistic centers like Milan.[66]

Another way to judge the scientific interests of a Renaissance painter is through a demonstration of study of anatomy. Such drawings are not life drawings but rather *écorché*, or drawings of musculature. Only a few anatomical drawings in Barocci's *oeuvre* exist.[67] In the midst of other sketches, Barocci will occasionally remind himself of the anatomy of the arm or another body part. Examples include Berlin 20132 **(Fig. 12)**, which, in addition to a sketch of Andrew's foot and arm for the *Calling of Saint Andrew,* also includes a study of an arm's musculature.[68] Like the perspective studies, these are done with confidence and expertise. While Barocci did not make the *écorché* studies of an artist who attended dissections or anatomy lessons, his close attention to the articulation of a hand, or the bulge of muscles in a forearm, suggests that he was concerned not only with the appearance, but also the workings of the human body.[69]

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[61] Gabinetto di Disegni e Stampe, Galleria degli Uffizi (hereafter "Uffizi"), inv. 135A, 42 x 46 cm; Malmstrom (1968/9); Günther (1969); Lingo (2008), 179, fig. 151.

[62] See also Uffizi inv. 11660F for the Urbino Cathedral *Last Supper*; Pillsbury and Richards (1978), 87, n. 1; and Uffizi 9339 S for the Urbino *Perdono*; Emiliani (2008), 1:272, fig. 34.5.

[63] Matheo. . .at Pesaro to Tingoli at Cagli, 13 February 1588; quoted Gronau (1936), 210: "*le scene sono tre, fatte dal Baroccio e questa basta dire.*" However, the Pesarese scenographer Nicolò Sabbatini (*Pratica di fabbricar scene e macchine ne' teatri*, Pesaro, 1637) does not mention Barocci.

[64] Chappell (2003).

[65] On Genga's *apparati* see Pallen (1999), 21-24; on his *quadratura* see Sjöström (1978).

[66] See Battistell (1986); Davidson (2002). For perspective in Milan in Barocci's time, see Bora (1980).

[67] Olsen (1965).

[68] Berlin inv. 20132, 41.5 x 27.3 cm, Emiliani (1985), 1:196, fig. 411; (2008), 2:17, fig. 41.19. The drawing is identified in Chapter 6 as primarily half scale.

[69] For additional drawings with anatomical studies, see:
Berlin inv. 20272, 24.5 x 34.5 cm, Emiliani (1985), 2:363, fig. 805; (2008), 2:278, not illustrated (for the *Crocifisso Spirante*, Prado, Madrid).
Berlin inv. 20438, 17.7 x 27.7 cm; Emiliani (1985), 1:142, fig. 263; (2008), 2:326, fig. 38.38 (for the *Madonna del Popolo*, Uffizi, Florence).

Given the absence of a significant body of perspective and anatomical drawings, Barocci has not traditionally been considered among natural philosophically-minded artists. Although his interest is not overtly or obviously that of a anatomist or mixed mathematician – that is, Barocci's scientific interests are not demonstrated in the ways that typically categorize a "scientific" artist – when considered alongside other evidence that indicates that Barocci was arguably as deeply steeped in a scientific culture than any comparable artist of his time, his drawings and paintings appear in a new and technologically illuminated light.

Leonardo and the *Codex Urbinas 1270*

In drawing ties between scientific and artistic culture, one must finally, but perhaps above all, give mention to a voice from the scientific past that nurtured Barocci: Leonardo da Vinci. Barocci may even be considered as something of the Leonardo da Vinci figure of the Counter-Reformation. Similar to the way that many of Leonardo's contemporaries like Perugino or Ghirlandaio continued to paint in a largely *quattrocento* style into the sixteenth century while Leonardo was pioneering new aspects of naturalism, lighting, and space, Barocci also pioneered a new way of painting that looked forward to the seventeenth century. Although Barocci was not the universal mind that Leonardo was, he was more technically inclined than previously documented and part of this lies in his probable knowledge of Leonardo's written works, perhaps including the *Libro di pittura* (Codex Urbinas 1270) itself.[70]

Credit must go to Gary Walters (proceeding on a hunch by Marilyn Aronberg Lavin) for discovering, in a close examination of Barocci's early works, a meditation on themes found in Leonardo's *Libro di Pittura*.[71] This period of activity indeed correlates to Barocci's profound change in style in the mid-1560s, when Barocci began using color head studies, experimenting with pastels, and achieveing his mature, graceful figure style. There is, however, a difficulty in determining exactly how Barocci had access to Leonardo's writings. The first objection, that Leonardo's Codex Urbinas was inventoried in the Castel Durante (Urbania) ducal library and would have been inaccessible,[72] can be put aside, for the Duke only retired to Castel Durante in 1621; the manuscript would have been in Urbino prior to that date. More problematic is the fact that Francesco Melzi, Leonardo's collaborator, did not die until 1570, and the manuscripts in his possession are generally thus presumed to have arrived in the ducal collections too late to influence Barocci.[73] The following speculations are not a definitive theory of the arrival of the Codex Urbinas in Urbino, but some important facts in consideration of such a theory.[74]

While it is possible that Barocci had access to a summary of Vincian themes, the abridgments available at that time do not reflect the relevant chapters of the *Libro di Pittura* that seemed to influence Barocci. All of the abridgments of the *Libro di Pittura*,

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[70] Leonardo da Vinci (1995).

[71] Lavin (1964); Walters (1977), 43-45.

[72] Pedretti (1977), 12, 34. This misunderstanding is also noted by Farago (1992).

[73] Thus, Zygmunt Wazbinski's (1994, 60) suggestion that the cause of Barocci's change in style "*fu probabilmente la scoperta dell'eredita' leonardiana, durante la sua visita fiorentina* (1579)," may only refer to reflected light.

[74] For the most up to date hypothesis on this, see Farago (2018).

including the *editio princeps* of 1651, do not include books five through eight dealing with light and color, what Anna Sconza calls the "scientific" chapters, and as we shall see these are the ones that most interested Barocci.[75]

Walters locates the stylistic break in Barocci's painting in the *Madonna of Saint Simon* (c. 1566) and *Crucifixion* (c. 1567), observing the behavior of light in different environments and along different surfaces, its reflections, and atmospheric perspective. Indeed, beginning with the *Saint Simon*, we see a consistent employment of aerial perspective (comprising color, chiaroscuro and acuity perspective) in the background. Barocci's famous still-life elements that he often places in the foreground of pictures similarly serve a perspectival function. They tend to be painted in a sharp focus in contrast to the *sfumato* of his principal figures, thereby demonstrating increased acuity that rigidly places his figures into a gradient of distance.[76] In the *Madonna of Saint Simon*, Simon's halberd and Joseph's saw are rendered with sharp focus, while the buildings in the back lost acuity and their color approaches transparency. The same is true of the *Crucifixion* created the next year.

Moreover, Walters also notes more technically that in addition to the atmospheric perspective, Barocci has experimented with reflected shadows, such that the left leg of Jude picks up the yellow from his garment, receiving a yellowish cast, while the Christ child's skin seems to reflect the blue of the Virgin Mary's mantle **(Fig. 13)**.[77] Importantly, many of the textual sources isolated by Walters are those present only in the Urbino *Libro di Pittura* and not in the later abridged *Trattato*. What we may add is that this period of stylistic change also correlates to Barocci's profound change in technique in the mid-1560s. At that time, Barocci committed himself to life drawing, began also using color head studies, experimenting with pastels and achieved his new, graceful figure style.[78] Evidence also indicates that Barocci began using a reduction compass to aid in the composition of his paintings.[79] The arrival of the *Libro di Pittura* at this time is somewhat confirmed by the fact that in the preface to the edition of Apollonius published in 1566, *Conicorum libri quattuor,* Commandino lauds duke Guidobaldo II's enrichment of the library.**[80]** The results suggest that, as already argued by Walters, Barocci consulted the actual *Libro di Pittura* (Codex Urbinas 1270) during his convalescence in Urbino c. 1563-5.[81]

As noted, I will not offer any hypothesis about how the Codex, or a lost version with the scientific chapters intact, could have arrived in Urbino. But the fact that codices were coming to the city is easy to document. In 1558, he had published the first of his editions of ancient authors, the *Planisphaerium* of Ptolemy, followed in 1562 with the

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[75] Sconza (2009): 307-366.

[76] On acuity perspective in Leonardo's writings, see Bell (1998). On the use of *sfumato* in Barocci's painting, see Hall (2011); Verstegen (2015).

[77] Walters (1978), 43-57.

[78] On this period, see Fontana (1998); Verstegen (2003b); on the pastels, see McGrath (1998).

[79] Marciari and Verstegen (2008).

[80] Apollonius (1566), "*bibliothecam aui tam optimis libris adauxifti*"; Rose (1975), 203.

[81] Babette Bohn (Mann, 2012, 38) argues that Leonardo's influence is not felt by Barocci "from the late 1560s," however, she also does not consider or even cite Walters' arguments and does not focus on aerial perspective.

Analemmate.[82] At exactly the time that the *Libro di Pittura* came to Urbino, the duke had asked Commandino (as Annibale Caro revealed to Felice Paciotto) to obtain some manuscripts from the Vatican Library.[83] In 1568, Duke Guidobaldo II della Rovere gave a copy of Francesco di Giorgio's *Opusculum de architectura* (c. 1475), a series of 200 drawings now in the British Museum (Codex 197 B 21) to the Duke of Savoy, a Spanish ally.[84] These drawings, incidentally, illustrated the panels that Barocci's own great-grandfather had carved.

There are a number of reasons that such individuals as Commandino, Paciotto, and Genga might be interested in Leonardo. Foremost of course is his work on fortifications. Knowing that this is a *Libro di Pittura*, however, would rule that out. The idea that one might have sought out the treatise, not quite knowing what was inside is also possible. For example, it was noted that Barocci was introducing pastels into his drawing technique and also using a reduction compass, both practices discussed by Leonardo in writings, and possibly connected to him by lore.

The Reduction Compass

Unusually in the history of art, the moment of the invention of a major technical innovation, the reduction compass, coincides with its use by an artist, Barocci. In this event, tool and temperament came together for a quick and easy way to adjust the scale of drawings. The primary means available to Renaissance artists to scale works – the pantograph would only be invented in the sixteenth century – was the use of the squared grid (*griglia quadrettata*). According to his biographer, Manetti, Brunelleschi used squared paper in order to draw the ruins of Rome, which was evidently useful for later transfer.[85] The first forensic use of such a grid for the clear enlargement of a drawing comes from the head of the Virgin in Masaccio's fresco of the Trinity (Santa Maria Novella, 1427-29).[86] There one may see a lattice of lines directly incised into the plaster, which presumably helped transfer the design from a lost drawing. The slightly later fresco by Paolo Uccello of Sir John Hawkwood (1436, Duomo, Florence) gives more complete evidence. Both the extant fresco and surviving drawing show correlating evidence that the latter was used to enlarge the composition for the fresco.[87]

Barocci utilized the grid technique often. Indeed, he developed a novel use of a double grid, which was elaborated by Gary Walters and not discussed since.[88] Walters showed that with his grid Barocci discovered he could take dimensions off of a near or a farther line, thereby obtaining different scales. What Walters did not know is the sheer preponderance of drawings in scaled ratios, so that the drawings (neatly organizing into round ratios, 1:4, etc.) are merely a subclass of the larger compass scaling.

In Urbino, another method of enlargement was discovered by Piero della Francesca. Roberto Bellucci and Cecilia Frosinini have determined that the head of Federico da

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[82] Commandino (1558); Sinisgalli and Vastola (1992); Commandino (1562).
[83] Rose (1972), 189; citing Caro (1961), 3:81.
[84] Scaglia (1992), no. 1, 50-51; no. 36, 101-2.
[85] di Tuccio Manetti (1970), 132.
[86] Bambach (1999), 189-194.
[87] Meiss (1970), 124-127; Melli (1999), 261-272.
[88] Walters (1978), 158-164.

Montefeltro in his Uffizi diptych is 16% larger than that in the San Bernardino altarpiece.[89] With a reflection on basic fractions, it is not difficult to see that the 16% must be a proportional division, namely 1:6. Divisions by half yield quarters, eights, and so on, in the following series: 50% (1:2), 25% (1:4), 12.5% (1:8). Dividing by thirds, however, we arrive at another series: 33.33% (1:3), 16.66% (1:6). In this case, the portrait in the Uffizi is exactly *one sixth* larger than that in the Brera. Put another way, the portrait in the Brera is six units and that in the Uffizi is seven.

Here is the method I suggest Piero used. In the first book of *De prospectiva pingendi*, Piero shows how the size of an object is determined proportionally by its distance from the viewer.[90] Each size is correlated directly to distance and we can see easily how one may pass from one proportion to another.[91] Piero asks us to imagine, but does not illustrate, seven squares in a long row marking out variable distances from a hypothetical viewer. Drawing a line through the vertical face of each cube, the line intersection that is created indicates the variably apparent size of each distance **(Fig. 14a)**.

Fortuitously, the distances chosen by Piero in his textual example are exactly those discussed above, that is, 6 units and (16.6% larger), seven units. Using a series of parallel lines (as with Piero's procedure to obtain the head "proportionalmente degradata," but much simpler), one can easily reproduce a face of a different scale and also create two groups of lines – one for the horizontals (the height of the eye, nose, etc.) and another for the verticals (the depth of the ear, etc.).[92] From here we arrive at the actual heads **(Fig. 14b)**. This is a method directly prescribed by Piero, and therefore, the likeliest he actually used.

In such a scientific context, it is unsurprising that other expedients for enlargement were discovered. Under the Euclid revival of the late fifteenth century and given his awareness of Piero's and Luca Pacioli's work, Leonardo da Vinci seems to have understood the geometry of a potential reduction compass, in his Codex Foster.[93] A version of the reduction compass may have been used for architectural plans by Antonio da Sangallo.[94] The use of two compasses, or readings from a single compass as Sangallo seems to have done, within both a building and military context, was the impetus for the reduction compass **(Fig. 14b)**.[95]

Reduction compasses (today called proportional dividers) work on the geometric principle of the similarity of triangles. Two parallels intersecting two triangles formed by two other intersecting lines form the same angles but different lengths (**Figs. 15 & 16**). The reduction compass was a two-arm compass with a variable central pivot; it created asymmetrical but geometrically equal triangles on each side, and consequently enabled the reduction and enlargement of drawings. Because the parallels insure that the angles are identical in the two triangles, the dimensions in the two remain proportional. A 4:3

[89] Bellucci and Frosinini (1997), (2001).
[90] Piero della Francesca (1942).
[91] This is amply discussed in Wittkower (1953); Kemp (1990), fig. 33.
[92] For the diffusion of Piero's method of parallel projection, especially for the conventions of architectural representation, see Di Teodoro (2002).
[93] For a review, see Veltman (1993).
[94] Frommel and Adams (1994), 246-247, 449; Camerota (2001).
[95] Camerota (2000); Rose (1968); Rosen (1969); Gamba (1994).

ratio is 1.333, an apparently non-intuitive number. It is important instead to imagine Barocci working the compass based on how large an object in the painting is compared to how much space he had on the sheet of paper.

According to Muzio Oddi, writing in 1633, it was in 1568 that the reduction and proportional compasses were invented by Federico Commandino and Guidobaldo del Monte.[96] There is a controversy as to whether or not this is absolutely true, but it is safe to say that Commandino and Guidobaldo were among the early experimenters with such instruments. Bartolomeo Eustachio requested that Commandino devise a compass with which to derive the ratios of triangles easily. Since Guidobaldo was then studying with Commandino (1566-70), he was there to help. Oddi remarks that Simone Barocci made the instrument. More interestingly, he says that Guidobaldo "was always at the house where Simone worked;"[97] in other words, Guidobaldo was always in the studio that Simone and Federico shared. Less important for us is Oddi's claim that Guidobaldo actually suggested the improvements to turn the reduction compass into a proportional compass, which could derive sines and tangents.

Remarkable about this story is the commonality of interests of the various natural philosophers tenured by the della Rovere – Eustachio, Commandino, Guidobaldo – all working on similar problems in a common scientific environment. At the time, both Commandino and the young Guidobaldo also resided in Urbino working closely with Simone, Federico's brother. This working relationship is only one of the countless occasions Barocci would have had to interact with the Urbino philosophers. Indeed, the reduction compass shall form a major part of this study, as it furnished the mechanism for Barocci quickly to derive the necessary ratios with which he could enlarge and reduce drawings. Barocci's brother, Simone, is known to have fashioned several of these compasses (and others) for Federico Commandino, Bartolomeo Eustachio, Guidobaldo del Monte and Fabrizio Mordente, some of the top mathematicians of the latter sixteenth century.[98] The ratios inscribed on the arms of the compass, from 2-8, describe exactly the range of ratios used by Barocci in his drawings.

It is because of Barocci's close association with the reduction compass that an anonymous Flemish painter might have deemed it appropriate, in the early seventeenth century, to present the personification of *Disegno* in the general guise of Barocci **(Fig. 17)**.[99] The reduction compass undergirds the whole analysis given in this book. To show the epochal nature of what Barocci was attempting with the reduction compass, it is necessary to delve more deeply into the process by which he evolved his compositions.

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[96] Oddi (1633/1865).

[97] Oddi (1633/1865), 442: "*L'illustriss. Sinore Guidobaldo de Marquesi del Monte, che in quei tempi si tratteneva in Urbino per conferire i suoi studij con il Commandino, et spesso era alla casa dove lavorava il [Simone] Baroccio.*"

[98] As noted above, Muzio Oddi's *Fabrica et Uso del Compasso Polimetro* (1633), preface, notes the year 1568 – extremely prescient for our narrative – when Eustachio, whom Barocci would have known at Cardinal Giulio delle Rovere's retinue in Rome, requested Commandino to design a compass for Simone Barocci to fashion.

[99] See http://mysteriousmasterpiece.com/an-alternative-candidate-for-disegno/; accessed 21 April 2016.

Inventing Light and Color

Barocci has been long been appreciated by scholars and collectors for his colored head and compositional studies in pastel and oil.[100] However, we may say further that these studies were part of a broader process in which Barocci invented "light" and "color" as we know them today. He was the first artist to separate tacitly the formal contribution of both light and color into the artistic message. He managed to create this separation by coordinating two kinds of preparatory painted drawings, the light compositional study (*modello*) and the color compositional study (*bozzetto*). By creating the two types of studies in parallel he cloves apart a fundamental distinction that can be taken for granted today. Moving beyond the more common discussion of Barocci's innovative choice of medium, we can discuss further the systematic nature of his working method.

Barocci's usage of monochrome and color studies will be outlined in great detail in the following chapters. Here I am merely concerned with the consequence of Barocci's conceptualization of the studies' joint functioning, a division of labor that forced the creation of new semantic categories. Quite early in his career, Barocci began using oil and pastel – a medium he brought to maturity – to make auxiliary cartoons of heads and *bozzetti* of the composition. Before Barocci, auxiliary cartoons of head in chalk were known, and Domenico Beccafumi had regularly painted oil sketches of heads, but Barocci was the first to see such heads as a necessary component of any major commission. For his fresco of *Moses and the Serpent* (c. 1563) in the Vatican Barocci already produced a head of Moses in oil **(Fig. 18)**.[101] The *modello* in ink wash with white heightening was well known from the High Renaissance, and Barocci continued to produce them throughout his career, but he also extended coloristic means to compositional studies. It is difficult to know if the chalk and pastel study for the *Madonna of Saint John* in the Morgan Library & Museum, given its condition, is actually by Barocci, but if so would constitute the earliest colored preparatory compositional drawings since some experiments by Polidoro da Caravaggio.[102]

The earliest such secure work is the well-known oil study **(Fig. 19**; Galleria Nazionale delle Marche, Urbino) for the large *Perdono* of ca. 1574-76 adorning the high altar of the Observant Franciscan church in Urbino.[103] Scholars have been reluctant to see this as a preparatory work for a variety of reasons discussed in detail in Chapter 5. These doubts have now been dispelled after a subtle and unnoticed shift in the composition clarified that it was indeed painted in the development of the composition, and not afterward, as a copy. The shift can easily be observed by using a straight edge that while the architecture and figure of Saint Francis align in the final painting (bottom) and the *bozzetto* (top), the figures of Chris and Mary are shifted *en masse* to the right.

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[100] See Chapters 5 and 7 for bibliography.

[101] Sotheby's (1993), 1993, 48; Haboldt & Co. (1995), 19. The authenticity of this head is not accepted by Bohn (Mann, 2012). It is discussed again in Chapter 7.

[102] For a reproduction of the Morgan drawing see Pillsbury and Richards (1978), 43. For a review of colored compositional drawings up to, and beyond Barocci, see Ferrari (1990). This drawing is discussed again in Chapter 5.

[103] Galleria Nazionale delle Marche, Urbino, 125 x 100 cm; Emiliani (1985), 1:105, fig. 181. This painting is discussed in Chapter 5. Note that the image with a manipulated scale is rendered in *gray*; this is a convention that will be used throughout the book.

Ironically, the presumed *modello* for the composition, in the Hermitage in St. Petersburg can now be seen to postdate the final work precisely because it has erased this compositional shift.[104] The lack of compositional change confirms that the drawing served instead for Barocci's important etching for the work, and the drawing and print match each other closely in size and distribution of figures. However, it is more economical to think of the second *modello* as a cleaned-up version of an earlier example of the same size, which was perhaps cut to experiment with the movement of the figure group, a fact that is confirmed by the existence of other very early drawings at the same scale investigating new poses.[105]

Juxtaposing these two works together produces some startling facts. First, we come to the realization that perhaps for the first time in western art history an artist has produced two redundant paintings, one focused on light and the other on color. To emphasize the significance of this distinction, we might make reference to classic semiotic theory, which holds that signs change their meaning (or value) when placed in different paradigmatic and syntagmatic oppositions. In the classic example of the French *mouton,* the word means both the species and the meat derived from it. Unlike the English *sheep-mutton* which has separate signifiers for each, *mouton* cannot differentiate between the two meanings.[106] Similarly, "modello" has the value of both light and color. When a new signifier, "bozzetto" arrives on the scene, it pries these two values apart and reassigns them. The description term monochrome and color sketch become semantically *not*-colored and *not*-monochrome respectively.

It is true that such pairs of light compositional (*modello*) and color compositional (*bozzetto*) studies do not survive for every painting. Nevertheless, as I shall argue in later chapters, for several: The *Entombment* (1582, Chiesa del Croce e Sacramento, Senigallia), *Calling of Saint Andrew* (1583, Musée Royaux des Beaux Arts, Brussels), and *Circumcision* (1590, Louvre, Paris), they do.[107] Barocci's first biographer, Gian Pietro Bellori, in his life of the artist of 1672, recorded that Barocci made such colored oil and pastel studies of the composition. Bellori noted that Barocci would "make a small cartoon in oil or gouache, in chiaroscuro" and "as regards the coloring, after the large cartoon Barocci made another small one in which he distributed the hues in proportions and sought to find the right tones between one color and the next."[108] Here, Bellori actually suggested the complementarity of light and color studies through his language; thus, to complement drawings in ink with white heightening (*cartoncini*) which Bellori says the artist used to understand "i lumi," Barocci supplemented another for the color (*cartone…picciolo*).

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[104] Hermitage Museum (Saint Petersburg), inv. 14714, 53.5 x 31 cm; Emiliani (1985), 1:106, fig. 182; Emiliani (2008), 1:267, fig. 34.1; Mann and Bohn (2012), fig. 5.7. Nicholas Turner, based on Michael Bury's communication, has already used size to link the model to the print (2000, 143) without reference to the compositional details. The example is fully discussed in Chapter 3.

[105] See Chapter 3, fig. 6, for documentation.

[106] de Saussure (1983), 115-116; Leach (1985).

[107] See Chapters 3 and 5.

[108] Bellori (1672/1978), 24; (1672/1972), 205-6: "*formava un cartoncino ad olio overo a guazzo di chiaro scuro…Quanto il colorito, dopo il cartone grande, ne faceva un altro picciolo, in cui compartiva le qualità de' colori con le loro proporzioni; e cercava di trovarle tra colore e colore; accioché tutti li colori insieme avessero tra di lor concordia ed unione, senza offendersi l'un l'altro.*"

Furthermore, these pairs also tellingly display scale relationships. The Saint Petersburg *modello* for the *Perdono* is half the size of the Urbino *bozzetto*, which itself is one quarter the size of the final painting (**Fig. 20**). To do this, Barocci had to begin with the dimensions of the final picture and scale down purposely to 1:8 for the model and then 1:4 for the oil sketch, each work reflecting its importance (the model smaller and more provisional and the oil sketch bigger and closer to the final work). These facts reinforce the complementarity of the two terms, and their signification of different contents.

By following a strict numerical relationship, Barocci presumes that *each is necessary for the work*. In other words, the two models are not different exploratory avenues toward the completion of a work of art but rather two independent and necessary works. In semiotic terms, Barocci has created a meaning of *paradigm* whereby messages become differentiated by their simultaneous presence in the system. Consequently, Barocci has tacitly invented light and color, because no one before him had severed the mixed function of the two, or the uniqueness of hue from *colorire*. Previous artists had studied *i lumi* and *i colori* to be sure, but by a rigorous method Barocci demonstrates a very intellectualized approach to the effects of light and color in nature that anticipated later theoretical developments.

Much scholarship has been directed toward overcoming the mistaken notion that cinquecento Venetian painting was directed toward hue (*colore*) by emphasizing the broadness of *colorire*; in the traditional comparison of Florence and Venice, the opposition was between *disegno* and *colorito* not *colore*.[109] Venetian painting was directed to powerful *chiaroscuro* and lifelike appearances, not bright colors. One need only compare Titian's late *Madonna della Misericordia* (Palazzo Pitti, Florence) with Barocci's contemporary *Madonna del Popolo* (Galleria degli Ufizzi, Florence) — itself a variation on the Misericordia theme—to understand the difference between the two approaches.

What Barocci did, then, was consolidate thought in the midst of a dawning pluralism and eclecticism, congealed in the Rome of the 1550s and 1560s. Barocci's companion and mentor, Taddeo Zuccaro, can be considered a major influence here, absorbing Venetian influences in the duchy of Urbino and central Italian tendencies arriving from the west, brought together in Rome. It is precisely in this period that two important authors, Giovanni Battista Armenini and Gian Paolo Lomazzo reflected a new sense of the perfections of the various Italian schools and consequently how they might be combined.[110] This outlook accepted the necessary components for a perfect painting based on both drawing and color.

A major step in this direction came with the rationalization of the color wheel away from the old Aristotelian division of colors into species of white and black. A number of scholars around 1610 began to reflect artists' practice of forming mixtures from the newly elevated primary colors: red, yellow and blue. The most conspicuous example was the Jesuit Aguilonius, a friend of Peter Paul Rubens, who in his *Opticorum libri sex Philosophis iuxta ac Matematicis* distinguished primary from secondary colors.[111] This helped

[109] Poirier (1980); Puttfarken (1991); and Rosand (1997).
[110] Kemp (1987).
[111] Parkhurst (1961),35-49; c.f., Gage (1993), 153-168; Shapiro (1994).

overcome the old medieval identification of hues as their mineral sources and led to their understanding as pure hue, with determinate properties subject to mixture.

Bellori wrote the most complete early biography of Barocci in 1672 and not too long afterward, an even more powerful conceptual shift was impacted in our understanding of artistic practice when Roger de Piles changed the meaning of *disposition* in works like his *Cours de peinture par principes* of 1708.[112] The term now means, as Thomas Puttfarken has recently shown, the total effect of the portable easel painting – the *effet du Tout-ensemble*.[113] Its visual effects could now be separated analytically into 'Coloris' and 'Clair-Obscur.' Critics of course knew the difference between light and color, but never before had they conceived of the role of painting as its instrumental effect on the viewer, which then could be analyzed into its components.

The notorious outcome of de Piles' revisionism was the distinctly modern result of his famous 'Balance,' included at the end of the *Cours de peinture*. It is easy to make too much of this document, and too much has, but the consequences for Barocci are clear. While de Piles holds his own with other artists (his overall 45 out of 80 is respectable, near Andrea del Sarto), in color he scores an abysmal 6 of 20, tying with Parmigianino and Poussin (the antithesis to de Piles' hero Rubens), and scarcely above Leonardo and Michelangelo.

Color was championed by de Piles in his defense of Rubens, but he fatally accepted the ground rules of his *Poussiniste* opponents. This included a caricature of Central Italian painting whereby artists were locked into a Michelangesque straight-jacket according to which color was a mere afterthought. For better or worse, de Piles's ideas are the source of our own and the modern oblivion of Barocci. Unbeknownst to De Piles, Barocci's experiments with light and color sketches were fundamental for de Piles's hero, Rubens, a painter of monumental works whose progeny became the small inventions of Watteau. It is perhaps poetic justice that de Piles, after codifying the narrow hue-based idea of color that Barocci introduced in practice, led to a modern neglect and underestimation of Barocci's color by critics. Ironically, Barocci, who suffered so badly in de Piles' estimation, had ultimately made de Piles' own procedure possible in his precocious experiments 100 years earlier.

As Janis Bell has recently shown with the case of Barocci's countryman Raphael, however, we neglect the coloristic contribution of central Italian painters to our detriment. We cannot anachronistically project our preconception (born of these seventeenth and eighteenth century views we have been reviewing) of Central Italian painters as not concerned with color, when in their time, they certainly were recognized as such.[114] If we think away the analytic separation of formal contributions to paintings of De Piles, and the idea of pure hue constituting "color," we arrive at a level playing field in which Fra Bartolomeo or Andrea del Sarto could easily arouse admiration in a Venetian, and Raphael might be considered indeed a "scientific painter." Seen in this light, Barocci's pursuits with media, perspective, and anatomy – to which we now turn – justify this appellation to the artist as much or more than they do to Raphael.

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[112] de Piles (1708).
[113] Puttfarken (2000).
[114] Bell (1995).

Fig. 9
School of Federico Barocci, *Portrait of Federico Commandino*, c. 1575, Museo Comunale, Urbania

Fig. 10
Federico Barocci, *Portrait of Marchese Guidobaldo del Monte*, c. 1590, Museo Civico, Pesaro

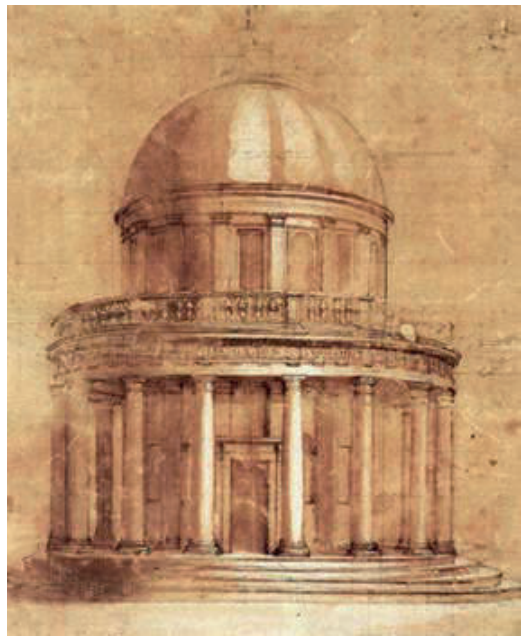

Fig. 11
Federico Barocci, inv. no. 135A, Gabinetto di Disegni e Stampe, Uffizi, Florence

Fig. 12
Federico Barocci, *Study of Arms and Legs* (for the *Calling of Saint Andrew*), inv. 20132, Kupferstichkabinett, Berlin

Fig. 13
Federico Barocci, *Madonna of St. Simon* (detail)

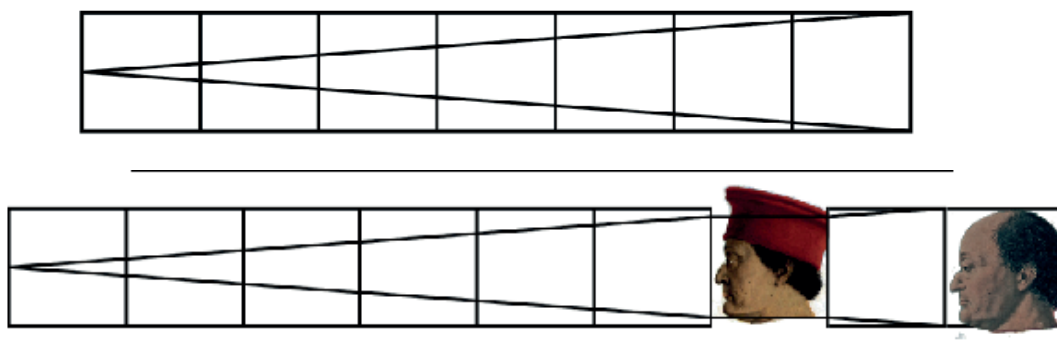

Fig. 14
The size-distance relation (after Piero, top); the relation of both heads of Federico da Montefeltro (6:7) (bottom)

Fig. 15
Simone Barocci? Reduction Compass, late sixteenth century, Istituto e Museo di Storia della Scienza, Florence

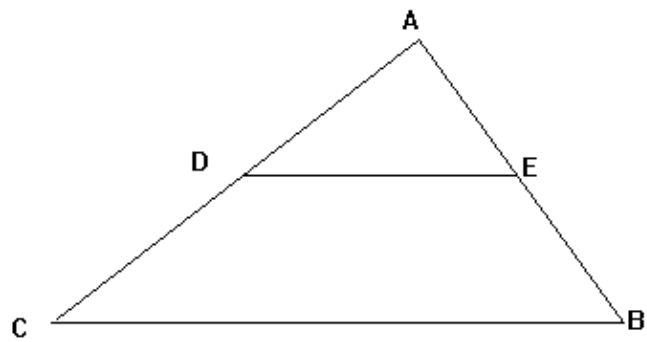

Fig. 16
Diagram of the similarity of triangles

Fig. 17
from Anonymous Flemish Painter, *Figure of Disegno (Barocci?)*, detail, *The interior of a Picture Gallery*, late 1620s, oil on copper, private collection, New York

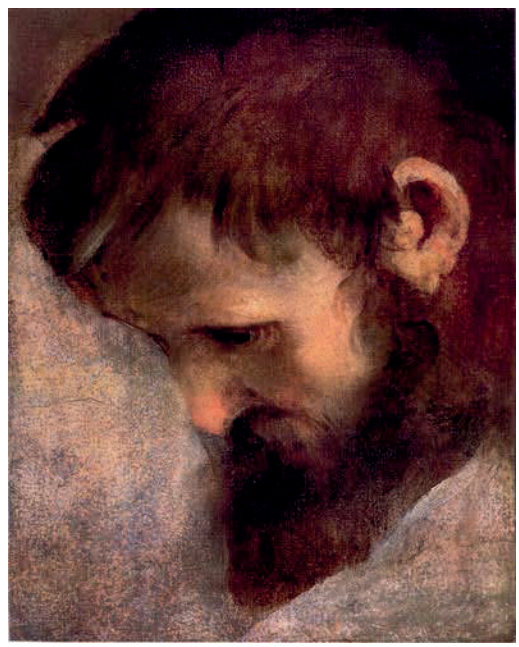

Fig. 18
Federico Barocci, *Head of Moses*, c. 1563, oil on paper, private collection

Fig. 19
Federico Barocci, *Madonna of St. John*, 1565, Morgan Pierpont Library, New York

Fig. 20
Federico Barocci, *Bozzetto* for the *Perdono* (top), and *Perdono*, San Francesco, Urbino, reduced four times (below)