Buch-, Druck-, Papier- und Schriftmuseen

Buch- und Druckforschung, 15. bis 16. Jahrhundert

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Nachrufe
The fifteenth-century origins of color printmaking have largely been neglected in both the history of the book and the history of art. After a brief but fertile period of research waned around 1910, only a few more incunable color prints have come to light. The known corpus consists of some monochrome and bi-color printed type, initials and printers’ devices; several monochrome copper engravings; and many of the multi-color woodcut illustrations that Erhardt Ratdolt (active in Venice c.1474–86 and in Augsburg 1486–1527/8) published from the 1480s. This article documents for the first time two incunable engravings that were printed in color to illustrate the so-called Buch von der Astronomie (c. 1476) issued by the innovative printer Nicolaus Götz (active in Cologne 1474–80). One survives in monochromatic impressions in black and in red and the other survives in monochromatic black and various bi-color combinations of red and black. They demonstrate that multi-color prints, color-printed book illustrations, and color-printed intaglio designs first appeared in an earlier decade than has been realized. By reconstructing the techniques of their production, this article offers new insights into both the role of color in early printing projects and the combination of intaglio printmaking with typography. The findings contribute to current research trends exploring the earliest development and dissemination of color printmaking techniques in the history of art, the history of science and the history of the book.

The study of the earliest history of color printmaking is based on two well known episodes: the bi-color decorated initials (red letters with blue marginal decoration, or vice versa) in the Mainz Psalter (Mainz 1457, GW M36179, ISTC ip01036000)1 and the diagrams, printers’ devices, frontispieces and illustrations issued in up to five colors by the workshop of Erhard Ratdolt in Venice (1482–86) and Augsburg (1486–1527/28).2 Occasional mention is made of monochromatic printing, e.g. of initials, decorations and printer’s devices in red and texts in gold, and of isolated dead-end experiments (e.g. the Book of St Albans, St. Albans, [not before 1486], GW 4932, ISTC ib01030000). This history is constructed exclusively from book illustrations that were printed in relief, whether woodcut, metalcast or metalcut; academic consensus has long held that the early development of color printing in the other category of early modern printmaking, intaglio, began in the sixteenth century (not the fifteenth) and in single-sheet prints (not book illustrations).3 However, an approach to color printmaking has been identified in intaglio illustrations for a book printed in c.1476, almost a decade before Ratdolt’s famous firsts.
Lazarus Beham’s *Hier fahet an eyn buch von der astronomien* (*Buch von der Astronomie*), preceded by *Kalendarii duo pro annis 1477–1537* (Cologne: Nicolaus Götz, [c. 1476], GW 3766, ISTC ib00296700), contains two engravings of astronomical instruments, a quadrant and a three-layer volvelle. They may be the earliest engravings to be an integral part of a typographically printed book (see Appendix 2). The former survives in monochromatic red and black impressions, the latter in monochromatic black and in combinations of monochromatic red and black. Although they were described as the first intaglio book illustrations by Henry Bradshaw in 1866, their color printing is not indicated in the main bibliographical sources (including GW and ISTC) and they are effectively unknown to art historians. Thus, it has not been recognized that the monochromatic red impression of the quadrant is among the first color-printed impressions of engravings or that the red-and-black impressions of the volvelle are

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1 It is often said that these bi-color decorated initials were an experimental one-off, printed only in 1457, but they were used over the next four decades. See Mayumi Ikeda: The Fust and Schoffer Office and the Printing of the Two-Coloured Initials in the 1457 Mainz Psalter. In: *Printing Colour in the Hand-Press Period: History, Techniques, Functions and Receptions*, ca. 1400–1700. Eds. ad stijnman and elizabeth upper. Leiden 2014 (forthcoming).

2 His workshop was most active in the 1480s and 1490s, but new evidence suggests that it issued woodcuts in up to three colors through the mid-1500s. Elizabeth Giselbrecht and Elizabeth Upper: Glittering Woodcuts and Moveable Music: Decoding the Elaborate Printmaking Techniques, Purpose, and Patronage of the *Liber selectarum cantionum*. In: *Senfl Studien I*. Eds. stefan gasch et al. Tutzing 2012, pp. 17–18. Elizabeth Upper: Materials and Techniques of Early Colour Printing until c. 1710. In: *Printing Colour in the Hand-Press Period* (see note 1).

3 On booklets of engravings to which manuscript text was added, which survive from as early as the 1450s, see Ursula Weekes: *Early Engravers and Their Public*, 1450–1500. Turnhout 2004, pp. 81–85, 88–93 and 101–3. Sérénée Lepape and Katherine Rudy: *Les origines de l'estampe en Europe du Nord*, 1400–1700. Paris 2013, pp. 119–21. On early owners of books pasting engravings into them as frontispieces in this period, see Hofer (see note 4), p. 208, fig. p. 204. His example is Raoul Letëvre: *Recueil of the histories of Troye*. Trans. William Caxton (Ghent c. 1473/74), GW m17449, ISTC il00117000; the ISTC describes the copy in The Huntington L. San Marino, as “with engraved frontispiece”. It is pasted on to the verso of the flyleaf and is therefore not an integral part of the book block, but its position in the book could have been shifted in conservation.

4 On booklets of engravings to which manuscript text was added, which survive from as early as the 1450s, see Ursula Weekes: *Early Engravers and Their Public*, 1450–1500. Turnhout 2004, pp. 81–85, 88–93 and 101–3. Sérénée Lepape and Katherine Rudy: *Les origines de l’estampe en Europe du Nord*, 1400–1700. Paris 2013, pp. 119–21. On early owners of books pasting engravings into them as frontispieces in this period, see Hofer (see note 4), p. 208, fig. p. 204. His example is Raoul Letëvre: *Recueil of the histories of Troye*. Trans. William Caxton (Ghent c. 1473/74), GW m17449, ISTC il00117000; the ISTC describes the copy in The Huntington L. San Marino, as “with engraved frontispiece”. It is pasted on to the verso of the flyleaf and is therefore not an integral part of the book block, but its position in the book could have been shifted in conservation.

5 Henry Bradshaw: Note on a Book Printed at Cologne by Götz in 1477, with Two Illustrations Engraved on Copper. In: *Cambridge Antiquarian Society Communications*. iii (1864–76), pp. 237–46; idem: Collected Papers of Henry Bradshaw. Cambridge 1889, pp. 244–5. Hofer was aware of them, but he did not mention color-printed impressions or consider them as illustrations. See Appendix 2 for a census of 25 incunabula with engraved illustrations.
the earliest known printed images printed in multiple colors of ink. The impressions of these instruments are marked by a great variety in the application of color. The early years of the press are characterized by experimentation, especially by printers, but this kind of artistic experimentation is not expected in incunable book illustrations. It is especially surprising in scientific diagrams and on the behalf of the printer. This article will present the content of the engravings, copy-specific analyses of the different color combinations, information about the press and techniques used to print them, and their significance for both historians of the book and historians of art. In doing so, it will emphasize the interdisciplinary ramifications of this finding in the context of the burgeoning academic interest in the early development of color printmaking techniques.6

Illustrations in the Buch von der Astronomie
The Buch von der Astronomie could be described as experimental in many respects, as could many of Götz’ publications,7 and the engravings must be understood in the context of the making and the compilation of the volume. To start with, the collation is irregular, and the number of folia per quire ranges from four to ten: ab8 c10 d6 e8 f4 g10 h8 i10.8

The book contains a large amount of visual material, which falls into five categories of production:

The first conference on the subject was organised by Ad Stijnman and Elizabeth Upper: Impressions of Colour: Rediscovering Colour in Early Modern Printmaking, c.1400–1700, Cambridge, Centre for Research in the Arts, Social Sciences and Humanities, 8./9.12.2011.7

7 Götz must have been a versatile and inventive man, not just because he trained as a goldsmith and a lawyer before turning to typography. Between his first dated book of 30.4.1474 (Ludolphus de Saxonia: Vita Christi. Cologne 1474. GW m19194, ISTC il00338000) and his last dated book of 7.9.1480 (Epistolae et Evangilia. Cologne, 1480. GW m34047, ISTC ie00064100), he produced 31 titles in six years. His earliest dated publication is the first book with a metalcut as printer’s device (see fig. 8), which he occasionally used (see note 4). His printer competitors used only woodcuts or metal casts for printer’s devices for long afterwards. Thus, he was probably the first printer to combine copper engraving with typography on one sheet in a book and to have printed page numbers in books, and he was unquestionably the first to apply intaglio color printing either in red or in a book and to make compound bi-colored prints. Severin Corsten: Götz, Nikolaus. In: LGB 2, vol. 3, supplement 19, p. 206. Isabel Heitjan: Die Stellung der Buchgewerbetreibenden in der Stadt Köln und zu ihrer Universität (15. bis 18. Jahrhundert). In: Börsenblatt für den Deutschen Buchhandel (Frankfurter Ausgabe). 26 (29.9.1970), 78 (Historischer Teil. lxxxi), pp. 2117–231. Die Kölner Büchermarken bis Anfang des XVII. Jahrhunderts. Ed. Paul Heitz, coop. Otto Zaretzky. Strasbourg 1898 (Die Büchermarken oder Buchdrucker- und Verlegerzeichen), pp. xvi–xvii. Ad Stijnman and Claudia Kleine-Tebbe (coop.): Hochzeit von Bild und Buch, Anflinge der Druckgraphik 1420–1515, aus den Beständen der Herzog August Bibliothek Wiesbaden 2009 (Wolfenbütteler Hefte. 26), p. 43.8

8 Please note that the signatures and foliation given for Lazarus Beham, Buch von der Astronomi (Cologne, c.1476) in this article are assigned by the authors.

9 Renzo Baldasso: La stampa dell’ editio princeps degli elementi de Euclide (Venezia, Erhard Ratdolt, 1482). In: The Books of Venice. Eds. Lisa Pons and Craig KalendOrf. Venice, New Castle (de / usa) 2009 (Miscellanea Mariana. 20), pp. 61–100.10

10 Until the second Vatican Council of 1962 changed the day of St. Matthias to 14 May, the Roman Catholic Church celebrated it on 24 February in normal years and 25 February in leap years.11

11 Surprisingly, full instructions were not copied along with the instruments. According to Richard Kremer, Dartmouth College (nh / usa), the volvelle indicates the number of degrees (from 0 to 6) that must be added to the mean lunar longitude indicated in the calendrical tables to yield the true lunar longitude, and the quadrant is used to find unequal or planetary hours when given the equal hours. We are grateful to him for this information.
– Cast type Small decorated initials printed from cast type are found throughout the volume.
– Metal strips Numerical tables printed from thin strips of metal, with metal type for letters, numbers, and other signs, are also found throughout the volume.
– Woodcuts Tables of solar and lunar eclipses with woodcut diagrams are found on fols. g8r–g10r (fols. 52r–54r; fol. g10v is blank). The white dots in the middle of each circle and the circular scratches around the dots indicate that the circles were incised in the woodblock with compasses.
– Moveable type and woodcuts set into double rings Eight smaller double rings, which are close together, encircle the names of some zodiacal signs. They were printed from relief matrices with slots for inset type, and there are two per page on fols. h1v, h2v, h3v, and h4v (fols. 55v, 56v, 57v, and 58v). These smaller double rings come in two versions: in one, the two circles are close to each other; in the other, the circles are more distant. Another six larger double rings encircle a star and the names of other zodiacal signs, sun, and moon. One each is on fols. h5v, h8v, i2v, i4v, i6v, and i8v (fols. 59v, 62v, 64v, 66v, 68v, and 70v). The consistency of the dents between impressions indicates that they were all printed from the same matrix, although the continuing distortion and irregular inking makes this difficult to confirm. The lateral and downward bumps, distortions, and outward bends of the outer circles of Aries (fol. h1v above) and Thaurus (sic, fol. h1v above, see fig. 1) indicate that they could not have been printed from woodcuts; compare the rings in the woodcut eclipses, which are of a different nature. They cannot be termed “metalcuts” because that implies engraving into a metal plate. Instead, they seem to be printed from metal strips, possibly set in a wooden block or cast in type metal, with slots cut out or reserved for inserting type. (The edges of the slots are visible where they were touched in inking, which indicates that the relief was not that high.) We might see them as precursors of the matrices with metal strips that Ratdolt may have used for his 1482 Euclid.9
– Engraved paper instruments Two were printed on separate sheets that were also printed typographically (with eclipse tables): a quadrant (with no title or instructions on the plate) and a volvelle consisting of a base plate and two dials, with the title INSTRVMENTVM VERI MOTVS LVNE (Instrument for the true motion of the moon) above and the instructions ADDE INDEM SCHALT IAR AN SANCt MATHIAs | SALTv DIE ZWO SCHIBEN FVRBAS. VF Xiii GRAD RUCKEN« (add up, in the leap-year on Saint Matthias,10 you will move the two discs 13 degrees forward) below. The quadrant is an inaccurate copy of the Instrumentum horarum inaequalium and the volvelle of the Instrumentum veri motus lunae, both woodcuts known only in black impressions, in Johann Müller of Königsberg (Johannes Regiomontanus), Kalender (Nuremberg 1472 or 1474; GW M37472, ISTC ir00100300).11 The copies similarly
required a piece of thread as a cursor, but their deviations from the models, which render them unusable, show that their designer did not understand how they worked. They were pasted together to form one leaf and bound in as fols. g1r and g2v (fols. 45r and 46v), with two conjugate leaves, fols. g9 and g10 (fols. 53 and 54). That the engravings and typography were printed on the same sheet is particularly evident in the London copy, as part of the base plate of the volvelle on fol. g2v is visible on the other side of the fold on its conjugate fol. g9v.

The authors have consulted or received detailed information about all ten surviving copies of the Buch von der Astronomie (see Appendix 1). Four (Cologne, Frankfurt/Main, The Hague, Paris) are fragments and lack both engravings. Four (Basel, Berlin, Cambridge, London) have the quadrant and the base plate of the volvelle printed in black; the dials are lacking in the Basel and Berlin copies, both are black in the Cambridge copy [fig. 3], and the lower dial is black and the upper dial is red in the London copy [fig. 4]. Two (Dessau, Munich) have the quadrant and base plate of the volvelle in red; the dials in the Dessau copy are lacking while the dials in the Munich copy are both black [fig. 5]. In the case of the volvelle, the bi-color printing was both aesthetically pleasing and practical, as it made the dials contrast with the base plate, but the combination of colors is inconsistent.
The Engravings

The engraving is precise in both prints, with few deviations from the geometrical design. However, the original design of the quadrant was altered before printing by scraping and polishing the left and lower lines, which now look buffed, and by engraving additional lines three degrees upwards and to the left. Horizontal and vertical lines intersect at the exact centers of the circle on the base plate and the lower dial, well within areas that were covered in the finished instrument by the lower and upper dials, respectively, to indicate where the thread should be inserted. The style is utilitarian, not pictorial, and there are no unnecessary elements or decorations. This style would be expected from a manufacturer of mathematical and astronomical instruments, engraving in brass or ivory rulers, polyhedrons, astrolabes, or the like; the ends of the lines are cut square and do not taper, as they tend to do in engravings of imagery, and there is no hatching or shading. The manner, which is comparable to the kind of line engraving that the Nuremberg mathematician Georg Hartmann (1489–1564) used for paper instruments half a century later, points to the involvement of a professional skilled in the engraving of instruments of measurement. Götz’ training as a goldsmith would have given him experience with engraving metal, but not necessarily the precision needed to produce these calculating instruments.

After they were cut, the plates were put in place for printing. The obliquely printed edges of the plate of the quadrant can be discerned because they are lightly impressed in the paper and because there is plate tone (a film of ink left on the plate after cleaning its surface, which shows as a lightly printed area on the sheet; here, it appears grey from black ink and pink from red ink) on most of the plate or, in some impressions, on the entire surface of the plate. It was rectangular and positioned

12 Intact fifteenth- and sixteenth-century paper instruments are rare, especially with original fastenings. The quadrant in the Cambridge copy has a blue thread for calculating the hours; the rest have holes in the lower lefthand corner of the quadrant that continue through to the volvelle. In the volvelle, the red thread of the Munich copy, the dark blue thread of the Cambridge copy, and the grey thread of the London copy may be modern replacements; the dials of the Berlin copy are facsimiles of those in the Munich copy. In the copies that lack the thread and dials, a pinhole in the centre of the circle on the base plate continues through to the quadrant.

13 According to Richard Kremer, the manuscript additions to the Munich copy are more accurate than the engraved lines because the curved lines in the engraved quadrant differ from those in Regiomontanus’ original woodcut for no apparent reason: “20-minute and 4-minute intervals are marked on the outer circle, running from at 0 at the top to 8:32 at the bottom. The value of 8:32 nearly matches the maximum value in Regiomontanus’ table of half-day lengths (8:34). The engraver of these instruments apparently decided to make the ends symmetrical, so he began with 0:08 at the top and ran to 8:52 at the bottom. This value would have been justified if he were matching a table of half-day lengths that went to higher geographical latitudes than Regiomontanus, but Götz’ edition does not contain a table of half-day lengths. This suggests that he did not understand the quadrant, which cannot be used without an accompanying table of half-day lengths.” We are grateful to him for this information.

14 One copy (in Dessau) is described in GW but not in ISTC. The copies in Frankfurt / Main, London and The Hague may originally have formed one volume, as indicated by their continuous foliation (1-26, 27-54, 55-71).

with the shorter sides printed at an angle of about 45° to the length of the sheet, with one shorter side pointing to the lower right corner and the other shorter side impressed in the upper half of the conjugate folio, fol. g10v. In contrast, the metal plate used to print the base plate of the volvelle had irregular edges. Its edges are slightly different in every impression, depending on the amount of ink left behind after wiping (the printer’s expression for cleaning excess ink off the plate). Apparently, the base plate was engraved into a leftover piece of copper or brass and no trouble was taken to cut the edges straight, as is typical of early intaglio printmaking. 16

The strong plate tone on and immediately around the engraved areas indicates that the printer inked the complete surface of the copper plate, filling the engraved grooves. Then he wiped the plate with a rag in such a way that the ink stayed in the grooves and a very thin layer of ink remained on the blank part of the surface outside of the image. This is typical for rubbing; pressure applied by hand to the sheet is insufficient to force it deep enough into the grooves engraved into the plate, so the grooves must be filled up to their edges with ink. With a roller press, the higher pressure forces the sheet so deep into the grooves that the plate’s surface can be wiped clean, thereby removing more ink from the grooves.

The wiping pattern is evident because the streaks left by the rag printed sharply. It is similar in the surviving impressions in both red and black. For example, in impressions of the quadrant, the ink at the bottom was wiped clean with a rag, but only at a safe distance from the engraved area (i.e. the bottom line of the instrument). This was presumably to avoid removing any ink from the grooves, and it left stronger plate tone around the engraved area. The wiping touched the right lower corner and the left upper corner in the Cambridge and Munich impressions. The Cambridge impression shows heavier plate tone, but the black ink could have had a different and possibly more viscous constitution than the red ink in the Munich copy; a less viscous ink is easier to wipe off. The fact that it is possible to recognize a personal hand of wiping indicates that the red and black impressions were printed by the same person within a short period of time, which suggests that the color impressions are contemporary with the black ones.

After wiping, the paper was positioned on top of the inked plates and covered with fabric and/or parchment. According to the earliest description of the intaglio printing process (which was written in Gaeta, northwest of Naples, around 1570 but contains recipes from before 1520 and likely derives from an earlier source), the (dampened) paper would be covered with folded serge and with a sheet of parchment on top, and a polishing tool would then be rubbed over the parchment in order to force

16 Stijnman 2012 (see note 3), p. 141.
the paper into the grooves to make the impression. The grid-like pattern in the plate tone in the black impressions clearly shows the structure of this coarsely woven fabric [fig. 3]. It is not visible in the red impressions, possibly because the red ink was not contrasting enough to leave a clear impression of the felt’s structure or because the rubbing was carried out onto parchment that was placed directly onto the paper, i.e. without fabric between paper and parchment.

Although all impressions show strong plate tone within and around the images, as the plates were wiped clean only at a safe distance from the engraved lines, many manques (unprinted white dots within the printed lines that result from inadequate pressure) can be observed. The combination means that excess ink was left on the surface of the plate to ensure that the engraved lines would print completely, as explained above, but they did not. This could only be because the pressure of the printing was insufficient to force the paper far enough into the grooves to contact the ink, so it also suggests that the plate was printed by manually rubbing the verso of the paper with a polishing tool instead of running it through a roller press. That conjecture may be supported by the pattern of wiping: did the printer limit his rubbing to the engraved area of the plate? If so, it would explain why the plate tone on several impressions fades towards the fold on both the quadrant and the base plate of the volvelle, and also
why the printing and the plate marks are irregular, or even not present. Because rubbing is tiresome, rubbed impressions can be irregular, and Götz had little control over the process (as the inconsistency of the impressions of the paper instruments shows), it may be unsurprising that he did not illustrate any other books with engravings, as far as we know. Printing by press would have given more homogeneous results that were better suited for a commercial product.19

But Götz may not have had an option. It is clear that he had a book printing press in his workshop, but it is unlikely that he also kept a roller press. The roller press had been introduced for intaglio printing only ten years earlier (in the Upper Rhine region, possibly in the studio of Master ES, not far from Götz’ hometown of Sélestat),20 but it would not become commonly used until the 1480s, when more than twenty professional German engravers were active.21 Götz apparently printed the plates by rubbing and achieved poor results. Because the folia with the engraved instruments (fols. g1r and g2v) are conjugate with folia printed with movable type (fols. g9 and g10), these leaves were printed in two manners: in intaglio for the engravings and typographically for the respective bifolia. This combination is not attested before the last quarter of the fifteenth century, and it is unusual for this period (see Appendix 2). Götz’ innovative method underlines that he was working at the very beginning of the integration of engravings into books.22 Although he may have been

[Fig. 4]  
BEHAMI:  
Buch von der Astronomie  
(see fig. 1). BSB Rar. 314, fol. 45v and 46v.  
Quadrant and volvelle, engraving, printed in red and black ink, with manuscript additions in pen and browned iron gall writing ink, fols. g1r and g2v.
attempting to follow the ways in which woodcut book illustrations were incorporated into the printed book – and he certainly copied the way that instruments were part of the 1474 (1472?) edition of Regiomontanus’ text – his idea was original. In some ways, it is similar to the integration of engraved book illustrations in Colard Mansion’s edition of Giovanni Boccaccio, De casibus virorum illustrium (De la Ruine des Nobles hommes et femmes), which is more securely dated to 1476 (see Appendix 2, no 2), and the way that Italian books were illustrated with engravings immediately afterwards in 1477–79 (Appendix 2, nos. 3–6). Although these books were issued in Italy, their organizers (e.g. Nicolaus Laurentii, Arnold Buckinck, and Konrad Sweynheym) – and their tools23 – were German.

The order of impressions cannot be ascertained from the surviving copies, but one revealing imperfection in the Munich copy is the slightly darker tone to the red ciphers and the extending lines along the inner curve of the quadrant. This is printing ink; they were not traced in pen and ink. Under magnification, remainders of black are visible at the sides of the red lines. The black must have been left over from a previous impression. This indicates that the plate was printed in black first and then cleaned, but not thoroughly. Shortly afterwards, before the black ink had a chance to dry and harden completely, the plates were inked in red and printed. The first impressions thus showed remainders of the black ink, which would have disappeared after a few print runs.

Despite the apparent inoperability of the quadrant (see above), the corrections, additions, and stains indicate that the instruments were used. A former owner of the Munich copy improved them by filling in the manques, reinforcing poorly printed lines, correcting text and the instruments, and inscribing additional information in pen and iron gall writing ink. The writing ink was originally black, but it is now difficult to discern because it has faded to a brown that is similar in tone to the red printing ink [fig. 4]. Because the author of the manuscript lines was knowledgeable about astronomical calculations but not an experienced draughtsman, we may presume that he was not the same person as the engraver of the instruments, who would have had the skills and the tools for making exact straight and curved lines but who lacked key astrological information.

A parallel may be drawn with an edition of Dante’s Divina Comedia issued by Nicolaus Laurentii in 1481 (see Appendix 2, no 8). The earlier stanzæ were illustrated with engravings that were printed by rubbing within the area printed with text, but the poor quality of the rubbing probably resulted in many losses. For the next group of stanzæ, he printed the plates on separate sheets that were pasted in. By the time he came to print the later stanzæ, he had given up on illustrations. See stiJnman 2012 (see note 3), p. 44. Like Götz, Nicolaus Laurentii did not print his engraved illustrations by press but by rubbing, although the roller press had been introduced in Italy some ten years earlier.

19 On the introduction of the roller press for intaglio printing, see stiJnman 2012 (see note 3), pp. 38–40.

20 Plans for Ambrogio Leone’s book of 1514 called for it to be produced in the same way, leaving pages blank so that engraved illustrations could be printed on them. However, the printer changed his approach and printed the engravings on separate sheets that were either bound with the text quires or cut out and pasted onto the blank pages. Ambrogio Leone nolanus: De Nola opusculum distinctum, plenum, clarum, doctum, pulcrum, verum, varium et utile. Venice 1514.

21 stiJnman 2012 (see note 3), pp. 410/1.

22 On the northern European origin of these engravers and their tools, see sean roberts: Francesco Rosselli and Berlinghieri’s Geographia Re-Examined. In: Print Quarterly. 28 (2011) 1, pp. 4–14.
Other books with engravings printed as an integral part of the book appeared in the same year and shortly afterwards. Colard Mansion’s 1476 edition of Boccaccio, *De casibus virorum illustrium* (*De la Ruine des Nobles hommes et femmes*) (Appendix 2, n° 2), has engravings and letterpress printed on bifolia in some copies and engravings pasted in on others.\(^{24}\) In the next year, Nicolaus Laurentii (Nicolo Todesco)’s edition of Antonio (Bettini) da Siena, *Monte santo di Dio* (Florence 1477) (Appendix 2, n° 3), had engravings usually printed on the same page as letterpress but sometimes pasted in.\(^{25}\) It is striking that books with engraved illustrations were realized in Bruges and Florence immediately after Götz published his engraved instruments. Did three people have the same idea independently, or did Götz’s working method for the instruments influence book producers around Europe extraordinarily quickly? In either case, since three printers in three countries undertook the same kind of experiment at roughly the same time, Götz’ engravings must be understood in their international context of production and not as an extravagance with only a local importance.

**Rethinking the Emergence of Intaglio Color Printing**

In that broader context, the engravings revise our understanding of the early history of color printmaking in intaglio and challenge the established narrative for the earliest development of color printmaking in general. The earliest known non-black engraving, Master ES, *Madonna and Child in a Garden* (Upper Rhine, c. 1465–67; Lehre 2, 130, 70), is printed with white ink on black prepared paper [fig. 6].\(^{26}\) In Northern Europe, the few color impressions of single-sheet early modern intaglio prints are often datable as late or posthumous – for instance, red impressions of prints designed by Albrecht Dürer and Lucas van Leyden – and color

\(^{24}\) We have not been able to study copies of this publication and thus cannot state whether the engraved illustrations were printed manually or by roller press.

\(^{25}\) See also Appendix 2 for a list of incunabula illustrated with engravings.


\(^{27}\) STIJNMAN 2012 (see note 3), pp. 346/7, 353–5.

\(^{28}\) For instance, some engravings by Andrea Mantegna (1431–1506) survive in blue, green, or brown impressions, and some later Italian engravings survive in blue, green, or red impressions. However, all are single-leaf prints.


\(^{30}\) AMBROGIO LEONE’S book (see note 22) contains four engravings by Girolamo Mocetto (c. 1458–c. 1531), of which half are printed in black and half in red or blue (now partially green), depending on the copy; for photographs, search VK (see note 15) for “Girolamo Mocetto.” RUTH MORTIMER (comp.): *Harvard College Library Department of Printing and Graphic Arts Catalogue of Books and Manuscripts*. Part II: Italian 16th Century Books. Cambridge (MA / USA) 1974, pp. 371–3.

\(^{31}\) In the Dessau copy, the quadrant and the base plate of the volvelle are printed in red, and the two dials are missing. Perhaps it looked like the one in Munich, with the dials printed in black, or perhaps one or both dials were printed in red. Similarly, only the black base plate of the volvelle in the Basel copy remains. Its upper dials may also have been printed in black or red; other copies with a black base plate survive with the top two dials printed in red (London) and black (Cambridge). The variety may be an indication that Götz’ approach for color printing was more experimental than efficient.

intaglio book illustrations from before the eighteenth century have only recently been brought to attention. In Italy, single-leaf color intaglio prints appeared infrequently but more or less regularly from the 1470s. Copper engravings were first produced in Italy c. 1460, and a number of the earliest Italian engravings, c. 1460–90, are known in blue impressions that are undated and could be contemporary or later restrikes [fig. 7].

The first known Italian engraved book illustrations printed in color (either blue or red) are found in Ambrogio Leone’s publication on his home town Nola of 1514. Because the color impressions of the engravings in the *Buch von der Astronomie* are contemporaneous with the book, they seem to be the second known engravings printed in any color other than black in the German-speaking lands, the first known engravings printed in red in Europe, and the first known engraved book illustrations printed in any color other than black in Europe.

It is equally important that, in at least two copies of Götz’ publication, the volvelle is bi-color (black and red). Current scholarly consensus holds that multi-color intaglio printing began in Italy in the first half of the sixteenth century and followed in Germany only in the second half of the century. The red-and-black volvelles may not be considered color prints in some definitions of the term because the three monochromatic elements are stacked and joined by a thread, not printed on one sheet.
However, each monochromatic layer is just one incomplete part of the whole; they were deliberately combined in order to create a single composite print. The instrument is the earliest attempt – and a very conscious one – at combining two colors of printing ink in one image, whether relief or intaglio, in Europe. It predates the well known red and black diagrams of eclipses printed by Erhard Ratdolt in his 1482 edition of Regiomontanus’ *Kalendarium* (gw m37456, istc ir00094000) by six years.

The color printing of the volvelle is unique in its time. A variety of multiple-color printing techniques emerged after Götz’ publication, sometimes in combination with other ways of incorporating color into the production of prints (e.g. printing on a colored support, whether paper, fabric, or leather). Additionally, the combination of various printed (or drawn) elements to create one coherent object is attested in and after the fifteenth century in paper instruments with movable elements, including volvelles. However, no other early modern color composite prints are known; all other known fifteenth-century composite prints are fully in black ink, and all other known fifteenth-century multiple-color prints involved adjacent or superimposed areas of colors on one sheet. Götz’
manner could therefore be termed a “compound color print.” Multi-color intaglio printing at this initial stage of the development of the printing trade is unknown otherwise, and it was not until the nineteenth century that color-printed elements were commonly combined in this way.35

**Dating the Book**

The two astronomical instruments in the *Buch von der Astronomie* reshape our understanding of many of the key stages in the early development of printing, but the book’s context of production is equally significant. Götz’ innovation becomes all the more significant when understood as one of several parallel but independent developments in book production that were taking place across Europe.

It is undated and has no colophon, but it is catalogued as the first book printed with engravings as c. 1476 and Bradshaw believed it was printed in 1477.36 Its terminus post quem is relatively straightforward; it followed the 1474 (1472?) edition of Regiomontanus’ *Kalendarium*37 and was presumably published soon afterwards. Because it would have been meant for immediate and future use (not for calculating historical astronomical data) and the earliest dates mentioned in the text are 1474, 1475, and 1477, perhaps a case could be made for a terminus ante quem earlier than 1476 – possibly even 1474. If printed before 1476, it may actually be Götz’ first known publication (see note 7). The experimental nature of the printing, including the metal rings printed in relief and the color printing, also suggests a very early date because Götz settled on more standard working methods soon afterwards.

Remember that Götz was an innovative printer/publisher. For instance, in 1474, he was the first to mark his publications with a printer’s device in metalcut (*Ludolphus de Saxonia, Vita Christi*, gw m19194, istc il00338000, fig. 8) (see note 7)38 and rings that decorate the text of the *Buch von der Astronomie* demonstrate that he used woodcut as well as alternative media. As far as is known, the paper instruments were his first and only attempts at printing in intaglio (assuming that he printed the plates himself). Like many other printers of his time, he was exploring the capabilities of a relatively new technology.

33 *Stijnman 2014* (see note 3).
35 More color-printed astronomical diagrams were produced in the following period. For instance, the German engraver Georg Brentel (before 1580–1638) issued about twenty paper instruments, both engraved and woodcut, and a number of the engraved instruments were printed in monochrome red-brown or black ink. Suzanne Karr Schmidt: Georg Brentel the Younger. In: *Prints and the Pursuit of Knowledge in Early Modern Europe*. Ed. Susan Dackerman. Cambridge (Ma / USA; etc.) 2011, pp. 300–3. For early modern bi-color impressions from composite plates, otherwise called jigsaw plates, see *Stijnman 2012* (see note 3), pp. 354/5.
36 Bradshaw (see note 5), p. 244.
37 ISTC: “The calendrical material consists of Cisioianus in Latin, a Tabula planetarum retrogradationum 1477–1526, and Johannes Regiomontanus, Kalendarium in German”.
38 Götz used his metalcut printer’s device later in Werner Rolewicz: *Fasciculus temporum*. Cologne 1478 (gw m38684, istc ir00258000). For images, search Vkk (see note 15) for >Druckermarke von Nikolaus Götz<.

**Fig. 6**

Master es: Madonna and Child in a Garden, c. 1465–67, engraving, printed with white ink on black-coated paper, 10.6 cm in diameter.

**Fig. 7**

Design for a silver dish or deckel, c. 1475, engraving, printed in blue ink, 23.6 cm in diameter.
Important of the Engravings

To summarize, close observation of Götz’ engraved paper instruments and comparison to contemporary book illustrations reveals a number of experiments that are indicative of early developments with the press (both for book and print production) across Europe.

Firstly, the historiography of the engraved instruments in the Buch von der Astronomie follows a pattern that has limited the understanding of early book illustrations and the early development of color printmaking in both the history of books and the history of art. One important point is that their publication in bibliographical catalogues did not cross over to the art historical literature, even though they are among the very first, if not the first, book illustrations printed from engraved brass or copper plates. An equally important point is that all published catalogues and online databases – both bibliographical and art historical – omit the color printing.39 This may be due to a bias against color in the graphic arts or to the consideration that the color of the impression was unimportant.40 The absence of cataloguing standards for recording color printing points to the needs for a descriptive vocabulary for (painted and printed) color in the graphic arts and for copy-specific research, which can be facilitated by the digitization of collections. The reception of these engravings has been shaped by the notoriously poor communication between the history of art and the history of the book and the invisibility of color in records and catalogue entries that describe them are characteristic, not exceptional. These issues have limited the understanding of the early development of book illustrations and color printmaking in both fields.

Secondly, the engravings were printed in intaglio on the same sheets as typographic text. They form an organic, integral part of a printed book. Together with Mansion’s De la Ruine des Nobles hommes et femmes, it is the first occurrence of a combination of intaglio and typographic printing on one sheet.41 Heavy plate tone in combination with manques is found throughout the impressions of these engravings, which means that the printer of the plates was not well acquainted with the intaglio printing process and struggled to make proper impressions. It may be telling that, after this sole experiment, Götz left it to others to develop intaglio printed book illustrations. Colard Mansion also used it in only one publication, and Nicolaus Laurentii struggled through the production of two books with engravings printed within the text (Appendix 2, nos. 3 and 9) before he decided to follow the example of the two earlier Ptolemies

39 To date, the only published major study that encompasses the field of early color printing across the history of art and the history of the book is Robert M. Burch: Colour Printing and Colour Printers. London and New York 1910. Reprint Edinburgh 1983. Recent scholarship is attempting to bridge this gap; see, for instance, Stijnman 2012 (see note 3) and Upper (see note 3).
40 Gieselbrecht and Upper (see note 2), pp. 20–4.
41 Earlier engravings that form an integral part of a manuscript (i.e., that are bound in rather than pasted in) are known. On booklets of engravings from the 1450s to which manuscript text was added, see LePape (see note 4), pp. 119–21. Weekes (see note 4), 81–5, 88–93 and 101–3.
42 Upper (see note 3).
43 Stijnman 2012 (see note 3), pp. 45 and 341.
(Appendix 2, nos. 4 and 5) by using engraved maps, printing the plates on separate sheets and binding them with the text of his Ptolemy (Appendix 2, no 13).

Thirdly, Götz’ approach to incorporating engravings into printed books was not a one-off. Instead, it was concurrent with at least two others across Europe and is an expression of the widespread experimentation with book production at this moment. His project, together with the 24 other incunabula illustrated with engravings, also raises the question of the involvement of incunable book printers with early intaglio prints. However, further research would be outside the scope of this paper.

Fourthly, both instruments are straightforward copies of two of the instruments in Regiomontanus’ Kalender, which were also copied in many other publications. They appear to be the first known paper instruments printed from engraved plates; engravings with images and texts printed from the same plate before 1476 are known only with Christian imagery and mottos. The basic designs of both instruments show that someone experienced in the production of calculating instruments engraved the plates. The mistakes and the manuscript additions with black (now brown) iron gall ink do not contradict this conclusion. The fact that the quadrant was so flawed that it was unusable did not stop one owner of the copy now in Munich from attempting to correct it, presumably after the original as printed by Ratdolt.

Finally, and possibly most significantly, the engravings represent the earliest known examples of the use of red ink for intaglio printing, and the volvelle can be considered the first multi-color printed image in the West. Even though (modern) standard terminological schemes would exclude it from the category of “color print” because it is a composite object made of rubbed monochromatic prints, it is the earliest example of such a print conceived of as being printed in multiple colors. Contrary to the accepted narrative, the early development of color printmaking seems to have involved intaglio and not just relief printmaking in the workshops of book printers. Book printers printed intaglio plates without the cooperation of professional plate printers, either because they were not available or because book printers thought they would be able to undertake the intaglio printing themselves. According to the literature, color printing began with multi-color relief prints issued in Venice and Augsburg in the 1480s, but Götz’ instruments show that multi-color printed images were produced in the decade before. Little to nothing is known about German engravings printed in non-black monochrome between the example by Master Es and the early sixteenth century, but our findings support the thesis that monochrome intaglio printing could also have been continuous in Germany.
Conclusions

These engraved paper instruments are unique in Götz’ production, and he created other graphic objects that are also unusual or unique but nevertheless essential for understanding his role in the first developments of color intaglio printing. The precise working of the engravings and the alterations to the model in Regiomontanus may indicate that Götz engaged a professional engraver of mathematical instruments. In contrast, the printing of the plates cannot be called professional, especially as intaglio printing by means of a roller press had already been known in southwest Germany for about a decade. Götz’ surviving engravings are of exceptional interest for the study of the history of copper engraving, intaglio color printing, book illustration, and natural science. They once again make clear that the division between book illustration and engraving for single-sheet (“fine art”) prints is artificial and that students of the book or the print should not limit their research to either libraries or print rooms.

The long-term oversight of color in early modern printmaking can be rectified only with comparative, copy-specific analysis, and, it is hoped, the technical examination of early color printing inks. The emergence of a scholarly interest in early color printmaking and the expansion of new research tools, such as the digitization of collections, are enabling new discoveries. This may reshape the understanding of color in early modern printmaking, and it will almost certainly include the identification of other very early color prints. Despite the progress made in digitization, the necessarily experimental nature of book and print production in the first generations after Gutenberg means that they, like this quadrant and volvelle, can only be understood through both personal examination and reference to bibliographical, art historical, and technological research.
Appendix 1

Extant Copies of the *Buch von der Astronomie* 44

<table>
<thead>
<tr>
<th>Place</th>
<th>Shelfmark</th>
<th>State of Volume</th>
<th>Quadrant</th>
<th>Volvelle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basel, UB</td>
<td>Kk viii 13</td>
<td>Complete</td>
<td>Black</td>
<td>Black base plate, dials lacking</td>
</tr>
<tr>
<td>SBB-pK</td>
<td>80</td>
<td>Complete</td>
<td>Black;</td>
<td>Black base plate; dials lacking</td>
</tr>
<tr>
<td>(Voull(b) 833.10)</td>
<td>Inc. 833.10</td>
<td></td>
<td>lacking thread</td>
<td>replaced with facsimiles of those in the Munich copy</td>
</tr>
<tr>
<td>Cambridge (UK) UL</td>
<td>Inc.5.A.4.9</td>
<td>Complete</td>
<td>Black;</td>
<td>Black base plate, blue thread</td>
</tr>
<tr>
<td>(sold 1858 by the BSB as a duplicate; Oates 596)</td>
<td>[514]</td>
<td></td>
<td>blue thread</td>
<td>black dials; blue thread</td>
</tr>
<tr>
<td>Cologne, UUSB</td>
<td>AD + BL 139</td>
<td>Incomplete;</td>
<td>Lacking</td>
<td>Lacking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>fols. 44-6 lacking 17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dessau, LB</td>
<td>Georg 866</td>
<td>Incomplete;</td>
<td>Red;</td>
<td>Red base plate, dials lacking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>fol. 4 is not printed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frankfurt/Main, UB</td>
<td>Flugschr.</td>
<td>Fragment: calendar</td>
<td>Lacking</td>
<td>Lacking</td>
</tr>
<tr>
<td>(Ohly-Sack 450)</td>
<td>g. Fr. 1, 165</td>
<td>(fols. 1-26)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Hague, M Meermann (IDL 724)</td>
<td>150 C 014</td>
<td>Fragment: book on astronomy (fols. 55-71)</td>
<td>Lacking</td>
<td>Lacking</td>
</tr>
<tr>
<td>BL (BMC i 238)</td>
<td>IA.3810</td>
<td>Fragment: calendar</td>
<td>Black;</td>
<td>Black base plate, black lower dial, gray thread</td>
</tr>
<tr>
<td>(fols. 27-54)</td>
<td></td>
<td></td>
<td>lacking thread</td>
<td></td>
</tr>
<tr>
<td>BSB (BSB-Ink k-3,1)</td>
<td>Rar. 314</td>
<td>Complete</td>
<td>Red;</td>
<td>Red base plate, black dials; red thread</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>lacking thread</td>
<td></td>
</tr>
<tr>
<td>BNF (CIBN-B-198)</td>
<td>Rés. G. 1156</td>
<td>Fragment 53</td>
<td>Lacking</td>
<td>Lacking</td>
</tr>
</tbody>
</table>

Appendix 2

A Short-Title List of Incunabula
Illustrated with Engravings

The istc and gw were checked for books illustrated with engravings with the keywords “copper*”, “engrav*” and »Kupfer*«, respectively. The impressa elucidate which printers/publishers attempted or specialised in intaglio book illustrations (i.e., Georg Reyser was the first to master the integration of engravings in texts) and show that German printers introduced them to Italy.54

1. Lazarus Beham: *Hie fahet an eyn buech von der astronomien*. [Cologne: Nicolaus Götz, (c. 1476)]. gw 3766, istc ib00296700. 2 engravings printed on pages conjugate with text. In the copies in Dessau, London, and Munich, the engravings are printed in red or red and black.

2. Giovanni Boccaccio: *De casibus virorum illustrium (De la ruine des nobles hommes et femmes)*. Bruges: Colard Mansion, 1476. gw 4432,
3. Antonio Bettini da Siena: Monte santo di Dio. Florence: Niccolò di Lorenzo (Nicolaus Laurentii), 1477. GW 2204, ISTC ia00886000. Up to 3 engravings, usually printed on the same page as text and occasionally on separate sheets pasted into the text.

4. Claudius Ptolemaeus: Cosmographia. Bologna: Dominicus de Lapis, 1462 (=1477). GW M36362, ISTC ip01082000. 26 engraved maps printed on separate sheets that were bound with the text.

5. Claudius Ptolemaeus: Cosmographia. Rome: Arnold Buckinck, 1478. GW M36368, ISTC ip01083000. 27 engraved maps printed on separate sheets (under the supervision of Konrad Sweynheym) that were bound with the text.

6. Fra Pacifico de Novara (Pacificus Novariensis): Sommola di pacifica coscienza (Sumula de pacifica conscientia). Milan: Filippus de Lavagnia, 1479. GW M29037, ISTC ip00001000. 3 engravings printed on separate sheets that were bound with the text. ISTC: “The book also contains, outside the collation, three copper-plates printed on separate half-sheets of specially thin quarto paper.”


8. Missale Messanense secundum consuetudinem Gallicorum (Messina). Messina: Henricus Alding, 31 May 1480. GW M24535, ISTC im00673200. 1 engraving (no details given); GW: »1 Kupferstich«.

9. Dante Alighieri: La Comedia. Ed. Christoforo Landino. Florence: Niccolò di Lorenzo (Nicolaus Laurentii), 1481. GW 7966, ISTC id00029000. 1 to 20 engravings (including two impressions of the same engraving). Some were printed on the same page as the text, underneath the text, or in the text, but most were printed on separate sheets and pasted onto the pages of text.

10. Missale Herbipolense. Würzburg: Georg Reyser, 1481. GW M24419, ISTC im00663900. 2 engravings in black only. As text is printed in red and black but the engravings are known only in black, the description of »2 Kupferstiche Rotdr.< on the GW website may be a mistranscription of the GW card catalogue, p.1: »2 Kupferstiche. Noten. schwarz und rot gedruckt«.

11. Missale Moguntinum. Würzburg: Georg Reyser, 1482. GW M24571, ISTC im00673600. 1 engraving printed with the text.


16. *Breviarium Herbipolense*. Würzburg: Georg Reyser, c. 1485. GW 5358, ISTC ib01162450. 1 engraving printed on a separate sheet that was bound with the text.


18. Bernhard von Breydenbach: *Des sainctes peregrinationes de iherusalem (Peregrinatio in terram sanctam)*. Lyon: Michel Topié, Jacques Heremberck, 1488. GW 5080, ISTC ib01192000. 1 map and 7 engravings. Hofer (see note 3) p. 225: “[The engravings] are not printed on the same page as the text, but are pasted together in sections.”


21. Claudius Ptolemaeus: *Cosmographia*. Rome: Petrus de Turre, 1490. GW M36372, ISTC io01086000. 27 engraved maps printed on separate sheets that were bound with the text.

22. *Missale Herbipolense*. Würzburg: Georg Reyser, 1491. GW M24426, ISTC im00664500. 2 engravings printed with the text.


Nachdruck und Wiedergabe, auch in elektronischen Medien (auch auszugsweise), sowie fotomechanische Reproduktion einzelner Beiträge nur mit ausdrücklicher Genehmigung durch die Gutenberg-Gesellschaft.

Typografische Konzeption, Layout
Prof. Ralf de Jong, Essen
Textschrift Fresco Plus (Ourtype)
Lithos Reinhold Amann
Druck Memminger Medien-
Centrum AG, Memmingen
Bindearbeiten Real Lachenmeier,
Reutlingen
Einbandmaterial Canoso von Kaliko
Textpapier geglättet holzfrei säurefrei
bläulichweiß »Alster« 1,3fach, 110 g/qm
Vorsatzpapier matt holzfrei gerippt
bläulichweiß Vorsatzpapier »Passat«, 120 g/qm; beide geliefert von Geese Papier GmbH und produziert von Salzer Papier GmbH