

Zeitschrift: Ferrum : Nachrichten aus der Eisenbibliothek, Stiftung der Georg Fischer AG
Band: 92 (2022)
Artikel: The stuff of literature : raw materials and the books of the Iron Library
Autor: Zoller-Blundell, Christopher
DOI: <https://doi.org/10.5169/seals-1007776>

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The Stuff of Literature

Raw materials and the books of the Iron Library

Christopher Zoller-Blundell

While the Iron Library's guiding interest in the history of materials science makes it an incredibly rich assemblage of literature for examining the development and uses of innumerable raw materials in the history of science, industry and economics, the physical substance of the books themselves presents fascinating raw materials stories too. Using a few selected examples from the holdings of the library's old and rare books collection, this article will provide an insight into these raw materials histories. Along the way, it will also show some of the more curious material qualities of individual works in the collection that are indicative of trends in the resource consumption of the publishing industry or else highlight features of the books' unique biographies.

Ask somebody what a book is and you will likely cause confusion, as what a book is, is generally considered self-evident. It is a word that has come to denote both the object and anything that imitates its form, and in the latter case there are even dedicated collections.¹ Books are, however, deceptively simple items. When dissected, a volume can prove to be made not just from paper and pigments but also card, adhesives,

thread, leather, wood, metal, glazes, paints, fabrics and so on, with the leaves folded, cut, sewn, glued and bound to produce a whole constructed with incredible delicacy and complexity in processes taking days, weeks or months.

Calling a book a book

The idea of the book, as it is most commonly understood and recognized, is descended from the codex, a series of inscribed surfaces bound together at one edge to form a unitary object, which emerged to supplant the scroll at some point during late antiquity.² This novel object's form was simple and yet remarkable, revolutionary and disruptive.³ People seem to have been at a loss to find a word to describe it adequately, however. To do so, some turned to words derived from those used to denote the method of production, such as the word meaning "to write," as is the case with Chinese ("shū"), Hebrew ("sīp̄rā") and Arabic ("kitāb").

Other language groups used words derived from those given to the raw materials used to make books. Examples of this can be found deeply engrained in the etymologies of words in the European languages. For instance, "book" in English, "Buch" in German, "boek" in



1 Pigments and their raw materials on display in the Ernst Müller Zimmer, home to the majority of the Iron Library's old and rare books collection.

Dutch, and “bog” in Danish derive from the Norse “bok” or proto-Germanic “bokiz,” meaning “beech,” which was the wood most commonly used to make writing tablets.⁴ This is similar to the root of “codex,” Latin “caudex,” which originally meant a “wood balk” or “log.”⁵ The French “livre,” Portuguese “livro,” Spanish and Italian “libro,” even the Gaelic “leabhar” and Welsh “llyfr” all stem from the Latin “librum,” which itself derives from the proto-Italic word used to denote the inner bark of trees such as birch.⁶ These natural sheets have long been used as media for carrying writing.⁷ Meanwhile, “Bible” derives from the Greek “biblion,” a word that had come to mean a piece of writing but also meant “papyrus scroll,” a name taken from the port of Byblos, which was the primary exporter of Egyptian papyrus in the ancient world.⁸

From late antiquity, the material requirements for producing books developed, becoming larger and more complex, gradually emerging as an industry so successful that books can be considered among the most highly produced cultural items in human history. While the total number in the world is beyond calculation, an estimate by data miners at Google back in 2010 put the total number of unique titles published as books in history at an estimated 130 million.⁹ According to Worldometer, which aggregates

the statistics put out by publishers and gathered by UNESCO, by the end of the first half of 2022 the number of new book titles will stand at over 1.3 million globally.¹⁰ The result of this is an enormous demand for raw materials, though as time passes this impact is proportionally diminishing per title each year as digital publishing proliferates.

An estimate by data miners at Google back in 2010 put the total number of unique titles published as books in history at an estimated 130 million.

The demands of the book industry for raw materials have not been consistent, and underwent significant changes in requirements from the medieval through to the Renaissance, early modern and Enlightenment periods. To highlight trends in the book industry over time, but also to give space to pick out the curious qualities unique to the material biographies of some of the individual print works in the collection, this article will focus on a selection of works from the collection of the Iron Library. Since its founding in 1948, the Iron Library has gathered a collection of print

works that currently counts over 47,000 items. Among these are 8,000 titles that fall into the category of old and rare print works, which is to say older than 100 years, hard to find and of particular scientific value.

The makings of an illuminated codex

To begin on this journey through the material history of publishing in the library, one cannot start anywhere but the oldest book in the collection: the Aristotle-Albertus-Magnus manuscript.¹¹ Produced in the late thirteenth century, the codex is a composite manuscript, which is to say that it comprises several parts, distinct in terms of both content and artistry, bound together to make one volume. These include Aristotelian and pseudo-Aristotelian works, writings by Albertus Magnus, Michael Scotus and Averroës, all in Latin translation, thematically covering mineralogy, comparative anatomy, astronomy, mathematics, botany, natural history and philosophy. It is a remarkably scientific compendium of writings for its era, containing a high number of illustrations meant to depict Aristotle. The manuscript is bound in leather and the texts are handwritten on 100 leaves of parchment with richly illuminated letters using numerous pigments and gold. It was studied extensively by Rudolf Gampfer during the 1990s and more recently by Federica Volpera, both of whom have concluded that it was produced in a scriptorium – a secular book workshop – in northern Italy, possibly Genoa, during the last third of the thirteenth century.¹² From its binding to the parchment leaves and pigments, the book's materials give many insights into its production and the raw materials requirements for a medieval manuscript.

Binding

The dark brown leather binding is not the original and is typical of the fifteenth century.¹³ To produce medieval leather, one began with animal hides, stripped of hair using lime and then tanned in urine and plant extracts, such as tannins from chestnut wood. The coloring comes from a combination of further plant extracts, such as oak bark, and metal salts.¹⁴ While standard leather could be a local product, requiring only locally sourced raw materials, bookbinding required a more supple and expensive leather, which in turn called for materials from further afield, such as alum, an aluminum salt. Much of the alum used in Europe's middle ages came from the African continent in the region of Chad or Egypt.¹⁵ It is for this reason, as well as the Mediterranean trade routes and optimal climatic conditions, that leather became such a major industry in Italy.¹⁶

Parchment

As with most surviving medieval manuscripts, the text-carrying surfaces of the Aristotle-Albertus-Magnus manuscript are parchment. Parchment is a remarkable product,

which kept in the right conditions is able to survive for over a thousand years. For that, its preparation is very laborious.

To make it, the pelts of calves, sheep or goats must be soaked in a lime solution for between one and two weeks to remove hair and cure the skin. After soaking, the parchmenter takes a pelt and scrapes it to remove all other layers but the outer membrane. This scraped skin is then soaked again for several more days in order to remove residual lime, before being stretched on a frame, moistened, scraped and stretched taut again before being left to dry, which depending upon climate can take weeks.¹⁷ Before being used for writing, parchment must be cut to size and buffed with chalk. Calves and young goats or sheep are preferred because they have not had an opportunity to scratch themselves or acquire the diseases or parasites that typically affect the skins of herd animals. Their skins are also softer and more pliable, allowing the production of larger, thinner sheets without mottling or blemishes.¹⁸ Therefore, while the general use of animal skins to produce parchment was part of a low-waste economy in the middle ages, a manuscript that would have been pristine when new called for a high degree of raw materials quality control and the use of the hides from what would amount to a moderately sized herd – a fact now being demonstrated by DNA analysis.¹⁹

Parchment is a remarkable product, which kept in the right conditions is able to survive for over a thousand years.

The leaves of the Aristotle-Albertus-Magnus manuscript are, for the greater part, without flaws, indicating that there was a high degree of raw material quality selection in its production. The analysis from the 1990s suggested that the parchment came from goats and calves, which is to say that it is in part a manuscript on vellum.²⁰ The terms parchment and vellum are often used interchangeably, but there is a difference: vellum is more specific in animal origin and derives from words for veal, or "veau" in French, and "vitellus" in Latin. Parchment, from the Latin "pergamenum" is so called because of a likely apocryphal story passed down by Pliny the Elder.²¹ He attributes its invention to King Eumenes of Pergamon in the second century BC, who did so in response to a shortage in papyrus caused by a trade blockade. Pergamon at that time was building up a library that competed with that of Alexandria, a fact that rattled the prestige of Ptolemaic Egypt.²² Whether or not it was the king himself who invented the material is debatable; however, the case nonetheless illustrates just how early the importance of control over the raw materials for producing literature was recognized.

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 a. u. r. d. i. g. n. i. t. e. a. n. t. e. e. t. e. o. y. u. i. a. n. t. e. s. u. n. t. e. g. r. a. d. i. n. e.
 a. c. o. p. o. u. b. e. x. p. e. l. l. u. t. s. i. n. e. q. b. u. s. p. a. n. i. e. o. f. a. r. e. e.

2 An illuminated letter from the Aristotle-Albertus-Magnus manuscript, depicting Aristotle examining plants.



3 Tannin-rich galls on an Aleppo oak branch in winter, the preferred raw material for pigment in medieval ink-making.

Pigments

The pages of the manuscript have endured centuries and yet look almost as crisp today as on the day that they were first written. Looking at the vibrant figures and designs of the illuminated letters, with their patches of burnished gold on pages covered with flourishes of red and blue fleurons, one quickly comprehends why these books were so expensive to make. Perhaps as impressive as the artworks themselves, however, are the potential distances traveled by the raw materials used to make the pigments on the page.

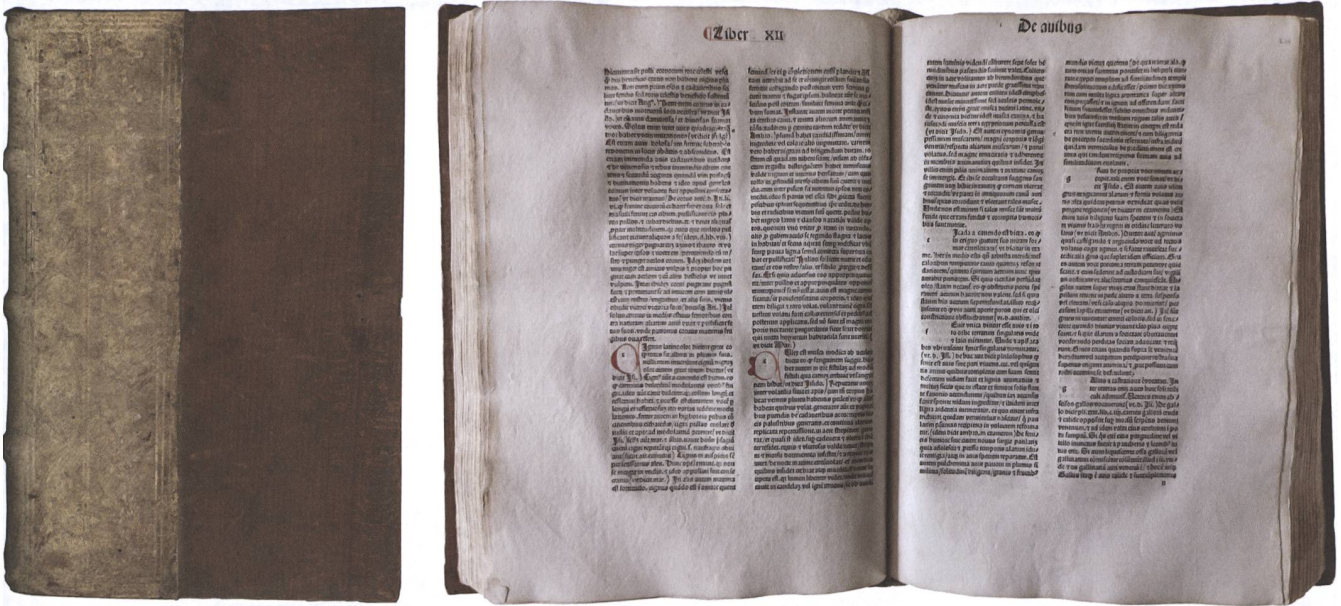
It is thought that between antiquity and the medieval period, up to a third of the gold that was circulated in Europe had its origins in Hungary.

The vivid red likely contains cinnabar, the highly toxic ore of mercury, which at the time was an export from the Iberian Peninsula, or else a mixture of cinnabar with lead compounds.²³ The blue could be azurite, of which there were sources in Bohemia and the Alps, or ultramarine produced from lapis lazuli, which if so would mean the raw material

having been traded down the Silk Road from Afghanistan.²⁴ An analysis of the skeleton of a woman from twelfth-century Germany discovered a grain of lapis lazuli in the calcified deposits on her teeth, attesting both to its availability and to her possible employment in manuscript production.²⁵

The gold is more of a mystery. Before the European colonization of the Americas and the extraordinary quantity of gold that resulted from that, most gold that was hammered into leaf or made into dust for paint had previously been in circulation as currency: florins, ducats and Hungarian gulden were typically the most pure.²⁶ Indeed, it is thought that between antiquity and the medieval period, up to a third of the gold that was circulated in Europe had its origins in Hungary.²⁷ The gold on the pages of the Albertus Magnus manuscript is particularly lustrous and looks almost three-dimensional. This suggests that the design for the gold was applied using a gesso, a thick paste-like glue, onto which the gold leaf adhered. Once dry it was burnished to a rich, glowing shine, and the remainder of the design was painted in around it.²⁸

Even the humble-appearing black ink, known as iron gall ink, was a complex and high-status product, made from ingredients that had potentially traveled significant distances. Gall ink is waterproof when dry and remained



4 The Iron Library's 1482 edition of 'De proprietatibus rerum,' the oldest printed book in the collection.

the most permanent available ink until the development of synthetic alternatives in the twentieth century.²⁹ The core ingredients are iron sulfate (sometimes called copperas or iron vitriol), oak galls, and gum arabic.³⁰ Oak galls are growths found on oak trees and are caused by parasitic gall wasps. The wasps sting leaf buds and lay an egg inside, from which hatch larvae. Around the larvae grow dense, tannin-rich bulbs, out of which the adult wasps eventually emerge.³¹ Though oak galls can usually be found throughout Europe, the most prized for making ink in the medieval period were those that grew on Aleppo oak trees, which (in spite of the name) could be found on the Eastern Aegean islands, through Turkey, and down into Syria and the Levant.³² The dark color of the ink is created by a reaction between the tannins in the galls and iron sulfate, a pale green-blue granule that occurred rarely in sufficient quantities in nature and demand for which drew the attention of alchemists and the early chemical industry.³³ The adhesive element in the mix was the gum arabic, though this is a misnomer. It is not a gum but a resin extracted from one of several varieties of acacia tree that grow in the Sahel region of Sub-Saharan Africa, stretching from Senegal to Sudan.³⁴ The "arabic" part of its name derives from it being exported across the Mediterranean to Europe from ports in Arab lands.

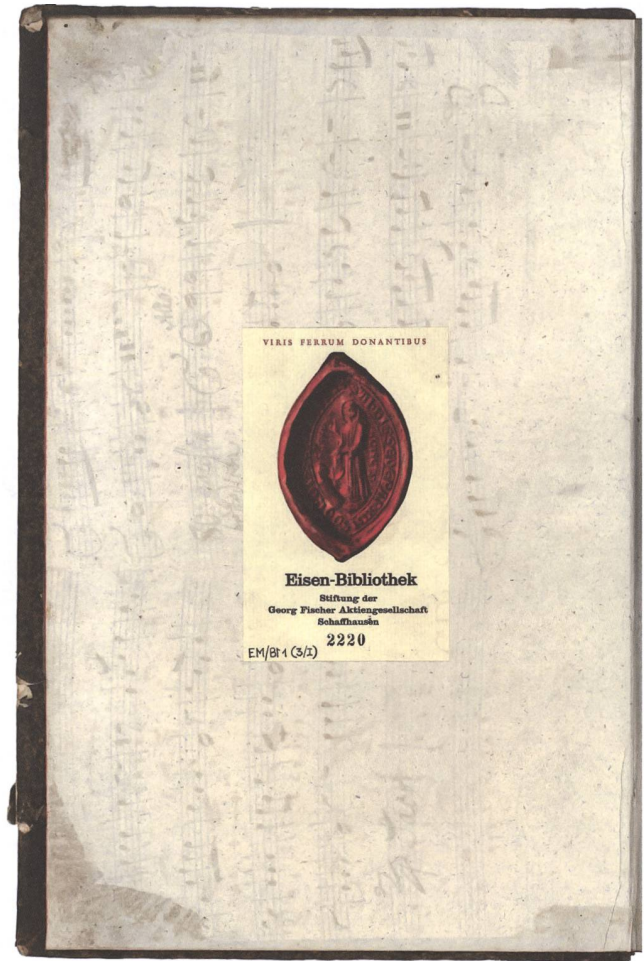
Gutenberg's printing revolution

Moving on from the Aristotle-Albertus-Magnus manuscript, we come to the Iron Library's oldest printed book, 'De proprietatibus rerum,' which was published by Pierre Hongre in Lyon in 1482.³⁵ An incunabulum, or cradle print, is a print work from the era between Johannes Gutenberg's invention of the printing press and the year 1500, while the book industry was in its infancy. 'De proprietatibus rerum' or 'On the Properties of Things' was originally written as a manuscript around the year 1240 by Bartholomaeus Anglicus, a Franciscan monk based in Magdeburg. It is considered a predecessor to the encyclopedia.³⁶ It is half-bound with parchment and, by coincidence, the book has beech wood plates for its front and back covers.

Gutenberg's printing press revolutionized the production of books in Europe not just through the ability to mass-produce a text but also in terms of the raw materials requirements. Each individual character in 'De proprietatibus rerum' was impressed upon the page by a cast type character made from a very specific alloy of lead, tin and antimony invented by Gutenberg.³⁷ The relatively low melting point of the recyclable alloy, yet its firmness when set, meant that with little heat, a specially designed reusable copper alloy hand mold could be used to mass-produce and replace movable type characters.³⁸ As a sign of the



5 Damage to the corner of a cheap nineteenth-century card transport binding, revealing the recycling of old sheets of paper.



6 A transcribed classic or a private composition shamefully disposed of? Music sheets used to line a 1774 edition of Leupold's *Wasserbaukunst*.

then-growing importance of sea lanes for transporting and easing the acquisition of specialist raw materials, it is perhaps unsurprising that although Gutenberg invented print in Mainz, it was editions printed in Venice that dominated the market by 1480.³⁹

Gutenberg's printing press revolutionized the production of books in Europe not just through the ability to mass-produce a text but also in terms of the raw materials requirements.

Gutenberg's publishing revolution led to the expansion of industries that could turn a profit supplying the raw materials required to produce books, and gradually this brought a cheapening of those raw materials. This, combined with the spread of the technology and the increase in the number of printers, led to a decline in the price of books, an increase in literacy, and an increase in the consumption of books, and therefore raw materials, and so on to the modern day. To put the scale of this increase and the impact of the printing press into some perspective, according to one

study in the year 1550 alone the printers of Western Europe turned out around three million books, which is more than the total number of manuscripts estimated to have been produced during the entirety of the fourteenth century.⁴⁰

One key material of this revolution was paper, the raw material for which was rags. Paper of the era was different from that which is used nowadays, which is wood pulp-based. Up until the nineteenth century, most paper used in Europe was made using the pulped fibers of linen, hemp or cotton.⁴¹ It is for this reason that old books have that "old book smell" of grass and vanilla, caused by the slow breakdown of substances such as lignin in the linen fibers.⁴² The rags were treated by washing, boiling, milling, fermenting and bleaching to create a paste which, when dried, produced lightly colored sheets.⁴³ This sort of paper is very stable and renowned for its durability and longevity.⁴⁴ The rags were initially gathered locally, but eventually had to be brought to papermaking centers from further afield due to the increasing demands of the industry. Because of this and their entwined raw materials demands, the textile and papermaking industries came to be found in the same locations, often developing alongside one another.⁴⁵ It is therefore no surprise that Lyon, where 'De proprietatibus rerum' was printed, was both a textile and paper-

De meorum criminibus.
Suntque factis suis sollicitudo
 solitudines factus suis sicut in
 licorum in demerito.
Dignus in re factus suis sicut
 passer solitudo in tecto.
Tunc die cupido in michi
 immo in re et qui laudat in
 me idocis in re in re in re
Dum in re in re in re in re in re
 in re in re in re in re in re in re
 cum in re in re in re in re in re
Facie in re in re in re in re in re

Korts und warhafftig antzeygung und
 berichte der beschwerden/gewalt/und grossen verderblichs sche-
 den/so der durchleuchtig hochgeborne Fürst / und Herr / Herzog
 Heinrich von Braunschweig/vn Lüneburg/der ältlinger/Dem Er-
 barn Rath/perg und hüttern/und gemeyns/Keyser freyen Keych
 Stadt Goslar/langesere daher zugewant/vn noch teglichen drauff
 verharret/und grüntlich ablegung alles scheyns / darauß genamer
 Herzog solchen gewalt furgenömen / mit warhafftiger beständiger
 entschuldigung der von Goslar / 216 den vorerweynten vrsachen/so
 derselb Fürst wider sie zu weytzeren spädlichen handelung und bes-
 schwerung sichtet und vornehmter / Wie hiu nach folget.

7 The complaints of a protestant nobleman and known dissolver of monasteries, Duke Heinrich I of Brunswick-Wolfenbüttel, bound in parchment likely recycled from a monastic library that fell victim to the Reformation.

docebit omnia, & suggeret vobis
 a, quaecumque dixerō vobis
 T. 8.
 a. **Pfal. Magnificat.** *Sabbato. Ad Eñō. Ant.* Cha
 i diffusa est in cordibus no

Büchsenmeisterei
 Das ist
**Kurze doch eigentliche erklä-
 rung deren Dingen / so einem
 Büchsenmeister fürnemlich
 zu wissen von nöthen:**
**Als ihre Freyheiten vnd Artikel / zu Feldt vnd
 in Befehlungen / auch der rechte gebrauch des gros-
 sen Geschütz / was damit anzurichten / sampt getrewlicher
 vnderweisung mancherley künstlicher Feuerwerck: Als nem-
 lich der Petardi / Spreng vnd andern Kugeln / zu
 Schiess vnd Leuch / in Wasser vnd Land
 zu gebrauchen nitlich / so vor niemals
 in Truck außgangen.**
**Wie sonderm fleiß erkündiget vnd
 vnd in Truck verfertigt**
Christoff Dambach, der Kunst Liebhaber.
 Mit Röm. Kayf. Majeft. Freyheit auff 10. Jar.
 Frankfurt am Mayn / in verlegung Wilhelm Hoffmann, 1688.

8 Guns bound in a Benedictus: music paper with the words and notes for songs of thanksgiving, protecting one of the earliest treatises on practical gunnery.

making center in the fifteenth century.⁴⁶ The flax used in this textile industry was not always a local product, however, and through Hanseatic traders entered the European market from as far away as Novgorod and Livonia.⁴⁷

The Iron Library's incunabulum demonstrates a shortage of two very particular resources in its biography, the poetic raw materials of any craft: time and patience.

Linseed oil, pressed from the seeds of the flax plant, was also required by Gutenberg's printing method. The thickened oil was the basis of the viscous printing inks that best adhered to the paper.⁴⁸ The pigment requirements, though based upon mostly locally sourceable raw materials, were not entirely revolutionary in style. While materially far removed from the illuminated manuscript, incunabula like 'De proprietatibus rerum' nonetheless show a stylistic adherence to trends set by manuscripts, such as in the width of the columns and the use of rubrication to decorate the pages. In this regard, the Iron Library's incunabulum demonstrates a shortage of two very particular resources in its biography, the poetic raw materials of any craft: time and patience. Though some pages show very beautiful ornate letters, others have been left entirely unfinished.

Circular economy: old literature into new

The papermaking industry's circular economy of rags to paper had a continuation in the recycling of paper into new paper and card. By the late eighteenth and nineteenth centuries, some printers sold larger or more expensive books in a protective sale binding of basic card, which the purchaser could have removed, to then have the pages rebound in a style of their choosing. These protective transport bindings rarely survive, and yet in the Iron Library there is a volume of Carl Friedrich Wiebeking's 1812 book 'Wasserbaukunst' (Hydraulic Engineering) that was kept in this binding, with its pages also left uncut.⁴⁹ Damage to a corner has revealed a letter in Fraktur font, demonstrating how old, waste and rejected sheets had been recycled into card. Another book on hydraulic engineering, a 1774 edition of Jakob Leupold's 'Theatrum machinarum hydrotechnicarum, Schauplatz der Wasser-Bau-Kunst,' shows how a binder used old music paper to line the insides. Whether this is a transcription from another score or a discarded personal composition is hard to tell.

There are cases of recycling where the combination of their material and literary contents can encapsulate an era in microcosm. Of all of the books in the Iron Library, none perhaps does this better than the pamphlet 'Kurtz unnd warhafftig antzeygung und bericht, der beschwerden, gewalt, und grossen verderblichen scheden, so der ...

Hertzog Heynrich von Brawnschweyg' ('Short and true account and report of the troubles, violence, and great pernicious harms, to the ... Duke Heinrich of Brunswick').⁵⁰ It is an example of the weaponized word during the territorial tumult of the Reformation. The 1527 text enlarges on claims to the profitable mining industry of Goslar by Duke Heinrich I of Brunswick-Wolfenbüttel.⁵¹ Heinrich's claims precipitated a minor regional war, during which several territories were occupied and their monasteries dissolved, he being a Protestant and member of the Schmalkaldic League.⁵² The pamphlet is bound in a recycled parchment page taken from what looks to be a thirteenth- or fourteenth-century psalm book, likely taken from the library of a dissolved monastery.

The same somewhat darkly poetic style of binding can be observed in 'Büchsenmeisterey, das ist kurtze, doch eigentliche Erklärung deren Dingen, so einem Büchsenmeister fürnemlich zu wissen von Nöthen.'⁵³ This 1609 treatise on gun making and gunnery by Christoph Dambach, published in a lull in the European Wars of Religion, was bound in music paper carrying the notes and words of canticles from the Gospel of Luke, the Benedictus and Magnificat, which are songs of thanksgiving.⁵⁴ From this, it could be suggested that a previous owner may have found the book's contents particularly helpful.

Summary

From the words used to describe them to the ink on the pages, the history of the book is as much a history of raw materials as it is of ideas. A material examination of books as artifacts can tell multifaceted stories about how they came into being: stories that are not just about the economy and society that produced them but that can also hint at the personality of previous owners. The production of the Aristotle-Albertus-Magnus manuscript required skilled artisans with specialist knowledge, a remarkable array of raw materials that had traveled great distances, and a great amount of time before the bound volume was completed. With Gutenberg's printing revolution, new raw materials demands were created. The library's copy of 'De proprietatibus rerum' is a very typical example of a print work from this era, showcasing how the form of the codex was adapted to mostly entirely new raw materials, many of which were at least more locally available if not always locally sourced. It was this change in materials that arguably ended the exclusivity of literacy, creating an increased demand, which in turn sparked the ingenuity of an extensive circular economy to ensure that the demand for print works was met.

About the author

Christopher Zoller-Blundell, M.Sc.



Christopher Zoller-Blundell has been the academic librarian of the Iron Library since 2019. After studying archaeology and human paleopathology at the University of Durham, he began work on a PhD in the history of archaeology and the international scientific organizations of the League of Nations at the University of Heidelberg and at the International Graduate Center for the Study of Culture in Giessen. Between 2015 and 2019 he worked in various university and county archives, as well as for the library of a private art gallery. He is a member of the Bibliosuisse Rare Books Working Group, and the Lake Constance Association of One Person Libraries.

Iron Library, Schlatt, Switzerland
christopher.zoller-blundell@georgfischer.com



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