Gutenberg Did Not Print the First Book In Europe

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Abstract

Gutenberg is the inventor of printing in the Western world, or so we were taught in school. Historians are less than convinced, since there is no direct evidence or testimony that this is the case. Historians work as detectives and gather clues out of the printed books themselves and out of archive documents. This is how the Gutenberg story was written, reaching the conclusion that his major achievement was printing the Bible in Latin by the year 1455 in Mainz, Germany.

This presentation comes to share a new detective work that brings to light an earlier printer and printed book. To follow the investigation some review of the historical paper manufacture process and 16th century print technology is needed.

In Avignon, France, in 1890 Pierre Henri Requin published results of his survey of notarial archives. He found out about Procope Waldvogel, a silversmith from Prague living in Avignon, who conceived a new method called ars artificialiter scribendi, the art of artificial writing. He is known through notarial contracts he signed with people he recruited, under non-disclosure clause, as partners, apprentices and money lenders. The contracts mention sets of metal letters, tools and equipment like a screw. For Requin there is no doubt that Waldvogel's secret invention was printing. All this happened in the years 1444 - 1446, before the time when the 1455-Bible came off the press of Mainz.

Waldvogel recruited a local Jew, Davin de Caderousse, an expert in fabric dying. Waldvogel prepared for Davin Hebrew types in metal. After the dissolution of their

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partnership in 1446, Waldvogel left Avignon and relinquished the Hebrew types in the hands of Davin. This is the first mention in history of Hebrew metal moving types.

In 2015 a set of Hebrew printed sheets was discovered in Jerusalem inside the binding of a Hebrew book. They were shown to experts at the National Library of Israel. One obvious detail is the watermark found on one of the sheets, that they identified with a known watermark recorded in Perpignan, France, and dated 1418. The design of this watermark is made of three hills inside two rings, with a cross on the central hill. (See picture below) They easily recognized the font used in this print as Spanish semi-cursive, pointing to that side of Europe as an origin, rather than Ashkenazi types which refer to Central Europe. The experts' conclusion was that the discovered sheets are a probable product of the Avignon 1444 - 1446 printing endeavor.

In 2018, a team of the Institute for Computerized Bibliography of the Hebrew Book took upon itself to revisit all evidences. The team visited libraries and archives to see the watermarks with the specific three-hill design in their context. After a year of visits an intermediate conclusion could be reached. Three hills inside two rings, with a cross on the central hill is a not so common design. The design belongs to a limited range of years, between 1418 and 1439. None of the visited watermarks had the same chain line distance as the investigated sheets, except one found in Fabriano, Italy. The Fabriano watermark, though, was found on a document bearing the date of 1536. The context analysis could accommodate the fact that the document was written a century after the paper was manufactured, although in general it is assumed that the time between manufacturing and usage is much smaller. But what about printing? Can it be stated that the paper was manufactured in 1439 and the sheets were printed in 1536?

By taking high-resolution pictures of a book, image processing allows to attribute to this book a metric that reflects the homogeneity of the printed letters. The metric was applied to three books, the investigated sheets, a book printed in Lisbon in 1489 and a book printed in Venice in 1519. All selected books use the Spanish semi cursive Hebrew font. The quantitative result of this analysis showed that the 1519 Venice book exhibits good homogeneity, the 1489 Lisbon book is less homogeneous. The investigated sheets have by far a lower score testifying for poor printing skills and most likely pointing at an early stage of the development of the printing craft.

Checking for known print shops using Spanish semi cursive Hebrew fonts in the 15th century and early 16th century, no match could be found with the sheets under investigation.

Following evidences gathered from the investigated sheets help reach a conclusion:

- Type inhomogeneity points at early 15th century print
- Presence of a watermark design recorded in the years 1418 - 1439
- No other known print shop using matching Spanish semi-cursive Hebrew font

Based on those evidence, the most plausible conclusion that those sheets are the product of the Avignon print shop led by Procope Waldvogel whose activity is recorded between the years 1444 - 1446.

Introduction

TAGA annual technical conferences are the ideal meeting forum for getting abreast of the latest technical innovation of the printing and graphic arts field of activity. In that respect the 2023 edition of the TAGA annual technical conference is no exception. This paper is somewhat standing out as looking back in the past, at the time of invention of printing, in the 15th century, when printing became one of the biggest inventions that Humanity experienced. Clearly, printing in the Western world, that originated in the fifteenth century, set off a revolution that changed the way knowledge was shared and spread.

Common knowledge says that Johann Gutenberg of Mainz, Germany, was the inventor of printing in the Western world. However, historians are less than convinced that this is the way things got started, since there is no direct evidence or testimony that this is the case. To probe this question, historians work as detectives and gather clues out of the printed books themselves and out of archive documents. Similarly, this paper comes to share a new detective work that brings to light an earlier printer and printed book, preceding Johann Gutenberg by about 10 years.

What do we know about Gutenberg

Strangely enough no piece of printing bears Gutenberg's name. Some of his biography is known through certain milestones, but most of his lifetime activities are not known.

Johann Gutenberg's birth is assumed to have taken place between the years 1394 and 1406. He belonged to a patrician family in Mainz, Germany. His family belonged to the local guild of silversmiths and goldsmiths[1].

Starting from 1434 he is found in local archives as living in Strasbourg, today in France. He paid taxes there and after 1444 he is not mentioned anymore in Strasbourg. The major set of documents that put him in the spotlight is a lawsuit that took place in 1439. We learn that he was running a partnership for which he raised capital. When one of the investors, Andreas Dritzehen, passed away, his brothers wanted the money back. Gutenberg refused to give the money back,

leading to the lawsuit. The declared goal of the partnership had to do with mirrors to be sold to pilgrims. Some other aspects of the partnership were kept secret. This led to speculations that Gutenberg already started development work on printing during his stay in Strasbourg[2]. Anyways the people of Strasbourg decided to honor Gutenberg's memory with a statue in the middle of a square bearing his name[3].

In 1448 Gutenberg reappeared in Mainz. The main source of information is again a lawsuit in 1455 from a money lender, Johann Fust, that claimed repayment of two loans with interest, which amounted to 2,026 Gulden. Gutenberg claimed back that some of the money was not a loan but investment in a partnership. Not much is known about the goal of the partnership. It only says that it deals with "the work of books". The outcome of the lawsuit is not clearly known, but it can safely be stated that Fust and Gutenberg parted.

February of 1468 is the time when Gutenberg is known to have passed away. No other mention of book printing was associated with him until the time of his death.

So, who said Gutenberg invented printing?

The first written reference is from 1471, three years after Gutenberg's death. In 1471 Guillaume Fichet, who together with Jean Heinlin established the first print shop in Paris[4], wrote[5]: They say that not far from the city of Mainz, there was a certain Johannes, surnamed Gutenberg, who first of all men contrived the art of printing."[6]

Very soon other contenders claimed the prestigious title of inventor of printing. For instance, Johann Schoeffer, the grandson of Johann Fust, claimed that his grandfather, the main financial partner of Gutenberg in Mainz was the real inventor.

Other see Laurens Janszoon Coster[7] of Haarlem, The Netherlands, as the inventor of printing. They imagine that Gutenberg would have stolen the idea from Coster. This led to many invented stories on how Gutenberg may have heard of printing. This is one of the reasons that Paul Needham wrote in 1988 that "Most of what has been written about Gutenberg and the invention of printing is not scholarship — most has no value at all"[8].

Looking at all different claims raises the question of what could be defined as the invention of printing. A reasonable definition can be given as the availability of three technical capabilities and the ability to perform them in a coordinate way, leading to printed items on a repetitive way. Those three suggested capabilities are:

- Production of movable types in quantity
- Ink to spread on the types
- A press to transfer ink from the types to paper

To document the time period of the invention of printing is a challenging task. Due to the huge commercial potential of such a revolutionary technique, secrecy shrouded the nascent trade. There is no contemporary description of printing in the 15th century. Also, first printed books did not have title page, colophon, date nor place of printing, as became later in use.

So, how do historians study origin of printing?

They need to collect evidences by examination of books themselves. Major clues come from rigorous analysis of paper and typography. As in all scientific work, evidences allow to infer conclusions that not always rally the approbation of all scholars. The description of the Needham/Reske controversy, later in this paper, provides an example of scholarly disagreement around collected facts.

To follow the detective work of this paper there is a need to present some facts on how paper was manufactured by hand for many centuries and how worked the first generations of printers.

Short introduction on paper hand manufacturing.

The first step[9] is to prepare a liquid paste made of fibers, named pulp. The origin of the fibers was mostly vegetal, coming from worn out linen and hemp clothes. This paste is poured in a large container called vat. See Figure 3. The vatman needs to immerse a mold made of dense metal wires where, by surface tension, a layer of the pulp holds. See Figure 5. Then the worker removes the frame around the mold, freeing the pulp and turns upside down the mold on piece of felt. This is called couching and is performed by the coucher. Felt starts to absorb humidity from the wet layer of pulp that will become a sheet of paper, after drying.

The process continues, another piece of felt is placed on top of the wet sheet. A vatman prepares another wet sheet, couches it on this new felt. After some time, there is a stack of wet sheets between pieces of felt. This stack is placed under a press. The role of the press is to squeeze out water out of the sheets. After this, sheets are dry enough to be separated from the felt. The process continues by hanging the sheets on ropes in a warehouse, the same way that laundry is hung for drying.

A collection of manual paper manufacturing equipment is on display at the Fondazione Fedrigoni Fabriano, in Fabriano, Italy as shown in Figure 1. From left to right are shown a vat, a mold, a couching surface, a post where a pile of paper and felt is built up and a press to squeeze out water.

The description of the mold will explain features of hand-made paper. The wooden mold holds a net of metal wires. To support this net, there are a number of roughly equidistant wooden ribs covering the area of the mold. The metal wires along the

wooden ribs are called chain lines. Perpendicularly to the chain lines, there are denser metal wires called wirelines. The density of the described net allows to hold the pulp out of the vat. Due to the change of thickness of the paper over the various wires, all the mentioned features are visible by looking at the sheet of paper with transmitted light. See Figure 2.

Figure 1: *Equipment on display at Fondazione Fedrigoni Fabriano.*

Towards the end of the 13th century another significant feature was added to the mold. A figurative design is formed with another metallic wire. It is called watermark. See Figure 4

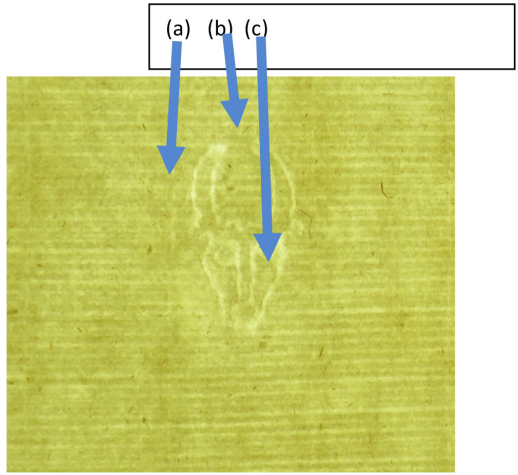


Figure 2: *Hand made paper features. (a) chain line (b) wire line (c) watermark.*

The three next pictures were taken at the Schweizerisches Museum für Papier, Schrift und Druck in Basel, Switzweland.

Figure 3: *Vat with mold and its frame on the right side of the vat*

Figure 4: *Close up on the mold with horizontal wooden ribs and Basel's blazon as watermark.*

Figure 5: *Vatman filling the mold with pulp solution*

Starting from the end of the 19th century, paper historians began to identify watermarks as a way to identify paper mills and to attribute a year bracket to watermarks. Starting with Briquet, watermark designs were collected and published in reference books[10].

It is worth noting that watermarks were subject to wear and tear due to the intensive work at the vat. At first, they get distorted and eventually they break. After the wire of the watermark broke, it was either repaired and discarded. This explains why watermarks have a limited shelf life. The variability caused by wear makes watermark comparison and identification a subtle science.

Similarly, distance between chain lines was also impacted by intensive work at the vat. But their life time was longer than watermarks due to simple nature of chain lines in comparison to the intricate form of watermark wiring[11].

What do we need to know 16th century printing

Printing starts with the availability of a quantity of metal movable types. From 16th century description[12] it can be learned how to prepare the types. It is a three-step process:

First to carve a character in mirror image out of a hard piece of metal like steel. It is called a punch.

Secondly, to apply the punch onto a softer metal, like copper. A matrix is obtained.

Third step is to pour liquid alloyed metal into the matrix. A type is then obtained also with mirror image of the character[13]. See Figure 6.

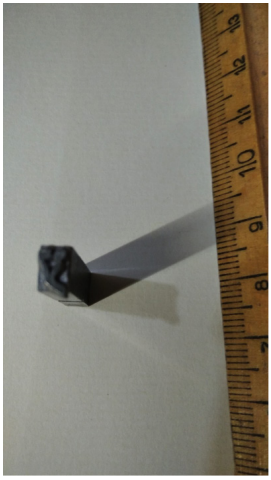


Figure 6: *Type of a Hebrew character*

With enough types a full page is composed. The composed text is placed on a flat plate on one side of the press, called platen[14]. See Figure 7. It is inked manually with cloth pads. On the opposite platen a sheet of paper is placed. The platen with the paper is brought down against the inked text and pressed against it with a device using a screw to apply pressure[15]. See Figure 8.

Figure 7: *Composed Hebrew text*

Figure 8: *one of the authors at the printing press*

New knowledge about the origin of printing appeared in 1890

In 1890 Pierre Henri Requin, a local cleric and historian, published results of his survey of notarial archives at Archives Départementales de Vaucluse[16]. He found out about Procope Waldvogel, a silversmith from Prague living in Avignon, that had conceived a new method called ars artificialiter scribendi, the art of artificial writing. He is known through notarial contracts he signed with people he recruited, under non-disclosure clause, as partners (like watchmaker Girard Ferrose, from Trier, Germany), apprentices (like Georges de la Jardine) and money lenders (like Manaud Vitalis).The contracts mention sets of metal letters in steel, tools (in tin, iron, copper, brass) and equipment like a screw. All the documents date from the years between 1444 and 1446. For Requin and those who followed him, there is no doubt that Waldvogel's invention, that he asked his partners to keep secret, was printing.[17]

Requin also reported that Waldvogel recruited a local Jew, Davin de Caderousse. Waldvogel prepared for Davin Hebrew 27 Hebrew letters in good iron, together with tin and wood equipment. Twenty-seven letters refer to the 22 regular letters of the Hebrew alphabet and the five so-called final letters. Davin committed to teach to Waldvogel fabric dyeing. After the dissolution of their partnership in 1446, Waldvogel left Avignon and relinquished the Hebrew types in the hands of Davin. This is the first mention in history of Hebrew metal moving types.

Those two years of activity in Avignon fall within the period of 1444 - 1448, when historians do not know where Gutenberg was and what his activity was. This led many authors to try to imagine how they could have heard from each other's endeavor. Some of those theories are brought here:

- They may have met in Strasbourg. It can be imagined that the way from Prague to Avignon goes through Strasbourg. (Suggestion by Requin).
- One of Waldvogel's partners, the watchmaker Girard Ferrose, from Trier, was German and may have worked with Gutenberg in Mainz or in Strasbourg. (Suggestion by Requin).
- One of the plaintiffs in the 1439 trial against Gutenberg in Strasbourg was from Lucerne, Switzerland and Waldvogel met him in Lucerne, since Waldvogel's presence is documented in Lucerne. (Suggestion by Fritz Blaser[18]).
- One of the witnesses of the documents from Avignon was from Strasbourg and may have brought information from Gutenberg. (Suggestion by Henri Stein[19]).

Further discovery in 2015

A set of Hebrew printed sheets was discovered in 2015 inside the binding of a Hebrew book. Two peculiarities characterized the sheets, the presence of a watermark and the font used for printing. The watermark figures three hills

encircled within two rings, and from the middle of the center hill, a mast with a cross. See Figure 9 and Figure 10. The font used in the printed sheets is a Spanish semi-cursive Hebrew font.

Figure 9: *Watermark under investigation with Hebrew printing surrounding*

From the database of the Computerized Thesaurus of the Hebrew Book[20], it appears that out of 175 recorded Hebrew incunabula 58 were set with Spanish semi-cursive Hebrew fonts. The other books were set with Ashkenazi types which refer to Central Europe.

Those sheets were brough for investigation to experts at the National Library of Israel[21]. They identified the watermark with Briquet's watermark no 11898, found in Perpignan in a notarial file dated 1418[22]. This prompted them to define the discovered sheets as a probable product of the aforementioned Avignon printing business.

Figure 10: *Beta-radiography of the watermark under investigation*

Current research and investigation started in 2018

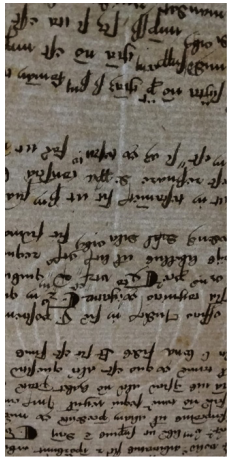
In 2018, the Institute for Computerized Bibliography of the Hebrew Book was asked by the new US-based owner of those printed sheets to revisit all evidences. The research team looked for the watermark, three hills encircled within two rings, and from the middle of the center hill, a mast with a cross, in libraries and archives. The visited locations were Perpignan[23], Vienna[24], Milano[25] and Fabriano[26].

In all cases, except in Fabriano, the investigated watermark was found in thick bound volumes with variants and signs of wearing off, meaning contemporary paper. See examples in Figure 11 and Figure 12.

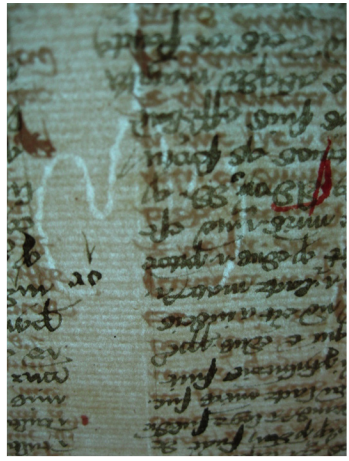
a) Three mounts in double ring Perpignan

b) Three mounts in single ring

Figure 11: *Pictures of 1418 notarial records in Perpignan*



a) Three mounts in double ring



b) Three mounts no ring, no bottom

Figure 12: *Pictures from 1439 Vienna legal document*

In Fabriano, the context is different. The watermark of interest is found on three folded sheets forming a document bearing the date of 1536. See Figure 13. It is attached to a group of documents unrelated as far as paper sourcing is concerned.

It was also observed that all visited watermarks and those found in bibliography have somehow larger chain-line distance than the investigated printed sheets, 47 mm, except the one of Fabriano. See Table 1. It may indicate. that the sheets under investigation were manufactured in Fabriano.

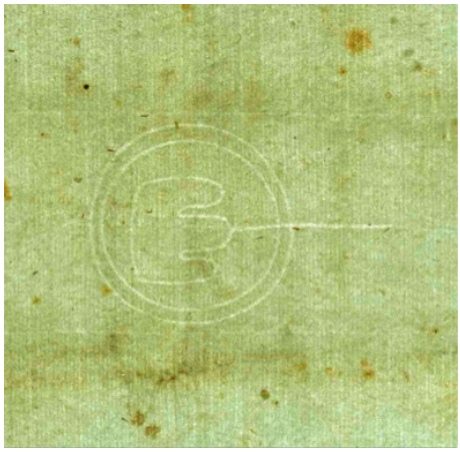


Figure 13: *Three mounts in double ring in Fabriano*

Source	Location	Year	Chain line distance (mm)
Briquet[27]	Perpignan, Archives Départementales des Pyrénées Orientales	1418	58
Briquet	Palermo, Archivio di Stato	1424	60
Briquet	The Hague, Nationaal Archief	1420	59
Harlfinger[28]	Milan, Ambrosiana Library	1431	60
Piccard[29]	Constance	1418	59
Website www.zmat.at[30]	Vienna, Österreichische Nationalbibliothek	1418	60
Website www.zmat.at	Vienna, Österreichische Nationalbibliothek	1439	61
Zonghi[31]	Fabriano, Fondazione	1541	42

Table 1: *List of three mounts in double ring watermarks found in the literature*

There is now a contradiction between the year written on the Fabriano document, 1536, and the assumed range of dates provided by the experts of the National Library of Israel, between 1418 and 1446.

Looking at the Fabriano riddle

Augusto Zonghi (1840 -1916) was one of the pioneers of watermark studies who lived in Fabriano, a historical center of paper manufacturing. He is known to have been collaborating with Moise Briquet[32].

According to Zonghi[33], due to the fact that Fabriano was a major center of paper manufacturing, it was expected that all paper found at the Historical City Archive of Fabriano would be locally manufactured.

According to Zonghi[34], with the exception of this watermark dated 1541, the date of the file, all the rest of the three-hills family, with one ring or no ring, spans the years 1385 -1492.

Zonghi[35] claimed that in general, the use of paper was very close to the manufacturing date, since paper was available in large quantities in Fabriano. It did not make sense to store old paper. However, he documented that a limited stock of unused sheets was found in Municipal Archive of Fano a few centuries after their fabrication. Interestingly, a similar occurrence in The Netherlands was recently reported by Henk Porck et al[36].

This led to the hypothesis that a similar situation could have occurred in the case of the three Fabriano sheets with the watermark under investigation.

If this were a good explanation for the date of 1536 on a document at the Historical City Archive of Fabriano with the watermark under study, what was there to prevent to a printer from similarly having used 1439-paper in 1536?

To answer this question, digital analysis was found to be a key tool.

Enters digital analysis of types

The first time a printed incunabulum met digital analysis was in the research performed by Paul Needham and Blaise Agüera y Arcas. Paul Needham and Janet Ing Freeman worked manually to collect different i letters from the Bulla Thurcorum, presumably printed by Gutenberg in 1456[37]. Their work found an extension in the research of Agüera y Arcas[38] who presented his digital image analysis of the Bulla Thurcorum as the continuation of the unpublished work by Paul Needham and Janet Ing Freeman. They had worked by naked-eye inspection on the different i letters and found twelve different variations. Digital analysis was

able to identify 204 variants. This was interpreted as evidence, that unlike what many thought, Gutenberg did not use the punch/matrix system to cast types.

The steps to performing the digital analysis were: a) taking high-resolution images at a resolution of about 1200 dpi; b) converting the images into grey scale; c) determining a threshold to differentiate ink from background noise; d) extracting individual letters from the text; e) performing a dissimilarity analysis, meaning "overlaying [the letters] in the position and orientation such that their shapes overlap as much as possible, and summing their area of non-overlap".[39]

In order to validate that this huge variability in letters is not inherent to printing technology, a similar analysis was performed on a book printed in 1500, a book printed within the time range of 1568 -72, and a book printed in 1902. The author does not give quantitative results of the different behaviors of the control books, but he states that what he observed on the 1456 printed book is not found in the control books that he studied.

Reske[40] felt that the punch/matrix approach was already used by Gutenberg. He analyzed Gutenberg's printed works with a microscope taking digital pictures at the resolution of 300 dpi. By playing with transparency of the image he was able to overlay letter over letter. He decided to evaluate the results by eye and not using computerized algorithms. His conclusion was that the variability is present but not so significant that it is was compelling enough to exclude the punch/matrix technology. Non-uniformity happening in the manual process of printing can easily explain, according to Reske, the observed variability. He lists typical printing process steps that could explain non-uniformity: a) producing the types; b) composing the printing forme; c) inking; d) paper wettability with respect to ink; e) printing press applied pressure.

If Reske concluded that the variability was not so significant regarding the punch/matrix question, what variability would be seen as significant? To answer this question, the introduction of a metric is required.

Introducing a metric

The metric has some requirements. It needs to be associated to a printed page. It should reflect the observed variability for a given letter. Ideally, it could be used to compare different printed pages. For the purpose of metric creation, besides the sheets under investigation, three books were selected, a book printed in Lisbon in 1489[41], a book printed in Constantinople in 1513[42] and a book printed in Venice in 1519[43]. The three additional books were also printed with Spanish semi-cursive Hebrew fonts. For each book the analysis takes into account one scanned page. The scanning resolution was 1200 dpi. On each page a sample of 60 letters was extracted for each of the three Hebrew characters: *aleph, lamed and tav*. Each character has

a different level of morphological complexity, enhancing the validity of the test. The letter extraction process bears some similarity to the work of Agüera y Arcas and was performed in the following manner:

RGB image acquisition, adaptive RGB to gray-scale conversion, histogram equalization, cropping (layers removal), lines detection, roll correction, inhomogeneity filtering (bilateral filter), re-histogram equalization, splitting by automatic tool built especially for this purpose and finally binarization.

For each sample of 60 letters, after the center was defined by cross-correlation, an aggregation of all letters was created. Such an aggregation is named here "master" since all the information was present. By applying a threshold, following an algorithm inspired by Otsu's method[44], the letters were separated from the background and a "mask" was created from the "master". This process is shown for the *lamed* of the book printed in Lisbon in Figure 14.

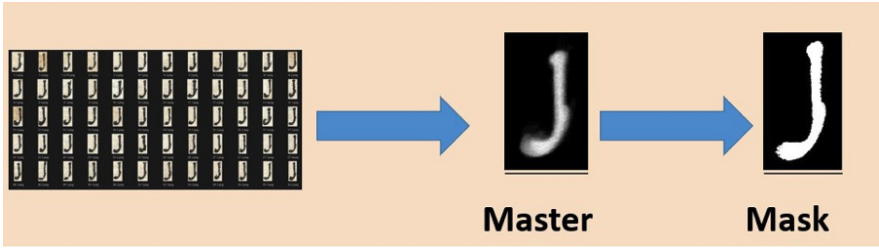


Figure 14: *Preparing a "master" and a "mask" from a sample of 60 letters*

After defining the "mask", a correlation was performed between each of the 60 letters and the "mask", algorithmically overlaying each letter and moving it around with respect to the "mask" until the maximum overlap in percentage was obtained. This maximum number was chosen as the correlation. Correlation of 100% means identity. Thus, the higher the number the closer the letter is in similarity to the "mask".

For each letter, the correlation from the four books was performed, obtaining the average and standard deviation from the 60-item sample.

The results are shown separately for each Hebrew letter with "masters", "masks", correlation both in tables and histograms below.

By looking at the letter *lamed*, the reader is referred to Figure 15, Table 2 and Figure 16. It clearly appears that the highest average correlation and the smallest standard deviation are found for the book printed in Venice in 1519. It points at the highest homogeneity in printed characters. Next in line is the book printed in Constantinople in 1513. It is followed by the book printed in Lisbon in 1489. The lowest average correlation and the largest standard deviation was found for the sheets under investigation, allegedly from Avignon.

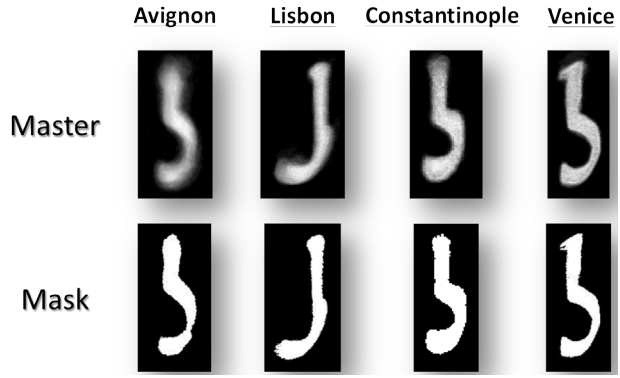


Figure 15: *"Masters" and "masks" for lamed in all four books*

	Average %	Standard deviation %
Avignon	61	13
Lisbon	73	7
Constantinople	81	5
Venice	84	4

Table 2: *Correlation statistics for lamed*

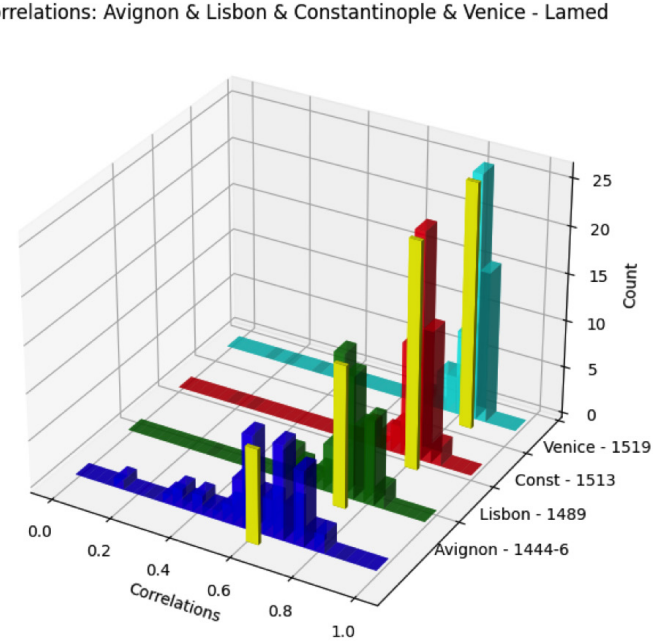


Figure 16: *Correlation histograms for lamed in all four books*

Turning to *aleph*, with reference to Figure 17, Table 3 and Figure 18, it appears that the results from Venice and Lisbon are very close. The results from Constantinople are slightly worse. The Avignon candidate, in this case as well, performed with a poorer correlation and with a wider distribution.

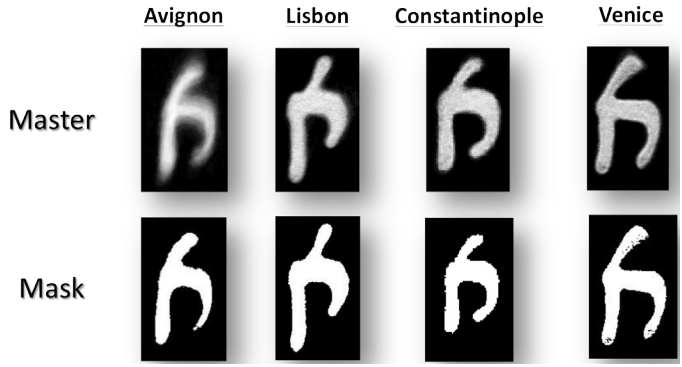


Figure 17: *"Masters" and "masks" for aleph in all four books*

	Average %	Standard deviation %
Avignon	65	12
Lisbon	85	4
Constantinople	79	3
Venice	84	3

Table 3: *Correlation statistics for aleph*

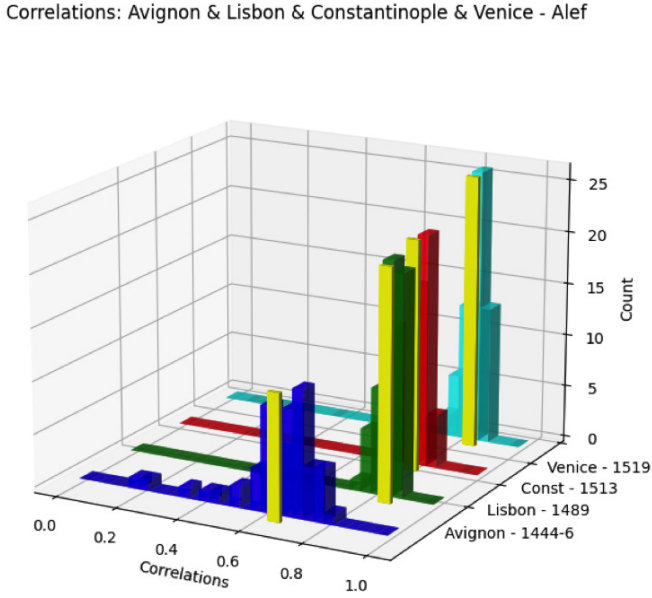


Figure 18: *Correlation histograms for aleph in all four books*

Finally, the results for *tav* are shown at Figure 19, Table 4 and Figure 20, where Constantinople had the best distribution indicating highest homogeneity, closely followed by Venice. Lisbon showed medium homogeneity and the Avignon candidate exhibited poor homogeneity.

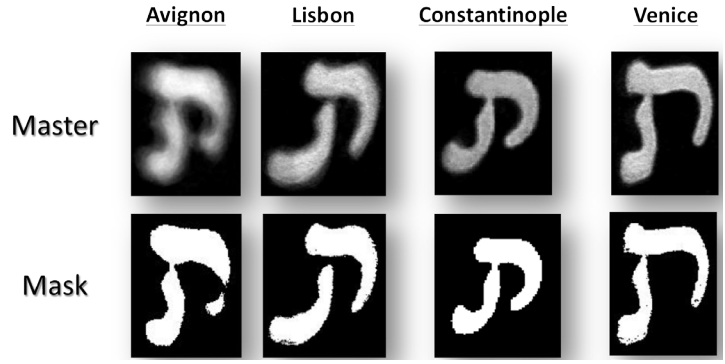


Figure 19: *"Masters" and "masks" for tav in all four books*

	Average %	Standard deviation %
Avignon	65	11
Lisbon	75	6
Constantinople	82	3
Venice	80	4

Table 4: *Correlation statistics for tav*

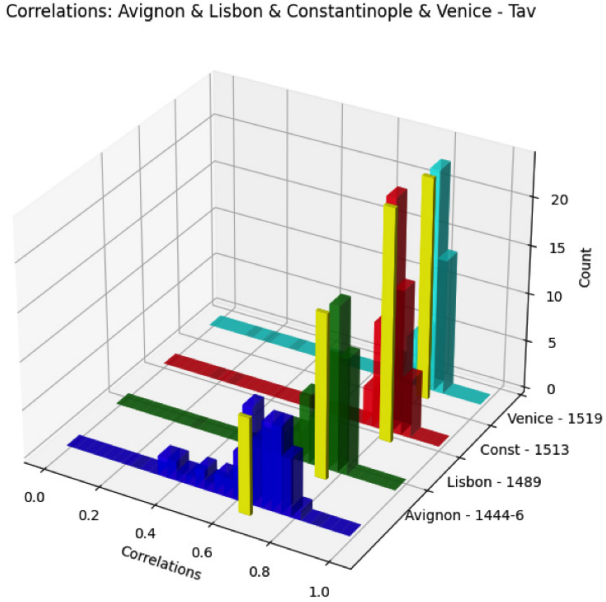


Figure 20: *Correlation histograms for tav in all four books*

Putting pieces together

The correlation analysis showed that the under-investigation sheets were printed with poor technical skills. If those skills are placed on a time scale, the poor technical skills reflect the early development stage of the printing craft. Those sheets can be dated from before 1489.

From the database of the Computerized Thesaurus of the Hebrew Book[45] a list of know printing place where Spanish semi-cursive Hebrew fonts were used in the 15th century can be given: Reggio di Calabria, Guadalajara, Lisbon, Toledo, Leiria and Hijar. The fonts of the investigated sheets were compared to those used in this list of printing shops.

For Reggio di Calabria, Guadalajara and Toledo reference works[46] were used. For Hijar, Lisbon and Leiria high-resolution scans were used.[47] Books printed at the beginning of the 16th century in places where Jews fled after the expulsion from the Iberian Peninsula were added to this study based on high-resolution scans, namely Constantinople, and Fez.[48] None of those places provided a match either.

Combining evidences gathered from the investigated sheets:

- Type inhomogeneity points to early 15th century print
- Presence of a watermark design recorded in the years 1418 -1439
- No other known print shop using matching Spanish semi-cursive Hebrew font

it is reasonable to reach the plausible conclusion that those sheets are the product of the Avignon print shop whose activity is recorded between the years 1444 -1446.

Conclusion

The possibility that other inventors succeeded to print books before Gutenberg has been around as long as Gutenberg has been known.

Here, for the first-time information from the historical archives from Avignon are shown together with recently discovered unknown printed sheets to present a clear and convincing case:

> Procope Waldvogel was successful in printing a Hebrew book in the 1444 -1446 time frame.

It is worth asking in this conclusion why History does not remember Waldvogel. Two thoughts, that may shed some light onto this question, are brought here.

- Waldvogel was not successful in turning his invention into a real business by lack of financial support. On the other hand, Gutenberg had presumably a business plan with the Bible.
- Clearly, Waldvogel's invention did not grow with further adopters. Conversely, in Mainz, Johann Fust and Peter Schöffer, Gutenberg's skilled worker and later Johann Fust's son-in-law, continued to promote printing.

The rest is History.

All pictures were taken by the authors

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