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# UNVEILING A NEW SOPHISTICATED INK ANALYSIS TECHNIQUE, AND DIGITAL IMAGE PROCESSING - A FORENSIC EXAMINATION OF MOZART'S THEMATIC CATALOGUE

Luca Bianchini<sup>1</sup>, Anna Trombetta<sup>2</sup>, Martin W. B. Jarvis<sup>3</sup>

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**Abstract:** *This study embarks on a forensic exploration into the authenticity of Wolfgang Amadeus Mozart's Thematic Catalogue, preserved in the British Library. It presents important research relevant for all Forensic Document Examiners, particularly because it introduces a new ink analysis technique. We reveal compelling evidence that the Thematic Catalogue, which emerged in 1799 under the stewardship of Mozart's widow, Constanze, was not a singular creation by Mozart. Instead, it was a composite work, probably crafted posthumously. Our research employed comprehensive calligraphic analysis, comparing the Thematic Catalogue's handwriting to Mozart's known autographs, revealing discrepancies in style and composition. Additionally, sophisticated ink analysis highlighted chronological and stylistic inconsistencies, suggesting posthumous alterations. The software developed for this study's graphic analysis, presented at the International Graphonomics Society Conference, offers a groundbreaking approach. It helps in deciphering the lexicon and stylistic elements in any given scribe's handwriting. This multifaceted investigation challenges traditional interpretations of Mozart's works. It exemplifies the application of forensic document examination techniques in historical musicology and extends their relevance to many other disciplines.*

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**Keywords:** Mozart, Forensic Document Examination, Handwriting Analysis, Ink Analysis, Paper Watermarks, Musicology, Thematic Catalogue.

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## 1. Introduction.

In this study, we conduct a multidisciplinary forensic examination of Wolfgang Amadeus Mozart's Thematic Catalogue, housed in the British Library's Stephan Zweig collection. Our approach integrates advanced ink colour triplet analysis with a novel lexical study, constructing distinct dictionaries of words for each scribe. This innovative methodology is complemented by a thorough examination of the document's palaeographical and philological aspects.

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By analyzing subtle variations in ink composition and the lexical tendencies of different scribes, we provide a nuanced understanding of the genesis of the Thematic Catalogue. This multifaceted strategy casts new light on the authenticity of Mozart's works and represents a significant advancement in the forensic examination of historical documents. Our research demonstrates the necessity and effectiveness of a comprehensive approach. This approach merges colour analysis, lexical profiling, and traditional document examination techniques. It provides a robust framework for exploring the veracity and origins of a wide range of documents beyond the musical domain.

When Mozart died on 5 December 1791, his estate was immediately suspended. In the following days, bailiffs meticulously inventoried the entire estate, which was found in his home. <sup>1</sup>The inventory of books also included musical scores, but not the Thematic Catalogue (*Verzeichniß aller meiner Wer<sup>1</sup>ke*) that the composer Mozart, according to Constanze, kept at his home.

1. Doctor of Musicology, University of Pavia, School of Palaeography and Musical Philology, Cremona, ITALY
2. Doctor of Musicology, University of Pavia, School of Palaeography and Musical Philology, Cremona, ITALY
3. OAM PhD FRSA, Charles Darwin University, Board Member of the Australia and New Zealand Forensic Science Society Northern Territory Branch

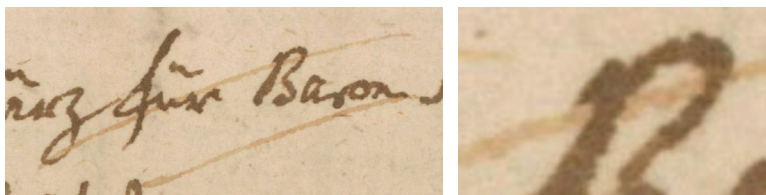


Figure 1. In the month of March for Baron Swieten revised Händel's Messiah

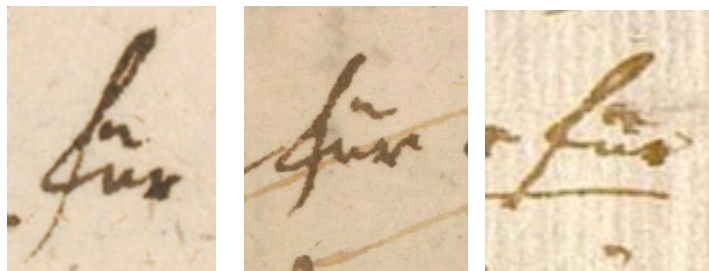


Figure 2. folio 2v, 1785–folio 20v, 1789–Mozart's letter 1786 (BD 974)

The Thematic Catalogue, held in the Stephan Zweig collection of the British Library in London (Stefan Zweig MS 63), is a small, ninety-page book in excellent condition. It is bound and has an elegant, part leather cover.<sup>2</sup> There seems no logical reason why the bailiffs would have failed to list it if it had been among Mozart's possessions.

Fifty-eight pages have text and music written on them, plus an additional twenty-eight pages (fourteen blank for text and fourteen ruled up for additional entries) remain unused. There are also four blank pages (two at the front and two at the back of the Catalogue). The Catalogue is organised in such a way that on one page (on the verso of the sheet) are the detailed descriptions of the instrumentation of the works, and on the opposite page (on the recto) the incipits of the pieces, usually four bars, each marked on two staves.

## 2. History of the Catalogue.

The Thematic Catalogue was not mentioned until 1798.<sup>3,4</sup> Mozart himself never made mention of it in any correspondence. On 25 May 1799, Constanze provided the editor Breitkopf & Härtel with a list of Mozart's works, specifying that "The complete thematic Catalogue in my husband's own hand from February 1784 will show how far you were right. It contains, up to 15 November 1791, 144 numbers and not individual pieces."w

As Constanze says, on the left-hand margin of the pages of the Thematic Catalogue, which describe the compositions, the pieces are numbered progressively from 1 to 144, but incorrectly, because between folios 5 and 6 verso the count is lost, and 30 is marked twice so that 144 works appear instead of 145. Those numbers, still legible in the Catalogue, were first marked in pencil and then revised in pen<sup>5</sup> from 1 to 10 on folios 0 and 1 verso. Three more pieces were later added to the Thematic Catalogue, bringing the actual total to 148 instead of 144.

In the letter, Constanze was evidently referring to the Thematic Catalogue in the state it was still in May 1799, not counting the three pieces added later, which, for this reason, had not been numbered. Analyzing the inks<sup>6</sup> and the overlapping order of the lines of the added works, one notices, for instance, on folio 20 verso that the text "NB In the month of March for Baron Swieten revised Händel's Messiah" annotated immediately after the date 29 April 1789 is over written on the double bars closing the page (Figure 1).

The pencilled numbers are drawn in the same ink as the underlining, the parentheses on folio 0 verso, and at least one of the three entries added on folios 19, 20 and 23 versos. The latter three have the same handwriting as other entries in the Thematic Catalogue, which clumsily attempt to imitate Mozart's handwriting. They are not written by Mozart but were made after May 1799. See the comparison of the word

“für” on folios 2 and 20 verso of the Catalogue with Mozart's letter of 1786 (Figure 2).

The notebook lacks any noticeable signs of deterioration, although Constanze keeps repeating, even to the publisher André, that Mozart perhaps took it with him on his travels,<sup>7</sup> using it continuously over no less than eight years. Considering Mozart's haphazard character—for example, he appears to have forgotten to sign, date and complete many autographs—it is, therefore, unlikely that he showed such care and meticulousness in keeping his Thematic Catalogue.<sup>8</sup> On the autograph of the concerto K.449, for example, someone in the late 18th century wrote “zu ergänzen” (to be completed). If the manuscript is complete today, it is because several hands finished it after Mozart had already died.

The Thematic Catalogue was the indispensable tool for bringing order to Mozart's manuscripts, which often lacked a name, place and date of composition. It served to authenticate the works and, at the same time, establish their chronology.

### 3. Analysis.

Constanze started talking about the Thematic Catalogue in June 1799,<sup>9</sup> possibly the year the watermarked paper used in the Catalogue was produced. Interestingly, Mozart never used this paper for any of his works, nor did any of his contemporary musicians in Vienna or elsewhere. A similar paper was found in a business letter dated 1802. Alan Tyson notes this fact in a marginal note in his edition of Mozart's Thematic Catalogue but without further comment. The watermark usually has a life of three or four years, then it becomes useless due to wear and tear and must be changed; the new one is never identical to the old one. It is thus possible to objectively date the sheets produced by various paper mills based on the shape of the watermark. Considering the timing of the production and sale of the paper batches, approximately seven years, it is safe to assume that the sheets in the Thematic Catalogue were produced no earlier than 1795, a date entirely compatible with Constanze's fragmentary admissions in her letters of 1798-99.

This implies that the Catalogue could not have been produced in 1784 but rather somewhere around 1798. That the Catalogue is not an autograph by Mozart is

confirmed by the language used, the allographs, the calligraphic and ink analysis, as well as the internal and external contradictions.<sup>10</sup> This supports the proposition that the signature on the cover of the Thematic Catalogue is forged.<sup>11</sup> Moreover, there are at least 35 entries in the Thematic Catalogue written with the same pen and ink, even months and years apart.<sup>12</sup> This is impossible considering the writing instruments of the late 18th century.<sup>13</sup>

The language the scribe uses in the Thematic Catalogue is not Mozart's language. There are 2451 different words in the Catalogue, of which 303, i.e. 12.4% of the total, never appear in Mozart's autograph letters between 1783 and 1791, either because they are missing or because they have important lexical variants. The unusual words are significant to understanding the nature and habits of the writer. The word “concert” in the Catalogue, for example, is always written with a “K” (“Konzert”), while in the letters, Mozart always writes it with the initial “C” (“Concerto”).

### 3.1 Inks.

During the IGS 2023 International Conference, held in Évora, Portugal, we presented an autonomous application developed in C#, designed by Luca Bianchini for the advanced analysis of inks used in the Catalogue. This investigation focuses on the different chromatic properties of each ink, whose components manifest distinct reactions to light exposure. The methodology employed involves the use of high-definition images of the Thematic Catalogue, which are composed of colour triplets representing the intensities of the colours red, green, and blue (RGB) in each pixel, with values ranging from 0 to 255.

Albert S. Osborn initially proposed a method for ink analysis based on colour using a microscope. He magnified the images of texts to determine the ink's tint and used filters to allow only specific colours to pass through, thus describing the ink's characteristics. Each ink, even if not perceptible to the naked eye, has a distinct colour.<sup>14</sup>

Our methodology builds on Osborn's approach by utilising digital tools and digitized images, which were unavailable to Osborn. Modern tools enable us to analyse the RGB colour triplets of each pixel in an image of a text without altering the original



Figure 3. folio 25r – folio 25r

document. This analysis measures the red, green, and blue components of the ink used for writing. This technique is non-destructive, unlike chemical analysis, preserving the document while yielding objective, precise, measurable, and replicable results. These results can be easily presented in court by forensic document examiners. Our approach allows for simple replication by anyone using dedicated software or, for smaller verifications, artificial intelligence.

The image capture process was standardized, using a uniform illumination condition, to ensure the consistency and reliability of the collected data. Our ink colour analysis system adheres to several fundamental criteria. The paper on which the texts are written must be the same, as different papers affect the ink's penetration and reflection, impacting the analysis. The acidity or alkalinity of the paper can influence the chemical reaction of iron gall ink, altering its colour over time. Environmental factors such as light exposure and humidity can accelerate or slow the oxidation process, affecting the ink's colour evolution. Our system requires uniform lighting conditions when photographing the documents. Different light sources produce chromatic dominances in photographs, affecting the camera's ability to reproduce colours accurately unless white balance is consistently maintained. In the case of the Mozart Catalogue, the conditions are ideal as the paper is the same for all pages, and the lighting and conservation conditions are uniform. The images were taken at the British Library under high-definition, standardized lighting and white balance conditions, declared in a set of reference colours. This ensures that the image capture process adheres to the same certified standards, enabling objective computerised evaluation of ink colours.

Through this analysis, it is observed that the colour composition and combination of RGB intensities vary

significantly depending on the type of ink. In Mozart's time, the most used ink in Austria was iron gall ink, made by mixing iron salts with tannins extracted from plant sources such as gall nuts. The chemical reaction between these components produced a dark black or brown ink, resistant to water and light, which permanently adhered to paper. Iron gall ink, despite its durability, can present different colour shades even after centuries due to various factors related to its chemical composition and preservation conditions, which depend on the variety of tannins. Different plant sources used for tannin extraction (oak galls, bark of various trees, etc.) contain varying concentrations and types of tannins, influencing the final colour of the ink. Different historical recipes for iron gall ink included varying proportions of iron salts and tannins, affecting the initial colour and its evolution over time. The ink's oxidation is a determining factor: iron gall ink darkens over time due to the oxidation of iron salts when exposed to air. This process can result in shades ranging from light brown to intense black, with various RGB components, depending on the degree of oxidation. Each ink has a characteristic colour, even if not perceptible to the naked eye, distinguishing it objectively from another. This chromatic variability is essential for historians, as it can provide clues about the provenance, age, and fabrication of documents, supporting, in the case of forged documents, the historical contradictions and other forensic analysis elements that must be considered. Regarding the colours in the Mozart Catalogue, different ink shades were found, significantly differing in RGB values. We are currently cataloguing all the shades used in the Catalogue, for each recorded character, which will be published subsequently. In the Catalogue, we identified at least six different types of ink that alternate and recur even years apart. Two different ink shades sometimes coexist on the same page of the Mozart

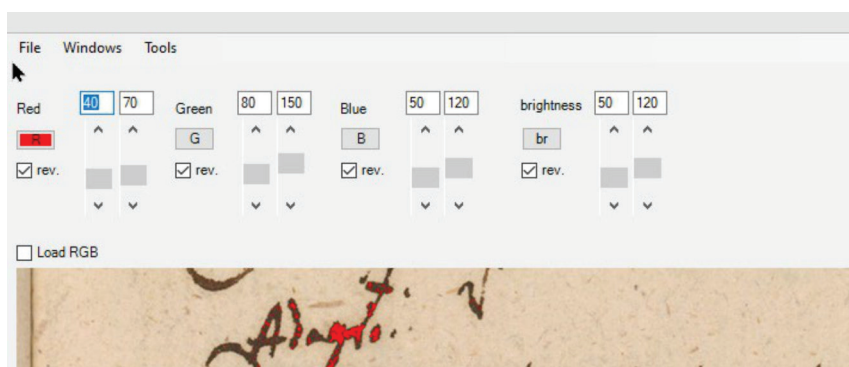


Figure 4. Red intensity (R) between 40 and 70 on a scale of 0 to 255

Catalogue, one characterized by an R component in the 0-255 range generally not falling below 40 (type 1) and the other not below 90 (type 2).<sup>15</sup>

Figure 5 represents the musical incipit found on page 25 recto of the Thematic Catalogue, under the heading “Ein Orgel Stücke für eine Uhr” (an organ piece for a clock). This piece was selected for its relevance and the unique characteristics of the ink used, offering a significant example of our study. Analysis of the musical incipit on folio 25 recto in the Thematic Catalogue reveals discrepancies in the calligraphic and chemical composition of the inks. It is particularly evident in the right section of the incipit, where differences in the formation of the upper-case letter “A” suggest the intervention of different hands (Figure 3).

Our methodology includes digital image processing, where special attention is given to points with red intensity (R) between 40 and 70 on a scale of 0 to 255 (Figure 4).

Different types of black iron gall ink may seem identical to a superficial observation but are radically different in their chemical composition. This difference is crucial in the investigation of contested documents, as forgers often lack knowledge of this diversity, leading to their discovery.

Instead of filtering many colours as Osborn did, the digitized image is already divided into the three essential RGB components. By implementing Osborn's model, we can further distinguish between colour ranges by measuring the R, G, and B components in the RGB triplet. This allows us to objectively differentiate one ink tint from another.

In summary, we scan the image of a text to determine the ink's tint. Our software automatically

removes the background and extraneous dots that would interfere with the analysis. We then measure the red component, identifying when pixels start having a noticeable red component and when the red component begins to increase. From there, the ink takes on redder colours, even if imperceptible to the naked eye. The red intensifies from this lowest point of the range, for example, 40. Then we find the point where the text pixels have reached the maximum red quantity and stop noticeably intensifying, for example, 70. This is the highest point of the range. We do the same for the green and blue components, scanning the image and distinguishing each pixel. Each ink tint is characterized and distinguished from others based on these RGB ranges. To make the ink visually evident, we colour each pixel of the image that meets the RGB range criteria with the same colour, chosen arbitrarily. This makes it clear to the observer that one ink is of a certain type and cannot be another. This technique is useful in court to show and distinguish different inks. In contested documents, differences between one tint and another can be immediately appreciated without altering the originals and in a measurable and objective way.

We chose to investigate the red colour for a specific text between 40 and 70 because 40 is the lower limit where the text pixels begin to take on red shades, and 70 is the limit where all the character pixels have reached the maximum red intensity. If we colour the pixels red (RGB 255, 0, 0) whenever the red components are between 40 and 70, the text written with that ink tint will appear entirely coloured in red.

These dots were enhanced and coloured bright red, allowing substantial differences in the chemical composition of the inks to be observed. Interestingly,

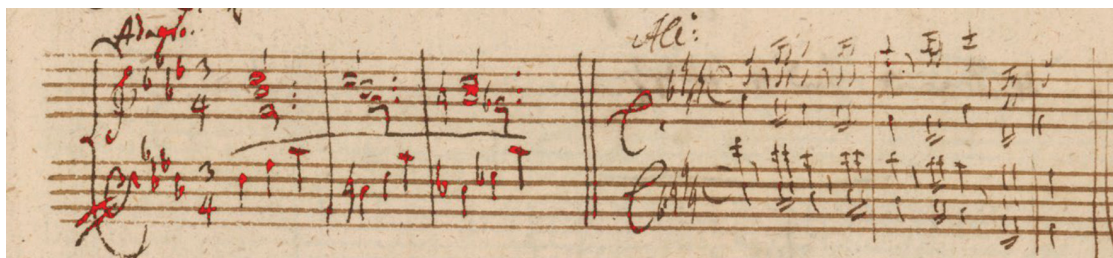


Figure 5. folio 25r



Figure 6. folio 24v (1790) – 25v (1791) – 26v (1791)

the ink used for the musical lines has a red intensity above 120 and is therefore not affected by this analysis, as the selected range (40-70) automatically excludes these values.

The comparative analysis between the colour triplets of the right (coloured red) and left sections revealed an average difference in the percentages of approximately -10.90%, with a standard deviation of 0.12%. This indicates that the inks used in the two sections are chemically different and react differently to light. In more specific terms, triplets with a red component in the range of 40-70 are less common in the right section by about -10.90%, with a slight variation around this average of 0.12% (Figure 5).

In the left section, the pixels with a red component within the range of 40 to 70 are more numerous than in the right section, indicating that the ink tint differs between the sections. If the same ink had been used, the red component would exhibit consistent intensity across both sections. In the right section, the red intensity is lower by approximately 10.90%, with a standard deviation of 0.12%. This means that, on average, the red component in the right section is about 10.90% less intense than in the left section, suggesting different inks were used. Given the same paper and lighting conditions, the only variable affecting this difference is the ink itself. The standard deviation of 0.12% reflects the variability of colour differences from the average. A very low standard deviation of 0.12% indicates that the colour differences are consistently uniform across the image. There are no

significant variations in colour intensity, reinforcing the conclusion that the inks are distinctly different.

The musical clefs are also different from those Mozart wrote in the autographs of works contemporary with the Catalogue entries. At the same IGS Conference, Anthony Howard Jarvis presented an in-depth study using digital analysis.<sup>16</sup>

Using advanced computer techniques, this research examined transcription errors in the music Catalogue in question, comparing Constanze Mozart's claims that each composition was added to the Catalogue immediately after its completion by Mozart. A detailed analysis revealed a remarkable discrepancy in folio 24v, dated December 1790, which lists "Ein Stück für ein Orgelwerk in einer Uhr" (A piece for a clock). Surprisingly, we note that the scribe of the Catalogue incorrectly duplicated the same entry on folio 25v, dated between 12 and 28 February 1791, and then deleted it. This error, typical of a copyist, is not documented in the Thematic Catalogue edition edited by Alan Tyson and raises serious doubts about its reliability. Further, on 3 March, on folio 26 verso of the Thematic Catalogue, an entry similar to Figure 5 appears: "Ein Orgel Stücke für eine Uhr" (An organ piece for a clock). All three entries are written in the same ink, as is evident by highlighting the red component of the triplet, between 90 and 100 (Figure 6).

The words on 25 verso were first crossed out with different ink and then erased, as can be seen in Figure 6. Examining the German article "Ein" on other



Figure 7. folio 0v (1784) – 13v (1787) – 17v (1788) – 28v (1791)

sheets, variations in the shape, proportions and stroke      irreconcilable. The differences are so striking that they

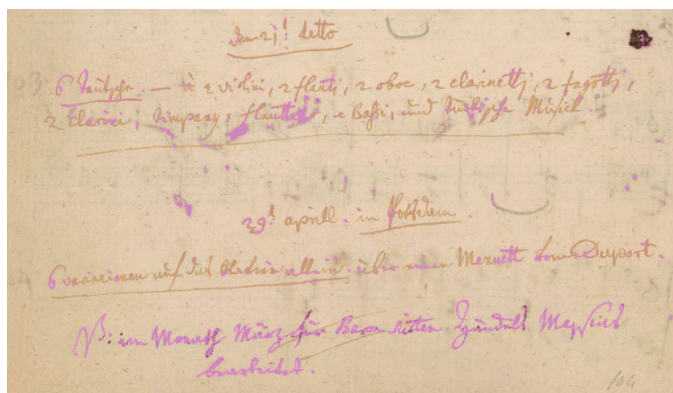


Figure 8. folio 20v

characteristics of the letters suggest distinct writing styles.

Using computer analysis, we examined Mozart's autographs of letters and musical manuscripts from the same period with the software we presented at the IGS 2023 International Conference.<sup>17</sup> In our comparison, while Mozart's writing in these autographs is fluid, with regular and sinuous letter strokes, the Catalogue exhibits thickened strokes and interrupted curves that contradict Mozart's graphic habits, not aligning with the standards outlined in the manual 'Handwriting Identification: Facts and Fundamentals' by Heidi H. Harralson and Larry S. Miller, which we use as a reference.

Mozart's health was very good between 1784 and 1790. Section 3.9 of Huber and Headrick's manual considers cases where an author's handwriting is distorted due to physical reasons, but Mozart did not suffer from adverse physical conditions during the years he supposedly wrote the Catalogue. There was no physical reason that could have altered the fluid writing that is consistent in contemporary autographs. The contradictions between the perfect proportion of letters in the musical manuscripts and Mozart's correspondence and that of the Catalogue are

are evident to the naked eye, even to an inexperienced reader.

It is also noticeable, by highlighting on this occasion the green component between 90 and 100, that the underlines are written at different times and in different ink (Figure 7).

The same method applied for the red colour can be applied to the green component. Highlighting the green component below 90 does not colour the character green. Green dots start to appear from 90 and reach their maximum at 100. This is why we chose the green range between 90 and 100 for these letters. The same can be verified with AI by highlighting in green the letters with a green component between 90 and 100.

The significant divergences in the allographs observed within a narrow time span reinforce the hypothesis that several people contributed to the writing of the Catalogue, attempting to emulate Mozart's handwriting. Such variations, which cannot be attributed to natural variations of the writing style, suggest that the Catalogue is a forged document.<sup>18</sup>

Delving further, we identified on sheet 20 verso of the Thematic Catalogue entries added at a later stage. To do this, we emphasised the colour triplets of



Figure 9. folio 20v

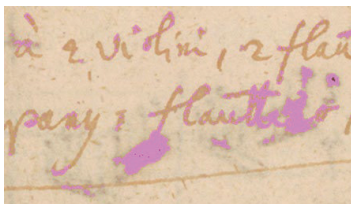


Figure 10. folio 20v

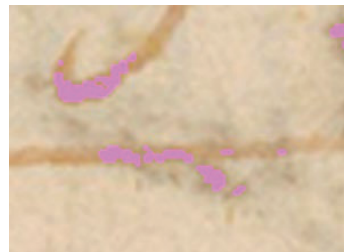


Figure 11. folio 20v

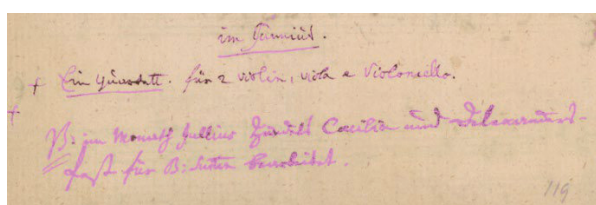
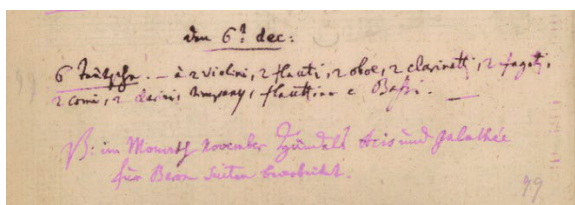


Figure 12. folios 19 and 23 verso

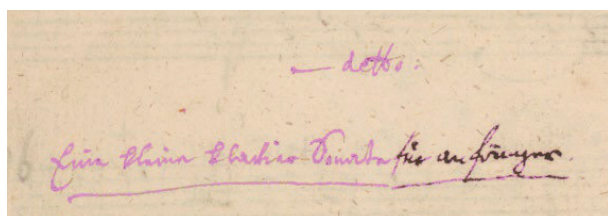


Figure 13. folio 17v

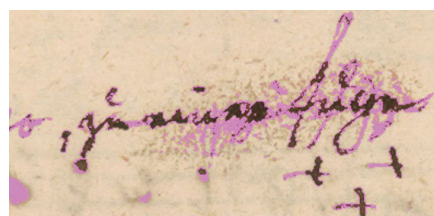


Figure 14. folio 17v

each pixel, containing red between 120 and 190, green between 80 and 150, and blue between 50 and 120. This approach allowed us to delineate the different stages of writing the Catalogue, providing a more complete and detailed view of the creative process and the changes made over time ().

In these characters, the R component starts to be visible at 120 and reaches its maximum at 190, similarly, the green component ranges from 80 to 150, and the blue component ranges from 50 to 120. By colouring pink the points that simultaneously meet these colour quantities, it is possible to visually identify everything written with ink having those R, G, and B quantities. For each ink tint, the RGB component ranges can be calculated to describe each tint more precisely.

The analysis of the inks reveals important details regarding the revisions and corrections made during the writing process. It can be seen, for example, that two diagonal bars were overwritten with the entry of K.572 (Figure 9).

Just above, the correction from “flautino” to

“flautti” in K.571 was made by a different hand with different ink at a later time (Figure 10).

The original writing is “flautino” because the ink has the same colour as the rest of the text in that catalogue entry. The over-writing was done with different ink, whose components are highlighted in pink. There is a deletion and an over-writing done with a new ink tint later. This new ink, which adheres to the colour ranges of this tint, is marked by the pink colour. The term “flautino” is uncommon, while “flautti” is more commonly used, even though there are two t’s instead of one. The analysis of the ink tints, it is possible to verify that it is an over-writing.

Below is the ink stain superimposed on the line in detail (Figure 11).

Like K.572, the two entries of K.566 and K.592-K.591 were also added in the same way at the bottom of folios 19 and 23 verso (Figure 12).

A similar analysis, using the same colour filter, conducted this time on folio 17 verso reveals that the entry for the Sonata for beginners in C major

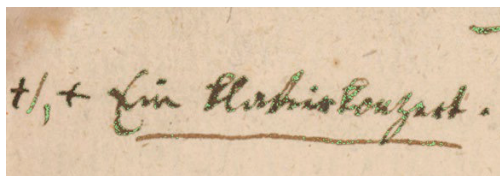


Figure 15. folio 0v

K.545 was written in the same ink as on folio 19 verso (c. 1799). First, it just said, “A Little Sonata for Keyboard,” and then someone, at a separate stage, added “for beginners” (Figure 13).

Interestingly, the underlines, recorded in the Catalogues as a supposed autograph, are later additions. Investigation of the colour components of inks reveals details that would otherwise go unnoticed by the naked eye. A little further down, on the same sheet 17v, an evidently erroneous entry has been erased and overwritten with different ink, revealing the evolution of the Catalogue (Figure 14).

Focusing on the green component between 90 and 100 on all sheets revealed that the underlines were added later with another type of pen and ink. In Figure 15 below, the added line is distinguished by the absence of this specific green component.

At the same time, the analysis of the blue component, in the range between 90 and 100, confirmed that the underlines do not show this range of blue either, unlike the other text, written with a chemically different ink (Figure 16).

The authors meticulously catalogued all details through computerized colour analysis, each time choosing different ranges of the red, green and blue components of individual pixels. In this paper, we give only a small sample. To ensure objectivity, the authors supported the analysis with intrinsic historical verifications of the document, reconstructing the origin and transmission of the catalogue as faithfully as possible.<sup>19</sup>

#### 4. Conclusions.

The present research conducted a multi-dimensional analysis of calligraphic variations, ink colour characteristics, watermarks, the notebook's history, lexical studies, and internal and external contextual inconsistencies. Additionally, the innovative ink analysis technique provided new

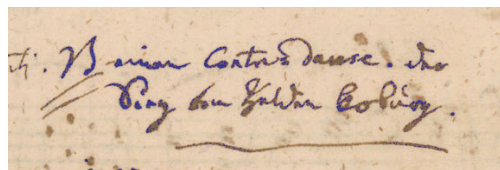


Figure 16. folio 23v

insights into the document's authenticity.

The most plausible explanation from the data that emerged during the research is that the Thematic Catalogue is a forgery. It was likely fabricated around 1798 by various individuals at Constanze's behest. This revelation challenges established narratives in Mozart's musicology and underscores the importance of a comprehensive approach to forensic document examination.

The use of advanced digital techniques, including the innovative ink analysis method, proved crucial in uncovering these insights. This approach not only highlights the methodological advancements in the field but also demonstrates their practical application in historical document analysis.

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- Bauer WA, Deutsch OE. Mozart Briefe und Aufzeichnungen Gesamtausgabe Herausgegeben von der Internationalen Stiftung Mozarteum Salzburg. Bärenreiter, Kassel; 1966-1975.
- Deutsch OE. Mozart Die Dokumente seines Lebens. Deutscher Verlag für Musik, Leipzig; 1961.
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#### Endnotes

- 1 Deutsch OE. Mozart: A Documentary Biography. Simon & Schuster; 1990. Appendix II, p.586.
- 2 It has been in Stefan Zweig's collection at the British Library in London since 1930.
- 3 In 1798 the biography of Mozart by Franz Xaver Niemetschek had come out. Constanze told him about Mozart's Catalogue, perhaps granting him access to it.
- 4 BD 1243.
- 5 See Huber RA, Headrick AM. Handwriting Identification. In: Harralson H, Miller LS, editors. 2nd ed. CRC Press; 2018. pp. 125-127.
- 6 See Huber RA, Headrick AM, op. cit., p.309, paragraph 3.
- 7 BD 1295.
- 8 In heroldage, Constanze wrote:"Whatonecould reproach Mozartwith isnotbeing very tidy with paper and sometimeslosing what he had started to compose" (BD 1419).
- 9 On the 15th of that month, having to justify to the suspicious Breitkopf & Härtel the fact that some works were missing, she wrote that "It is possible that Mozart composed an even larger number of songs from 1784 than are listed in his Thematic Catalogue. However, they are unlikely to be more than one or a couple because he seems to have taken this Thematic Catalogue with him on his travels. Thus, the Gigue, and things he composed in Berlin, are noted under Leipzig and Potsdam in the appropriate chronological order" (BD 1245).
- 10 The paper "A Questionable Catalogue", presented by Luca Bianchini and Anna Trombetta at the 21st Conference of the International Graphonomics Society (IGS 2023) held at the Universidade de Évora from 16 to 19 October 2023, offers an analysis of the alleged personal Catalogue attributed to Wolfgang Amadé Mozart, highlighting strong inconsistencies with Mozart's autographs.
- 11 The paper "Why the Thematic Catalogue is Not Written by W.A. Mozart", presented by Martin Jarvis and Heidi Harralson at the International Symposium of the Australia and New Zealand Forensic Science Society in September 2022 in Brisbane, focuses on verifying the authenticity of the handwriting and signature in the Catalogue. Using forensic graphological examination techniques, Jarvis and Harralson presented evidence to support the hypothesis that neither the musical handwriting nor the handwriting in the Thematic Catalogue is Mozart's.

- 12 See reference to Brunelle and Reed (1984) and Brunelle and Crawford (2003) in Huber RA, Headrick AM. *Handwriting Identification*. In: Harralson H, Miller LS, editors. 2nd ed. CRC Press; 2018. p. 381.
- 13 See Huber RA, Headrick AM., op. cit., pp.125-127.
- 14 Osborn AS, *Questioned Documents*. Rochester, New York; 1910, p.355.
- 15 Mitchell CA, Hepworth TC. *Inks - Their Composition and Manufacture*. Griffin & Company, London; 1904.
- 16 The research conducted by Anthony Howard Jarvis, presented in the paper entitled "A Digital Analysis of Mozart's F Clefs" at the 21st Conference of the International Graphonomics Society (IGS 2023), held from 16 to 19 October 2023 at the Universidade de Évora, provides further clues as to the possible multiplicity of authors involved in the drafting of the Thematic Catalogue. The study, using image analysis tools and statistical tests, compares the bass clefs of the Thematic Catalogue with those extracted from autograph manuscripts. The analysis reveals that the clefs of the Thematic Catalogue are distributed around a different average than those of the autographs. The most plausible explanation is that the bass clefs in the Thematic Catalogue were written by different hands.
- 17 Our examination includes all the quantitative and qualitative characteristics reported by Huber and Headrick, specifically Qualitative Features such as the form of the letters, connections between letters, pen pressure, inking pattern, and individual style, as well as Quantitative Features such as angular measurements and proportions, spacing between words and letters, length and height of letters, speed and rhythm of writing, and pressure distribution.
- 18 A forgery is a simulated document where deception is the intent.
- 19 From the letters, crucial information regarding the catalogue can be extracted. On 29 September 1799, Constanze wrote to the music publishers, Breitkopf & Härtel, suggesting that they purchase "all the originals" written by her husband. She proposed that, after the scores served as the basis for the edition, they could "sell them in England or other libraries" (BD 1258). A month later, not having received a response, she initiated further negotiations with a rival publisher. By 8 November 1799, she had signed a contract with Johann Anton André to sell the scores (BD 1262). Most of these scores were sealed in fifteen parcels, but a list was drawn up for others, including keyboard concertos, quartets, and quintets. On 8 January 1800, Constanze sent a sixteenth parcel, which included the Thematic Catalogue. André published this handwritten booklet in 1805 and 1828, accompanied by the editor's commentary. He had never seen the Thematic Catalogue before 1800 and relied on Constanze's account, rendering his testimony inconclusive for proving that the Thematic Catalogue was part of the Mozart bequest of 1791. In 1798, Niemetschek reported in his biography of Mozart what Constanze had told him, namely that "the complete Catalogue of his compositions from 1784 to his death, in which he noted in his own hand the theme of each work and the date of its completion, shows how often he worked in a single month" (Niemetschek F. *Lebensbeschreibung des K. K. Kapellmeisters Wolfgang Gottlieb Mozart*. Prague; 1798. p. 100; see also Nissen GN. *Biographie W.A. Mozart's*. Breitkopf & Härtel; 1828. p. 693). André realised that much music was missing, despite Constanze's assertion that her husband had marked each piece in order as he completed it. When André pointed out the missing works, she provided him with a new version, claiming that Mozart had intentionally omitted certain pieces he had given as gifts, thereby depriving himself of the autographs (Nissen GN. *Anhang zu W.A. Mozart's Biographie*. Breitkopf & Härtel; 1828. p. 10). This claim is scarcely credible, given Mozart's obsessive concern with secretly copying his music (BD 790). However, in the preface to the 1805 edition of the Thematic Catalogue, André cautiously noted that Mozart entered his pieces in the Thematic Catalogue either on the day he began them or on the day he finished them, which could not be determined with certainty, and that the dates in the Catalogue might mean one thing or another: "At best, I like to think that they follow the time in which they were recorded. The works that show the exact day in the Catalogue seem to have been made on that date, although the same indication is rarely found in the manuscript" (André A. *W.A. Mozart's thematischer Catalogue*. Offenbach; 1828).