
GUEST AUTHOR

ARRANGEMENT, NATURAL VARIATION, LEGIBILITY AND LINE
CONTINUITY AS DISCRIMINATING ELEMENTS IN FORENSIC
HANDWRITING ANALYSIS: A STUDY OF HERMAN MELVILLE'S APRIL
11, 1846 *HYDRARCHOS* SATIRE

Roger Stritmatter, PhD¹

Abstract: *Along with a discussion of the CEDAR-FOX results, four of 21 discriminating elements described by Huber and Headrick in their text Handwriting Identification: Facts and Fundamentals (1999) were applied to investigate the genuineness of an 1846 handcrafted satirical newspaper called the "Hydrarchos." As the writership of the "Hydrarchos" was unknown when the author purchased the original document in 2009, and because the author's research pointed to Herman Melville as the probable writer, he approached Professor Sargur Srihari director of the CEDAR-FOX project at the University of Buffalo to see if Dr. Srihari's scientific methodology and handwriting research could assist in determining whether Melville wrote the "Hydrarchos." Once Dr. Srihari and his colleagues' research (2010, 2013) confirmed that Melville was the likely writer of the "Hydrarchos," the author decided to use a more traditional approach to see if the techniques used by forensic document examiners would substantiate the CEDAR-FOX results.*

Reference: Stritmatter, R. (2017) Arrangement, Natural Variation, Legibility and Line Continuity as Discriminating Elements in Forensic Handwriting Analysis: A Study of Herman Melville's April 11, 1846 "Hydrarchos" Satire. *J. Forensic Document Examination*, Vol 27, pp. 31-54

Key Words: Pattern recognition, forensic document analysis, Arrangement, Natural Variation, Legibility, Line Continuity, Discriminating Elements, Herman Melville, Standards, LLR scores.

1. Introduction

Among the recommendations of the 2009 National Academy of Science (NAS) report, *Strengthening Forensic Science in the United States: A Path Forward* is the challenge to forensic handwriting analysts to improve "the scientific basis for handwriting comparison" (166), employing "experience-based pattern recognition methods" (136) to strengthen "the reliability and replicability of the practices used by trained document examiners" (167). The present

essay responds to this call, proposing terms – or at least tactical rapprochement and interdisciplinary collaboration – between the separate intellectual cultures of forensic science and practice on one hand, and literary studies on the other, through the application of an "experience-based pattern recognition" methodology to an object of sufficient intrinsic interest to merit sustained attention from specialists in various disciplines.

Of these disciplines there are at least three that may be relevant: the forensic scientist, who uses statistical measures produced by software algorithms to test propositions about writership, the traditional forensic practitioner, who among other specializations can analyze and evaluate handwriting in a courtroom setting, and the literary scholar, who considers everything from semantics to textual history

1. Coppin State University
Department of Humanities
2302 Lyndhurst Ave.
Baltimore, MD, 21216
410-764-9202
rstritmatter@coppin.edu

Recto (right side)



1. Detail of *Hydrarchos* MS, recto. 24.3 x 40 cm, ink and watercolor over pencil. Title: "GAZETTE - EXTR. PHILADAL 4mo 11th 1846. Dated April 11, 1846 in "plain style" Quaker date.

Verso (left side)

The introduction of ^{Indian} Corn has caused much excitement as the Brits
 we no proper ideas as to the various modes of cooking it. Many
 are seen limping about with blistered feet, on account of having
 been averse to one of our "dark" soups for a true recipe.

"The way to bake de noc cake, Stick de noc cake to de foot
 O le virginny nuber five. And hold it to de fire".

Time and American cooks (who are much in demand) we trust will set
 all to rights. The introduction of our important staple will have
 a good effect as it will cause an interchange of hominy between the two
 nations. We fear the fog of war when corn-fed Jonathan meets
 corn-fed Jonathan Bull. The English are becoming reconciled
 to hominy, but as yet "they don't know beans".

Italy. A Bull of the Popes has been penned and is very
 furious. Immense quantities of Foussells Soap are being used
 to allay the eruptions of Mount Vesuvius.

China. A whole dinner set of the Queens was recently sent
 to Smash. The Emperor is warlike and it is said has a notion
 of asking the English again to "Come to tea".

Our Foreign Relations
 are coming over in
 private conveyance
 to attend Yearly Meeting.

It is proposed that
 the "Cluster" hold an
 Extra meeting to asto
 give them a decent
 Reception.



Our Foreign Relations.



The reduction of Postage

The reduction of Postage is very
 much railed at. It is hardly
 known whether it will be considered
 as a de fence ive or an off
 fence ive measure.



The Rail Road movement

The rail road movement will consign
 many to the stocks.

The picture represents one of the
 Presidents of the Companies at his
 Country seat, which he earned
 by Speculation.

and historical context. All three groups practice distinct professional protocols; each employs its own specialized vocabulary, tools of inquiry, and conceptual orientations and dogmas; obviously, the potential abounds on all sides for misunderstanding the corresponding methods and orientations of the other disciplines. The gulf between the literary theorist on the one hand, and the forensic practitioner or scientist on the other, is diagnosed by Thomas Davis, a University of Birmingham bibliographer and textual scholar who has also worked since 1974 as a forensic document analyst. In his 2007 *Library* article, "The Practice of Handwriting Identification," Davis – one of only a few with sufficient experience in both forensic practice and literary studies to contribute to any synthesis – bluntly observes that "[literary] paleographers and forensic scientists read and write for different journals, attend different conferences, work in different environments, and do not communicate with each other". The impact of this initial alienation may be compounded by the innovations in forensic method enabled by the use of computerized algorithms, such as the system used by Professor Sargur Srihari at the University of Buffalo CEDAR-FOX labs. The CEDAR-FOX methodology, as outlined in many extant summaries, uses algorithms measuring multiple variables of the design of writing to generate Log-Likelihood Ratios to perform handwriting identification or verification tasks (Srihari, Srinivasan & Desai, 2007; Owen 2014).

On the humanities side, forensic handwriting analysis, whether conducted by a traditional practitioner or a skilled operator of a user-interactive system like CEDAR-FOX, faces a perceptual barrier brought about by its historical association with graphology – the belief that one could read a person's character or destiny the qualities of his or her handwriting. Graphology and forensic handwriting analysis share a common underlying assumption (or, perhaps better, premise) that handwriting, like genes or fingerprints, is a unique expression of provable singularity. 19th century advocates of the singularity of handwriting, as Tamar Plakins Thornton shows in her *Handwriting in America: A Cultural History* (1996), were often advocates of graphology who endorsed rash generalizations about the efficacy of reading a person's character from his or her handwriting. One

need not endorse the subtly macabre determinism of Edgar Allen Poe, for whom the existence of "a strong analogy...between every man's chirography and character will be denied by none but the unreflecting" (Thornton, 1996), to recognize the accumulating evidence that forensic study of the formal characteristics of handwriting, especially in conjunction with other forms of evidence, can very often prove or disprove a hypothesis of common writership. In other words, the premise of individuality in handwriting, classically defended by Srihari, et al(2002) or more recently by Harrison, Burkes and Seiger (2009), can and should be separated from the romantic belief that handwriting directly communicates character.

One powerful challenge to the idea of the individualizing of handwriting, historically an impediment to the emergence of forensic handwriting analysis as a true science, is that unlike genes or fingerprints, the handwriting of an individual coexists in multiple samples typically illustrating significant divergences of form, thereby introducing a factor unique to handwriting analysis, namely the concept of *Natural Variation* (variation within the corpus of a single individual). Add to this the possibility of forgery, or even honest confusion resulting from practices of close imitation in similarly-trained writers, and forensic handwriting analysis poses problems of interpretation and method that can benefit from close associations between the historian/humanist and the forensic scientist.

Using four of the discriminating features listed in Huber and Headricks book (1999), the author attempted to see how the traditional methods of handwriting comparisons used in forensic document examination would or would not substantiate the findings of the CEDAR-FOX study.

The *Hydrarchos* will hereafter be referred to by its name or as the questioned document (QD). The QD is a handcrafted newspaper, a popular genre in the 19th Century. The document, dated April 11, 1846, is 25.3 x 40 cm and is folded four times horizontally and one time vertically to form a 17 x 13 cm packet as if it was intended to be mailed. Figures 1.1 and 1.2 reproduce the left side (Verso) and the right side (Recto) at about 50% of the scale.

Especially in view of its unique visual and literary appeal, the QD may represent a significant lost-and-

found example of American folk art heritage, one that deserves informed attention and scrutiny by qualified professionals in several fields. In 2009 Professor Sargur N. Srihari at the University of Buffalo Center for Excellence in Document Recognition (CEDAR) generously agreed to test the authors hypothesis – a hypothesis that was itself already the product of a granular analysis of the document’s character, language, and history as summarized in another study (Stritmatter, 2017) – identifying the novelist Herman Melville (1819-1891) as the writer. In three separate, progressively more reliable studies (Ball, Pu, Stritmatter and Srihari 2010A and 2010B, and, Srihari 2013), the Cedar Lab confirmed the handwriting to be Melville’s. Based on a range of proven criteria, including bigram comparison, measures of slant, spacing, thickness, etc., these three studies employed state-of-the-art CEDAR-FOX software to compute Log Likelihood Ratio scores (see analysis under “Consistency and Natural Variation”) expressing the probability of Melville’s writership. As Srihari (2013) summarizes, seven out of eight CEDAR-FOX trials categorically identified the QD as Melville’s, and the last rated his writership as “highly probable.” To validate the method, moreover, Cedar conducted a “comparison between the QD and known documents penned by various contemporary writers likely to have similar penmanship styles,” concluding that these documents were “written by different writers” than the *Hydrarchos* writer (13-14/14). The results of these three CEDAR-FOX studies are summarized in Figure 4.1.

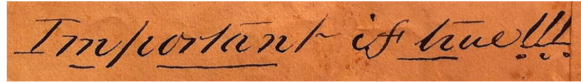
Partly for reasons already noted, humanities scholars may be reluctant to consider such findings as definitive. To anyone without the requisite preparation in both statistics and forensic method, the CEDAR-FOX findings may seem to emerge from the “black box” of a highly technical and specialist methodology (Owen, 2014); thus potential gains in rigor or reproducibility – the proper standards of a scientific inquiry – are vulnerable to a possibly unwarranted skepticism by the humanist with limited statistical preparation.

We humanists or Melville scholars, moreover, may not feel equipped to evaluate or understand new methodologies in a field whose premises, methods, and episteme are so different from their own, all

the more so when doing so involves a long and complicated history resulting in the current use of statistical methods that they may not yet understand. Humanists may even be inclined to dismiss as outside the province of their scholarly specialization the clear evidence that today’s forensic handwriting analysis really is a science, with reviewed failure and success rates and a body of theory and practice that can justify an informed opinion (Srihari, Cha et al, 2002; Jackson 2006). They may not understand that forensic handwriting analysis, originally as a result of the studies of Drexel University professor Moshe Kam during the 1990s and the cumulative decisions of *Daubert*, *Joiner*, and *Kumho tire* cases (the so-called “Daubert trilogy”), is by 2018 permanently established as a court recognized science. Kam’s 1993 *Journal of Forensic Sciences* article, “Proficiency of Professional Document Examiners,” followed by a larger study published in 1997, proved the existence of special expertise in the art: novices were six times more likely to misidentify hands than established forensics professionals (Jackson, 2006). As summarized by Harralson, et al. (2015), “extensive published research exists on developments in signature verification [among other subtopics] which supports research into the replicability and reliability of handwriting”.

In contrast to the emphasis on replicability and cross-verification seen in modern, computer aided techniques, the more traditional methodology of the forensic practitioner, as classically described by Alfred S. Osborne (1929) and more recently exemplified in Huber and Headrick’s *Handwriting Identification: Facts and Fundamentals* (1999), may assume a renewed relevance in adjudicating the potential standoff between the scientist and the humanist. If humanities scholars are skeptical of computer algorithms, will they trust the evidence of their own sense and reasoning, as shaped by a direct encounter with the evidence? What happens when visual evidence of the formal relationships of shape, line, and design used in the more traditional analysis of the skilled practitioner takes the place of the fearsomely abstract of idea of Log Likelihood Ratios? Can we learn to follow the advice of Michael I. Saks to “learn to be comfortable refocusing [our] thinking about the building blocks of what truly makes evidence that is beyond the knowledge and experience of lay persons useful to

1.3 Contextualization – Linguistic

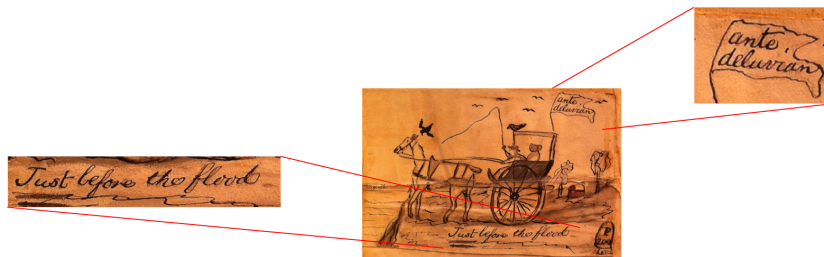


IMPORTANT IF TRUE—Mr. HERMAN MELVILLE's forthcoming work,
Omoo.

The April 10, 1847 *Yankee Doodle* advertisement for *Omoo* (p. 2) utilizes a quote from the skeptical travel historian Alexander William Kinglake that appeared a year earlier in the *Hydrarchos*.

Figure 1.3

1.4 Etymologizing of the word "Antediluvian"



antediluvian — a port before the flood.

[Joppa]... "Antediluvian — a port before the flood" (Weaver, p. 70). Sequence 32 Houghton MS.

Figure 1.4

them in resolving disputes”), or even engage the goal of establishing handwriting examination as part of an “experience-based method of pattern recognition?” As Davis (2007) asks, “can one communicate expertise?”.

2 Background

Hand-crafted newspapers like the *Hydrarchos* – often of a markedly satiric character¹—were a popular form of entertainment throughout the United States during the 19th century. Named after the sea serpent pictured in the leading panel, the MS. blends satiric “news” from all over the world with familial “intelligence” referable only to the local context of the document’s production and original audience. The thematic emphasis on high speed transatlantic communication on p. 1 gives way by the denouement on p. 2 to a flood of refugees of crisis in Europe and the President of a bankrupt railroad scheme being “rid out on the rails” by angry investors.

Throughout 1846 the *Hydrarchos* – the name given by the enterprising showman Albert Koch to the reconstructed skeleton marketed in lucrative public displays up and down the Eastern seaboard of the United States as a prehistoric reptile – was a media sensation. In fact the beast was a fossil whale. Writing several years later in *Moby Dick* (pub. 1851), in his chapter 104, “The Fossil Whale,” Melville would give a detailed account of the *Hydrarchos* controversy of the 1840s.

Purchased by the author from New Jersey antique and rare glass dealer John Di Caro in 2009, the document’s provenance before that time is obscure, but is mid-Atlantic in origin. This geography is consistent with Melville’s writership, since many of Melville’s possessions had passed after his death in 1891 to his daughter Francis (“Fanny”) Melville (1855-1938). Fanny married Henry Besson Thomas, and afterwards lived in Orange, New Jersey with her four children. A 2011 news story in the *South Orange Patch* by Marcia Worth, “Herman Melville: Lost and Found in South Orange,” even reports on the discovery of a possible Melville manuscript in South Orange, speculating that “if a sheaf of papers turns up in South Orange, and its signed Herman Melville, it just might be a dream come true” (n.p.).

The suspected writer, Herman Melville (1819-1891), is not only the author of *Moby Dick* (1851)

and ten other major books, several volumes of poetry and many shorter satires and essays – he was also a known visual artist and fine arts critic and theorist (Robillard,(1997), Sten (1991)), who possessed the satiric imagination and advocated the Universalist ideals visible in the QD. Melville’s biography also furnishes a local context for the document’s creation and explains much of its obscure humor (Stritmatter, 2017). In April, 1846, Melville was engaged in a transatlantic conversation, exchanging letters and news with his brother Gansevoort, who had in January just secured a British publisher, John Murray, for Herman’s first book, *Typee* (1846). The book, based on Melville’s real-life experiences deserting a whaling ship in the exotic Marquesas Islands in the South Pacific, was shortly published to some critical acclaim by Putnam’s in the United States. Was the *Hydrarchos* MS created as part of this sequence of literary exchanges between the two brothers?

Among many other curious coincidences, within months of the date of the *Hydrarchos* MS, as if remembering the document’s image of the sea serpent delivering the transatlantic mail to Liverpool, Melville published an anonymous satire in the Sept., 1847 issue of *Yankee Doodle*, “Mr. Cave Johnson’s New Method of Distributing the mails.” An American imitation of the popular British satire journal, *Punch*, edited by Melville’s friend and close colleague Evert Duyckinck, and later by Cornelius Mathews, *Yankee Doodle* during its short existence (1847-1848) contained numerous anonymous contributions by Melville (Hayford et al. 1987).² The satire advertises for a “smart jockey” to ride the “sea-serpent of Nahant notoriety....for the transmission of the European mails from Boston to Halifax” (Hayford et al. 429). *Yankee Doodle* contains further evidence associating Melville with the QD. On April 17, 1847, the journal ran advance notice of Melville’s second book, *Omoo*, then forthcoming from John Murray in England and Harper Brothers in the United States. The book’s advertising slogan, echoing the slogan of Melville’s fellow travel writer Alexander William Kinglake –well known to the young Melville according to Melville biographer Hershel Parker (II, 321) – was “Important if true,” as Lynne Horth (1993) has noted and Figure 1.3 illustrates.

Many linguistic features of the QD do support the hypothesis of Melville’s writership, including

My dear Aunt
 You asked me to write
 you a letter but I thought that I could
 not write well enough before this. I
 now study Spelling, Arithmetic,
 Grammar, Geography, Reading, and
 Writing. I past a very pleasant
 vacation at Bristol. give my love
 to Grandmamma, Grandpapa,
 and all my aunts.
 Your dear Nephew,
 Hermann Melville.

Samples of Melville's Known Writings

Melville 1828

My Dear Uncle
 Pittsfield Dec 31st 1837

At my departure from Albany last
 fall with Robert you expressed a desire that I should write
 you when my school should have gone into operation,
 but when in a few weeks I again returned you did not
 repeat your request; still, however, I considered my
 promise binding - & it is with pleasure that I now
 proceed to redeem it.

I should have taken up my pen
 at an earlier day had not the variety & importance of
 the duties incident to my vocation been so numerous
 and pressing, that they absorbed a large portion of my
 time.

But now, having become somewhat acqu-
 ainted with the routine of business, - having established
 a system in my mode of instruction, - and being fa-
 miliar with the characters & dispositions of my scholars:
 in short, having brought my school under a proper organ-
 ization - a few intervals of time are afforded me which
 I improve by occasional writing & reading.

My scholars are about thirty in number, of
 all ages, sexes, ranks, characters, & education; some of them
 who have attained the age of eighteen can not do a sum in
 addition, while others have struggled through the Arithmetic:
 but with so great swiftness that they can not recognize objects
 in the road on a second journey; & are about as ignorant
 of them as though they had never passed that way before.

My school is situated in a remote & secluded part of the town
 about five miles from the village, and the house at which I am
 (over)

Melville 1837

New York, Jan 4 20th 1845

My Dear Sister: - What a charming name is yours
 - the most engaging I think in our whole family
 circle. - I don't know how it is precisely, but I have
 always been very partial to the particular appellation &
 can not avoid imputing the person who bears it, with
 certain quite captivating attributes; so, when I hear of
 Kate Pack a one - whether it be Kate Smith or Kate
 Jones, or Kate Wigg Body, &c I invariably impute to the
 said Kate all manner of delightful characteristics.
 - Not, that terms of general admiration will do at
 all, when applied to the Blue-States - for the
 States, if you see, are a peculiar race, & are disting-
 uished by peculiar attributes - Thus, the States as
 a general rule are decidedly handsome, but if we may
 not speak of their beauty in terms of insignificant
 admiration, they still will be found to incline toward
 good looks, and at any rate, they are never positively
 ugly. - But, "Some feathers don't make fine
 birds" & "Handsome is, that handsome does" & all
 that sort of thing; - & so if the States were only

Melville 1845

Figure 2.0

vocabulary, diction, figures of speech, and words or ideas like “express,” “antediluvian,” “before the flood,” “galvanized,” “telegraph,” “American,” “Liverpool,” “minutes,” “Indian,” “established,” “important,” “particular” or “wonderful.” The use of embedded song, Afro-American vernacular, labels on pictures, and many other features, as detailed elsewhere (Stritmatter 2017), also support the attribution. Among the most striking thematic indications of common writership, both Melville in his 1856-57 Journal of his voyage to the Holy Land, and the writer of the *Hydrarchos* MS., etymologize the word “Antediluvian” as meaning “before the flood” (Figure 1.4).³

These and many other linguistic, thematic, and contextual questions are addressed in detail in a separate publication, available by request from the author.

3. Standards and Definitions Used in Study

A “standard” is a known document selected for comparison to an unknown document. The three primary standards used in this study, hereafter Melville 1828, Melville 1837, and Melville 1845, are illustrated in Figure 2.0.

Melville 1837 and Melville 1845, consisting of only the first page of letters written those years by Melville to his uncle Thomas (1837) and his sister Kate (1845), were made available by Thomas Lannon of the NYPL’s Gansevoort collection and were employed for comparison in the CEDAR reports.⁴ The Melville 1828 letter,⁵ not utilized by CEDAR but also consulted in the present study, is the earliest surviving sample of Melville’s handwriting and is therefore useful for studying the young Herman’s careful but characteristically flawed implementation of copybook standards at an early age. Although Melville’s handwriting, as often happens over the lifetime of a writer, declined markedly from this copybook standard as he aged, there is no legitimate theoretical basis to exclude the 1828 sample from consideration merely on the basis of chronology. It represents one extreme end of the range of variation of his hand as expressed over the history of his writing practices and tas expressed over the history of his writing practices. In creating a visual and calligraphic document the writer of the *Hydrarchos* MSS was calling on a wide

range of variability in his handwriting, and – it can be argued – tends to revert in significant ways to the copybook standards of penmanship he had learned as a youth.

From their survey of the literature of forensic handwriting analysis, Huber and Headrick (1999) identify 21 discriminating elements, each constituting “a relatively discrete element of writing or lettering that varies observably or measurably with its author and may, thereby, contribute reliably to distinction between the inscriptions of different persons, or to evidencing the sameness in those of common authors” (90). This paper abstracts from a more comprehensive study four of 21 discriminating features - *Arrangement*, *Natural Variation*, *Legibility*, and *Connectivity*. Together, these comprise a strategic combination of features, each allows analysis from a distinct perspective. *Arrangement* is an element of style. *Legibility* and *Connectivity* are elements of execution, and *Natural Variation* are an attribute of writing habits (Huber and Headrick, 1999). The consideration of these four elements, then, covers a significant spectrum of Huber and Headrick’s listing of 21 discriminating elements.

Legibility, classified as an element of execution, refers to the ease by which a reader can recognize words or individual letters. It not only varies greatly between writers but is also an aspect of *Natural Variation*. *Connectivity* includes not only measurement or assessment of the frequency of connection or disconnection (hiatus) between letters in a cursive or predominately cursive hand, but also to the predictable patterns by which some letters or combinations of letters are more likely to be unconnected than others.

A comparison of two samples of Melville’s hand separated in time by 38 years (Figure 2.1 A and B) reveals how vexing the problem of natural variation can be in its more extreme forms.

The contrast illustrated in Figure 2.1 reveals the evolution from a rounder, more fluid, more carefully slanted and legible hand in 1850 to a more angular, upright, “utilitarian” and less legible hand in 1888. The difference that is exaggerated by, but not fully accounted for, by the difference in writing implements used in the two samples, as [A] is ink and [B] is pencil. It is easy to see how even a highly competent and well trained practitioner might mistake the fact that these texts are the product of a single writer.

After considering some further theoretical problems and possibilities posed by the existence of *Natural Variation*, this article concludes with a comparative analysis of *Legibility* and *Connectivity*. Given that the *Hydrarchos* is an artistically designed document, the writer, whoever he was, can be expected to have been on his “best manners,” so to speak. Thus, while the QD is inscribed in a generally more legible – sometimes even “calligraphic” or “decorative” – hand than usually seen in Melville documents, when natural variation and genre are taken into account the discrepancies appear instead like variations of a common underlying theme that is visible even in exemplars of differing legibility, and the decorative character of the document lettering may even remind the Melville scholar of Ishmael’s amusing account of how the style of his handwriting “unconsciously” adjusted to the topic of his composition: “How, then, with me, writing of this Leviathan? Unconsciously my chirography expands into placard capitals. Give me a condor’s quill! Give me Vesuvius’ crater for an inkstand!”.

Ultimately, the practitioner of forensic handwriting studies must be prepared to discover new modes of measurement and observation. This is best illustrated by means of a final feature of handwriting analysis considered here, although not listed among Huber and Headrick’s 21 categories of discriminating features. This is the category of *Whole Word Comparisons* (WWC) that become available when one has comparable words, especially longer words, in both samples. Such word-for-word comparisons, while often not available, are themselves certainly of great interest when found, since they permit comparison of identical sequences of letters, to facilitate an assessment of dynamic, *in-situ*, similarities or distinctions of form. In this case, just as found in the consideration of linguistic context, features for comparison abound for the simple, but telling, reason that there is a large degree of overlap in the vocabularies of the two samples. The credibility of our findings will be significantly enhanced by the availability of such WWC as *office*, *Liverpool*, *papers*, *o’clock*, *minutes*, *important*, *voyage*, *made*, and *particular*. As these examples suggest, the selection of whole words for comparison should concentrate on longer and more unusual words. Longer words,

as Srihari (2013, 14) suggests, – whether they support an H0 (null hypothesis) or an H1 (alternate hypothesis) conclusion – yield stronger results. While our whole word comparisons are primarily oriented towards consideration of the factors of legibility and connectivity, it will be observed in Figures 5.5., 6.2, 6.4 and 6.5, illustrate, how well the overall dynamic design of these more complex words supports the common origin of the two samples.

4. Arrangement

Arrangement refers to a group of habits involving the disposition of elements on the page, including interlinear spacing, parallelism of lines, paragraphing, and indentations of lines, or even the use of dashes or other glyphs as spacing devices. *Arrangement* is the most global feature of a document. Close attention to features of arrangement can either disclose subtle parallelisms of form confirming the identification, or point to discrepancies supporting an H0 conclusion. For measurement purposes, to assess features of arrangement, electronic versions of the documents were laid out in Microsoft Word in grids of 1 cm/grid. Figures 3.1-3.2 illustrate this process.

Once scaled, counts of word numbers per side, word or character counts per line, and vertical distances between lines can be computed. Figure 3.3 summarizes the results of preliminary measurements made under the categories of lateral and vertical expansion in the arrangement of lines on a page, as computed from the three standards.

Also in the category of *Arrangement*, margins and indented lines are compared in Figure 3.9, with both documents illustrated a tendency to make use of very wide 5-9 cm. secondary indents in distributing space on the page (Figure 3.4). The results of these measurements are compiled in Figure 3.5.

Figure 3.6 illustrates a common feature of both samples that is idiosyncratic in the 1840s, namely the tendency to supply hyper-punctuation in the form of a line of several letters length, both within and between sentences. Such a feature is rarely seen among the dozens of 19th and early 20th century hands reproduced in Hamilton 1979.

Both samples use not only the straight (Figure 3.6) but also wavy (Figure 3.7) lines, both within and between sentences – as unorthodox elements of arrangement.

Grids were used to assess arrangement

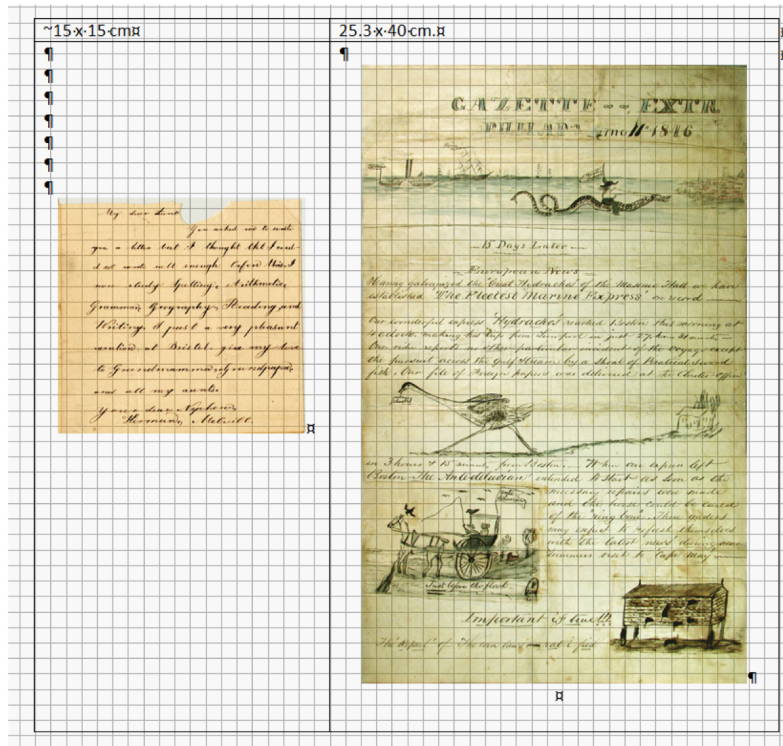


Figure 3.1

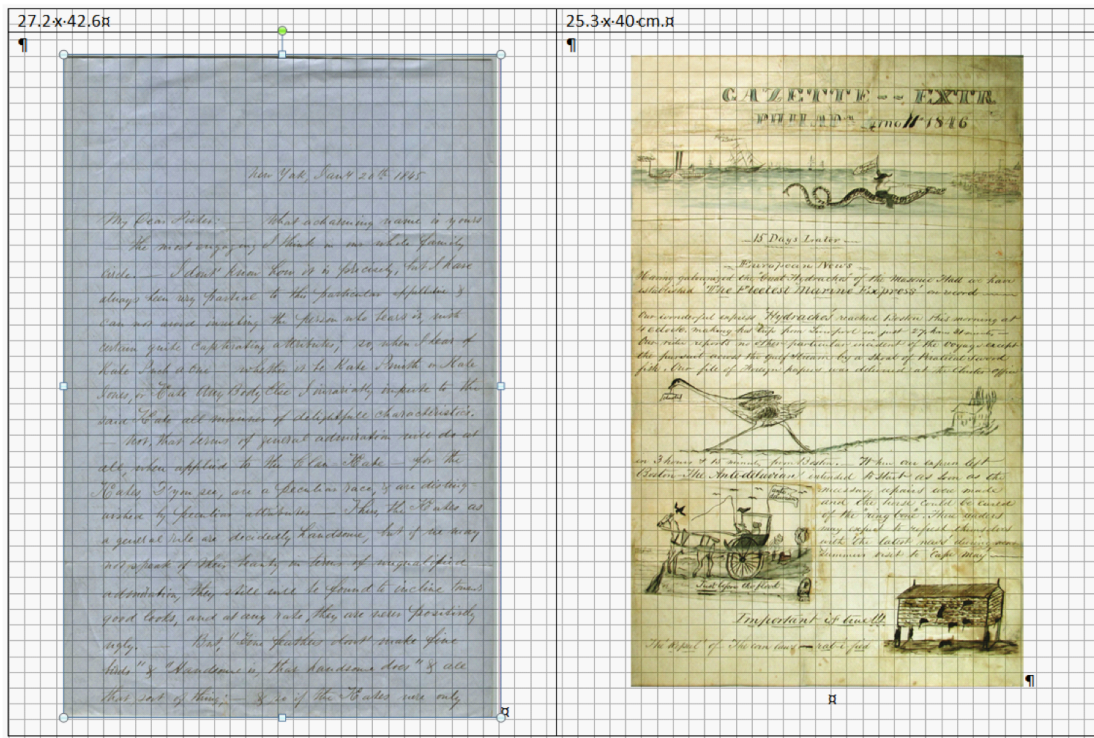


Figure 3.2

		Hydrarchos recto 25.3 x 40 cm.	Hydrarchos verso 25.3 x 40 cm.	Melville 1837 24.6 x 39.5	Melville 1845 27.2 x 42.6 cm	Melville Typee leaf 19 x 31.8
vertical	l/cm	1	1	1.21	1.5	~.84
Horizontal	w/l	11.3	11.6	~10	9.6	~10
	c/l	56	51	49	43	~51

Figure 3.3 Arrangement, Horizontal and vertical spacings, summarized.

The use of the wavy line (Figure 3.7), a rare feature in 19th c. American hands, introduces a new dimension to the analysis, as wavy lines may be evaluated not only for their presence or absence, but both for the amplitude and the periodicity of their waves. In this case, even without more precise measurement, the comparison greatly strengthens the impression of common writership.

Finally, both samples also employ the highly literate use of a caret to insert text during revision (Figure 3.8) – a practice frequently employed by Melville in his surviving correspondence and MS materials.

These features illustrate not only that Melville’s writership of the QD is consistent with his general habits of the sizing and arrangement of words on the page, but also that his practices are evident in several key elements of idiosyncratic design, including the use of both straight and wavy lines, and the literary use of the caret to introduce revisions into an otherwise completed text.

5. Natural Variation

Natural Variation, as defined by Huber and Headrick, refers to the fact that “variations tend to lie within ranges peculiar to the individual”. In many ways the most enigmatic and, from the analyst’s perspective, problematic, quality of handwriting, *Natural Variation* is especially important when examining documents of different genre or compositional technique. The spectrum of *natural variation* is often much larger, on closer acquaintance with a sufficient sample, than might be anticipated, as is shown in the comparison of two MS Melville documents, figures 2.1A – written in 1850 – and 2.1B, written 38 years later in 1888.

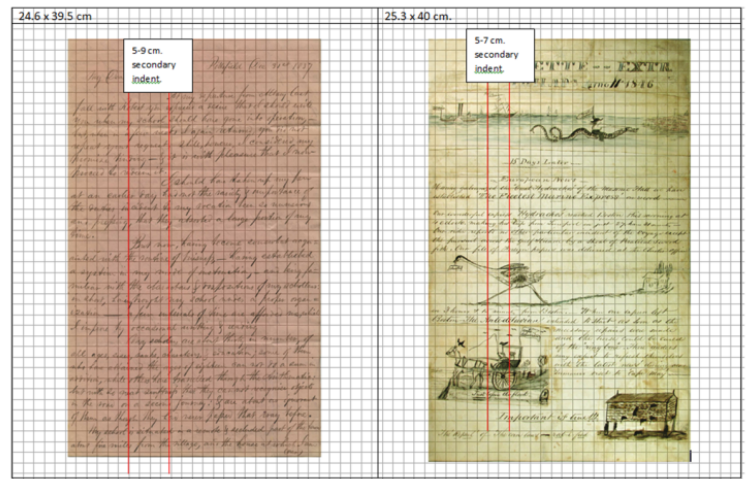


Figure 3.4 Arrangement - secondary indents

	Melville	Hydrarchos
Margins (1837)	>.5 cm	>.5 cm
Margins (1845)	2 cm left and 1 cm. right	>.5 cm
Paragraph indents	Non-existent in Melville 1837 and 1845	On verso only, ~2 cm
Secondary indents (1845)	~5-9 cm	~5-7 cm

Figure 3.5 Arrangement - Indents and Margins Checklist

Among the stranger dimensions of this data involves comparison of two data types – the final measurements between the full *Hydrarchos* document and the two Melville letters were 56.11 and 189.54, indicating a very high probability of common writership. According to Srihari, these results imply “similarity stronger than all but about 2% of all validation cases”. Paradoxically, however, comparison between the two sides of the *Hydrarchos* document, while also indicating common writership,

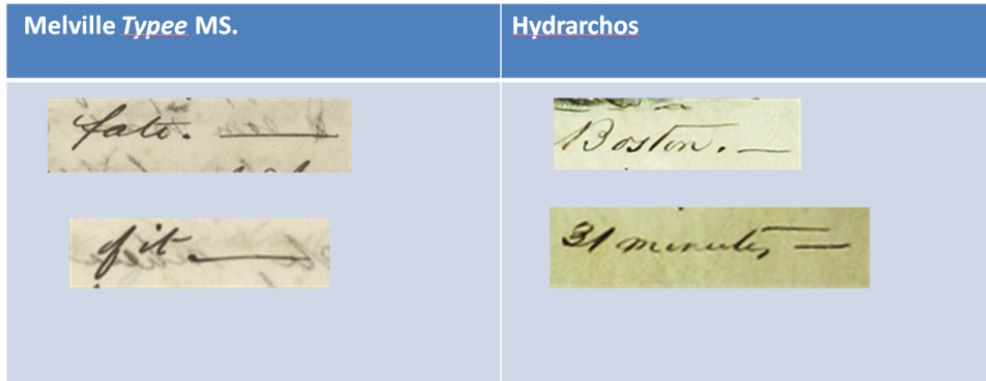


Figure 3.6 Arrangement - Straight Lines (including following periods) - Melville vs. *Hydrarchos*



Figure 3.7 Arrangement - Wavy Lines - Melville vs *Hydrarchos*



Figure 3.8 Arrangement - Caret used to insert text- Melville vs. *Hydrarchos*

	Total LLR	System Opinion
H. Melville Letter 1 vs. Hydrachos, verso	35.29	Identified As Same
H. Melville Letter 2 vs. Hydrachos, verso	129.42	Identified As Same
H. Melville Letter 1 vs. Hydrachos, recto	20.82	Highly Probable Same
H. Melville Letter 2 vs. Hydrachos, recto	60.12	Identified As Same
H. Melville Letter 1 vs. H. Melville Letter 2	333.52	Identified As Same
Hydrachos manuscript, verso vs. recto	42.87	Identified As Same
Full Hydrachos manuscript vs. H. Melville Letter 1	56.11	Identified As Same
Full Hydrachos manuscript vs. H. Melville Letter 2	189.54	Identified As Same
T. Melville Letter vs. H. Melville Letter 1	-14.84	Indications Did Not
T. Melville Letter vs. H. Melville Letter 2	12.38	Indications Did
T. Melville Letter vs. Hydrachos, recto	-68.18	Identified As Different
T. Melville Letter vs. Hydrachos, verso	-73.03	Identified As Different
A. Melville Letter vs. H. Melville Letter 1	-671.41	Identified As Different
A. Melville Letter vs. H. Melville Letter 2	-386.09	Identified As Different
A. Melville Letter vs. Hydrachos, recto	-318.96	Identified As Different
A. Melville Letter vs. Hydrachos, verso	-448.61	Identified As Different
A. Melville Letter vs. T. Melville Letter	-284.46	Identified As Different

After Srihari (2013 n. p.).

Figure 4.1 Natural Variation. Ceder-Fox Scores – Melville 1837 and 1845 vs *Hydrachos* with controls from Alan Melvill (1782-1832) and Thomas Melvill (1776-1845)

yielded a much lower LLR score of only 42.87, while the combined *Hydrachos* LLR scores for comparison with the two Melville documents are significantly higher (56.11 and 189.54).⁶ These discrepant results can be visualized by examining definite, definable differences between the writing on the two sides of the *Hydrachos* MS. Variation in degree of *Line Continuity* is one of them. Others, including the typical formation of such letters as *m*, *n* or *r*, or the bigrams *th* or *to*, fall into visibly distinctive patterns depending upon which side of the MS they are from (Figures 4.3-4.8). These categories are not exclusive – gradations of the forms exist on both sides that ultimately blend into the conclusion of common writership, but they are, *seemingly*, systematic in a manner that requires explanation or else they may easily be misread as evidence that the two different sides of the QD were written by different persons. More likely, as evidenced in such factors as the much wider variety in the line thickness and considerably higher rate of disconnects on the verso side, they are attributable to the two sides being composed at different sittings and with two different writing implements.

Add to this the fact that in several cases one side of the document is identifiably closer to Melville's norms than the other, but that it is not always the same side (depending on the feature selected for comparison or the choice of exemplars from the standards). This "mixing" that results from sometimes one side and then the other seeming closer to an hypothetical norm from the known sample points to the common origin of the samples by one writer with a relatively large range of natural variation. To summarize these findings in plainer language, it seems that three points should be made: 1) While it looks like the two sides of the *Hydrachos* are written by the same writer (LLR score 42.87), this is not a very strong conclusion; there are many parallelisms of form observable between the two sides, but there are also variations that could easily be mistaken as evidence of two different writers; 2) On closer inspection, and in view of the total circumstances of various LLR scores, it appears that the variations observable between the two sides (which resulted in the relatively low LLR score) are best explained as instances of natural variation within the

	H. recto	H. verso
Hydrarchos		
Melville		

Figure 4.2 Natural Variation- |m

	H. recto	H. verso
Hydrarchos		
Melville		

Figure 4.3 Natural Variation- Th bigram

	Hydrarchos recto	Hydrarchos verso
Hydrarchos		
Melville		

Figure 4.4 Natural Variation within the *Hydrarchos* MS compared to Melville - to bigram

	Hydrarchos recto (c hitch)	Hydrarchos verso (c curl)
Melville		

Figure 4.5 Natural Variation- C/c, illustrating curl variant

Recto – cursive r	Verso – italic r

Figure 4.6 Natural Variation, forms and gradations of small letter - r. H document-verso and recto

	Melville	Hydrarchos
initial		
medial		
terminal		

Figure 4.7 small letter r Melville vs Hydrarchos

hand of a single writer; 3) It is much more likely (up to LLR 189.54), in fact, that the *Hydrarchos* was written by Melville than that the two sides of the document were written by the same person (LLR 42.87).

In other words, the concept of *Natural Variation* can explain this pattern of evidence while confirming that all the data sets are written by the same hand. If the null hypothesis is correct, a larger sample size should lead to a divergence in the samples and

declining LLR scores. But if the two samples are both by the same hand, the larger the samples are, the more they will converge – as they do in this case – to produce the effect of a unity, resulting in larger LLR scores. One can visualize this effect – the way the larger sample results in a blurring of ephemeral difference to allow for the emergence of underlying identity of the forms, by comparing Melville graphs against those

from the two different sides of the document. Seeing this with examples should assist us in visualizing why – paradoxically – Cedar’s LLR score for the two sides of the *Hydrarchos* MS was so low in comparison with the more robust conclusions identifying Melville as the writer. The small letters *m* (4.2) and *c* (4.5), as well as the bigrams *th* (4.3) and *to* (4.4), for example, help illustrate the CEDAR-FOX findings.

When sorted by side, the graphs of *m* (figure 4.2) from the *Hydrarchos* illustrate a divergent pattern. The recto forms are typically more rounded and carefully arched, while those of the verso are more angular, “saw-toothed” or triangular, the result of a different pen, a swifter and less precise execution, or both.

For the *th*-bigram (4.3) the more streamlined and less full forms of the recto, lacking a loop for the *h* but including a true cross-stroke for the *t*, are a closer match to Melville, although like the other letters, the Melville sample reflects the full range of variety seen in the *Hydrarchos*, including -sometimes- full loops on the *h* and uncrossed letter *t*.

A very similar pattern is evident in the *to*-bigram (4.4), with graphs from both samples illustrating both the true cross-stroke form of the letter *t* and the informal variant with the faux-cross, in which the pen does not leave the page to form the cross stroke.

Figure 4.5 illustrates the same type of three-way comparison with the allomorphs *C/c*, showing forms on the verso of the *Hydrarchos* of graphs with a strongly garlanded curl in the opening part of the stroke compared to those seen on the recto, which typically begin more in a tight hitch. Again the Melville corpus shows forms matching both types as well as including a similar range of intermediate forms.



Finally, the distribution of the forms of the highly variable small letter *r* constitutes an important clue to the individuality of a 19th century hand, and close study of these forms again reveals an underlying pattern of distribution that confirms the common origin of both samples. Two primary allographs– the cursive () and the italic () of small letter *r* (exemplars from *Hydrarchos* sample) are found throughout both samples in many variations and gradations.

Figure 4.6 illustrates the basic contrast of the *Hydrarchos* forms between recto – on which the modern cursive-*r* predominates – and the verso – on

which the classic italic form predominates. Like the other variations considered here, the distinction is not absolute, and both sides intermix at least a few graphs constructed on an alternate pattern.

Comparison with the QD reveals a striking congruence of the range of Natural Variation of small letter-*r* in both samples (Figure 4.7), that both employ the same forms in the same locations with comparable frequencies. The small *r* (Figure 4.7) has perhaps the greatest range of *natural variation* of any of the small letters. When exemplars from both samples are sorted by position (initial, medial, or terminal). Their distribution reveals patterns that again support the hypothesis of common writership of both samples.

6. Line Continuity

Line Continuity, which refers to interruptions in or discontinuity of the writing line, resulting from pen stops, pen lifts, or disconnections, is perhaps the single most important feature used for evaluating the genuineness of samples in suspected cases of forgery. The forger typically leaves telltale signs of pen hesitation caused by reorienting the direction of a line to follow the predetermined artificial trajectory of a model. In a case such as this one, where forgery is not a consideration, line quality, -- especially attention to the patterns of connection or disconnection within words – can still be a highly revealing mode of analysis.

Both the known and questioned samples contain a broad range of variation in the degree of connectedness of the letters, with the *Hydrarchos* verso showing a much smaller rate of disconnection within letters than the recto side. Melville’s handwriting, likewise, reveals variation with respect to rates of disconnection between cursive letters. Melville 1828, very carefully inscribed when the writer was only nine years old, contains almost no intraword disconnections between letters; Melville 1837 standard contains approximately one hiatus – most typically before or after such letters as *c*, *a*, *i*, *g*, *e* or *o* – for every eight words, most typically in longer words. Melville’s 1845 standard illustrates a closely similar pattern of the distribution of disconnections but at a higher rate of closer to one for every five words. Within the approximately 237 fully or mostly cursive words of the *Hydrarchos* recto, there are about 32 disconnects, about one for every four words; within the ~290 words of the verso,

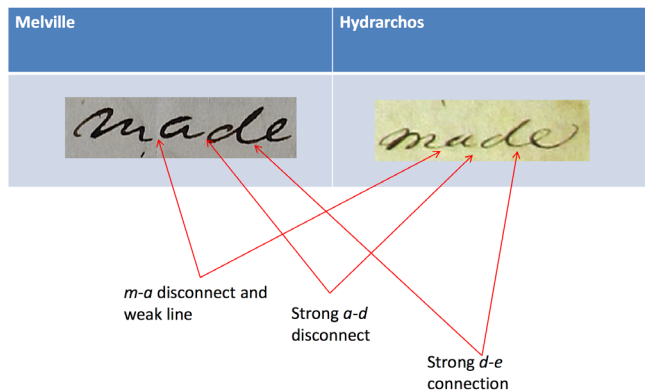


Figure 5.1 Line Continuity in Melville and *Hydrarchos*

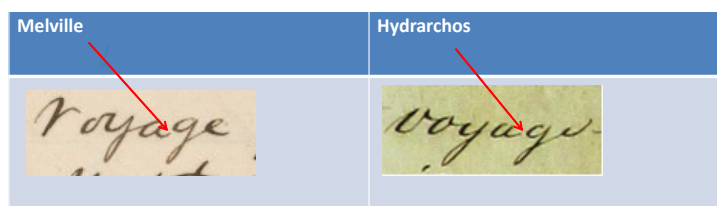


Figure 5.2 Line continuity - *a-g* hiatus in *voyage*



Figure 5.3 Design and Construction of Allographs- U/u-V/v

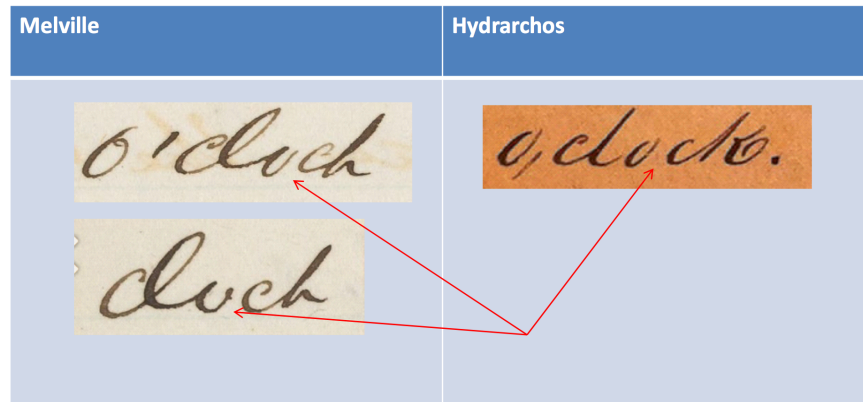
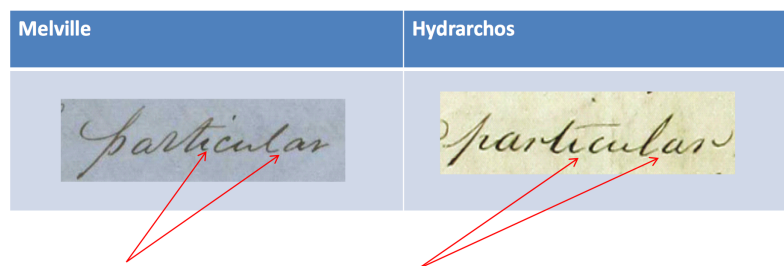
only six disconnects are found. Thus, both samples show a similar range of variation of the rate of disconnection – and, most interestingly, the expressed discontinuities involve many of the same letters in both the *Hydrarchos* and Melville samples. Figures 5.1-5.5 illustrate parallelisms of line discontinuity in both samples.

In both Melville and *Hydrarchos* sample graph *made* (5.1) the pattern of line continuity is the same. In both samples, there is an *a-d* disconnect; in figure 5.1 there is also an *m-a* disconnect. In figure 5.2 the connecting line, while visible, is very faint compared to the line continuity between *d* and *e*. In both samples,

also, the *d-e* connection is the most viable, with the thickest and most continuous connecting line.

The graphs of *voyage* in 5.2 show many remarkable features of common form, except that the initial *V* is visibly of different design.

Do such discrepancies disprove identification? That depends both on the quality of the other types of evidence in the case, including to what extent the discrepancy can be reconciled by enlarging the sample size for the particular discrepant trait. In this case, sampling the range of variation in the graphs of both samples (Figure 5.3) resolves the discrepancy by showing that the QD graph falls within the range of variation documented in the known sample.

Figure 5.4 Line Continuity, *o-c* disconnection in O'clock

As is typically for Melville 1845, the Melville sample shows slightly *more* line discontinuity than the Hydrarchos, also leaving an initial *p-a* gap that is filled in the Hydrarchos sample with a light connecting link between the two letters.

Figure 5.5 Line continuity - disconnected *i-c* and *l-a* in particular

Figure 5.4 illustrates the parallel patterns of *o-c* hiatus – among other elements of comparable form in the graphs *o'clock* and *clock*.

Finally, Figure 5.5 illustrates graphs of *particular* from both Melville and the QD, showing the same pattern of *i-c* and *l-a* disconnection in the second half of the word. The *p-a* hiatus in the Melville 1845 graph is typical of the larger concentration of disconnections in that sample, which also has wider margins and more generally expansive use of white space, leading to the entire document a greater sense of visual balance compared to the usually more crowded pages of his typical MS letters and literary remains.

7. Legibility.

Legibility is defined as the ease of recognition of letters. Melville's writing was often notoriously hard to read. It is less well known that his hand was not consistently or *always* as bad as this general observation might lead the examiner to believe. As Melville editors Merrell R. Davis and William H. Gilman assert, when

he wanted to be "Melville could write deliberately and carefully with an eye to clear and understandable penmanship" (Horth, 1993). As illustrated in Figure 2.1, there is a wide range of legibility documented in Melville's surviving holograph.

Figure 5.1 shows that although the QD exemplars are generally more legible than Melville's, they are also formed on the same design and reveal many parallel features. The motion and proportions of the capital letter *L* (see 4.10), the initial *pa* in papers, which shows not only a closely parallel formation of *p* but also a *p-a* hiatus in both exemplars; and even the shape of the *fi* bigram in office.

If the QD is, generally speaking, more legible than the average Melville document, using more complete and carefully inscribed allographs with fuller connectors, and sometimes with ornamental embellishment of the type seen in the Melville sample only for special effect, it is also on close examination somewhat erratic in its forms. Especially towards the top of the obverso side of the document, or in certain

Melville	Hydrarchos

Figure 6.1 Legibility detail - Liverpool, papers and office

	Melville	Hydrarchos
1		4
2		5
3		
	Mnts (abbreviation for <i>minutes</i>)	

Figure 6.2 Legibility detail, *minutes*.

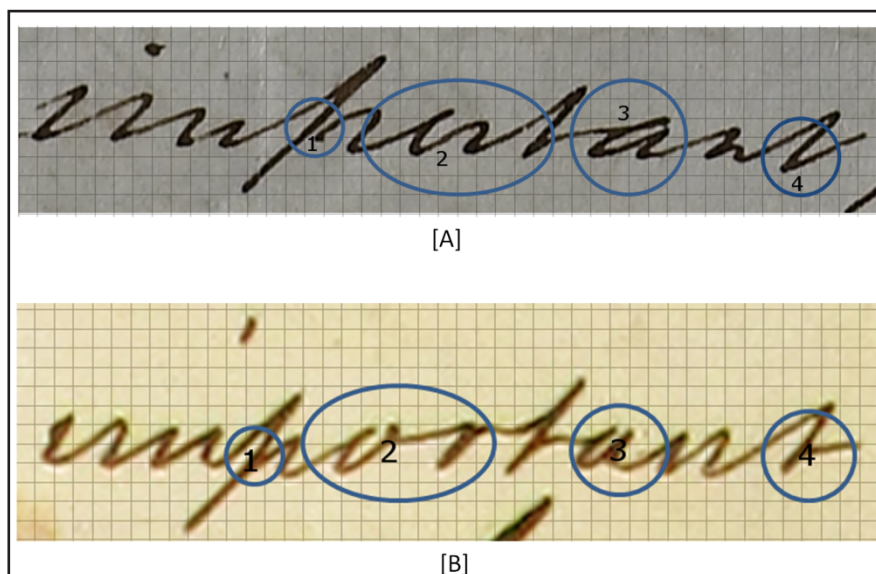


Figure 6.3 Legibility detail - *important*

hurried words on the recto, like *minutes*, the hand reverts more to the hypothetical mean of legibility. Figure 6.2 shows five samples, three from Melville and two from the *Hydrarchos*, of the construction and execution of the word *minutes*, with pointers to the *m-i* disconnects. Uncharacteristically, Melville's example 1 in Figure 6.2 is written more legibly and complete than in the *Hydrarchos*'s examples 4 and 5.

Despite these obvious differences, on the other hand, the two examples of the word *minutes* show that they are probably of common authorship. Evidence of common authorship is present in the following: four of the examples in Figure 6.2 show the same idiosyncratic feature of the *m-I* hiatus; the placement, size, and shape of the diacritic marks are very similar on examples 1 and 4; the *ntes* endings on the abbreviations in examples 3 and 4 illustrate common features in slant, location, and the right-extended crossbar on the *t*. In his more legible writing as seen in example 1 in Figure 6.2, Melville adopts many of the forms and practices seen in the more legible writing in the *Hydrarchos*. And although the *Hydrarchos* examples are usually more carefully planned and diligently executed than their equivalents in the Melville examples, they are also regularly formed with a similar design and show many parallel features as 6.3 illustrates.

Above and beyond the strong general resemblance in the formation of this nine letter word, Figure 6.3 enumerates the four main characteristics that render the [A] known samples of Melville different from the [B] the *Hydrarchos*. These differences are all readily explicable on account of the greater speed and less clearly defined articulation of A, and are characteristic of differences commonly seen in *Natural* as opposed to *Artificial Variability*, i.e. the product of variations within a hand, in this case being readily attributable to the more casual and rapid execution of the known sample. Angles, proportions, patterns of connectivity, letter formations, slant, and many other features illustrate the identity of the writer notwithstanding these instances

8. Discussion

A purpose of the present paper has been to promote an interdisciplinary inquiry into the history and genesis of the "*Hydrarchos* MS," approaching this task using both a scientific method developed by the CEDAR-FOX project and a more traditional approach used by forensic document examiners. While many questions have been answered, further inquiry beckons. The forgoing analysis has shown that even though the QD, in the main, is more legible than most of Melville's other writing, its letter forms and writing patterns fall well within the range of variation seen throughout Melville's known corpus. For example, after cataloging discrepancies in legibility caused by the generally faster and more casual execution in the Melville sample of the word, *important* (Figure 6.3), the angles, proportions, patterns of connectivity, letter formations, slant, and many other features confirmed the high likelihood of shared writership as indicated in the CEDAR-FOX findings. Such marked parallelisms of form are visible in many other words found in the two samples which illustrate and substantiate the CEDAR-FOX findings.

While these findings provide solid support for the conclusion of Melville's writership, they may not have proven it. Further study can not only improve our knowledge about a document of intrinsic interest, but also may provide novel illustrations of the applicability of various forensic techniques to a problem of this nature. One especially useful line of further inquiry is computational linguistics. While several elements of linguistic analysis support Melville's authorship of this document, the language of the *Hydrarchos* could benefit from as much attention from forensic linguists as it has received from handwriting scientists like Professor Srihari and the CEDAR-FOX team. Another critical area of inquiry includes the artistic techniques and themes expressed in the document. Testing of paper, inks, and paints could be used to validate the document's authenticity as an 1840's document. Melville scholars, themselves, might be further encouraged to wrestle with the possible implications of the *Hydrarchos* for Melville studies, given the already existing weight of forensic evidence summarized here. It seems, in short, that scholars by using the scientific techniques and the traditional methods utilized by forensic document examiners are

probably nearer the beginning than the end of a having a fully comprehensive and satisfying explanation of this strangely wonderful manuscript.■

Reference

- Ambrose, Stephen. (Dec. 1996). "When was the Real Techno-Revolution?" *Forbes* 2/12/1996 Supplement 158, 26-27.
- Anon. (January 1845). "The Hydrarchos, or Great Fossil Sea Serpent," *New York Dissector* II:1.
- Anon. (1845) "The Great Hydrarchos," *Medical and Surgical Journal* (1828-1851) Nov. 12, 33, 15.
- Arvin, Newton. (1957). *Herman Melville: A Critical Biography*. New York: Viking Press.
- Ball, Gregory R., Danjun Pu, Roger Stritmatter and Sargur N. Srihari (2010A) "Comparison of historical documents for writership", *Proc. SPIE* 7534, 75340P (2010); <http://dx.doi.org/10.1117/12.839923>.
- Ball, Gregory R., Danjun Pu, Roger Stritmatter, and Sargur N. Srihari. (2010 B). "Writer Verification of Historical Documents among Cohort Writers," *Frontiers in Handwriting Recognition* (ICFHR), 2010 International Conference, 16-18 Nov., 2010), 314 – 319, Digital Object Identifier: 10.1109/ICFHR.2010.55.
- Bryant, John. "The Melville Text," 553-266 in Wyn Kelly et al.
- "Melville's L-Word: First Intentions and Final Readings in Typee," *The New England Quarterly*, 03/1990, 63:1, 120-131.
- The Fluid Text: A Theory of Revision and Editing for Book and Screen*. University of Michigan (2002).
- Caligiuri, Michael P. *The Neuroscience of Handwriting: Applications for Forensic Document Examination* (International Forensic Science and Investigation).
- Cha, Sung-Hyuk. (2001). *Use of Distance Measures in Handwriting Analysis*. A dissertation submitted to the Faculty of the Graduate School, State University of New York at Buffalo.
- Christian, Richard S. (2012). "John Jenkins and 'The Art of Writing': Handwriting and Identity in the Early American Republic," *New England Quarterly* 85:3 491-525.
- Committee on Identifying the Needs of the Forensic Science Community. (2009). *Strengthening Forensic Science in the United States: A Path Forward*.
- Davis, Merrell R. and William H. Gilman. (1960). *The Letters of Herman Melville*. New Haven: Yale University Press.
- Davis, Tom. (2007). "The Practice of Handwriting Identification," *The Library: Transactions of the Bibliographical Society* 8.3, 251-276.
- Gilman, William H. *Melville's Early Life and Redburn*. (1951). New York: New York University Press.
- Hayford, Harrison, MacDougall, Alma A., and G. Tanselle, Thomas (1987). *The Piazza Tales and Other Prose Pieces (1839-1860)*. Vol. 9. Evanston, Ill.: The Northwestern Newberry Edition.
- Hamilton, Charles. (1979). *The Signature of America: A Fresh Look at Famous Handwriting*. New York: Harper & Row.
- Harralson, Heidi H. and Larry S. Miller (eds). (2017). *Huber and Headrick's Handwriting Identification: Facts and Fundamentals*, 2nd edition.
- Harralson, H. H., E. Waites and E. J. Will. "A Survey of Forensic Handwriting Examination Research in Response to the NAS Report," in Rémi, C, L. Prevost and E. Anquetil, Eds. (2015). *Drawing Handwriting Processing Analysis: New Advances and Challenges. Proceedings of the 17th Biennial Conference of the International Graphonomics Society*.
- Harralson, H. H., C. Kaufman, and M. W. B. Jarvis. (2015). "Handwriting and Visual Impairment: A Forensic Analysis of J.S. Bach's Signatures," in Rémi et al. *ibid*.
- Harrison, Diana, Ted M. Burkes and Danielle P. Seiger. (October 2009). "Handwriting Examination: Meeting the Challenges of Science and the Law," *Forensic Science Communication* II:4.
- Henning, William E. (2002). *An Elegant Hand: The Golden Age of American Penmanship and Calligraphy*. Oak Knoll.
- Higgins, Brian and Hershel Parker. (1995). *Herman Melville: The Contemporary Reviews*. Cambridge: The University Press.
- Horth, Lynne, ed. (1993). *The Writings of Herman Melville: Correspondence*. Chicago: Northwestern-Newberry Edition, Vol. 14.
- Horsford, Howard C. and Lynne Horth, eds. (1989). *The Writings of Herman Melville: Journals*. Chicago: Northwestern-Newberry Edition, Vol. 15.
- Huber, Roy A. and A.M. Headrick. (1999). *Handwriting Identification: Facts and Fundamentals*. CRC Press.
- Jackson, Kirsten. (2006). "The Daubert Era," chapter 6 in Jean Seaman Kelly and Brian S. Lindblom, eds., *Scientific Examination of Questioned Documents*. Boca Raton: Taylor and Francis.
- Joseph, Jacqueline. (1996). "Identifying the Maker of Numerals," *Journal of the National Association of Document Examiners* 19:1.
- (1996). "Limited Exemplars and their Use in Forming Expert Opinions," *Journal of the National Association of Document Examiners*, 22:3.

- Kelly, Jan Seaman and Brian S. Lindblom. (2006). *Scientific Examination of Questioned Documents*, CRC Press.
- Kelly, Jan Seaman. (2002). "Identification of Hand Printing and Numerals," Kelly and Lindblom, 109-118.
- "Habits Observed in Naturally Written Numbers," *Journal of the American Society of Questioned Document Examiners*, 5 58-66.
- Kelly, Wyn. (2006). *A Companion to Herman Melville*. Blackwell.
- Koch, Albert C. (1845). *Description of the Hydrarchos Harlani: A Gigantic Fossil Reptile Lately Discovered by the Author, in the State of Alabama (March, 1845)*. New York.
- Levine, Robert S., ed. (1998). *The Cambridge Companion to Melville*. Cambridge: The University Press.
- Marquardt, C. and N. Mai (1994). "A computational procedure for movement analysis in handwriting," *Journal of Neuroscience Methods* 52:1 39-45.
- Metcalf, Eleanor Melville. (1948). *Herman Melville: Journal of a Visit to London and the Continent, 1849-1850*. Cambridge, MA: The Harvard University Press.
- Morris, Ron N. *Forensic Handwriting Identification: Fundamental Concepts and Principles*, Academic Press (2000).
- Myers, Albert Cook (1902, rep. 1994). *Immigration of the Irish Quakers into Pennsylvania, 1682-1750* Baltimore: Genealogical Publishing Company.
- Osborne, Albert S. (1929) *Questioned Documents*. 2nd edition. Nelson Hall: Chicago.
- Owen, Jessica. (2014). "Pilot Study: Screening the Handwriting of Different Individuals Using Cedar-Fox," *Journal of Forensic Document Examination* 24, 53-66.
- Parker, Hershel. (1996). *Herman Melville: A Biography (Volume I, 1819-1851)*. Baltimore: The Johns Hopkins Press.
- (2002) *Herman Melville: A Biography (Volume II, 185-18911)*. Baltimore: The Johns Hopkins Press.
- (2013) *Melville Biography: An Inside Narrative*. Northwestern University Press.
- Prothero, Donald R. & Robert M. Schoch. (2002). *Horns, Tusks & Flippers: the Evolution of Hoofed Mammals*. Baltimore: Johns Hopkins U. Press.
- Purdy, Dan C. (2006). "Identification of Handwriting," chapter 8 in Kelly and Lindblom 47-74.
- Renker, Elizabeth. (1996). *Herman Melville and the Scene of Writing: Strike through the Mask*. Baltimore: Johns Hopkins U.
- "A_____!": Unreadability in The Confidence Man," in Levine et al. (1998), 114-134.
- Robillard, Douglas. (1977). *Melville and the Visual Arts: Ionian Form, Venetian Tint*. The Kent State University Press.
- Rosenberry, Edward H. (1979). *Melville and the Comic Spirit*. New York: Octogon Books,
- Srihari, Sargur N. et al. (2002) "Individuality of Handwriting," *Journal of Forensic Science* 47:4, 1-17.
- (2013) "Determining Writership of Historical Manuscripts Using Computational Methods," presented at "Automatic Pattern Recognition and Historical Handwriting Analysis" workshop at Erlangen, Germany, June 14-15, 2013.
- Srihari, S.N., H. Srinivasan & K. Desai. (2007). "Questioned Document Examination Using CEDAR-FOX," *Journal of Forensic Document Examination* 18, 1-19.
- Sten, Christopher, ed. (1991). *Savage Eye: Melville and the Visual Arts*. The Kent State University Press
- Stritmatter, Roger, and Mark K. Anderson and Elliot Stone. (2015). "'Melville's Billy Budd and the Disguises of Authorship'" *The New England Review*, 36:1, 100-131.
- Stritmatter, Roger. (MS, 2011). "The 'Great Hydrarchos' Satire of April 11, 1846: A Lost Literary Manuscript."
- (MS, 2017) "Herman Melville's Seas Serpent: A Lost and Found Literary Legacy"
- (MS, 2018) 26 *Forensic Standards: A Study in Forensic Method Conducted on Herman Melville's April 11, 1846 'Hydrarchos' Satire*.
- Taroni, F., R. Marquis, M. Schmittbuhl, A Biedermann, A. Thiéry and S. Bozza (2013). "The Use of the Likelihood Ratio for Evaluative and Investigative Purposes in Comparative Forensic Handwriting Examination," *Forensic Science International*, 230: 1 1071-116.
- Thornton, Tamara Plakins. *Handwriting in America: a Cultural History*. Ann Arbor: Yale University Press, 1996.
- Worth, Marcia (Feb 16, 2011). "Herman Melville: Lost and Found in South Orange," *South Orange Patch*, Web. Accessed 4/5/2012.

Endnotes:

- 1 Many surviving examples are archived at handwrittennews.com or described in Michael Ray Smith, *A Free Press in FreeHand: The Spirit of American Blogging in the Handwritten Newspapers of John McLean Harrington 1858-1869*. Detroit: The Free Press (2011), and the online blog of the *Handwritten Newspapers Project: An Annotated Bibliography & Historical Research Guide to Handwritten Newspapers from Around the World*.

- 2 In addition to the nine “Anecdotes of Old Zack” series (Hayford, et al. 212-229) Hayford et al. list 13 short satires from *Yankee Doodle*, published in 1847.
- 3 Melville biographer Newton Arvin has described Melville’s language as one in which “the distinction between verbs and nouns, substantives and modifiers, becomes a half unreal one” and even declared that “this [disaggregating of verbs and nouns] is the prime characteristic of his work” (165); this same linguistic pattern is readily apparent in the QD’s abundant use of such participial phrases as “having galvanized,” “making his trip,” or “modes of cooking it,” and further reinforced abundantly in the document’s pattern of puns which evoke both actions and visible objects, like “penned,” “railed at,” or “interchange of hominy.”
- 4 In addition to these three main control samples, which can be recognized in electronic reproduction by their colors – orange-yellow paper for Melville 1828 ruby paper for Melville 1837, and light blue paper for Melville 1845, graphs have sometimes been excerpted for illustrative purposes from several other Melville documents, including, 1) Melville’s 1849 and 1856-57 journals (Harvard MS 371 and 374); 2) the 1850 *White Jacket* preface (Harvard MS 392); 3) Melville’s 1845-1848 correspondence with his English publisher John Murray (Horth 54-115); supplied in facsimile by the Murray archive of the Scottish National Library, courtesy David McClay; 4) leaves of the *Typee* MS downloaded from the University of Virginia’s rotunda.upress *Typee* edition edited by John Bryant; Thanks are also due the Cody Memorial Library of Southwestern University, Harvard University’s Houghton library, and the Gansevoort-Lansing archive of the NYPL, for supplying reproductions of documents for study and analysis.
- 5 Respectively, 1828: Davis-Gilman unlocated 272 (Horth 4); 1837: NYPL GL (Horth 7-9); 1845: NYPL GL (Horth 28-30)
- 6 They are also much higher than either of the scores comparing Melville samples to only one side of the document (35.29 and 20.82 for Letter #1 and 129.42 and 60.12 for letter #2)..

Disclosure

The author purchased the *Hydrarchos* in 2009 and is the current owner of the document.

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