

THE LOST MANUSCRIPTS OF LEONARDO DA VINCI

A history of Leonardo da Vinci's manuscripts
and a calculation of how many remain lost

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DECLARATION

I declare that THE LOST MANUSCRIPTS OF LEONARDO DA VINCI is my own work and that all the sources that I have used or quoted have been indicated or acknowledged by means of complete references.

.....
Richard Shaw Pooler

Date

Title:

THE LOST MANUSCRIPTS OF LEONARDO DA VINCI

A history of Leonardo da Vinci's manuscripts and a calculation of how many remain lost

Summary:

This thesis investigates the history of Leonardo da Vinci's manuscripts, explains the recovery of some of those that were lost, and calculates what proportion of his work remains lost. It does this by researching the following four main topics: the compilation of his manuscripts; the dispersal and loss of his manuscripts; the recovery and reconstruction of some manuscripts; and an estimate of what remains lost.

Most of Leonardo's manuscripts were written in the last thirty years of his life. The first part of this thesis traces which manuscripts were written and when.

After his death, his manuscripts dispersed and it is not known how many were lost. The next section details the dispersal.

Recovery of some manuscripts took place followed by further dispersal and loss. Part of the recovery was due to key collectors such as Pompeo Leoni. Other recovery was due to the compilation of material from extant manuscripts, such as the *Treatise of Painting*.

There still remains the question of how many manuscripts were lost that were never recorded or known. The final section develops a method for calculating how many manuscripts remain lost, including those that are not part of the historical record.

List of key terms: Art history in the Italian Renaissance; Leonardo da Vinci manuscripts; *Treatise of Painting*; *Codex Urbinas*; Francesco Melzi; Orazio Melzi; Pompeo Leoni; Du Frêne editions; Cassiano dal Pozzo; Count Libri.

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PREFACE

Studies on the work of Leonardo da Vinci are, of course, numerous. My familiarity with his work resulted from a dissertation I completed in the year 2004 which analysed the 1721 English edition of the *Treatise of Painting*. At the time it became clear that much is known about his various extant manuscripts, but almost nothing is mentioned about those that are lost. There are references to those manuscripts that passed from hand to hand in the dispersals, and subsequently entered major collections. There are various comments on those that were seen and read at some time, and simply disappeared. There are hints that manuscripts were written of which nothing is recorded, and nothing is known.

There is the common sense assumption that little can be said of manuscripts that are no longer extant. There is the odd reference that between half to four fifths of his work appears to be lost. The main purpose of this thesis is to refine that estimate, and to establish if a methodical assessment can be made of the full corpus of his written work, and how much of it remains lost. That attempt is made by compiling what is known about extant manuscripts, and references to those that were known about and subsequently lost. The provenance of those manuscripts is well known and easily available.

That body of evidence forms the basis for a reasoned assertion of the full extent of Leonardo's written work, with its subsequent calculation of what remains lost. That is original work, and references to that methodology do not appear elsewhere.

I wish to note that for all references I prefer footnotes or endnotes, but for references to books in the bibliography I have inserted references in the text because that is the style required by the University of South Africa. The dates of birth and death of persons mentioned in the text are provided in an endnote with the relevant source.

I wish to record my particular thanks to Professor Bernadette Van Haute whose enthusiasm and critical guidance have proved invaluable. She has encouraged me at low points, and tactfully curbed my excesses at high points, and I feel fortunate to have benefitted from her experience.

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LIST OF ABBREVIATIONS

AMsB	<i>Anatomical manuscript B</i>
AODC	Ottino della Chiesa, A. 1985
CA	<i>Codex Atlanticus</i>
CAR	<i>Codex Arundel</i>
CAW	<i>Collection at Windsor</i>
CF	<i>Codex Forster</i>
CFB	<i>Codex on the flight of birds</i>
CL	<i>Codex Leicester</i>
CM I	<i>Codex Madrid I</i>
CM II	<i>Codex Madrid II</i>
CT	<i>Codex Trivulzianus</i>
DAH	Dictionary of Art Historians
DNB	Oxford dictionary of national biography
EB	Encyclopaedia Britannica
GDA	Grove Dictionary of Art
MsA	<i>Manuscript A</i>
MsB	<i>Manuscript B</i>
MsC	<i>Manuscript C</i>
MsD	<i>Manuscript D</i>
MsE	<i>Manuscript E</i>
MsF	<i>Manuscript E</i>
MsG	<i>Manuscript F</i>
MsGan	<i>Manuscript Ganay</i>
MsH	<i>Manuscript H</i>
MsH229	<i>Manuscript H 229 Inf.</i>
MsI	<i>Manuscript I</i>
MsK	<i>Manuscript K</i>
MsL	<i>Manuscript L</i>
MsM	<i>Manuscript M</i>
NQ	Notes and Queries journal
TDB	Treccani Dizionario Biografico
UL	Universal Leonardo (http://www.universalleonardo.org)

INTRODUCTION

Leonardo da Vinci compiled an unknown number of manuscripts and notes in his lifetime. After his death, many of these were dispersed, some recovered, some despoiled and others reconstructed. It is not known how much was lost in the dispersal, and this thesis attempts to estimate and calculate how much of Leonardo's work remains lost. It investigates the history of the compilation of Leonardo's autograph manuscripts, explains the recovery of some of those that were lost, and records the despoiling of other manuscripts. It then attempts to calculate what proportion of his work remains lost by estimating and calculating what Leonardo is likely to have written. After subtracting the extant manuscripts from that estimate, the remainder is expressed as the percentage of Leonardo's work that remains lost.

Very little has been written on Leonardo's lost manuscripts on the assumption that little can be argued or discussed about material that is not available and not known about. The main purpose of this thesis is to challenge that assumption, and to explore what can be asserted about his manuscripts that were lost in an effort to define more clearly what remains lost. The thesis does this by researching the following four main topics: the compilation of his manuscripts; the dispersal and loss of his manuscripts; the recovery and reconstruction of some manuscripts; and an estimate of what remains lost.

Most of Leonardo's manuscripts were written in the last thirty years of his life and cover an astonishing range of subjects. He in fact worked on compiling a record of the world around him and how things worked which he illustrated with drawings in a number of different manuscripts, and those that survive are today in major collections around the world.

His intention was to compile a number of treatises from his notes, especially a *Treatise of Painting*, which he never seems to have achieved. There were several reasons for this. Perhaps the most important reason was his character trait that he started several projects and paintings, but then lost interest or became distracted, and never brought them to completion

(Mazenta 1635:7). With regard to his manuscripts, perhaps the main reason was that he kept adding to his notes haphazardly, rather than consolidate and order them, and as he grew older, he no longer had the strength or time to do so.

After Leonardo's death, his manuscripts were inherited by his companion, Francesco Melzi. It is not known how many manuscripts Melzi inherited, but today about 7000 pages survive, some of which are blank.¹

Leonardo's wish was that Francesco Melzi would compile a *Treatise of Painting* from his notes after his death. Melzi committed himself to working through what seems to have been a disordered jumble of manuscripts, and extracted from them whatever comments on art that he could, and transcribed them into a manuscript called the *Treatise of Painting*. He very largely achieved that goal, and then he too died.

The *Treatise of Painting* and all the other manuscripts were inherited by Francesco's son Orazio Melzi, who had little regard for them. He gave many of them away, and they began to disperse, and even the *Treatise of Painting*, later named the *Codex Urbinas Latinus 1270*, was lost (Mazenta 1635:24). This was a disastrous turn of events, and Leonardo da Vinci's priceless manuscripts appeared destined for complete dispersal and loss.

Fortunately fate played a hand as serendipitous as the dispersal was disastrous. A number of those manuscripts came into the hands of a small handful of collectors, especially Pompeo Leoni, who located and acquired an astonishing number of the manuscripts. I have compiled a stemma based on one by Pedretti showing the dispersal, and how various manuscripts passed through several hands into the collections in which they now reside. This thesis records how that came about. I also try to define the little that is known of the manuscripts that dispersed and were never recovered.

The *Treatise of Painting*, later to be known as the *Codex Urbinas*, was also lost. In a twist of fate, that treatise was recovered at a much later date. In the meantime, an enormous effort

was made by Cassiano dal Pozzo to produce a *Treatise of Painting* from whatever autograph manuscripts he could locate and produce a printed edition. This was the completion of Leonardo's dream, to compile a *Treatise of Painting* from his notes so that students could benefit from it. This thesis explains how that came about.

When the contents of the *Treatise of Painting* were later compared to whichever of Leonardo's manuscripts that had survived, it was realised that only a quarter of its contents could be found in extant manuscripts, and three quarters of its sources were untraceable (Pedretti 1965b:8). Was this an indication of how many autograph manuscripts by Leonardo had been lost as a result of their dispersal? An important part of this thesis examines this question, to determine whether there is any way of knowing how much has been lost in relation to what remains.

The evidence is scanty and much of it anecdotal, in the form of sightings, many of which lead nowhere. There are some historical connections as manuscripts passed from hand to hand, some to finally find safety in well-known collections. Other manuscripts simply disappeared. This text explores the dispersal, and partial recovery of manuscripts, but comes up against the traditional problem that little can be asserted about manuscripts that are lost, and to which there is no reference.

The surviving pages from Leonardo's original manuscripts were written between 1487 and 1519. No-one knows how many pages have been lost. It is therefore predictable that references to lost pages are vague and of a general nature. The following references are typical examples:

Ludwig Heydenreich wrote, "...The fact that less than half of the chapters in the *Codex Urbinas* can be found among the still extant Vincian manuscripts proves that substantial parts of Leonardo's literary legacy have been lost" (McMahon 1956:xiii).

Carlo Pedretti (1965:225) wrote, "...This early phase of the dispersion of the manuscripts shows that there must have been a tremendous loss of Leonardo's material within the period of a few years".

Martin Kemp (2007:Preface) suggests that four fifths of Leonardo's work may be lost.

As mentioned, another estimate of what has been lost relates to the *Treatise of Painting*. Today three-quarters of the notes in the *Treatise* cannot be traced in extant manuscripts, which suggests that only a quarter of his manuscripts have survived. The difficulty with this figure is that it relates to only the *Treatise of Painting*, and it has been tempting to apply the survival figure of only one quarter to all his manuscripts in general which is bound to be unreliable.

So there are the loose estimates that between half and four fifths of Leonardo's manuscripts have been lost. Those estimates are vague, and this thesis attempts to refine them based on historical evidence and a method of calculation which looks at the accumulated evidence from a fresh angle. It proposes a way of determining what is lost, at least in extent if not in detail, in a new and original manner.

Very little has been written directly on the topic of lost manuscripts on the assumption that writing about what does not exist and is therefore not available for analysis seems to be an impossible task, so missing and lost manuscripts receive little mention. It is therefore not possible to appraise the evidence, or make useful comparisons in terms of other studies as the data base does not exist. What does exist is the sophisticated and scholarly analysis of extant manuscripts. However a deeper and deeper analysis of extant manuscript does not take us any further towards solving the main aim of this thesis. This is a very important point of departure, as it must be recognised that in-depth analysis of what exists has limits for the purposes of this thesis, and those limits seem to confine any possible solution to the

manuscripts that exist. A method has to be found to take us beyond those limits, a thought experiment which will enable us to say something about manuscripts that do not exist.

Chapter one.

The starting point here and one of the main objectives has been to establish a database showing what manuscripts Leonardo wrote as far as is known, and when he wrote them, and to collate any data regarding lost manuscripts from whatever sources are available. The collation of these data has best been achieved by documentary analysis.

The first chapter of the thesis is therefore an overview of where Leonardo lived and when. That has provided information on which notebooks he compiled in each place, and the topics in which he was interested at each particular stage of his life, which is vital information for the calculations in the final section of this thesis. Of necessity the background history of political events has been included, but kept to a realistic minimum. Leonardo began writing his notes when he moved from Florence to Milan. Up to that point, his painting activity was his key focus. But after moving to Milan, the writing of his notes became a parallel and growing activity and continued for the rest of his life.

Chapter two.

After Leonardo's death, Francesco Melzi inherited his manuscripts, and compiled the *Treatise of Painting* from his notes, which was Leonardo's wish. However there is no complete list to show what manuscripts Melzi inherited, and on his death, the manuscripts began to disperse.

It will never be known exactly how many manuscripts have been lost, but there are some clues regarding lost manuscripts which are detailed in chapter two. Comments were made by Paolo Lomazzo and Giorgio Vasari about manuscripts they had seen which are now lost. Similar comments were made by Benvenuto Cellini,² Luca Pacioli³ and Antonio Franchi⁴ regarding early treatises that now appear to be lost. There are records of manuscripts

bequeathed or given to people which later have not appeared in their estates, such as the manuscript owned by the Duke of Amalfi (Mazenta 1635:25-6).⁵ And there are other references concerning the nature of equilibrium, the motion of water, the *De ludi geometrici* and comments by Raffaele Borghini. These are all hints at manuscripts that have been lost which contribute to our awareness of loss, but do not add much more than that to any actual calculation of loss, if that proves possible.

Chapter three.

After Francesco Melzi's⁶ death, Orazio Melzi⁷ inherited his manuscripts, and chapter three explains how they began to disperse. There are historical references to manuscripts passing from one hand to another, entering certain libraries, and then disappearing for one reason or another. Giovan Ambrogio Mazenta⁸ gave a manuscript to the Duke Carlo Emmanuele of Savoy⁹ which has not survived, and it may have burnt in one of the fires in the Royal Library of Turin in 1667 or 1679. Mazenta gave another manuscript to the painter Ambrogio Figino.¹⁰ It passed from Figino to Ercole Bianchi,¹¹ and he sold it to Consul Joseph Smith¹² in Venice. That manuscript is also lost (Mazenta 1635:24).

There have been records of other sightings that have led nowhere, such as those regarding *Libro W*. That manuscript has been seen on at least two occasions, so it is possible that it will someday re-appear (Pedretti 1965b:147).

Other manuscripts were lost and later found, such as the two *Codices Madrid*, and the recovery of *Libro A* in that remarkable text by Carlo Pedretti where he rediscovered it partly copied into the *Codex Urbinas* and partly into the *Codex Leicester* (Pedretti 1965b).

The *Codex Huygens*, Carlo Urbino's notebook, contains material from Vincian manuscripts that are now lost. Although not a Vincian manuscript, it assumes the status of one as the only remaining repository of material from autograph manuscripts that are no

longer extant. Apart from the existence of this manuscript, there are no other references to identify the manuscripts from which it was copied.

Chapter three also contains a stemma, showing how the original manuscripts dispersed passing from one owner to another, how some were lost, and how others came into the hands of collectors and finally entered the collections in which they now reside.

Other evidence consists of fragments that remain from lost manuscripts. One is a folio in the Royal Collection, *Windsor 12,604*, which may be one page from a manuscript on painting.

Then there are curious discrepancies. One regarding the British Royal Collection occurred in 1778 when Mr. Richard Dalton, librarian to King George III, found a book of drawings in the bottom of a chest in Kensington Palace. They numbered 779 drawings at that time, but when later mounted in the 19th century they amounted to 614 drawings. The discrepancy of nearly 180 drawings has never been explained (Clark 1968:v.1, xiii).

Another discrepancy occurred with the Pompeo Leoni collection which was inherited by Polidoro Calchi. He offered fifteen manuscripts and the *Codex Atlanticus* to the Grand Duke Cosimo II, who declined it. The collection later entered the Ambrosian Library and it then consisted of eleven manuscripts by Leonardo and one by Luca Pacioli. That discrepancy in the size of the collection has never been explained, and no-one knows what happened to the missing manuscripts.

Chapter four.

Francesco Melzi had fulfilled Leonardo's wish for a *Treatise of Painting* to be transcribed from his notes. But that *Treatise* was lost. The history of the manuscripts was not only one of loss. The pendulum of events swung back, and there were times when manuscripts were discovered, copied and restored. Chapter four explains how the remarkable figure of Cassiano dal Pozzo was determined to transcribe a *Treatise of Painting* from surviving manuscripts, and explains how that came about. Cassiano dal Pozzo's transcription

became the early basis for most subsequent abridged editions that are being reprinted up to today. Many copies were made, and copies of those copies with variations, and a selected list of those that survive is in Appendix 2.

Chapter four also tries to analyse the relationship between the abridged editions and the complete editions, by analysing a Concordance of several abridged and complete editions that is in Appendix 4. This proposes that the structure of the abridged editions goes back to the thinking of Cassiano dal Pozzo to produce a student edition for beginners with one section to be read each day of the year.

Chapter five.

Then there has been comment on partial losses, where manuscripts have portions missing, as with the *Codex Urbinas*, the *Codex Trivulzianus*, or the despoliation of *Manuscripts A, B, E*, and the *Codex on the Flight of Birds* by Count Libri. The activities of Count Libri have been explained in chapter five. Although it is a short chapter, it has been kept separate because his despoliation of manuscripts was not part of the general dispersal and loss, and occurred at a different time and under a set of particular circumstances that were in no way connected to the other dispersals and losses.

Chapter six.

These scattered references have been compiled and consolidated to form a record of loss and recovery. The supporting data on what is known to be lost have been collated and analysed in chapter six, but the frustrating realisation is that the collection of data on what exists does not tell us how much remains lost. That analysis has to look at the manuscripts that have survived in another way to see whether there are any clues to the extent of Leonardo's notes which are unknown and which remain lost.

The question of "what did Leonardo write" has been misleading, and has trapped us within the limits of the 'known'. Everything changes when we ask the question "what could

Leonardo have written”. Here we are in the realm of deduction based on known information and facts, but it is inherently speculative so approximations should be allowed for. We know the years in which Leonardo seems to have written his surviving manuscripts. Some are certain and are dated, others closely estimated. The folios in extant manuscripts are also known.

A table has been compiled, showing the years of Leonardo’s life in which he produced his manuscripts related to the known number of folios he produced in total. The number of pages in each of the manuscripts that has survived has been averaged over the years it took to write each manuscript. This has resulted in a table showing the total number of folios that Leonardo wrote in any one year based on only the manuscripts that have survived. This, of course, is based on a number of assumptions which are discussed later, but it serves as a relative guide to his productivity. It is that productivity figure which is all important because it establishes what his maximum output could have been. The extant manuscripts, on the other hand, establish a minimum, but we know from the fact that there are a number of lost manuscripts that the actual number of manuscripts that Leonardo wrote is somewhat greater. Chapter six discusses the implications of these figures in an attempt to estimate the percentage of Leonardo’s work that has actually been lost. The initial application of the methodology is based on the calculation of folios and the times when they were written. Objections to this approach are then listed and discussed as a way of refining that approach. Common to many of the objections are the various differences between manuscript pages. A nuanced methodology is then developed enabling all manuscript pages to be compared whatever their sizes, textual matter or illustrative contents based on the scanned documents at Leonardodigitale.¹³ This becomes a method of comparing ‘apples with apples’. The initial methodology and the refined methodology are referred to as the folio method and the pixel

method, and their results differ in important respects showing the value of the refined pixel method.

Four appendices have been included, starting with a list of extant Vincian manuscripts in Appendix 1. They have been listed elsewhere, but appear here in more detail as a convenient reference.

Appendix 2 lists manuscripts copied from the *Codex Urbinas*. This is a select list showing the collections in which they reside.

Appendix 3 shows a list of printed editions of the *Treatise of Painting*, showing its remarkable extent, dates of first editions and their reprints, and ancillary details.

Appendix 4 contains the Concordance which is the basis for the analysis of the abridged editions in relation to the complete editions. An earlier Concordance compared the Du Frêne editions with the Ludwig and McMahon editions. That has been expanded to include the 1721 and the Rigaud editions. That was an enormous task, and all analyses and conclusions based on that Concordance are original to this thesis.

A note on the original manuscripts and their translations is necessary. The peculiarity common to all Leonardo's manuscripts is the mirror script in which he wrote from right to left, in both his quick notes and his final or good copies. There are a few instances of his writing left to right but they are rare. He was naturally left-handed, and seems to have developed the dexterity to write from right to left with ease.¹⁴ For him it must have been a matter of convenience and habit, allowing him to see clearly what he was drawing or writing as his hand moved away from the ink without smudging it. Leonardo's handwriting from right to left was not the only difficulty affecting its legibility. He also wrote in a late mediaeval style which was influenced by the notarial or mercantile hand of his father, and his grandfather, which had its roots in the Carolingian miniscule hand.

Of course the names that are used today for the various surviving manuscripts have changed a little over the years depending on who owned them, and in which collections they were held. After Leonardo died, his close companion Francesco Melzi inherited them and he marked them with his own symbols, some of which are sometimes used. Several manuscripts today bear the names of people who owned them at one time or another in the past, such as the *Codex Arundel* after Lord Arundel, or the *Codex Forster*, or the *Codex Leicester* after Lord Leicester, which changed to the *Codex Hammer*, and then back again. Two are named after the collection that holds them, the *Codices Madrid*. A key collection of manuscripts is in the Institut de France in Paris, and they are named *Manuscripts A to M*. For ease of reference and clarity in this text, manuscripts are referred to by their names as they are known today.

This thesis makes an original contribution to the history of Leonardo da Vinci's manuscripts throughout his life in various ways. Although most of that history is the compilation of known facts, the form of compilation of that information and ancillary supporting analysis is original.

Furthermore I have compiled two stemmae – the first on the dispersal of Leonardo's manuscripts, based on an earlier one by Pedretti, and the second on the printed editions of Leonardo's manuscripts.

The critical comments comparing the early English editions is original work, as is the analysis of the printed editions which contains the argued conclusion that the abridged editions were intended to be beginners' or students' editions of Leonardo's thinking on art. That has been asserted elsewhere, but actually demonstrated here. There is the additional assertion that a section should be read each day as part of a one-year course. Although this is conjectural, it is based on the number 365 which leaves little room for other explanations. It

is frustrating that there is no other supporting or explanatory evidence, but it is demonstratively not coincidence. These are assertions based on information derived from the Concordance, which is an expansion of one completed by me in a dissertation I wrote in 2004.

The analysis of the missing manuscripts, with its argument of how much of Leonardo's work is lost based on the accumulation of data, is original work both in its method, analysis and its conclusion, and is the culminating argument of this thesis. What is also original is the refinement of the methodology which develops a method of comparing manuscripts of different sizes and densities, whether based on drawings or text, or a mixture of both. This enables the comparison of different manuscripts on the basis of 'apples with apples', rather than the unrefined comparison of manuscripts on the basis of possibly widely differing folios.

ENDNOTES

¹ The calculation of blank pages is dealt with later in the thesis.

² 1500-1571 (GDA Sv Benvenuto Cellini).

³ c. 1445-c. 1514 (GDA Sv Luca Pacioli).

⁴ 1634-1709 (GDA Sv Antonio Franchi).

⁵ 1498-1565. (nobili-napoletani.it).

⁶ 1493-c.1570 (GDA Sv Francesco Melzi).

⁷ Born c. 1592.

⁸ 1565-1635 (TDB Sv Giovan Ambrogio Mazenta).

⁹ 1562-1630 (EB Sv Carlo Emmanuele).

¹⁰ 1548/1551-1608 (TDB Sv Ambrogio Figino).

¹¹ 1576-1636 (worldcat.org/identities).

¹² c. 1682-1770 (EB Sv Joseph Smith).

¹³ A digital archive of Leonardo's manuscripts at the Biblioteca Leonardiana in Florence.

¹⁴ Luca Pacioli mentions that Leonardo was a *mancino* in his *De viribus quantitatis* (1496-1508) and Lomazzo in his *Trattato dell'arte della pittura* refers to Leonardo writing with his *mano stanca*, or tired hand. See Bambach 2003: 32.

CHAPTER 1 – Leonardo’s life 1452-1519

1.1 INTRODUCTION

The focus here is on the strands of Leonardo da Vinci’s life that contributed to the development of his autograph manuscripts, and the story of when they were written. As a very brief background to his working life, Leonardo spent the first seventeen years in Florence. After that he went to Milan for sixteen years, and then spent further periods in both cities, before travelling to Rome and finally settling in France. During each of these periods in his life, he painted the few paintings that have survived, a few that are unfinished, and those that are lost, but are known about. He also created a small body of sculpture, very little of which has survived.

The other great monument to his genius that survives and arguably rivals his paintings in importance is the body of notes and autograph manuscripts that he began writing when he was 26 years old and which he continued to compile for the rest of his life. His intention was to record what he could learn about the natural world around him and to use his art to illustrate it. A portion of those notes survives, and most are now in important collections around the world. The various notes that survive are usually referred to as *Codices* or *Manuscripts*, for example *Codex Atlanticus*, or *Manuscript K*.

His first period in Milan was important because that was when he first began writing his notes, after which he kept compiling them to the end of his life as a parallel and growing activity alongside his painting.

Our knowledge of Leonardo and the life that he led depends on information from four sources of reference, which are the manuscripts of four authors. It seems sensible to introduce them at this stage.

Antonio Billi¹ (Billi 1969) was a Florentine merchant who compiled notes on various artists from Cimabue to Pollaiuolo in the early 1520s. His style was not very informative,

being not much more than a list of artists and the works they had produced, but it did include an appendix of contemporary artists which included Leonardo da Vinci. His original manuscript is lost, but there were two copies made in the 16th century, now known as the *Libro di Antonio Billi*.²

The second source is another Florentine who had access to the *Libro di Antonio Billi* in the early 1540s, and amplified it to include material from an artist called Giovanni di Gavina. Beyond that almost nothing is known of the author and as he is anonymous, he is generally referred to as the Anonimo Gaddiano, from his 128 folio manuscript which was owned by the Gaddi family, a famous family of Florentine artists. This manuscript³ was unknown until about 1755 when it was discovered in the Magliabechiano collection of manuscripts⁴ in Florence, but was brought to the attention of scholars only in 1892 by the art historian Carl Frey.⁵ Because of this provenance, the author is sometimes referred to as the Anonimo Magliabechiano,⁶ and the Anonimo Fiorentino, or simply the Anonimo – the anonymous author of that particular manuscript of *Lives*. The first part records artists from Classical antiquity derived mainly from Pliny, and the second part contains artists from Florence and Siena, as well as other pieces. His comments on the artists from Siena were based on Ghiberti's⁷ *Commentarii*.⁸ There is internal evidence in the form of an angry drawing at the end to suggest that the Anonimo worked on his text until January 1547, and then abandoned it possibly because he knew that Vasari's much more ambitious work would supercede it.

The next source is the key document of the sixteenth century that was to establish Leonardo's reputation, although somewhat inaccurately. It is of course Vasari's



Figure 1.
Self-portrait of Giorgio Vasari

Lives (1996).⁹ The idea for a book of *Lives* was first mooted at the Papal Court in Rome in the 1540s (Turner 1992:60-62). Paolo Giovio,¹⁰ the bishop of Nocera and historian at the Papal Court, was approached to write it since he had written a few brief lives in the 1520s. These included one of Leonardo (Giovio 1949:35) which he wrote in Latin on the island of Ischia sometime after 1527.¹¹ He had probably met Leonardo in Milan or Rome in about 1508 but he also knew Francesco Melzi, and lived near him (Farago 2009b:13-14). He turned down the project, but one evening at Cardinal Alessandro Farnese's¹² apartment in Rome he suggested the idea to Giorgio Vasari (figure 1), who was interested in the proposal and started working on it (Boase 1971:43-8). It was a considerable undertaking, and quite an achievement when he produced the first edition of his *Lives* in 1550. It must be remembered that much of what he wrote was compiled from conversations with third parties, from memories and scandal, from anecdotes and general comment. As a result much about Leonardo is hearsay and unreliable as Vasari was only eleven when Leonardo died, and so could never have met him. A feature of his *Lives* is that he hardly mentions non-Italians, that European art was Italian art, and Italian art sprang naturally and directly from the culture of Ancient Rome. Despite his narrow view he was very influential, and his *Lives*, with all its inaccuracies, spread to other European centres over the years. Later artists and writers in other countries copied it extensively, with the inclusion of their own artists.

The fourth source of reference are the manuscripts of Gian Paolo Lomazzo,¹³ an Italian mannerist painter who went blind in about 1571 at the age of 33, and turned to writing. He published his *Trattato dell'arte della pittura* in 1584 (Lomazzo 1844), which was really a practical guide to painting and sculpture. He followed it with his *Idea del Tempio della Pittura* (1974) in 1590 which was a more theoretical work covering art criticism and abstract concepts.

1.2 FAMILY BACKGROUND

Ser Piero da Vinci, 26 years old, lived in the small village of Vinci, consisting of perhaps 20 to 30 houses, which lay 35 kilometres west of Florence. His title Ser indicated that he was a notary, as was his father, and his father before that. The family lived together in a large house owned by Piero's father Ser Antonio, in a typical rural community.¹⁴ About three kilometres away lay the small hamlet of Anchiano, and there it is supposed lived Caterina in a farmhouse. Piero and Caterina met and in the middle of 1451, Caterina fell pregnant with the subsequent illegitimate birth of Ser Piero's first son in the spring of 1452 (Heydenreich 1954:11).

Ser Piero refused to marry Caterina but went to some lengths to make the birth of his first son respectable. He had him baptised by a priest, with five men and five women present from the community. This was recorded by the child's grandfather Ser Antonio, who wrote:¹⁵ *"My grandson was born, son of Ser Piero, my son, on April 15, Saturday, at three in the night."*¹⁶ *He was named Lionardo. He was baptized by the priest Piero di Bartolomeo, ..."* and then he listed the ten villagers who witnessed the baptism.¹⁷ This was done to record the birth of Leonardo da Vinci as his first son, a proper and full member of his family despite the fact that he was illegitimate.

Very little is known of Caterina – just her name. There is no picture of her except for a drawing at Windsor (CAW 12,276v) which seems to be of various family members, and the woman at the bottom of the page could be Caterina, but that is pure speculation.

For the first fourteen years of Leonardo's life he was the only child in the household, then he left home and the village of Vinci and moved to Florence in the period between 1462 and 1467 (Villata:4-7). After leaving Vinci, he started his working life in Florence joining the studio of Andrea del Verrocchio.

1.3 FIRST FLORENTINE PERIOD 1466-1483

According to Vasari (1965:626), Leonardo was introduced to Andrea del Verrocchio¹⁸ by his father, Ser Piero, in the mid 1460s, probably 1466, and was admitted to his studio which was just behind the Duomo. He would have been about 14 or 15 years old. This move to Florence may have been occasioned by the death of his grandfather, Ser Antonio, the effective head of the household, and ‘in loco parentis’ for Ser Piero. The date of Ser Antonio’s death is not certain but it was before 1465.

Andrea Verrocchio, or properly Andrea di Michele di Francesco di Cione, accepted him into his studio on the Via de Agnolo in about 1467, and he remained a pupil there until 1477 (Turner 1992:12).

By the year 1477, when Leonardo had worked in Verrocchio’s studio for ten years, it was time to break away and set up his own studio. He was able to work as an independent artist, starting a new phase in his life which would last a further six years, until he decided to leave and move to Milan in 1483 (Heydenreich 1954:11). It was his move to Milan that concerns us here as that was the time in which he started writing his notes and manuscripts, which he continued doing for the rest of his life.

He received several commissions, and they contained the evidence of a trait that was to characterize Leonardo and his work for the rest of his life. This was his extraordinary vision and skill in whatever he did, but his inability to see many projects through to the end and finish them. He had almost unrivalled talent and a brilliant mind, but much that he attempted simply was not brought to completion.

Paolo Giovio (1949:35) said of him, “but while he was thus spending his time in the close research of subordinate branches of his art he carried only very few works to

completion; for owing to his masterly facility and the fastidiousness of his nature, he discarded works he had already begun”.

The Anonimo Gaddiano (1949:37) had the view that Leonardo completed so little because he became frustrated that he was not reaching the perfection that he so desired. He wrote, “... He was learned in mathematics and equally in perspective, he worked as a sculptor and his drawings surpassed all others by far. He made many beautiful inventions, but left very few paintings, because it is said that he could never be satisfied with his own work.”

Sebastiano Serlio (1611:fol.8v)¹⁹ had a similar view when he said, “... In fact, theory springs from the brain, but practise depends on the hands, and that is why Leonardo Vinci who was most learned was never satisfied with what he did, achieved perfection with only a few works and often said that the reason was that his hand could not follow his intellect.”

Vasari (1965:627-628) agreed with him, when he said, “... We find that Leonardo, through his understanding of art, began many works, none of which he completed, since he felt that his hand could not reach the artistic perfection conceived by his mind...”.

This was echoed by Lomazzo (1590:100), when he wrote, “... And thus although Leonardo shook with emotion whenever he began painting, he never finished anything he started because he thought of the greatness of Art, and always found mistakes in works which to others seemed miraculous”.

In his book *The Renaissance in Italy*, John Addington Symonds (1899:Ch.VI)²⁰ summed it up with the following:

... often he made vast preparations and accomplished nothing. It is well known how the Prior of Santa Maria delle Grazie complained that Leonardo stood for days looking at his fresco, and for weeks never came near it; how the monks of the Annunziata at Florence were cheated out of their painting, for which elaborate designs had yet been made; how Leo X, seeing him mix oils with varnish to make a new medium, exclaimed, ‘Alas! This man will do nothing; he thinks of the end before he makes a beginning’ ... he would do nothing as taskwork, and his creative brain loved better to invent than to execute.

The above comments were echoed by Henry Fuseli,²¹ in a lecture to the Royal Academy in 1801, when he said,

Such was the dawn of modern art, when Leonardo da Vinci broke forth with a splendour which distanced former excellence; made up of all the elements that constitute the essence of genius, favoured by education, and circumstances, all ear, all eye, all grasp; painter, poet, sculptor, anatomist, architect, engineer, chemist, machinist, musician, man of science, and sometimes empiric, he laid hold of every beauty in the enchanted circle, but without exclusive attachment to one, dismissed in her turn each. Fitter to scatter hints than to teach by example, he wasted life, insatiate, in experiment. To a capacity which at once penetrated the principle and real aim of the art, he joined an inequality of fancy that at one moment lent him wings for the pursuit of beauty, and the next, flung him on the ground to crawl after deformity: we owe him chiaroscuro with all its magic, we owe him caricature with all its incongruities. His notions of the most elaborate finish and his want of perseverance were at least equal (Fuseli 1831:11).

It was Leonardo's inability to complete projects that affected both his paintings, and his notes and manuscripts.

Leonardo stayed in Florence until 1483, working in his own studio for five years during which time the Pazzi conspiracy took place. Lorenzo de' Medici had fallen out with Pope Sixtus IV, and in 1478 when Leonardo was 26, a nephew of the Pope masterminded an attempt to assassinate Lorenzo de' Medici (Hay 1989:161). In the attempt, his brother Giuliano de' Medici was stabbed to death, and this led to war between the Florentines and the Pope (Turner 1992:18). It was this background of conflict that promoted Leonardo's interest in designs for machines of war and fortifications which he started to record in a manuscript possibly as early as 1478. This was the beginning of a lifelong habit of recording the world around him in notebooks that have given us an insight into Leonardo's extraordinary creativity and curiosity. Some of the notes were preliminary sketches for later paintings but by far the majority of drawings were to illustrate Leonardo's investigations, to record how things worked, and to devise various machines to exploit and control the world around him.

1.4 FIRST MILANESE PERIOD 1483-1499

In 1483 Leonardo decided the time had come to leave Florence and went to Milan for the first time to work for the Duke, Ludovico ‘Il Moro’ Sforza (Heydenreich 1954:12). A point of interest is that they were the same age, Leonardo being born on the 15th April 1452, and Ludovico on the 27th July in the same year.

Why did Leonardo go to Milan from Florence where he spent the next 17 years? Perhaps he had tired of Florence, and maybe his restless nature found the much larger city of Milan an attraction. Milan with a population of about 125 000 was rather larger than Florence with about 41 000 (Zöllner 2003:64).²² Or perhaps he realised that he had developed a reputation as an artist who did not complete his commissions, and he wished to make a fresh start. The Anonimo (Steinitz 1949:37) suggests he was sent to Milan by Lorenzo de’ Medici. There is no certainty in this, but there is a possible explanation in a letter that Leonardo had written to Ludovico Sforza (Goldscheider 1959:33) explaining his skills and talents, and an interesting aspect in his letter is that his skill as an artist and painter comes far down the list. The main thrust of his letter explained what he could do to assist Ludovico Sforza in the matter of war (Beltrami & Villata 1999). He offered to make portable bridges, scaling ladders, catapults, mangonels and cannons. He knew how to make covered vehicles for protection when attacking the enemy, he could tunnel underground noiselessly, and could make a variety of instruments and machines for attack or defence, either on land or at sea. He could drain moats, and conduct water from one place to another. He was as good as any other as an architect, and was keen to undertake work on a bronze horse to honour Ludovico’s father. Near the end, in all this welter of undertakings, he offered the following: “... Also I can execute sculpture in marble, bronze and clay. Likewise in painting, I can do everything possible as well as any other, whosoever he may be” (CA:391r). This seems almost like an understated after-thought,

tacked on after recording his real skills as a military engineer. It seems he was being realistic, first promoting his skills as a military engineer in a time of political turbulence, uncertainty and threatening war (Clark 1958:84,139).

Leonardo was known to be in Florence on the 28th September 1481 and to be in Milan on the 25th April 1483. His departure was somewhere in between. The Anonimo (Steinitz 1949:37) says he was 30 when he left which would be after his birthday on 15th April 1482, presuming the Anonimo is correct.

His first year in Milan could not have been easy. Leonardo must have received some work, maybe a few small commissions that somehow kept him going, and he struggled on until his breakthrough occurred not much more than a year after he had arrived in Milan. It was on 25th April 1483 that Leonardo was commissioned to paint the *Virgin of the Rocks* (AODC 15:93)²³ and at last he was able to live on the advances he received to carry out the commission.

This was a critically important time for him, and the start of a major activity that was to last for the rest of his life, the writing of his notes and manuscripts. His first manuscripts or notebooks were written in about the mid 1480s, and what may have inspired Leonardo is a manuscript²⁴ by Francesco di Giorgio (Vecce 2003:69)²⁵ that is now in the Laurentian Library in Florence, containing plans of churches and drawings of machinery and weapons. That manuscript²⁶ was actually owned by Leonardo and annotated by him (Clark 1958:108). Francesco di Giorgio was a Siennese architect, engineer and artist, and a close friend of Leonardo who seems to have been a strong influence on him in Milan. We can see this in many of Leonardo's early drawings of military machines and architectural drawings. There is a view (Menziés 2008:177-196) that di Giorgio took his ideas from Mariano Taccola (Prager 1971),²⁷ and he in turn borrowed from the Chinese *Nung Shu* (Menziés 2008:189).

Another treatise on warfare and military machines that seems to have influenced him was the *De Re Militare* by Roberto Valturio.²⁸ He was an engineer and writer working for

Sigismondo Malatesta²⁹ in Rimini, and he published his *De Re Militari* in Latin in 1472 and in Italian in 1483.³⁰ Leonardo owned a copy of his book,³¹ and it clearly inspired his own drawings of chariots with whirling blades and other machines of war (Vecce 2003: 68).

Francesco di Giorgio's manuscript and Valturio's illustrated text could well have inspired Leonardo to compile his own manuscript, now known as *Manuscript B* (UL 2013:MsB). This is probably the earliest of his surviving manuscripts, and is dated from about 1487 to 1490 and runs to 84 sheets.³² On folio 42r there is the date 2nd April 1489. *Manuscript B* is a miscellany of notes containing architectural drawings of churches and their structural problems, flying machines and a submarine, military technology and civil engineering, a steam powered cannon, cogs and wheels, and geometric figures. *Manuscript B* also contains drawings of elevated buildings and elements of town planning. These could have been inspired by the horrors of a three year Bubonic plague that swept through Milan from 1484 to 1487.³³ Leonardo approached Ludovico Sforza with plans for reconstructing the city on improved sanitary principles. Some of his plans and drawings appear in this early manuscript.

A peculiarity of *Manuscript B* is that it contains sketches of flowers. Leonardo claimed to have sketches of "... many flowers drawn from the life" (Emboden 1987:116),³⁴ but only about fifteen drawings survive.³⁵ The probability is that a manuscript, or manuscripts, detailing flowers and plant growth have been lost. Many of his paintings contain highly detailed and exquisitely painted flowers, particularly in foregrounds, with symbolic significance. There are a few botanical sketches in *Manuscript G*. Leonardo's knowledge of flowers and their depiction was clearly so extensive that there must have been notes that contain preparatory sketches for plant growth that are now lost.

Another collection of notes that began as early as 1487³⁶ and continued for the rest of Leonardo's life is the *Codex Atlanticus* (UL 2013:CA). After Leonardo's death, this collection of loose notes was put together by the collector Pompeo Leoni into an 'atlas' sized

volume containing 1119 folios. That collection of drawings and notes is the largest of all Leonardo's works, and covers every aspect of all his diverse interests ranging from 1487 to the end of his life.

Another early manuscript, written at about the same time as *Manuscript B*, is the *Codex Trivulzianus* (UL 2013:CT)³⁷ which Leonardo started in about 1487 and finished in 1490. It was named after the Trivulzio family which owned it in the 18th century. This is a manuscript of 55 folios but there were originally 62 folios, and six are now missing. It contains notes on military studies and architecture including stables and designs for a dome for the Milan Cathedral. There are caricatures, Latin vocabulary lists³⁸ and word lists that he compiled to widen and enrich his vocabulary.

There is also a list of five books in the *Codex Trivulzianus* (CT 2v) that Leonardo owned which appears to be the beginning of his library. A list in the *Codex Atlanticus* (UL 2013:CA) from the early 1490s lists 40 books in Leonardo's possession, and a later list in the *Codex Madrid II* (2v-3r) of 1504 lists 116 volumes.

The late 1480s was a time of intense study for Leonardo, when he concentrated on his studies of biology, mathematics, physics and mechanics, and also began experiments in human flight. It was also at this time that he began his first notes and drawings of anatomy.

Whilst Leonardo was to make a huge contribution to the understanding of anatomy with his own dissections and anatomical drawings, he depended initially on existing texts such as the *Fasciculus Medicinae*, which was first published in Latin in 1491 with many subsequent editions (Tite 2011). It was a compilation of six separate mediaeval medical treatises and was the first illustrated medical work to be printed. There were originally two handwritten copies, one of which was owned by the German physician Johannes de Ketham, and was incorrectly ascribed to him as the author or translator. The first Italian edition appeared in 1495 (Anonymous 1495) as the *Fasciculo de Medicina*, and a copy of this book



**Figure 2. Windsor 19 000 v
Studies of the bones and musculature
of the arm**

is listed in Leonardo's personal book list. What is surprising is that the first text on dissection and anatomy was written as early as 1316 by Mondino de'Liuzzi³⁹ in his *Anathomia corporis humani* which was published in 1478. It was later incorporated into the *Fasciculus Medicinae* in 1491.

In 1489 Leonardo was planning his own treatise on anatomy with the title *De figura umana*,⁴⁰ convinced that a knowledge of anatomy as well as

geometry was essential for a painter (Turner 1992:35).

The first date that appears in Leonardo's notes dealing with anatomy is at Windsor (figure 2) and records the following: "On the second day of April 1489 book entitled Of the Human Figure" (Richter 1970: R 1370).

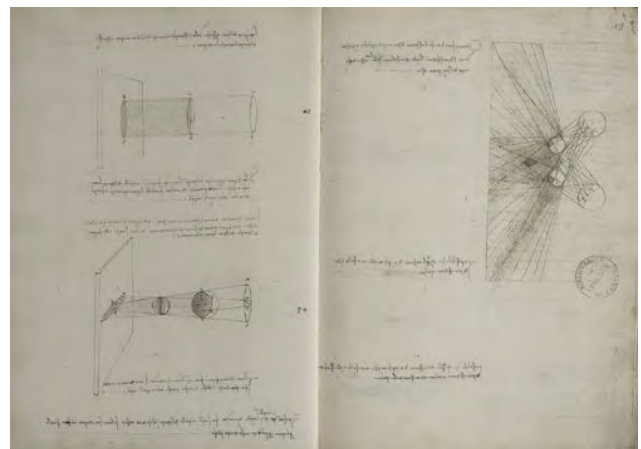
Leonardo visited Pavia in June 1490 (Clark 1958:114), travelling with his friend Francesco di Giorgio Martini⁴¹ who was acting as a consultant to Pavia Cathedral with regard to some building activities (Turner 1992:34). While there, Leonardo entered the old Visconti Castle and the library collected by Galeazzo Visconti II,⁴² an earlier ruler of Milan. This was a considerable library for the time, holding more than a thousand books and manuscripts. It was later looted by King Louis XII⁴³ of France to augment the Royal collections, and the rest of the contents became dispersed to many other collections throughout Europe. Amongst the manuscripts, Leonardo found one by Erazmus Ciolek Witelo,⁴⁴ the Polish mathematician and Dominican. This was of particular interest to him as Leonardo mentioned Witelo four times in his surviving manuscripts, in the *Codex Atlanticus* (fol.225 r-b, and fol.247 r-a), the *Codex Arundel* (fol.74v), and in *Manuscript B* (fol.58), which Leonardo completed in 1490

after his visit to Pavia. In this he noted that “... In Vitulone there are 805 conclusions in perspective”.

Scattered throughout Leonardo’s various manuscripts were his notes on the paintings he was working on, notes on sculpture, and notes on art theory. It was in about 1489 that he wrote many of his notes on painting that were later collected together by his friend and apprentice Francesco Melzi to form a *Treatise on Painting* which survived, and entered the Vatican Library under the name *Codex Urbinas Latinus 1270*.

Leonardo then began *manuscript C*.

It contains a note confirming when it was begun, being 23rd April 1490, and was completed the following year. *Manuscript C* (UL 2013:MsC)⁴⁵ consists of 14 sheets folded to form 28 folios, dealing mainly with shadow and light (figure 3), optics and



**Figure 3. Manuscript C Fol 18v-19r
Studies of light and shade**

geometry, but also physics, acoustics, games and jokes, water and miscellaneous items. It

also contains a note that Leonardo had begun the Sforza horse, which was to be an enormous equestrian statue which Ludovico Sforza commissioned in mid 1489 to commemorate his father Francesco (Vasari 1965:633). This project had been commissioned in 1472 by Ludovico’s elder brother, Galeazzo Maria Sforza,⁴⁶ who was Duke of Milan before him. He had engaged two sculptors, Antonio⁴⁷ and Cristoforo⁴⁸ Mantegazza, but they found the project too large for them and never made a start.

Leonardo accepted the commission for the Sforza monument, and surprisingly completed the clay model of the gigantic horse by 1493 and it was exhibited in the courtyard of the Castello Sforzesco.

Luca Pacioli helped Leonardo with calculations for the casting of the bronze. Luca said that when cast, the bronze horse and rider would have been about 12 *braccia* tall, with a bronze mass of 200,000 *libbre* (Pacioli 1509:Preface).⁴⁹



**Figure 4. Codex Madrid I, 45r
Technique to regulate springs**

In addition to *Manuscript C*, other notes from this time refer to the *Sforza horse* (CAW 12,320),⁵⁰ and most of them are part of the two volume set known as the *Madrid Codices* (UL 2013:CM I,II). Various folios are bound together to form the two volumes and the earliest is a notebook of 17 folios forming the last section of the *Codex Madrid II*, dating from 17th May 1491 to 20th December 1493. It contains notes and drawings on the design, casting and transporting of the *Sforza horse*, and records that on 17th May 1493 the horse was ready for casting. Towards the end of 1493 Leonardo was preparing to cast the horse, and made sketches of his method. But this was never to come about. Ludovico Sforza simply could not afford this amount of bronze at a time of war, especially when he was fighting for his survival. So the casting was delayed (Clark 1958:142). Then in late 1494, the bronze which had been set aside for the casting was sent by Ludovico Sforza to his father-in-law Ercole d'Este⁵¹ in Ferrara to be used in the casting of cannon instead (Heydenreich 1954:65). Nothing further was to happen until the outcome of Ludovico's battle against the French.

Codex Madrid I was begun on 1 Jan 1493, and Leonardo continued working on it for about 7 or 8 years, reaching completion in about 1499. It deals with theoretical and applied mechanics and is full of drawings of industrial devices, textile machines, grain mills, windmills, spinning wheels, lifting devices, the mechanics of clocks, and basic mechanical principles (figure 4). *Codex Madrid II* followed a bit later, and the bulk of it was written between 1503 and 1505.

The other manuscript written about this time is *Manuscript A* (UL 2013:MsA),⁵² probably begun in 1492. It is a painter's manual, dealing with painting techniques, optics, perspective, proportion, movement, mechanics, and physics, and more on light and shade (figure 5). This was used more extensively than any other of the notebooks in the compilation



**Figure 5. Manuscript A, 20v-21r
Measuring the distance of the sun**

of the *Treatise of Painting*. An interesting note by Luca Pacioli and a later one by Paolo Lomazzo may refer to *Manuscript A*. In the dedicatory epistle of the *De Divina Proportione* dated 1509, Luca Pacioli claims that "... Leonardo has already finished a worthy book on painting and human motion" (Clark 1958:125). Lomazzo (1584:158) later referred to a book, "... which I read a few years ago, which he wrote with his left hand, at the request of Ludovico Sforza, Duke of Milan". These comments seem to refer to *Manuscript A*, but if not, then they clearly refer to another manuscript similar to *Manuscript A* which is now lost. It was possibly based on *Manuscript A* and would have been written between about 1495 and 1508. But there is doubt that Lomazzo could have seen such a book. He was born in 1538, thirty-nine years after Lodovico Sforza was overthrown. It is possible that he may have seen such a treatise in the mid 1500s, but there was no mention of such a treatise in the manuscripts inherited by Francesco Melzi after 1519.

The next manuscripts that were written by Leonardo were the *Manuscripts H1, H2, and H3* from 1493 to 1495. These were three pocket books bound together⁵³ to form *Manuscript H* (UL 2013:MsH).⁵⁴ They contain notes on Euclidean geometry, allegories, Latin grammar, a bestiary, currents in rivers, hydraulic engineering, notes on the excavation of the Martesana

canal and drawings of compasses. There are notes on optics, perspective and painting, a stairway, a vineyard at Vigevano and a fountain. There are plans for a drawbridge, a pavilion, a watermill, a recipe to control itching, musical instruments and his invention of the viola organista.⁵⁵

The notes on Latin grammar in *Manuscript H* are a reminder that Leonardo was uneducated in a formal sense. He began to study Latin at the University of Pavia⁵⁶ to enable him to read the works of writers such as Euclid, Galen, Celsus, Ptolemy, Pliny, Vitruvius and Archimedes. He described himself as “omo sanze lettere”,⁵⁷ and a knowledge of Latin and grammar would have allowed him to communicate better with the very gifted and educated men around him at Court. Nevertheless Leonardo’s claim of being uneducated was a bit disingenuous. He had grown up in a landowning family of notaries, so would have received a basic education in numeracy and literacy. Although he had not received a higher education and was not well-read in the classics, he did not seem to be interested in philosophising and competing with the brilliant and well-educated circle at Court. His knowledge was gained from experience and observing nature which was actually congruent with the tradition of Aristotelian thinking of the day, and he excelled at it. His claim of being unlettered set him apart rather than at a disadvantage.

There is an entry in *Manuscript H* that is intriguing which indicates that he may have maintained contact with his mother Caterina (MsH:64v). Towards the end of his stay in Milan, he wrote in this notebook that he had visited Caterina in hospital and gave her 20 soldi at the end of January 1494 when he was about 42. He later noted the expenses for her burial (CF II: 64v) when she died the following year in 1495, which at 138 soldi were sufficient to show that she was someone important or close to him, but there is no other reference to her other than her first name. Perhaps his mother had come to visit him in Milan, fallen ill and died. There was another mention in his notes of Caterina who had joined his household in

1493 (Richter 1952:320) but it seems unlikely that Leonardo would have provided such an expensive funeral for her. It seems more likely that this Caterina was his mother. At the same time as he wrote *Manuscript H*, Leonardo began work on the *Codices Forster* (UL 2013:CF) starting in about 1487 and continuing to 1505.

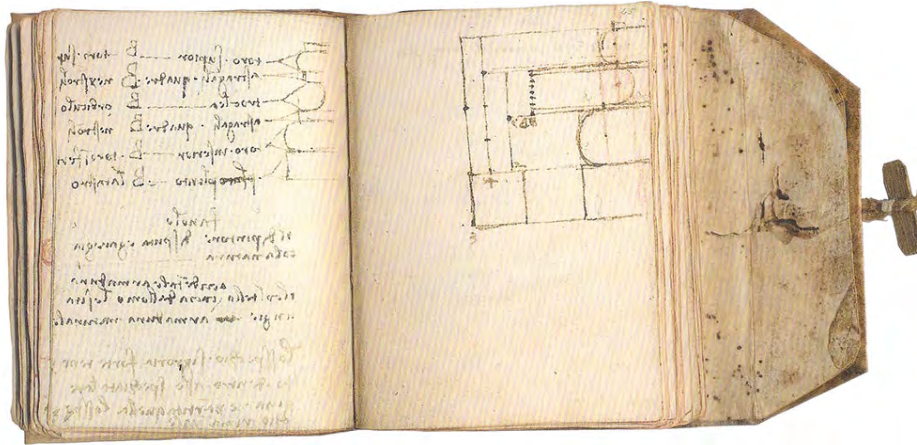


Figure 6. Codex Forster III 44v-45r, Proportions of a column base

The *Forster codices* are pocket books in the V&A Museum in London and they consist of three codices, but the first two contain two manuscripts each. The details are as follows:

Codex Forster I. Manuscript 1: This manuscript contains a note, “begun by me Leonardo da Vinci on July 12, 1505”. This is a treatise on the transformation of plane rectilinear figures and geometric and curvilinear solids into equivalents, which was what Leonardo called ‘the Science of Equiparation’, but is today known as topology. It has become a major subject area in mathematics and concerns spatial properties under transformation, such as stretching, and Leonardo’s interest in it extended from his interest in geometry. It was at one time known as ‘*geometria situs*’, or the geometry of place. A great deal of his thinking on this is also in *Codex Madrid II*.

Codex Forster I. Manuscript 2: This was written between 1487 and 1490, and contains notes on hydraulic engineering.

Codex Forster II. Manuscript 1: This was written in about 1495 and contains notes on proportion, the work of Luca Pacioli, notes on bells and other miscellaneous matter.

Codex Forster II. Manuscript 2: This was written between 1495 and 1497 and contains notes on weights, traction and balances, as well as notes on the crossbow.

Codex Forster III: Written between 1490 and 1493, this manuscript contains a very miscellaneous selection of notes on weights, hydraulics, geometry, horses' legs, clothing and the anatomy of the human head (figure 6).

In 1497, Leonardo started further notes on geometry, architecture, mechanics, hydraulics, and the measurement of his vineyard at San Vittore near Milan. This was to become *Manuscript I* which he completed in 1505. *Manuscript I* (UL 2013:MsI)⁵⁸ consists of two notebooks bound together and is quite long at 140 folios. It also contains notes on perspective and proportion, which Melzi did not include in the *Codex Urbinas*.

Political upheaval again interrupted Leonardo's life and Ludovico, his patron, was in trouble. Charles VIII⁵⁹ of France died in April 1498. The Duke of Orléans Louis II succeeded him becoming King Louis XII.⁶⁰ His grandfather had married Valentina Visconti so he was a descendant of the Visconti family who had ruled Milan before the Sforza, and provided him with a claim to the Duchy of Milan which he was determined to exercise (Hay1989:165).

Louis XII of France, the Pope and Venice had formed a plan to capture the Milanese and divide it between them. News came through that the French were mustering forces for an invasion, and that Louis XII had crossed the border into Italy in May 1499.

Ludovico Sforza countered this by forming a league with the northern principalities of Italy by plotting with the Turks against Venice, and by plotting with the Germans and Swiss against France. The Germans and Swiss fell out with each other and Louis XII's forces continued to advance down Italy towards Milan. Ludovico decided to flee and left Milan on

2 September heading for Innsbruck with the hope of patching up the alliance, and getting help from the Emperor Maximilian. The French took Milan on 6 September when the garrison gave in without a fight, and King Louis XII entered the city one month later (Corio 1554:49v). Baldassare Castiglione⁶¹ witnessed the arrival of the French which he memorably described as follows (Villata 2005:7):⁶²

“In this parade the Majesty of the king of France entered the castle of Milan, formerly the receptacle of the flower of the men of the world, now filled with the basest taverns and perfumed with dung.”

After all the political upheaval and uncertainty and the expulsion of his patron Ludovico from Milan, and with the French in control, it was now time for Leonardo to leave. It was late in December that he left Milan, in the last days of 1499 (Turner 1992:41).

1.5 THE WANDERING YEARS 1499-1503

We are now at the point where Leonardo had completed a sixteen year stay in Milan, from when he was 31 to his 47th. It was 1499 and he spent the next four years travelling (Clark 1958:158,159). He went to Mantua and Venice, visited Florence and Rome briefly, and joined Cesare Borgia⁶³ on his aggressive rampages round central Italy and the Romagna (Turner 1992:43). He left Cesare Borgia and returned to Florence in 1503, settling down for his second period there which lasted until 1506 (Heydenreich 1954:13).

At the beginning of this period, Leonardo left Milan with Luca Pacioli in December 1499 and headed for Mantua. An intriguing aspect of their arrival in Mantua is that Luca Pacioli and Leonardo spent time with Isabella d’Este the Duchess of Mantua, who is known to have been a chess enthusiast - so was Luca Pacioli, and it now seems Leonardo. It appears that after that meeting in about 1500, Luca Pacioli wrote a 48 page manuscript on chess, the *De ludo scacchorum*, that he dedicated to Isabella d’Este and Francesco Gonzaga, her husband and Duke of Mantua. The manuscript of the *De ludo scacchorum* was then lost for

centuries, and some even disputed whether Pacioli ever wrote it. The single manuscript copy was rediscovered by a bibliophile, Duilio Contin, in the 22 000 volume Coronini Cronberg library⁶⁴ in Northern Italy in 2006 (FPCC 2012). Count Guglielmo Coronini had bought it from a collector in Venice some years earlier in a lot with some other books. The manuscript contains over a hundred chess problems, and it has been suggested that Leonardo designed the chess pieces that are illustrated in the manuscript.⁶⁵ A point to note is that the pieces conform to the Golden Mean, or 1:1.618 in which both Leonardo and Pacioli were interested. Leonardo's collaboration is supported by the fact that some of the drawings have been drawn with both left and right hands. He may have contributed to the chess problems as well, particularly one which is extremely difficult. This collaboration with Pacioli, and the chess illustrations that appear to be by Leonardo suggests another supposition, namely that Leonardo probably made notes with drawings on chess in one of his own manuscripts. It is highly unlikely that he drew the chess pieces conforming to the golden mean and devised one or more chess problems without initial exploration of the subject in his own notes. But there are no notes on chess in any existing manuscript. If this supposition is correct, Leonardo's notes on chess may well have been part of a manuscript which is now lost.

Leonardo then travelled on to Venice where he spent his time studying mathematics and cosmography.

In the meantime, Ludovico Sforza had returned to Milan with Swiss mercenaries and recaptured it in February 1500. But in April he had to fight the French again at the town of Novara. Ludovico was defending the town with his 6000 Swiss mercenaries against about 10 000 Swiss mercenaries under King Louis. His mercenaries deserted him allegedly over a pay dispute precipitated by the fact that they would have to fight against other Swiss mercenaries, notably in greater numbers. King Louis agreed to a conditional surrender to avoid the Swiss fighting each other, sons against fathers and so on, on condition that Ludovico Sforza

surrendered. Ludovico was captured while trying to escape in disguise. The French exacted revenge and Milan was then sacked (Eggenberger 1967:313).

In April 1500 Leonardo heard of the second defeat of Ludovico Sforza, gave up the



Figure 7. Manuscript M, 78v-79r
Diagrammatic drawing of the growth of trees

thought of returning to Milan and pressed on to Florence which he reached by the 24th April 1500 (Clark 1958:162). He had been away 18 years to find his father was still practising as a successful notary in his mid-seventies. That was when Leonardo began *Manuscript M* (UL 2013:MsM)⁶⁶ starting it in about 1500 and completed it

by 1502. It contains his notes on Euclid, Aristotle and the great classical authors, and notes on geometry, physics and plant growth (figure 7).

In the summer of 1502, Leonardo was on the move again joining Cesare Borgia, Duke of Romagna and Duke of Valentinois, as his family architect and general engineer. He received a passport to travel through and survey the military buildings in the territories Cesare had overcome and grabbed for the Papal States, with the added authority that Pope Alexander VI⁶⁷ was Cesare's father.

Throughout the following year, from July 1502 to March 1503, Leonardo travelled over much of central Italy through Emilia and the Marches in his capacity as Chief Inspector of Military Buildings. This entailed extensive travel through Umbria, Romagna and Tuscany, and formed the basis for many of his notes on architecture, fortifications and cartography (Heydenreich 1954:14).

This was when he drew the beautiful maps that are now at Windsor, such as the map of Imola (CAW 12284). Leonardo recorded this expedition in a diary which is now known as

Manuscript L (UL 2013:MsL)⁶⁸ (figure 8). It includes notes on the *Last Supper*, military fortifications, and his early thoughts on flight. These notes on flight were to be expanded in a *Codex on flight* which Leonardo completed about three years later. It also included some notes that Francesco Melzi transcribed into the *Codex Urbinas*.

A further point of interest is that *Manuscript L* contains notes on a bridge for the Sultan of Turkey, Sultan Bayezid II.⁶⁹ It would have crossed the Golden Horn with the longest span in the world at the time of 240 metres. The Sultan did not proceed with the design (UL 2013:MsL).



Figure 8. *Manuscript L*, 79v-80r Acoustics

Leonardo went to Piombino (Villata 2005:34), Siena and Urbino, then through Pesaro and Rimini to Cesena. Two months were spent between Cesena and Cesenatico managing canal and harbour works and surveys. Leonardo then went on to Imola, Sinigaglia and Perugia, and finally through Chiusi and Aquapendente to Orvieto, and maybe even Rome where Cesare Borgia arrived on 14th February 1503 (Clark 1958:170-171). After the fall of Perugia and Siena early in 1503, Leonardo decided to resign his employment with Cesare Borgia and return to Florence, which he reached at the beginning of March.

1.6 SECOND FLORENTINE PERIOD 1503-1506

It was on his return to Florence in 1503 that Leonardo then started two major enterprises both of which failed (Turner 1992:43-46). One was a design (CAW 12,679, 12,680) and plan to divert the River Arno. The city relied on foreign trade that used the River Arno to reach Florence. However Pisa was situated at the mouth of the Arno, and Pisa and Florence were in

dispute with each other (Villata 2005:34). Two engineers submitted plans to divert the Arno round Pisa and redirect it to Florence. One was Leonardo da Vinci and the other was a man called Colombino. Leonardo proposed diverting the Arno with weirs and a single channel, and calculated that the project would take 54 000 man-days (Clark 1958:192). He designed a mechanical digger to speed things up and the design appears in the *Codex Atlanticus* (CA 4r,7r,v, 386r,v) (figure 9).

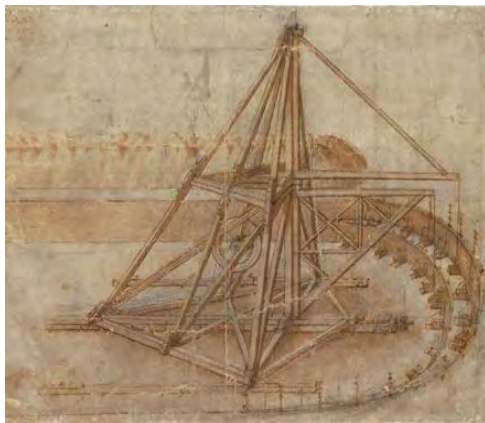


Figure 9. *Codex Atlanticus*, 4r
Machine for excavating canals

But Colombino proposed two smaller channels which would be easier to construct, hoping that the flow of water would erode the land between the channels, thus resulting in one large channel over time, promising his plan to be quicker and cheaper. Colombino's plan was accepted, but a number of things went wrong. Pisan troops attacked the workers, they were not paid, and a chance flooding of

the Arno took place, drowning eighty workers. The river then reverted to its normal course and the plan was abandoned (Masters 1999:96-133).

The other major enterprise was the picture of the *Battle of Anghiari* (Vasari 1965:637) (AODC 33:106).⁷⁰ In 1503 Leonardo was commissioned to paint this battle on one of the walls of the Sala del Gran Consiglio, which later became the Hall of the Five Hundred, the Salone dei Cinquecento in the Palazzo Vecchio in Florence (Villata 2005:34-5). The deadline for completion was February 1505, and Michelangelo was commissioned to paint the *Battle of Cascina* on the opposite wall (Clark 1958:193).

Leonardo never finished this painting which was to be enormous - 7 x 17 metres, twice the size of the *Last Supper*. Because it was so large, Leonardo worked on the cartoon in the Sala del Papa at Santa Maria Novella, and finished it within two years in about July 1504.

He then left Florence in early October, and seems to have gone to Piombino via Vinci. There is a note that he was at the castle of Piombino on the 20th October, and he was still there on the 1st November.⁷¹

Leonardo's notes (CAW 12,330)⁷² on the *Battle of Anghiari*, and on the project to divert the course of the Arno River with a canal linking Florence to the sea are recorded in a manuscript that he began in 1503. This is the *Codex Madrid II* which is dated from 1503 to 1505 and includes military engineering notes relating to Piombino, notes on perspective and optics, studies in geometry, and the casting of the monument to Francesco Sforza. It also contains Leonardo's list of books in his library.

During this second period in Florence, Leonardo pursued his interest in mathematics and anatomy, and began studying flight. But this stimulated wider research, and his studies of flight led to studies on hydraulics and the movement of water. This formed the basis of his next manuscript which was *Manuscript K* (UL 2013:MsK)⁷³. It was begun in about 1504 and was completed in 1507, and contains notes on geometry, water, on flight, further studies for the *Battle of Anghiari*, hydraulics, architecture and anatomy, and studies of the moon.

Before he completed *Manuscript K*, Leonardo's obsession with flight led to the compilation of the *Codex on Flight* (UL 2013:CFB), which is a small manuscript of only 18 folios. It was written in Florence between 14 March and 15 April 1505, with the date 1505 on the manuscript. This *Codex* deals with the mechanics of flight, designs for a flying machine, wind resistance and air currents (Clark 1958:190-191).

About the time when Leonardo was beginning *Manuscript K*, his father Ser Piero died on 9 July 1504 and Leonardo noted he was 80 years old – he was actually 78 (Heydenreich 1954:19). That discrepancy in the record of his age may be a small indication of the distance between Leonardo and his father which was reflected in his father's will. He left two

daughters and ten sons including Leonardo, who learnt that his father's considerable assets had been inherited by his legitimate half-siblings, and he had been left nothing.

1.7 SECOND MILANESE PERIOD 1506-1513

In 1506 Charles d'Amboise,⁷⁴ Lord of Chaumont, Marshal of France and Grand Admiral of the French Fleet, was appointed Governor of Milan. In May he invited Leonardo to return to Milan (Turner 1992:49).

Leonardo left his manuscripts safely in the Ospedale di Santa Maria Nuova in Florence and travelled to Milan where the French Governor, Charles d'Amboise, welcomed him as his honoured guest. Leonardo was due back in Florence by the end of August 1506 to complete the *Battle of Anghiari*, but Charles d'Amboise wrote to the Signoria requesting an extension of time which they agreed to as France had protected Florence against Cesare Borgia. By the end of that extended period Leonardo had not returned to Florence. The Signoria ran out of patience and sent a letter of demand to Charles d'Amboise. This resulted in an exchange of letters in which the Signoria refused a further request for three month's leave. Finally King Louis XII of France intervened in 1507 by instructing his Florentine ambassador to write to the Signoria telling them he wished to employ Leonardo as Royal painter and engineer. Louis XII followed this with his own letter, and the Signoria of Florence gave way (Clark 1958:201-205).

Thus began Leonardo's second stay in Milan which lasted for seven years from 1506 to 1513. During this period he studied nature, geology, hydrology and aerology. He also completed most of his anatomical studies, and concentrated on biology using his skill in drawing to illustrate his now dominant interest in the sciences.

It was about this time, 1507, that Leonardo met Francesco Melzi. His family home was at Vaprio d'Adda, an old villa built above the river Adda, about 30 kilometres north-east of Milan. Leonardo became very close to the Melzi family, which consisted of Girolamo, a

nobleman and captain in the Milanese militia, and his two sons Francesco and Bartolommeo. The boys' mother had died some time previously, and Girolamo's duties must have confined him to Milan to a great extent. Not only did Francesco leave Vaprio with Leonardo, but in 1508 Leonardo officially adopted him when he was about 16 and Francesco stayed with him for the rest of Leonardo's life. He travelled and worked with Leonardo as an apprentice, and became his companion, personal assistant, scribe and literary executor. He inherited most of Leonardo's estate, which may have been as much due to the terms of his adoption agreement as to the deep and obvious affection between them. Francesco also seems to have had an income of his own, as Leonardo did not record any payments to him in his notes. What he did record in his notes are various sketches of Melzi which can be found in the drawings at Windsor (CAW 12,282r, 12,554, 12,557) and in the *Codex Arundel* (CAR 317r, 137r).

Leonardo went to Florence for six months in the winter of 1507-8, It was on this trip to Florence that Leonardo retrieved his manuscripts from the Ospedale di Santa Maria Nuova where he had left them for safe-keeping when he left Florence two years earlier. It was now



**Figure 10. *Codex Leicester* 24v-24r
Studies of water**

1508 and Leonardo entered a very productive phase, working on five manuscripts over the next year or so. The first was the *Codex Leicester* (UL 2013:CL) which he began in about 1506 and completed it in 1509. It deals mainly with hydraulics, some studies on astronomy and of the moon. It also

researches into geophysics, investigating the natural history of the earth and its structure, dealing with gravity, fossils, and especially the movement of water and its forces (figure 10).

Then he began the *Codex Arundel* now in the British Museum (Pedretti undated), which has a

note at the beginning “begun at Florence in the house of Piero di Braccio Martelli, on the 22nd day of March, 1508” (CAR:1r). He worked on it for ten years and finally completed it in 1518.



**Figure 11. Codex Arundel 3r
Studies of centres of gravity**

The *Codex Arundel* is very miscellaneous. It deals with a variety of subjects, including physics and mechanics, Euclidean geometry, weights, levers and equilibrium, optics, astronomy, hydraulics and architecture (figure 11). It also contains studies for the *Virgin of the Rocks* and the *Last Supper*, and includes studies for canals, the flow of water, the flight of birds, fables, allegories and travels in Tuscany, Emilia Romagna and Lombardy.

Between 1508 and 1513 Leonardo was focused on his studies into anatomy and water, which was when he wrote *Manuscript F* (UL 2013:MsF).⁷⁵ It contains the date of compilation being September 1508, and at the end is the date October 1508, so he completed it within six weeks. Part of its importance is that it is one of the manuscripts that Melzi transcribed into the *Codex Urbinas*. The notes cover mainly water, but also optics, geology and cosmology. It consists of 192 folios and the title is ‘*Di mondo ed acque*’ or *Concerning the World and Water*. Apart from notes on the currents and various forms of running water, it includes notes on flight modelled on the structure of bats wings, on geometry and optics, and his thoughts on the sun. There are also notes on geology, and the strength of natural forces that hint at his later visions of the deluge (Clark 1958:211).

Then in 1508 Leonardo started *Manuscript D* (UL 2013:MsD),⁷⁶ a small notebook which he completed the following year. This is a slim but very carefully written volume of only 20 pages on vision dealing with optics and the eye (figure 12).

Another manuscript from this time was recorded by Francesco Melzi at the end of the *Codex Urbinas* as *Libro A*. It was begun in about 1508 and was completed in 1515. This was a manuscript that was lost, but Carlo Pedretti realised that most of it had been copied into the *Codex Urbinas*, and the rest into the *Codex Leicester*, and by

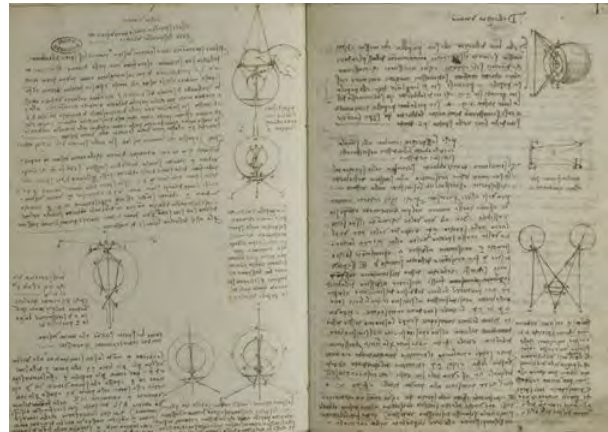


Figure 12. Manuscript D, 3v-4r
On the human eye: dilation of the pupil

astonishing academic deduction was able to reconstruct it (Pedretti 1965b). Through analysing length of lines and other indicators, he was able to relate *Libro A* in size and extent to *Manuscripts E, F* and *G*, all being 96 folios long. He established that folios 1 to 65 had been copied into the *Codex Urbinas*, and the other folios, 66 to 96, had been copied into the *Codex Leicester*, and these were notes on hydraulics. This meant that 107 passages became part of the *Codex Urbinas*. By 1508 Leonardo was nearly 60 years old. The early months of 1508 were the last Leonardo would spend in Florence after which he returned to Milan.

Meanwhile Leonardo was concentrating on his studies of water and water courses, and his notes appear in the Windsor collection (CAW 12,660v, 12,661, 12,662, 12,579 r), and in *Manuscript G* (UL 2013:MsG)⁷⁷ which he began in 1510. *Manuscript G* contains notes on the *Sforza Horse*, drawings for the mint at Rome, and a miscellany of subjects, but mainly botany. It was a late manuscript which he completed in 1515, and was one of the manuscripts that Melzi transcribed into the *Codex Urbinas*. Leonardo also continued work on various folios that are now in the Royal Collection at Windsor, such as *Anatomical Manuscript A*, and designs (CAW 12,353)⁷⁸ for a mausoleum for Marshal Gian Giacomo Trivulzio⁷⁹ which was never finished. Trivulzio had deserted Ludovico Sforza and commanded French forces against Milan

for Louis XII (Hay 1989:164). The French had appointed Trivulzio as Governor of Milan, but he abused his position and left Milan in disgrace retiring to France.⁸⁰

In 1511 Leonardo furthered his studies of anatomy and spent some months in Pavia, attending the lectures of the anatomist Professor Marcantonio della Torre.⁸¹ He recorded the lectures and dissections of criminals in red chalk and ink according to Vasari (Vasari 1965:634) who wrote that he

began to illustrate the problems of medicine, ... and to throw true light on anatomy, which up to that time had been wrapped in the thick and gross darkness of ignorance. And in this he [Marcantonio della Torre] found marvellous aid in the brain, work, and hand of Leonardo, who made a book drawn in red chalk, and annotated with the pen, of the bodies that he dissected with his own hand, and drew with the greatest diligence.

Leonardo's work on anatomy went back much earlier to 1489 when della Torre was only seven years old. However their meeting never led to any further collaboration as the young anatomist died shortly afterwards of the plague at the age of only 29 (Clark 1958:230).

Political trouble broke out again. In 1511 Charles d'Amboise died, and Pope Julius II formed a Holy League which was an alliance with the Venetians, the Spaniards and Swiss mercenaries, enabling him to finally drive the French from Italy. In April of 1512, the French Governor of Milan Gaston de Foix was killed at the battle of Ravenna, and by the end of December of 1512 Massimiliano Sforza⁸² the son of Ludovico Sforza⁸³ had re-entered Milan. With the French gone, Massimiliano Sforza now ruled Milan.

With his patron dead and all the earlier political alliances having irrevocably changed, Leonardo realised he was no longer in favour with the Court and decided to move in with the Melzi family at the Melzi Villa in Vaprio d'Adda (Clark 1958:227,230).

Then an event occurred that uprooted Leonardo again. Pope Julius II died, and Giovanni de Medici, one of the three sons of Lorenzo de Medici, became Pope taking the name of Leo X. His younger brother Giuliano⁸⁴ then invited Leonardo to come to Rome in 1513. Now

sixty, Leonardo decided to accept the invitation as he could expect no further patronage in Milan. On 24th September 1513 he left for Rome with four pupils, Francesco Melzi, Salai, Lorenzo and Fanfoia (Clark 1958:235). Looking back, he had left Florence to stay in Milan for about three months and had actually stayed there more than seven years.

1.8 ROME 1513 -1515

Leonardo arrived in Rome and was installed in the Belvedere of the Vatican by Giuliano de' Medici, who also provided him with a monthly income.

It is possible that Leonardo went to Rome several times but there is evidence for only two trips; an earlier one in 1505 when he was consulted on the minting of new coins for Pope Julius II; the other was his longer final stay in Rome from 1513 to 1516.

This turned out to be an unpleasant time for Leonardo. Younger artists were now at their peak, especially Raphael who was greatly influenced by Leonardo, and Michelangelo who was particularly hostile towards Leonardo (Clark 1958:235).



Figure 13. Manuscript E, 24v-25r
Squaring the circle

a map of the Pontine Marshes as part of a project to drain them. This can be seen in *Manuscript E (Libro B)* (UL 2013),⁸⁵ which is dated to about 1513-14, and deals with the flow of water

Leonardo's manuscripts mention nothing of the artistic activity that surrounded him in Rome. He seems to have been withdrawn and concentrated on his scientific studies, producing notes full of mathematical, anatomical and mechanical studies. He also did some engineering work on the harbour and defences of Civitavecchia, and drew

and land reclamation, plants and trees, physics, statics, weights and gravity, the flight of birds, and notes on his journey to Parma (figure 13).

Leonardo remained in Rome for three lonely years which proved unrewarding. Political events then forced him to consider whether it was time to leave Rome. King Louis XII of France died at the end of 1514 and the new King, Francis I,⁸⁶ was crowned early in 1515 at the age of 21. In that same year, he made a surprise crossing of the Alps into Italy to recapture what he considered to be his lost territories. Pope Leo X ordered his brother Giuliano to lead Papal forces into the Emilia as a precaution against Francis I, and Leonardo accompanied them.

Giuliano suddenly fell ill and went to Florence and died there on 17 March 1516 at the age of 37, but Leonardo stayed with the Papal forces in Piacenza (Clark 1958:251). Although Giuliano's death was sudden, he had evidently suffered from ill health for some time. A year earlier Leonardo had written to him after hearing that Giuliano's health had improved, and mentioned that he had problems with his own health, saying "I was so greatly rejoiced, most Illustrious Lord, by the desired restoration of your health that it almost had the effect that my own health recovered" (Goldscheider 1959:38). This may have been connected with the later comment in 1517 of Antonio de Beatis (1979:132-133) that Leonardo's right hand was paralysed (Nicodemi 1957:86).

The battle of Marignano followed giving the French a decisive victory, after which King Francis I and Pope Leo X agreed to meet in Bologna towards the end of 1515 to discuss the return of Milan to France. With the French again in control of Milan, the Swiss mercenaries were forced to withdraw and never fought the French again.

In October 1515 the Pope and his entourage travelled from Rome to Florence and then to Bologna to meet the new French King, Francis I. Leonardo then went from Piacenza to Bologna, and was presented to the young French King. This was the start of a strong friendship between them, and Leonardo accompanied Francis I on his return journey as far as Milan. It is

surmised that Francis I then proposed to Leonardo that he accompany him back to France and retire there with a pension of 1000 gold scudi⁸⁷ a year, money for Melzi and Salai and a palace of his own (Pedretti 1953:117-120).

With Milan back in French hands, it was time for Leonardo to decide his future. He accepted the generous invitation from Francis I to live in France at the Chateau Clos Lucé near Amboise, and a pension for life.

1.9 FRANCE 1516-1519

By the end of 1516, Leonardo had settled into Amboise in the Loire valley, living in the manor-house of Clos Lucé. It is not known exactly when Leonardo went to France. It is clear that he was still in Rome in August 1516 because in the *Codex Atlanticus* (CA162v) he gives measurements of the Basilica of San Paolo fuori le Mura, which included the date, and he was in Clos Lucé in January 1517 as that was when he visited Romarantin.

It seems probable that sometime in the last quarter of 1516 Leonardo set off for France with his small entourage. They travelled through Milan where Salai left Leonardo and stayed behind in his house in the vineyard, which he would inherit within a few years in terms of Leonardo's will.⁸⁸

It is certain that Leonardo was at Amboise and well settled into Clos Lucé by the autumn of 1517 as Cardinal Luigi of Aragon visited him there in October. Luigi of Aragon was on his way home after an extended European trip in which he met the new King of Spain, Charles V. His secretary Antonio de Beatis (1979:132) recorded his meeting with Leonardo and the journey there in his diary,⁸⁹ and Leonardo showed him three pictures which appear to have been the *Mona Lisa*, the *Madonna with St. Anne*, and the *St. John* (Clark 1958:253-255).

When the Cardinal saw Leonardo's anatomical studies, he was told by him that he had dissected "more than thirty bodies, both of men and women" (de Beatis 1979:132). He

recorded a discussion of Leonardo's notes, as follows: “He also wrote concerning the nature of water, of divers machines and other things - according to what he says, an infinity of volumes, and all in the vulgar tongue,⁹⁰ which when they are published will be useful and most interesting”.

The visit to Amboise had an intriguing corollary. After Cardinal Luigi of Aragon visited Leonardo in Amboise, he may have returned to Naples with one of Leonardo’s manuscripts. He died on 21 January 1519, about three months before Leonardo died. He left part of his estate to his nephew the Duke of Amalfi, Alfonso II Piccolomini. The Duke’s son Innico Piccolomini inherited his estate, and when he died in 1566, an inventory of his books and manuscripts recorded a manuscript by Leonardo possibly on hydraulics and machines that is now lost (Willette 2009:152, 166).

On 23 April 1519 Leonardo “... duly considering the certainty of death and the uncertainty of the hour of its coming ...”, drew up his will before Guillaume Borian, the Royal Notary (Richter 1952:391). In his will, Leonardo detailed various bequests, then left the remainder of his estate to Francesco Melzi which included his money, his clothes, and his manuscripts, and appointed him his executor. He died just over a week later on the second of May 1519 at the age of 67, reputedly in the arms of the French King (Vasari 1996:639). This has been shown to be fiction as Francis I was at his court of Germain-en-laye at the time. Nevertheless it was a sufficiently powerful fiction to be recorded in a painting by Dominique Ingres,⁹¹ and also by François-Guillaume Ménéageot.⁹²

1.10 CONCLUSION

This chapter has recorded what manuscripts Leonardo wrote at particular stages of his life – but those are the manuscripts that are extant or are known about. Nevertheless it is the initial step in compiling a database of his manuscripts showing when they were written which is critical information for later analysis.

A table can now be compiled, showing the years in which Leonardo produced his manuscripts, related to the known number of original folios he produced, and this is shown in Section 6.6. This database has to be extended further to see what then happened to Leonardo's manuscripts. Most were dispersed and some lost, many survived and were later found, some were replaced or restored, and some were copied. Some manuscripts of which nothing specific is known remain lost, but there are a few clues, references in the historical record that tell us something, just a little of what remains lost, and that investigation now follows.

ENDNOTES

¹ Active 16th century. See Beltrami & Villata 1999.

² Now in the Biblioteca Nazionale in Florence.

³ It is in the Biblioteca Nazionale Centrale, Firenze, as *Manuscript Magliabechiano XVII* dated about 1542-1548. See also Budd, D. 2002. Leonardo da Vinci through Milan: studies on the documentary evidence. Ph.D. thesis. Columbia University.

⁴ The Biblioteca Nazionale Centrale di Firenze started in 1714 as the private library of Antonio Magliabechi, which he left in his will to the city of Florence, and it contained about 30 000 volumes. It was opened to the public in 1747 (<http://www.bncf.firenze.sbn.it>).

⁵ 1866-1922 (DAH Sv Carl Frey). It was transcribed by Carl Frey in 1892. An English translation was made by Kate Steinitz in 1949 and published in the *Leonardo Exhibition Catalogue of the Los Angeles County Museum 1949*. Ludwig Goldscheider transcribed it in his *Leonardo da Vinci* (1959, 30-32).

⁶ There is a view that the Anonimo was Bernardo Vecchiotti (1514-1590) from an examination of his handwriting, and that he wrote his manuscript between 1536 and 1546. He was a patron and collector mentioned by Dante as Del Vecchio (GDA) (<http://www.rug.nl/staff/b.s.wierda/oudereversieartikel.pdf>).

- ⁷1378-1455. He achieved fame with his bronze doors for the Baptistery of the Cathedral in Florence, which Michelangelo called the 'Gates of Paradise' (EB Sv Ghiberti).
- ⁸Ghiberti included a history of ancient Art, 14th and 15th century Art, as well as optics and hence perspective very influenced by the work of Alhazen. He also included comments on his own work to assure his place for posterity (EB).
- ⁹Vasari's *Lives* was first published in 1550, then revised and expanded to include living artists in 1568.
- ¹⁰1486-1552. Paolo Giovio was a physician, historian and bishop of Nocera Inferiore-Sarno, formerly Nucerinus Paganorum-Sarnensis, from 1528 to 1552. He was best known for his *Histories of His Own Times*, which became the standard account for the wars of Italy for about two hundred and fifty years. It was notable not only for its account of the entire Mediterranean region, but also for the fact that Giovio included the histories of various Muslim nations with those of Europe (EB Sv Paolo Giovio).
- ¹¹It was written in Latin in about 1527, but published only in 1796. His *Life* was later published by Giuseppe Bosse in his *Del "Cenacolo" di Leonardo da Vinci* (Milan 1810). An English translation appeared in *The Literary works of Leonardo da Vinci* by J.P.Richter (ed.2) (London 1959).
- ¹²He became Pope Paul III in 1534 (EB Sv Alessandro Farnese).
- ¹³1538-1600 (GDA Sv Gian Paolo Lomazzo).
- ¹⁴The house is described in the land register or catasto of 1451.
- ¹⁵This document still exists, and is in the State Archives in Florence. See Möller, E. 1939. *Jahrbuch preussischer Kulturbesitz* LX:73.
- ¹⁶This was 11.00 p.m.
- ¹⁷Florentine archives, Notarile anticosimiano 16192, 105v.
- ¹⁸1435-1488 (GDA Sv Andrea del Verrocchio).
- ¹⁹1475-1564 (GDA Sv Sebastiano Serlio).
- ²⁰1840-1893. An English poet and literary critic, and historian especially of the Renaissance who wrote several biographies of writers and artists (EB Sv John Addington Symonds).
- ²¹1741-1825. An English painter and writer on art, who was born in Zurich. He was appointed Professor of Painting at the Royal Academy in 1799, and Keeper of the Academy in 1804 (EB Sv Henry Fuseli).
- ²²Rome had a population of about 85000 in about 1517, which declined rapidly to about 54000 by 1527 (Hay 1989:207).
- ²³Leonardo da Vinci, *Virgin of the Rocks* (1483-1485). Oil on canvas (transferred from panel). 199 x 122 cm. Louvre Paris, inv.777(MN) (AODC 15:93).
- ²⁴The *Trattato di architettura, ingegneria e arte militare*.
- ²⁵1439-1502 (TDB Sv Francesco di Giorgio).
- ²⁶*Codex Mediceo Laurenziano 361*.
- ²⁷1382-c.1453. (Vecce 2003: 69).
- ²⁸1405-1475 (TDB Sv Roberto Valturio).
- ²⁹1417-1468. An Italian condottiero and lord of Rimini known as the "Wolf of Rimini", after his daring military exploits (TDB Sv Sigismondo Malatesta).
- ³⁰Leonardo read the Italian version published by Paolo Ramusio in Verona in 1483.
- ³¹Leonardo's copy of Robert Valturio's *De Re Militari* appeared on his book list in the *Codex Atlanticus* (fol.210r).
- ³²Venerella, J. 1999-. (2003. *Manuscript B*. v.7).
- ³³See also (www.wordfocus.com/word-black-death-pt2.html).
- ³⁴*Codex Atlanticus*: "molti fiori ritratti de naturale."
- ³⁵See *Manuscript B*, fol.14r,13v, also Accademia, Venice, inv.4, and Windsor 12 429, 12 427, 12 424, 12 423.
- ³⁶Some would date the earliest parts of the *Codex Atlanticus* to the late 1470s.
- ³⁷205 x 140mm. referred to as *Libro F* by Francesco Melzi. See Marinoni 1980.
- ³⁸A Latin grammar by Niccolò Perotti and a Latin vocabulary by Luigi Pulci (Clark 1958:110).
- ³⁹c.1270-1326 (TDB Sv Mondino de'Liuzzi).
- ⁴⁰*Of the Human Figure*.
- ⁴¹1439-1502. He was a painter, sculptor, engineer and architect who worked for Federico da Montefeltro, the Count and later Duke of Urbino. He then worked for the Kingdom of Naples, and returned to Lombardy in 1490. From 1482 to 1490 he wrote his *Treatise of Architecture, Engineering and the Military Arts*, which greatly influenced Leonardo (EB Sv Francesco di Giorgio Martini).
- ⁴²c.1320-1378 (EB Sv Galeazzo Visconti II).
- ⁴³1462-1515 (EB Sv Louis XII).
- ⁴⁴c.1233-1278 (GDA Sv Erazmus Ciolek Witelo).
- ⁴⁵Venerella, J. 1999-. (2001. *Manuscript C*. v.4).

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- ⁴⁶ 1444-1476 (EB Sv Galeazzo Maria Sforza).
- ⁴⁷ Active 1457-died 1495 (GDA Sv Antonio Mantegazza).
- ⁴⁸ c.1429-c. 1481 (GDA Sv Cristoforo Mantegazza).
- ⁴⁹ 12 braccia was about 23 feet or 7 metres, and 200,000 *libbre* was about 67,800 kg, or 147,400 lbs.
- ⁵⁰ See numerous sketches at Windsor, 12 320, 12 317, 12 310, 12 319, 12 286, 12 294, also in Turin Royal library and the Budapest Museum of Fine Arts.
- ⁵¹ 1431-1505. He was the Duke of Ferrara from 1471 to 1505. His daughter Beatrice married Ludovico Sforza. Ercole admired Savonarola, and tried to have him freed by the Church authorities of Florence, but failed (EB Sv Ercole d'Este).
- ⁵² Venerella, J. 1999-. (1999. *Manuscript A*. v.1).
- ⁵³ The second pocket book is bound upside down.
- ⁵⁴ Venerella, J. 1999-. (2003. *Manuscript H*. v.12).
- ⁵⁵ The viola organista was recorded in *Manuscript H* (fol.45v) and in the *Codex Atlanticus* (fol.218r), and was the first bowed keyboard instrument ever to be devised (Magni-Dufflocq 1956).
- ⁵⁶ Pavia is 30 kilometres south of Milan.
- ⁵⁷ An uneducated and unlettered man (Treatise of Painting 27r). Also Villata 2005:19.
- ⁵⁸ Venerella, J. 1999-. (2003. *Manuscript I* v.2).
- ⁵⁹ 1470-1498 (EB Sv Charles VIII).
- ⁶⁰ 1462-1515. He reigned from 1498 to 1515 (EB Sv Louis XII).
- ⁶¹ 1478-1529 (Treccani Sv Baldassare Castiglione).
- ⁶² In a letter of 8 October 1499.
- ⁶³ 1475-1507 (EB Sv Cesare Borgia).
- ⁶⁴ The *De ludo scacchorum* is in the Palazzo Coronini library in Gorizia, Italy. Gorizia is in the North East of Italy, near the Italy Slovenia border.
- ⁶⁵ (<http://www.leonardochess.com/de-ludo-scachorum>).
- ⁶⁶ Venerella, J. 1999-. (2001. *Manuscript M*. v.3).
- ⁶⁷ 1492-1503 (Hay 1989:163).
- ⁶⁸ Venerella, J. 1999-. (2001. *Manuscript L*. v.5).
- ⁶⁹ 1481-1512 (Hay 1989:163).
- ⁷⁰ Leonardo da Vinci, *Battle of Anghiari* (1506-unfinished). Oil then 'overpainted'. 7 x 17 metres. Palazzo Vecchio, Florence (AODC 33:106).
- ⁷¹ *Codex Madrid II*:24v, 125r, and Pedretti 1977, 2:189.
- ⁷² See Accademia, Venice, British Museum, London, Turin Royal Library, Budapest Museum of Fine Arts, and Windsor 12 330, 12 340, 12 339.
- ⁷³ Venerella, J. 1999-. (2004. *Manuscript K*. v.10).
- ⁷⁴ 1473-1511. The French governor of Milan during the reign of Louis XII. He was also the son of Charles d'Amboise, governor of Champagne and Bourgogne, and the nephew of Cardinal Georges d'Amboise, prime minister under Louis XII. He advanced his position, becoming Viceroy for Lombardy, then Grand Master of France, and Marshal of France (EB Sv Charles d'Amboise).
- ⁷⁵ Venerella, J. 1999-. (2002. *Manuscript F*. v.9).
- ⁷⁶ Venerella, J. 1999-. (2007. *Manuscript D*. v.11).
- ⁷⁷ Venerella, J. 1999-. (2002. *Manuscript G*. v.6).
- ⁷⁸ Windsor 12 353, 12 355, 12 343, 12 356r, 12 356v, 12 303, and others.
- ⁷⁹ 1440-1518 (EB Sv Gian Giacomo Trivulzio).
- ⁸⁰ EB. Sv "Gian Giacomo Trivulzio".
- ⁸¹ 1481-1511 (TDB Sv Marcantonio della Torre).
- ⁸² 1493-1530 (EB Sv Massimiliano Sforza).
- ⁸³ Ludovico had died in the prison of Loche in 1508.
- ⁸⁴ 1479-1516 (TDB Sv Giuliano de Medici).
- ⁸⁵ Venerella, J. 1999-. (2001. *Manuscript E* v.8).
- ⁸⁶ 1494-1547 (EB Sv Francis I).
- ⁸⁷ The scudo was a coin used in the Papal States until 1866, and was replaced by the lira. There were both gold and silver scudi at various times, and their value varied enormously. It is therefore not possible to estimate a modern equivalent value, but it was a very generous pension.
- ⁸⁸ Set out in Leonardo's will as follows: "The same Testator gives and bequeaths in and forever to Battista de Villanis, one half, that is the moiety, of his garden that lies outside the walls of Milan, and the other half of the garden to Salai, his servant, in which garden the aforesaid Salai has built and constructed a house which shall be and shall remain in perpetuity the property of the said Salai, his heirs and successors; and this shall be in

remuneration for the good and gracious services which the said de Vilanis and Salai, his servants, have performed for him in the past until now” (Richter 1952:387).

⁸⁹ The diary is in the Biblioteca Nazionale of Naples.

⁹⁰ “*infinita di volume et tutti in lingua volgare*”.

⁹¹ Jean Auguste Dominique Ingres, *The death of Leonardo da Vinci* (1818). Oil on canvas. 40 x 50 cm. Musée du Petit Palais, Paris.

⁹² François-Guillaume Ménégeot, *The death of Leonardo da Vinci* (1781). Oil on canvas. 270 x 360 cm. Hôtel de Ville, Amboise.

CHAPTER 2 - Leonardo's legacy before 1570

When we hear the term 'Renaissance Man', the name that springs to mind is Leonardo da Vinci. The evidence shows him to have been exceptional, a leading figure of the Renaissance, itself one of the great ages in European history. It has to be remembered that much of this reputation is a feature of our modern world, and has grown slowly over several centuries. Of course his talent was recognised in his own artistic circles through his paintings and his manuscripts. He also became a leading figure in the courts of Florence and Milan, eventually befriending the French King Francis I. But the courts of the day were fickle and were quick to forget.

It is surprising to realise that on his death, Leonardo left a small surviving body of accessible work - a handful of paintings, several of them unfinished or damaged, claims to architecture and sculpture with very little surviving evidence, and manuscripts that until long after his death were largely unknown, except in certain artistic and specialist circles. It is therefore necessary to look at his legacy to establish what notes and manuscripts have survived, which were lost, and which restored in the century after his death.

2.1 NOTES, CODICES AND MANUSCRIPTS

Leonardo da Vinci died leaving thousands of pages of notes, some of them bound into notebooks, and others as single sheet studies on a wide variety of topics. There is no record of the number of pages that he left, and of course there is no knowing exactly how many have been lost, but the pages that have survived amount to about 7000,¹ written between 1487 and 1519. The manuscripts are held in various major collections, and single sheet studies are in a number of smaller collections.

Some of the manuscripts remain as they originally were, others have been renamed 'codices' which is a term used with reference to hand written manuscripts. Recent

developments have seen a few of Leonardo's codices disassembled, to allow their folios to be separately mounted, and presented very differently today from how they were originally organised, such as the *Codex Atlanticus*.

It is these manuscripts and codices which are Leonardo's original notebooks and drawings that established his reputation as a creative thinker, and they are remarkable in range and quality. It is these surviving notes that constitute a monument to Leonardo as equal to the few paintings that have survived. Many manuscripts seem to have been lost, and many copies of Leonardo's notes in other artists' manuscripts cannot be related to any sections in his surviving manuscripts.

The idiosyncrasy common to all Leonardo's manuscripts is that he wrote from right to left, in a mirror script (figure 14). There are a few examples

of his writing left to right, but they are rare. He was naturally left-handed, and seems to have developed the dexterity to write and draw from right to left with ease. For him it must have been a matter of convenience and habit, allowing him to see clearly what he was drawing or writing as his hand moved away from the ink without smudging it.

Leonardo's handwriting from right to left was not the only difficulty affecting its legibility. He also wrote in a late

mediaeval style which was influenced by the notarial

hand of his father, and his grandfather, which had its roots in the Carolingian miniscule hand.

Charlemagne² encouraged Alcuin of York³ to develop the Carolingian hand to standardise religious texts, and to ensure that Latin texts appeared consistent and legible, and could be read easily from region to region. It was gradually replaced by Italic script or Chancery cursive which was faster, more modern and fashionable (Wells 968:448B).

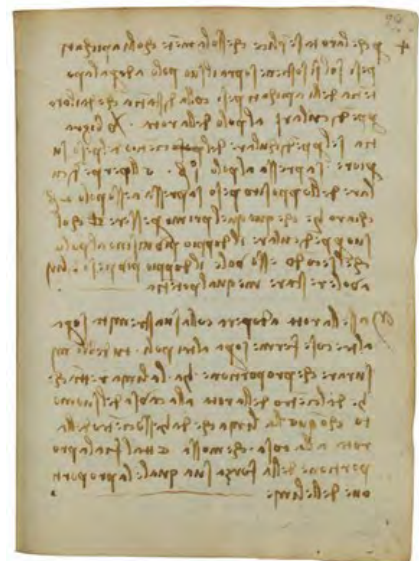


Figure 14. Codex Forster II-2, 94r
An example of Leonardo's handwriting

Leonardo's writing was not the only factor hampering the reading of his manuscripts. As his studies expanded and his subjects widened, he began talking of them as different treatises. At times he would return to his earlier studies and add more and different material wherever there was space. The result was that notes on particular topics became repetitive and scattered throughout his manuscripts. Although he referred to particular sections as treatises, they were only partially consistent and none of them was complete.

During his second Milanese period, Leonardo wrote:

This is to be a collection without order, made up of many notes which I have copied for the purpose, in the hope of arranging them in their proper place, according to subject. But I think that before I achieve this I shall be liable to repeat the same thing more than once, and for this the reader should not blame me, as the topics are numerous and one's memory is not able to recall them so precisely as to say 'I will not treat of this since I have done so before' (CAR:263v).

Leonardo's thinking and accumulation of knowledge were based on what he called "the observation of nature". This approach was not a new idea and had a long history, but Leonardo stressed it in particular as a way of attaining knowledge of the world, and used his art and drawing as the way to record it. He wrote, "... it is my intention first to cite experience, then to demonstrate through reasoning why experience must operate in a given way" (MsE:55r). He recorded his observations in drawings with accompanying notes, trying to understand and depict how the world around him worked. He studied anatomy so that he could understand how the human body worked. His early drawings of landscapes led on to studies of botany and geology; he studied birds in flight, which led to studies of flight and the air. This led to studies of currents, which led in turn to the movement of water and hydraulics. He then studied mechanics and optics, compiling thousands of pages of notes as he did so. Each new area of study widened into adjacent fields, or led backwards into earlier fields of study. His curiosity and spirit of enquiry, illustrated by his drawings, led into wider and wider fields of scientific discovery. As the volume of Leonardo's notes increased, so his

focus on painting diminished, and his interest in science, mechanics and the world around him intensified. His interest in the natural sciences increased, and it was his range of ever widening enquiry that led him into new fields of knowledge rather than concentrate on his existing studies and thus reach the conclusions that were to make later scientists famous.

McCurdy (1906:27) wrote:

This habit of scientific investigation in inception subsidiary to the practice of his art, so grew to dominate it as to alienate him gradually from its practice to the study of its laws, and then of those which govern all created Nature. The fruits of these studies lay hidden in manuscripts of which the contents have only become fully known within the last half century.

Another problem has been estimating the dates of the manuscripts and loose sheets that have survived. A few of the manuscripts have dates at the beginning, and even at the end for completion. But the way Leonardo worked has helped in dating the others. In his early years, he used pen and ink, and also metalpoint (Popham 1994:5-10). This was usually silverpoint used on paper that had been coated with finely ground bone. A coarser version was leadpoint used on untreated paper. In about 1492 Leonardo started using black and red chalk more and more in tonal studies, and then increasingly black chalk where it had a greater tonal range than red chalk. From about 1495 he sometimes used red chalk on reddish paper, black chalk and charcoal. From 1500 onwards he used combinations of colours, so we see black, red and white chalk drawings on a red ground or on a blue ground. From 1510 some of his scientific drawings were outlined in red chalk and worked with pen and ink. In his last few years he simplified his colour ranges seldom using red chalk, and concentrated on black chalk with pen and ink on a buff tinted ground (Bambach 2003:17). Leonardo often used pastels or coloured chalks, and he even included a recipe for making them in his notes (CA:669, CF II.2:159r).

The paper he used also changed over the years. Before 1481 he worked with a variety of papers, pink, red, orange and buff. When he was in Milan after 1481 he used a deep blue.

In about 1487 he used a blue-green surface. From 1508 he used a dyed blue paper called 'carta azzurra', and from 1513 a rough light brown paper (Pedretti 1965b:124,149).

These changes in media, colour and backgrounds have been essential guides in dating his various notes. Another indicator has been the size of paper he used at different times. The paper he used was folded to form different sized notebooks. The smallest he used is *Manuscript M*, which is a small pocket book of 98 x 70 mm. and the largest is *Manuscript C* at 315 x 220 mm. The different sizes Leonardo used at different times have also helped date loose sheets.

Another useful indicator has been the watermark on different sheets, relating sheets to each other where a particular sheet may have been dated, or where the production dates for that particular paper are known.⁴ An example is the watermark which was common in Italy between 1495 and 1508, showing a bellflower or campanula, found in the *Codex Leicester*.

Leonardo's handwriting has also been used to date sheets. His early hand was elaborate and a bit spidery, but it gradually changed to a more rapid and simple hand. After 1495 it changed very little for about fifteen years, then became faster and simpler (Clark 1968:v.1, xxii).

In his middle years Leonardo used his drawings to record what he saw, as a better record than words, such as his anatomical drawings. But in his later years he produced more and more drawings inspired by his imagination, such as those of the deluges that he drew at the end of his life (CAW 12 378).⁵

With a few unimportant exceptions, all Leonardo's notes were written in the last thirty years of his life. He planned a number of treatises and started ordering his notes accordingly, but like many of his enterprises, this was never completed. After his death his notes became scattered and perhaps less than half have survived. We now need to turn to the question of

what happened to them to see if our data base of information can be extended and later analysed to refine the estimate of how many manuscripts remain lost.

2.2 FRANCESCO MELZI AND THE *CODEX URBINAS*

Francesco Melzi (Steinitz 1958:18-21) inherited all of Leonardo's available manuscripts in 1519, and he returned with them to his villa in Vaprio d'Adda, except for some notes on anatomy that Leonardo had left in the hospital of Santa Maria Nuova in Florence when he went to France in 1516. What Melzi was attempting was an enormous project. He had before him thousands of pages of notes in a largely disordered state, a chaos of information. What he was facing was the sheer practical difficulty of ordering Leonardo's notes, with the main focus on compiling a *Book of Painting*, a *Libro di Pittura*. This was a task that Leonardo had wished to achieve himself, with the intention of transcribing material in his manuscripts into different treatises on a number of topics, especially painting, mechanics and anatomy, but it seems that he never achieved it (Kemp and Barone 2009:39). So Francesco Melzi started compiling a *Treatise of Painting* from Leonardo's thousands of pages of notes in their disordered and incomplete state. According to Carlo Pedretti, there are three 'hands' identified in the transcription, Melzi, an assistant and perhaps a consultant expert (Pedretti 1965b:99-109).

Melzi was 28 years old when Leonardo died, and lived a further 49 years. Vasari visited Milan in 1566, and appears to have met Melzi in Vaprio. He described him as "a gentleman of Milan, who in the time of Leonardo was a very beautiful boy, and much beloved by him, and now is a no less beautiful and gentle old man" (Vasari 1965:634). Melzi lived a further two years, dying at the age of 77 in 1568.

In all that time Melzi managed to compile most of the *Libro di Pittura* from Leonardo's notes but left it unfinished. To compile the *Treatise of Painting*, he had to

manage thousands of pages of largely disordered information – how many thousands of pages remains unknown, to be determined by the conclusion of this thesis. Meanwhile he had embarked on a new life for himself. After Leonardo's death in 1519, Melzi married Angiola Landriani of Milan, a woman of good birth, and fathered eight children. Given the responsibilities of his own life and family, it seems remarkable that he achieved what he did with Leonardo's notes out of devotion to the memory of Leonardo.⁶

He went through the manuscripts he had inherited, and picked out the passages he thought related to painting, and copied them into a book which he had divided into eight parts (Pedretti 1965b:120). There are blank pages at the end of each section that suggest he did not complete his selection and intended to add more in his neat Italic script (Pedretti 1965b:97). The dividing of the material into eight parts was a very rough division of the material into subject areas. It was not in any sense a proper editing of the texts, and there is contradiction and repetition in the paragraphs he transcribed. One also has to recognise the difficulty of defining what properly fell within the definition of painting and what fell outside it from the profusion of topics in Leonardo's notes. There is, arguably, an undue inclusion of material on trees and too little on the technical aspects of optics and perspective. This collection of notes on art, or the *Treatise of Painting*, is therefore in some respects unbalanced (Kemp and Barone 2009:40). It is a collection of 1008 paragraphs from Leonardo's original notebooks, and today three-quarters of this material cannot be traced in extant manuscripts, so the original sources have to be assumed lost (Pedretti 1965b:10). Perhaps there were originally double the number of manuscripts that have actually survived or more, but without evidence this is pure speculation and guesswork. This thesis is an attempt to refine those estimates.

The Melzi compilation ends on Folio 231v with a list of the original manuscripts he had used in his compilation, with his own code marks on them. The list refers to eighteen manuscripts that contained notes on painting. When Melzi's marks are related to extant

manuscripts, we can see that only the following sources on painting have survived (Pedretti 1965b:8):

Windsor 12,604⁷

Codex Trivulzianus (c.1487-1490)

Manuscript A (c.1492)

Manuscript Ashburnham 2038 (c.1492)

Manuscript L (c.1502)

Manuscript F (c.1508)⁸

Libro A (c.1508-1515)

Manuscript G (c.1510-1515)

Manuscript E (Libro B) (c.1513-1514)⁹

Codex Madrid II (1503-1505)¹⁰

Melzi marked the passages he intended to include in his compilation, but his marks contain inconsistencies which suggest some material may be missing. Carlo Pedretti (1968:202) suggests that the missing section seems to be from the beginning of Book Three where the title page is missing.

Other surviving manuscripts contain notes on painting which Melzi did not use in the compilation, although it is probable he intended doing so. These are as follows (Pedretti 1965b:8):

Manuscript C (c.1490)¹¹

Manuscripts H1, H2, and H3 (c.1493-1495)

Codices Forster I, II and III (c.1487-1505)¹²

Manuscript I (c.1497-1505)

Codex Arundel (1508-1518)¹³

Codex Atlanticus (c.1478-1518)

Manuscript M (c.1500-1502)

Manuscript K (1504-1507)

Manuscript D (c.1508-1509)

Codex Leicester (c.1508-1512)¹⁴

Folio Resta (c.1508-1510)

It is Melzi's compilation of the *Treatise on Painting*, now in the Vatican Library and known as the *Codex Urbinas Latinus 1270*, that is considered the earliest source of all other manuscript copies of Leonardo's notes on painting.

2.3 EARLIER TREATISES – NOW LOST

An intriguing problem is that there are several references to early treatises completed by Leonardo which of course would pre-date the *Codex Urbinas*, and which now appear to be lost.

One such reference was by the mathematician Luca Pacioli who wrote in the *De Divina Proportione*, "Leonardo with painstaking care has finished his praiseworthy book on painting and human motion" (Clark:1958:125).¹⁵ Another reference was by Giorgio Vasari (1965:634) who wrote, "So also there are in the hands of ... a painter of Milan, some writings of Leonardo, in characters written with the left hand backwards, which deal with painting and the methods of drawing and colouring. Not long ago, he came to Florence to see me, wishing to print this work, and took it to Rome to achieve this"(Clark 1958:126). Vasari did not mention the name of this artist, so he could have been one of several Milanese painters, such as Aurelio Luini (Mazenta 1635:4),¹⁶ the son of Bernardino Luini who had been one of Leonardo's students, or Paolo Lomazzo (Steinitz 1958:24).

Vasari, in speaking of the equestrian statue of Francesco Sforza, wrote, “Also lost is a small wax model of it that he had completed, together with a book on the anatomy of the horse that he had compiled in his studies”. And he then said, “Of Leonardo we have the anatomy of horses and that of men, much more complete; for so many divine achievements his name and fame will never die out” (Vasari 1965:640). The anatomy of the horse was also mentioned by Mazenta, who wrote “The author had a peculiar talent at drawing those animals, and designed this treatise for the use of those who paint battles or triumphs (Mazenta 1635:25)”.

Another mention is by Benvenuto Cellini¹⁷ who referred to a manuscript he had bought in 1542,¹⁸ and described it as a book, “of great excellence and beautifully done after the admirable genius Leonardo ... I found in it among other amazing subjects a discourse on perspective ... The aforesaid Leonardo had found the rules and explained them with such a facility and order that they were comprehensible to everyone who saw them” (Cellini 1857:225-227). This manuscript copy which was owned by Benvenuto Cellini may have included a completed *Treatise on Perspective* by Leonardo that is now lost. Cellini then described how Sebastiano Serlio¹⁹ wished to read the same material (Steinitz 1958:25-26), and use it in his second book on Architecture, *On Perspective*, which appeared in 1551 (Leonardo 1956:xxi). Mazenta also mentions a *Treatise on Perspective*, divided into several books. He wrote, “Leonardo ... delivers the method of drawing figures larger than life... (Mazenta 1635:25)”.

Another reference concerns Giovanni Paolo Lomazzo (1585:158)²⁰ who wrote “Leonardo da Vinci in his book which I read some years ago which he wrote with his left hand on request of Lodovico Sforza, Duke of Milan, ...” (Steinitz 1958:21-24). There is doubt that Lomazzo could have seen such a book. He was born in 1538 and Lodovico Sforza was overthrown in 1499. Leonardo left Milan in the same year at the end of his first stay

there, and surely would have taken the treatise with him. His second period in Milan was from 1506 to 1513. There was no mention of such a treatise in the manuscripts inherited by Francesco Melzi after 1519. Lomazzo (1844:III, 179) also referred to Leonardo and his "... various drawings of whom are in the hands of several owners, and especially in the house of Francesco Melzi, a gentleman of Milan, his disciple, in addition to the anatomy of the horse that he made". Later he wrote, "But above all writers Leonardo da Vinci is worthy of note; he taught the anatomy of human bodies and of the horse which I have seen in the home of Francesco Melzi, drawn divinely by his hand" (Leinati 1957:390). Lomazzo also referred to a treatise on sculpture by Leonardo that he had seen (Lomazzo 1585:159).

Antonio Franchi (Franchi 1739),²¹ a painter who worked in Lucca and Florence, recalled reading a manuscript by Leonardo when he was a young artist in Florence, as it circulated from one artist to another, where he wrote, "for in this form it circulated in the hands of the studious painters before it was printed".²² The manuscript came into his hands sometime after the death of Guido Reni, the previous owner (Steinitz 1958:27).²³ This is corroborated by the fact that Leonardo's own notes and the transcription by Francesco Melzi, the *Codex Urbinas*, were made freely available to interested painters at the time (Steinitz 1958:17).

In another reference (Leinati 1957:390), Gustavo Uzielli²⁴ commented in 1869 on Rubens' work, *Osservazioni di Fisionomia*, which had been burnt in a fire in 1720. He claimed that Rubens discussed Leonardo's studies of human and equine anatomy, having seen the original drawings and manuscripts in the house of Pompeo Leoni. Whether this referred to existing notebooks or a separate treatise, remains unanswered. Rubens visited Pompeo Leoni sometime between 1600 and 1606, and Roger de Piles (de Piles 1767:168) recorded this visit.

Mazenta also mentions a treatise on Anatomy, as well as a treatise on the nature of equilibrium and motion of water, with many designs of machines for conveying, raising and supporting of water (Mazenta 1635:25).

Another treatise mentioned by Leonardo as completed at Rome in 1514 is the *De ludo geometrico* which is now lost (Heydenreich 1954:111,165).²⁵

Another mention was made in 1584 by Raffaello Borghini (Williams 2009:65) who referred to writings by Leonardo in Florence that had not yet been published.²⁶ Another copy was owned by Annibale Caracci who said “if he had known of it earlier it would have saved him twenty years of labour” (Clark 1958:126).

In the Codex Atlanticus²⁷ Leonardo notes, “Messer Battista dell’ Aquila has my book ‘de vocie’ in his hands. This was Gian Battista Branconi who was a member of the Papal Court (Richter 1952: 380).

There is another reference on a Windsor folio²⁸ that Leonardo had handed “The book on water to Messer Marco Antonio”, which must have been in about 1510 when he worked with Marcantonio della Torre.

The above comments could have been made after seeing some of Leonardo’s notes or Melzi’s transcription and confusing them when remembered many years later. Some of the comments could have been made having seen Leonardo’s own notes after they had been split up and passed into subsequent hands. There can be no certainty about this, and no manuscript survives to show that Leonardo ever managed to compile any of his work into a complete treatise, although he referred to particular sections as treatises. It seems likely that they were only partial manuscripts or notes that were never complete. And yet the comments by Benvenuto Cellini are precise and convincing, and affirmed by the wish of Sebastiano Serlio to make use of his manuscript. There is nothing vague or confused about his comments. Taken with the other comments, and with the fact that so much is lost, it seems

likely that he did complete a treatise on human motion, the anatomy of the horse, perspective or the movement of water which was seen by other artists of the day – and if so - it is now lost.

Although there does not seem to have been a complete compilation of a *Treatise on Painting* by Leonardo himself, what he envisaged can be fairly closely surmised by virtue of the following. Firstly, Melzi was a constant companion of Leonardo and would have known very well what he intended. In addition, the surviving notes by Leonardo in the various manuscripts are obviously meant to be brought together in a logical order. It is also known that Leonardo had written a book on painting because Luca Pacioli, Paolo Lomazzo and Vasari referred to it. In addition, Leonardo expressed his intention to produce a *libro di pittura* in three places in his notes (CAW 19 076, CA 181r, CA 79r).

Luca Pacioli's comment that "Leonardo with painstaking care has finished his praiseworthy book on painting and human motion" (Clark 1958:125) suggests that there was a treatise completed by 1498. However a large part of the notes for the *Treatise of Painting* were written after that date. Pacioli must have seen another codex, earlier and less ambitious. Ludwig Heydenreich²⁹ comments that Luca Pacioli could have seen the *Codex 2038* which was part of *Manuscript A*, and is now in the Bibliothèque Nationale in Paris (McMahon 1956:xxii). This contains material on painting and human motion and dates from 1490-1495, and contains some of the material that Melzi used in the *Codex Urbinas*, and hence the *Treatise of Painting*. Heydenreich also suggests that this early manuscript that Pacioli mentioned could be the same one that both Lomazzo and Vasari saw (McMahon 1956:xxiii). Whatever the truth of the matter may be, what we have today is the Melzi compilation known as the *Codex Urbinas Latinus 1270* in the Vatican Library, and it is on that manuscript that the complete editions of Leonardo's *Treatise on Painting* are based.

ENDNOTES

¹ This includes blank pages which are accounted for later in the thesis.

² c. 742-814 (EB Sv Charlemagne).

³ c.740-804 (EB Sv Alcuin of York).

⁴ Paper was first made in Italy in about 1268 and watermarks were used in Italy from 1282, initially being crosses and circles. An extensive reference collection of watermarks has been assembled by the Dutch Institute in Florence, with a focus on northern and central Italy (paperproject.org/) (niki.meysen.net/).

⁵ Probably drawn between 1515 and 1517. See also Windsor 12 388, 12 376, 12 379, 12 380, 12 382, 12 383.

⁶ TDB Sv Francesco Melzi.

⁷ This is only one page of a lost manuscript from Leonardo's early period, about 1487-1490.

⁸ This manuscript has a note claiming it was begun in Milan on Sept. 12th 1508, and deals largely with the study of water.

⁹ This manuscript deals with plants and trees.

¹⁰ Melzi used 14 sections from this Codex (Pedretti 1968:202).

¹¹ This manuscript on light and shade contains a note that says, "on the 23rd day of April 1490, I commenced this book."

¹² *Codex Forster I manuscript I* was begun in 1505, *Codex Forster I manuscript 2* between 1487 and 1490, *Codex Forster II* in about 1495, and *Codex Forster III* between 1490 and 1493..

¹³ The *Codex Arundel 263* in the British Museum has at the beginning "begun at Florence in the house of Piero di Braccio Martelli, on the 22nd day of March, 1508".

¹⁴ This was subsequently renamed the *Codex Hammer* after Armand Hammer bought it, and reverted to the *Codex Leicester* when Bill Gates bought it.

¹⁵ In the introductory letter addressed to Ludovico Sforza in his book *De Divina Proportione*, dated February 9, 1498.

¹⁶ c. 1530-1593 (GDA Sv Aurelio Luini).

¹⁷ 1500-1571 (GDA Sv Benvenuto Cellini).

¹⁸ Cellini was working for the King of France at the time, and bought the manuscript from an impoverished nobleman in Paris, according to Paolo Lomazzo (1584:264).

¹⁹ 1475-c. 1554 (GDA Sv Sebastiano Serlio).

²⁰ 1538-1592 (GDA Sv Giovanni Paolo Lomazzo).

²¹ 1634-1709 (GDA Sv Antonio Franchi).

²² Antonio Franchi, 1739, *Teorica della pittura*, Lucca, p.47.

²³ 1575-1642 (GDA Sv Guido Reni).

²⁴ 1839-1911 (Uzielli 1884).

²⁵ Clark 1958:237.

²⁶ See Pedretti, *Commentary*, v.1, p.32.

²⁷ 287r.

²⁸ 19120b.

²⁹ 1903-1978. Director of the Zentralinstitut für Kunstgeschichte, Munich; historian of Italian renaissance architecture and art, and expert on Leonardo da Vinci (DAH Sv Heydenreich).

CHAPTER 3 – Dispersal, loss and recovery of manuscripts

3.1 ORAZIO MELZI

After Leonardo's death, Francesco Melzi compiled a *Treatise of Painting* which must have been an enormous task because of the number of manuscripts in their disordered state, all in mirror script. A more disastrous problem occurred after Francesco Melzi's death, which was the dispersal of the manuscripts before complete copies of them were made.

Francesco Melzi died in 1568, and all Leonardo's manuscripts were inherited by his son and heir Orazio Melzi who seems to have had little interest in them, and no idea of their value. A tutor to the Melzi family at Vaprio d'Adda, Lelio Gavardi d'Asola, noticed that these manuscripts were left in the attic and he stole thirteen of them. This was at some point between 1585 and 1587, and his intention was to sell them to Francesco I the Grand Duke of Tuscany¹ in Florence. His plan failed because of the Grand Duke's death in October 1587. Lelio Gavardi then met another student in Pisa called Giovan Ambrogio Mazenta (Pedretti 1965b:252)² who challenged him about taking the manuscripts. It was Mazenta who returned them to Orazio Melzi. Orazio claimed he had many more in his attic and let Mazenta keep them. That was when the manuscripts began to disperse (Mazenta 1635:23-4).

3.2 POMPEO LEONI

Pompeo Leoni,³ a sculptor working for the King of Spain, returned to Italy in 1582 and heard about the dispersal of Leonardo's manuscripts probably early in 1588. Sometime between then and 1590 he approached Orazio Melzi for any original manuscripts by Leonardo that he still had. He wished to offer them to the King of Spain, and extended an inducement to Orazio that he could arrange a seat for him in the Senate of Milan which was under Spanish control at the time (Mazenta 1635:24). It is improbable that Pompeo could have arranged that even with his royal connections, but it was a strong inducement for

Orazio. By now most of the manuscripts must have dispersed because Orazio approached Mazenta, who still had the thirteen manuscripts stolen by Lelio Gavardi, and asked for their return. Mazenta returned only seven plus some loose sheets which Orazio Melzi handed over to Pompeo Leoni (Mazenta 1635:24). Mazenta kept the other six, and in the year 1600 he gave what is now known as *Manuscript C* to Cardinal Federico Borromeo. This has survived and is a manuscript on light and shade. Mazenta also gave a manuscript to the Duke Carlo Emanuele of Savoy⁴ which has not survived. It is possible that it burnt in one of the fires in his library in 1667 or 1679. He gave another manuscript to the painter Ambrogio Figino,⁵ which then passed from Figino to Cardinal Borromeo's agent Ercole Bianchi (Mazenta 1635:24),⁶ and he in turn sold it to Consul Joseph Smith⁷ in Venice. Why he sold it to Consul Smith, and not to Cardinal Borromeo is a mystery. Perhaps Consul Smith simply offered more for it. That manuscript is also lost.

Joseph Smith was a great collector and one of the biggest buyers of the Sagredo collection⁸ (Oxford 2010). Zaccaria Sagredo's collection had been inherited by his heirs, and was sold after the death of his nephew Gherardo in 1738. In due course Joseph Smith's collection was bought by King George III in 1762 for 10 000 pounds, and it forms an important part of the Royal Collection of Drawings at Windsor and the King's Library at the British Museum.

The remaining three manuscripts eventually ended up in Pompeo Leoni's hands (Lomazzo 1974:17),⁹ and he may in the meantime have acquired more from Giovan Ambrogio Mazenta or his brother Guido.

Leoni divided his loose notes into two halves, one roughly on technology, the other on anatomy and artistic studies. The former became the *Codex Atlanticus* (UL 2013:Codex Atlanticus), so called because of its size, and it is now in the Ambrosian Library in Milan; the

latter were the manuscripts that finally ended up in the Royal Collection at Windsor, of which about one third are the *Anatomical Manuscripts*.

It is astonishing that Pompeo Leoni managed to collect so many of Leonardo's manuscripts. Of those that have survived, he appears to have owned the following (Pedretti 1965b:256-257):

Manuscripts A,B,D,E,F,G,H,I, L,and M.

Manuscript on the Flight of Birds.

Codex Trivulzianus.

Codex Atlanticus.

Windsor Manuscripts.

Codex Arundel.

Codex Madrid I and II,

and possibly the *Forster Codices*.

Further detail about the dispersal of Leonardo's manuscripts at this stage is hazy. There are gaps in their provenance and more seem to have been lost.

3.3 AMBROSIAN LIBRARY - THE ARCONATI DONATION

Pompeo Leoni died in 1610 which led to further dispersal of the manuscripts. He left his collection to Polidoro Calchi, the husband of his daughter Vittoria (Mazenta 1635:25). Calchi offered a portion of the collection to the Grand Duke of Tuscany Cosimo II¹⁰ in 1614. What he offered was the *Codex Atlanticus* and fifteen manuscripts, but Cosimo declined the offer. Sometime later Polidoro Calchi died and his son Francesco Maria inherited the manuscripts. In 1622 Francesco Maria Calchi sold this collection to Count Galeazzo Arconati for 300 crowns.¹¹ Count Arconati held it for about five years and then generously gave the collection to the Ambrosian Library in 1637, and it is now known as the Arconati Donation.¹²

In 1603 the famous Cardinal Federico Borromeo¹³ had founded the Ambrosian Library in Milan, and it became the first public library in Italy, and second in Europe only to the Bodleian at Oxford (Burton 1937:254). It was intended to be an Art and Science Academy, a Library and a Museum, and was described in 1869 as follows (Dalton 1869:472): “Cardinal Federigo Borromeo founded the Ambrosian College, and appointed sixteen doctors to teach all the fine arts and sciences gratuitously: to this noble establishment he joined the Ambrosian Library, and opened it to the public under the title of ‘Bibliotheca Ambrosiana’. It is said to contain more than 40,000 volumes and 15,000 Manuscripts”.¹⁴

In 1609 Cardinal Borromeo had deposited Leonardo’s *Manuscript C* there, the *Treatise of Light and Shade*, which he had received from Ambrogio Mazenta in 1600. The Ambrosian then acquired an abridged copy of the *Codex Urbinas* from the library of G.V.Pinelli,¹⁵ which is known as the *Codex Pinellianus* (Pedretti 1965b:4).

The Arconati donation then greatly enriched the Ambrosian (NQ 1869:472). This donation and other acquisitions enabled the Ambrosian Library in Milan to become the home of an astonishing collection of Vinciana. Count Galeazzo Arconati’s donation was to include the *Codex Atlanticus*, *Codex Trivulzianus*¹⁶ and the *Manuscripts A,B,E,F,G,H,I,L* and *M*. The arrangement was that these would remain with Arconati until his death. When the donation was eventually given effect, it was found that the *Codex Trivulzianus* had been replaced with *Manuscript D*, and there was a discrepancy between the earlier offer to Cosimo and the Arconati donation – a difference of three manuscripts which Arconati evidently retained. Why this occurred has never been explained, and what happened to the three manuscripts is unknown. They are simply lost.

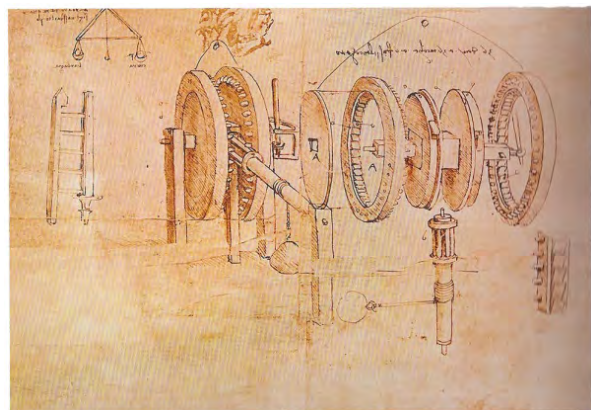
In 1674 the Ambrosian enlarged its collection further with *Manuscript K* which it acquired from Count Orazio Archinti, and its provenance is unknown. It is astonishing that so many of the extant manuscripts (Appendix 4) ended up in the Ambrosian through the

Arconati donation, and also astonishing that Pompeo Leoni had managed to collect so many of them. Without his efforts many more would have been lost.

The manuscripts in the Ambrosian were only a portion of Pompeo Leoni's collection. Another of Pompeo Leoni's manuscripts that ended up in Milan, but not in the Ambrosian, is the *Codex Trivulzianus* (UL 2013:Codex Trivulzianus), mentioned above. This is possibly Leonardo's earliest manuscript along with *Manuscript B* and part of *Anatomy B*. It was written in the last years of the 1480's when Leonardo was about 35 and contains notes on military and religious architecture and on his efforts to improve his education and language skills. After it was exchanged with *Manuscript D* when the Arconati donation took effect at the end of 1648, it disappeared for a bit. It then turned up in the hands of Gaetano Caccia from Novara who gave it to Carlo Trivulzio¹⁷ in 1750. Carlo Trivulzio recorded at the time that he had exchanged the manuscript for a silver watch which had cost him sixteen guilders.¹⁸ The manuscript became part of the municipal collections of Milan in 1935 and is now in the Biblioteca Trivulziana in the Museums of Castello Sforzesco.

3.4 THE MANUSCRIPTS THAT WENT TO FRANCE

The Ambrosian collection was later to suffer a sudden devastating reversal (Turner 1992:92). In 1796 Napoleon entered Milan, and on the amazing pretext that "All men of genius, all who have attained a distinguished rank in the republic of letters are French, whatever the country that gave them birth",¹⁹ he transferred the Ambrosian collection of Vinciana to France. The *Codex Atlanticus* (figure 15) went to the Bibliothèque



**Figure 15. Codex Atlanticus 30v
Hoist with reciprocating lever**

Nationale in Paris, and the rest of Leonardo's manuscripts in the Ambrosian went to the Institut de France. Some recompense was made in 1815 when the *Codex Atlanticus* was returned to the Ambrosian,²⁰ but the other twelve manuscripts, A to M, remained in the Institut de France in Paris.

Some years later, the manuscripts in Paris suffered further loss and damage when Count Libri despoiled them. This is dealt with in Chapter 5, which includes details of how the *Codex on the flight of birds* was separated from Manuscript B, sold, recovered and then entered the Royal Library in Turin.

The rest of Pompeo Leoni's manuscripts dispersed widely, some went to England, another to Turin, but two stayed in Madrid.

3.5 THE 'LOST' MADRID CODICES IN SPAIN

Codex Madrid I (figure 16) and *Codex Madrid II* are the two Codices from Pompeo Leoni's collection that remained in Spain, and are in the Biblioteca Nacional (UL 2013: *Codex Madrid*). These two volumes originally went to Spain in about 1590 with Pompeo Leoni who offered them to King Philip II. The King declined to buy them and they were inherited by Polidoro Calchi, Pompeo Leoni's heir, with the rest of his collection in 1610.

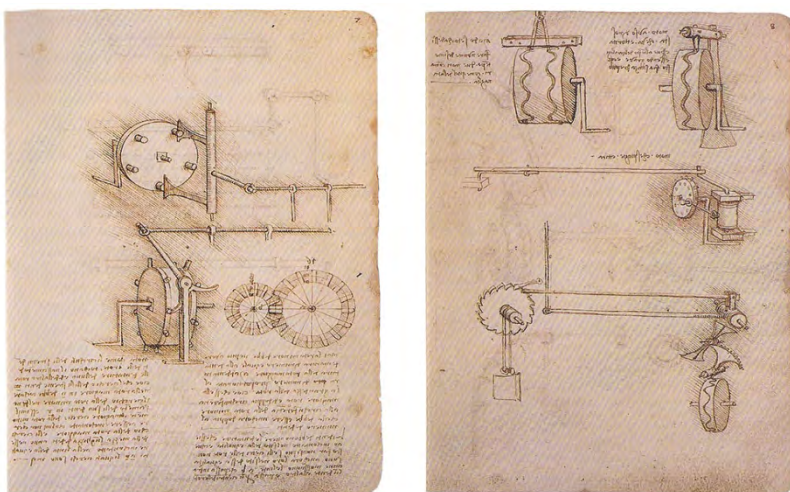


Figure 16. *Codex Madrid I*, 7r- 8r Escapement mechanisms

They were then mentioned in an interesting reference by Vicente Carducho,²¹ court painter to Philip III of Spain, who wrote, “I saw there, in Juan de Espina’s home, two books drawn and written by the hand of the great Leonardo da Vinci, of great learning and curiosity, which he would at no price sell to the Prince of Wales,²² who was at the court” (Carducho 1633:193).²³ What Carducho saw were probably the *Madrid Codices*. How they came into the hands of Juan de Espina,²⁴ the famous collector, is a mystery. Nevertheless he left them to King Philip IV of Spain on his death in 1642.

These two volumes were in the Royal Library of Spain until about 1830 when King Philip V transferred them to the Biblioteca Nacional in Madrid when the Royal Library was merged with the National Library. They were known to have actually entered the National Library, but on their reception in the library a cataloguing mistake occurred before the books were placed in their correct positions on the shelves (Reti 1968 v.3:11) Thereafter the

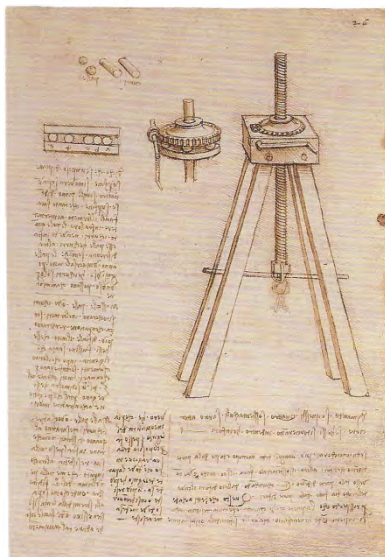


Figure 17. Codex Madrid I, 26r Jack with roller bearing

incorrect catalogue reference was used, and as a result the volumes could not be found and were considered lost.

Scholars realized the two *Madrid codices* should be somewhere in the Biblioteca Nacional of Madrid as they were registered there in an inventory prepared by the chief librarian, Antonio Gonzalez, in 1830. The catalogue entry again appeared in 1863 in the appendix to the book *Ensayo De Una Biblioteca Española De Libros Raros Y Curiosos* by Bartolome’ José Gallardo²⁵ who quoted it as ‘*Leonardo da Vinci, tractados de fortificacion, meccanica y geometria*

escritas al reve’s y en los anos 1491 y 1493, 2 vols. Aa.19.20.’ (Reti 1968 v.3:11).

In 1898 Professor E. de Marinis of Florence checked those references, and found two different volumes in their catalogued places, being the *De Remediis Utriusque Fortunae* of

Petrarch, and glosses from the *Digest of Justinian*. It was assumed that these had been exchanged for the Leonardo volumes that were now somehow stolen or lost. Subsequent searches revealed nothing, although one wonders how thorough the searches could have been. Whoever placed them on the shelves in about 1830 must have followed some sort of shelving system which was not followed in the searches (Reti 1968 v.3:11-12).

There are two versions of what happened next. The first is that André Corbeau, a French scholar, raised the possibility of a cataloguing error in 1964, and the Director of manuscripts started another search. The two manuscripts were found but their discovery was kept very low key and only became generally known about in 1967.

Another version claims that in 1965, Dr Jules Piccus,²⁶ an expert in early Spanish literature, was looking for mediaeval ballads or *cancioneros* and accidentally re-discovered the two *Madrid Codices* on the shelf where they had been for 135 years.²⁷

Perhaps both versions took place, and Jules Piccus discovered the volumes when the Director of manuscripts was still dithering about announcing that they had been found - when they had never really been lost, just miscatalogued and mislaid.

3.6 THE MANUSCRIPTS THAT WENT TO ENGLAND

Important manuscripts in Pompeo Leoni's collection that dispersed to England are the drawings in the Royal Collection, the *Codex Arundel* in the British Library, and the *Codices Forster* in the V&A (assuming they were in Pompeo Leoni's collection).

The provenance of the Royal Collection is not clear but it is known that some folios had come from Pompeo Leoni's collection, because one of them has a note on it which reads "Disegni di Leonardo da Vinci Restaurati da Pompeo Leoni" (Keele & Pedretti 1979:Intro). After his death, they passed into the hands of Don Juan de Espina, and they seem to have been sold later to the collector Thomas Howard Earl of Arundel,²⁸ and brought to England

between 1625 and 1630. They are known to have been part of Lord Arundel's collection as three were copied and engraved by Wenceslaus Hollar²⁹ when they were still in the Arundel collection, and they bear the inscription 'Ex collectione Arundeliana'. Hollar worked for Lord Arundel from 1636 to 1641. The drawings were in Lord Arundel's collection when he died in 1646, and they subsequently entered the Royal Collection though not all at the same time, but probably by 1690. There are several pieces of evidence for this below.

Constantine Huygens, a secretary to William III,³⁰ noted in his diary on the 1st September 1690 that he was shown a book of Leonardo's drawings by Queen Mary (Kurz 1936:135). There is an earlier reference suggesting that King Charles I of England had obtained some manuscripts of Leonardo. How he acquired them is unknown, but it goes back to about 1639 (Richter 1937:139-140) (Uzielli 1884:351). This earliest reference is intriguing in that it appears in three sources; in the *Manuscript Ganay* (MsGan:115v), in *Manuscript H 227 Inf.*, and in *Manuscript H 229 Inf.* (MsH229:18).

Another reference was an inventory of Leonardo's drawings in the Royal Collection which was compiled after 1737 which established that by 1760 almost all the present inventory was in the Royal collection.

A further reference is a note that Jean Paul Richter³¹ found in the British Museum which states that some drawings of Leonardo da Vinci were delivered for Her Majesty's use in the year 1728, without any other details. He also found a note at Windsor from the early 1800's claiming that one of the Leonardo drawings had been bought in Venice from the Bonfiglioli collection.³² This collection had been transferred to Venice from Bologna when Zaccaria Sagredo bought it for 3000 sequins or zecchini.³³

The *Codex Arundel* (UL 2013:Codex Arundel) also ended up in England. This manuscript was bought in Spain in 1636 by the avid collector Thomas Howard Lord Arundel after the death of Pompeo Leoni. Thomas Howard's grandson Henry Howard³⁴ inherited it,

and John Evelyn³⁵ the diarist persuaded him to present it to the Royal Society in 1667, and the British Museum bought it from the Royal Society in 1834. It is now in the British Library.³⁶

The other manuscripts that went to England are the *Codices Forster* (UL 2013: Codices Forster). Their early provenance is unknown and it is assumed that they were part of Pompeo Leoni's collection (figure 18). They were bought by Lord Lytton³⁷ in Vienna sometime before 1863, and how they got there is a mystery. He gave them to John Forster³⁸ in the 1860s, who in turn bequeathed them to the Victoria and Albert Museum in London on his death in 1876.



**Figure 18. Codex Forster 1, 43v
Perpetual motion machines
and Codex Forster II, 90v-91r
Perpetual motion wheels**

3.7 OTHER MANUSCRIPTS

One of Leonardo's manuscripts that was never owned by Pompeo Leoni is the *Codex Leicester* (UL 2013: Codex Leicester), and its movement from one owner to the next took it from Italy to England, then to America. Its early provenance is not known, but it seems to have been owned by the sculptor Giovanni della Porta, and then his son Guglielmo della Porta.³⁹ Pedretti thinks that Giovanni della Porta may have received the manuscript from Francesco Melzi (Farago 2003: 194). It seems that della Porta's heirs gave the manuscript to the painter Giuseppe Ghezzi,⁴⁰ and he subsequently sold it to Thomas Coke in Rome in about

1717.⁴¹ It remained in the library of Lord Leicester at Holkham Hall, Norfolk (NQ 1865:89)⁴² until it was bought by Armand Hammer⁴³ in 1980, and was catalogued in the Los Angeles County Museum under the title *Codex Hammer*. In November 1994 it came up for sale, and was bought by Bill Gates⁴⁴ of the Microsoft Corporation. Instead of renaming it the *Codex Gates*, he decided that it should revert to its previous title of the *Codex Leicester*.

Another of the manuscripts lost in the Orazio Melzi dispersal was a *Manuscript on Light and shade (Libro W)*. There have been comments that it has been seen, but its location is unknown (Pedretti 1965b:147). This was another *Manuscript on Light and Shade*, distinct from Manuscript C, probably written between 1508 and 1515 and Francesco Melzi, who named it *Libro W*, may have copied it into the *Codex Urbinas*. It is possible that it could have been bound together with *Manuscript C* and later separated. *Manuscript C* was the manuscript which was given to Cardinal Borromeo and eventually entered the Ambrosian (Pedretti 1965b:146-47). These sightings were claimed in Milan in 1866 and 1958. The first sighting was reported by the *Gazzetta di Milano* that a Dr Ortari had discovered a Leonardo manuscript of 112 pages dealing with light and shade, which was a surprisingly precise description, but the information did not lead anywhere. The second was a rumour that it had been seen in a library of the Borromeo family in Milan. Carlo Pedretti followed this up without success (Pedretti 1965b:147-48).

Then there are separate sheets in various collections, such as the Galleria dell'Accademia in Venice, the Biblioteca Reale in Turin, the Louvre in Paris, and the collection in the Uffizi in Florence. There are a few scattered sheets in collections elsewhere, such as the Budapest Museum, the Albertina collection in Vienna, and the Brera in Milan.

There are two manuscripts that contain transcribed material from Leonardo's notes where some of the original manuscript sources are lost. They therefore assume the importance of manuscripts by Leonardo, although they were not written by him.

The first is the *Codex Urbinas* which was transcribed by Francesco Melzi, and was lost in the dispersal when Orazio Melzi inherited Leonardo's notes. Its provenance and significance are discussed in Chapter 4.

The other is the *Codex Huygens* (Steinitz 1958:134-136)⁴⁵ and it is important because it is a copy of material which shows that the artist who transcribed it must have had access to Vincian manuscripts that are now lost. It originated in Italy, passing from hand to hand, and is now in America.

3.8 THE CODEX HUYGENS

The *Codex Huygens* was transcribed sometime before 1570 in Milan and contains five books dealing with the form and structure of the human body.⁴⁶ It contains material on the theory of human movement, transformation, the theory of proportion and a theory of perspective that date from Leonardo's later notes (Steinitz 1958:135). In the *Codex Huygens* there are copies of some of Leonardo's original drawings that have not survived in any other manuscript.⁴⁷

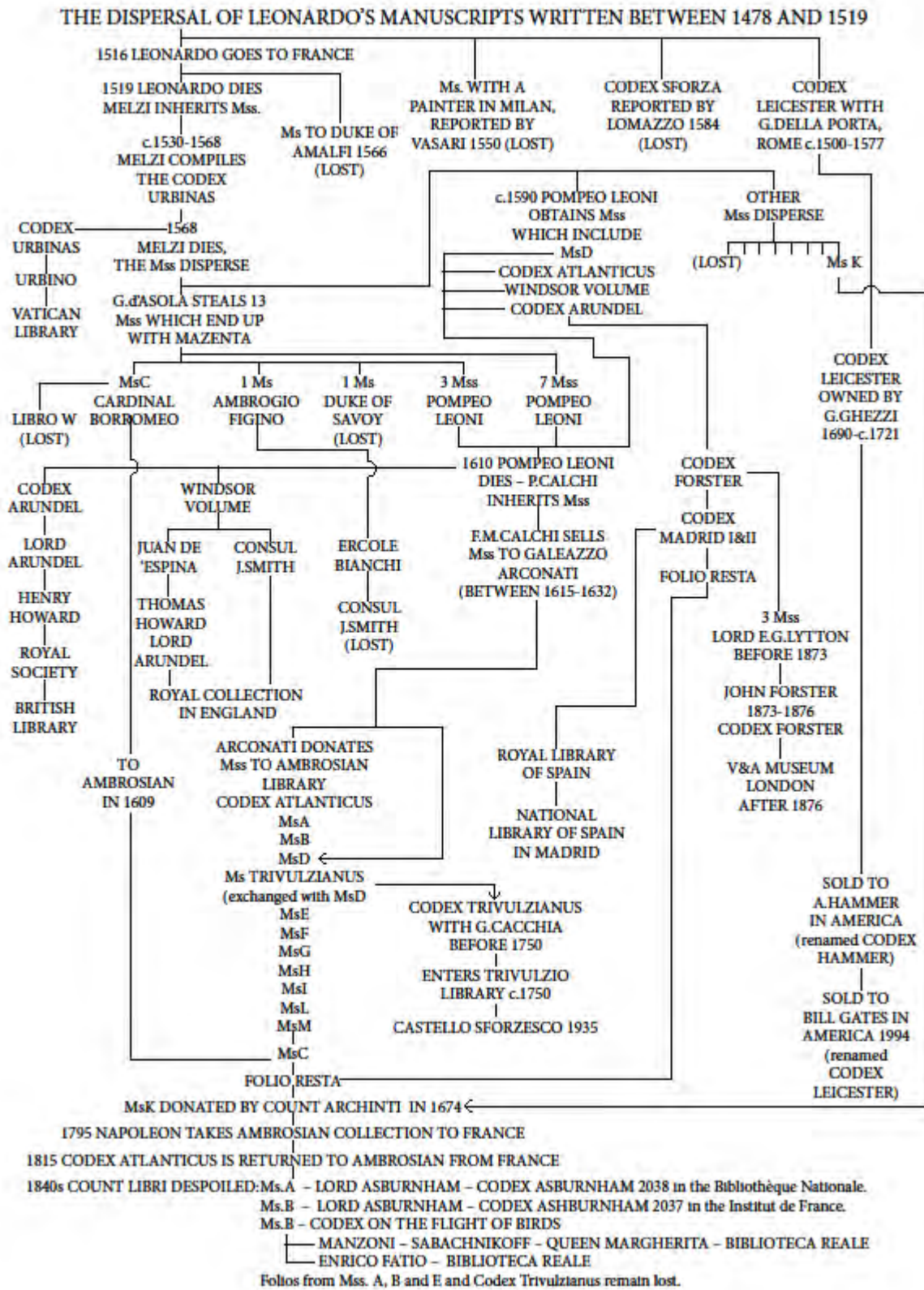
Until recently, there remained the question of who had transcribed the *Codex Huygens*? Part of the mystery was that the title page was missing. Over the years various names had been proposed, including Aurelio Luini,⁴⁸ Ambrogio Figino,⁴⁹ Bernardino Campi,⁵⁰ Paolo Lomazzo, and Carlo Urbino.⁵¹ The title page eventually turned up at auction, establishing that the manuscript was compiled by Carlo Urbino (Marinelli 1981:214). It also contained illustrations from the body of the *Codex Huygens* in an engraving, and the inscription *Tavola Cavata dal quinto libro della Prospettiva delle regole del Disegno di Carlo Urbini pittore*, referring to "the five books on perspective and the rules of drawing of the artist Carlo Urbino". It seems that the *Codex Huygens* was Carlo Urbino's own notebook, and his dates agree with the Milanese watermarks of the *Codex Huygens* which suggest a date

around 1560-1570. He was born in Cremona and trained in Venice, but worked for some years in Milan. Carlo Urbino died in 1585.

The title page also contained the signature of Gaspare dall'Olio who was active in Bologna from about 1583⁵² as an engraver and dealer in prints, which established that this notebook passed directly from Carlo Urbino to Gaspare dall'Olio. The title page had probably been removed at some stage to conceal the author's name, so that the manuscript could be passed off as an original by Leonardo.⁵³ Its provenance seems to be that it was acquired by Remigius van Leemput⁵⁴ some years later. Van Leemput was a Flemish artist who had been an assistant to Van Dyck, and he died in 1675. The well-known collector Constantine Huygens⁵⁵ then bought the *Codex Huygens* in 1690 from the widow of van Leemput for the bargain price of three and a half guineas.⁵⁶ There was then an hiatus in its provenance until the Pierpont Morgan Library in New York acquired the *Codex Huygens* in 1938 (Argentieri 1956:409).

The first dispersal of Leonardo's manuscripts occurred when Orazio Melzi inherited them, and many seem to have been lost. Pompeo Leoni managed to collect a surprising number of them, but a further dispersal took place after his death in 1610, with the resultant loss of further manuscripts. This pattern of events has been traced and detailed, and a stemma has been compiled to show the dispersals. The next chapter is one of reconstruction, showing how the abridged printed editions were compiled despite the setbacks. Then Melzi's transcription of the *Treatise of Painting* was found, and the complete editions could be published at last. That is followed by Chapter 5 showing further destruction by Count Libri.

3.9 STEMMATA OF THE DISPERSAL OF THE MANUSCRIPTS⁵⁷



ENDNOTES

¹1541-1587 (EB Sv Francesco I).

²1565-1635.

³Italian sculptor (1533-1608) (<http://www.treccani.it/enciclopedia/ricerca/Pompeo-Leoni/>).

⁴1562-1630 (EB Sv Carlo Emmanuele).

⁵1548/1551-1608 (TDB Sv Ambrogio Figino).

⁶1576-1636 (<http://www.worldcat.org/identities/lccn-no2011-28124>).

⁷1682-1770 (DNB Sv Joseph Smith).

⁸*Oxford Companion to the book*. 2010. Sv “Joseph Smith”, edited by M. Suarez, and H. Woudhuysen, Oxford: Oxford University Press.

⁹Pompeo Leoni returned to Italy from Spain in 1582, and must have acquired the manuscripts sometime between then and 1590 when Lomazzo mentioned the exchange.

¹⁰1590-1621 (EB Sv Cosimo II).

¹¹(http://xoomer.virgilio.it/ecalc/Calchi/Leonardo_da_Vinci.htm).

¹²“... that the most valuable treasure in the library was a manuscript collection, in 12 vols. Folio, of various works of Leonardo da Vinci, consisting of drawings, designs, etc. These had been presented to the library by a citizen of the name of Galeas Arconati, who generously refused vast sums for this precious deposit. To secure its possession to his country, he consigned it to the Ambrosian Library, as to an inviolable sanctuary. The reverend gentleman states that this collection was torn from the Milanese by the French, and ‘sent off, tost and jumbled in the common mass of plunder, to Paris’” *Notes and Queries*, 4 Dec 1869:472.

¹³1564-1631. Federico Borromeo was only twenty-three when he was made a Cardinal in 1587 by Pope Sixtus V. Eight years later, in 1595, he was made Archbishop of Milan by Pope Clement VIII (GDA Sv Federico Borromeo).

¹⁴The building of the Ambrosian started in 1603. However it only opened its doors to the public for the first time on 10th December 1609. It was officially opened by the Cardinal Archbishop of Milan, Federico Borromeo (*Notes and Queries*, 4 Dec 1869:472).

¹⁵1535-1601.

¹⁶The *Codex Trivulzianus* which was owned by the Trivulzio family in Milan, had been sold to Don Carlo Trivulzio in about 1750 by Don Gaetano Caccia of Novara.

¹⁷1715-1789 (Seregni 1927).

¹⁸A guilder was a gold coin, from ‘gulden’ or ‘golden’. It was later replaced with silver, and metal. One and a half guilder was a ‘daalder’, or ‘thaler’, which became ‘dollar’.

¹⁹Expressed in one of Napoleon’s letters dated 1796.

²⁰A typical reference to the *Codex Atlanticus* being in the Ambrosian appeared in *Blackwood’s Edinburgh Magazine* in 1861: “Folio volumes contain the drawings of Leonardo in Milan; and no forms of human face, whether in beauty or caricature, seem to have escaped the keenness of his observation ...” (Anon.Sept 1861, p.386).

²¹1578-1638 (EB Sv Vicente Carducho).

²²That particular Prince of Wales would in due course become King Charles 1 of England.

²³“dos libros dibujados y manoscritos de mano del Gran Leonardo de Vinchi, de particular curiosidad y doctrina.”

²⁴1568 -1642 (<http://www.bne.es/es/Micrositios/Exposiciones/Leonardo/Exposicion/Seccion3/subsec2/>).

²⁵1776-1852. The Librarian for the Congress of Deputies in Spain, a writer, and deputy for the province of Badajoz (<http://blog.bne.es/biblioteconomia/?p=653>).

²⁶1920-1997 (<http://www.sysoon.com/deceased/jules-piccus-35>).

²⁷New York Times 14 February 1967, and Reti 1968.

²⁸1585-1646 (EB Sv Thomas Howard).

²⁹1607-1677. Wenceslaus Hollar was a famous Bohemian engraver, protected by the Earl of Arundel and Charles I and lived in England from 1637. He fled to Antwerp during the Commonwealth and returned to England after the Restoration. He was the originator of over 2400 engravings (EB Sv Wenceslaus Hollar).

³⁰1650-1702 (EB Sv William III).

³¹1847-1937. An art historian (DAH Sv Jean Paul Richter).

³²McCurdy 1906:38.

³³A sequin or zecchino was a gold coin minted in Venice weighing 3.5 grams.

³⁴1628-1684 (DNB Sv Henry Howard).

³⁵1620-1706 (DNB Sv John Evelyn).

³⁶See http://www.bl.uk/manuscripts/FullDisplay.aspx?ref=Arundel_MS_263.

³⁷1831-1891 (DNB Sv Robert Bulwer-Lytton).

-
- ³⁸ 1812-1876. An editor, writer, historian, critic and major collector of 18000 books, several of them annotated first editions, he wrote the *Life of Oliver Goldsmith*, the life of *Sir John Eliot*, the *Life of Landor*, the *Life of Charles Dickens*, and the *Life of Jonathan Swift*, as well as other works (EB Sv John Forster).
- ³⁹ c.1500-1577. He was influenced by Michelangelo, but should not be confused with Giacomo della Porta who actually worked for Michelangelo, and who worked on the dome of St. Peter's with Domenico Fontana (TDB Sv Guglielmo della Porta).
- ⁴⁰ 1634-1721. Ghezzi was a painter of the Baroque period, working mainly in Rome, and was the first 'Secretary in Perpetuity' for the Accademia di San Luca in Rome (TDB Sv Giuseppe Ghezzi).
- ⁴¹ 1697-1759 (GDA Sv Thomas Coke).
- ⁴² " ... the following notices of the famed Holkham library: Early in the last century, an accomplished member of a famous family, Thomas Coke, Lord Lovel, and ... Earl of Leicester, collected, during his lengthened travels on the Continent, and more particularly in Italy, a choice collection of MSS ... there, the elaborate treatise of Leonardo da Vinci on the movement of water, illustrated with drawings by his own hand." (*Notes and Queries*, 29 July 1865:89).
- ⁴³ 1898-1990. An American oil tycoon and philanthropist (EB Sv Armand Hammer).
- ⁴⁴ 1955- (American National Biography Sv Bill Gates).
- ⁴⁵ 180x135mm of 121 folios, plus 7 folios that are larger, making 128 folios.
- ⁴⁶ Cremante, S. 1999.
- ⁴⁷ Panofsky, E. 1940.
- ⁴⁸ c.1530-1593 (GDA Sv Aurelio Luini).
- ⁴⁹ 1548-1608. He was a pupil of Paolo Lomazzo (GDA Sv Ambrogio Figino).
- ⁵⁰ 1522-1591. A painter from Reggio Emilia who worked in Cremona (GDA Sv Bernardino Campi).
- ⁵¹ c.1515-1585 (GDA Sv Carlo Urbino).
- ⁵² TDB Sv Gaspare dall'Olio.
- ⁵³ Marinelli, S. 1981.
- ⁵⁴ 1607-1675 (GDA Sv Remigius van Leemput).
- ⁵⁵ 1628-1697 (DNB Sv Constantijn Huygens Jr.).
- ⁵⁶ See letter from Constantine Huygens to his brother Christian dated 3rd March 1690, from Kensington.
- ⁵⁷ This stemma is based upon one in Pedretti 1965b:256-7 which has been extended and elaborated.

CHAPTER 4 - The printed editions

The dispersal of the manuscripts after they were inherited by Orazio Melzi was disastrous. Many manuscripts were lost, including the *Codex Urbinas*. However there were two main factors at the time that led to the recovery of some of the material. One was the remarkable role of Pompeo Leoni whose collecting skills rescued an astonishing number of manuscripts. The other was the fortunate fact that Leonardo's original manuscripts had circulated amongst the artists and intellectuals of his time and complete or partial copies had been made of some of them (Farago 2009:77). It was the surviving manuscripts and some of their copies that now became in the present study the basis for another major attempt at reconstructing Leonardo's *Treatise of Painting* to prepare a text with the aim of finally producing a published edition. Whilst this section does not contribute directly to the solution of how much of Leonardo's work is lost, it is a central part of the history of the manuscripts. Their history was not only one of loss, but also reconstruction, so it seems appropriate to cover the topic of the printed editions, but not in exhaustive analysis as it does not contribute to the solution of how much is lost.

4.1 THE DEVELOPMENT OF THE PRINTED EDITIONS

Leonardo wished to compile a number of treatises from his notes, including his particular desire to produce a *Treatise of Painting* which could take its place among the other published art treatises of the time. Francesco Melzi honoured his wish and transcribed a *Treatise of Painting* from his manuscripts, and it later became known as the *Codex Urbinas 1270*. This became the basis for the publication of the complete editions much later.

In the meantime great efforts were made to produce abridged editions from surviving manuscripts. The development of the abridged printed editions goes back to the early 17th century, and begins with Cardinal Francesco Barberini¹ who founded the Biblioteca

Barberiniana in Rome (Steinitz 1958:70-74). He was the nephew of Pope Urban VIII who had been Cardinal Maffeo Barberini,² and he benefitted enormously from his uncle's nepotism. This enabled him to indulge his passion as a patron of the arts, both in his private capacity and on behalf of the Church. He was a bibliophile and keen collector and established a new and important library in his Palazzo Barberini on the Quirinale Hill in Rome. He was able to acquire the important manuscript that would become known as the *Codex Barberinus* 832, now renamed the *Codex Barberinus* 4304.³ The *Codex Barberinus* was an early abridged copy of the *Codex Urbinas*, and the Cardinal allowed it to be copied several times. As a result of this, his new library became a centre of interest in Vincian studies, and the key figure behind this was his brilliant and scholarly secretary Cassiano dal Pozzo.⁴ He had studied the *Codex Barberinus* and became an enthusiastic scholar of the writings of Leonardo. He decided to widen and build the collection of material for the Library, commissioning copies from other manuscripts elsewhere, and even transcribing a copy of the *Codex Barberinus* for himself (Bell 1988:116-120).

The *Codex Barberinus* is a 16th century manuscript, and almost nothing is known about its provenance. Until relatively recently it was believed that the *Codex Barberinus* was the oldest abridged copy of the *Codex Urbinas*, and thus closest to the source (Steinitz 1958:46-54). There is a view that another codex, the *Codex Pinellianus*, now has that distinction (Ames-lewis 2005: 1). It is also a 16th century manuscript and was copied for the bibliophile Gian Vincenzo Pinelli⁵ of Padua in 1585. In due course the *Codex Pinellianus* (Steinitz 1958:53) was acquired by Cardinal Borromeo and deposited in the Ambrosian library.

Cassiano dal Pozzo pursued his project to produce a printed edition of Leonardo's notes on painting. Sometime between 1630 and 1640 he started transcribing a manuscript copy from the *Codex Barberinus*, and included his own copies of the diagrams. His copy is now known as *Manuscript H 228 inf.* in the Ambrosian library (Steinitz 1958:75-80), and it was to

become one of the copies used when typesetting the first printed and abridged edition known as the *Trattato della Pittura* (Steinitz 1958:45). He then had to check his copy against other existing sources. There were several in the Ambrosian library such as the *Codex Pinellianus*, and *Manuscript C* which had been donated by Cardinal Borromeo (Farago 2009b:5). Also in the Ambrosian was the Arconati⁶ Donation and *Manuscript K*. Several of these manuscripts were the original sources on which the *Codex Urbinas*, and therefore subsequent copies, were based.

The notebooks, especially *Manuscript A*, contained material on painting that had not appeared in either the *Codex Barberinus*, or the *Codex Pinellianus*, and Arconati made a copy of this material as well. All this additional transcribed material contained notes dealing with optics, perspective, mechanics, hydraulics, physics, and the natural sciences, and Cassiano bound them up into a number of volumes.⁷ Cassiano dal Pozzo had assistants working for him on the manuscripts (Bell 1988:116-119), and that resulted in more copies such as the *Zaccolini manuscripts*.⁸ These were copies made by the painter Matteo Zaccolini⁹ in the 1630s which Cassiano dal Pozzo had edited (Steinitz 1958:113-117).

It was in about 1639 that Cassiano was able to send his transcription of the *Codex Barberinus* to Galeazzo Arconati to be checked against the *Codex Pinellianus*, and against the other original manuscripts (Bell 1997). It now seems that the *Codex Pinellianus* was the source for the *Codex Barberinus*, and that there were earlier sources for the *Codex Pinellianus*, being possibly the *Codices Concini*, *Giacomini* and *Gaddi* (Farago 2009: 80-85).¹⁰

Cassiano dal Pozzo realised that illustrations from extant manuscripts would be totally inadequate for a printed edition of the *Trattato della Pittura*, so he turned to his artist friend Nicolas Poussin (Steinitz 1958:70-74). Cassiano had met Poussin through the Italian poet Giambattista Marino. For a time Poussin lived in Marino's house in Rome, and through

Marino and his connections he was able to meet Cardinal Barberini. This led to a meeting and subsequent friendship with Cassiano dal Pozzo.

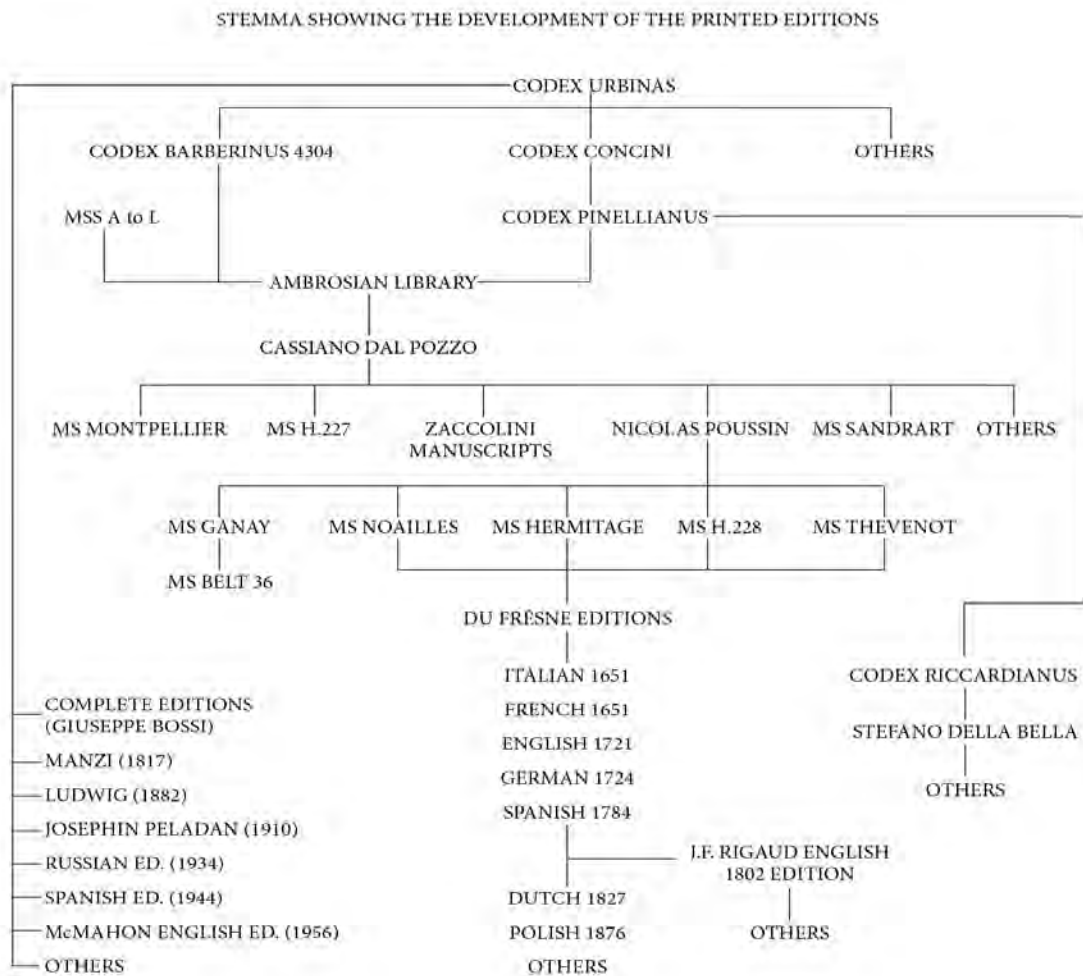
Cassiano then asked Poussin to illustrate his copy of the *Trattato* and made the *Codex Barberinus* available to him as source material. That provided him with a guide to the poses he needed to illustrate, and studies have shown that he modelled his figures on various classical sculptures that were around him in Rome at the time (Barone 2009:197-237).

A curious anomaly is that Poussin included some illustrations that do not occur in the *Codex Barberinus*, but do appear in the original source, the *Codex Urbinas*. The other copies of the *Codex Urbinas* available to him at the time do not contain those illustrations (Barone 2009:225). So he must have had access to a copy of the *Codex Urbinas* that still remains unidentified or lost. The original manuscript now illustrated and known as the *Manuscript H228 inf.* was returned to Cassiano dal Pozzo. This whole project and the enthusiasm of Cassiano dal Pozzo so inspired Poussin that he made a copy for himself, now known as the *Manuscript Ganay* (Steinitz 1958:80-82). He appears to have made several other copies as well. Nevertheless it is *Manuscript H 228 inf.*, Cassiano dal Pozzo's own copy, that is of particular interest because it is one of the key copies that led to the production of the first printed Du Frèsne edition (figure 19).



**Figure 19. Title page
Du Frèsne 1651 Italian edition**

4.2 STEMMA OF THE PRINTED EDITIONS



4.3 THE FIRST PRINTED EDITION - DU FRÊSNE 1651

Despite the earlier loss of Leonardo's manuscripts, this profusion of copies now enabled Cassiano dal Pozzo to pursue the next logical step to at last produce a printed edition which would partially offset the loss of the *Codex Urbinas* and fulfill the wishes of Leonardo himself.

In 1640 Paul Frèart, Sieur de Chantelou,¹¹ was travelling in Italy with his brother Roland Frèart, Sieur de Chambray.¹² Cassiano met them in Rome and handed them at least one complete manuscript with illustrations, and possibly as many as four copies. They then returned to France accompanied by Nicolas Poussin¹³ who took his own copy with him for the purpose of producing a printed edition.

It is not clear which copies were used by Jacques Langlois the printer in Paris. The candidates for this are the *Manuscript Hermitage*, *Manuscript Noailles* and *Manuscript H 228 inf.* as they all contain comments or notes that they went to France with M. de Chantelou (Steinitz 1958:147). Poussin's own copy, the *Manuscript Ganay*, also went to Paris with him but is almost certainly not the one that the printer used as it is about sixty lines shorter than the printed edition. Raphael Du Frêsné mentions the courtesy of Signor Thevenot who provided him with "a more correct copy" (Steinitz 1958:27). But the Thevenot copy seems to have disappeared.¹⁴ Whichever manuscript copies were received by the printer in France, they were the basis for the first two Du Frêsné editions.

Then fate played a hand that no-one expected with consequences that would affect the printed editions. Francesco Maria della Rovere II, the last Duke of Urbino, had died in 1631.¹⁵

After about 1600, the Duke had turned his summer residence at Casteldurante into his main residence (Mei 2005), and actually built a separate building for his magnificent library which had been founded by Federigo da Montefeltro in 1472, and built up to be one of the

largest in Europe. In his will of 1628, the Duke left his library of books and the library building to the Chierici Regolari Minori, and left his manuscripts to the Compagnia della Grotta of Urbino. After the Duke's death, the Pope simply ignored the terms of his will¹⁶ and decided that the library should go to the Vatican instead. The Duke's library had meanwhile been transferred from Casteldurante to the Palace in Urbino, and was left in a store-room in 12 crates. In one of those crates was Melzi's *Treatise of Painting*, which was confirmed by an inventory made in 1631. In 1657, the *Treatise of Painting* still in its crate was transferred to the Vatican, and astonishingly it was only in 1797 that the crate was unpacked, and it was discovered. The *Treatise of Painting* that would become known as the *Codex Urbinas Latinus 1270* was no longer lost. How the *Codex Urbinas* came into the Duke's hands has never been explained and remains a mystery.¹⁷

Cassiano's manuscript was now at the printer in Paris but it was the abridged edition, and there was going to be a long wait before the full *Codex Urbinas* was published for the first time in Rome. That was the Guglielmo Manzi edition of 1817. Cassiano's manuscript had been placed in the hands of Raphael Trichet Du Frêsné¹⁸ who was the publisher, and he took ten years to prepare and produce the 1651 printed edition. Roland Frèart, Sieur de Chambray translated it into French and the Du Frêsné edition was published at last, separately in Italian and French.

The timing was good. In 1648 the Académie Royale de Peinture et Sculpture was established in Paris to train students in the principles of the fine arts. The Du Frêsné edition of the *Traitté de la Peinture* was welcomed by the Académie, not without controversy, and Leonardo's *Treatise of Painting* now became an important part of the foundation of the French School of Painting (Kemp 2009:239-240). Now in published form, Leonardo's thinking was to influence generations of art students, intellectuals and collectors.

The Du Frêrne edition was a large format book (Steinitz 1958:145-152),¹⁹ and its impressive size and richly illustrated design seemed appropriate for the first printed edition of Leonardo's *Treatise of Painting*. It was published in Italian with a French translation, and both versions appeared almost simultaneously. It was an ideal book for the libraries of the educated collectors of Europe. Subsequent editions were the smaller octavo size²⁰ which was more appropriate for a painter's or student's handbook.

After Cassiano dal Pozzo's hard work and the efforts of the publisher Du Frêrne, one would have expected the work to be consistent and well structured. This was not the case. The style made it difficult to read, similar topics were not gathered together, and it was badly edited (Leonardo 1802:viii-xii). This was surprising as Du Frêrne had the position of 'correcteur' at the Imprimerie Royale,²¹ and clearly did not assess and correct the manuscript sent to him by Cassiano dal Pozzo.

The translation into French by Fréart de Chambray also attracted criticism and the style was described at the time as being too antiquated, so a revised translation was used in the subsequent 1716 French edition (Leonardo 1802:vii).²² One is left with the conclusion that Raphael Du Frêrne did not perform well in the publishing and production of the first abridged editions of 1651.

The structure of the Du Frêrne editions suggests that they did not have a skilled editor. Furthermore the ten years that it took Raphael Du Frêrne to see the books into print suggests that he could not give them the attention that they required.

The criticism of the Du Frêrne editions did not end there - more was to come. The printer in Paris, Jacques or Giacomo Langlois, clearly considered Nicolas Poussin's illustrations inappropriate for the overall design of the 1651 editions. He therefore commissioned Charles Errard (Steinitz 1958:72-73) to produce heavily engraved

backgrounds to Poussin's illustrations. Poussin knew nothing of this, and when he saw the printed editions with his embellished illustrations and their heavy shading, he was enraged.

Cassiano dal Pozzo, who had done so much to get Leonardo's *Treatise* into print, cannot be spared criticism. He had acted in the role of midwife and 'editor' of the work, scrupulously checking its accuracy without due attention to its structure. Cassiano was clearly insufficiently skilled as an editor to shape the text as it should have been. Or perhaps he so revered the source manuscripts and his respect for Leonardo was so great, that he dared not change them – which revived one of the early criticisms of the way Leonardo worked without discipline and order.

Another result of the reverence for Leonardo was the curiously grand format and treatment of headings in the Du Frêsné edition. The later compact octavo editions are less expensive and more appropriate to the requirements of an instructive *Treatise of Painting*.²³ The Du Frêsné editions are not. One can only guess at the reasons for this, but the elevated name and stature of Leonardo must account for part of it. Included must be the fact that this was the first printed edition 132 years after Leonardo's death. An octavo edition with simple typography would have been insufficient to mark such an occasion. Additional expectation was present in the form of the figure of Cassiano dal Pozzo in the background, with the Du Frêsné edition being the fulfilment of his wishes and dreams from so many years before. He was still alive when the Du Frêsné edition appeared in 1651, and died in 1657. The magnificent Du Frêsné editions²⁴ honoured these accumulated expectations, and were followed by the more appropriate octavo and quarto formats with their simpler headings in later abridged editions and their reprints.²⁵

After the dispersal of the manuscripts, their partial recovery and reconstruction, an historical high point had been reached in that at last Leonardo's notes on art in the form of the *Treatise of Painting* had survived their various vicissitudes and were now in published form,

albeit just the abridged editions with all their flaws. The Du Frêsné editions which had appeared in the middle of the 17th century more or less set the pattern for the next 150 years.

An interesting exception to this pattern was the fourth Italian edition which was published in 1792 by Francesco Fontani. Its source was the *Codex Riccardianus* which was a manuscript in the library of the Marchese Riccardi in Florence. The *Codex Riccardianus* was beautifully illustrated by Stefano della Bella,²⁶ and had been copied by him for his own use in about 1650 from the *Codex Pinellianus*, so it was congruent with the other sources used for the Du Frêsné editions (Steinitz 1958:44-54).

What is abundantly clear is that the Du Frêsné editions were unsatisfactory and the editions based upon them perpetuated their faults. Then everything changed at the beginning of the nineteenth century. In 1802, John Francis Rigaud²⁷ re-edited, re-ordered and in fact re-wrote most of the abridged *Treatise of Painting* in clearer English (Quilley 2009:505).

Rigaud was born in Turin, after his family had to flee there from Lyon and Geneva when the Edict of Nantes was revoked. He studied history painting under Claudio Beaumont²⁸ in Turin, and then spent several years travelling through Italy. His time in Bologna at the Academia Clementina would have exposed him to various treatises on art, particularly copies of Leonardo's work. He went to London in 1771, and settled there becoming an associate of the Royal Academy and later a member of the Royal Society. He regularly exhibited his paintings at the Royal Academy and received many commissions for both history paintings and portraits at various country houses of the nobility.

It was while he was in London that he started work on the *Treatise of Painting* to produce his own improved edition. He went back to the Italian Du Frêsné edition and compared it with the French edition of 1716, and the first English edition of 1721. In the Translator's Preface to his new edition, he described the Du Frêsné editions as follows: "... the original work, consisting in fact of a number of entries made at different times, without

any regard to their subjects, or attention to method, might rather in that state be considered as a chaos of intelligence, than a well digested treatise ...” (Leonardo 1802:ix).

So John Francis Rigaud tackled the structural and language weaknesses of the previous editions and completely re-edited the text. This resulted in the Rigaud edition of 1802 in which the subject matter was re-ordered so that similar topics were displayed together. In addition he changed the style completely, and the awkward text which was difficult to read became readable, and stylistically a lot more straight-forward. Rigaud’s re-arrangement turned a chaotic edition into a good readable text, and many of the subsequent editions conformed to this one. It became in the words of Kenneth Clark “the only good English edition available” (Pedretti 1965b:xi).

At last Leonardo’s *Treatise* was in a properly edited and readable form, and reprints have continued in English with translations into other languages to the present day. But there is another intriguing point that we can deduce about these editions which explains the point of producing an abridged edition. This is revealed by examining a Concordance (Pooler 2004) of various editions which is available as Appendix 4. Compiling this appendix was an enormous amount of work, but surprisingly valuable as it reveals the possible original intentions of Cassiano dal Pozzo²⁹ as follows:

In Appendix 4, the sections in the Du Frêsné editions have been listed with comparable lists from the first English edition of 1721,³⁰ and the Rigaud edition of 1802. These are then compared with the German translation of the full *Codex Urbinas* done by Heinrich Ludwig³¹ in 1882, and the English translation of the *Codex Urbinas* by Philip McMahon in 1956. This comparison shows us how the abridged editions differ from the full *Codex Urbinas*, and suggests why.

The full *Codex Urbinas* runs to 1008 sections. Almost all the 365 sections in the abridged editions come from only two main chapters in the *Codex Urbinas* – chapters two

and three. Only 12 sections come from elsewhere. That means nearly 97% comes from the two practical chapters in the *Codex Urbinas*. The first is *Of Rules for the Painter* which contains a range of information, especially on light and colour, that appears in more detail in other sections, and is clearly intended as an introduction. The second practical chapter is *Of Various States and Movements of the Human Body*, which is a guide to simple anatomy and movement including *Contrapposto*. There is also a small representative selection from the chapter on draperies. So the abridged edition is a basic selection or introduction. More advanced information which is covered in the other sections of the *Codex Urbinas* was left out of the abridged editions. It is clear from this basic introduction that the abridged editions are all directed at the same audience, that of the beginner or student (Steinitz 1958:158). That selection comprises the basics, the heart of information for the student painter without the detail required by a more advanced artist, and the Concordance inescapably confirms this.

There is another interesting point that suggests the abridged editions were intended for students. The Du Frêsné editions, and those later editions closely based on them, contain 365 sections, and Rigaud followed this in his edition of 1802, as do subsequent editions closely based on his. This suggests the view that the text was originally intended as a one-year course for students with a section to be read and studied each and every day of the year. Why else settle on 365 sections, neither more nor less? There are many sections that could have been omitted or amalgamated with others to change the total number of sections, which in fact happened in other editions. An example of this would be the 1721 English edition which had seven fewer sections. However, all editions that closely conform to the Du Frêsné and later Rigaud editions have the same number of sections as there are days in the year. Nowhere do any of the editors mention that the purpose was to read a section each day, but that conclusion seems highly probable, although it is conjectural. The alternative is that it is a coincidence which is highly improbable. It also throws light on the original intentions of those who

developed the *Treatise of Painting* from the beginning, and gives us an insight into the thinking of Cassiano dal Pozzo himself. It seems from the above that behind his transcription of the various manuscripts was his determination to produce a beginners' or students' edition of Leonardo's thinking on art with a section to be read each day as part of a one year course for art students.

4.4 COMPLETE EDITIONS OF THE *CODEX URBINAS*

Over the years new editions and translations of the abridged edition were published, but there persisted the desire to publish the full text of the *Codex Uribinas* as Melzi had transcribed it.

The first attempt was by Giuseppe Bossi in 1809 (Steinitz 1958:27,44). He was a neo-classical painter from Milan who became the Secretary of the Brera Academy, and wrote several works on art.³² He approached Abate Gaetano Luigi Marini,³³ who was the first custodian of the Vatican Library, and offered to pay to have the complete *Codex Uribinas* transcribed. Marini arranged for a complete copy to be made of about 600 pages. Giuseppe Bossi died in 1815 before his copy could be published. The original manuscript copy is now in the Ambrosian Library in Milan.

Two years later in 1817 the full *Codex Uribinas* was published in Rome by Guglielmo Manzi, the librarian of the Barberini library (Steinitz 1958:186). He had worked from the *Codex Uribinas* transcribed by Melzi, now in the Vatican library.

This first Italian edition of the complete *Codex* consisted of 912 sections, divided into eight books, and was important for a number of reasons, not least among which was that it included material from a source close to Leonardo himself namely Francesco Melzi.

Furthermore certain sections from the complete *Codex* were now in print that had never previously appeared in the abridged editions, such as the *Paragone*,³⁴ named by Manzi,³⁵

containing Leonardo's discussion and comparison of the different arts in section 1. The abridged editions had concentrated on sections 2 and 3 of the *Codex Urbinas*, but here at last were published other sections on light and shade, clouds and the horizon, trees and perspective, and more on drapery, making available the other six sections up to section eight. The sections of the full *Codex Urbinas* were constructed in a reasonably orderly manner in that Melzi compiled everything he could on painting from Leonardo's manuscripts within eight subject divisions. But the order within each division was unstructured and illogical. Melzi was simply trying to include whatever he could on painting from the material scattered throughout Leonardo's notes. He was not extracting specific material for a particular readership, apart from artists in general. And the *Codex Urbinas* is not itself complete. Melzi planned to include further material from other manuscripts some of which are now lost, in addition to part of a section that had already been transcribed which now appears to be missing.

But there were some problems with the Manzi edition (Steinitz 1958:187) – his transcription into modern Italian was difficult to read; the sections were headed but unnumbered, and he made some arbitrary changes in their arrangement; and there were some misinterpretations as well as omissions from the original text. Nevertheless it was the first published text of the full *Codex Urbinas*.

The next complete edition (Appendix 3) was that of Heinrich Ludwig in 1882. This was an important translation into German with accompanying text in Italian consisting of 944 chapters and appeared in four volumes.

In 1910 a French edition appeared compiled by Joséphin Péladan³⁶ in which he had rearranged the Manzi edition of 1817, now divided into 19 chapters.

This was followed by a Russian translation in 1934 in Moscow, containing the full 944 chapters of the Ludwig edition.

The complete *Codex Urbinas* in Spanish appeared in 1944. This was a translation of Joséphin Péladan's text of 1910 divided into 1100 chapters, with Péladan's rearrangement of Manzi's text.³⁷

Two other fairly recent editions are of historical interest to show how widely translations of Leonardo's texts have spread – the first Romanian edition of 1947 based on the full *Codex Urbinas*, and the first Serbo-Croatian edition of 1953.

The next important edition in this historical trail (Appendix 3) was the 1956 edition of the complete *Codex Urbinas* in English by Philip McMahon. It was published in two volumes with an introduction by Ludwig Heydenreich. One volume is a facsimile edition of the *Codex Urbinas* and the other is an English translation of the full text. This is divided into the 1008 chapters of Melzi's transcription, as against the 944 of Ludwig's translation and 912 of the Manzi edition. Philip McMahon died before he had reached the end of the complete English edition, and it was finished by his wife.³⁸

Since then there have been several other complete editions of the *Codex Urbinas*, but notable among them is the *Libro di Pittura* published by the Giunti Editore Group in Italy in 1995. This was transcribed by Carlo Vecce, and edited with a commentary by Carlo Pedretti.

What of the other manuscripts? In 1796 Napoleon transferred the collection of Vincian manuscripts in the Ambrosian to Paris, and that led to further despoliation and dispersal as discussed in the following chapter.

ENDNOTES

¹1597-1679 (GDA Sv Francesco Barberini).

²1568-1644 (GDA Sv Maffeo Barberini).

³ Later known as the *Codex Barberinus Latinus 4304* when it entered the Vatican Library in Rome.

⁴ 1588-1657 (GDA Sv Cassiano dal Pozzo).

⁵ 1535-1601 (Grendler 1981).

⁶ Cassiano dal Pozzo was put in touch with Count Galeazzo Arconati by Mazenta (Farago 2009:80).

⁷ Volumes which became known as the *Manuscripts H 227 inf.*, *H 229 inf.* with its copies, and the *Manuscript Montpellier H 267*.

⁸ In 1973, Carlo Pedretti found examples of these, known as the *Zaccolini Manuscripts*, in the Laurentian Library in Florence. They consist of four parts called: 1) *De colore* 2) *Prospettiva del colore* 3) *Prospettiva lineale* 4) *Della descrizione dell'ombra prodotte da corpi opachi rettilinei*.

⁹ 1574-1630. A painter, a priest, and mathematical theorist on perspective (GDA Sv Matteo Zaccolini).

¹⁰ See Williams 2009:63.

¹¹ 1609-1694. A French Art collector and patron (Larousse encyclopedie Francais Sv Paul Frèart, Sieur de Chantelou).

¹² 1606-1676. A French theorist and writer on architecture (Larousse encyclopedie Francais Sv Roland Frèart, Sieur de Chambray).

¹³ Poussin's friendship with Paul Frèart, Sieur de Chantelou was most important, as he acted as his patron in Paris, and introduced him to other patrons and collectors. Paul Frèart de Chantelou commissioned Poussin to paint the second series of *The Seven Sacraments* in 1644, which are now in the National Gallery of Scotland.

¹⁴ K.T.Steinitz suggests this could be *Codex 967* in the Bibliothèque Nationale, Paris.

¹⁵ TDB Sv Francesco Maria della Rovere.

¹⁶ It was Alexander VII (1599-1667) who became Pontiff in 1655 two years before the manuscripts were transferred to the Vatican .

¹⁷ Carusi, E. *Trattato della Pittura di Leonardo da Vinci*, in *Per il IV Centenario della morte di Leonardo da Vinci*, Bergamo: Istituto Italiano d'Arti Graphice, 1919, p.430.

¹⁸ 1611-1661 (DAH Sv Trichet Du Frèsne).

¹⁹ 380 x 265 mms.

²⁰ 190 x 115 mms.

²¹ Sparti 2003:157.

²² See Giffart preface in the 1716 French edition.

²³ All the abridged English editions are octavo. The imposing first Italian edition was followed by two quarto excerpts, then three folio editions; subsequent Italian editions were either quarto or octavo. The imposing first French edition was followed by octavo editions, except for the 1773 excerpt, and the 1901 fragmentary edition, both of which were folios. The first two German editions were quarto, all subsequent editions being octavo. The Spanish and Swedish editions were quarto; the Dutch, Russian and Polish were all octavo.

²⁴ 38 x 26.5cms with elaborate typography.

²⁵ After the first two Du Frèsne editions, came excerpts which were the Italian editions of 1657 and 1674, and the Dutch edition of 1682. Then came the first abridged octavo edition, the Giffart, in 1716.

²⁶ 1610-1664. Stefano della Bella was an Italian printmaker who lived in Rome, Paris and then Florence, who was known for his etchings which numbered more than 1000 (GDA Sv Stefano della Bella).

²⁷ 1742-1810 (GDA Sv John Francis Rigaud).

²⁸ 1694-1766 (GDA Sv Claudio Beaumont).

²⁹ This not to suggest that this was Rigaud's intention, but he was working with material that already reflected dal Pozzo's intention.

³⁰ Where the editions do not have numbered sections, I have imposed numbers running seriatim from the beginning for the purposes of the Concordance.

³¹ 1829-1897 (GDA Sv Heinrich Ludwig).

³² 1777-1815. His books included a *Discourse on the Political Utility of the Arts of Design* in 1805, *Four Books on Leonardo's Last Supper* in 1810, and *Researches on Natural and Artificial Chromatic Harmony* in 1821 (GDA Sv Giuseppe Bossi).

³³ 1742-1815. He studied Law and Philology at Bologna University, and was appointed president and prefect of the Vatican Museum, Library and Archives (TDB Sv Gaetano Luigi Marini).

³⁴ *Paragone* means 'a comparison', in this case comparing different art forms with each other.

³⁵ 1784-1821 (TDB Sv Guglielmo Manzi).

³⁶ 1858-1918. The French journalist, novelist and occultist, interested in Rosicrucianism, the Kabbalah, and Jewish Mysticism (Larousse encyclopedie Francais Sv Joséphin Péladan).

³⁷ This should not be confused with another Spanish edition in 1944, also based on Péladan's edition, but abridged into 777 chapters.

³⁸ Leonardo da Vinci, 1956. *Codex Urbinas*. First English edition by McMahan. New Jersey: Princeton University Press. Introduction.

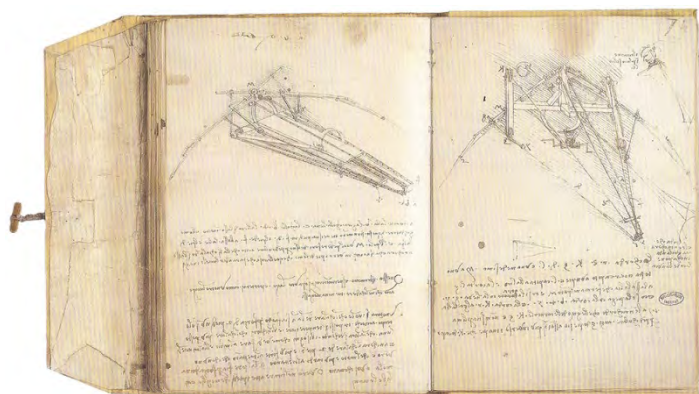
CHAPTER 5 - Count Libri and his theft of manuscripts

The story of the dispersal of Leonardo's manuscripts, and the loss of many of them including the *Codex Urbinas* was a dark period in this historical tracement. A much brighter period began with the reconstruction of the *Treatise of Painting* from the manuscripts that remained in the Ambrosian and Barberini libraries. The high points were reached with the publication of the first printed editions of the abridged *Treatise of Painting*, and the rediscovery of the *Codex Urbinas* in 1640 and its subsequent publication. Then occurred that momentous event when Napoleon transferred the collection of Vincian manuscripts in the Ambrosian to Paris in 1796 which led to yet another setback.

The transfer of the manuscripts to Paris provided the opportunity for an enterprising thief, Count Guglielmo Libri,¹ to despoil several of the Vincian manuscripts in France in about 1840. The manuscripts affected were as follows.²

Leonardo's *Manuscript A* was one of those that suffered at the hands of the eponomously named Count Libri. In about 1840, he tore out and stole folio 54, and then folios 65 to 114. He sold folios 81 to 114 to Lord Ashburnham,³ and they were later returned to France in 1891. They are now known as the *Codex Ashburnham 2038* in the Bibliothèque Nationale, Paris.⁴ Folios 65 to 80 and folio 54 remain lost.⁵

Then Count Libri despoiled *Manuscript B*⁶ (figure 20). In 1840, he stole folios 91 to 100, which were later recovered and became *Manuscript Ashburnham 2037*. He also stole folio 3, and folios 84 to 87 which remain lost. *Manuscript Ashburnham 2037*⁷ is now part of *Manuscript B* at the Institut de France.



**Figure 20. Manuscript B 74v-75r
An ornithopter**

*Manuscript E*⁸ was also a victim. It had 96 folios and the last 16 are now lost, having been stolen by Count Libri also in about 1840, and never recovered.

Leonardo began his studies on flight in 1486, the last being dated 1515, and compiled the *Codex on the flight of birds*⁹ which is in the Biblioteca Reale in Turin (figure 21). It was originally bound together with *Manuscript B* and was stolen by Guglielmo Libri just before 1848. Count Giacomo Manzoni¹⁰ of Lugo bought it in December 1868 when it consisted of thirteen folios, as Count Libri had previously sold five folios. In 1894, Prince Theodore Sabachnikoff bought it from the Manzoni collection at auction.



Figure 21. *Codex on the flight of birds, 8r Studies on flight*

The five missing folios had dispersed and were later bought in sales, one by Sabachnikoff, and the other four by the collector Enrico Fatio in Geneva. Sabachnikoff then published the first printed edition of the folios in his possession. In 1893, Sabachnikoff gave his manuscript to Queen Margherita of Savoy,¹¹ after which it entered the Biblioteca Reale in Turin. Enrico Fatio also generously donated his folios to the Biblioteca Reale, thus re-uniting all the folios.

The story of how Count Libri pulled off these thefts is fascinating (Ruju 1995). He gained access to thousands of valuable manuscripts, and stole an astonishing number of them. A brief look at his background will show how he achieved this (O'Connor 2003). Count Libri, or more properly Count Guglielmo Libri Carucci dalla Sommaja,¹² (figure 22) was born in Florence on 1 January 1803. He entered the University of Pisa in 1816 and proved himself to be such a gifted mathematician that he was appointed to the Chair of Mathematical Physics at Pisa in 1823 at the age of only 20 (Ruju 1995:29,37-38). As Professor of

Mathematics he visited Paris in the following year and made friends with other leading mathematicians of the day. This was to stand him in good stead (Ruju 1995:39-51). He returned to Italy but was suspected of being involved in a political conspiracy against the Grand Duke of Tuscany Leopold II.¹³ It seemed prudent to leave Italy, and he decided to return to France at the age of 27 (Ruju 1995:72-80).



Figure 22. Count Libri

He was welcomed by his scientist and mathematician friends in Paris and within three years, in 1833, was elected to join the prestigious Institut National des Sciences et des Arts.

The secretary of the Institut National immediately helped Count Libri gain a further position at the Collège de

France which secured him an income. Not only had he landed firmly on his feet, but the following year gained another position as assistant Professor at the Sorbonne lecturing on the Calculus of Probabilities (Ruju 1995:84-93).

After a few years the enterprising Count Libri became known as a collector of rare books and manuscripts from which he quoted in his own publications. By 1847 he had amassed an astonishing collection of about 40 000 books and over 1800 manuscripts,¹⁴ many of which were rare and are now thought to be lost. Then the truth gradually dawned. A few years earlier, in 1841, Count Libri had been appointed Inspector of the Libraries of France, a case of ‘a rapacious fox guarding the chickens’. It was noted that valuable manuscripts and books had started disappearing and over a few years these losses became connected with his visits to various libraries. His own library was expanding at a commensurate rate (Ruju 1995:161-179). An investigation into the losses began and in due course Count Libri heard that a warrant for his arrest was to be issued. It was 1848 and revolution was in the air – not a good time to be arrested in France. He fled again, this time to England, but not before

arranging for 30 000 of the stolen books and manuscripts to be packed and dispatched to London (Ruju 1995:238-258).

He was welcomed in London as a refugee from the French revolution and convinced several influential new friends that he was the victim of political animosity simply because he was Italian. Any thought of returning to France was doomed when, on the 22nd June 1850, a French court sentenced Count Libri to 10 years in prison for his theft of valuable books and manuscripts (Ruju 1995:259-263).

The penniless Count staged two large sales of his collection in 1861, the first lasting 12 days and the second 8 days. The catalogue contained 7628 lots and was introduced as the *Catalogue of the Mathematical, Historical, Bibliographical and Miscellaneous Portion of the Celebrated Library of M. Guglielmo Libri*. The sales raised over a million francs for the talented thief who had so abused his official positions to enrich himself (Ruju 1995:290-299). In 1868 his health began to deteriorate and he finally returned to Italy. A large part of his remaining library was bought for 2000 lira in gold by the bibliophile and collector Count Giacomo Manzoni¹⁵ from Libri's second wife H el ene de La Motte. This was the Count Manzoni who had bought the *Codex on the flight of birds* that Count Libri had stolen (Ruju 1995:316-319). Nevertheless, the 16 folios from Leonardo's *Manuscript A*, the five from *Manuscript B*, and the 16 folios from *Manuscript E* were never recovered and remain lost.

ENDNOTES

¹ 1803-1869 (GDA Sv Guglielmo Libri Carucci dalla Sommaja).

² McCurdy 1906: 33-4.

³ 1797-1878 (GDA Sv Lord Ashburnham).

⁴ 34 sheets 9.5 x 7.5 in. – 240 x 190 mm. *Codex Ashburnham 2038* contains mainly artistic studies.

⁵ Corbeau 1968:187-90.

⁶ Venerella, J. Manuscript B. v.9 of the *Manuscripts of Leonardo da Vinci* in the Institut de France. Ente Raccolta Vinciana.

⁷ 10 Sheets plus six additional sheets 9.5 x 7.5 in.

⁸ Venerella, J. 2002. Manuscript E. See the *Manuscripts of Leonardo da Vinci* in the Institut de France. Ente Raccolta Vinciana. Milan: Castello Sforzesco. xiii-xv.

⁹ 213 x 154mm. *Manuscript 'Sul Volo degli Uccelli'*.

¹⁰ 1816-1889 (TDB Sv Giacomo Manzoni).

¹¹ 1851-1926. She was the wife of King Umberto I of Italy.

¹² The name Libri was recorded in Florence in the fourteenth century and added to his name by Ser Francesco di Feo. It is not a nickname derived from Count Libri's activities.

¹³ 1797-1870. Ruled 1824-1859 (EB Sv Leopold II).

¹⁴ His collection included the Zaccolini manuscripts (Bell 1988:109).

¹⁵ TDB Sv Giacomo Manzoni.

CHAPTER 6 - Analysis of what may be lost

A datum- point for the analysis of missing manuscripts is the number of pages in the manuscripts that have survived, and the pages that survive amount to about 7000. Anything above that number becomes inherently speculative. A base has been established and various lines of enquiry have been pursued on what is known. So a brief summary of what has been covered in previous chapters seems useful at this point, although it has limitations, and does not provide access to the unknown. An attempt will then be made at a thought experiment into the unknown to see which parts of the database can take the argument forward, and require more extensive analysis.

BRIEF SUMMARY

6.1 MANUSCRIPTS THAT ARE LOST

Looking at the Stemma of the dispersal of manuscripts (Section 3.9 in this thesis), there are five that were recorded, passed from hand to hand, and which are now lost.

6.1.1 The Duke of Amalfi owned one – an inventory of his books and manuscripts recorded a manuscript by Leonardo, known as the *Codex Amalfi*, that is now lost (Willette 2009:152, 166; Vecce 1998:438-48).

6.1.2 Giorgio Vasari (Vasari 1965:634) wrote, “So also there are in the hands of a painter of Milan, some writings of Leonardo, in characters written with the left hand backwards, which deal with painting and the methods of drawing and colouring ... ” (Steinitz 1958:24).

6.1.3 Another reference concerns Giovanni Paolo Lomazzo (Lomazzo 1584:158) who referred to the *Codex Sforza* when he wrote, “Leonardo da Vinci in his book which I read some years ago which he wrote with his left hand on request of Lodovico Sforza, Duke of Milan”.

6.1.4 Giovan Ambrogio Mazenta gave a manuscript to the Duke Carlo Emmanuele of Savoy, which has not survived and it may have burnt in one of the fires in his library in 1667 or 1679 (Mazenta 1635:24).

6.1.5 Mazenta gave another manuscript to the painter Ambrogio Figino (Mazenta 1635:24). It passed from Figino to Ercole Bianchi, and Bianchi¹ sold it to Consul Joseph Smith in Venice. That manuscript is also lost.

6.2 REFERENCES TO MISSING MANUSCRIPTS

There are several references to a number of early treatises completed by Leonardo.

6.2.1 Luca Pacioli claimed that “Leonardo has already finished a worthy book on painting and human motion” (Clark 1958:125).

6.2.2 Vasari wrote (Vasari 1965:640), “... Of Leonardo we have the anatomy of horses and that of men ...”, and Lomazzo referred to Leonardo and his “various drawings ... in the hands of several owners, and especially in the house of Francesco Melzi, a gentleman of Milan, his disciple, in addition to the anatomy of the horse that he made by his hand” (Lomazzo 1844:III, 179). He also referred to a treatise on sculpture that he had seen.

6.2.3 Antonio Franchi (Franchi 1739), a painter who worked in Lucca and Florence, recalled reading a manuscript by Leonardo when he was a young artist in Florence. It came into his hands after the death of Guido Reni, and he said, “...for in this form it circulated in the hands of the studious painters before it was printed” (Steinitz 1958:27).

6.2.4 Another mention is by Benvenuto Cellini (Cellini 1857:225-227) who referred to a manuscript he had bought in 1542, and described it as a book, “of great excellence and beautifully done after the admirable genius Leonardo ...”. Cellini then described how Sebastiano Serlio wished to use it in his second book on Architecture, *On Perspective*, which appeared in 1551.

6.2.5 With the other references by Borghini and Mazenta, and Leonardo's own references to the *De ludo geometrico*, the *De voicie*, and the book on water, it seems probable that Leonardo did complete one or more treatises on human motion, perspective, the horse, or another topic which were seen by other artists of the day – if so, they are now sadly lost.

6.2.6 Another reference is intriguing. There have been comments that the lost *Manuscript on Light and shade, Libro W*, has been seen, but this is not certain. This was corroborated in 1958 by a rumour that it had been seen in a library of the Borromeo family in Milan, but the information did not lead anywhere (Pedretti 1965b:147).

6.2.7 Leonardo claimed to have sketches of “many flowers drawn from the life” (Emboden 1987:116) but only about 15 drawings of flowers survive. The probability is that a manuscript detailing flowers in particular as distinct from plant growth has been lost.

6.3 PARTIAL MANUSCRIPTS

6.3.1 A curious event regarding the Royal Collection occurred in 1778 when Richard Dalton found a book of drawings in the bottom of a chest in Kensington Palace. They numbered 779 drawings at that time, but when later mounted in the 19th century, they amounted to approximately 614 drawings. The discrepancy of nearly 180 drawings has never been explained (Parker 1945).

6.3.2 There was a curious discrepancy with the Pompeo Leoni collection, which was inherited by Polidoro Calchi. He offered 15 manuscripts and the *Codex Atlanticus* to the Grand Duke Cosimo II who declined it. The collection was inherited by Calchi's son who sold it to Count Arconati. Sometime later Arconati gave the collection to the Ambrosian and it then consisted of 11 manuscripts by Leonardo and one by Luca Pacioli. That discrepancy in the size of the collection has never been explained and no-one knows what happened to the three missing manuscripts (Dalton 1869:472).

6.3.3 Part of the *Codex Trivulzianus* is missing. This is a manuscript of 55 folios, but there were originally 62 folios, thus seven folios are now missing. Their loss has never been explained (Marinoni 1980:vii-xxi).

6.3.4 Other missing portions of manuscripts due to the thieving ways of Count Libri have been detailed earlier in chapter five. Some of the portions that he stole were recovered, but lost sections which were never recovered affect *Manuscripts A, B and E*.

6.3.5 Another manuscript with missing folios is the *Codex Urbinas*. Francesco Melzi's transcription marks suggest some material is missing, in which case the missing section seems to be from the beginning of Book Three where the title page is missing.

6.4 LOST AND FOUND OR RECOVERED MANUSCRIPTS

6.4.1 A rather oblique reference to a possible lost manuscript of Leonardo is a manuscript of Luca Pacioli on chess. Leonardo left Milan with Pacioli in December 1499, and it appears that in Mantua Pacioli wrote a 48 page manuscript on chess, the *De ludo scacchorum*. The manuscript of the *De ludo scacchorum* was then lost for centuries, and was rediscovered in Northern Italy in 2006. Leonardo may have designed the chess pieces that are illustrated in the manuscript, and it is probable Leonardo made notes with drawings on chess in one of his own manuscripts which is now lost.

6.4.2 Another manuscript was recorded by Francesco Melzi at the end of the *Codex Urbinas* as *Libro A*. This was a manuscript that was lost, but Carlo Pedretti realised that most of it had been copied into the *Codex Urbinas*, and the rest into the *Codex Leicester*, and was able to reconstruct its possible form (Pedretti 1965b).

6.4.3 A unique manuscript that is extant is the *Codex Huygens* which was the notebook of Carlo Urbino. It is important because he copied into it material from Vincian

manuscripts that are now lost (Panofsky 1968). So although this is not an original manuscript by Leonardo, it partially assumes that status being the only surviving record.

6.4.4 Two lost and found manuscripts are the *Codex Madrid I* and the *Codex Madrid II*. Earlier detail in section 3.5 shows how they were misplaced in the Biblioteca Nacional due to a cataloguing mistake in 1830, and were re-discovered 135 years later.

6.4.5 Another key manuscript that was lost with the general dispersal after Francesco Melzi died is the *Codex Urbinas*. Nothing was known of it until by chance it turned up again in 1631 in the library of the Duke of Urbino, and it was discovered in a crate after being transferred to the Vatican Library.

6.4.6 And of course there is the possibility, however remote, that other manuscripts will be found. Recently a lost fragment was found in the archives of a public library in Nantes in France. It is part of a collection that was donated to Nantes in 1872 by the painter and collector Pierre-Antoine Labouchère,² and has remained unidentified in the archives for 140 years. It is too early to assess its significance.

6.5 OTHER EVIDENCE

It will never be known how many manuscripts have been lost but there are some clues.

6.5.1 Pompeo Leoni marked his collection with numbers in addition to approximately 2000 loose sheets, and the highest number on an extant manuscript from his collection is 46.³ Only 19 of those manuscripts have survived, which presumably were part of the 46. But the number 46 may not have been the highest number in his collection. There may well have been higher numbers attached to manuscripts now lost.

6.5.2 Another list of interest is in the *Codex Madrid II*. On folios 2v and 3r appear the titles of 116 books that Leonardo left in Florence when he went to Piombino in 1504, and

two of them appear to be original manuscripts of his own. But on the next folio, 3v, is a list of books itemized by size and not by title. They add up to 50 volumes and could well refer to his original manuscripts.

6.5.3 Another estimate of what has been lost relates to the *Treatise of Painting*. Today three-quarters of the notes in the *Treatise* cannot be traced in extant manuscripts, so the original sources have to be assumed lost. But that is not to suggest that only a quarter of *all* his manuscripts has survived.

What has been established in this thesis so far is a database of the manuscripts Leonardo wrote that have survived, and manuscripts that have been mentioned but are now lost. What have not been mentioned are the lost manuscripts that remain unknown without any early references, and they constitute the key portion of manuscripts that must be convincingly estimated if this thesis is to succeed. The question at this point is whether there is any way of calculating or estimating the extent of those manuscripts, and this thesis asserts that a calculation is possible.

This brings us to a key point. An exhaustive analysis of what is known, and more information on manuscripts that have survived or have been recorded at some stage do not get us closer to solving the apparently impossible question of, “how much did Leonardo write in his lifetime, and how much has been lost?”. Deeper analysis of what is known confines us to exactly that – what is known, and that gets us no nearer a solution to what is unknown. Somehow the limitations of what is known must be overcome, and a new way of estimating Leonardo’s total intellectual output must be found.

We are now able to embark on a thought experiment that hopefully breaks down those limitations, and possibly provides access to estimates of what Leonardo actually wrote, whether known about or not. That access becomes possible by changing the question from

“what did Leonardo write”, to “what could Leonardo have written?”. That change appears deceptively simple, but it changes the entire methodology.

6.6 ANOTHER WAY OF LOOKING AT THE EVIDENCE

The methodology has to shift from the analysis of the known, the actual, to the unknown or speculative, and that analysis depends on the measurement of potential. The tools required to make that shift are available in the database that has been assembled. The history of the manuscripts and their analysis now need to be looked at differently, using the known to gain access to the unknown, and moving from the actual to the potential. That hopefully will achieve the shift from the evidence of extant manuscripts to an estimate of all the manuscripts that Leonardo may have written.

From the database what is known is the following:

- The years of Leonardo’s life: 1452-1519.
- The years in which he seems to have written his surviving manuscripts. Some are dated and thus certain, others estimated.
- The present number of folios in extant manuscripts.
- The original number of folios in extant manuscripts.

This information can be compiled in a way that will show how productive Leonardo was in his best years, and how his productivity dropped in his slowest years, although that could be explained by manuscripts that have been lost. The most important figure here is the estimate of his average productivity which will then be analysed to draw key conclusions.

6.6.1 We now need to establish what folios survive in extant manuscripts, as follows:

MANUSCRIPTS	DATES	EXTANT FOLIOS
<i>Codex Arundel</i>	1508 – 1518	285
<i>Codex Atlanticus</i>	1487-1518	1119
<i>Codex Forster I,</i>	1487-1490, 1506	54
<i>Codex Forster II</i>	1494-1497	159
<i>Codex Forster III</i>	1490-1493	94
<i>Codex Leicester</i>	1506-1509	36
<i>Codex Madrid I</i>	1490-1508	184
<i>Codex Madrid II</i>	1503-1505	157
<i>Codex on the Flight of Birds</i>	1505	18
<i>Codex Trivulzianus (Libro F)</i>	1487-1490	55
<i>Manuscript A</i>	1490-1492	63
<i>Ashburnham 2038</i>	1490-1492	33
<i>Manuscript B</i>	1487-1489	84
<i>Ashburnham 2037</i>	1487-1489	9
<i>Manuscript C</i>	1490	32
<i>Manuscript D</i>	1508-1509	10
<i>Manuscript E (Libro B)</i>	1513-1514	80
<i>Manuscript F</i>	1508	96
<i>Manuscript G</i>	1510-1515	96
<i>Manuscript H</i>	1493-1495	142
<i>Manuscript I</i>	1497-1505	140
<i>Manuscript K</i>	1503-1507	128
<i>Manuscript L</i>	1502-1503	94
<i>Manuscript M</i>	1500-1502	94
<i>Libro A</i> ⁴	1508-1515	65
<i>Windsor</i> ⁵	1487-1518	234

Plus scattered folios elsewhere whose influence is not material.

TOTAL 3495

The total of 3495 folios doubled will give us pages, amounting to a working total of 7000 extant pages. But various manuscripts have been despoiled since they were originally written,

and we need to express them in their original foliation to determine how many were lost in the dispersal.

6.6.2 Where the original number of folios in extant manuscripts is known, we can establish the number of lost folios as follows:

MANUSCRIPTS	DATES	EXTANT	ORIGINAL
<i>Codex Trivulzianus (Libro F)</i>	1487-1490	55	62
<i>Manuscript A</i>	1490-1492	96	114
<i>Manuscript B</i>	1487-1489	93	100
<i>Manuscript E (Libro B)</i>	1513-1514	80	96
<i>Windsor</i>	1487-1518	234	approx. 298 ⁶

6.6.3 A table can now be compiled, showing the likely years in which Leonardo produced his manuscripts, related to the known number of original folios he produced. The folios have been divided by the years in which he wrote them, to give us the average number of folios he wrote in any particular year per manuscript.

MANUSCRIPTS	DATES	FOLIOS	APPROX FOLIOS WRITTEN PER YEAR
<i>Codex Arundel</i>	1508 –1518	285	28.5
<i>Codex Atlanticus</i>	1487-1518	1119	36
<i>Codex Forster I,</i>	1487-1490, 1506	54	13.5
<i>Codex Forster II</i>	1494-1497	159	53
<i>Codex Forster III</i>	1490-1493	94	31.33
<i>Codex Leicester</i>	1506-1509	36	12
<i>Codex Madrid I</i>	1490-1508	184	10.2
<i>Codex Madrid II</i>	1503-1505	157	78.5
<i>Codex on the Flight of Birds</i>	1505	18	18
<i>Codex Trivulzianus (Libro F)</i>	1487-1490	62	20.7
<i>Manuscript A (incl. Ashburnham 2038)</i>	1490-1492	114	57

<i>Manuscript B (incl. Ashburnham 2037)</i>	1487-1489	100	50
<i>Manuscript C</i>	1490	32	32
<i>Manuscript D</i>	1508-1509	10	10
<i>Manuscript E (Libro B)</i>	1513-1514	96	96
<i>Manuscript F</i>	1508	96	96
<i>Manuscript G</i>	1510-1515	96	19.2
<i>Manuscript H</i>	1493-1495	142	71
<i>Manuscript I</i>	1497-1505	140	17.5
<i>Manuscript K</i>	1503-1507	128	32
<i>Manuscript L</i>	1502-1503	94	94
<i>Manuscript M</i>	1500-1502	94	47
<i>Libro A</i>	1508-1515	65	9.3
<i>Windsor</i>	1487-1518	234	7.5
	TOTAL	3609	

What is now required is to account for the overlap of work on different manuscripts, and add together the pages of manuscripts that he was working on at the same time, and express his productivity as average folios completed in any particular year.

This has resulted in the table below which shows the total number of folios that Leonardo wrote in any one year, based on only the manuscripts that have survived. This of course is based on a number of assumptions, but it serves as a guide to his productivity.

One of the key assumptions is that his output was steady, expressed as an average per year for each manuscript. This could never have been the case, but the averages add up to the correct totals. Another assumption is that these figures relate to existing manuscripts, and make no allowance for lost manuscripts. Inherent in that assumption is another, that lost

manuscripts would tend to be reflected in years showing lower productivity, not high productivity, which is not an unreasonable assumption. And there are other assumptions, such as folios being treated equally, despite their differing contents and size. These assumptions will be dealt with later as a refinement of this methodology. I first wish to put the methodology in place as a base from which objections and refinements will follow. Initially the methodology is a bit of a blunt instrument, but it is mitigated by an over-riding consideration as follows:

What we are looking for is a guide to Leonardo's periods of highest productivity, and conversely his lowest, in addition to a guide to average productivity. These are essentially interpretative figures, as the figures that are available contain inherent unknowns.

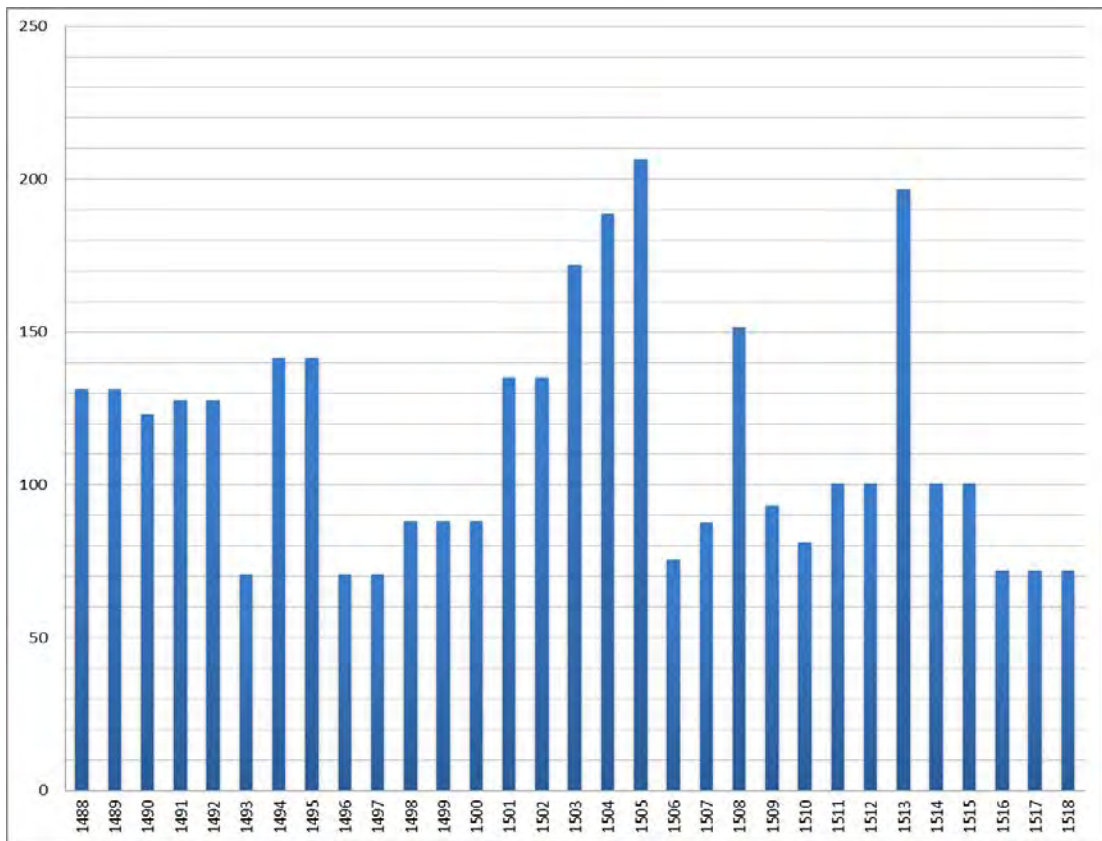
In the figures that follow, productivity throughout the years in which Leonardo wrote his manuscripts has been expressed beginning in the second year, being the completion of the first year of work in each case, rather as birthdays are expressed.

6.7 AN ANALYSIS OF THE FOLIOS PER YEAR

YEAR	ESTIMATED FOLIOS COMPLETED PER YEAR
MILAN ONE	
1487	
1488	131.2
1489	131.2
1490	123.2
1491	127.7
1492	127.7
1493	70.7
1494	141.7
1495	141.7
1496	70.7
1497	70.7

1498	88.2
1499	88.2
WANDERING YEARS	
1500	88.2
1501	135.2
1502	135.2
1503	172
FLORENCE TWO	
1504	188.5
1505	206.5
1506	75.5
MILAN TWO	
1507	87.5
1508	151.5
1509	93.3
1510	81.3
1511	100.5
1512	100.5
1513	196.5
ROME	
1514	100.5
1515	100.5
1516	72
FRANCE	
1517	72
1518	72
1519	

The above table can be better illustrated by converting it to a bar graph, below:



A glance at the bar graph gives rise to a number of thoughts. The first thing to notice is how productive Leonardo was in 1503 producing 172 folios when nearing the end of his time with Cesare Borgia, followed by an average of nearly two hundred folios per year in 1504 and 1505 during his second period in Florence. This was a rising trend which really began in 1501. Another good year was 1508 in which he produced more than 151.5 folios, followed by the outstanding year of 1513 when he was in Milan, producing 196.5 folios. Those were his best years.

Then there was the broad middle ground in which he wrote about 100 to just over 140 folios per year. The first period started with his arrival in Milan in 1487 and continued through to 1495. There was one exception which was the low year of 1493 when he wrote just over 70 folios. His productivity then rose again to the level of the 135 folios he produced in 1501 and 1502. The middle years from 1501 to 1505 were exceptionally productive,

followed by the ordinary years of 1511-12, and 1514-15 when he produced just over 100 folios per year. This was at the lower end of his middle range of output.

There were three periods characterised by lower productivity. The first was from 1496 to 1500, when he wrote between 70 and 90 folios per year at the tail end of his first stay in Milan. This was preceded by the low year of 1493, strangely in a period of reasonably good output. The second low period was from 1506 to 1510, with the exception of the high in 1508.

The third and final low period was from 1516 to 1518. It was to be expected that his last year in Rome and the final years in France were times of lower output as Leonardo was now at an advanced age and in poor health. He had suffered what seems to have been a stroke, but still managed a folio per week during that time.

The erratic nature of Leonardo's productivity is noteworthy. We see a low year in a period of good productivity, and a high year in a period of low productivity, and these aberrations need to be explained. These figures are based on extant manuscripts, so it is not an unreasonable assumption to ascribe the years with lower rates of productivity to the loss of manuscripts that were written in those years.

The manuscripts that are extant are commonly estimated to be only half or less of the number that Leonardo left when he died. That is a very loose estimate, and it seems possible to refine it.

6.8 DEDUCTIONS

It is now possible to calculate the highest total number of pages Leonardo theoretically could have written given the figures in the table showing folios per year. His greatest productivity was the possible completion of 206.5 folios in 1505, and if it is assumed theoretically that he more or less maintained that rate for the 32 years in which he compiled

his notes, the result should be an indication of the maximum number of folios he could have written – albeit totally unrealistic, and assuming that no manuscripts have been lost from that year of very high productivity. The calculation comes to 6608 folios or 13216 pages. As shown earlier, the number of pages that survive today is closer to 7000 because of more recent losses. It seems sensible to work on the figure of 7200, because that relates to the pages that survive from the original Orazio Melzi dispersal, without accounting for more recent despoliation. More recent losses are known, so we need to go back beyond them to figures that do not include them.

If we subtract 7200 from the theoretical maximum of 13216, the result will be the maximum number of pages, including blank pages, that could have been lost, being 6150. That figure expressed as a percentage of manuscripts lost amounts to approximately 46%, when related to the figures above. The usual estimate that between 50% and 75% of his manuscripts have been lost is guesswork, and an unacceptably high range, particularly as the loss of 46% calculated above represents the theoretical and unrealizable maximum, based on Leonardo's highest level of productivity.

The existing folios per year are only a sample within the larger population of all folios that Leonardo wrote, and that is an unknown number. It was hoped that an analysis of the sample might provide a statistical insight into the population of all possible folios, so that a statistical formula could be used to discover more about all possible manuscripts. That would depend on an overlapping factor of some sort, and there is none. Nevertheless this can be overcome to some extent by using the lowest and highest productivity numbers, being the folios written per year in the sample. The folios per year can be expressed in a table, shown below, but now sorted by number, not in years:

Table of folios per year sorted in numerical order

Folios	Year	Comment
70.7	(1493)	Bottom of the range – lowest number of folios per year.
70.7	(1496)	
70.7	(1497)	
72	(1516)	
72	(1516)	
72	(1516)	
75.5	(1506)	
81.3	(1510)	
87.5	(1507)	
88.2	(1498)	
88.2	(1499)	
88.2	(1500)	
93.3	(1509)	
100.5	(1511)	
100.5	(1512)	
100.5	(1514)	100.5 is the median.
100.5	(1515)	
		114.26 is the straight average and 114.40 is the mathematically correct mean.
123.2	(1490)	
127.7	(1491)	
127.7	(1492)	
131.2	(1488)	
131.2	(1489)	Lower probability density as numbers move down from the exact mid-range.
135.2	(1501)	Upper quartile.
135.2	(1502)	
		138.6 (140) is mid-range, the optimal figure for folios per year.
141.7	(1494)	Lower probability density as numbers move up from the exact mid-range.
141.7	(1495)	
151.5	(1508)	
172	(1503)	
188.5	(1504)	
196.5	(1513)	
206.5	(1505)	Top of the range – highest number of folios per year (1505).

This table provides us with a statistical model, or ascending set of data. Looking again at the numbers in the table, a straight average would be 114.26 folios per year. We can calculate the correct mean number of folios he wrote by choosing an assumed mean, and then listing the standard deviation from that assumed mean in each year. When calculated, that results in a mathematically correct mean of 114.40 folios per year, based on the extant manuscripts.

What is now needed is a realistic estimate, or statistical inference, of the mean number of folios Leonardo wrote per year. This is inherently an estimate, but it must fall within parameters that give it credence, and that fit the known numbers. What we know from the list of folios per year is that the lowest number is 70.7 and the highest is 206.5. These two parameters enable the calculation of the median which is 100.5, and it is also the base of the middle ground in the bar graph. The mathematically correct mean of 114.40 folios per year is an important number because the extant manuscripts consist of the mean number of folios multiplied over 32 years, so a realistic estimate of the folios that Leonardo wrote, including the ones that are lost, is somewhere between 114.40 and the upper extreme of 206.5. The estimate of total manuscripts has to be above 114.40 because that is the mean derived from extant manuscripts and does not include lost manuscripts. It has to be below 206.5 because that is the theoretical and unrealistic maximum that Leonardo could ever have written. The certainty that it falls between these numbers creates a high confidence interval,⁷ and the more we narrow that range, the higher the probability density will be.

A calculation of the range is now required, and that range is the theoretical highest number of folios minus the lowest number (206.5 minus 70.7), resulting in the figure of 135.8. The most probable number of folios that Leonardo wrote per year would be exactly mid-range, and would therefore be 135.8 divided by 2, and added to 70.7, which would be 138.6 – rounded to say 140 folios. That number is just within the top quartile of the numbers in our table above, and higher numbers will have a lower probability density, as will lower numbers.

The estimate of the folios that Leonardo wrote per year that best satisfies the parameters should fall within the mid-range, being between 135.2 and 141.7, because that is the range with the highest probability density, and the mathematically optimal figure is 138.6. Higher figures have a lower probability density as they move away from the mid-range,

especially as they are in the top quartile and represent increasingly exceptional years. Lower figures likewise have an increasingly lower probability density, and account increasingly less for lost manuscripts as they get closer to the mean.

It seems sensible to work on 140 folios per year which is very close to the mid-range figure of 138.6. When 140 is multiplied by 32 years of writing, and doubled, it results in the total number of pages that Leonardo possibly wrote which amounts to 8960 pages. When related to the base figure of 7000 extant pages, this indicates that about 1960 pages have been lost. Assuming the average output of 140 folios per year to be reasonably correct, possibly a little high, 1960 pages out of 8960 represents a loss of Leonardo's work of approximately 22%.

An overwhelming fact seems to emerge from this: if the above analysis is approximately correct, the loss of 50% to 75% or more generally quoted seems wildly inaccurate, and is a great deal higher than the theoretical maximum of 46%. Surprisingly the actual loss is closer to 22%, and possibly lower. There is no certainty in this as there never can be when trying to get a grip on the unknown. But the history and the evidence available have been assembled. Deduction has been applied to known figures of Leonardo's productivity to establish a theoretical maximum. That has provided us with a basis for calculating a total number of pages that Leonardo was likely to have produced – deduction supported by history, evidence, facts, figures, and a method that fits these factors.

6.9 OBJECTIONS

The analysis above has been described as a blunt instrument, but it has provided a methodology for moving beyond the known, the extant manuscripts, to the unknown estimate of Leonardo's total written output. That estimate has led to the calculation of how much of his work remains lost. Nevertheless the methodology needs to be refined. Serious and valid

objections can be raised, both in a general and a textual sense, and they need to be discussed and resolved.

The methodology has moved from a historical approach to a statistical one. The overarching question can therefore be asked whether the analysis of statistics is a valid way of calculating how many manuscripts are lost?

This question hints at a sense of unease that we have a result based on the immediacy and direct simplicity of numbers – it has the feel of a skeleton without the manuscripts to flesh it out. It lacks the nuanced arguments and considerations of a historical approach. It is not traditional in that it lacks the hindsight of a fully evidence-based approach dealing with the known. However it has provided us with a methodology to move from the known to the unknown, and is based on a historically derived database. Without a statistical methodology, a result would not have been achieved, and the reality is that a result is often an important test of validity.

This statistical approach raises other problems, in both the forms of general objections and textual objections.

6.9.1 General objections

- The first objection is that these figures relate to existing manuscripts, and make no allowance for lost manuscripts.

That is so, but existing manuscripts are all that are available. In statistical terms they can legitimately be used as a sample to determine the population of all Leonardo's work. The methodology has allowed us to break down the limitations inherent in the known, represented by extant manuscripts, and gain an insight into the unknown, or all possible manuscripts.

- Another objection is that lost manuscripts may relate to any year, and would affect the productivity results.

Lost manuscripts would tend to be reflected in years showing lower productivity, not high productivity. They would have the effect of depressing productivity figures in particular years, which would be offset by other years of higher productivity. Both high and low years of productivity are accounted for in overall productivity, and that is the figure we require. Furthermore an estimate of average productivity is an interpretative figure, and not an exact figure.

- In what sense can we talk about an average rate of production? Leonardo was doing a lot of other things in between writing. One of the key assumptions is that his output was steady, expressed as an average per year for each manuscript. This could never have been the case.

The writing of manuscripts is, of course, not an even process, leading to distortions in the analysis of time and productivity, but the averages add up to the correct totals making the smoothing of work rates over time periods quite acceptable. One of the key figures we are estimating is an overall average figure of literary output, which includes high and low periods, and their various fluctuations. An average work rate is simply a smoothing of high and low periods and is not an inherent or structural problem.

Other objections are that:

- Autograph manuscripts are not produced neatly from start to finish, but may contain notes from different time periods.

It is not a critical factor whether notes at any particular time become part of one manuscript or another, as long as their production enters the overall calculation of the work rate.

- The datings of the manuscripts are conjectural, not proven facts.

Variations in the production of manuscripts and their dating does not require critical accuracy. When total work rate figures are analysed, an average rate of productivity is estimated. That average estimate considerably dilutes the efforts at exhaustive accuracy.

We are looking for interpretative figures on productivity.

More important for our purposes are the textual objections, and these affect the methodology critically.

6.9.2 Textual objections

- The first is that there are blank pages and fragmentary pages.

Blank pages, and mostly empty and fragmentary pages have to be accounted for. There are pages, for example in the *Codex Atlanticus*, which are only half pages or fragmentary. A refinement of the methodology has to account for this, and an approach that deals with this is detailed below. That approach also has to account for other objections:

- In what sense can one compare pages with drawings to pages with text, and the variations between them?
- Different pages are covered with different densities of information and illustration.

Essentially, how does one compare an illustration with a page of text? How does one assess a mixed page of illustration and text? How does one assess a heavily shaded illustration with a light illustration, and a similar variation in text? Accounting for this mix is a fascinating conundrum. The main thrust of these considerations is the need to compare ‘apples with apples’. In addition, text and drawings are so integrated that one cannot tell in the evolution

of an idea whether the text is the inspiration for the illustration, or vice versa (Vecce 2003: 71).

There has to be an acknowledgement that there is no ultimate or ideal comparison between the ‘thought value’ of an illustration and a page of text. They are too different. It is hard enough comparing one paragraph of text with another, or one illustration with another. A starting point, however, is to acknowledge that both text and illustrations share a commonality of thought behind their expression which is that both are expressed as marks on a surface such as paper – text using the alphabet, and drawings using line and shading. Text that uses more letters will be more dense. A drawing using a thin line and little shading will be less dense. There is then a real sense in which the density of marks on a page represents the application of ‘thought value’ on that page. In a practical sense it is the density of the marks that is important. If we could measure the density of different pages, the variations between text and illustrations, whether light or dark, would no longer matter. The measurement of density would provide a standard of comparison which allows us to compare like with like.

Is this possible? Modern scanning programmes make this relatively straightforward. The background of a page, whatever the colour, can be set to read as white. Any mark, whether it is part of a letter or a drawing will read as black. The black marks will be recorded as pixels, with a greater number of pixels recording dense areas, and vice versa. Different pages, whatever their content, can then be compared by noting their number of pixels. Blank or fragmentary pages are accounted for because only the marks of text or illustration are recorded, and blank areas are not. Both full and fragmentary pages are accounted for in the pixel count.

Density is a good indicator of ‘thought value’ in a practical sense. It measures the representation of thought on paper by making marks, and thus places illustrations and text

and their combinations on a comparable basis. What it cannot do is measure the quality of thought. The measure of whether a drawing or a paragraph is a good one or a bad one remains subjective. But density is a good measure of the application of thought and that is expressed as pixels.

There is a final objection:

- The pages are of different sizes in different autograph manuscripts - compare the small *Forster* notebooks with the larger *Manuscript C*. How does one compare the large compilations of the *Codex Atlanticus* and *Codex Arundel* with the personal autograph notebooks of Leonardo?

The same approach applies. Digital scanning of any manuscript page will produce a pixel count. If the scanned 'input' is the actual size of the manuscript page, the pixel count will reflect that exactly, which is in fact the case with the Leonardodigitale scans. If not, the scan 'output' can then be either reduced or enlarged to match the actual size of, for instance, the *Forster codices* or the *Codex Atlanticus*. As the 'output' is enlarged in size to match the original, the computer programme adds pixels to account for it, and vice versa. The pixel count becomes a common standard of comparison between all manuscripts, whatever their content or size.

The pixel count is a standard of measurement that overcomes the various textual objections. It now remains to be seen how this refinement affects the methodology and its results.

6.10 APPLICATION OF THE REFINED METHODOLOGY

Looking differently at the evidence in our database began in section 6.6, and a preliminary application of the methodology resulted in a loss of Leonardo's intellectual output of 22%. In section 6.9, it was acknowledged that the application of the methodology

required further refinement, and a method to achieve further refinement has been proposed. It is now possible to apply those refinements whilst repeating the underlying original methodology in section 6.6.

Leonardo's manuscripts have been scanned in their original sizes and digitalised on the same basis, containing the same parameters such as the number of dots per inch (dpi). This has been done at enormous cost by Leonardodigitale, and an enquiry to them has proved invaluable. Their digital records contain a pixel count for each page, and an average pixel count per page for each manuscript. In the table below, the average pixel count has been multiplied by the number of scanned pages to obtain the pixels per manuscript. The advantage in this is that only the pages with marks will generate pixels, and blank pages will not. The question of accounting for blank and partial pages thus falls away.

Now that we can calculate the pixel count per manuscript, a table can be compiled as before, showing pixels per manuscript, and the approximate years during which they were compiled. Pixels per page run into the millions, so the totals per manuscript have been divided by 1 million to make them more manageable.

MANUSCRIPTS	DATES	MILLION PIXELS PER MS.	APPROX MILLION PIXELS COMPILED PER YEAR
<i>Codex Arundel</i>	1508 –1518	4338.51	433.851
<i>Codex Atlanticus</i>	1487-1518	20145.23	649.85
<i>Codex Forster I,</i>	1487-1490, 1506	217.32	54.33
<i>Codex Forster II</i>	1494-1497	266.05	88.68
<i>Codex Forster III</i>	1490-1493	170.42	56.81
<i>Codex Leicester</i>	1506-1509	684.6	228.2
<i>Codex Madrid I</i>	1490-1508	1660.2	92.23

<i>Codex Madrid II</i>	1503-1505	1367.11	683.56
<i>Codex on the Flight of Birds</i>	1505	190.56	190.56
<i>Codex Trivulzianus (Libro F)</i>	1487-1490	446.32	148.77
<i>Manuscript A (incl. Ashburnham 2038)</i>	1490-1492	747.93	373.97
<i>Manuscript B (incl. Ashburnham 2037)</i>	1487-1489	1182.50	591.25
<i>Manuscript C</i>	1490	592.43	592.43
<i>Manuscript D</i>	1508-1509	104.74	104.74
<i>Manuscript E (Libro B)</i>	1513-1514	370.05	370.06
<i>Manuscript F</i>	1508	415.09	415.10
<i>Manuscript G</i>	1510-1515	408.21	81.64
<i>Manuscript H</i>	1493-1495	341.15	170.58
<i>Manuscript I</i>	1497-1505	331.78	41.47
<i>Manuscript K</i>	1503-1507	251.71	62.93
<i>Manuscript L</i>	1502-1503	232.49	232.49
<i>Manuscript M</i>	1500-1502	205.99	103
<i>Libro A</i> ⁸	1508-1515	299.74	42.82
<i>Windsor</i> ⁹	1487-1518	5704.89	184.03
	TOTAL	40675.05	5993.34

What is now required is to account for the overlap of work on different manuscripts at the same time. This has resulted in the table below which shows the total number of pixels that Leonardo compiled in any one year, based on the manuscripts that have survived.

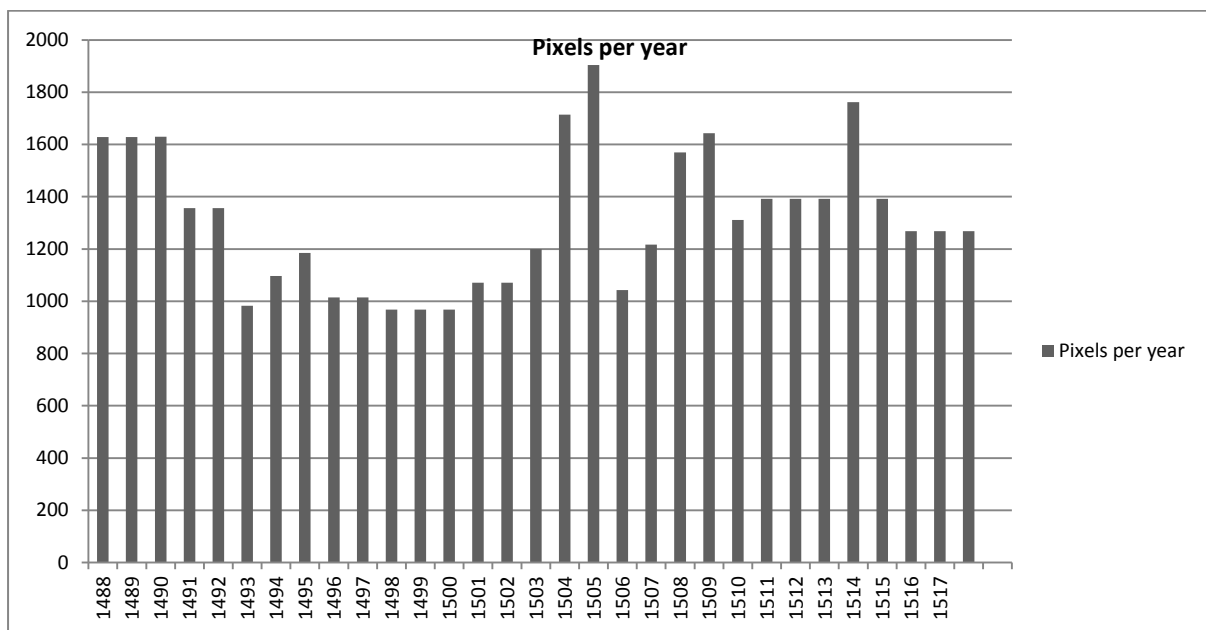
What we are looking for is a pixel count of Leonardo's periods of highest productivity, and conversely his lowest, in addition to a guide to average productivity as was done before.

6.11 AN ANALYSIS OF THE PIXELS PER YEAR

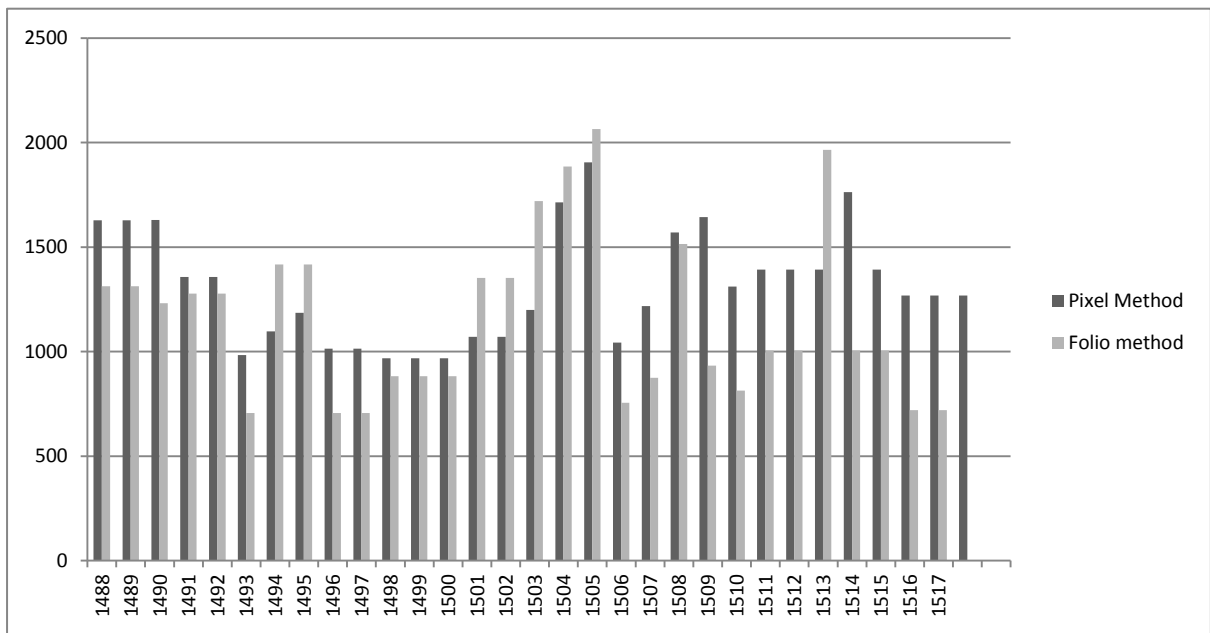
YEAR	ESTIMATED MILLION PIXELS COMPILED PER YEAR
MILAN ONE	
1487	
1488	1628
1489	1628
1490	1629
1491	1357
1492	1357
1493	983
1494	1097
1495	1185
1496	1015
1497	1015
1498	967
1499	967
WANDERING YEARS	
1500	967
1501	1070
1502	1070
1503	1200
FLORENCE TWO	
1504	1714
1505	1905
1506	1043
MILAN TWO	
1507	1217
1508	1569
1509	1643
1510	1310

1511	1392
1512	1392
1513	1392
ROME	
1514	1762
1515	1392
1516	1267
FRANCE	
1517	1267
1518	1267
1519	

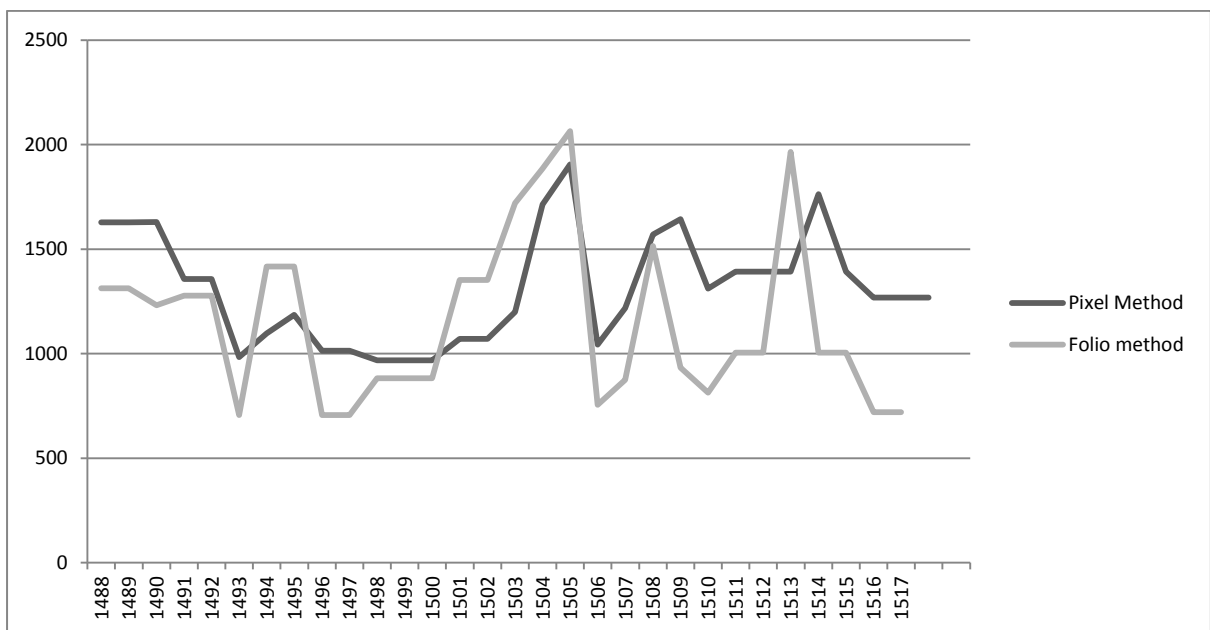
These figures can be better seen in the bar graph below:



This bar graph is clearly a bit different to the earlier bar graph, showing that the analysis of manuscripts based on the pixel method is producing results that are different from the analysis based on folios. It remains to be seen how important those differences are. To illustrate the differences, I have overlaid the earlier folio-based graph over the pixel-based graph, and shown it below.



Below are the same results, but shown more clearly in a line graph, which illustrates how the pixel method is more smoothed, avoiding the exaggerated ups and downs of the folio method.



6.12 REFINEMENTS TO PREVIOUS DEDUCTIONS

It is now possible to calculate the highest total number of pixels Leonardo theoretically could have compiled given the figures in the table showing pixels per year in section 6.11. His greatest productivity was the possible completion of 1905 million pixels in 1505, and if it is assumed theoretically that he more or less maintained that rate for the 32 years in which he compiled his notes, the result should be an indication of the maximum number of pixels he could have compiled. The calculation comes to 60960 million pixels. As shown on page 125, the number of pixels that survive today is 40675 million, and these relate to actual images, without recording all blank pages and blank sections on fragmentary pages. If we subtract 40675 million pixels from the theoretical maximum of 60960 million pixels, the result will be the maximum number of pixels that could have been lost, being 20285 million. That figure expressed as a percentage of loss amounts to approximately 33.28%, when related to the figures above, which represents the theoretical and unrealistic maximum, based on Leonardo's highest level of productivity. The folio method produced a comparable loss figure of 46%.

The pixels per year can be expressed in a table, shown below, but now sorted by ascending numbers, not in years:

Table of million pixels per year sorted in numerical order

Pixels Year Comment

967	1498	Bottom of the range – lowest number of pixels per year in millions.
967	1499	
967	1500	
983	1493	
1015	1496	
1015	1497	
1043	1506	
1070	1501	
1070	1502	
1097	1494	

1185	1495	
1200	1503	
1217	1507	
1267	1516	
1267	1517	
1267	1518	
1310	1510	
1357	1491	
1357	1492	
1392	1511	
1392	1512	
1392	1513	
1392	1515	lower probability density as we move down from the mid-range.
1436 – mid-range average number of pixels per year in millions.		
1569	1508	lower probability density as we move up from the mid-range.
1628	1488	
1628	1489	
1629	1490	
1643	1509	
1714	1504	
1762	1514	
1905	1505	Top of the range – highest number of pixels per year in millions.

What is now needed is a realistic estimate, or statistical inference, of the mid range. As before, a calculation of the range is the theoretical highest number of million pixels minus the lowest number (1905 minus 967), resulting in the figure of 938. The most probable average number of pixels that Leonardo compiled per year would be exactly mid-range, and would therefore be 938 divided by 2, and added to 967, which would be 1436 million. When 1436 is multiplied by 32 years of working, it results in the total number of pixels that Leonardo possibly compiled, which amounts to 45952 million pixels. When related to the base figure of 40675 million extant pixels, this indicates that about 5277 million pixels have been lost. Assuming the average output of 1436 million pixels per year to be reasonably correct, 5277 million pixels out of 45952 million represents a loss of Leonardo’s work of approximately 11.48 %. This is a very important figure as it represents the final result that this thesis sets out to achieve – and is a surprisingly low figure.

There is a sense of unease when discussing pixels instead of folios, not least because they are so dislocated from tradition, and the figures are so large that they are cumbersome. Nevertheless this is a refined application of the original methodology in section 6.6 which properly accounts for blank and fragmentary pages, manuscripts and sheets of very different sizes, drawings versus text, and different densities of material on the pages. In fact it accounts for all the general and textual objections raised in section 6.9.

6.13 FINAL CONJECTURES

It has been mentioned before that the large numbers expressed in pixels seems a bit removed from traditional historical analysis of Leonardo's manuscripts. Let me try to express this in more meaningful terms.

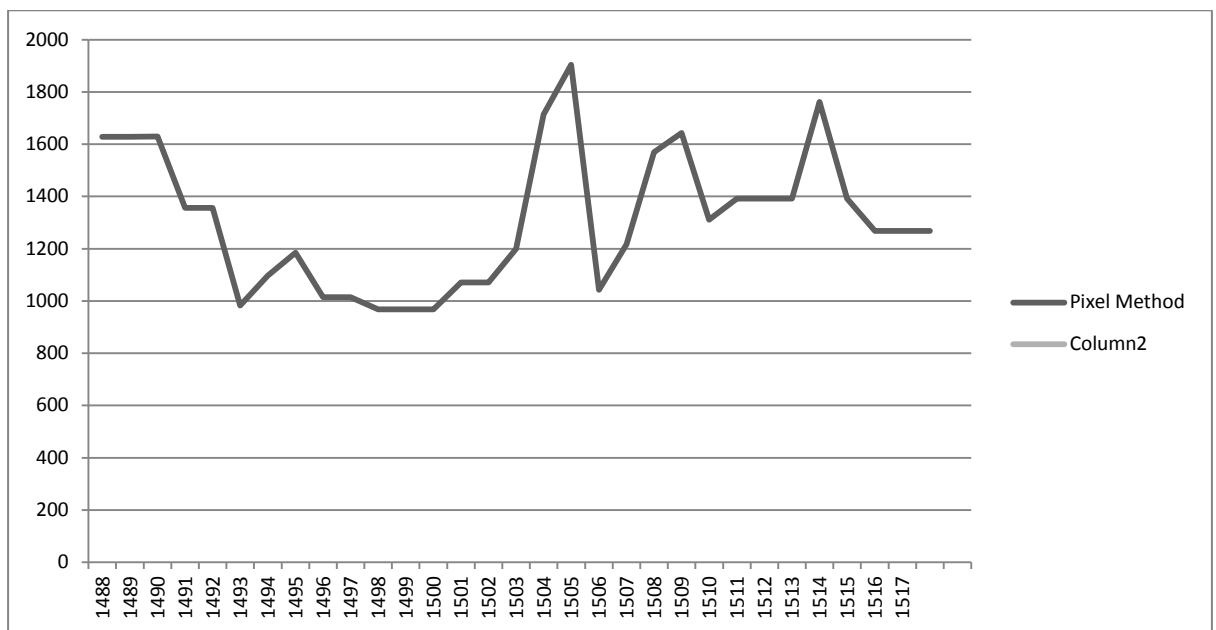
A manuscript such as the *Codex Leicester* is about 685 million pixels in length. The total loss of Leonardo's work amounts to 5277 million pixels, which is the equivalent of losing about eight manuscripts the size of the *Codex Leicester*.

Those eight lost manuscripts could include the manuscript owned by the Duke of Amalfi, and those that Mazenta gave to Duke Carlo Emmanuele of Savoy and to Ambrogio Figino. It could also include the *Codex Sforza* referred to by Lomazzo, and those referred to by Vasari, Franchi, Cellini, Lomazzo, Pacioli and Mazenta. There will also be the *Libro W*, possibly another on anatomy, one on flowers and maybe one on chess. There will be the missing manuscripts on Melzi's list at the end of the *Codex Urbinas*, and the discrepancy in the Arconati donation. There will be the *De ludo geometrico* and the *De vocie* mentioned by Leonardo, as well as the book on water which he handed to Marcantonio della Torre. There are the writings mentioned by Borghini, the 180 drawings that disappeared from a chest in Kensington Palace, and there may well be more that are unknown. The overall estimate of loss equivalent to eight manuscripts the size of the *Codex Leicester* is so low that after

accounting for references to the manuscripts mentioned above, there may not be much more than that still missing. In fact the above references may be exaggerating the extent of the loss.

If we look at the years with lowest productivity, it is not an unreasonable assumption to ascribe the lower figures to the loss of manuscripts written in those years – in fact it is quite probable. Those years of lowest productivity reflect lost manuscripts which can possibly be linked with the topics he was interested in at those times. We can therefore speculate to an extent on the possible topics of the manuscripts that are lost.

The probable years of loss can be more clearly seen by looking again at the line graph below which shows years of productivity by the pixel method only.



We can see from this graph that the years that concern us are those that are near the 1000 million pixel line. They would be 1493, 1496 to 1500 and 1506.

During those years, Leonardo concentrated primarily on geometry, hydraulic engineering, applied mechanics and the movement of water, as well as architecture.

In the early period, around 1494, he seems to have written on painting techniques, optics and

perspective, and there may be a manuscript on chess from about 1500. He then began his studies on nature, geology, hydrology and aerology. In 1506 Leonardo was working on his anatomical studies, and concentrated on biology using his skill in drawing to illustrate his now dominant interest in the sciences.

The years from 1493 to 1506 were a broad enough period to encompass most of Leonardo's interests in one form or another. So it is disappointing that the evidence is insufficiently specific to give any hint of a topic that may have been the subject of a lost manuscript.

A further conjecture is possible. Based on Leonardo's productivity, it has been argued above that approximately 11.48% of Leonardo's material has been lost, which is equivalent to about eight manuscripts the size of the *Codex Leicester*. That means that about 500 pages are lost.

After Leonardo died, Melzi inherited his manuscripts and compiled the *Codex Urbinas* (6.3.7). It was mentioned earlier that three quarters of the material in the *Codex Urbinas* cannot be traced to any existing manuscript. A lot of material was quite clearly copied into the *Codex Urbinas* before the manuscripts dispersed after Melzi died. That makes the useful distinction that the manuscripts may be lost, but some of the material they contained seems to have been transcribed into the *Codex Urbinas* and therefore preserved. The manuscripts concerned may well be *Libro W* (6.2.5) as well as the manuscripts that went to Ambrogio Figino (6.1.5) and the Duke of Savoy (6.1.4), and the three that were missing when the Arconati Donation took effect (6.3.4), in addition to any others that are not known about.

Melzi compiled 250 pages in the *Codex Urbinas* in his neat Italic hand. If three quarters of that cannot be found in extant manuscripts, approximately 180 pages have come

from manuscripts that are lost. That further reduces the percentage of irretrievably lost material from 11.48% to perhaps under 10%.

In addition to that is the material in the *Codex Huygens*, where Carlo Urbino’s notes seem to have preserved some of Leonardo’s text although the manuscripts are lost. However it is not possible to assess the extent of the material that was copied. Of course transcribed material cannot be considered the same as autograph material, but it does in its own way ameliorate the loss.

So the percentage of actual irretrievably lost material is not as drastic as first thought, and may be even lower than 10%. This is conjecture, but within the bounds of possibility.

A final conjecture is possible. The folio method is inexact, crudely comparing pages of different sizes and densities. The pixel method on the other hand is very exact, capturing every mark of a drawing or text on a surface. Each of those marks is the application of part of a thought. Given that the loss figure of Leonardo’s manuscripts is much lower than previously thought, we should be able to use the pixel method to determine exactly where the application of Leonardo’s thought really lies, and where his considerable intelligence and talent is concentrated. To achieve this, a table has been compiled below listing his extant manuscripts, showing their folios and the percentage of his work that those folios represent. Next to that are the pixel counts of the same manuscripts, showing those percentages.

The table demonstrates the relative importance of each manuscript, showing where the value of different manuscripts really lies.

MANUSCRIPTS	FOLIOS	% OF THE TOTAL	PIXELS IN MILLIONS	% OF THE TOTAL
<i>Codex Arundel</i>	285	7.9	4338	10.67
<i>Codex Atlanticus</i>	1119	31.01	20145	49.53
<i>Codex Forster I,</i>	54	1.5	217	.53
<i>Codex Forster II</i>	159	4.41	266	.65

<i>Codex Forster III</i>	94	2.6	170	.42
<i>Codex Leicester</i>	36	1.0	684	1.68
<i>Codex Madrid I</i>	184	5.1	1660	4.08
<i>Codex Madrid II</i>	157	4.35	1367	3.36
<i>Codex on the Flight of Birds</i>	18	.5	190	.47
<i>Codex Trivulzianus (Libro F)</i>	62	1.72	446	1.1
<i>Manuscript A (incl. Ashburnham 2038)</i>	114	3.16	748	1.84
<i>Manuscript B (incl. Ashburnham 2037)</i>	100	2.77	1182	2.91
<i>Manuscript C</i>	32	.89	592	1.46
<i>Manuscript D</i>	10	.28	105	.26
<i>Manuscript E (Libro B)</i>	96	2.66	370	.91
<i>Manuscript F</i>	96	2.66	415	1.02
<i>Manuscript G</i>	96	2.66	408	1.0
<i>Manuscript H</i>	142	3.93	341	.84
<i>Manuscript I</i>	140	3.88	332	.82
<i>Manuscript K</i>	128	3.55	252	.62
<i>Manuscript L</i>	94	2.6	232	.57
<i>Manuscript M</i>	94	2.6	206	.51
<i>Libro A</i>	65	1.8	300	.74
<i>Windsor</i>	234	6.48	5705	14.03

The above comparisons show that most of the manuscripts represent percentages of Leonardo's work in the low single digits. One would expect this of the small notebooks because of their small formats. For instance the *Forster Codices* with their small formats reflect 8.5 percent of his work by the folio method, which actually diminishes by the pixel method to 1.6 percent. And *Manuscript I* decreases from nearly 4 percent to less than 1 percent. Most other changes are modestly up or down. Even the *Codex Arundel* is modestly up from just under 8 percent, to 10.67 percent. The *Windsor* collection, however, more than doubles, from 6.48 percent to over 14 percent. The big figure to notice is the *Codex Atlanticus*. It has increased in importance from about 31 percent to about half of all Leonardo's output. That is a significant finding by this pixel method, and shows how that

‘scrapbook’ has captured so much of Leonardo’s effort and output. These notable increases explain how the pixel method has halved the loss figure of Leonardo’s manuscripts from 22% to 11.48%, and show that the *Codex Atlanticus*, the *Windsor* collection, the *Codex Arundel* and the two *Madrid Codices* together add up to nearly 82 % of Leonardo’s notes.

ENDNOTES

¹ DNB Sv Joseph Smith, and Oxford 2010 Sv Joseph Smith, and Stemma of dispersal.

² 1807-1873 (<http://.mobile.reuters.com/article/topNews/idUSTRE6B53T520101206?i=3>).

³ On the *Codex Forster I*, 2 in the V&A in London, see Marani 2003b:385-388.

⁴ From *Libro A*, folios 54-95 were copied into the *Codex Leicester* and are already accounted for. Folios 1-65 were copied into the *Codex Urbinas*, which are accounted for under *Libro A*.

⁵ 614 drawings (originally 779 drawings) are on 234 folios at Windsor. See p.ix Clark 1968).

⁶ The extant pages number 234, and consist of 614 drawings, although there were previously 779 drawings before 165 were inexplicably destroyed. The number of pages at that time is unknown, so I have estimated it to be 298, as a ‘pro rata’ extension of the existing pages.

⁷ A confidence interval is generated by a procedure that will give correct intervals at least 95 % of the time, as in this case where there is a certainty that our estimate is within the interval of 114.26 and 206.5.

⁸ The numbers for *Libro A* have been based on the numbers for Manuscript E, and have been estimated as 65/80 of Ms E.

⁹ The scans and pixels for the Windsor Collection have been completed for the anatomical manuscripts only. I have estimated them as constituting about one third of the collection and adjusted the numbers accordingly.

CONCLUSION

The central topic of this thesis was inspired by the loose estimate that half to four-fifths of Leonardo's manuscripts have been lost, and possibly more. After researching the matter, it became clear that very little is available to support that claim. While common sense suggested that the analysis of manuscripts that are lost is either impossible or fruitless, the question remained whether it is possible to refine that estimate.

Logically, Leonardo's manuscripts fall into three groups: those that are extant; those that have been referred to at some stage; those that are no longer extant, and are not known about in any way. Information on the first group is available, but necessitated tracing the pattern of Leonardo's life and detailing the development of his manuscripts. That created a database from which subsequent analysis could follow. The compilation of that historical record provided detailed information about the extant manuscripts, their extent and when they were written.

That historical record of extant manuscripts revealed references to, and information on, the second group of manuscripts which were those that had been seen at some stage and subsequently lost.

In addition to these two groups is the question of manuscripts that were lost without any early references, and therefore unknown. Some of the evidence lay in manuscripts such as the *Codex Urbinas* and the *Codex Huygens*, in which sections could not be related to extant manuscripts, and their sources had to be assumed lost.

It became clear that periods of dispersal, destruction and loss alternated with periods of compilation, rescue and restoration, rather like a historical pendulum swinging from loss to gain, and back again. Nevertheless the periods of loss outweighed those of restoration, and the extent of that growing loss is the central question of this thesis.

After tracing the history and provenance of the extant manuscripts, and references to those that were lost but known about, the question still remained: what about the manuscripts of which nothing was known? Was there any way of gleaning information about them? At first it seemed that the application of statistical analysis to the database appeared promising. There was the hope that something from the sample of extant manuscripts would overlap with the population of all Leonardo's manuscripts which would provide an opportunity to apply statistical formulae to what remained lost. Unfortunately, it became clear that there was no overlap to provide that opportunity. At this stage, there was still no indication of how much of Leonardo's work was lost, and further analysis of existing manuscripts was not providing progress towards an answer.

Then the breakthrough occurred. The compilation of the database was related to the question of "what did Leonardo write", and was thus restricted by what we know. When the question was changed to "what could Leonardo have written", those restrictions fell away. This new question relied less on historical fact and more on potential, and potential includes manuscripts about which nothing is known. This change in question has changed the status of Leonardo's unknown lost manuscripts from unknown unknowns to known unknowns. Any information on potential depends in this case on an analysis of productivity, which in turn relies on the analysis of the database.

The database contains information about the compilation of manuscripts, their dates, however speculative, and their number of folios. Those numbers have been expressed as a measure of productivity that establishes credible co-ordinates of high and low productivity within which further analysis could take place. Somewhere between those co-ordinates was an average productivity figure that could be applied to all the years in which Leonardo compiled his notes, and that would determine his total output. When that figure was established, the big question of the extent of loss of his manuscripts could then be deduced.

It was a surprise to realise that this folio-based methodology resulted in a calculation of lost material as low as 22%, and could be even lower as transcription into other existing manuscripts may have preserved a significant further portion. That figure of 22% results from productivity figures with a high probability density, and thus credibility, and is underpinned by a mass of historical evidence in the database. It is further strengthened by the fact that the productivity approach is independent of historical factors such as the sighting of manuscripts, and other details of provenance. It also invites the speculation that low productivity in certain years is due to the loss of manuscripts in those years, possibly on topics in which Leonardo was interested at the time.

However, the application of this methodology has serious flaws and several objections have been detailed and discussed. The objections centre round the fact that folios in different manuscripts have been compared with each other as if they are similar. They differ in size and content, and an attempt has been made to develop the methodology to account for those differences. All the manuscripts have been scanned, and a factor common to them all is the pixel count in the scans that accounts for all the differences. The methodology has therefore been 'rerun' on the basis of pixel counts, which means that productivity measures from one manuscript to another are 'true' comparisons.

What can be termed the folio methodology, although a blunt instrument, resulted in a loss figure of 22%. That method was considerably refined and nuanced by developing the pixel methodology. What is surprising is that the pixel methodology halved the percentage of loss to 11.48%.

Another point of interest is that the pixel method produced a more even graph of productivity without the erratic highs and lows of the folio method. Apart from the high years of 1504 and 1505, Leonardo's output was steadier and more disciplined than at first appeared, even in his final years in France.

It can be argued that the averaging of figures for the *Codices Arundel, Atlanticus* and *Windsor* manuscripts over a large number of years created an undue smoothing of the figures, but it should be noted that the same averaging equally applied to the folio method which produced more erratic results. A glance at the line graph demonstrates this quite clearly. So the averaging of figures can be discounted as a source of bias.

Another point to make is how superior the pixel method is to the folio method in that it compares ‘apples with apples’. Manuscripts of different sizes, different densities of material, and different mixtures of text and drawings have been measured by a system that compares them on a comparable basis. Scanning has literally measured each stroke on paper in each manuscript and given it its appropriate value. This overcame what appeared to be a serious source of bias in the folio method, simply comparing pages with each other.

Finally, the comparison of pixels has shown how overwhelmingly important the *Codex Atlanticus* is, constituting about half of Leonardo’s total output.

What we have is a calculated deduction of what has actually been lost, being 11.48% based on the historical database – in part speculation, but with a high degree of probability and credibility. That is the result that this thesis set out to achieve, and is an important refinement on the previous wild estimates that half to four fifths of Leonardo’s manuscripts have been lost.

APPENDIX 1- Extant autograph manuscripts by Leonardo

Codex Arundel

1478-1519. 285 folios. Various sizes, but mainly 220 x 150 mm. The *Codex Arundel* 263 is now in the British Library. The folios from the *Codex Arundel* have been unbound since 1991 and have been glued onto backing sheets.

Codex Atlanticus

1478-1519. 1119 folios. Various sizes. The enormous *Codex Atlanticus* in the Biblioteca Ambrosiana in Milan was originally bound together by Pompeo Leoni. He bound the technical and scientific drawings together into one volume despite their different sizes, and the resultant large size of the bound volume inspired the name *Codex Atlanticus*. It was so named in 1780 by Baldassarre Oltrocchi (1714-1797), the Prefect of the Ambrosian Library, because it was so large in format that it was 'Atlas' sized. The drawings cover topics as varied as mathematics, geometry, botany, zoology, the military arts, astronomy, and many other subjects.

Codex Forster I, II and III

Codex Forster I - manuscript 1. 1505. Mss. 1 and 2 contain 54 folios.

145 x 100 mm.

Codex Forster I - manuscript 2. 1487 – 1490. 145 x 100 mm.

Codex Forster II - manuscript 1. 1495. 63 folios. 95 x 70 mm.

Codex Forster II- manuscript 2. 1495 – 1497. 96 folios. 195 x 70mm .

Codex Forster III. 1490 – 1493. 94 folios . 90 x 60 mm.

The *Codices Forster* are bound up as three manuscripts on paper, and backed in parchment, but they were originally five manuscripts. Victoria and Albert Museum, London.

Codex Leicester

1506-1509. 36 folios. 290 x 220 mm. Bill and Melinda Gates collection, USA.

The date is supported by the watermark which was common in Italy between 1495 and 1508, showing a bellflower or campanula. It deals mainly with hydraulics and the movement of water, some studies on astronomy, and researches into the natural history of the earth and geophysics.

Codex Madrid I

1490-1508. 184 folios. 210 x 150mm. Biblioteca Nacional, Madrid.

Codex Madrid II

1503-1505. 157 folios. 210 x 150 mm. Biblioteca Nacional, Madrid.

Codex on the Flight of Birds

1505. 13 folios. 212 x 154 mm. Biblioteca Reale, Turin.

It was 18 folios originally bound together with *Manuscript B*, and was stolen by Count Libri just before 1848. 5 folios are now missing.

Codex Trivulzianus (Libro F)

1487-1490. 55 folios. 140 x 200 mm. Biblioteca Trivulziana, Castello Sforzesco, Milan. This is a folder of 55 folios but there were originally 62 folios.

Manuscript A

1490-1492 . 64 folios. 220 x 150 mm. Bibliothèque de l'Institut de France. Count Libri stole folios 54, and 65 to 114. He sold folios 81 to 114, and they were later returned, and are now known as *Codex Ashburnham 2038*. The other folios remain lost.

Manuscript B

1487-1489. 84 folios. 235 x 160 mm. Bibliothèque de l'Institut de France. It is perhaps the earliest of Leonardo's manuscripts. It was originally 100 folios, now 84 after Count Libri despoiled it. He stole folios 91 to 100 and they were later returned, and are now known as *Codex Ashburnham 2037*. He also stole folios 3, and 84 to 87 which remain lost.

Manuscript C

1490. 32 folios. 315 x 220 mm. Bibliothèque de l'Institut de France. This is the *Treatise on Light and Shade* that was given to Cardinal Federico Borromeo in 1600 by Mazenta, and was placed in the Ambrosian in 1609. It was marked '*Manuscript C*' by G.B.Venturi in about 1796, but had appeared as *Libro G* on Melzi's list at the end of the *Codex Urbinas*. Originally covered in red velvet, it is now bound in brown leather with gold tooling.

Manuscript D

1508-1509. 10 folios plus 4 blank folios. 222 x 160 mm. Bibliothèque de l'Institut de France.

Manuscript E (Libro B)

1513-1514. 80 folios. 150 x 99 mm. Bibliothèque de l'Institut de France. It contained 96 folios before Count Libri stole 16 of them. This was *Libro B* on the list at the end of the *Codex Urbinas* compiled by Melzi.

Manuscript F

1508. 96 folios. 145 x 105 mm. Bibliothèque de l'Institut de France.

Manuscript G

1510-1515. 96 folios. 140 x 95 mm. Bibliothèque de l'Institut de France.

Manuscript H

1493-1495. 142 folios, divided into three parts, separately numbered 1-48, 1-46, and 1-47. 104 x 74 mm. Bibliothèque de l'Institut de France.

Manuscript I.

1497-1505. 140 folios divided into two parts separately numbered 1-48, and 2-91. 102 x 74 mm. Bibliothèque de l'Institut de France.

Manuscript K

1503-1507. 128 folios, divided into three parts separately numbered, consisting of 49 folios, 32 folios, and 48 folios. 960 x 650 mm. Bibliothèque de l'Institut de France. This is the manuscript that Count Archinti donated to the Ambrosian. Parts 1 and 2 are dated 1503 to 1505, and part 3 is dated between 1506 and 1507.

Manuscript L

1502-1503. 94 folios. 101 x 75 mm. Bibliothèque de l'Institut de France.

Manuscript M

1500-1502. 94 folios. 98 x 70 mm. Bibliothèque de l'Institut de France.

Windsor

1487-1518. 614 drawings composed of 234 unbound folios. Various sizes. These are the *Anatomical manuscripts A and B (Dell'Anatomia Fogli A and B)* and the *Quaderni d'Anatomia I-VI*, and separate folios that passed from Lord Arundel into the Royal Library. These manuscripts, as their names suggest, are mainly notes and illustrations of the human figure, of anatomical studies, geography, studies of horses, sketches and caricatures, and a series of maps.

APPENDIX 2 - Selected manuscripts copied from the *Codex Urbinas* (and their copies)

Important manuscripts in this group include Poussin's illustrations, or their copies, as fore-runners of the first printed editions, and are marked with an asterisk.

Rome: *Codex Barberinus* in the Vatican Library (16th Cent).

Codex Ottobonianus in the Vatican Library (17th Cent).

Codex Casanatense 968 in the Biblioteca Casanatense (17th Cent).

Codex Casanatense 5018 in the Biblioteca Casanatense (17th Cent).

Codex Corsini in the Biblioteca dell' Accademia dei Lincei (17th Cent).

Manuscript in the library of Ignazio Danti

Milan: *Codex Pinellianus* in the Ambrosiana (16th Cent).

Manuscript C.III 43. in the Raccolta Vinciana.

**Manuscript 228 inf.* in the Ambrosiana (17th Cent).

Florence: *Codex Riccardianus* in the Biblioteca Riccardiana (17th Cent).

Codex Laurenzianus in the Bibl. Medicea Laurenziana (16-17th Cent).

Manuscript Concini (Riccardiana 2308) in the Biblioteca Riccardiana (16th Cent).

Manuscript from the library of Lorenzo Giacomini (Riccardiana 2136) now in the Biblioteca Riccardiana (16th Cent).

Manuscript from the library of Niccolo Gaddi now in the Biblioteca Nazionale (class 17,28) (16th Cent).

Zaccolini Manuscripts in the Biblioteca Laurenziana, Florence. (1630s)

7 more in the Biblioteca Nazionale Centrale.

- Venice: *Manuscript Ital.Lanino* in the Biblioteca Marciana (16th Cent).
Manuscript Ital.Nani in the Biblioteca Marciana (16-17th Cent).
- Bologna: *Manuscript B.271* in the Biblioteca dell' Archiginnasio (17th Cent).
- Cortona: *Manuscript 297* in the Biblioteca Etrusca (17th Cent).
- Modena: *Manuscript Furini* in the Biblioteca Estense (17th Cent).
- Paris: *Codex 967* in the Bibliothèque Nationale (17th Cent).
**Manuscript Ganay* in the Marquis de Ganay collection (17th Cent).
- Los Angeles: *Manuscript Belt 35* in the Elmer Belt Library (16th Cent).
**Manuscript Belt 36* in the Elmer Belt Library (17th Cent).
- St. Petersburg: **Manuscript Hermitage* in the Hermitage Museum (17th Cent).
- Unknown: **Manuscript Noailles* now lost but copied from an original in the Barberini library in the 17th Century.
**Manuscript Sandrart* now lost but given to Joachim Sandrart by Nicolas Poussin early in the 17th Century.

Manuscripts on Art and Science

- Milan: *Manuscript H 227 inf.* in the Ambrosiana, compiled between 1634 and 1640.
Manuscript H 229 inf. in the Ambrosiana, compiled between 1634 and 1640.

Montpellier: *Manuscript H 267* in the Bibliothèque de la Faculté de Médecine (early 17th Cent.).

Naples: *Manuscript XII D.79* in the Biblioteca Nazionale, copied from *Manuscript H 229 inf.* in about 1637. Giuseppe Bossi made a copy of this in 1810, but it is now lost. However G.B.Venturi made a copy of Bossi's manuscript sometime between 1810 and 1815, and this is now in the Biblioteca Civica of Reggio Emilia.

Manuscripts from the printed editions

There are a number of manuscripts that were transcribed by artists and teachers from the first printed editions. These were copied in the late 17th and 18th centuries.

APPENDIX 3 - Printed editions of the treatise of painting

The first two printed Du Frêsne editions appeared in 1651, in Italian and French, and the Italian edition is now known to have been published first. These were followed by many abridged editions, none of which included the *Paragone*. That appeared in the first complete edition, the Manzi edition, of 1817, and subsequent complete editions. Of course many language editions appeared, interspersed with excerpts, selections and the *Paragone* only editions. Listed below are printed editions that have appeared since 1651 in date order, which shows abridged and complete editions with the dates of reprints, and **omits selections, excerpts, fragmentary editions and *Paragone* only editions**. Other omissions are ‘Print on demand’ books, where earlier editions have been scanned, and marketed under a new imprint in various languages. What follows is a list in language groupings with brief descriptions of each edition, and their reprints (Guffanti 2009).

Note: A recent development is that a number of publishers have scanned versions of existing editions, and marketed them under their own imprint as ‘Print on demand’ books. For example, Nabu Press has scanned the Italian Du Frêsne editions with Amoretti and Orsini additions of 1804 and 1805. They have done the same with the Du Frêsne Gault de St. Germain edition of 1803, and Kessinger Publishing has scanned the 1716 French edition. There are several others. These are not new editions, but ‘Print on demand’ versions of existing editions. They do however occupy a niche created by new technology which could be considered reprints, but not in the sense of traditional reprints. To include them would have been repetitive and confusing, so they have been omitted.

ITALIAN EDITIONS

- 1651 The first Du Frêsné Italian edition in Paris, printed by Jacques Langlois.
- 1723 The first Italian printing of the Du Frêsné edition.
- 1733 The 1723 edition with additional supplementary matter.
- 1786 Resetting of the 1651 edition with changes to supplementary matter, and illustrations from the 1733 edition.
- 1792 From the manuscript of Stefano della Bella, the *Codex Riccardianus* copied from the *Codex Pinellianus*.
- 1804 Conforms to the 1651 Du Frêsné edition with the Amoretti biography of Leonardo.
- 1805 The Du Frêsné text with Orsini additions.
- 1817 The Manzi edition - the first printed edition of the full text of the *Codex Urbinas*, which included the *Paragone* for the first time. It was Manzi who named the first section the *Paragone*. The illustrations are engravings by Gherardo di Rossi.
Reprinted 1982.
- 1859 Edited combination of the Amoretti 1804 and Manzi 1817 editions.
- 1890 Gaetano Milanesi version based mainly on Manzi.
Reprinted 1984, 1989, 1996, 2006.
- 1914 An edition edited by Angelo Borzelli based on the *Codex Urbinas* – a pocket edition abridged to 935 chapters.
Reprinted 1924.
- 1939 Resetting of the Du Frêsné edition with changes in supplementary matter and illustrations.
- 1970 Based on the *Codex Urbinas* in 935 chapters.
Reprinted 1990.
- 1977 Reprint of the 1786 edition with a new French translation by A. Keller.

Reprinted 1982.

- 1979 Reprint of the 1786 edition with a Spanish translation by A. Cardona.
- 1995 The complete *Codex Urbinas* with transcription and critical notes by Carlo Pedretti and C. Vecce.
- 1995 The same edition above in one volume, with a facsimile of the *Codex Urbinas* in a second volume.
- 1995 Based on the Milanesi edition of 1890 and the Borzelli edition of 1914 with an index.
Reprinted 2000.
- 1997 Based on the *Codex Urbinas* with notes, published by Demetra.

FRENCH EDITIONS

- 1651 The first Du Frêsné edition (the same format and same printer as the first Italian edition) translated by Roland Frèart, Sieur de Chambray.
- 1716 Resetting of the French edition of 1651 in octavo (Giffart edition) with changes in the illustrations, using Mazenta's *Memorie*.
- 1796 Resetting of the 1716 edition (Giffart) with illustrations based on those in the 1716 edition.
- 1803 Gault de St. Germain edition based on the 1716 (Giffart) edition and *Manuscript H 228 inf.*, with his own annotations.
Reprinted 1820.
- 1803 Resetting of the 1716 (Giffart) edition.
- 1910 Translation and re-arrangement by Péladan of the Manzi edition of 1817, followed by a supplement.
Reprinted 1911, 1911, 1913, 1919, 1921, 1924, 1928, 1939.

- 1910 Translation from the 1817 Manzi edition of the Codex Urbinas of the chapters on light and shade and landscape, with commentary by Péladan.
Reprinted 1913, 1919, 1921, 1926, 1940.
- 1960 A re-grouping of Leonardo's notes on painting by A. Chastel.
Reprinted 1987.
Translated into English, and printed in 1961.
Reprinted by Dover in 2002.
- 1977 Reprint of the 1651 edition by M.de l'Ormeriaie.

ENGLISH EDITIONS

- 1721 The first English edition.
- 1796 Resetting of the 1721 edition.
Reprint 2006 by Pranava Books of the 1796 edition.
- 1802 A new edition by J.F.Rigaud.
- 1835 Resetting of the 1802 edition with changed introductory matter by John William Brown.
Reprint 2007 by Pranava Books of the 1835 edition.
- 1877 Resetting of the 1835 edition with additional supplementary matter.
Reprinted 1887, 1892, 1897, 1901, 1906, 1910.
Reprint 2002 by Prometheus Books of Rigaud's 1892 edition published, with hardcover in 2008 Reprint 2004 by Kessinger Publishing of the Rigaud edition of 1897.
Reprint 2005 by Dover Books of Rigaud's 1877 edition.
Reprint 2007 by Saveth Press of Rigaud's 1877 edition, with a hardcover in 2008.
Reprint 2010 by Elibron Classics of the 1897 Rigaud edition.

- 1956 The first English translation of the complete *Codex Urbinas* by Philip McMahon.
- 1989 Leonardo's writings on painting, selected, translated and edited by M.Kemp and M.Walker.
Reprinted 2001.

GERMAN EDITIONS

- 1724 The first German edition of the 1651 French and Italian editions translated by Johan Böhm with a new grouping of chapters, and line drawings based on the 1716 Giffart edition.
- 1747 Resetting of the 1724 edition.
- 1786 Revised and modernised version of the 1724 edition.
- 1882 Full text of the *Codex Urbinas* translated by H. Ludwig in three volumes, with a fourth volume in 1885 which was reprinted in 1888.
- 1909 A condensation of the *Codex Urbinas* by W. Von Seidlitz, in vol 1.
Reprinted 1935.
- 1909 M. Herzfeld's edition of the Ludwig text of 1882.
Reprinted 1925, 1989.
- 1910 Condensation of the *Codex Urbinas* by W. Von Seidlitz from the 1909 edition (vol.1), printed separately.
Reprinted 1919.

SPANISH EDITIONS

- 1784 First Spanish edition based on the Du Frêsne edition of 1651 and translated by Rejon da Silva.
Reprinted 1827, 1980, 1985, 1998, 1999, 2004.

- 1942 Resetting of the 1784 edition with changed supplementary matter.
Reprinted 1945.
- 1943 935 chapters translating the Italian Milanesi 1890 edition and Borzelli 1914 abridged edition.
Reprinted 1944.
- 1944 Translation of the Codex Urbinas from the French text of 1910 using the Péladan arrangement, and edited by J. Gil.
- 1944 Small format edition in 777 chapters based on Péladan and edited by M. Aguilar.
Reprinted 1950, 1951, 1958, 1964.
- 1947 Based on the Péladan edition of 1910 in 767 chapters.
Reprinted 1956, 1964.
- 1976 Edition based on works by J.P.Richter, A.M.Brizio and P.McMahon.
Reprinted 1979, 1980, 1986, 2004.

DUTCH EDITIONS

- 1827 Translation by J. Vos from the French Giffart edition of 1716.

RUSSIAN EDITION

- 1934 Translated (apparently) from the *Codex Urbinas* by A. Guber and V. Silejko.

POLISH EDITIONS

- 1876 The first Polish edition based on the 1651 Italian edition, and on the 1724 German edition.
- 1961 A Polish translation of the complete Ludwig edition, edited by M. Rzepinska.
Reprinted 1984, 2006.

ROMANIAN EDITION

1947 The first Romanian edition based on the *Codex Urbinas*.

APPENDIX 4 - The concordance

The Concordance compares the sections in the abridged Du Frêsné editions with those in other editions. The primary aim is to compare the abridged editions with the complete editions to show the nature of the abridgements by identifying which sections in the complete editions had been selected for the abridged editions. A secondary objective is to compare the 1721 edition to the Rigaud abridged edition of 1802 to assess the extent of his re-organisation of the text. Rigaud's edition became the basis for most of the later abridged editions.

The complete edition selected for comparison was the first English complete edition, being the McMahon edition of 1956, consisting of 1008 sections. A secondary complete edition was the first German complete edition, being the Ludwig edition of 1882 in 944 sections. These have been compared to the abridged Du Frêsné editions of 1651 in 365 sections. A secondary abridged edition was the first English edition of 1721 because it closely follows the Du Frêsné editions, however it has unnumbered sections. I have therefore imposed numbers on the sections to achieve the comparison. The Rigaud abridged edition of 1802 has been included as it runs to the same number of sections as the Du Frêsné editions, and also shows how Rigaud re-organised the text and placed the sections under new headings.

Du Frésne 1651	1721	Rigaud 1802	Ludwig 1882	McMahon 1956
1	1	1	47	59
2	2	175	48	62
3	3	2	49	60
4	4	3	51	64
5	5	29	52	91
6	7	130	53	69
7		27	54-55	67-68
8	6	360	58a	72
9	6	349	60	93
10	6	180	61	94
11	8	363	62	82
12	9	15	63	61
13	10	131	64	257
14	11	356	65	78
15	12	358	65a	84
16	13	163	66	76
17	14	21	67	65
18	15	181	70	63
19	16	25	75	83
20	17	365	76	256
21	18	129	78	97
22	19	28	79	96
23	20	112	80	70
24	21	354	81	77
25	22	19	83-84	117-114
26	23	188	84a	109
27	24	186	85	129
28	25	262	86	140
29	26	190	87	136
30	27	20	88	121
31	28	17	89	116
32	29	126	90	118
33	30	325	91	139
34	31	184	92	132
35	32	195	93	137
36	33,106	249,240	95	143
37	34	135	96	264
38	35	18	100	113
39	36	362	101	120
40	37	182	103	133
41	38	183	104	128
42	39	14	105	85
43	40	59	106	124
44	41	140	108	86
45	42	128	109	87
46	43	185	110	142
47	44	4	111	101
48	45	5	112	105
49	46	6	113	104
50	47	165	115	250
51	48	263	116	156

Du Frêne	1721	Rigaud	Ludwig	McM.
52	49	122	117	88
53	50	124	118	220
54	51	123	119	265
55	52	187	120	135
56	53	176	121	106
57	54	32	126	127
58	55	152	127	251
59	56	119	130	216
60	57	189	135	130
61	58	166	142	252
62	59	167	143	254
63	60	168	144	253
64	61	169	145	255
65	62	162	146	284
66	63	157	147	281
67	64	158	148	282
68	65	308	149	230
69	66	307	150	227
70	67	266	151	152
71	68	125	152	219
72		309	153	217
73	69	272	154	260
74	70	191	155	138
75	71	213	156	157
76	72	214	157	158
77	73	275	158	167
78	74	216	159	163
79	78	215	160	166
80	76	218	161	160
81	77	280	162	174
82	75	217	163	165
83	79	220	164	161
84	80	277	165	169
85	81	279	166	168
86	82	282	167-170	164,172,170,175
87		273	171	162
88	83	219	172	173
89	84	85	175	125
90	85	141	173	258
91	86	120	174	263
92	87	256	176	262
93	88	164	177	266
94	89	136	178	20
95	90	142	179-180	249,248
96	91	132	181	259
97	92	137	183-185	268,272,269
98	93	139	186-187,189	273,271,261
99	94	271	190-190a	185,183
100	95	232	191	191
101	96	251	192	200
102	97	287	193	235
103	98	288	194	229

Du Frêne	1721	Rigaud	Ludwig	McM.
104	99	252	196	206
105	100	253	197	207
106	101	298	198	232
107	102	293	199	231
108	103	297	200	233
109	104	243	201	294
110	105	302	202	195
111	106	240	203	197
112	107	269	204	151
113	108	233	205	179
114	109	234	206	190
115	110	235	207	187
116	111	236	208	239
117	112	237	209	199
118	113	238	210	188
119	114	228	211	214
120	115	229	212	215
121	116	226	213	178
122	117	276	214	201
123	118	222	215	205
124	119	274	216	171
125	120	223	217	198
126	121	259	218	240,144
127	122	16	219	144
128	123	289	220	228
129	124	326	221	245
130	124	327	222	247
131	125	224	223	210
132	126	225	224	209
133	127	343	225	192
134	128	284	226	226
135	129	221	227	212
136	130	285	228	222
137	131	268	229	148
138	132	254	230	150
139	133	212	231-231a	154,155
140	134	255	232	149
141	135	200	233	145
142	136	299	234	237
143	137	300	235	241
144	138	270	236	110
145	139	328	237	213
146	140	281	238	184
147	141	241	239	202
148	142	294	240	223
149	143	295	241	234
150	144	239	242	189
151	145	292	243	225
152	146	296	244	242
153	147	242	245	193
154	148	198	246	146
155	149	244	247	204

Du Frêne	1721	Rigaud	Ludwig	McM.
156	150	245	248	196
157	151	278	249	159
158	152	261	250	203
159	153	211	251	147
160	154	210	252	153
161	155	227	254	176
162	156	248	225-227	192,226,212
163	157	301	260-260a	244,246
164	158	341	261	236
165	159	304	262	238
166	160	8	263	292
167	161	10	264	285
168	162	34	265	290
169	163	9	266	289
170	164	35	267	299
171	165	33	268	298
172	166	87	269	359
173	167	7	270	291
174	168	30	271	296
175	169	11	272	286
176	170	36	273	300
177	171	37	274	301
178	172	38	275	302
179		39	276	303
180	173	51	180	248
181	174	92	278	369
182	175	153	279	373
183	176	154	280	384
184	177	86	281	358
185		13?	282	438
186	178	109	283	317
187	179	171	285	418
188	180	22	288	417
189		23	289	416
190	181	24	290	415
191	182	194	291	413
192	183	63	295	335
193	184	151	296-298	402,395,401
194	185	56	302-303	308,313
195	186	82	305	347
196	187	83	306	351
197	188	84	306	351
198	189	79	307	343
199	190	68	308	349
200	191	80	309	342
201	192	66	310	339
202	193	67	311	348
203	194	60	312	345
204	195	57	313	293
205	196	58	314	304

Du Frêne	1721	Rigaud	Ludwig	McM.
206	197	81	315	340
207	198	88	316	360
208	199	61	317	346
209	200	78	318	336
210	201	99	319	382
211	202	95	320	383
212	203	155	321	386
213	204	26	322	388
214	205	64	323	330
215	206	65	324	341
216	207	133	325	299
217	208	134	326	389
218	209	156	327	404
219	210	161	328	394
220	211	40	329	318
221	212	41	330	325
222	213	42	331	326
223	213	43	332	312
224	214	45	333-333a	321
225	215	55	336	328
226	216	44	337	319
227	217	46	341	305
228	218	52	342	315
229	219	31	343	315
230	220	47	344	306
231	221	96	345	379
232	222	54	346-347	380,381
233	223	89	348	368
234	224	48	349	365
235	225	49	350	366
236	226	50	351	297
237	227	97	352	375
238	228	53	353	316
239	229	103	354	356
240	230	104	355	357
241	231	105	356	367
242	232	101	357	385
243	233	160	361	412
244	234	170	365	397
245	235	106	370	408
246	236	110	371	409
247	237	111	372	410
248	238	102	373	406
249	239	70	374	294
250	240	12	375	287
251	241	149	377	387
252	242	138	378	393
253	243	150	379	391
254	244	159	380	424
255	245	173	381	422
256	246	174	382	423
257	247	172	384-385	420-421

Du Frêne	1721	Rigaud	Ludwig	McM.
258	248	108	386	390
259	249	107	390	377
260	250	93	387	392
261	251	90	392	371
262	252	91	393	370
263	253	62	394	322
264	254	77	395	337
265	255	98	396	334
266	256	75	397	331
267	257	72	398	350
268	258	71	399	344
269	259	69	400	295
270	260	94	401	376
271	261	100	402	363
272	262	359	405	441
273	263	364	406	439
274	264	355	407	440
275	265	350	408,410	432,431
276	266	351	411	433
277	268	177	412	434
278	296	179	413	435
279	269	193	414	443
280	270	357	415	555
281	271	118	416	500
282	272	306	417	510
283	273	209	418	454
284	274	260	419	446
285	275	338	420	550
286	276	353	421	554
287	277	196	422	452
288	278	199	423	456
289	279	192	424	450
290	280	127	425-425a	499
291	281	114	426	511
292	282	121	427	505
293	283	291	428	522
294	284	197	429	463
295	285	74	430	354
296	286	250	431	451
297	287	347	432	496
298	288	247	433	469
299	289,290	73	434-435	352,353
300	291	345	436	498
301	292	346	437	497
302	293	257	438a-b	636,741
303	294	201	440	453
304	295	267	441	455
305	267	178	442	461
306	297	305	443	501
307	298	329	444	529
308	299	322	445	457
309	300	312	446	533

Du Frêne	1721	Rigaud	Ludwig	McM.
310	301	332	447	476
311	302	321	448	539
312	303	311	449	536
313	304	323	450	539
314	305	324	451	535
315	306	313	452	537
316	307	117	453	508
317	308	290	454	518
318	309	116	455	502
319	310	315	456	504
320	311	316	458	514
321	312	314	460	509
322	313	115	461	491
323	314	320	462	534
324	315	318	463	541
325	316	317	464	470
326	317	319	465	538
327	318	202	466	523
328	319	258	467	478
329	320	331	468	472
330	321	336	469	479
331	320	330	470	471
332	322	342	471	465
333	323	344	481	488
334	324	265	482	464
335	325	352	483	428
336	326	204	484	467
337	327	205	485	460
338	328	264	486	506
339	329	246	487	468
340	330	303	488	445
341	331	348	494	487
342	332	206	497	458
343	333	207	498	444
344	334	335	500	549
345	335	334	501	548
346	336	337	502	551
347	337	333	503	552
348	338	340	505	545
349	339	113	509	490
350	340	76	510	333
351	341	361	512	556
352	342	230	513	557
353	343	231	514	558
354	344	283	517	521
355	345	310	526-526a	447,513
356		286	527	525
357	346	208	528-528a	517,449
358	347	143	532	564

Du Frêne	1721	Rigaud	Ludwig	McM.
359	348	144	536	566
360	349	145	537	563
361	350	146	538	572
362	351	147	540	560
363	352	203	542	565
364	353	148	543,544	570,571
365	354	339	943	1007

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