

The Digital Reconstruction of Leonardo's Library: Revealing Formal Patterns in Early Modern Thought

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The present article combines an individual, object-based approach with digital technologies with the aim to define the relation of verbal and visual inscriptions in Leonardo da Vinci's technical-scientific and literary-artistic works. By conducting a comparative analysis of Leonardo's folios featuring fables, emblems, and engineering projects, I identify the archetypes of this interaction in the books contained in his personal library and examine the convergence of his use of empirical, diagrammatic, and pictorial strategies toward the investigation of nature. The material component of this study consists in a series of analytical drawing tables which examine recurrent patterns, and textual and visual connections in Leonardo's manuscripts. The identified patterns are subsequently cataloged and examined through the web-publishing platform "LILeo" created in collaboration with the Rutgers Digital Humanities Laboratory as part of my dissertation project. By digitally highlighting the interaction of elements on the space of the page, and enabling the layering of drafts belonging to similar projects in Leonardo's works and sources, this study traces the formal patterns of the artist's analytical thinking in order to uncover the origins of his interdisciplinary research.

Key words:

Leonardo da Vinci, Early Modern Word-and-Image, Fables and Emblems, Scientific Diagrams, Digital Exhibits.

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1. INTRODUCTION

The embodied combination of images and words throughout time in Leonardo da Vinci's manuscripts demands reflection on the chronology of his works, and on the theoretical nexus between disciplines in relation to modern thought. Leonardo's appeal for the unity of knowledges, and collaboration of different fields of analysis, is indeed relevant to current word-and-image debate and questions recent trends in digital humanities [Mitchell 1994; Ruffini 2011; Baca 2016]. What does it mean to consider Leonardo's transdisciplinary research that merges words and pictures in present-day visual culture? To what extent may early modern sources be identified considering

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current technology developments? Can digital humanities help us to unveil early modern textual and visual combinatory devices?

My study centers on Leonardo's compositional methods in his drawings and writings, investigating their relationship with technical-scientific studies and diagrams. By blending an individual, object-based approach with digital technologies, I identify the main sources for Leonardo's development of visual and written narratives in the books belonging to his personal library. Subsequently, I analyze recurrent patterns in Leonardo's folios featuring fables, emblems, and engineering projects, and examine the convergence of his use of empirical, diagrammatic, and pictorial strategies toward the investigation of nature.

Considering the multifaceted materials displayed by Leonardo's sheets, one gets the sense that connections between words and pictures are accidental or deeply subconscious, rather than purposeful, as a wide branch of scholarship in the field has claimed [Clark 1979; Fanini 2017]. In addition, the 'mythical' use of Leonardo promoted by scholars such as Giovanni Battista Venturi and Fritjof Capra favored the exaltation of grand pictorial and scientific achievements as representative of the public face of the artist's production, much to the detriment of his sketches, notes, and unfinished works [Barkan 2011; Frosini and Nova 2013]. With the present analysis, I argue that every element on the page of Leonardo's manuscripts is in relation to the others, and that their interaction enabled him to make sense of the complexity of nature in both visual and textual terms. This study concentrates on the chaotic character of Leonardo's notes, and considers both the "factual content" and the "tangible form" of his thought traced across his manuscripts [Zwijnenberg 1999]. From this perspective, Leonardo's fragments of fables are not just drafts for future written developments, but forms in relation, whether the artist knows it or not, with the scientific diagrams that over time layered beside them. Similarly, his emblems escape the classical definition as a form of hermetic language composed of an image or *figura* (its body), and a caption or *motto* (its soul). Leonardo's emblems are not only a codified genre with a clear audience part of the high culture crowd, but pictographs belonging to the repertoire of images that circulated in the early modern workshop. These conglomerates of words and pictures that pertain to different discourses are in dialogue primarily because they are found on the same page [Pinkus 1996; Barkan 2013].

The increasing diversification and specialization in the analysis of Leonardo's manuscripts since the publication of the first modern anthologies by Charles Ravaissin Mollien and Jean Paul Richter in 1880s produced comprehensive catalogues and collections of essays focusing on either his scientific-technical projects [Galluzzi 1987; Nanni 2013], or his artistic [Marani 1989; Bambach 2003; Zöllner 2003] and literary works [Marinoni 1952; Vecce 1992]. Fabio Frosini and Alessandro Nova's international conference *Leonardo on Nature*, held in 2013 at the Kunsthistorisches Institut in Florenz, introduced a significant change in Da Vinci studies by promoting collaborative projects across disciplines with the aim to reconstruct Leonardo's philosophical thought and the sources of his creative process. Another important contribution toward the understanding of movements across formats in Leonardo's artistic and scientific outputs is the exhibition *Leonardo da Vinci and Perpetual Motion: Visualizing Impossible Machines* (6 February – 12 March 2019) organized by the Vasari Research Centre at Birkbeck in collaboration with the Ravensbourne University London and the Museo Galileo of Florence. Nevertheless, wholly transdisciplinary research is still needed to

initiate dialogue about this multifarious material, as well as to enlighten Leonardo's reasoning concerning different compositional forms found in his notebooks and collections of loose leaves.

Digital humanities initiatives offer the unique opportunity to examine, handle, and recombine Leonardo's numerous, inconclusive paper testimonies, according to both form and content, in order to retrace the paths of their development. The first printed editions of Leonardo's manuscripts not only signified the possibility to access these outstanding resources, but—being the first prototype editions in the history of publishing—they also stimulated modern advancements in image reproduction. Leonardo himself was aware of the power of printing that was spreading at his time and, even if he criticized the devaluation of the work of art's uniqueness caused by its reproduction, he probably planned to print his works at some point. Since the foundation of the digital archive of Leonardo's facsimile manuscripts "e-Leo" (<https://www.leonardodigitale.com/>), multiple digital initiatives arose with the aim to broaden access to this multifarious material, and to contribute to academic research in Da Vinci studies [Vecce 2017]. The digital examination of Leonardo's different modes of investigation questions origins, influences and filiations in his oeuvre, and provides original insights for early modern research on intertextual languages. With this article, I intend to contribute to the new approaches in the digital humanities with traditional fine arts practices and combine them with promotional techniques developed by art research centers and media companies such as "e-Leo". This would entail the information of innovative methods in contemporary art and implement the online archives of Leonardo's manuscripts with his sources by making them available to a wider public.

2. MATERIAL MODELS: WORD-AND-IMAGE LIBRARY ITEMS

As preliminary research, I conducted a survey of Leonardo's manuscripts using the electronic databases of "e-Leo" from which I selected, grouped, and classified visual and textual narratives. The combination of scientific, artistic and literary analysis revealed to be at the core of his fables and emblems. Leonardo's fables are a collection of 52 fragments written between 1490 and 1494, to be found in the Institut de France manuscripts H and L, and the codices Forster III, Arundel and Atlanticus. These fragments—which are modeled on different traditions, such as the Aesopic fables, Pliny's encyclopedia, ancient bestiaries, and even Burchiello's sonnets—entail various modes of interaction between words and images. For instance, the fables of the citron, the peach, the fig, and the fig and the elm trees feature besides images acting as clarifying illustrations of the fables, which create a sequential narrative with the literary texts and scientific notations adjacent to them. In a few cases—such as in the fable of the lily—the fable appears among scientific diagrams and illustrations on similar topics, which evolve in emblematic representations found in different manuscripts. Some other times, we find fables translated in the form of emblems, or sequences of images showing different scenes of the fable on separate folios—as the fable of the spider and the keyhole clearly exemplifies [Ciriagliaro 2013; Vecce and Ciriagliaro 2013; Ciriagliaro 2019] (Fig. 1). By the end of the fifteenth century, emblems became major means of self-representation and self-definition within the Italian early modern social networks; they were a way for artists and writers to establish their courtly recognition. Leonardo's production of emblems was certainly addressed to win the support of his patrons—apparently, he designed emblems for Ludovico Sforza, Cesare Borgia, Charles II of Amboise and Cardinal Ippolito d'Este. Concurrently, as I argue here, it embodied his most

successful mode of investigation and representation of nature, which moved from the fabular to the emblematic format by combining his technical-scientific and creative skills, and writing and drawing performances [Reti 1959; Vecce 1993; Vecce 1995; Vecce 2000; Schirg 2015; Cirmigliaro and Vecce 2019].

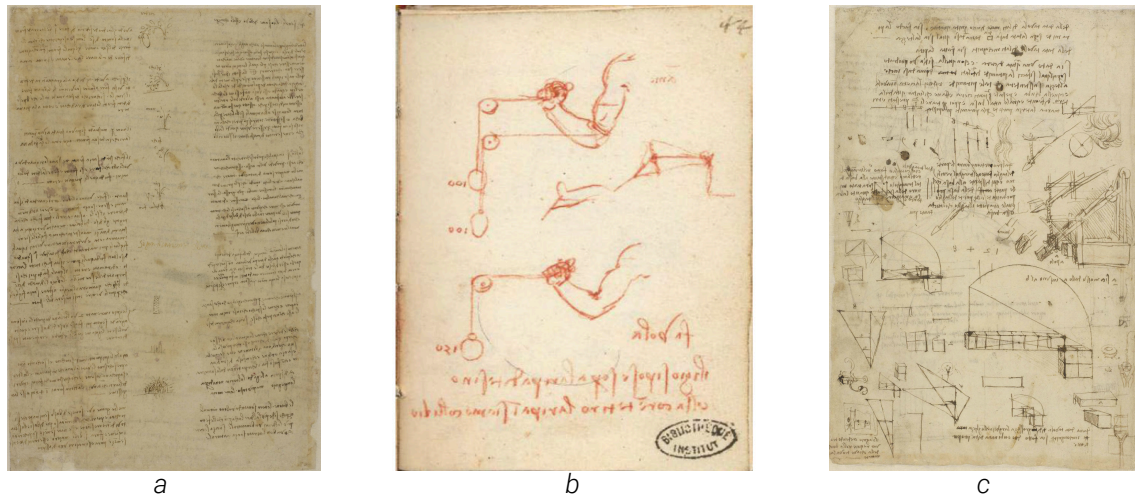


Figure 1. Leonardo's fragments of fables and emblems: a) Leonardo da Vinci, Fables and illustrations of the citron, the peach, the fig, and the fig and the elm tree. Codex Atlanticus, fol. 207r. c. 1490. Veneranda Biblioteca Ambrosiana, Milan; b) Leonardo da Vinci, Studies of dynamometers and the fable of the lily. Manuscript H, fol. 44r. 1493-1494. Bibliothèque de l'Institut de France, Paris; Leonardo da Vinci, Fable and emblem of the spider and the keyhole. Codex Atlanticus, fol. 820v. c. 1515. Veneranda Biblioteca Ambrosiana, Milan.

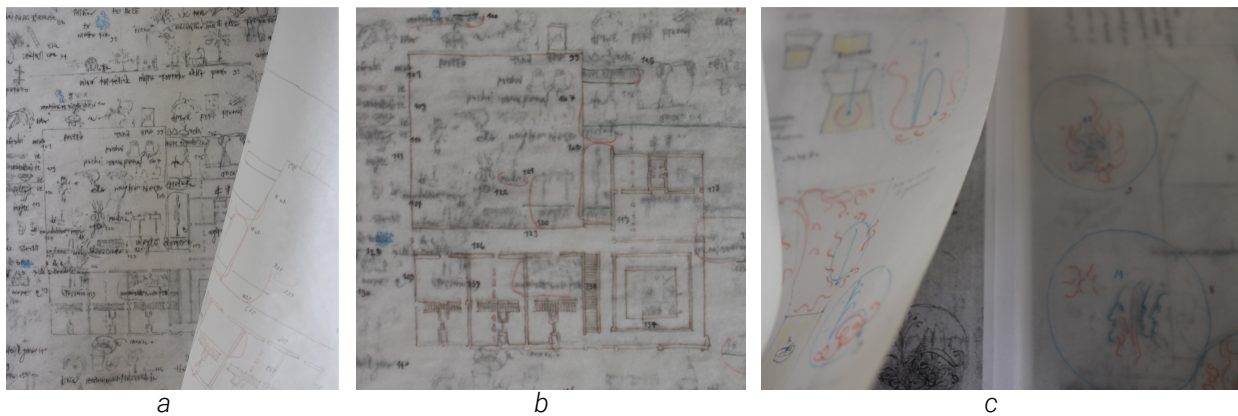


Figure 2. Diagrammatic Tables: a) Transcriptions page. Leonardo da Vinci, List of images: pictographs. RL 12692r. 1487-1490. The Royal Collection of Windsor, Berkshire; b) Diagrammatic notes. Leonardo da Vinci, List of images: pictographs. RL 12692r. 1487-1490. The Royal Collection of Windsor, Berkshire; c) Diagrammatic notes. Emblem of the lily, and diagrams and notes on geometry. RL 12700v. 1508-1510. The Royal Collection of Windsor, Berkshire.

In order to analyze the interactions of words and pictures in Leonardo's manuscripts, I designed a diagrammatic model to track the evolution of forms through different media in his output. The material component of this work consists in a set of analytical drawing tables, which visually and textually translate the manuscripts under investigation. Each table shows the reproduction of a sheet in its original size on which I layer two combinable tracing pages. The first page contains the transcriptions of Leonardo's notes featured in the exact original manuscript position, and readable from left to right. The aim of the transcriptions is to overcome issues related to his mirrored writing without changing the disposition of the elements on the space of the sheet. The second page concerns diagrammatic notes on recurrent aesthetic and scientific patterns, and visual and textual connections between different elements in the space of the manuscript (Fig. 2).

3. DIGITAL CATALOGUE: THE "LILEO" PLATFORM

The diagrams identified by means of the analytical drawing tables are subsequently cataloged and analyzed as part of the Omeka digital library site "LILeo," which I launched in collaboration with the Rutgers Digital Humanities Laboratory. The library site consists of an open source web-publishing platform for the cataloguing and display of Leonardo's personal library items, and the reconstruction of his creative process that interlaces words and images in the form of emblems. "LILeo" is composed of three basic sections. The first two sections—*item* and *collection*—serve to classify and organize the data according to their provenance. The items gathered in the preliminary research are visualized in the digital platform under the title of the manuscript or the book to which they belong and the page on which they feature; for example, *CTr Iv* corresponds to the verso of the folio 1 from the Codex Trivulzianus (Fig. 3).

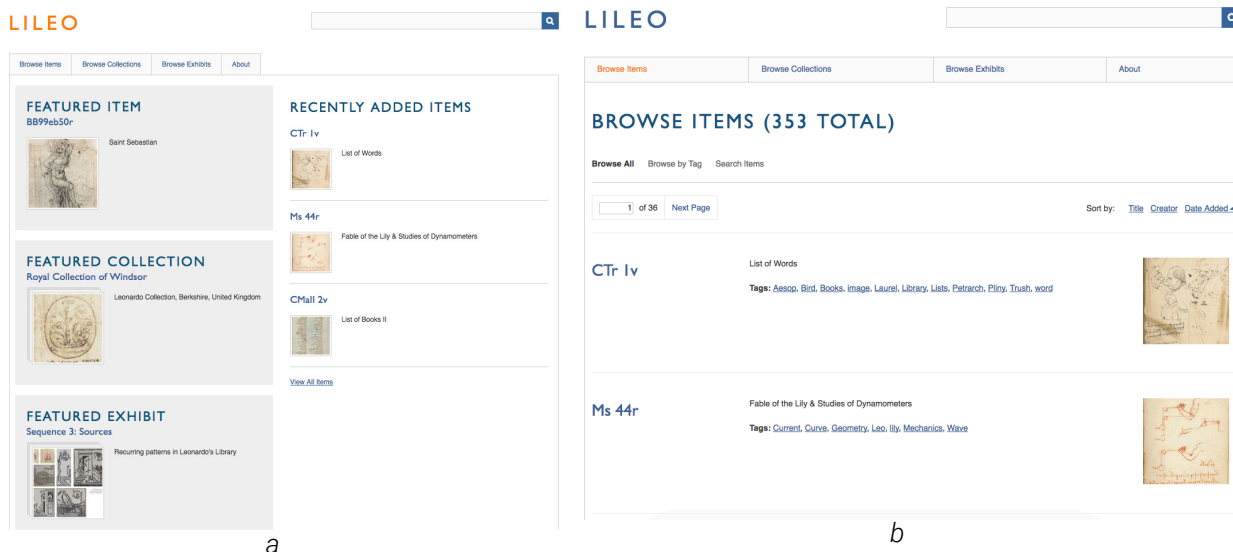


Figure 3. The "LILeo" platform: a) Homepage and sections; Featured Item, Featured Collection, Featured Exhibit; b) Items section; Browse Items.

It is possible to access "Lileo" at: <https://blogs.libraries.rutgers.edu/lileo/>.

The digital collections represent the physical archives where the items are preserved, such as the Royal Collection of Windsor (UK), the Biblioteca Nacional de España de Madrid, the Bibliothèque nationale de France, and the Veneranda Biblioteca Ambrosiana in Milan. Finally, the *exhibit* section is devoted to the analysis and interpretation of the data, concerning the development of Leonardo's library holdings into his visual and textual narratives, and the evolution of Leonardo's fables into emblems. It contains four digital exhibits which are representative of significant case studies, namely, *I. Library Patterns*; *II. Fable>Emblem [Lilies]*; *III. Fable>Emblem [Spiders]*; *IV. Digital Edge* (Fig. 4).

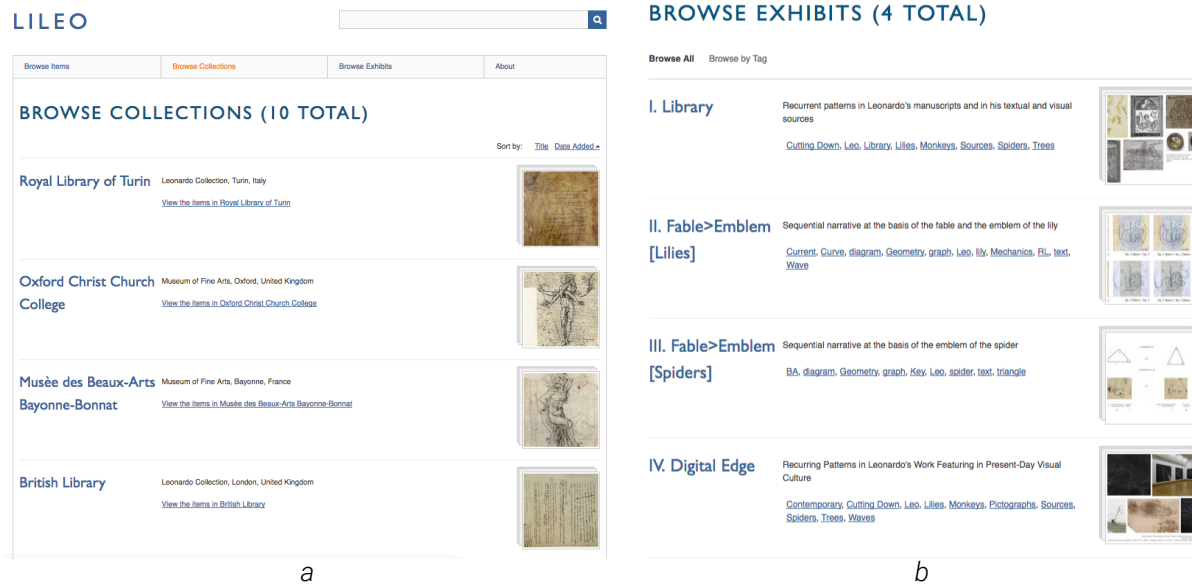


Figure 4. The "Lileo" platform: a) Collection section; Browse Collections; b) Exhibit section; Browse Exhibits.

3.1 Sources: library patterns

Drawing on online databases and multi-archival research conducted at major early modern European and American collections, I identified the primary sources for Leonardo's development of fables and emblems, and written and visual narratives, in scientific-didactic and fable books featured in his personal library. A major source for Leonardo's combination of words and images revealed to be Aesopic fables, which widely circulated in Early Renaissance Milanese and Florentine courts often accompanied by charming illustrations. Aesopic collections were certainly among Leonardo's favorite books, as he owned them in at least three different editions: Fazio Caffarelli, "Favole" (Cosenza 1478) or Francesco del Tупpo, "Vita et Aesopus moralisatus" (Naples 1485); "Les fables d'Esopé" (Lyon 1484); Accio Zucco, "Aesopus moralisatus" (Verona 1479) [Vecce 2017; Ciriagliaro 2019].

The first digital exhibit section, entitled *Library Patterns*, explores the sources at the basis of Leonardo's development of written and visual narratives, which are mainly identified in the editions of Aesop contained in his personal library. Each *Library Patterns* exhibition page features the visual juxtapositions of recurrent motifs found in Leonardo's manuscripts, Aesop's illustrations from his

personal library, and other relevant images circulating in early modern workshops. In particular, the page entitled *Monkeys: Recurrent Patterns* focuses on illustrations of monkeys and birds which are possible archetypes for Leonardo's fable of the monkey and the bird (n. 27). Curiously, Leonardo's twists his textual model—the Aesopic fable of the monkey's sons—by pairing the monkey with the bird, as suggested in his collections of fables' background illustrations (Fig. 5).

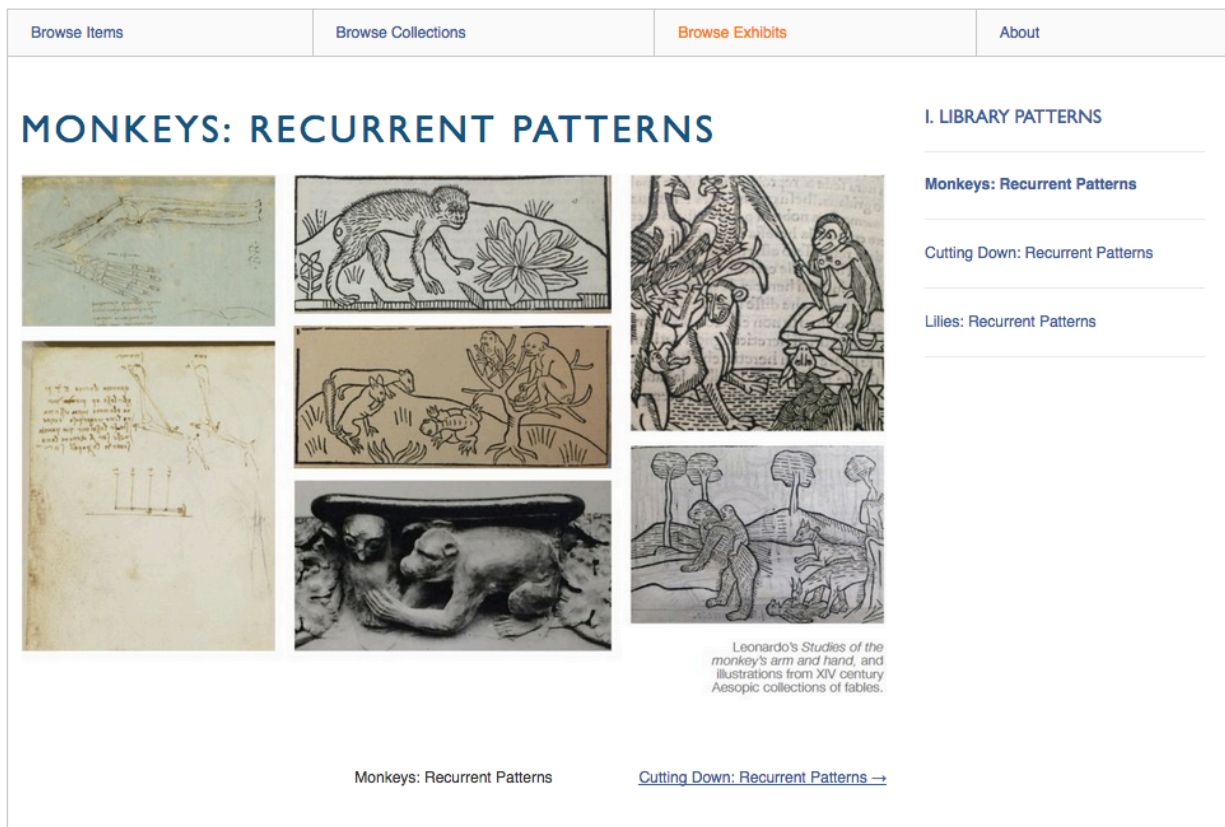


Figure 5. Library Patterns digital exhibit. *Monkeys: Recurrent Patterns* exhibit page.

The exhibition page *Cutting Down: Recurrent Patterns* identifies cutting down motifs in Aesop's illustrations and juxtaposes them with Leonardo's drawings of humans interacting with plants (RL 12644-12646). The same motifs are at the core of Leonardo's fables, whose favorite subjects are torn and stoned plants (nn. 10, 13, 19, 22-24, 26, 29-33, 43, 46, 50). Finally, *Lilies: Recurrent Patterns* shows occurrences of bent plants in the illustrations from the Aesopic collections which could have served as inspirational motif for Leonardo's fable and emblem of the lily (n. 41; RL 12700v) [Vecce 1992; Marsh 2004; Ciriagliaro 2013; Vecce and Ciriagliaro 2013; Ciriagliaro 2019] (Fig. 6).

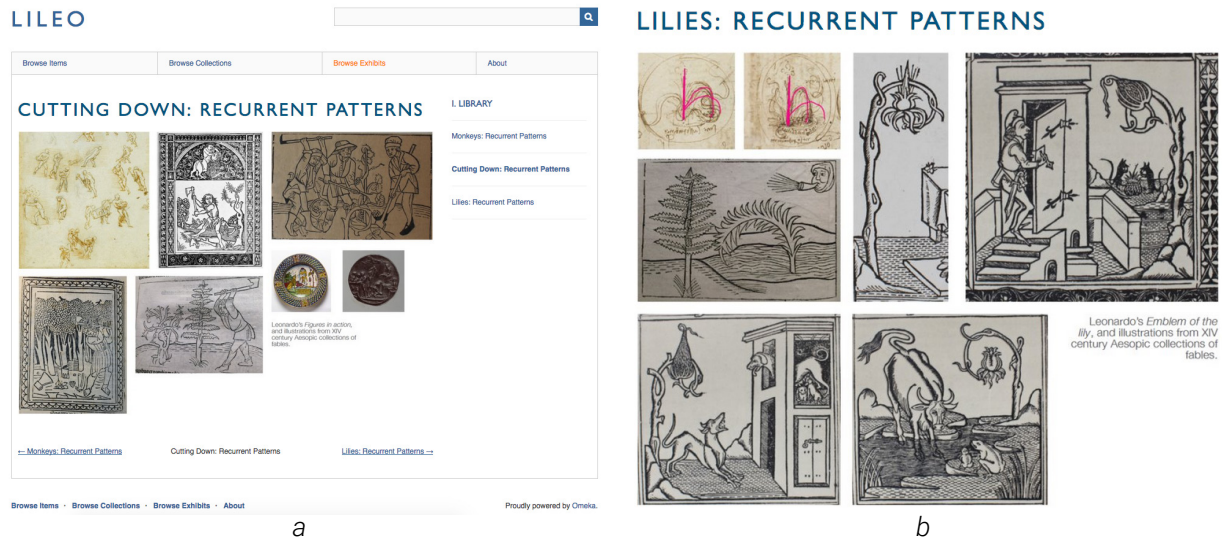


Figure 6. Library Patterns digital exhibit: a) Cutting Down: Recurrent Patterns exhibit page; b) Lilies: Recurrent Patterns exhibit page.

3.2 Moving across forms: fables and emblems

Building upon these premises, the “LILeo” exhibit tool allowed me to further my inquiry by centering on clusters of fables and emblems, which I examined in relation to scientific studies featured on the same folios. The comparative analysis of these materials reveals that Leonardo structures his fables on a binary model derived from his studies of mechanics and scientific diagrams to display simultaneously the causes and the effects of a situation. Then he develops his fables into emblems, which are synthetic texts condensing written and pictorial material, modeled on the same binary structure. The two exemplary cases of the fable and the emblem of the lily, and the fable and the emblem of the spider are illustrated in the digital exhibits: *Fable>Emblem [Lilies]*, *Fable>Emblem [Spiders]*.

3.2.1 The fable and the emblem of the lily

The fable of the lily, at the core of the exhibit entitled *Fable>Emblem [Lilies]*, is found at the bottom of folio 44 from Manuscript H, complemented by two scientific diagrams representing dynamometers. The text is particularly short in comparison to the others in the collection: “The lily sets itself on the banks of the river Ticino, and the current sweeps away both the bank and the lily” (n. 41) [Marsh 2004]. The fable is composed of two coordinate clauses following the cause-effect model: because the lily stands boldly on the riverbank, she is dragged away by the stream. Curiously, the very same model is re-enacted in the preceding drawings of dynamometers, illustrating the cause-effect interaction of mechanical forces. Few pages later, on folio 127, we encounter a sketch identified by Leonardo scholars as a drawing of a gown [Marinoni 1952; Venerella 2003]. Thanks to digital inquiry, we could easily rotate the dubious image of 180 degrees and place it side by side a schematic drawing on the verso of the same folio. As a result, the so-called gown appears to be the life drawing of a lily—that is arguably the inspirational motif of the fable (Fig. 7).

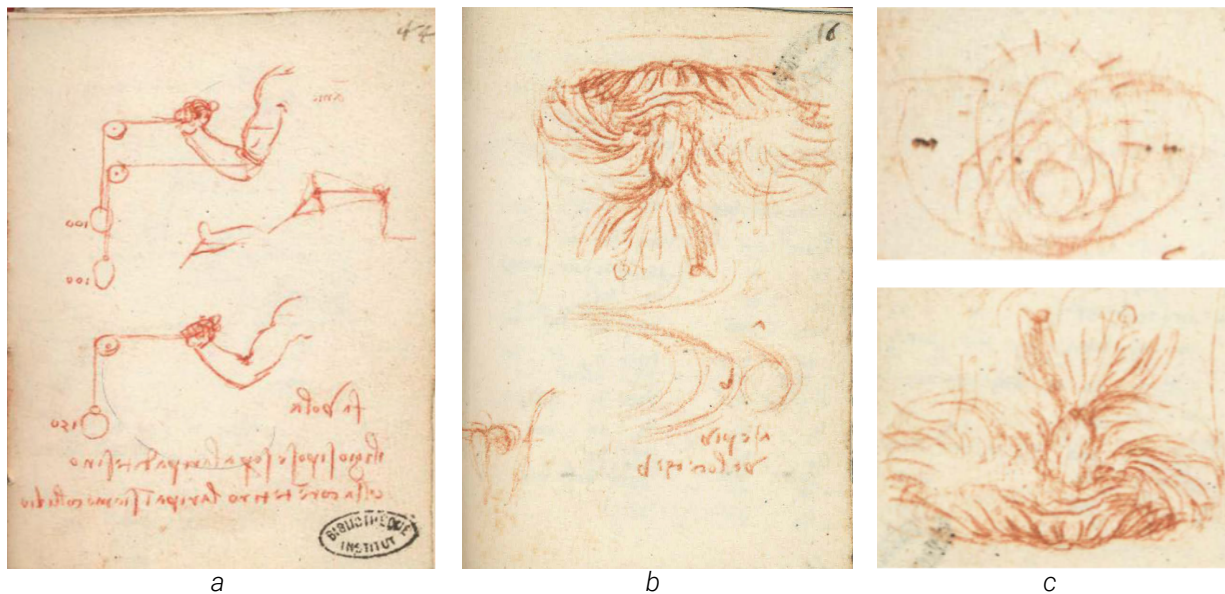


Figure 7. Leonardo's fable of the lily: a) Leonardo da Vinci, Studies of dynamometers and the fable of the lily. Manuscript H, fol. 44r. 1493-1494. Bibliothèque de l'Institut de France, Paris; b) Leonardo da Vinci, Consequences of water's action on the riverbank. Manuscript H, fol. 127v. 1493-1494. Bibliothèque de l'Institut de France, Paris; c) Leonardo da Vinci, Lily and diagrams, details. Manuscript H. fols. 127r-v. 1493-1494. Bibliothèque de l'Institut de France, Paris.



Figure 8. Fable>Emblem [Lilies] digital exhibit. The Fable and the Emblem of the Lily exhibit page: a) Leonardo da Vinci, Emblem of the lily, and diagrams and notes on geometry. RL 12700v. 1508-1510. The Royal Collection of Windsor, Berkshire; b) highlighted elements; c) single elements.

Even more striking are the correspondences found by digitally juxtaposing the fable on Manuscript H and Leonardo's sketches of the emblem of the lily on folio RL 12700v from the Royal Collection of Windsor. Among various studies of geometry, the Royal Collection sheet presents eight sketches which offer the visual summary of the fable by illustrating in both words and images the irrationality of fighting nature with a corresponding scheme. In fact, in the drawings of the lily we clearly identify the scroll (in the shape of the river waves) and the two moments of the fable—with the lily standing and bowing down.

In the first page of the *Fable>Emblem [Lilies]* digital exhibit we can see the recto and the verso of the manuscript sheet containing the emblem of the lily, with the corresponding captions. At the bottom, the various drafts of the emblem of the lily are highlighted as part of the original manuscript sheet, and as single elements (Fig. 8).

The following page, *Recurrent Elements: Curves*, reorders the single elements previously extracted from the manuscript in a sequential narrative. The next page, *Shapes Evolution*, highlights the recurrent patterns—which are the curves of the lily stalk, in this case (Fig. 9).

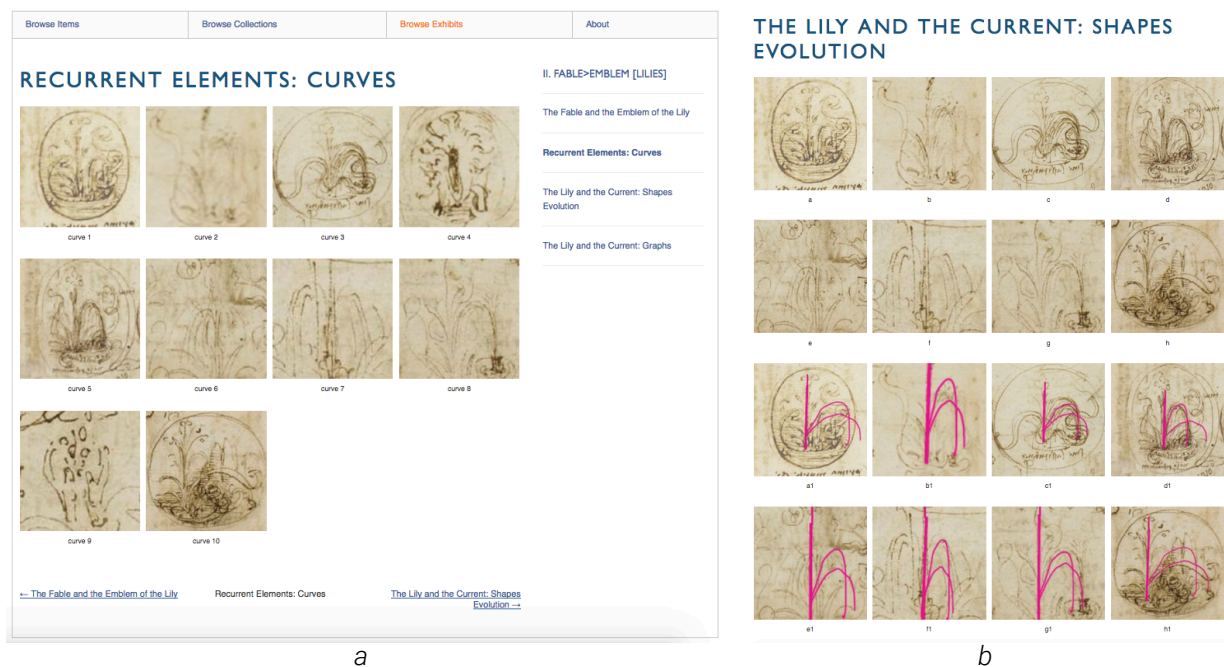


Figure 9. *Fable>Emblem [Lilies]* digital exhibit: a) *Recurrent Elements: Curves* exhibit page; b) *The Lily and the Current: Shapes Evolution* exhibit page.

Finally, the *Graphs* page illustrates the recurring motif of the stalk (represented by the green lines), and the gradual changes in shape and location of the river waves (with blue lines). In the end, lines from each image are superimposed. The straight lines and the curves representing the stalk maintain the same location and inclination in the diagrams referring to the emblem sketches. The

superimposition of the lines from each image displays the recurring motif of the stalk, which is always standing and bowing down in the same way (Fig. 10).

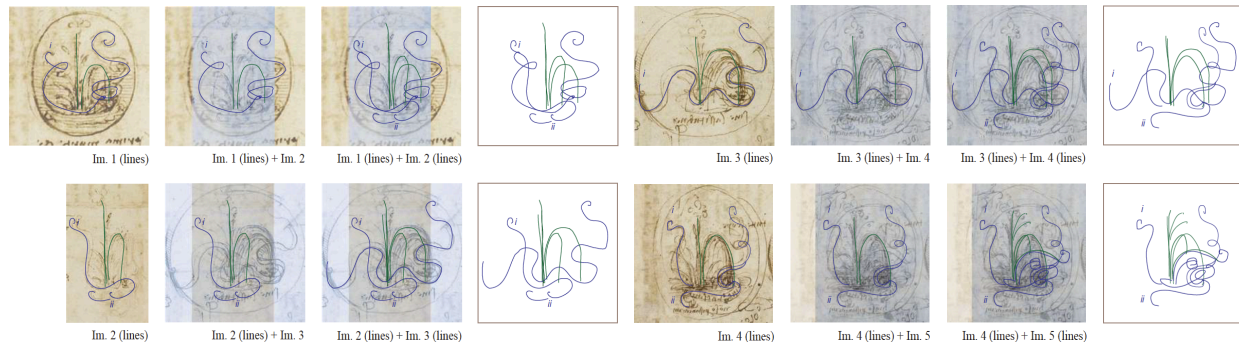


Figure 10. *Fable>Emblem [Lilies]* digital exhibit, *The Lily and the Current: Graphs page* (detail).

Curiously, the last image of the sequence shows the lily's stalk in three different positions that represent three different moments in its bowing down. The waves occupy the lower right of the image in multiple intertwined lines: in one case, the line illustrating the stalk bowing coincides with that of a wave. This image is arguably the last of the process because it shows unique delicacy and refinedness of the sign, and better summarizes the scheme of causes and effects at the basis of the fable and the emblem of the lily (Fig. 11).

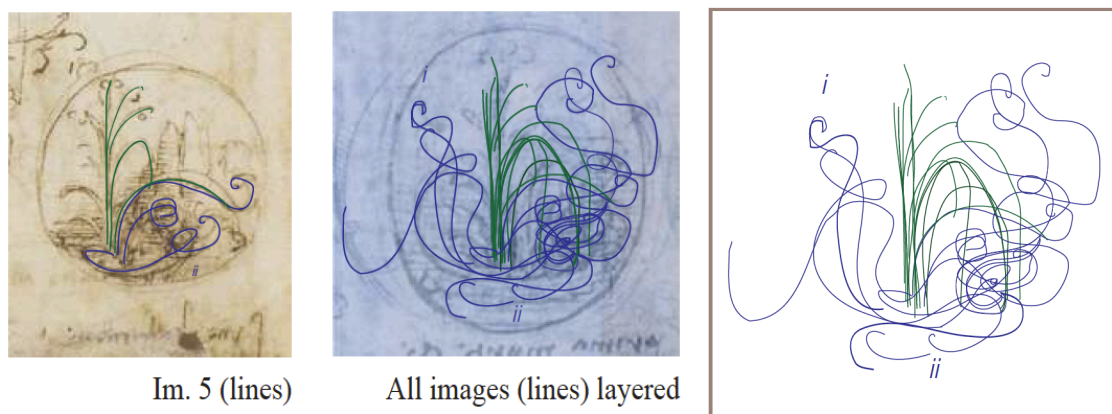


Figure 11. *Fable>Emblem [Lilies]* digital exhibit. *The Lily and the Current: Graphs page* (detail).

3.2.2 The fable and the emblem of the spider

The exhibit *Fable>Emblem [Spiders]* examines the sequential narrative at the basis of the fable and the emblem of the spider and the keyhole, by means of the same diagrammatic method employed for the analysis of the fable and the emblem of the lily. The fable of the spider and the keyhole is transcribed, together with two sketches for an emblem on the same topic, on the lower corner of folio

820v from the Codex Atlanticus: "The spider, thinking to find rest in the keyhole, found death instead" (n. 33) [Marsh 2004]. The extreme brevity of the text and its structure recall the fable of the lily: the causes (the web's weaving) are followed by the effects (the death of the spider). A similar structure is re-enacted in the emblem sketches. The two drawings represent, respectively, the spider approaching the keyhole, and the encounter between the spider and the key. In this case, the emblem scroll takes the form of a ribbon which adorns the key. Furthermore, the fable of the spider and the keyhole is surrounded, such as the emblem of the lily, by geometrical studies, thus confirming the proximity of the creative processes as the basis of both fables and emblems.

The exhibit pages show the recto and the verso of the manuscript sheet under consideration, and the elements of the spider and the key highlighted in the space of the sheet, and isolated as single items (Fig. 12).

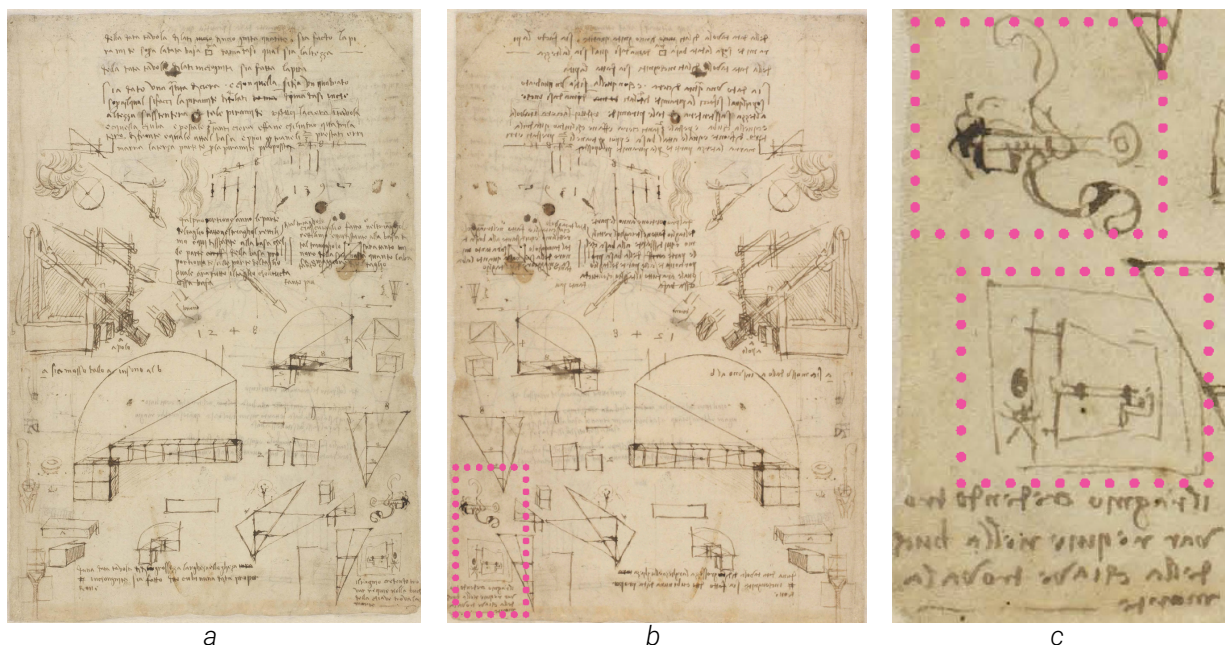


Figure 12. Fable > Emblem [Spiders] digital exhibit. The Fable and the Emblem of the Spider exhibit page: a) Leonardo da Vinci, Fable and emblem of the spider, and diagrams and notes on geometry. Codex Atlanticus, fol. 820v. c. 1515. Veneranda Biblioteca Ambrosiana, Milan; b) highlighted elements; c) single elements.

Identified patterns are, in this case, geometrical shapes in the form of triangles, as shown in the corresponding exhibition page, *Recurrent Elements*. In particular, the *Shapes Evolution* page illustrates the visual correspondences between the triangular shapes that are the subject of the geometrical studies in the upper part of the folio and the schematic representation of the emblem of the spider in the lower left corner of the sheet (Fig. 13).

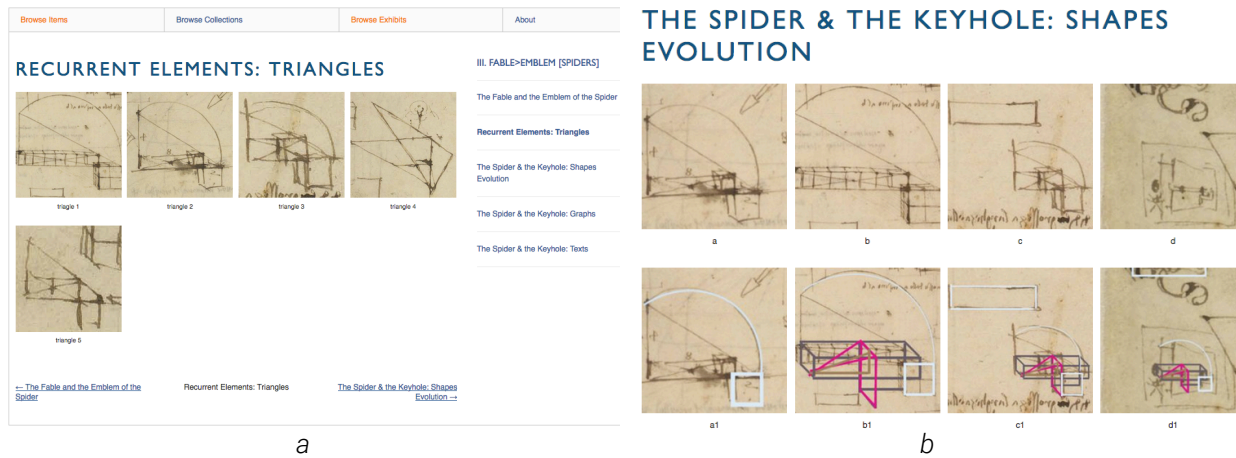


Figure 13. *Fable>Emblem [Spiders]* digital exhibit: a) *Recurrent Elements: Triangles* exhibit page; b) *The Spider and the Keyhole: Shapes Evolution* exhibit page.

Similarities in themes and structure are also reflected in the scientific texts gathered on the manuscript sheet, which widely suggest to the individual not to overcome natural laws. The juxtapositions of the catalogued textual and visual items, as shown in the *Graphs* page, reveals that Leonardo's technical-scientific studies influenced his development of the fable of the spider into the corresponding emblem (Fig. 14). (The final page, *Texts*, concerns a possible development of the site's features with the superimposed Italian transcription and English translation on each manuscript sheet.)

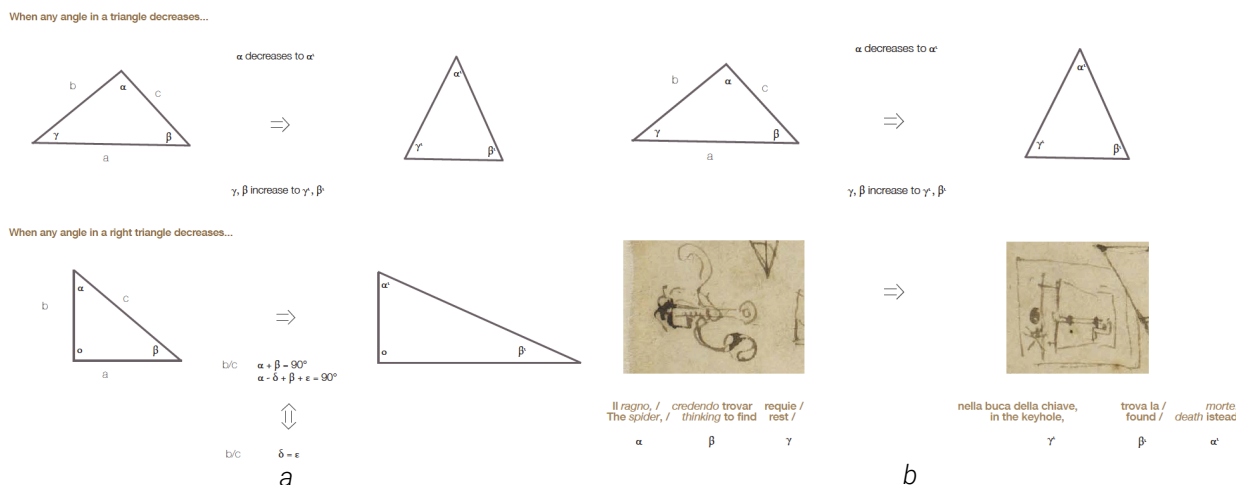


Figure 14. *Fable>Emblem [Spiders]* digital exhibit. *The Spider and the Keyhole: Graphs* page.

Further research has been conducted with the aim to locate Leonardo's development of fables into emblems in the broader context of early modern emblem theory, including a survey of sixteenth

century emblem treatises and the analysis of visual narratives—particularly, fables and emblems—applied to technical scientific projects by Leonardo's contemporaries, such as Giuliano da Sangallo [Pellecchia 2012]. This research has yet to be digitally documented and showcased. As suggested in the last exhibit section *Digital Edge*, a digital catalogue on present-day visual culture would eventually serve to investigate issues pertaining to material culture studies in face of current digital technology developments by examining the digital juxtaposition of Leonardo's visual sequences and the work of recent writers such as Italo Calvino, Carlo Emilio Gadda, and Primo Levi, and artists as Tacita Dean, Peter Greenaway, Andrei Tarkovsky, Yervant Gianikian and Angela Ricci Lucchi (Fig. 15).

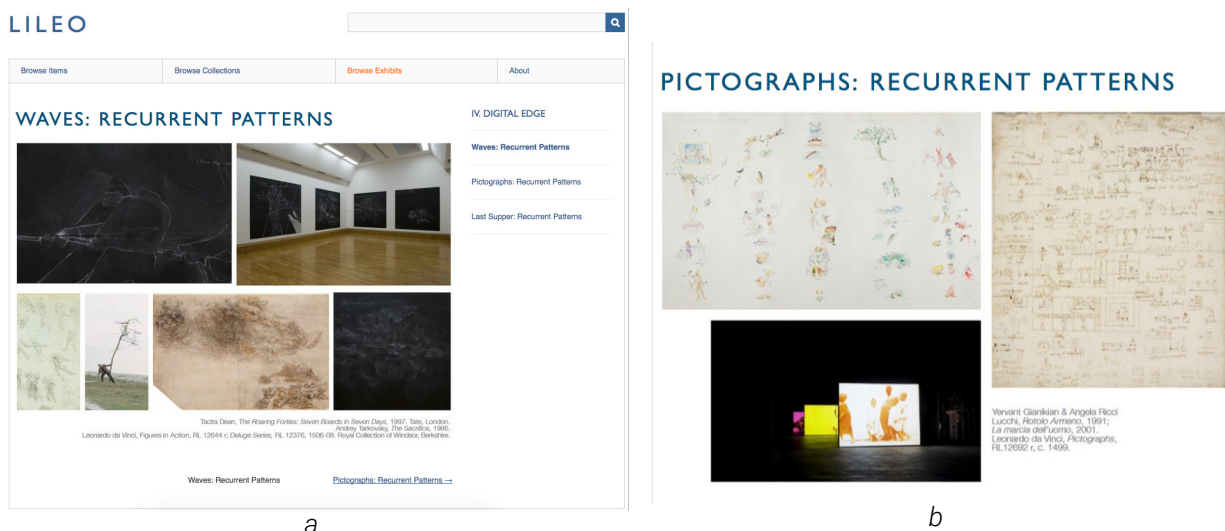


Figure 15. *Digital Edge* digital exhibit: a) *Waves: Recurrent Patterns* exhibit page; b) *Pictographs: Recurrent Patterns* exhibit page.

4. CONCLUSION

The present article applies digital humanities tools to visual analysis of material culture objects, such as Leonardo's fables, emblems and technical-scientific studies, to illustrate the interaction of different fields of investigation in his textual and visual compositional modes. In fashioning his fables, Leonardo reworked not only the Aesopic literary style and formulaic structure, but also the terrific iconographic apparatus of Aesop's editions belonging to his personal library. Case studies on clusters of fables and emblems revealed that Leonardo structured his fables on a binary model that is reflected in his scientific studies and diagrams. Leonardo employs the same model to develop his fables into emblems in order to concurrently show the causes and the effects of a situation. Eventually, Leonardo's emblems, which are synthetic texts condensing written and pictorial material, are arguably the visual and textual conclusion of his investigation. By focusing on the digital juxtaposition, layering, and diagrammatic annotation of images, the present analysis does not aim to link Leonardo's sketches to his public masterpieces, but to trace the formal patterns of his

analytical thinking throughout his various textual and visual projects. The digital juxtaposition, layering, and diagrammatic annotation of Leonardo's works and sources reveal vectors of movement and repeated signs across different materials. This suggests that formal configurations can move from image to text and pertains to the study of the work of art in progress, rather than focusing on the final outcome.

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