Vol. 7, n. 1 (January 2016)

JLIS.it

Italian Journal of Library,
Archives and Information Science
Rivista italiana di biblioteconomia,
archivistica e scienza dell'informazione

Università di Firenze
Dipartimento di Storia, Archeologia, Geografia, Arte e Spettacolo (SAGAS)

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Italian Journal of Library, Archives and Information Science
Rivista italiana di biblioteconomia, archivistica e scienza dell'informazione
Pubblicazione periodica quadrimestrale (esce in gennaio, maggio e settembre)
ISSN: 2038-5366 (print) – ISSN: 2038-1026 (online)
Website: http://jlis.it – Email: info@jlis.it

ABBONAMENTO 2016:
Italia € 50,00; Estero € 60,00.

SUBSCRIPTION 2016:
Italy € 50,00; Overseas € 60,00.

Ledizioni – LediPublishing – Via Alamanni 11
20141 - Milano - Italia
Tel. +39-0245071824 – Fax +39-0242108107 – IVA/VAT: IT04627080965

JLIS.it è edita dall'Università di Firenze, Dipartimento di Storia, Archeologia, Geografia, Arte e Spettacolo (SAGAS).
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JLIS.it is published by the University of Florence, Department of Dipartimento di Storia, Archeologia, Geografia, Arte e Spettacolo (SAGAS).
SUBMISSION & PEER-REVIEW: Papers submitted via the journal website will be checked by one of the editors: if these pass the first step, the papers will be sent to two reviewers for the peer-review process. After this, the author will be notified on the acceptance of his paper, or will be given suggestions on how to improve it.

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"Mirabili visioni": from movable books to movable texts

Gianfranco Crupi

To Ek
because "*the voice of* her *eyes is deeper than all roses*"

Introduction

Movable books are hand-crafted books created for a wide range of different purposes (teaching, mnemonics, play, fortune telling, etc.) including mechanical or paratextual devices demanding or soliciting the interaction of the reader. Recipients are called on to activate the mechanical device or system incorporated into the paper pages or parchment, which add 2- or 3-dimensional, kinetic, dissolving and other visual effects to the iconic and textual representation. The interactivity justifying the generic yet effective name of *movable books* for this type of published products is obtained mainly by: the reader moving some elements of the support (volvella, flap; revolving picture; metamorphosis book or harlequinade; carousel book; dissolving picture); the sequential arrangement of images held together by tabs, opening the book in a bellow-fashion (peep show book or tunnel book); the reader flicking rapidly and sequentially through the pages, animating the represented figures to create the illusion of movement (flip book); the decomposition of the support, adding a three-dimensional effect to the portrayed scenes (pop-up, scenic book, stand-up, V-fold, toy book, action book, etc.). These

JLIS.it Vol. 7, n. 1 (January 2016)
DOI: 10.4403/jlis.it-11611

operations become a physical, multi-sensory as well as an intellectual experience for the reader, transforming the mechanical or paratextual device created by the author into a semiotic and communicative space enhancing the semantic value of the text and generating original and totally unexpected iconic reading spaces.

The scientific interest in *movable books* is relatively recent; the first pioneering studies of Swedish scholar Sten G. Lindberg (1914-2007) and English scholar Peter Haining (1940-2007) date back to the late 1970s (Lindberg 1978; Haining 1979). In the following two decades, from different points of view art and book historians, bibliophiles and collectors focused their attention on the history of the movable paper devices and elements,[1] already found in some Medieval manuscripts and in the first xylographic reproductions, in the form of "fugitive sheets". This bibliography comes mainly from Anglo-Saxon sources (this fact is also confirmed by the specific terminology used to describe the different types of books), and in the 1990s met the curiosity of a much wider audience, not by chance also through the extraordinary publishing success of children's pop-up books. Riding the long wave of this success, over the past twenty years mainly - above all American - libraries have made efforts to recover and enhance animated books, thanks also to donations received from private collectors, also running seminars and conferences on the subject (Rubin 2010; "Smithsonian Institution Libraries Paper Engineering Lectures Series" 2010; Denslow 2014) and organising important bibliographical exhibitions (Walker 1988; Lavender and Smith 1997; Karr Schmidt 2003; Dackerman 2011; Karr Schmidt and Nichols 2011).[2] Welcoming the interest in the variegated world of movable books, in 1993 US

[1] Although more oriented to modern books, significant in this sense is the rich and analytical book by US collector Blair Whitton (Whitton 1986).

[2] A list of chronologically updated events can be found in Rubin 2015.

librarian Ann Montanaro, author of a bibliographical repertory of animated books in the English language, published between 1850 and 1997 (Montanaro 1993; Montanaro 2000), set up the "Movable Book Society" and the newsletter "Movable Stationery". Despite the very few Italian contributions, some are of particular importance, including those of collector Pietro Franchi, curator of an exhibition (Franchi 1996) and author of a rich, documented book devoted to "meccanismi, figure, tridimensionalità in libri animati dal XVI al XX secolo" (Franchi 1998); and writer and scholar of experimental literature Paolo Albani (Albani 2007; Albani 2013).

Medieval origins: Matthew Paris and Ramon Llull

Among the first, if not *the* first to use movable elements in a book was the English Benedictine monk Matthew Paris (1200 ca. – 1259), author of numerous works including the large historical narration, *Chronica majora*,[3] enriched personally by him with an extraordinary collection of images, demonstrating his own excellent artistic talents. The first seven pages of *Chronica* are filled with a series of maps which, together, form "a kind of Medieval road map" (Connolly 2009, 5), representing the paths and routes that, through major European cities, linked London to

[3] "It was not, however, a single-handed undertaking. Up to the annal for July 1235, it consists of a revision of the *Flores Historiarum* written by Roger Wendover and represents Matthew's work only in the continuation of the monumental history to 1259. An illustrated autograph copy of the *Chronica Majora* survives in three volumes: MS 26 in Corpus Christi College, Cambridge, containing the annals from Creation to 1188; MS 16, also at Corpus Christi College, with annals from 1189 to 1253; and British Library MS Roy. 14. C. VII, which contains the entries from 1254 to Matthew's death in 1259 on fols. 157 to 218. The relative scale of Paris's contribution to the *Chronica Majora* may be suggested by noting that his annals for the last twenty-four years (1235-1259) are roughly as long as the whole preceding history from Creation" (Lewis 1987, 9).

the most important destinations of religious pilgrimage, Rome and Jerusalem. Matthew Paris's great innovation was to "aver unito l'idea di itinerario con quella di mappa" (Wilkins 1997), offering his brothers, confined to the monastery and unable to personally visit the sacred places of Christianity, a geographic context of the historical narration. But the real novelty lay in the fact that in his work Paris added folded parchment flaps to the top and sides of some maps,[4] which when opened and closed could modify the itinerary and the represented geographic space. Thus through this performing action, the map became a dynamic space and an exercise in memory, in the eye of the reader offering the possibility to undertake an interior journey of meditation, a mental pilgrimage that could be remodulated, open to alternative itineraries. The extent of the natural confines of the manuscript, functional to the representation of a sacred geography, thus became a multi-sensory experience: "The layout of Matthew's itinerary maps solicited their monastic viewer's *and* reader's sense of their bodies' position before the manuscript, and so constructed its spaces as a vehicle for movement" (Connolly 2009, 55).

And not only. The eclectic Benedictine monk is also reputed to have introduced another mechanical expedient in his *Chronica* (f. 1v), the *volvella*, which was to enjoy long-lasting success due to the versatility of its applications.[5] The volvella, a term deriving from Medieval Latin, consists of one or more paper or parchment discs, shaped and overlapping and fixed to the page with a pin (a string or a rivet), allowing each disc to be independently rotated around its central axis. Sometimes the pin or string knot fixing

[4] http://utfus.blogspot.it/2013/04/figure-1-matthew-paris-map-of-holy-land.html.

[5] Both the volvella and the flaps can also be appreciated respectively in f. 1v and ff. 4r-4v of the digital version of Ms Roy. 14.C.VII owned by the British Library.

point is covered by a small, decorative cap, fixed with a spot of glue to the page below. The forms, sizes and materials used, the contexts and frequency of use of the volvellae varied greatly, and this affected to their survival over time (Cunningham 2004; Gravelle, Mustapha, and Leroux 2012; for the bibliographical description of volvellae, cf. Drennan 2012).

Compared to the traditional ecclesiastic *computus*, used to determine the date of Easter and other variable festivities (Borst 1997; Capasso and Piccari 2000) consisting of circular tables (*rotae*) which, due to their static nature, forced the reader to turn the codex to read the numbers, the innovation introduced by Matthew Paris in fact allowed readers - as Daniel Connolly well observed - to rotate the disc, aligning it to their bodies thus facilitating the reading of the dates (Connolly 2009). The ingenuity of this invented artifice - presuming that Matthew Paris was indeed the first to adopt the volvella in a codex – modified the relationship between reader and text, introducing a new practice of reading through interactive processes, as in the case of the flaps, transforming the manual gesture into an intellectual experience, one of knowledge. The reader thus becomes not merely the interpreter of the text but also its author, whose intervention enables the algorithm that generates meaning.

A different case is that of the Catalan philosopher Ramon Llull (1233/35 – 1315), who between the 13th and 14th centuries exploited the computational mechanism for complex processes of logical combination, concentrating a huge amount of information into its compact form. In his work *Ars compendiosa inveniendi veritatem seu ars magna et maior* (1274), the contents of which were then reproposed in *Ars magna generalis et ultima* and *Ars brevis* (1305-1308), Llull developed a complicated logical system used to achieve truth ("Ramon Llull Database" 2015). Underlying Llull's *ars* was a detailed symbolic structure which, by decomposing reality into its elementary principles, identified by letters of the

alphabet and other signs, was then used to explain more complex fields of analytical and synthesizing inquiry. Through a game of relationships and combinations represented by graphic devices based on the rotation of geometrical figures, which in fact required the use of volvellae, Llull's aim was to understand all knowledge with one single instrument, used to prove or confute every single statement. As well as representing a form of art of memory,[6] according to Leibniz's understanding, Llull's system is therefore an *ars combinatoria*, an art based on inferential procedures.

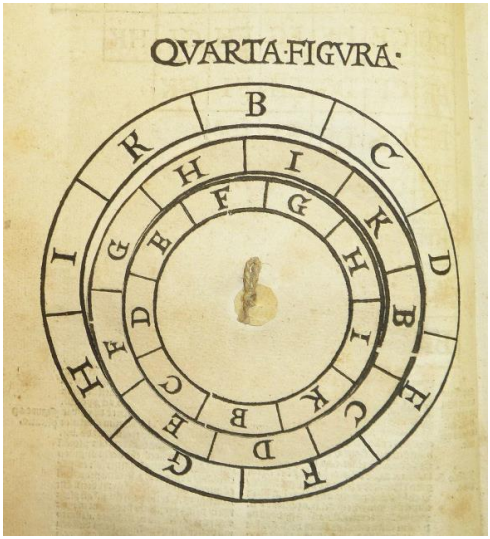

Image 1 Volvellae from *Raymundi Lull Ars magna, generalis et vltima.*

[6] "Llull thus became revolutionary by reintroducing movement into artificial memory. With it, he produced a tool that freed the intellect from remembering how to remember" (Karr Schmidt 2004, 106).

Ciphered languages

According to US historian David Kahn, Llull's *ars inveniendi veritatis*, expressed in the computational mechanics of overlapping rotating discs, was the basis for the creation of language ciphering systems and, thanks to his example, the invention of a ciphering volvella by Leon Battista Alberti (1404-1472) (Kahn 1967). In his work *De componendis cyfris* or *De cifris* (Alberti 1994),[7] composed around 1466 for the apostolic secretary Leonardo Dati, to make his correspondence more secure, Alberti designed a polyalphabetic cipher based on the sliding of two concentric discs "contenenti un alfabeto ordinato per il testo in chiaro (testo da cifrare) e un alfabeto disordinato per il testo cifrato (testo risultante)" ("Disco Cifrante" 2014). In truth, the expedient had already been the focus of interest of the Paduan scientist and humanist Giovanni Fontana (1390 ca.-1454 ca.), who in his *Secretum de thesauro experimentorum ymaginationis hominum*, dated to around 1430 and dedicated to artificial memory, had proposed "una serie di congegni e macchine per la memoria costituiti da una struttura fissa (ruote, spirali, cilindri) e da una parte mobile e variabile che permette di mutare le combinazioni di segni all'interno del sistema" (Muccillo 1997).

Of course the fortune of the volvellae and their multi-purpose function was confirmed with the revolution of movable type printing, which extended their use (limited earlier practically exclusively to the holder of the codex and its few lucky readers) to a wider audience able to exploit their interactive features. A revolution that - as we will see - for this and other movable devices led to the research and invention of technical solutions which, in terms of typographic composition and publishing, had to reconcile serial production with the creation of unique pieces, which needed to be wholly or partially assembled by hand by the

[7] http://www.apprendre-en-ligne.net/crypto/alberti/decifris.pdf.

reader or, in a subsequent post-production phase, by the typographer/publisher. In the case of the volvellae, the printed shaped discs and any other accessories were usually cut out by the reader and assembled either inside the book or separately.[8]

Remaining in the field of cryptology, one example can be found in the extraordinary work of scientist Giovambattista Della Porta (1535-1615), the *De furtivis literarum notis* (1563),[9] for which numerous editions and reprints were issued, above all following the later extension, *De occultis literarum notis* (1593)[10] (Della Porta 1563; Della Porta 1593). In the various editions the author made the manual increasingly comprehensible, with a rich assortment of tables, illustrations and movable discs.[11] These inserts, which helped to assure the long-lasting commercial success of the book, in fact offered the reader

> a form of hands-on experimentation with all its elements already present in the movable dials. Potential Magicians who could not afford a laboratory or the leisure of the members of the Accademia, or Otiosi, might still be able to afford these handbooks, and could heighten their investment in the scholarly exercise by cutting out and mounting the dials themselves. (Karr Schmidt 2004, 107)

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[8] In some books the volvellae were presented in separate sheets, accompanied by specific instructions on the assembly, the exact position in the book and the ways of interpreting the results obtained once the volvella was placed in a condition to be moved. The sheets containing the volvellae to be assembled were fixed to the book binding ready to be cut out (Karr Schmidt 2004).

[9] http://bibdig.museogalileo.it/Teca/Viewer?an=000000941123.

[10] https://archive.org/stream/bub_gb_SiMSx93gvRYC#page/n5/mode/2up.

[11] Some examples can be admired on pages 91-92, 97-98, 103-104 of the 1593 edition of *De occultis literarurm notis*.

Wheels of fortune and "libri delle sorti"

The rotating discs produced after Matthew Paris and Ramon Llull were used above all to understand and calculate certain natural phenomena or forecast future events. The fact of substantially being a versatile computer led to the application of the volvellae for fortune-telling purposes, motivated by both prejudice and faith, to learn the favour or otherwise of future events (as with another work by Paris, the so-called *Book of Fate*)[12] (Iafrate 2013) or predictions linked more directly to everyday events (weather forecasts, zodiacal influences, the choice of the most appropriate days to embark on a journey or undergo blood-letting, etc.).

Despite the fragility and vulnerability of the support, easily subject to wear and tear (Braswell-Means 1991) and the fact that they were often cut out for use in social games (Lindberg 1979, 53), some interesting examples of divining wheels and wheels of fortune have in any case been preserved (cf. Karr Schmidt 2006). One of these comes from the *Libro delle Sorti* by Lorenzo Spirito Gualtieri (1426-1496).[13] Although he was not the inventor of this lucky, ludic fortune-telling publishing genre (Urbini 2006), the version he designed enjoyed great popularity into the 17th century.[14] These books (known also as "lottery books", "books of

[12] Bodleian Library & Radcliffe Camera, Book of Fate, MS Ashmole 304.

[13] The handwritten codex kept at the Marciana National Library in Venice (Ms. IX.87=6226), is richly illuminated, carrying the following *subscriptio*: "Qui finiscono le sorte facte e composte per mano di me Lorenzo Spirito da Peroscia e recopiate per mia propria mano, finite a dì 10 de gennaio 1482" (Urbini 2006). From the same year is the *princeps* published in Perugia by Stephanus Arndes, Paulus Mechter, Gerardus Thomae, of which only one copy is still known to exist, kept at the Stadtbibliothek in Ulm.

[14] Spirito's text, representative of a much broader phenomenon, is a form of bibliomancy, the distant temporal and geographical roots of which lie in classical and Middle Eastern culture. One such example is "stichomancy", a fortune telling technique practised in Ancient and Medieval times, consisting in the random opening of an authoritative text – the *Bible* (*sortes profetarumm et*

fate", "Losbucher" in German) with a divining function (answering questions about the future) were usually accompanied by a rich variety of images (in the Germanic area consisting mainly of religious iconography) and were activated by instruments based on chance such as dice, cards, coins, or indeed volvellae. They were able to exercise great suggestion in the visual imagination of the "players", as, in the popular iconographic form of the *rota Fortunae*, they evoked the capricious nature of fate and its impenetrable blind will (Helfand 2002). But in this case with a substantial difference: in rotating the volvella (which, for technical reasons, could not spin uncontrollably like a *roulette*), the player became responsible for his own fate, assuming the role of Fortune itself, both the object and subject of its imponderability. Thus, the book became a space for interpretation, and the volvella the device transforming the book into a material machine for experimenting time, the future and the whims of Fate. In this way, rituals based on the randomness of chance found their way into the iconographic, textual and performing framework offered by this very particular graphic and literary genre, represented by "libri delle sorti": books to look at rather than read, books in which the boundary between the sacred and the profane, pleasure and moral edification, play and knowledge, was undefinable. Thus the book became a bridge between heaven and earth, between otherworldly arcane designs and the unforeseeable events of earthly life.

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apostolorum), *Eneide* (*sortes* virgiliane), *Divina Commedia* - and, according to the passage extracted by chance, obtaining a divination. In particular, in addition to the type represented by Spirito's text, "libri di sorte" also include "i "libri di fortuna", che pronosticano i giorni fausti e infausti, e i "libri oracolari", come l'*I-Ching*, dove la risposta è determinata in modo diretto da tre lanci successivi di dadi" (Sotzmann 1850-1851, cited by Urbini 2006, 43).

Between astronomy and astrology

As we have seen, in addition to its use for fortune telling, fun and entertainment, the volvella was also widely used for scientific purposes, above all for simple calculations of astronomic phenomena and as an application in the art of navigation. Three classics of late Medieval and Renaissance cosmography bear witness to this. English astronomer and mathematician Johannes de Sacrobosco (1195 ca. – 1256 ca.) (Vasoli 1970) was the author of a short work on astronomy, *De sphaera mundi* (1230 ca.),[15] which was extraordinarily popular both in its hand-written and printed versions, as an elementary compendium of Ptolemaic doctrine. The elementary nature of the concepts explained greatly facilitated its use as a teaching text until almost the late 17th century; its popularity increased not only due to the many commentaries on the work but also due to the introduction, from the first printed version dated 1538 (Wittenberg, Josef Klug), of three volvellae which made the complex calculations demanded of Ptolemaic cosmology in determining the movement and orbits of the planets far easier (Gingerich 1994).

[15] Some digital versions of the work are available on-line: two Venetian incunables dated 1485 and 1490 and a Valencian print from 1553.

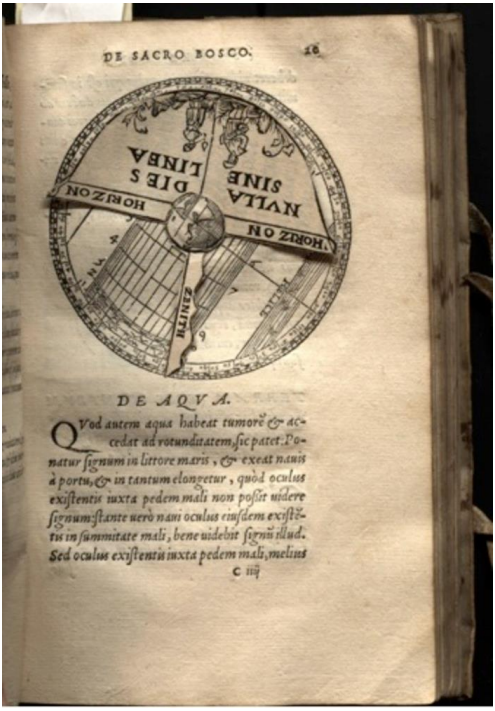

Image 2 Ioannes de Sacrobosco Sphaera (Paris 1552). © Thomas Fisher Rare Book Library by Architectures of the Book Image Database.[16]

Also to provide more solid bases for astrology, the validity and forecasting effectiveness of which, on a par with his contemporaries he did not deny, the German Johann Müller (more well-known by his humanist name "Regiomontanus", 1436-1476) focused his studies on astronomy producing accurate mathematical models of the movement of celestial bodies (Zinner 1990; O'Connor and Robertson 2004). Author of popular almanacs and ephemerides, known for the precision of the data and the accuracy of the prints he produced in his own print shop,

[16] http://drc.usask.ca/projects/archbook/images/index.php.

as well as his essays on the functioning of astronomic instruments, he was one of the first to understand the impact printing was to have on the dissemination of the scientific culture. In 1474 he published one of his most famous works, the *Kalendarium*,[17] an innovative calendar that predicted solar and lunar eclipses and calculated the day of the year in which, from 1477 to 1531, Easter would fall. In fact, the text was an updated compendium of the astronomic and mathematical knowledge of the time, and had an openly practical and teaching purpose. However, its absolute originality in book history consists in the fact that, twenty years after Gutenberg's invention, he had introduced four movable devices (including a volvella),[18] some of which involved the use of rotating brass pointers fixed to the page below with a rivet, to illustrate the operation of some astronomic instruments.[19]

The introduction of the volvellae as a teaching support to transmit "technical information in an interactive format" (Gravelle, Mustapha, and Leroux 2012) was even more exemplary in the essay on *Cosmographia* (Landshut, Johann Weyssenburger, 1524) by the German astronomer, cartographer and mathematician Peter Bennewitz (or Peter Bienewitz), who

[17] http://daten.digitale-sammlungen.de/~db/0003/bsb00031144/images/.

[18] Bayerische StaatsBibliothek, Johannes Regiomontanus, Kalender.

[19] "An astronomical calendar that, among other accomplishments, attempted to rectify the temporal flaws of the Julian calendar by introducing a new, reformed Gregorian variant. It was the first calendar actually printed in Europe and in many ways became the standard for later efforts. Though Gutenburg published a calendar which calculated the times of new and full moons and planetary positions, the calculations provided by Regiomontanus proved to be far more accurate. The *Kalendarium* contained numerous astronomical volvelles and astrological tables, as well as brass devices for constructing horoscopes. It also provided a full perpetual calendar for the years 1475-1532 which diagrammed and foretold the significance of eclipses and contained astronomical data giving the true times of sunrises, sunsets, lunar cycles, and solar cycles". (Helfand 2002, 30).

latinised his name to Petrus Apianus (1495-1552), by which he is universally known (van Ortroy 1963). Compared to Sacrobosco's work, *Cosmographia*,[20] one of the most popular scientific books of the 16th century, by virtue of the fact that it was translated into three languages and in just one century it had no less than 45 editions, this potentially targeted a far broader audience. It was presented as a more general introduction to astronomy and geography, cartography and calculating instruments for measuring space and time.[21] Cosmography was in fact considered a practical art, demonstrating the utility of mathematics as a science of calculus, serving a range of applications in both civil and military fields. "The success of practical mathematics in solving real-world problems; its utility in such important areas as navigation, war and commerce; and the prestige associated with this utility conferred upon cosmography a great measure of confidence and popularity. Here we can locate an important reason for *Cosmographia's* popular success" (*Cosmographia: A Close Encounter. A Student Virtual Exhibition at the Museum of the History of Science, Oxford* 1998).

[20] Some digital editions of Apianus' work are also available on-line: the Paris edition from 1553 and the Antwerp editions of 1540 and 1564.

[21] Starting from the two editions of 1533 (Antwerp, A. Birckman and J. Grapheus; Antwerp, G. de Bonte and J. Grapheus), Gemma Reiner (better known as Gemma Frisius, 1508-1555), professor of medicine at the University of Leuwen, an enthusiastic scholar of astronomy and inventor of some of the instruments described and illustrated in Apianus' work, cooperated in the typographic layout of the book (*Cosmographia: A Close Encounter. A Student Virtual Exhibition at the Museum of the History of Science, Oxford* 1998).

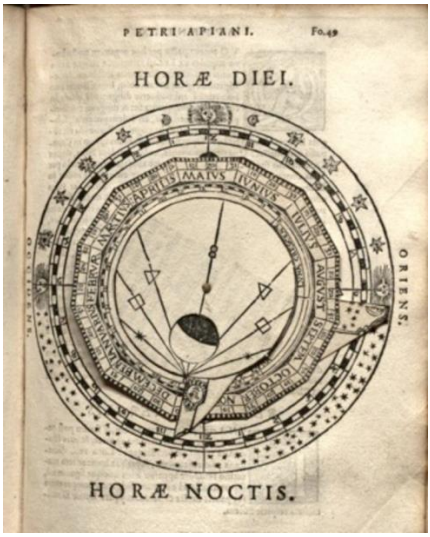

Image 3 Petrus Apianus, *Cosmographia* (Antwerp 1564) © Thomas Fisher Rare Book Library by Architectures of the Book Image Database.[22]

In fact, from the 1533 edition, the book included a rich series of illustrations of mathematical instruments and relative instructions for use (the armillary sphere; the sundial;[23] the lunar clock; the nocturnal; the astrolabe; etc.) and, above all, four volvellae, which by then were a popular and inalienable complement to any astronomy handbook. As we have seen, these mechanisms, almost miniature astrolabes, held a huge amount of information in a small device, concentrating into a two-dimensional structure what conventional instruments were able to demonstrate in three dimensions. A few years later Apianus, who in the meantime had become a professor of mathematics at the University of Ingolstadt (1527), printed one of the most beautiful books of the

[22] http://drc.usask.ca/projects/archbook/images/index.php.
[23] https://dcs.library.virginia.edu/files/2014/07/29670_0080_edited.png.

Renaissance period, *Astronomicum Caesareum*,[24] dedicated to Charles V, earning himself not only titles and prebends but also the loyalty of the Emperor himself, who often called on him for astronomic counsel. This magnificent and highly costly book reproposed the known cosmographic doctrines, enhancing them with a rich array of illustrations and, above all, more than twenty volvellae (some made from several rotating discs), coloured in by hand and assembled directly in Apianus' printing workshop.[25]

> "What makes these books from the incunabula period particularly special is the fact that they contain images that had to be assembled after the sheets that would become the book had left the press, after the sheets had been folded to form the gatherings that would form the book, and almost certainly after the gatherings had been stitched together to form the book itself" (Cunningham 2004).

In addition to this, the speciality consisted in the fact that the book was not only a medium of knowledge but became an instrument of experimentation of that knowledge, a physical space for self-learning that had to be operated and manipulated by the readers to experience and check their effective understandingThe eyes alone are not sufficient, hands are needed to observe how the scientific knowledge works, and the book

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[24] The book was printed in 1540 at the printing workshop that Apianus himself had set up in Ingolstadt. The magnificence of the book can be appreciated in the copy available on-line at the Deutsche Digitale Bibliothek (DDB).

[25] "Consisting of multiple paper discs, pointers, and silk strings that accurately determine the positions of the planets and other celestial phenomena, the volvelles here include as many as six rotatable dials, representing central, eccentric, and epicyclical shifts, to harmonize with the Ptolemaic theory of stellar movements, and include up to three silk threads representing "fiducial" lines of reference. (Tiny pearls attached to the silk threads initially served as sliding indicators on some of the non-rotating circular charts.)". (Helfand 2002, 21).

becomes a kind of laboratory, a "gabinetto delle scienze" *ante litteram*, placing the book-world and the world beyond the book in direct relationship. The mind's eye thus goes beyond the boundaries of the book, observing through it not how the universe works but how the "things" that are part of it work. The editorial success of books of fortune ended up blending with that of astrology and astronomy texts, lasting until the early 18th century. Bearing witness to this is *Dariotus Redivivus* (1653) by Claude Dariot (1533-1594) which, in its sixth posthumous edition, offered a series of divining devices "by configuring astrological signs and the positions of the planets" (Gravelle, Mustapha, and Leroux 2012), which however needed to be used by educated readers and experts who were able to decipher the underlying complex symbolic system.[26]

Geography and the art of navigation

As explained, the volvellae created to transmit technical information interactively were also widely used in geography and the art of navigation, as valid supporting instruments for measurements and calculations. We may offer two examples from among these. The *Breve compendio de la sphera y de la art de navegar con nuevos instrumentos y reglas exemplificado con muy subtiles demonstraciones* (Seville, Anton Alvarez, 1551) by the Spanish cosmographer Martín Cortés (1510-1582)[27] which, translated by Richard Eden, became the first English navigation handbook (*The arte of navigation*, London, Richard Jugge's widow, 1584), "the navigational bible in effect […] of English pilots and mariners" (Waters 1992, 22). In both versions the text was accompanied by models and cut-outs used to build astronomic instruments and volvellae including assembly instructions (cf. Cunningham

[26] Cf. Architectures of the Book Image Database.

[27] The digital version is available on-line at the website of the Biblioteca Nacional de España.

2009).[28] The other example is the *Spieghel der Zeevaerdt* (Leyden, 1584-1585) − better known in its English version by the title *The Mariner's mirror* − by Dutch cartographer Lucas Janszoon Waghenaer (1533 ca.-1606). Translated into several languages and printed repeatedly during the 17th century, it was the first text of its kind in the history of maritime cartography. In fact, it was an atlas of nautical maps, with the relative instructions for navigation, based on the position of the constellations, which could be measured using some volvellae,[29] for which Waghenaer also provided the instructions for use [30] (Lindberg 1978; Gravelle, Mustapha, and Leroux 2012).

In the following centuries, rotating discs were used in various fields and for a wide range of different purposes (teaching, practical, ludic), and by the 19th century had become an entertaining complement for illustrated children's books, and over the 20th century an object that was independent from the book (parking discs, computing instruments, teaching supports, advertising means, etc.), also based on interesting interactive and graphic expedients.[31]

From the start of its long history, the volvella has always been a multi-functional device for communicating knowledge that, when incorporated in a book, crosses the confines of text in its strictest sense, activating different codes of use (reading, viewing, manipulating, interacting). In fact, these characteristics alter the author-text-reader relationship: for the author's textual message to be fully transmitted, the reader has to assemble, construct and operate the device the author has created for him. The complementarity of the reader and author is thus achieved

[28] R. Cunningham also curated the digital version of the *Arte of Navigation* (Cunningham s.d.).
[29] http://www.vliz.be/wetenschatten/beeldbank.php?album=1227&pic=43555.
[30] http://www.vliz.be/wetenschatten/beeldbank.php?album=1227&pic=43658.
[31] Helfand (2002) offers an extensive documented overview of these.

through the acceptance of sharing the authorial control over the text through a device which, above all in its logical and computational applications, in the hands of the reader becomes a rhetorical instrument of semantic production.

Flap and other movable elements

The other movable device whose functional potential we have already mentioned (in Matthew Paris's *Chronica majora*), consists of flaps, paper tabs designed and used to reveal an image or text, kept deliberately hidden from the reader. This technology required the close collaboration between illustrators, printers and book-binders and which, in the 16th and 17th centuries was widely used in anatomy books, the so-called *anatomical flap books*. In its most sophisticated form - as we will see - there could be more than one flap, thus creating a logical and visual layering of information; in this case, the single flaps, arranged on overlapping levels, were glued in one spot and fixed to the page below.

These movable book elements (the first to offer an effect of depth, three-dimensionality or the time sequence between "before" and "after") were widely used in anatomy books, by progressively lifting each flap (*lift the flap*), showing the internal structure and layered arrangement of the organs and systems in the human body. According to scholar Pamela Smith, the research and acquisition of new knowledge in the early modern age passed through what she defined as "the epistemology of handwork" (Smith 2004, 28); in other words, practical and direct observation, physically involving the researcher in the interaction with natural phenomena and objects, marked a radical change in the methodology of scientific investigation from the 16th century.

Anatomical flap books

The use of flaps in anatomy textbooks demonstrates how a physical feature of the book can be used to represent

> subsurface information, and how such images (representative of viscera and layers of the human anatomy) might be designed in relation to each other. Without actually appearing in three dimensions, these works still grant the reader the opportunity to move deeper and deeper into the body and its organs. The placement of these flaps, then, is just as important as what the flaps depict or disguise. (McNiff e Schultz 2012).

The main *anatomical flap books* catalogued by researcher Andrea Carlino covering the period from 1538 to 1687 (Carlino 1999), bear witness to the scientific interest and progress made in anatomical and physiological studies of the human body, starting from the unique scientific perspective offered by Flemish scientist Andreas van Wesel (1514-1564), better known by his Italianised name Andrea Vesalio. He is deemed responsible for overcoming the age-old medical tradition based on Galen's theories and the introduction of a study method based on the direct observation of the body, through autopsies and the dissection of corpses. His work, *De humani corporis fabrica libri septem* (Basilea, Oporinus, 1543), was accompanied by an impressive amount of images (thanks to the skills of a famous engraver, Jan Stephan von Calcar), and became an editorial model, also due to the introduction of a large number of flaps, which from then on became an inalienable educational complement to medical texts. By progressively leafing through these movable elements, the reader/spectator is invited to take part in a virtual autopsy, a simulation of the process of human dissection performed in anatomical theatres. In doing so, the invisible topography of the human body is revealed to a wider audience of medical students, and made even more clear and true in some hand-coloured examples. "Although the use of Vesalius's flap prints transfers the experience of surgery and dissection away from an actual body, it nonetheless continues to provide physical interaction for the student, who must manually

operate the printed surrogate bodies. The prints thematize the process of inquiry, while the users enact it" (Dackerman 2011, 32).[32] Preceding the publication of Vesalio's work, and thus the re-writing of his medical knowledge, by a few years, Heinrich Vogtherr the Elder (1490-1566) produced some engravings considered to be the first known prints with the inclusion of flaps.[33] Vogtherr thus introduced a way of disseminating anatomical knowledge by producing individual prints that were not necessarily fixed in a book, known as *anatomical fugitive sheet*s, used to indicate the ephemeral nature of these objects.

The interaction with the body, mediated by these movable devices on paper, was the central focus of other important medical works,[34] from the ophthalmology handbook by the German George Bartisch (1535-1607), *Ophthalmodouleia*[35] (1583), to *Catoptrum microcosmicum*[36] (1619) by physician Johann Remmelin (1583-1632) who, with the help of artist Lucas Kilian (1579-

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[32] The images and videos of an interesting exhibition put on in the United States in 2011 are particularly effective in illustrating the different types of anatomical flap books (Finucci and Rippa-Bonati 2011). The exhibition website also offers a rich Bibliography of Flap Books (M. Brown 2011).

[33] "In 1538 some curious woodcuts made their appearance on the print market. They were published in pairs and represented the human body, in both its male and female forms. Some were coloured, a brief text was printed around them, and the figures were made of a series of layered strips of paper: lifted up in turn, they revealed the body's internal organisation. These images had an immediate and tremendous commercial success. Edition upon edition appeared in many European countries throughout the century and continued to do so until the end of the seventeenth century. Anatomical fugitive sheets- thus have they been baptised by librarians, scholars, collectors and historians- have been studied and analysed since the mid-nineteenth century" (Carlino 1999, 1).

[34] A rich collection of illustrated and animated anatomy texts can be found on the Anatomia highlights web page of the University of Toronto website.

[35] http://exhibits.library.duke.edu/exhibits/show/anatomy/anatomy/item/12241.

[36] http://sdrc.lib.uiowa.edu/exhibits/imaging/remmelin/index.html.

1637), produced a technically sophisticated work including numerous flaps in each image, which were lifted in order to observe the internal structures of the human body starting from the outer layer of skin. Just a few examples, therefore, in addition of course to philosopher René Descartes' *De homine figuris et latinitate donatus a Florentio Schuyl* (1662), perhaps the first European work on physiology, which was however published posthumously, as while alive he feared being convicted of heresy. The principle underlying the paper construction of the flaps was subsequently adopted also in other scientific and professional fields, using communication methods other than the book, as we will see. One example among many comes from the works of the famous English architect and landscaper Humphry Repton (1752–1818), who documented his designs using water-colour flaps to offer clients a visual projection of the required restoration works. His *Red Books* (thus called due to their Morocco leather bindings) offered an effective comparison of the architectural works in question, before and after[37] the proposed works. Certainly on a more light-hearted subject we may mention the album (Bertelli 1589-1596) published by chalcographist Pietro Bertelli[38] in the late 16th century which included a number of tables illustrating exotic customs and habits, some of which used flaps to allow the viewer to peek beneath the clothing of some characters, such as the image of the Venetian courtesan.[39]

Fugitive sheets

Studies by Suzanne Karr Schmidt (Karr Schimdt, 2004) and Susan Dackerman (Dackerman 2011) have firmly demonstrated how one of the most formidable and effective means of

[37] http://www.themorgan.org/collection/Humphry-Reptons-Red-Books#self.
[38] http://www.treccani.it/enciclopedia/pietro-bertelli_(Dizionario-Biografico).
[39] http://starlightmasquerade.com/PortraitGallery/Closed-Bodice-Venetian/inspiration-pages/closedbodice31.htm.

communicating knowledge in the early modern age was that of woodcut prints which, far from performing a purely illustrative or decorative function or statically reproducing the results of inventions and research, were rather put to a vast and unimaginable host of uses:

> Thus, interactive prints insisted on an actively personal, tactile and auto-didactic viewership. The implications of this interdisciplinary medium expand beyond art history and the history of the book — to the ephemeral tools of early modem propaganda, science and medicine. Interactive and sculptural prints assumed many roles: as surrogates for devotional objects; as dissectable models of anatomies both normal and deformed by religion; as scientific instruments for personal experimentation; as lavish, yet functional book illustrations and artworks for noble and humanistic patrons; and finally as moralizing emblems in *Stammbucher*. The latter led to the trivialization of the genre and its ultimate use as pop-ups in children's literature (Karr Schmidt 2006, 1);
>
> It demonstrates that prints represent, enable, and work to produce knowledge, and that the printmakers thematized this work in the prints themselves (Dackerman 2011, 20).

Two examples: edible devotional images and paper instruments. The first were sheets printed with religious images and cut into small pieces, dissolved in the mouth and swallowed (almost like a host) for superstitious or propitiatory purposes (the so-called "santini eduli" or *Schluckbildchen*)[40]; or, accompanied by short devotional texts (*Brevert*), used as talismans and kept in lucky charms or folded into small sachet sometimes containing medicinal herbs.

[40] http://www.bilderlernen.at/anekdoten/schluckbilder.html.

Image 4 Example of a Breverl.

The second type included that kind of print which, when cut out, assembled and glued mainly to wooden supports could be turned into three-dimensional objects: astronomic instruments (sundials, astrolabes, sun clocks, etc.) or terrestrial or celestial globes (by assembly the individual segments).[41] *Fugitive sheets* were highly popular: they were put on display at fairs, public baths, in taverns or improvised temporary stalls set up by barber-physicians, and the flap mechanisms offered insight into the human body or challenged the prudishness or polemic spirit of onlookers. By lifting the flap, you could look under a lady's skirt (sometimes with the bitter surprise of discovering a skeleton) or beneath the garments of a public figure, then revealed with a different semblance (such as the pope who became the devil). And thus, playfully, the *nosce te ipsum* became a menacing *memento mori*.

[41] "The earliest surviving Niimberg globe, by Martin Behaim from 1492 also consists of ovoid strips of parchment drawn upon and painted after being glued to a wooden core" (Karr Schmidt 2006, 228).

As we have seen, the rhetoric and discursive power of the image not only challenges the bibliographical confines of the book, but also represents an iconic and visual mode of thought, educating the reader to tackle complex and non-canonic forms of text demanding his interaction and skill as a *bricoleur*. It also reveals a highly ingenious, dynamic, elastic, multifaceted material culture capable of transcending the two-dimensional surface of the page and opening new spaces for communication, new codes, new "forms of expression". The technical ingenuity of paper flaps in fact demanded a full command of the graphic arts and extensive experience in three-dimensional design: without recourse to the expedient of optical illusion, sculptural paper shapes had to be created that communicated the sense of movement as well as depth. Not by chance, the greatest designers of paper instruments were also experts in the art of graphics and printing. In this sense the example offered by Sten Lindberg is significant: it refers to an English edition (1570) of the Euclidian *Elementi di geometria* (Euclide 1570), in which, in order to explain and concretely demonstrate solid geometry to the reader, the printer John Day invented one of the first pop-up books (Lindberg 1979, 71). Tackling some unique technical difficulties, John Day (with the help of translator and curator Henry Billingsley) designed and printed the polyhedra directly on the flaps, which once opened revealed the three-dimensional[42] appearance of the solids.[43] Thus

[42] http://www.astronomicalimages.group.cam.ac.uk/database/detailed/File1174.jpg.

[43] Henry Billingsley wrote in his explanation of pyramids: "Although the figure of a Pyramis cannot be well expressed in a playne superficies, … And yet that the reader may more clerely see the forme of a Pyramis, I have here set two sundry Pyramids which will appeare bodilike, if ye erecte the papers wherein are drawen the triangular sides of eche Pyramis, in such sort that the pointes of the angles F of ech triangle may in every Pyramis concurre in one point, and make a solide angle": one of which hath to his base a fower sided figure, and the other a five sided figure" (University of Cambridge, Astronomical Images. "Diagrams, Figures, and the Transformation of Astronomy, 1450-1650").

the reader could better understand some complex mathematical concepts by viewing both forms (two- and three-dimensional).

Children's books. Paper engineers

From the late 18th century, a specific publishing field devoted to children's books began to flourish. In the immediately preceding centuries, with the exception of specifically popular literature, the so-called *chapbooks*,[44] the only text to have made history was *Orbis sensualium pictus* (1657) by the Czech philosopher and pedagogist Jan Amos Komenskỳ (1592-1670), better known by his Latinised name Comenius. "The first book, apart from alphabets and catechisms, to have been written expressly for children" (Haining 1979, 6), *Orbis*, used for over two centuries as a school text, was a small encyclopaedia of elementary knowledge, a "compendium" in which the images perform the essential function of supporting learning (Farné 2002). Two skilled and enterprising English publishers and book sellers, John Newbery (1713-1767) and Robert Sayer (1725-1794), had the task of introducing that very successful literary and editorial genre, the children's book, paving the way for a new book-selling business which met with huge commercial success in just a very short time. If it is true that "nuovi lettori producono nuovi testi" (McKenzie 1995, V), this pair understood and welcomed the demand from a new segment of readers, implementing a simple yet, for the time revolutionary pedagogical idea based on the enhancement of the ludic dimension of learning processes. While the first produced finely-bound, illustrated short stories, the second invented a type of animated book that he defined *metamorphoses books*. Exploiting the flap technique, Sayer created a simple and effective mechanism: the illustrations, generally accompanied by a short text in rhyme,

[44] Booklets of just a few pages, roughly illustrated and narrating mostly medieval tales.

were printed on a single sheet, then folded perpendicularly in four parts so that two images were overlapping; a horizontal cut then divided the upper image into two equal halves. Thus, lifting the two halves, it was possible to see the image below, which was previously hidden from sight. These books are better known by the term *harlequinade*,[45] because their success was ordained by the type of stories told (taken mostly from the commedia dell'arte) and their characters, including the absolute star, Harlequin. "The Harlequinade, or turn-up book, was the first printed item to be produced for young readers which can be fairly described as a movable" (Haining 1979, 11). The popularity of harlequinades, which combined the charm of illustrated books with the ludic dimension of the toy, lay mainly in their complex technical representation combining words, images and movement, based on the combinatory mechanism of the flaps. Like a theatrical canovaccio, the text allowed the reader to improvise, as both narrator and actor, changing the scene almost like a proto-scenographer of the performance. In terms of narrative logic, the harlequinade anticipated the cardboard theatres and theatre-books of the late 19th century, which required a more sophisticated command of paper engineering and the use of different mechanical devices. We have to wait a few more decades to see the first pioneering attempts which were translated into the conscious choice of a publishing house, Dean & Son[46] which, from the mid-19th century focused on the production and sale of toy-books,[47] "in which characters can be made to move and act in accordance with the incidents described in each story", as they announced in 1860, when self-proclaiming themselves as

[45] http://blogs.bodleian.ox.ac.uk/theconveyor/files/2008/05/metamorphoses.jpg.
[46] The company was founded by Thomas Dean. From the late 1850s onwards the Deans printed over two hundred book titles, all in the same format and with the same price (six pence).
[47] http://www.metmuseum.org/collection/the-collection-online/search/349133.

"the originators of Children's movable books" (Haining 1979, 21). From that point on, ingenious creators of children's books, like the Germans Ernest Nister (1842-1909), Raphael Tuck (1821-1900), Lothar Meggendorfer (1847-1925), exploited their inventive skills in producing masterpieces of paper engineering (Whitton 1986). Authentic *paper engineers* (as they were defined using this lucky formula), these artist-publishers transformed the book into an enchanted toy, which opened before children's eyes like a magic trick that they themselves could control.[48] Books that were physically animated, like the stories they told, using levers, discs and pulls (*panorama picture*, *mechanical picture*, *revolving picture*), books which were transformed as they opened (*carousel book*, *theatre book, peep show* or *tunnel book*), or which opened to reveal surprising three-dimensional effects, and which were represented in the very successful era of the *pop-up* book.[49]

"Philosophical toys" and toy-books

This happy season for animated paper production and publishing would not have been possible if the 19th century had not assured the scientific inheritance of optical studies and vision sciences, applying them to the creation of a huge variety of optical

[48] On key paper engineers and the paper devices they invented, refer to the contribution of Mara Sarlatto, which is considered complementary to this article, also in this issue of JLIS.it.

[49] As we have seen until now, the ability to manipulate paper to create mechanical devices, used for a wide range of purposes, or the printing of shapes to be cut out, has an ancient, sacred and profane history. Alongside the production of cut-out sheets (playing cards, toy soldiers, dolls to dress up etc.), there was another devotional and religious area which included, in addition to those already mentioned, nativity scenes (with figures to by cut out and arranges in a small stage with side panels and backdrop) or, in the late 19th century, theatrical nativity scenes which, sold already mounted, came with simple movements offering a three-dimensional appearance, or were animated by strings and paper tabs (Gulli Grigioni and Pranzini 1995).

instruments and toys, precursors only a short time before the invention of brothers August and Louis Lumière (1895) (Mannoni and Pesenti Campagnoni 2009). The roots of this inheritance, that of the most visionary aspects of optical science, lie deep in the tradition of late Renaissance and above all 17th century studies, in line with the spirit of the period, with a clear "theatrical" lean for illusion and wonder. Optical toys, indeed "philosophical toys" (as they were later defined in Victorian times), built from a range of materials, including paper and cardboard, sometimes on wooden, glass or mirrored supports, the operating principles of which were also based on the phenomenon of the persistence of vision. In optical boxes, magic lanterns, catoptic theatres,[50] other visual devices with curious names, unveiling new sciences, such as the zoetropes, phenakistoscopes, stereoscopes (Biagi e Marconcini 2016), indeed it is here we must trace the mechanics underlying some of the expedients and effects of paper engineering and kinetic illusionism (Pesenti Campagnoni 2007).

[50] Catoptics is the part of optics which studies the phenomena of reflected light on mirrored surfaces.

Image 5 Lanterna magica © Comune di Roma – Sovraintendenza Beni Culturali – Ville e Parchi Storici.

Image 6 Zootropio © Comune di Roma – Sovraintendenza Beni Culturali – Ville e Parchi Storici.

Image 7 Fenachistoscopio © Comune di Roma – Sovraintendenza Beni Culturali – Ville e Parchi Storici.

Image 8 Stereoscopio © Comune di Roma – Sovraintendenza Beni Culturali – Ville e Parchi Storici.

The reasons for the success of the "marvellous visions" offered by these "industriose macchinette"[51], which change the values of size and perspective, alter the relationship between space of vision and space of representation, using catoptic effects and anamorphosis[52] to distort the projected images, where already envisaged in the hefty tome *Ars magna lucis et umbrae in decem libros (1645)* by the German Jesuit Athanasius Kircher (1602-1680) (Baltrušaitis 1969; Lo Sardo 2001).

Image 9 Giandomenico Tiepolo, Mondo novo (1791) Museo del Settecento veneziano Ca' Rezzonico di Venezia.

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[51] The definition of "industriosa macchinetta", referring particularly to the cosmorama (an "optical box" used to view enlarged panoramic images with relief effects), can be found in the "ottava rima" composition, *Il mondo novo* (1760 ca.), by Italian playwright Carlo Goldoni: "E mentre anch'egli il suo signore aspetta, / Che ritorni alla Patria dal Levante, / Per divertir la santa giovanetta / E le amabili sue compagne sante, / Forma un'industriosa macchinetta, / Che mostra all'occhio maraviglie tante, / Ed in virtù degli ottici cristalli, / Anche le mosche fa parer cavalli. // Di tai lavori ne veggiam sovente / Moltiplicar dagl'inventori in Piazza, / E in specie il carnoval corre la gente / Ad essi intorno, e per vederli impazza. / Suonar tamburi, e schiamazzar si sente, / E con un soldo si trastulla, e guazza, / E si vedon battaglie e ambasciatori / E regate, e regine, e imperatori// Queste macchine, dette volgarmente/ Il Mondo novo, mostran dell'ingegno […]" (Goldoni 1955, 689-690). An effective pictorial representation of the *mondo novo* can be seen in a famous fresco (1791) by Giandomenico Tiepolo, now housed in the Museo del Settecento veneziano Ca' Rezzonico in Venice.

[52] Anamorphosis is a "tipo di rappresentazione pittorica realizzata secondo una deformazione prospettica che ne consente la giusta visione da un unico punto di vista (risultando invece deformata e incomprensibile se osservata da altre posizioni)" (Dizionario online, in Treccani. La cultura italiana).

While the monocular and the microscope were used to see beyond the natural limits of the human eye, these machines of illusion and their artificial effects (widely described, after Kircher, for more than two centuries) allow audiences thirsty for stupefying images to see the "non-existent" or the "unknown". Indeed, some of the ingenious visual and knowledge experiences find a place - and this is of great importance - in the form of books: a manageable and familiar structure, able to bend and adapt to different uses from the usual ones. Thus based on the model of a travelling entertainment instrument, like *peep show books* or *tunnel books*[53] which, opening in a bellow-shape, have a hole through which the viewer looks at the images arranged one after the other, giving the illusion of depth; *flip*[54] or *flick*[55] *books* which, by rapidly flicking through the sequence of pictures on the pages, demonstrated how a succession of static images could offer the illusion of a subject in motion; or again books and prints exploiting dissolving effects and transparency.[56]

[53] https://www.flickr.com/photos/smithsonianlibraries/4554202783/in/photostream.

[54] http://www.flipbook.info/videos/haik.htm.

[55] http://www.flipbook.info/videos/weetman.htm.

[56] One interesting example of playing cards is offered by the *movable Biedermeier cards*.

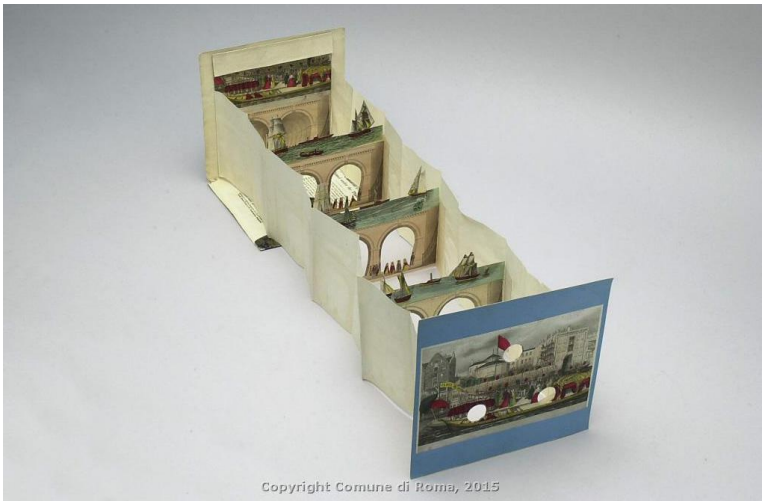

Image 10 Scatola prospettica © Comune di Roma – Sovraintendenza Beni Culturali – Ville e Parchi Storici.

Books and papers often with no text, books to look at, which when opened become scenographic theatre settings, books which have not just readers but spectators, seduced by the magnetic attraction for the view of exotic places and landscapes and for those "tricks" of perception that can no longer be catalogued as magic. We know and learn not only by "reading" or "doing" (i.e. using, as we have seen, flaps and volvellae) but simply by "seeing". In particular, along with children's books the idea that an object could be both book and toy began to spread: "la scoperta del gioco quale forma educativa si riverbera sull'impianto dei libri" (Chiosso 2010, 209). And readers, young readers no longer simply read, or rather, are not merely bound by the act of reading, but through reading can interpret other roles: magician, player, prophet or showman, depending on the type of book-object in hand. These characteristics are emphasised in the toy book, and particularly in the pop-up, the use of which involves a ludic and creative aspect: the reader is called on to bring the narrated story alive, transforming the book into a story-

telling toy. This theatrical staging of the book once again becomes functional to the tactile comprehension of the written word, thus reconfirming the original vocation of the animated book, that of being a complementary instrument of knowledge and education. Indeed, the "i primi anni del nuovo secolo vedono la nascita di diversi libri tecnici con parti mobili [per rendere] meno ostica e più accattivante una materia apparentemente arida come la tecnologia delle macchine" (Franchi 1998, 51).

The mobility of the book, the mobility of the text: the Futurist book

The technical complexity of modern animated books (which are unique pieces, assembled individually by hand even though they are printed in series) can be found in the 20th century "artists' book", which made its mark as an independent form of artistic expression, with a precise, formal statute,[57] however expressed in a wide variety of different materials and expressive forms (Caproni 2003). Moreover, it is well known that the book-format was used as a vehicle for the most significant artistic phase of the 20th century in which it was used, that of Futurism, which aimed to radically destructure its form. This movement saw the intense experimentation of expressive languages, affecting all arts and with a lasting impact that was to continue until the Neo-Avant-Garde of the 20th century. And yet, while Marinetti (1876-1944) announced the death of the book, a "passatista" symbol of the *ancien régime* by now superseded by the new media (the radio, the phonograph and cinematography), he could not do without the book itself to state and disseminate the poetics of the group, to conduct his "rivoluzione tipografica".[58] Compared to the

[57] The "artists' book" is a work of art in the form of a book.

[58] Dopo la liberazione delle parole, subentra l'emancipazione della lettera: viene così inaugurata una 'tipografia oggettuale', che apre la strada alla poesia postlinguistica, trasmettendo un lascito di vitale importanza alle recenti

graphism and calligrams[59] of "figurative poetry" and poetic-visual practices (Pozzi 1981; Pozzi 1984; Bartezzaghi 2010; Sbrilli and De Pirro 2010), the Futurists aimed to subvert the canons of poetic writing and its iconic representation, proposing a plastic and anti-conventional use of characters and inks, transforming the page into a dynamic space of phonetic and semantic forces and counter-forces (Caproni 1994; Salaris 2001b). The act of reading was thus thwarted, replaced by the gesture of performance, demanding the full physical involvement of the recipient of the work and the over-dramatisation of the declamatory act. The text thus unfolds like a musical score, the notes of which are expressed by the iconic function of the words, no longer mere symbols but also images. The typographical significant amplifies the poetic meaning and, in turn, the poetic message is typographically crushed within a plurality and multitude of expressive codes. The next step thus becomes the passage from "tavole parolibere" to the more daring experiments of book materials and the creation of object-books. We may think only of *Depero futurista* (1927)[60], one of the greatest expressions of Marinetti's "rivoluzione tipografica" and avant-

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neoavanguardie. I libri di Marinetti e le prime 'tavole parolibere' pubblicate da "Lacerba" rappresentano gli incunaboli di un'intensa attività sperimentale che investe il movimento futurista, ma in cui sono coinvolte anche altre avanguardie. Infatti con il 'paroliberismo' incomincia la tradizione del nuovo, che comprende i calligrammi di Guillaume Apollinaire, il simultaneismo di Blaise Cendrars, la lingua transmentale 'zaum' e le elaborazioni tipografiche dei futuristi russi, da Vasilij Kamenskij a Il'ja Zdanevic, la poesia fonetica di Hugo Ball, quella rumorista di Pierre Albert-Birot e Tristan Tzara, i collages verbali di Kurt Schwitters, le costruzioni di lettere di Theo van Doesburg, gli ideogrammi di Ezra Pound, le libertà tipografiche di E.E. Cummings, e infine, nel nostro dopoguerra, il lettrismo e la poesia 'concreta' e 'visiva'" (Salaris 2001a, 8).

[59] The word was used as the title of a collection of poems (*Calligrammes*, 1918) by Guillaume Apollinaire.

[60] https://www.youtube.com/watch?v=Eldwq-4PRRA.

garde publishing, for its variety of graphic and technical solutions, upturning the canons of the printed book, and for the amazing "rilegatura dinamo", created by publisher Fedele Azari using nuts, split pins and bolts: and authentic challenge to the sophistication of the decorations and materials used in the ancient art of book binding.

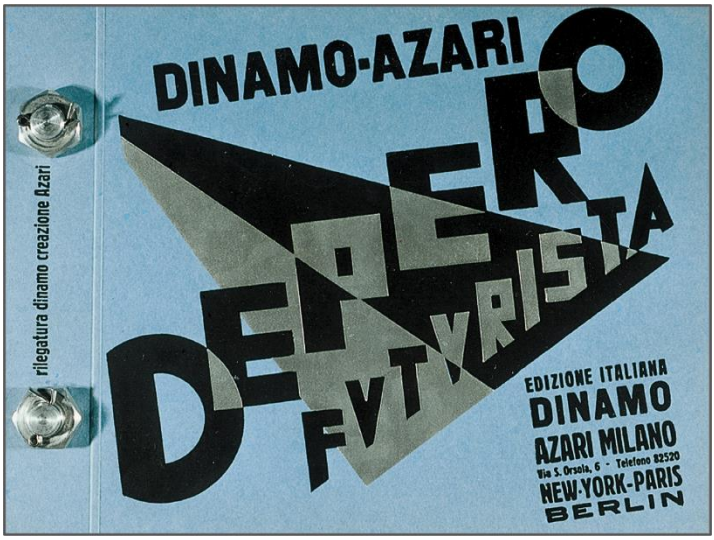

Image 11 Fortunato Depero, Depero futurista (Milano 1927).

Without forgetting the litho-tin books of the 1930s (the famous "litolatte")[61] and other object-books, the result of assembling multi-material structures (which were experimented by the Russian Cubo-Futurists at the same time), and Fortunato Depero's designed (but never produced) disc-books (1892-1960). Futurism thus introduced a concept of interaction with books that was very different from that examined until now: no longer with its movable elements and devices (volvellae and flaps) nor with the sculptural structure seen when opening the book (as

[61] http://web.tiscali.it/samarchivia/Litolatta/scheda.htm.

found in pop-ups). Here, the interaction concerns both the text and the support; that is to say, the destructuring of the book coincides with the destructuring of the text. The visual-verbal structure of Futurist "paroliberismo" in fact demolishes the idea of illustration, understood conventionally as the accompaniment to the text, and promotes writing to an absolute iconic value, a total communication system.

From Bruno Munari's unreadable books to the disarticulation of the text

Various avant-garde movements, and a current of ludic and imaginative graphic wave which included Bruno Munari (1907-1998) as one of its greatest members, were to use Futurist linguistic and aesthetic codes and experiment the semiotic potential of techniques and materials other than printing.

> Un modo per azzerare la comunicabilità del libro legata alle parole stampate sulle proprie pagine è di renderlo illeggibile, fenomeno che di per sé lo trasforma da luogo per eccellenza di trasmissione delle idee e delle esperienze umane in un oggetto dalla forma bizzarra, in un ossimoro estetico; le tecniche per attuare questo sadico proposito sono diverse: si va dalla cancellazione di un testo esistente alla sottrazione dello spazio dedicato alla stampa lasciando solo i margini bianchi delle pagine; dall'uso di grafie incomprensibili, enigmatiche alla raffigurazione del linguaggio con elementi materici quali filo di cotone, frammenti di legno, piume, ecc., e ad altre modalità ancora, basate sul gioco di parole o su operazioni di tipo concettuale (Albani 2007; see also Albani 2013).

For the first time in 1949 Munari designed a series of "unreadable books", works which ultimately renounced textual communication in favour of visual and tactile communication, by

way of the paper, its shape, colour, thickness, transparency, the presence of textures and cuts, etc.

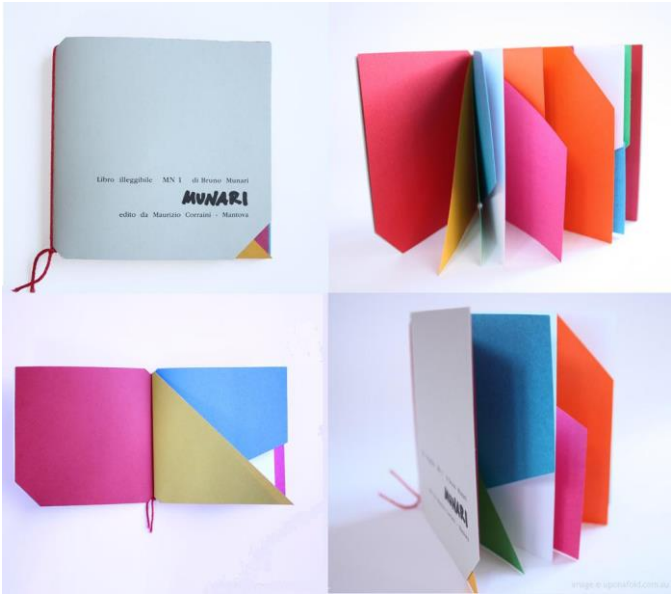

Image 12 Bruno Munari, *Libri illeggibili* (Mantova 1984).

The paratextual elements of the traditional book are omitted (colophon and title page) going as far as thwarting the text, the book's *raison d'etre*, confined in this new oxymoronic nature. Un libro illeggibile si può usare aprendo le pagine a caso, cominciando dove si vuole, andare avanti e tornare indietro, per comporre e scomporre ogni possibile combinazione (Munari 1993, 222). An unreadable book does not transmit words and thoughts, it communicates itself. And mobility is no longer constituted by the presence of mechanical elements but rather by the matter and form in which the book is built and created, by its iconic syntax which offers a new method of reading, based on the learning of a visual lexicon made of symbols and sensations.

Following on the trail of these experiences, in the 1970s some experiments in conceptual art were conducted, deleting parts of books, adding symbolic cuts, combinations and collages and other deconstructive acts, often aiming to provocatively give words and images new meaning, restoring the meaning lost in a now commoditised reality. Similarly, the text itself, its semantic organisation in a coherent, linear structure, its identity as an organism equipped with meaning and therefore readable and interpretable, is also radically destructured. From this moment onwards, the disarticulation of the book-form became functional to the most extreme avant-garde experiments, acting on the verbal and iconic significants to delegitimise the meaning of the literary language and the communicative codes of the art. Radically removed from its original function, the book-form is no longer the "magic box" of which many ingenious variants were known but rather becomes the pretentious and artificial container of manipulation and performance, the object and target of which is the "form of content" of the text and its linguistic expression.

The cut-up technique: Tristan Tzara and William Burroughs

Closely following the Futurist experience, Tristan Tzara (1896-1963) proposed his poetic 'dada' of destruction in *Manifeste sur l'amour faible et l'amour amer* (1920)[62]:

> Prenez un journal. Prenez des ciseaux. Choisissez dans ce journal un article ayant la longueur que vous comptez donner à votre poème. Découpez l'article. Découpez ensuite avec soin chacun des mots qui forment cet article et mettez-le dans un sac. Agitez doucement. Sortez

[62] Tzara read his manifest on 12 December 1920 at the Galerie La Cible Povolozki, on the occasion of a personal exhibition of Picabia, and was later published in the journal "La vie des lettres".

> ensuite chaque coupure l'une après l'autre dans l'ordre où elles ont quitté le sac. Copiez consciencieusement. Le poème vous ressemblera […].

Thus the mobility of the book becomes the extreme mobility of a text in its creation, yet equal to itself, because its author is pulverised in the infinite combinations offered by chance to its improvised poet. In the late 1950s, this principle was returned to by the US author William S. Burroughs (1914-1997) and the English artist Brion Gysin (1916-1986), with the literary technique of *cut-up*, which consisted in the cutting up of their own works or those of others into fragments of words, mixed together and randomly recomposed in a new text. The mobility of the text is the mobility of language, and becomes a literary language when, freed of pre-set codes, is realised in the extemporaneity of association. Thus doing, Burroughs goes further than Tzara: literature can only be generated from other literature, and its product is a collage that requires the author and the reader/spectator to compose - one materially, the other mentally - the logic of the text.

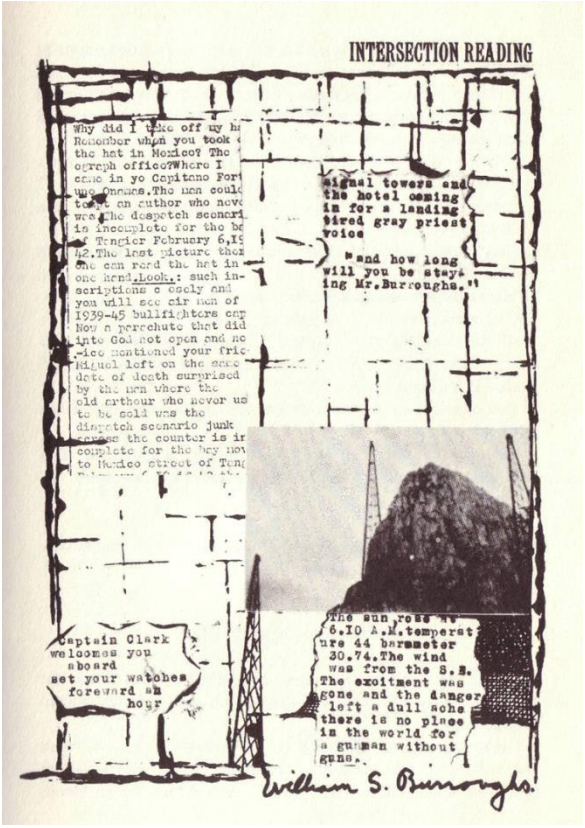

Image 13 A page from *The Third Mind* by William Burroughs e Brion Gysin (New York 1978).

Grangerizing e scrapbooking

Alternatively, there is another way, another more ancient manner of producing a text in which the author is the reader. This technique was described by John Locke in his work *A New Method of a Common Place Book* (1706), and involved the ordered collection of a great variety of texts in a notebook (medical prescriptions, quotations, letters, poems, proverbs, prayers, etc.). The texts were decomposed into fragments, and then

reassembled, and keeping a trace of his own readings the reader constructed his own book (Darnton 2011): memories, everyday graffiti destined to be continuously composed and recomposed in a sort of repository of interiorness, a topography of the heart. Between the 18th and 19th centuries this procedure was recovered in the art of *grangerizing*, a technique of visually adding to a text by taking images from other books.[63] "Grangerizing specifies a deliberate attempt to augment or rewrite a text via images. […] Grangerizers freely cannibalized other books to find the best images for their chosen text" (Visconti 2012). This practice was for the upper classes, and - as can be seen - produced new, unique works, as precious as artists' books.[64]

[63] The term originates from James Granger (1723–1776), an English preacher, biographer and print collector; in 1775 Granger published a history book in England, leaving some pages blank at the end of the book. These pages were destined to contain *memorabilia* added by the book owner, who was thus able to customise his own copy of the book. Between 27 July and 28 October 2013, at the Huntington Library in San Marino, in the county of Los Angeles, an exhibition was held on this type of book: Illuminated palace: Extra-illustrated Books in the Huntington Library.

[64] The evolution of this bibliographical genre, also in a more specifically artistic key, was recorded above all in the 1900s with the art of scrapbooking, using and assembling poor materials from different sources, and even more recently with digital applications. "Scrapbooking is the process of making completely new books by pasting blank pages with newspaper columns, obituaries, advertisements, drawings, and other images that the maker for some reason wished to preserve. Scrapbooks could be thematic or miscellaneous, rather like an image-inclusive version of the old technique of common-placing" (Visconti 2012).

Image 14 Anthony, Count Hamilton, Mémoires du comte de Grammont (London 1794) © The Huntington Library, Art Collections, and Botanical Gardens.[65]

One paradigmatic example, half way between the *scrapbook*, meta-narrative fiction and more daring editorial experimentation, is the recent novel *Ship of Theseus* written jointly by two authors Doug Dorst and Jeffrey Jacob Abrams, more famous for directing hit television series such as *Felicity* and *Lost* (Abrahms and Dorst 2013). *Ship of Theseus* is formally an imaginary novel written by a fictitious novelist, V. M. Straka, published posthumously in 1949, edited by an equally imaginary scholar and translator named F. X. Caldeira. The book is presented in a black cardboard slip case printed with some paratextual elements (synopsis, names of the authors and publisher). Compared to the meta-book, thus

[65] http://www.huntington.org/WebAssets/Templates/content.aspx?id=14386.

represented by the slip case, the book has all the characteristics of a vintage book, its pages aged and yellowed, a label on the spine indicating that it came from a library, with the check-out card printed inside the back cover. Moreover, the pages are filled with fictitious hand-written notes in pencil or different coloured pen, added by two students, Eric and Jen, who exchange the book in an attempt to discover the identity of the author and the characters of the novel. This thick set of notes (which in itself is a parallel narrative plot to the story) is integrated by a huge quantity of inserts, in the form of post-its, newspaper cuttings, postcards, letters and other memorabilia.

Image 15 Abrahms, Doug Dorst, La nave di Teseo di V. M. Straka (Milano 2014 [2013]).

The book is therefore a maze of parallel stories that weave through different time frames and challenge the reader in a multilinear reading, forcing him into a philological interpretation and reconstruction of the various autographies. Moreover, depending on their type, the many inserts force the reader to

interact with the text not only on a conceptual, hypertextual level, but also on a material level, through the voyeuristic gesture of ploughing through visual and textual objects belonging to the lives of others. If it was not for the fact that that gesture (deemed exclusive by each reader) is infinitely multiplied by the number of potential readers and is an integral part of the narrative fiction. A fiction that extends into the editorial and paper engineering marvels of serial reproduction of a product which simulates an ideal pre-digital world in the variety of supports and images used, provokingly declaring the irreplaceable physical nature of the book. Upstream from this lies the question whether a text remains such after the act of reading, after its physical and intellectual manipulation by the reader. This question, which lies at the heart of this complex bibliographical and literary machine, is implicit in the very title, which allusively refers to the famous "philosophical paradox of the ship of Theseus"[66] on the identity of things over time, on their persistence when they become something else.

Combinatorial machines: from Caramuel to Raymond Queneau

Taking a step backwards (a "false step", which in fact will take us even further forwards), we have seen how from the time of Ramon Llull, creating special devices the potential of computational mechanics has been investigated for its complex

[66] The ship of Theseus is mentioned in Plutarch's *Lives*: "The ship on which Theseus sailed with the youth and returned in safety, the thirty-oared galley, was preserved by the Athenians down to the time of Demetrius Phalereus. They took away the old timbers from time to time, and put new and sound ones in their places, so that the vessel became a standing illustration for the philosophers in the mooted question of growth, some declaring that it remained the same, others that it was not the same vessel" (Plutarch, *Lives*, Theseus, 23, 1).

processes of logical and linguistic combination, the latter used above all to create cryptographic systems. Indeed, the combinatorial nature of linguistic elements has been used experimentally also to generate new texts starting from given elements. As is well know, this procedure lay at the heart of the poetics of Italo Calvino and the theory of literature developed by the group of Ou.Li.Po (Ouvroir de Littérature Potentielle), which we will return to shortly. Among the important names of the 17th century, a particularly rich century for the study and use of combinatorial and ludic forms, above all in the texts of Cabalist tradition, is that of the humanist Juan Caramuel y Lobkowitz (1606-1682), author of many works running from theology to linguistics, from mathematics to astronom.[67] In particular, in *Metametrica*, a masterpiece of "enigmistica testuale e figurativa" (Bartezzaghi, 2007), Caramuel offers a representation of the textual structure in terms of two- and three-dimensional figures, from mazes to "cubic poems". The chapters of *Metametrica* are preceded by tables consisting of discs, which when rotated combine different elements of a sentence, or by mazes of words which highlight some letters, arranged in an orderly, symmetrical fashion, allowing the message to be read starting from different directions. As the message is sometimes in the form of a palindrome, the number of possible readings is doubled. Caramuel also designed a literary machine, a cylindrical instrument in which four nouns, four adjectives, four verbs and four other nouns are inscribed: by separately rotating the different elements 4^4 (=two hundred and fiftysix) complete sentences are obtained.

[67] Giovanni Pozzi's studies (Pozzi 1981) led to the discovery of Caramuel and his importance in the history of the *carmina figurata*.

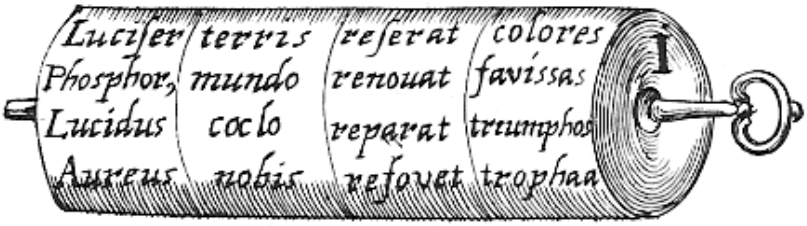

Image 16 Juan Caramuel y Lobkowitz, Combinatory cylinder.

This ingenious polygraph also engaged in "estenuanti conteggi del numero di permutazioni consentite da una certa combinatoria, nel numero di volumi necessario per trascriverle, nell'ampiezza della biblioteca necessaria per contenerle, nel numero di secoli necessario per leggerle, fino al costo di stampa di una simile edizione" (Bartezzaghi 2007). This combinatoric process lies at the base of author Raymond Queneau's (1903-1976) poetic experimentation in 1961 in *Cent mille milliards de poèmes* (Queneau 1961), a collection of sonnets with the same rhyme scheme and a grammatical structure such that every line of every sonnet can be combined with every other line in the same position. The pages of the book consist of a series of separated strips of paper, each printed with a line of a sonnet, so that by lifting the strips as they wish the readers can create their own personal sonnet.

Image 17 Raymond Queneau, *Cent mille milliards de poèmes* (Paris 1961).

For each line there are ten possible independent choices, and as there are fourteen lines in each sonnet there are 10^{14} possible combinations and therefore 10^{14} sonnets[68]. The work does not set a predefined order of the verses, but arranges their combinations according to formal processes. The composition is thus not read but played, and the reader is called on to interact with the text, constructing the meaning by manipulating a reading device, used to disassemble and reassemble the book following the rules of the game given by the author. In this way, what is offered by this literature is not so much a literary product but rather a production method, a literary object half way between work and

[68] "Calcolando 45" per leggere un sonetto e 15" per cambiare la disposizione delle striscioline, per otto ore al giorno e duecento giorni all'anno, se ne ha per più di un milione di secoli di lettura. Oppure, leggendo tutta la giornata per 365 giorni l'anno, si arriva a 190.258.751 anni più qualche spicciolo (senza calcolare gli anni bisestili e altri dettagli) (Queneau 1981, 50-51).

structure. This experiment thus involves techniques for decomposing and disarticulating the text, making it very similar to those of toy-books, requiring a high level of reader interaction. This is all the more true for the fact that Queneau himself stated that his inspiration for the work came from an interactive children's book more than from the literary games proposed by the Surrealists:

> C'est plus inspiré par le livre pour enfants intitulé Têtes de Rechange que par les jeux surréalistes du genre Cadavre esquis que j'ai conçu – et réalisé – ce petit ouvrage qui à tout un chacun de composer à volonté cent mille milliards de sonnets, tous réguliers bien entendu (Queneau 1961, Mode d'emploi).[69]

Moreover, the book included some instructions explaining to the reader how to read the text, in contrast to what already seen in some older works in which the instructions concerned the operation of the mechanical devices. Because now the machine is the text itself, and the act of reading coincides with its setting in motion: an arbitrary gesture of the reader.

[69] The children's book Queneau referred to was called *Têtes folles* (1948). The pages of the book are divided into three separated strips: the top strip has a drawing of a head, the centre strip the body and the bottom strip the legs; by flipping the strips, different combinations of figurines with different heads and clothes are produced (Albani 2007).

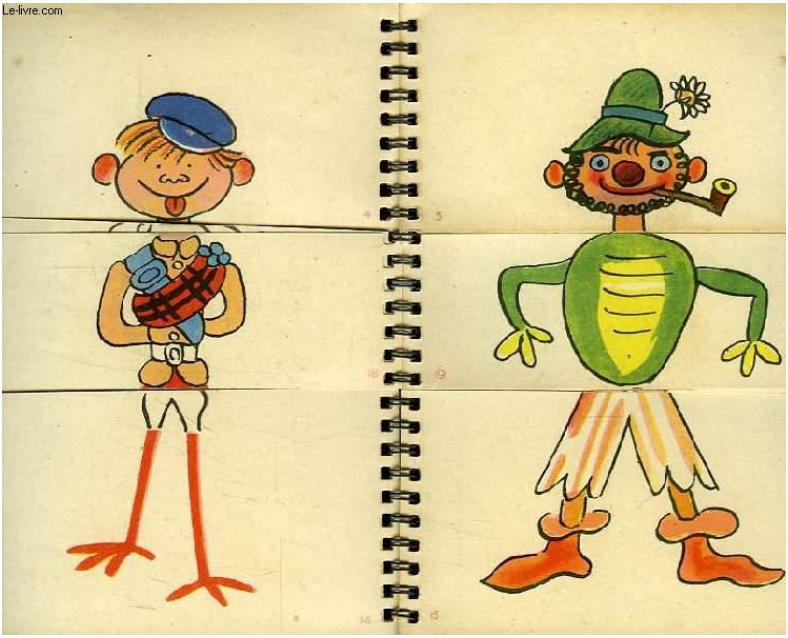

Image 18 Walter Trier, *Tetes folles* (Paris 1948).

The disarticulation of the text: Marc Saporta, Julio Cortázar, the Ou.Li.Po. movement

That random gesture is the same the reader is required to do with the novel *Composition n. 1* by Marc Saporta (1923-2009), released the following year. Here the mechanism is complicated even further, because the cover states that "si invita il lettore a mescolare queste pagine come un mazzo di carte. Se gli fa piacere, può anche alzarle con la sinistra, come si fa dalla cartomante. In ogni caso l'ordine in cui appariranno allora i diversi fogli determinerà il destino di X" (Saporta 1962). The reader may therefore decide which novel to read: the - unnumbered – one hundred and fifty pages are loose, physically separated from each other, printed only on one side and each one can be narratively linked to the previous or following sheets.

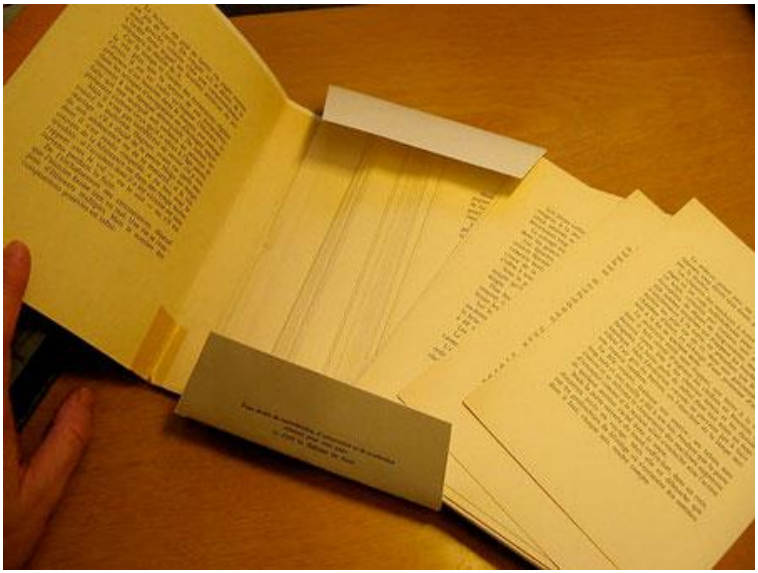

Image 19 Marc Saporta, *Composition no. 1* (Paris 1962).

And what's more, the fate of the characters, like that of the reader, is in the hands of the prophetic gesture he himself is called on to make ("a ciascuno il "suo" romanzo", as the cover slip recites). So there is not one single narrative order but rather a broad class of acceptable orders the reader can decide on, each with its own literary effect; as also happens in the novel *Rayuela* (1963) by Julio Cortázar (1914-1984) which offers a multitude of readings according to two possible structured paths, recommended by the author in the table of instructions.[70] The dates of composition of the novels of Queneau, Saporta, Cortázar, and the structural methods adopted by them, tell us something of the spirit of the time, a highly experimental artistic

[70] The novel *The life and opinions of Tristram Shandy, gentleman* by English novelist Laurence Sterne (1713-1768) is considered the forerunner of the breakage in linearity of narrative writing and reading.

season (that of the Neo-Avant-Garde) marked greatly by the desecration of languages and the destructuring of expressive forms and codes. And it was not by chance that in those years Queneau and writer François Le Lionnais (1901-1984) founded the Ou.Li.Po group (1960), which theorised on the use of a compositional constraint ("contrainte") to explore and experiment new possibilities of composition; according to this different concept of literature, the narrative game is a system of restrictions and therefore itself an exercise in creative freedom.[71] Finally, came the turn of "electronic literature" to experiment new textual mobility, new orders of reading and writing, starting from the experiments in hypertextual literature in the 1990s and the early 2000s. But that is another story. Our story ends here, offering readers an image of the "artificiosa" machine invented by Italian engineer Agostino Ramelli (1531-1608). A return to the book, therefore, re-evoking - despite its protean and changing nature - its most exclusive quality: that of being the most technologically efficient knowledge machine ever invented. At first glance, it would seem almost the image of a watermill, if it were not for the fact that its blades carry books, in their movement miming the mobility of associative thought: a rotating mechanism to "vedere e rivoltare una gran quantità di libri, senza moversi d'un luogo", a mill for the mind, which is after all also an ingenious hypertextual machine (Ramelli 1588).

[71] One of the most famous and difficult *contrainte* is the composition of a literary work omitting all the words in which a given letter appears. This mechanism, known as lipogram, was used by French author George Perec (1936-1982) who wrote the novel *La disparition* (1969) without ever using a word containing the letter "e".

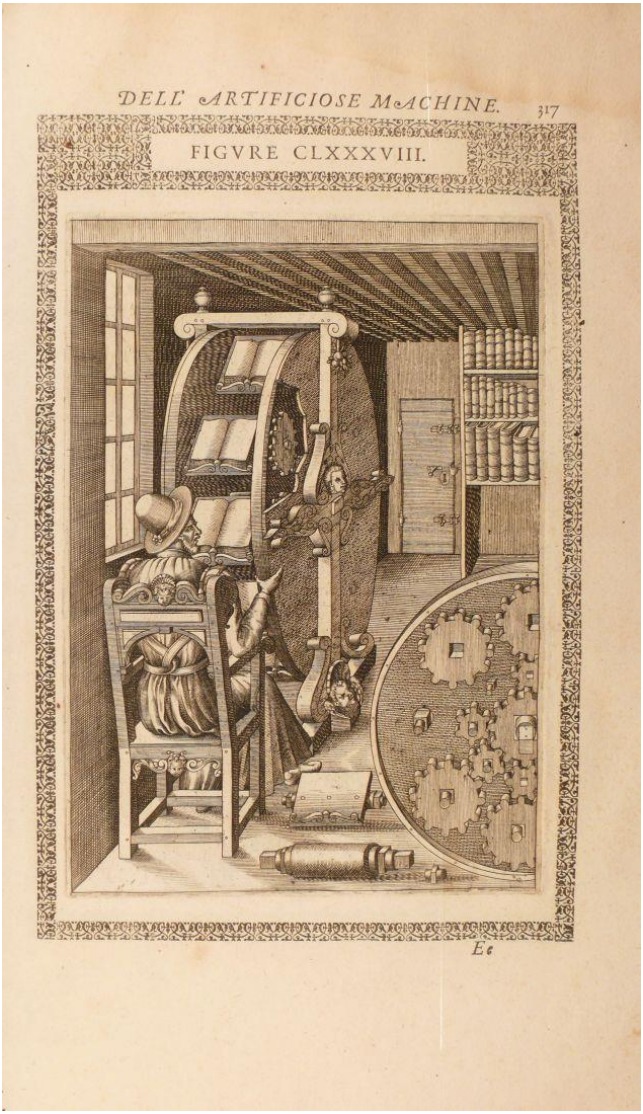

Image 20 Agostino Ramelli, *Le diverse et artificiose machine del Capitano Agostino Ramelli* (Parigi 1588).

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Crupi, G. "*Mirabili visioni*: from movable books to movable texts". *JLIS.it*. Vol. 7, n. 1 (January 2016): Art: #11611. DOI: 10.4403/jlis.it-11611.

ACKNOWLEDGMENT: Mine is not a formality but a sincere expression of gratitude: my thanks go to Emma Marconcini and Maria Cristina Biagi, those extraordinary custodians of the Roma Capitale Collection of antique toys, a unique collection that deserves being shown to the general public. Thanks to their generous courtesy and skill, I was able to see the "mirabili visioni" of the philosophical toys they curate so lovingly. My warmest thanks also go to collector and scholar of animated books, Pietro Franchi, who told me the fascinating story of some pop-up books and their imaginative creators with such erudite passion.

ABSTRACT: This contribution reconstructs the history of movable books, books created for a wide range of different purposes (teaching, mnemonics, play, divining, etc.) including mechanical or paratextual devices demanding or soliciting the interaction of the reader. The investigation runs from hand-written books to the most courageous paper-engineering experiments of the 20th century Avant-Garde, considering some specific editorial genres, including calendars, "libri di sorti", anatomical books, navigation handbooks etc., and animated children's books. In particular, it demonstrates how the happy season for animated paper production and publishing of the 19th century would not have been possible without the scientific inheritance of optical studies and vision sciences, precursors a short time before the invention of the Lumière brothers (1895). The study also examines some literary works using combinatorial mechanisms, experimenting the semiotic potential of expressive codes and very different techniques and materials: the reference is to books of Futurism and Dadaism, the "artists' book", and other avant-garde texts from the second half of the 20th century.

KEYWORDS: Movable books; Combinatory literature; Volvella; Anatomical flap books; Paper engineers.

Submitted: 2015-11-30

Accepted: 2015-11-30

Published: 2016-01-15

JLIS.it

Dipartimento SAGAS, Storia, Archeologia, Geografia, Arte e Spettacolo

con il supporto di: supported by:

Casalini libri

Le Lettere

La piattaforma ICT, lo sviluppo e la manutenzione dell'installazione di OJS che ospita JLIS.it sono forniti da:

ICT platform, developing and maintenance for the OJS installation hosting JLIS.it are provided by:

CINECA

Direttore Responsabile ai termini di legge: Nicola Cavalli

In attesa di iscrizione nel registro stampa del Tribunale di Milano.

Finito di stampare nel mese di gennaio 2016 da

Ledizioni
The Innovative LEDIpublishing Company

http://www.ledizioni.it