The kaleidoscopes applied to figurative arts: the genius of Paolo Anania de Luca

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Abstract: This work deals with a series of kaleidoscopes dating from the first half of the 19th century. They are preserved in the Museum of Physics of the University of Naples Federico II. The research began with their maker, Paolo Anania de Luca, who was not only a politician and a patriot but also a forgotten scientist, whose university education took place in Neapolitan athenaeum.
In Naples he grew up as a young man keen incredibly devoted to Science and, in particular, he cultivated his passion for Physics. Among the different studies he carried on, this work will focus on kaleidoscopes and their applications in craftsmanship.
Indeed, thanks to his work, the Kaleidoscopes became useful tools for the arts: infact all those who are devoted to the decoration used them to obtain an unfailing number of different and symmetrical sketches.
Based on the Kaleidoscope model thought up by Brewster, de Luca produced a series of them catalogued by orders, genres, species and varieties.
Following this study, he made a new instrument, called “Simmetrizzatore”, apt to replicate the same effects of every genus, species and variety of “special kaleidoscopes”.

Keywords: Kaleidoscope, Simmetrizzatore, de Luca Paolo Anania.

1. Paolo Anania de Luca

As a man who lived at the turn of the 18th century, Paolo Anania de Luca had a multifaceted personality who perfectly embodied the eclecticism of his time; over time he dealt with a multitude of different activities: he was a scholar, a scientist and a skilled mechanic as well as a political activist. Because of his political commitment in the Neapolitan Revolution in1799, he was condemned to the *damnatio memoriae* at the behest of the Bourbons.

He was born in Montefusco Irpino in 1778 and later moved to Naples where, according to his family’s wishes, he studied civil and canon law and followed the group led by Mario Pagano and Gaetano Filangieri. Firm supporter of freedom, he lived the fervour of the French Revolution which ultimately led to the expulsion of the Bourbons and the proclamation of the Parthenopean Republic. As a consequence of the defeat of the revolutionary ideals and the restoration of the monarchy by King Ferdinand IV, de Luca was arrested and sentenced to life imprisonment: initially transferred to the prison of Ventotene, he was later moved to Montefusco, where he witnesses the death of his brother Giovanni Pirro.

In 1800 he obtained the grace ensuing the amnesty granted by the Bourbons. Hence he returned to Naples and became head of the Ministry of the Interior of Naples.

In spite of the sufferings, the mournings, the disappointments and the privations de Luca didn't give up on politics and the dream of freedom: as an undeterred veteran, although old and sick, he openly stood up against Ferdinand II during the revolts of 1848 and thereupon suffered a violent aggression (Di Nunno 2012, pp. 1-5).

In his Neapolitan period, de Luca pursued the scientific career, notably as a physicist. He designed and made several instruments such as the tonometer and a particular type of plummet sound that not only allowed to detect depths of the sea, unthinkable for that time, but also to evaluate the direction of the marine currents. Focusing his research activities in the field of Optics, he designed and created several models of kaleidoscopes. For his scientific activities he was appointed "honorary professor" from the Minister of Education Francesco de Sanctis. However, due to his advanced age and blindness, de Luca declined the title and in gratitude he donated all his instruments to the University's Cabinet of Physics (Imbriani 1864, pp. 1-14).

He died on 26 January 1864 and was buried in the monumental cemetery of Naples; his memorial stone is covered in bas-reliefs depicting his inventions.

De Luca's inventions are to be considered brilliant long-sighted and daring works for the time. Despite being a renown scholar in the international scientific community, his creative genius was overshadowed in the homeland (Imbriani 1864, pp. 1-14).

2. Kaleidoscopes by Paolo Anania de Luca

> Data una superficie qualunque, abbellita con tratteggiamenti o rilievi, dati o non dati, in guisa che ne rimanga soddisfatto il gusto di chi la vede (de Luca 1837).

With these words de Luca expressed his conception of the art of decoration and he firmly believed that before performing any work, an artist should always sketch it out to verify that it complies with the aesthetic taste; he therefore claimed that an ideal automa would be an artist par exellence if it were able to provide an overview of all the sketches obtained from the infinite combinations of objects. De Luca envisaged the possibility for the kaleidoscope to become this "automa" and estimated its application in the arts and in the industry. He consequently undertook a scientific study and investigated a way to obtain sketches suitable for embellishing any kind of flat surface by the use of catoptric means; in 1837 he presented the first memory *Sul caleidoscopio e sua applicazione* to the "Accademia delle Scienze" in Naples where he thoroughly analysed the Brewster's kaleidoscope, represented as a cross-section in Fig. 1.

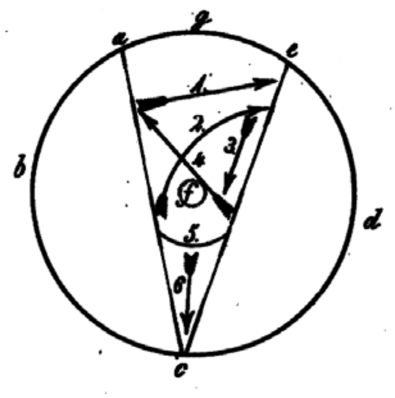

Fig. 1. Section of Brewster's Kaleidoscope.

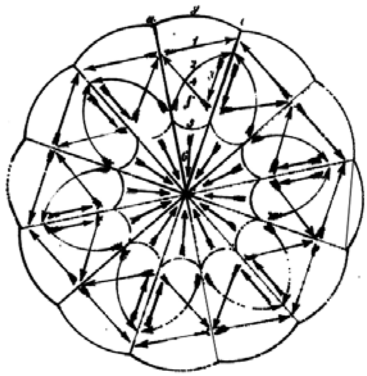

Fig. 2. Ornate images.

The figure shows the mirrors, forming a triangular mixtilinear based prismatic cavity *ace* and *f* indicates the point where the eyepiece hole falls, which "imprisons" the gaze in the prismatic cavity, and its extension, in which the object compartment is to be found. The numbers from 1 to 6 represent the images of the real objects placed in the kaleidoscope, observed in the prismatic cavity with the mirrors deprived of the reflecting power. By restoring mirrors' reflecting power, the visual completely changes and an optical illusion takes over on the real vision, leading to the vision of 12 symmetrical arranged images and 12 "ornate" as shown in Fig. 2.

Analysing the symmetries obtained as the angle between the mirrors changes according with the formula 360: *n*, de Luca identified Brewster's Kaleidoscope as one of many types of catoptric instruments, applicable to the arts. He indicated with the word "morphe" (form) the images and with "adelphos" (brother) the ornamentation obtained by reflection. If *n* is even, the kaleidoscope yields regular species characterized by a number of perfectly symmetrical images, so from *n* = 2, 4, 6 ... originate the species "bimorfa", "tetramorfa", "esamorfa", etc. Whereas if *n* = 3, 5, 7, it generates an asymmetrical image since the number of images produced is uneven, therefore the species "trimorfa", "pentamorfa", "eptamorfa" etc. are all irregular. Lastly if *n* is a fractional value it generates even more irregular species "iperbimorfa", "ipertetramorfa", "iperesamorfa", etc. inasmuch as fractions of non symmetrized images adds up to the whole not symmetrized image.

Depending upon the ways in which objects are presented to the mirrors, kaleidoscopes can be classified into three main genera: simple, compound and mechanical. With regard to the former, the objects are external to the kaleidoscope, which means they exist in the surrounding environment; in compound kaleidoscopes instead, tiny objects are placed in a small container enclosed in the instrument, whereas in mechanical kaleidoscopes a system consisting of two circles rotate in the same or the opposite direction via a system of pulleys. Once examined genera and species, de Luca investigated the varieties and their dependence on the geometry in which the symmetrical images are inscribed. From the law of symmetry he deduced that the only perfectly symmetrical figures are circular, elliptic or inscribed in such figures, as in the case of polygons and polypetals. The possible varieties are thus “circolari”, “ellittiche”, “poligone” and “polipetale”. In case the outline of these figures exhibits some mouldings, these moulding varieties should be taken into account and listed along with the already mentioned ones. As an element of variation in the figure and in the outline, de Luca introduced a “benderella”, namely a piece of cardboard (de Luca 1837, pp. 38-44; 101-106; 165-170).

Experimenting with the application of these kaleidoscopes to the arts, de Luca realized the factual impossibility of obtaining sketches to decorate hems and fabrics; he also understood that the exclusive attention he gave to the kaleidoscope of Brewster led him astray: consequently he revised and broadened his previous classification starting from a wide array of potential fields of application which he shall later use as classification criteria to design kaleidoscopes which could be usefully applied to the arts. The variables to which a field to be ornamented is subjected comprehend both the extension and the figure itself; therefore, according to the typology of the fields to be adorned de Luca identified three genera: the first genus, known as “determinato”, includes all the kaleidoscopes through which one can decorate a field circumscribed by a perimeter; the second genus or “semideterminato” is characterized by a field which can be inscribed between two indefinite parallel lines or between concentric circle portions. The third genus, known as “indeterminato” subsumes all the tools which allow to decorate fields without limits and therefore it is well suited to irregular surfaces. In the wake of the previous studies, de Luca analysed the modalities used by the artists to create symmetrical decorations within the fields and then deduced which species give rise to the symmetries. If a given field can be divided by an axis into two opposite but equal parts, it shall be regular, otherwise it shall be irregular. From this assumption, de Luca deduced that the only species that can be found in the genus “determinate” fields are those yielding symmetrical figures such as the “monadelfa”, the “diadelfa”, the “tetrafelfa” etc. As regards the case of a “semideterminato” field, symmetry occurs in the repetition of the images inscribed between two parallel lines or between two concentric curves; in the first case rectangular shapes are obtained whilst in the second case the shapes are cuneiforms. As far as the “indeterminato” fields are concerned, symmetry can be attained exclusively by creating a sort of reticulation with rectangular or triangular meshes within which the ornaments are repeated.

In 1842 in a second memory *Sul caledoscopio e sua applicazione*, de Luca presented to the “Academia delle scienze” a collection of self-built kaleidoscopes, characterized by the presence of two or more mirrors arranged in such a way as to obtain an apparent “determinate”, “semideterminato” and “indeterminato” field. The three orders corresponded to the genera of the first classification: simple, Brewster and mechanical. Each of these orders presents the three previously identified genera. The first is characterized by the presence of two plane mirrors arranged to form an 360:n angle, where n is an even number which determines the character of the species (e.g. n = 2: the species is “monodelfa”); the author made the first ten species. The distinctive traits of the second genus are two parallel mirrors or three mirrors arranged as the three sides of a rectangular prism, or two opposite non-parallel mirrors; in this case the species depend on the number and position of the mirrors and are respectively "rettilinea monodelfa", "rettilinea diadelfa" and "curvilinea". The third order has a peculiarity that is the combination of three or four mirrors to form a prismatic cavity, whose base's shape allows to discern the character of the: "diadelfa" (4 mirrors yielding a square or rectangular variety), "triadelfa" (3 mirrors arranged in equilateral triangle) "tetradelfa" (3 mirrors arranged as an isosceles triangle), "esadelfa" (3 mirrors arranged in a way to create an equilateral triangle at base; lacks variety). By using this classification, each genus admits a limited number of species and varieties which is however sufficient to adorn any kind of field presented to the artist (de Luca 1842, pp. 66-71).

Along these lines, de Luca defined the necessary conditions to be fulfilled by the universal kaleidoscope, which he already hypothesized in the first memory of 1837.

3. The Simmetrizzatore

On 5 March 1844, de Luca presented to the "Accademia delle scienze" a memory entitled *Del Simmetrizzatore considerato nella doppia qualità di Caleidoscopio universale e di strumento didascalico* with which he illustrated and described a new self-designed apparatus, the so called "Simmetrizzatore", initially conceived as a sort of "Pancaleidoscopio", with a dual function: as a didactic tool, useful as a guide to manufacture kaleidoscopes applicable to the ornamental arts as well as an universal kaleidoscope apt to replicate the same effects of every genus, species and variety of special kaleidoscopes. The main element is represented by the quadrangular camera obscura which contains four rectangular flat mirrors supported by metal reinforcements. Two mirrors are hinged by the longest side and connected to a pulley mechanism which not only allows them to simultaneously rotate with respect to the union axis but also enables the transition from a horizontal to a vertical position. One of the two perpendicular side of the camera obscura exhibits the eyepiece which is located at half of the radius of a semicircle with a double gradation, placed at the mirrors' union axis. Connected to the mirrors there are two indicators, called "vernieri", which move on the graduated measuring scale and indicate the angle between the two mirrors. Two additional mirrors are to be found within the camera obscura: the first is constantly kept in a vertical position and is parallel to the rotation axis of the two joined mirrors, whereas the second one moves upwards and downwards in a vertical rectilinear motion, remaining opposite and parallel to the first mirror. The "Simmetrizzatore" is provided with a fifth removable mirror that can be used to create some particular species of the "indeterminato" genus. The opposite side to the eyepiece exhibits the opaque crystal and a horizontal shutter that functions both as a "benderella" and a container. In the first case, it outlines the apparent field of the objects' images that are to be symmetrized and is called "benda". In the second case it accommodates the objects to be symmetrized which can be held in place by a screw. Subsequent to the description of the instrument, de Luca went further, explaining that in the case of a "determinate" field, all the species can be obtained with a variation of the angle between the hinged mirrors; he however stated that only those yielding regular images and therefore with even values of *n* (monodelfa, diadelfa, triadelfa, tetradelfa, etc.) are relevant to the purposes of the ornamentation art. In case that the field to be adorned is "semideterminato", the different distance between the opposite and parallel mirrors along with the variability of the inclination of the two opposite and oblique mirrors, yield all the possible second genus varieties ("rettilinea monodelfa", "rettilinea diadelfa" e "curvilinea"). With an "indeterminato" field, the square and rectangular varieties of the "diadelfe" species are obtained, after having arranged the four square mirrors, through the progressive movement of the third mirror. The "triadelfa" species in the equilateral triangular variety is obtained with the addition of a fifth mirror superimposed on the first and second ones inclined at 60°; the two remaining mirrors are darkened. The other species of the third genus ("tetradefa" and "esadelfa") are attained by combining three mirrors respectively arranged as isosceles rectangular triangle and as equilateral triangle with 60° or 30° angles.

The "Simmetrizzatore" is therefore a versatile instrument, able to reproduce the species and varieties of each of the three kaleidoscope orders. In the case of the first order, the objects to be symmetrized are fixed to the "benda"; in the second order the position and the objects' arrangement are left to chance through the use of a rotating box; in the third order the symmetry resulting from the moving objects is achieved by sliding the objects between the two sheets of the "benda" or by moving the "benda" itself along the grooves.

5. Conclusions

In his *Treatise on the Kaleidoscope*, Brewster (1819) didn't think of a purely recreational use of the instrument; being an optimistic Victorian scientist, his inventions aimed to be useful and improve the everyday life, with a particular regard to the decorative arts. Despite its public acclaim and success, the kaleidoscope is still regarded as having a predominant amusing function (Correia 2016, pp. 1-7).

Reports revealing the application of the kaleidoscope to the figurative arts came from the "Accademia delle belle arti" in Bologna where the illustrious professor of "ornato architettonico" (architectural decoration) Antonio Basoli

> Si avvide che, non che essere semplice trastullo, poteva detto Caleidoscopio tornare utilissimo per scompartimenti di soffitti e volte, per fregi da ricami, per intrecci d'inferriate da finestre, e servire non meno per la distribuzione di parterre o ajuole da giardino (Bosi 1834-36, pp. 103-108).

Basoli obtained five variants of the "Brewster kaleidoscope" using a black cardboard, varying the number of mirrors from a minimum of two to a maximum of four and changing their arrangement within the Kaleidoscope, alternately arranging them in parallel, perpendicularly or in such a way to form the angles of a pentagon or any other even-sided polygon. A study similar to the Basoli's one was carried out in Naples by Paolo Anania de Luca, whose initial intention was the application of the tool to the visual arts and industry, undertook a meticulous and original scientific research as witnessed by the words of the physicist and mathematician Ferdinando De Luca[1] in his report to the "Accademia delle scienze" on the work of the Irpinian scientist:

> Il lavoro del sig. Paolo Anania de Luca è uno di quei capi d'opera che fanno conoscere nell'autore una mente chiara, una perfetta cognizione della catottrica, e una certa ostinazione a vincere ogni ostacolo. Non sapremmo se lodarlo per lo servigio reso alle arti, o per la severità matematica, e la esattezza del metodo con cui ha saputo ordinare una serie di novità da lui scoperte (Ferdinando De Luca 1843).

The originality of de Luca's work is to be seen in the systematic classification of kaleidoscopes which, although partly harking back to the Brewster's one, is enriched with the introduction of the varieties. A further distinction between the works of the two scientists can be drawn: one hand, the Scot restricts his study to the theory as he just assumed the existence of different genera and species but only commissioned the realisation of a single type of instrument; conversely, the skilled mechanic de Luca made different species of kaleidoscope belonging to different genera with the intent to solve the issues related to the ornamentation of heterogeneous surfaces.

> Il caleidoscopio da semplice gioco ottico, diviene nelle mani di de Luca uno strumento utile a tutte le arti. Infatti tutti coloro che sono dediti alla decorazione, dal pittore al ferraio, dal ricamatore al gioielliere, possono servirsi di questi semplici strumenti per ottenere un numero inesauribile di bozzetti diversi e simmetrici (De Luca 1843, pp. 52-54).

Noteworthy is also the introduction of the "benderella", which, although recalling Basoli's black card, has a more complex function. Another innovative feature introduced by de Luca concerns the mechanical kaleidoscopes, formerly hypothesized by the Scottish physicist; here de Luca stands out for the non-random position of the moving objects allowing to obtain pre-established kaleidoscopic figures that can be used for the "fuochi cinesi" (fireworks).

The greatest merit of the Irpinian scientist is however, the condensation of all his researches and studies in a single instrument of his invention, the "simmetrizzatore": an instrument with the dual function of universal kaleidoscope and didactic tool, useful to experimentally prove the laws of symmetry involved in the construction of kaleidoscopes applicable to the arts.

De Luca remaining kaleidoscopes series along with part of the "simmetrizzatore" (Fig. 3) are currently housed in the Museum of Physics of the Università di Napoli Federico II. They undeniably represent the inspiration and starting point for the present work which allowed to retrace the story of these unique instruments as well as to cast a new light on the ingenious scientist who Paolo Anania de Luca was.

[1] De Luca Ferdinando (Serracapriola 1783-Napoli 1869) wasn't a relative of Paolo Anania de Luca.

Fig. 3. Caleidoscopi e Simmetrizzatore conservati nel Museo di Fisica.

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