Anamorphosis and Contemporaneity

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Abstract: Today, anamorphoses are increasingly used in the field of Graphic & Architectural Design. The construction methods of anamorphoses have not changed since those theorized and used by the first treatise writers in 1600. A comparison between some of the existing procedures, based on the use of new technologies, and the theoretical concepts of the past shows that little or nothing has changed from a conceptual point of view. Those who make anamorphoses these days still follow, for example, the indications taken from Niceron’s studies, even though this task is made easier by the use of computers and video projectors. Some researchers have also developed software programs to facilitate the transformation/anamorphic deformation, although they did so mostly for their personal interest rather than to follow an input given by research bodies. The final objective of the study is to understand the possible further developments of anamorphoses in the field of Graphic & Architectural Design. In other words, the way reverse perspective is used, not only as a subject matter that is taught and explored at a theoretical and academic level, but as a living matter, with which one can have a dialogue to achieve those results that have always fascinated both researchers and the beneficiaries of the works inherited from the past up to our days.

Keywords: Anamorphosis, Graphic Design, 3d Modeling

1. Introduction

In Graphic & Architectural Design, anamorphoses are increasingly used with different implementing and representation methods; this is still a topic of interest in research, pretty much like personal reflections (think of the studies on perspective conducted by Erwin Panofsky (Panofsky, 1927) and Decio Gioseffi (Gioseffi, 1957) and the debate on spatial representation from the 1950s onwards) which can therefore find new opportunities in terms of research and development.

In recent years, anamorphoses have been used and applied to Graphic Design. Many researchers have observed and documented the artistic experimentation by "3D Chalk Painters; among them, Kurt Wenner, Julian Beever, Manfred Stader, Edgar Muller, Eduardo Relero and Leon Keer; they also looked into certain types of anamorphic art made without drawings and paintings, as the "ephemeral
garden” realized in the square of the town hall of Paris (Lazzaro et al., 2013), or the urban anamorphoses created by the Swiss artist Felice Varini (Di Paola et al., 2014) (Varini et al., 2004).

Some artistic experiences, as it happened in the past with the painting of the Ambassadors by Hans Holbein (1533), have created a movement of perspective investigators, focusing their attention on anamorphoses and their contemporary applications.

In Graphic & Architectural Design, anamorphic studies are still based on a theoretical/practical approach tied to the first treatise writers of 1600, on studies and ideas from the last 40 years, and on those who are now testing new computer-based techniques and technologies.

The first treatise writers studied the main aspects of perspective and thoroughly examined the theoretical and practical aspects of anamorphoses. They still represent an important reference with respect to theory. Among them, it is worth mentioning S. de Caus (de Caus, 1611), J.F. Niceron (Niceron, 1638) (Niceron, 1646), E. Maignan (Maignan, 1648) and A. Pozzo (Pozzo, 1693). Initially, anamorphosis was studied by exploring cross-sectional subject matters such as mathematics, physics, gnomonics and perspective itself. In particular, Donato Bramante, Andrea Pozzo and Emmanuel Maignan carried out in Italy some studies on perspective and anamorphosis which later became true cornerstones, frequently recalled in studies conducted in the subsequent centuries: Bramante, thanks to the clever use of perspective, in the church of Santa Maria in San Satiro in Milan, realized the perspective illusion of an apse in a space where, for architectural and dimensional reasons, the nave only ended with a transept (Fig. 1); Pozzo painted, in the church of St Ignatius of Loyola in Rome, a false dome ceiling on the flat ceiling of the Church (Fig. 2); Maignan realized a fresco on the life of S. Francesco di Paola, in a hallway of the convent of Trinità dei Monti in Rome.

Much later, coming to our days, thorough studies of anamorphosis, anamorphic works and treatise writers have been conducted in the last forty years by J. Baltrusaitis Baltrusaitis (1978), S. Naitza Naitza (1980), E. Battisti (1981), J. Elffers (Elffers et al., 1981), D. Toffanello (1996), R. Migliari (Migliari et al., 1999), A De Rosa (De Rosa et al., 2002), K. Andersen (2007).

Other investigators have analyzed the links between anamorphoses and other contemporary research areas, emphasizing 3D geometry, like D. Hansford (Hansford et al., 2007); others, like F. Di Paola (Di Paola et al., 2014), have described how digital techniques can simplify anamorphic applications even in the case of projections on complex surfaces and some contemporary artistic applications, like P. Di Lazzaro (Lazzaro et al., 2013).

In architecture, anamorphoses were used to realize special viewing effects or to solve problems like the impossibility to provide complex structures due to the lack of space or money; in our time, anamorphosis is mostly employed in Graphic & Architectural Design and related applications (visual graphic, exhibit design, advertising design, playful design).

This study aims at describing the state of the art and any possible theoretical and practical developments in this specific field.

As we will see, the construction methods of anamorphoses have not changed since those theorized and used by the first treatise writers in 1600. A comparison between some of the existing procedures, based on the use of new technologies, and the theoretical concepts of the past shows that little or nothing has changed from a conceptual point of view. Those who make anamorphoses
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The final objective of the study is to understand the possible further developments of anamorphoses in the field of Graphic & Architectural Design. In other words, the way reverse perspective is used, not only as a theoretical subject that is taught and explored at a theoretical and academic level, but as a living matter, with which one can have a dialogue to achieve those results that have always fascinated both researchers and the beneficiaries of the works inherited from the past up to our days.
FIG. 1 - Donato Bramante, fake apse of the church of “Santa Maria presso San Satiro” in Milan, 1483. (Image by the author)
2. Construction of anamorphoses: past and present techniques

In Graphic & Architectural Design, the first and important prerequisite is the possibility to use representation tools embedded in the latest technologies (such as computers, 3D simulations and video projectors). Have these new tools generated new procedures to create anamorphoses? Or the construction principles of the geometric structure have remained unchanged?

The following paragraphs show that the geometrical structures of anamorphoses (thanks to the analogies between the anamorphic constructions suggested by the treatises of ‘600, with particular reference to the Niceron’s studies, and contemporary operational methodologies) are still based on the same theoretical and construction principles of the past with the addition of certain contemporary instruments.

The cases analyzed range from the transformation of a 2D representation to the realization of a 3D model:

1. use of photo editing (2D) applications to generate an anamorphic grid;
2. use of video projectors connected to a computer, with the addition of a photo-editing software (2D);
3. The construction of the anamorphoses according to Niceron

One point perspective anamorphosis (on a horizontal or vertical plane) was well described by J. F. Niceron in his treatise *La perspective curieuse ou magie artificielle des effets merveilleux*, published in Paris in 1638 (Niceron, 1638).

The second book of *La perspective curieuse ou magie artificielle des effets merveilleux*, second proposition, illustrates "the process to draw any sort of figure, image, or painting, in the same manner as the chair of the previous proposition, i.e. so that it is perfectly recognizable only if viewed from a certain point".

The process explains how to realize the anamorphoses of a square or rectangle, divided into many smaller squares, and then move, as in a magnification, any image through the use of a square mesh.

The method to obtain the anamorphoses of the figure inserted in the square is illustrated in Table XII (Fig. 3): "Draw a segment having the same size as the side of the square, then divide it into as many parts as the divisions of that side; start from these divisions to draw straight lines to the main point, that will be placed as far as the desired deformation; after choosing the point of distance, on the horizontal line, near the main point, join it with the opposite end of the segment from which you started. In this way, by drawing a parallel line to this segment, whenever this junction intersects one the straight lines leading to the main point, you will obtain the subdivisions, in depth, of the chessboard, and therefore its distorted image".

This proposition has three corollaries. The first relates to the examples in Table XIII (Fig. 4), where two faces are redrawn, distorted, inside these elongated quadrangles in such a way as to require a side view.
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FIG. 3 - J.F. Niceron, La perspective curieuse ou magie artificielle des effets merveilleux, ed. Paris, 1638. Table XII.

FIG. 4 - J.F. Niceron, La perspective curieuse ou magie artificielle des effets merveilleux, Parigi, 1638. Table XIII.
In *Thaumaturgus opticus* (Niceron, 1646), Latin edition of 1646, an expanded version of the treatise with respect to *La perspective curieuse*, Niceron explained how some prospective machines operate; he illustrated a method where straight wires are employed to materialize visual rays and draw large anamorphic images as the one shown in Book Three of Emmanuel Maignan’s treatise (Maignan, 1648) (Fig. 5).

Methods similar to those described above are used to transfer scenic paintings created "flat" on curved surfaces (domes and vaults, for example). Yet, the observer perceives "natural" images regardless of the shape of the pictorial surface: for this purpose, we may use the projection of shadows through light sources, with the help of grids or pierced cardboards that are projected above highly tilted plans or other kinds of surfaces (Iurilli, 2014, p 47-48).

**FIG. 5 – Anamorphic structure by J.F. Niceron, Thaumaturgus Opticus (Tab. 33, Fig. LXVI and LXVII), Paris, 1646.**

### 4. The construction of anamorphoses in Graphic & Architectural Design

#### 4.1 Use of photo editing applications

Some procedures currently employed to create anamorphoses are conceptually and operationally very similar to the studies conducted by Niceron in *La perspective curieuse* and to the anamorphic structure described in Table 33 of *Thaumaturgus opticus* (Fig. 5).

Photo editing applications allow to interpret in a similar manner the second proposition of *La perspective curieuse* by Niceron and the content of Tables XII (Fig. 3) and XIII (Fig. 4).
Given the ABCD grid and the abcd mesh (Fig. 6a), distorted according to the projection from point of view Y (with X projection in the reference plane α), you can distort the figure of a cube positioned in ABCD grid (Fig. 6b) using the application transformation tools. AD points first coincide with ad (Fig. 6c), then CB side coincides with the straight line containing cb (Fig. 6d). Using the "distortion" or "perspective" command, the ABCD grid is caused to coincide with abcd grid (Fig. 6e). The resulting anamorphic image (Fig. 6f), displayed from point of view Y (Fig. 6g), takes on the true, desired shape.

This procedure is used to define anamorphic images on vertical or horizontal planes, as in advertising panels in football or rugby stadiums or in Formula 1 circuits.

FIG. 6 - Anamorphic grid realized with a photo editing software.
4.2 Use of video projectors

The use of projectors or video projectors placed in point of projection, constitutes a contemporary interpretation of what was described by Niceron in Tab. 33, Fig. LXVI, LXVI of *Thaumaturgus opticus* (Fig. 5).

With a high brightness projector, such as, for example, in Felice Varini’s works of art, a transparent film on which the monochrome image that you want to decompose in space is used: this is like an "anamorphosis obtained by spatial decomposition".

Projection point in Varini’s works is placed at eye-height (about 1.50 m) from the floor plane. The identification of the points of objects, arranged in space, on which to draw the anamorphic figure does not need the construction grid assumed by Niceron; thanks to technology, the lines of projection are replaced by the light rays of the projector itself and the shape of the figure is directly transferred on the surfaces on which it is projected.

The contours of the distorted image are marked with the use of tapes, brushes or markers directly on the spot, quite similarly to the character in figure LXVII, Tab. 33 of *Thaumaturgus opticus* (Fig. 5).

During the next step, the parts that make up the image to be displayed will be filled with colored paints (Fig. 7).
In the case of video projectors, such as, for example, in Ghigos Ideas’ exhibit design for the DOCVA archive design and fitting at the MAXXI museum in Rome (Fig. 8a), the above described procedure is slightly different. They used a video projector to realize the anamorphosis of the logo of the Documentation Center for Visual Arts, with the point of view placed at the entrance of the exhibit itself (Fig. 8b). A video projector connected to a computer, and a photo-retouch software, allow to project different colors, differently from the previously described procedure, so that you can handle polychrome pictures as well (Fig. 8c).

**FIG. 8** - (a) Ghigos Ideas: Anamorphosis reconstructed in space, Maxxi Museum, Rome (2011). (b) Ghigos Ideas: Point of view marking. (c) Ghigos Ideas: Logo broken down in space. (Image by Ghigos Ideas)

### 4.3 Use of 3D modeling

The three-dimensional modeling procedure allows an operating mode in which the construction, with reference to exhibit design, in the anamorphic apparatus may also occur in a place different from where it will be displayed.

The 3D simulation and construction of both objects, on which the anamorphic projection is made, and the anamorphosis itself are more controllable; editing and processing operations can be performed in real time. The virtual environment allows for a “preview” of both the expected result and the anamorphoses.

A convincing illustration of the procedure is the reconstruction of the 2014 exhibition "The Observatoire des innovations" at the Musée de la Cité des Sciences et de l’Industrie de la Villette in Paris.
Anamorphosis is created by spatial deconstruction on objects designed and arranged for a spatial reconstruction of a square from the point of view (Fig. 9). It is the evolution of the procedures described by Niceron, where technology allows for an improved control of shapes and desired results. The anamorphic apparatus described in Tab. 33 of *Thaumaturgus opticus* is created and verified in a virtual environment with the help of numerical control machines. The virtual image and assumptions are then put together on site.

FIG. 9 - (a) Musée de la Cité des Sciences et de l’Industrie: point of view where the anamorphic deconstruction is reconstructed, Paris (2014). (b) Point of view of anamorphic reconstruction. (c) 3D reconstruction of objects on which the anamorphic image is broken down. (d-e) 3D reconstruction of objects making up the deconstructed space. (Images by the author)
5. Anamorphosis software

A projection procedure can be associated to a computer algorithm to process and distort an image. However, with few exceptions (like Anamorph Me! and "Simple Anamorphic Converter"), no specific software is available to facilitate the realization of anamorphoses; used softwares simply performs a 3D check of the final result of the spatial processing. This can be obtained, for example, with Grassopher (algorithmic modeling for Rhino) and Blender, or with other generic 3D modeling applications.

In the field of "Portable Devices", some smartphones and tablet apps have been developed, like "Imorph" or "AnamorPhoto" to provide minor anamorphic transformations; however, these apps are mostly used for entertainment purposes rather than to obtain significant results having a real interest or value in the field of perspective.

It is quite clear that researchers’ interest has not turned yet into the manufacture of special computer software and projection tools. The study of descriptive geometry and the development of its related research is currently explored by a limited group of investigators, in spite of the widespread interest in some of its specific applications, like anamorphosis.

6. Dynamic anamorphoses

"Dynamism in anamorphoses" is closely linked to the use of new techniques and technologies, and is the subject of research and applications in several, different areas:

- dynamic anamorphosis that adapts itself to the changing position of the observer so that wherever the observer moves, he sees the same undeformed image. This dynamic changing of the anamorphic deformation in concert with the movement of the observer requires from the system to track the 3D position of the observer’s eyes and the re-computation of the anamorphic deformation in real time (Rvnik et al. 2014. 46-62);
- dynamic anamorphosis that take into account the motion of objects, such as for example their rotation around an axis of revolution or the movement of the observer, moving around one or more objects, to obtain different anamorphic reconstructions.

The second case is increasingly common in advertising design (shorts and videoclips) where filmmakers focus on optical effects and anamorphic images.

The camera movement, along a pre-arranged path, allows the spatial reconstruction of a sequence of serial anamorphoses; they are part of the narrative path, for example, in the 2013 advertising campaign of Honda CR-V3 (Fig. 10), or Vodafone4 in New Zealand (2010), or the video for OK Go band in “The Writing’s On the Wall”5 (2014).

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2 In 2001, Philip Kent developed a free software, Anamorph Me!, that allows to carry out almost all traditional anamorphic transformations using perspective and mirrors.

Anamorph Me! (http://www.anamorphosis.com/software.html) can read images in the most common formats (e.g. JPEG, BMP) and carry out a range of anamorphic transformations on them - including oblique, cylindrical mirror and conical mirror.

Being the software an author’s independent project, it offers only limited image manipulation functions. For standard operations such as cropping, changing brightness, contrast and colors, and advanced printing, users need a professional image manipulation program.

3 https://www.youtube.com/watch?v=7PGXZ-o2g-g
4 https://www.youtube.com/watch?v=T4WfzwkCkC
5 https://www.youtube.com/watch?v=m86ae_e_ptU
7. Conclusions

While anamorphosis was used in the past to hide certain messages in the painting (as in pictorial images or drawings) or to exploit illusory images in the absence of real architectural structures (walls, domes, depths of spaces in general) or it was just impossible to create them, today anamorphosis is predominantly used in the field of Graphic & Architectural Design, Architecture and advertising for visual communication purposes (visual design, exhibit design, advertising design, etc.).

We have seen that the construction methodology has not changed compared, for example, to Niceron’s theories in the seventeenth century. Operating modes have changed, though: computer and video projectors simplify the geometrical construction and realization of anamorphoses.

Moreover, the new techniques allow to introduce the 4th dimension (kinematism). In fact, the possibility to view the space no longer only from a fixed point, thanks to the use of the cameras, as seen in the paragraph on "applications in advertising", allows to create "anamorphic paths" in which the shape and meaning of objects change as a function of the angle with which they are framed and then shot. The construction of the "anamorphic path", in this case, can be ruled only by computer procedures.

As to IT applications, there is still a lack of research defining specific anamorphosis-generating software. The use of popular applications (photo editing or 3D modelling software) entails a sound knowledge of the rules of descriptive geometry and perspective. This is the reason why anamorphoses can only be realized by investigators with a proper scientific background in this field. As to the future, a joint interdisciplinary research effort between descriptive geometry experts and algorithm developers would be more than welcome. Such research could enable, for example, the implementation of open source software programs with new pull down menus for anamorphosis creation, like Blender\(^6\).

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\(^6\) Blender allow to customize pull down menu considered as an implementation of the system using Python scripts.
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