INTEGRATION OF ART AND TECHNOLOGY IN ARCHITECTURE AND CITY PLANNING. VISUAL ARTS AND THE LAWS OF OPTICS

The discovery of the laws of optics in the Renaissance had a large influence on the history of art including sculpture, painting and architecture. Although initially, Michelangelo was not particularly interested in undertaking the task to paint a fresco in the Sistine Chapel, the fresco is considered to be one of the most outstanding workpieces of the artist. It perfectly focuses emotions expressed by the artist. The painting combines art and *al fresco* technology, available at that time. These are the most frequently highlighted values of the masterpiece, both in various types of popular – science periodicals and professional studies. The sizes of the figures depicted in the painting increase from the side of the entrance in the direction of the altar which is supposed to provide a spectator with an impression that the figures are of equal size, according to the rules of perspective.

The fresco on the ceiling of the Sistine Chapel was created between 1508--1512. Due to misunderstandings with Pope Julius II, the work was often interrupted, sometimes for a longer period of time. In spite of this, consistence of spatial arrangement was maintained. The artist divided the barrel vault into formal and theme sections, according to the Bible narrative. Rhythmical arrangement is bilaterally divided by arch pilasters finished with Tuscan heads connected by stiffeners. The designer placed there figures in different poses to depict the history of humans from the Creation to the Biblical Flood.

The only 3 dimensional elements of the composition are telescopes decorated with delicate ornaments. However, the perfect composition of figures sitting, kneeling or standing on the heads make the impression of being 3 dimensional as well. Only scenes forming the central sequence of events and those located in the tops of the telescopes are perceived as being 'flat' images. All this makes up a coherent composition consistent with the author's intention.

Pilasters, heads and stiffeners of particular sections were constructed in ' single convergent perspective' or they make up a 'divergent' system. This 'trick' can be noticed only after a thorough 'insight' into the complexity of the system of paintings whose contents overlap. The author's space interpretation methods show not only his outstanding skills but also a profound knowledge of the laws of perspective and perhaps intuition based familiarity with the laws of optics. The barrel vault deprived of any 3 D elements was provided with completely new quality, and became a complex and rich in detail spatial form with a specific, though positive harmony (Fig. 1,2 [1]).

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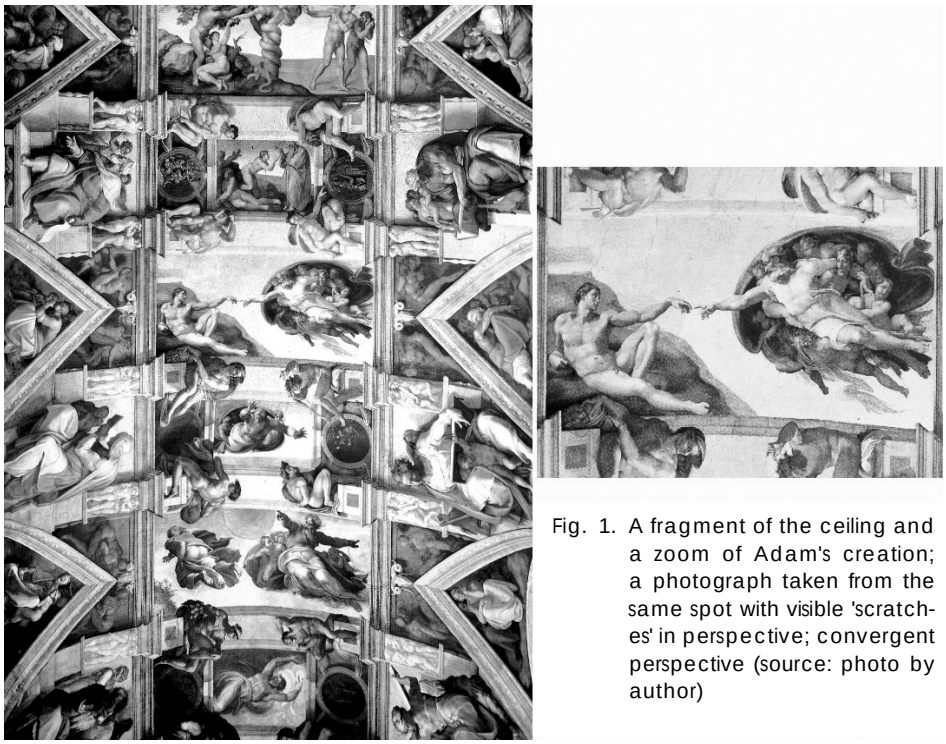

Fig. 1. A fragment of the ceiling and a zoom of Adam's creation; a photograph taken from the same spot with visible 'scratches' in perspective; convergent perspective (source: photo by author)

Fig. 2. For 'divergent' perspective in the central part of the photograph, '3 dimensional' heads and characters look more convincing than from a 3 dimensional top of a telescope (source: photo by author)

The fresco triggered a series of other creations of the artist, characterized by very individual approach to form creation thus affecting the way they are perceived, reached its *apogeum.* In 1524 Michelangelo started one of his unfinished works; Saint Lorenzo Monastry in Florence undoubtedly stands out for its solutions of both the exterior and the interior, and the author's perfect hand is visible throughout the object. Buonarotti's developed the 150 year earlier work of Filipo Bruneleschi who, apart from Albrecht Dűrer was considered to be the discoverer of perspective. He was not as good at using its laws as Buonarotti. The Vestibule of Laurentian Library of

the Medici (Laurenziana), finished by Vasari and Ammanati, after the artist's death, is considered by John Shaerman to be an interior with distinct traits of mannerism. Niches, double clips 'tightened' in the corners and similar pilasters, all create a unique climate of a place which was also supposed to be a theater. This intention of the master was to come true no sooner than in XIX century, spectators were also placed on the stairs (that is in a multi-direction audience), they were „surrounded" by action of performance based on Michelangelo's poetry (Fig. 3 [2]).

a) b)

Fig. 3. 'Non-ergonomic' stairs were supposed to function as seats; for the Renaissance audience it was a very bold proposal, like graphs in the corner (source: photo by author)

In 1536 Michelangelo started construction of the Capitol Square. With all the doubts concerning authorship of Michelangelo that have been bothering researchers until the present day, the place is filled with the artist's style. Divergent composition of objects before the central Palace of Senators closes the extended space. Moreover, marble 'cuts' in the floor which guide the eyes, increasing the impression of the place spatiality, were 'embraced' by an oval, in the center of which a statue of Mark Aurelius on the horse is situated. The master's inspiration is well reflected in all those solutions (Fig. 4).

In the second part of XVII century, Gianlorenzo Bernini repeated Buonarotti's solution. There can be at least two reasons of such a formation of colonnade. Door leaves that open onto the facade of Carlo Maderna and provide it with dynamics, whereas the entrance to the first part of the colonnade provokes eyes to look up, making the top of the 'lost' dome not as much dominant as distinctive (Fig. 5).

Fig. 4. Despite existence of axial symmetry, the arrangement of the square in Capitol makes it look dynamic (source: photo by author)

Fig. 5. Verge of a collonade: point which provides an almost overall view of the dome of St. Peter's Cathedral, Maderna tambour remins "hidden' behind the elevation; It seems that he read Buonarotti's intention in the right way (source: photo by author)

Works of the most prominent and equally versatile master of Baroque are milestones in the world architecture as the laws of perspective were innovatively used in them. The solutions somehow resulted naturally, creators did not use any optics, the *clou* of the composition of each analyzed work is the result of artistic intuition on the one hand and almost engineering calculation on the other hand. Achieving the result by successive trials and errors could not be the case.

In comparison with the Sistine Chapel vault, the Capitol Square, or the complex of Saint Peter Baslica in Vatican, the optical deepening of the apse of Saint Satyrus of Milano by Donato Bramante seems to be a less important achievement.

Taking into consideration the period of the object construction (1476-1482), and the necessity to meet requirement of the principal, despite adverse spatial conditions caused by a lack of possibility to erect a deep *prezbiterioum*, Donato Bramante successfully fulfilled the task. An elaborate detail used in the exedra deepens it optically up to 4-5 meters, while its real depth does not exceed 0,8 m. A similar impression is provided by 'The Last Supper' , a painting by Leonardo da Vinci which is nearby, in the refectory of Santa Maria della Grazie Monastry complex. In both cases the artists used one central convergence point though the perception of space is more complete in Bramante's work due to a shortened, but *de facto* existing, third dimension. Actual dimensions and proportions of the exedra are visible only from the transept (Fig. 6).

Fig. 6. Bramante's work is a remarkable example of familiarity with the laws governing perspective as well as outstanding skills; elaborate details ' authenticate' depth of the exedra (source: photo by author)

The staging assumptions regarding functioning and foundation of the first indoor theater of modern Europe involved a complex and still unexplained sequence of events. Andrea Palladio died in 1580 leaving the duty of Teatro Olimpico construction to his son Scilio. The famous object in Vicenza most probably was not covered with roof yet, as erection of *Frons scenae*, was not finished. Palladio left two variants of *episkenion*, differing significantly in height. Around 1584 Vincenzo Scamozzi took over the undertaking though he did not comply exactly with the proportions suggested by Palladio. This can be established without a doubt. However, the height of *puplitum*, is still a puzzle as well as the *orchestra* depth in relation to the first row. However, these are not all changes which have a significant influence on the theater staging conditions.

The space behind *frons scenae* features 'alleys' with the Roman style buildings, situated on their both sides. Most probably Scamozzi, following earlier trials of Rafael Santi/ Peruzzi, tried to create a 'universal scenography'. Watchability, and subsequently the impact on spectators' imagination is rather poor, not to mention the concept itself which is incorrect. For instance, the central street coming out of

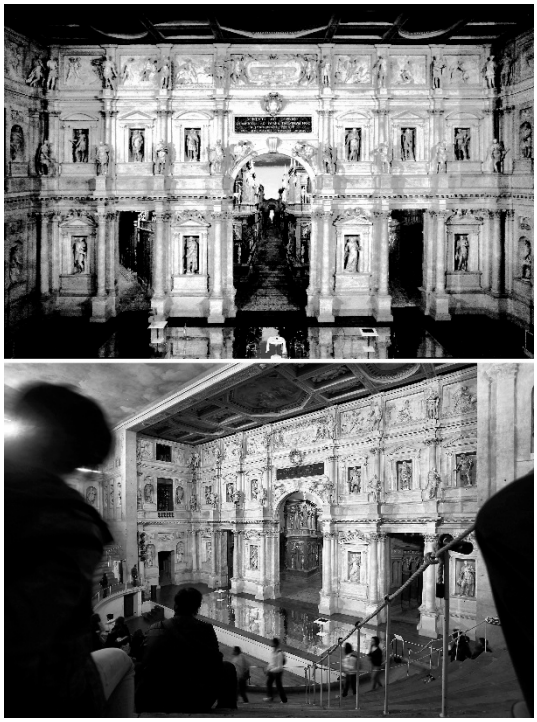

Fig. 7. A shot taken with the use of standard optics, centrally from the fourth row; the purpose of optical prolongation of an 'alley' was fulfilled, though limited visibility (for 9, 10 spectators) determined the popularity of the scene in Olimpico in XVI century; premiere 'King Edyp' was performed only once; a shot taken from the highest row, from a side 'flank' of the audience, shows limited usability of Scamozzie's solution (source: photo by author)

Porta Regalis, finished with a symbolic gate, is fully recognizable only from a few middle seats of the fourth row. Views of the 'alleys', in four side openings are also recognizable from only a few seats of the audience. This determined usability of the stage. Scamozzi designed an illusionist space, in fact he created 'art for art's sake" (Fig. 7 [3]).

What needs to be stressed at this point is the fact that at that time spatial illusion had already become an important element of an architect's craftmanship, more precisely: creators of all arts with an emphasis on 'visual' arts.

It is known that the theory of perspective is closely connected with the laws of optics and 'overlaps' with an invention called *camera obscura* (dark chamber) used already during the Renaissance. At that time when recording an image was not heard of, artists used it mainly for obtainment of correct proportion and perspective. Engravings of the creator of vedutas (most probably Antonio Canal or Bernardo Belotto), sitting on a plank seat with his head covered by black linen, with a tubus of lens emerging from under the head cover (lens as in earlier "models' it was only an opening cut out in a rectangular box).

Recording an image had not been possible until XIX century when Dauguere, Niepce and Talbot, independently on each other though around the same time, announced their inventions to the world. A recorded silver image (most generally) provided creators with a tool to be used by them in a variety of ways. Apart from the possibility of recording everyday events in an 'ordinary' way, it enabled quite advanced transformations of reality. However, it was the Bauhause School that most largely contributed to a different 'perception of the world' through a lens. Photography became an indespensible element not only for masters of architecture and its practitioners, but also for creators of all arts. It was used for registration of significant (or less significant) events, but what is more important, it provided the possibility of recording and correcting the process of design or a multi-side

view of an object model or large space assumptions. These are only a few examples of many other possibilities connected with photography which in XIX century and at the beginning of XX century did not bear distinctive features of art and at that time was still underestimated. It won more appreciation, gradually in the 20s and 30s of XX century. The already mentioned School 'Bauhaus' certainly contributed to its prestige. Erwin Piscator was going to appeal to spectators by photographs projected onto semitransparent screens, placed in a gallery surrounding the ground floor of the audience. The spatial arrangement of the total theater, for which this specific assumption was accepted by Piscator with Walter Gropius, initiated other, mostly unimplemented solutions, which 'focused' on various applications of a 'time frozen' image. Hence, slowly, but no sooner than in the post-war times, a completely different photograph reception formula emerged. It is caused mainly by mass reception of an image processed with the use of optics. Initally, cinema later television, imposed a new form of perception of the real world. A common tv user is not aware of the fact how much a picture they see on the tv screen is transformed. It is possible to transform the color or the pitch, though they are important elements affecting perception, and subsequently its composition, or atmosphere. However, this is the frame and optical transformation of the space, including proportion of the composition elements, which seem to be of most importance. An image producer provides the photographed objects or persons, with appropriate dose of emotion. The viewers (tv-viewers), are not aware of the method used for achievement of the transformed space, and they will not necessarily percieve it as transformed. An image transmitted to viewers can also be a simple coverage without distinctive features. Then, the proportions of a composition are consistent with those perceived by the human eye, lighting is appropriate and covers the whole frame and the color is viewed by spectators as 'real'. This is professionalism of broadcast producers and camera operators (cameramen) which determine whether a frame (or sequence), will make an impression on the viewers. This professionalism can produce momentary pieces of art which will stay in their memory for a long time, as intended by the authors of the spectacle. Optics and its consciuos users have unlimited possibilities [4].

Today's tv camera has a wide range of transfocation. Lens with viewing angle 70˚ to 30˚, is regarded to be of medium capacity. In stationary film cameras, extreme values reach 90 and 20 degrees, respectively, and for an appropriate format of orthicon, they provide the possibility of using the sharpness depth. It is purposefully 'flattened' in current lenses produced for professional tv cameras and digital cameras in order to obtain a plastic image (Fig. 8, 9).

How can these possibilities be used by space planners ...? not only by architects. The so far presented study has provided a wide and almost immeasurable *spectrum* of applications. Each piece of visual art can be interpreted in different ways, of course keeping in mind a conscious goal of the real world possible transformation. By application of appropriate wide-angle optics, 'long' (telephoto lens), or standard (consistent with the human eye perceptiin ability), it is possible to emphasize what is important or neglect what the artist does not want to be revealed. This can easily lead to distortion of reality and provide a mediocre work with the prestige of GREAT ART . However, these possibilities should be viewed in terms of their positive impact on an artpiece perceptio rather than the negative

Fig. 8. A photograph taken with the use of wide-angle optics with viewing angle 65°; the foreground sculpture is nearly 1.20 m high. Below a shot from nearly the same spot by standard optics with viewing angle 45° (source: photo by author)

one. Thus, such effects as: exeggeration of proportions of persons/ objects, 'shortening' of perspective or exposure of some plane by its 'sharpening', can highlight the qualities of visual art, sometimes providing it with a completely new quality. This is the knowledge of the laws of optics and its applications that makes it poossible for an artist to use this versatile tool, extending the *spectrum* of expression means (Fig. 9).

Even a brief study of the relations between optics and perception of pieces of art needs to include a name of a German painter Hans Holbain the Younger (1447?-1543?). He was younger than Albrecht Dürer (1471-1528) and it is easy to establish whether he was familiar with Dürer's studies on this subject, however his knowledge in the field made him the unquestionable discoverer of perspective. While staying at the court of the English king Henry the VIII he created a painting whose complexity and mysterious use of symbols have been puzzling art experts and art lovers until today.

The French 'Ambassadors' depicted by the artist are of natural size (oak plank 207x210 cm). They are surrounded by musical, navigation and astrologial instruments and books of various origin. The solar clock shows date 11.04.1533 which was accepted to be the painting finish date. Everything is connected with travels, spiritual life and the atmosphere of the court and refers to lives of the ambassadors.

In the foreground, there is an obscure object which is suppsed to convey some information that the artist was not going to provide in a direct manner. Upon close observation of this fragment at a sharp angle it is possible to figure out a scull – a special way to express *memento mori.* Having in mind social relations

of the English society during the reign of Henry the VIII, in particular the court atmosphere, one can refer the reminder of death directly to the characters of the painting; as they all were in danger. However, as far as the expression means are concerned, Holbein was not only a master of perspective but even more. An English painter and investigator of 'secret' artistic menas, David Hockney, proves that the master used a simple, familiar at that time, lens consisting of two symmetrically assembled flat-convex lenses (periscope). In this way he projected a scull directly onto the board, through a lens tilted from the axis and precisely reconstructed the distorted form. It is possible, though there is no certainty. In order to recreate a given form, a common spoon can be used. When it is put at a proper angle the image of a scull it reflects is only slightly distorted. There is no certainty though just because, by this and other works, the artist proved his highest skills and talent. When it comes to the 'Ambassadors' more transformations of perspective can be found. Both the treaty and the church choirbook lying beneath the mandoline neck were exaggerated in terms of perspective, convergence points are not 'consistent with' the horizon although both things lie horizontally. According to Kazimierz Bartel all those intended 'imperfections' come from Holbain's desire to emphasize contradictions and mitigate detailed realism present throughout the painting (Fig. 10 [5,6])

Fig. 9. A photograph taken with the use of 'fish-eye-lens' ; viewing angle 150˚, next, projections and a view of the room performed with the use of optics with viewing angle 65 degrees. A photograph taken by the author. Exhibition of dollies organized by the Center of Polish Scenography in an unfinished and unused educational object of the Faculty of Organization and Management of the Silesian University of Technology: Piotr Obracaj, project and implementation 2002-2003

The example of Hans Holbein's work confirms the thesis referred to in this article: association of optical laws with visual arts of different background can provide measurable expression forms and artistic effects. Skillful incorporation of computer techniques into art aided by the laws of optics will certainly boost the development of all kinds of arts although the fear of abusing the new possibilities will never disappear.

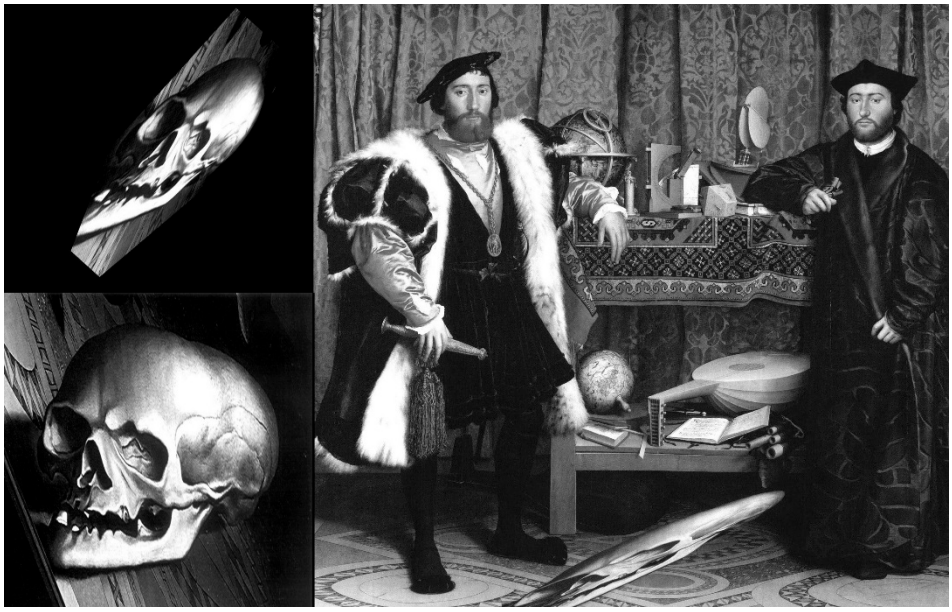

Fig. 10. Work of Hans Holbein the younger 'Ambassadors' and a scull recorded in 'Photoshop' program ; easier to 'discover' the book convergence lines are drawn inconsistently with the reality, only the mandoline is 'undistorted' (source: author's Archives)

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Holbein's work was thoroughly analyzed, perspective transformations presented in the form of drawings

INTEGRATION OF ART AND TECHNOLOGY IN ARCHITECTURE AND TOWN PLANNING. VISUAL ARTS AND THE LAWS OF OPTICS

SUMMARY. Since the era of Renaissance the spatial illusion has become one of powerful means of expression. It has often been used as part of town planning including interiors or building elevations. Having mastered this specific skill, a creator can shape space in conditions which seems not to favor this form of expression.

The XIX century photography invention of photography has largely contributed to multidirection development of forms for recording and broadcasting images, both still and animated ones. This has significantly contributed to the perception of different forms of art

Nowadays, in the era of media and information, high quality images are easy to access thanks to high technology which enables precise and efficient recording. A complex multimedia machine has been created. It can provide creators with numerous benefits, but can also reveal and highlight their imperfectness and technical errors.

Thus, the perception of a piece of art has become the function of many factors of different origin made up of a variety of components, whereas the passive function is often performed by the art piece itself. Lighting, atmosphere and finally the overall impression have changed due to optical effects largely affecting all the parameters of perception. Thus, average art viewers have become more demanding, though their expectations are not always accompanied with consciousness and understanding.

Key words: art, architecture, optics, illusion, perception