Colour and Light in the Post-Byzantine Church Architecture in the Town of Arbanassi, Bulgaria

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ABSTRACT
The aim of the paper is to elucidate how the seventeenth-century architects of the Arbanassi churches optically manipulated the visual space of the naves, through the particular use of light. The paper argues that the choice of the orientation of the main axis of the Arbanassi churches was made in accordance with astronomical principles that assured planned interaction between sunlight and architecture. Accordingly, the colours selected for the execution of the decoration were chosen because of the quality of the interior illumination.

Keywords: Architecture Design, Orientation of the Longitudinal Axis, Interior Illumination

1. INTRODUCTION
The village of Arbanassi is situated on the Balkan Peninsula, in the middle part of the present territory of Bulgaria, about four kilometers to the north-east of the old capital Veliko Turnovo. There are three post-Byzantine churches in the village that are assumed to have performed the role of parish churches. These are dedicated respectively to the Nativity of Christ, the Archangels Michael and Gabriel and St Atanass, incorporating the Chapel of St Haralampii. All the churches are single storey buildings of very simple construction protected by heavy overhanging roofs. All are partially underground. The organisation of the interiors is to a common pattern and usually includes a nave, inner-narthex and outer narthex. The apparently plain exterior is contrasted by an often rather complex interior plan. The chambers in all four churches are small, with small window openings and low ceilings, but completely decorated with lavish wall paintings (Fig. 1).

In the wall paintings of the churches the common colours are: bright and dark red, yellow, white and black. The colour green appears only in the interiors of two churches: the Nativity of Christ and St Atanass. A light blue colour is used very sparingly in the interior of St Atanass. In principle, the interior light is either natural (day) light or artificial light, but most commonly a combination of both. There is no historic evidence for the particular artificial lighting scheme. but because of the theological significance of light it can be expected that there were plenty of candles and oil lamps as this has long been the tradition in the Christian Church.

The aim of the paper is to elucidate how the seventeenth-century architects of the churches optically manipulated the
visual space of the naves, through the particular use of light. The underlying hypothesis of the thesis is that both light and colour have been consciously deployed in the interiors. This hypothesis is contrary to the prevailing opinions that by this time, the knowledge and skills of the Byzantines were almost completely lost. For example, both Bojadjiev [1] and Koeva [2] in their reviews of the historic ecclesiastical architectural tradition insist that after the Ottoman conquest any new churches were built to the simple pattern of small rural chapels, where the interior was more important than the exterior. The starting point is that the decoration is a means to introduce the presumed illiterate congregation to the biblical text by illustrating different sections. Philov [3] wrote about the stagnation in artistic development after the conquest as the monasteries on Mount Athos became the guardian of the Byzantine theological tradition and the training of painters. Later Prashkov [4] continued that line in his monograph on the Church of the Nativity of Christ. For him the interior decoration in the period between the sixteenth and the eighteenth centuries became truly akin to illustration, hence the noticeable decrease in size of the individual scenes and the increase in the total number of compositions. His analysis stressed that the meaning created by the decorative programme mattered more than the architectural structure at the time when the churches of Arbanassi were erected. Vatchev [5] attributed the decline to the aggressive policies of the Ottoman administration. These researches found an explanation in the nature of the Ottoman Empire, which could be described as a strong Islamic theocracy dividing the population not ethnically but on the basis of their belief system. Moreover, because of restrictive planning policies, new churches were often erected in haste and only a general orientation of the building towards the east was considered.

Researchers in the context of general Byzantine studies defined the fenestration of a building as the ultimate source of illumination. For example, I. G. Illiadis [6] based his methodology on the relation between the fenestration and the orbit of the sun. Similarly, Potamianos [7] examined the orientation of the building and its fenestration in relation to astronomical research on the timekeeping system of the church and the movement of the sun during the year and each day of the year. There appears to be no consensus on the question of the exact orientation of the Christian churches. For example, Y Illiadis [8] found that the majority of post-Byzantine churches follow the prescribed orientation to the east. At the same time Liritzis and Vassiliou, [9] after examining the orientation of 21 late Byzantine and post-Byzantine churches built between the fifteenth and eighteenth centuries, concluded that as a rule, post-Byzantine church buildings do not follow the true east orientation.

Fig.1 Interior in the Church of the Archangels, Arbanassi, Bulgaria
2. EXPERIMENTAL

Having in mind the inconsistency of the reviewed research, an empirical study of the true orientation of the axis of each of the Arbanassi churches was carried out. The main axes of the churches determine the orientation of each church. The combined effect of the orientation of the building and the trajectory of the sun determines how the sunlight interacts with the architectural structure.

It is easy to establish the notional lines of the longitudinal axis of each church, as each church is rectangular. Compass measurements were performed in a direction parallel to the longer sides of the building using a military handheld magnetic compass of the fluid-filled variety. The compass measurements deviate from the true east orientation. The results are systematised in the table below (Table 1).

<table>
<thead>
<tr>
<th>Church</th>
<th>Measurement (value ± 0.5°)</th>
<th>Deviation from true East</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nativity of Christ</td>
<td>88°</td>
<td>- 2°</td>
</tr>
<tr>
<td>Archangels Michael and Gabriel</td>
<td>109°</td>
<td>+19°</td>
</tr>
<tr>
<td>St Atanass</td>
<td>84°</td>
<td>- 6°</td>
</tr>
</tbody>
</table>

Table 1. Azimuth of the longitudinal axes of the three Arbanassi churches.

Because the majority of the windows in every church are permanently closed with shutters, it was not possible to conduct any direct observation of how the light enters the windows of the nave. Therefore a methodology needed to be devised which would overcome this problem. At the heart of the method is the cyclical nature of the yearly and daily patterns of the Earth’s movements around the sun and on its axis.

It is necessary to know the sunrise and sunset azimuths on the days of the solstices, as these produce the two extreme patterns in the path of the sun. The azimuths of all the other sunsets and sunrises during the year are included between those for the two solstices. Using the geocentric model, an outline footprint of each building (generalized, but to scale), with the apertures of the marked windows (also to scale), is positioned in the centre of a circle, denoting the daily path of the sun. An outline of the nave of the church of the Archangels Michael and Gabriel, instead of the whole building, is used in this particular schematic examination. Each of the footprints is orientated in accordance with its longitudinal axis. The azimuths of the sunrises (SR) and sunsets (SS) of the summer solstice (SRss/SSss) and winter solstice (SRws/SSws) are marked on each circle. The extended projection of the direction of the sunlight at the sunrises and sunsets at the solstices and the points where they impinge upon the footprints of the buildings delimit the outline of the surface of the building that could receive direct sunlight at some stage of the day. Furthermore, two lines, defined by the centre of the coordinate system and the east reveal of the first apertures and the west reveal of the last of the apertures on the south wall, are extended to the point where the lines impinge upon the circle denoting the path of the sun. These identified sections of the path of the sun give an indication of the time of day and of the length of the time it takes the celestial body to pass through each section.

The methods of measuring time in the Ottoman Empire during the sixteenth and the seventeenth centuries were still
Fig. 2
The Church of the Nativity of Christ in the context of the relation between the orientation of its axis and the path of the sun throughout the year.

Fig. 3
The Church of the Archangels Michael and Gabriel in the context of the relation between the orientation of its axis and the path of the sun throughout the year.
3. RESULTS AND DISCUSSION

The results of this investigation are presented in the tables below (Tables 2-3). The tables also include the windows of the chapel of St Haralampii, as the illumination of the chamber is linked to the illumination of the nave via the door on the south wall of the chamber.

<table>
<thead>
<tr>
<th>Church</th>
<th>Window 1 Azimuth/hour</th>
<th>Window 2 Azimuth/hour</th>
<th>Window 4 Azimuth/hour</th>
<th>Apse Azimuth/hour</th>
<th>Door Azimuth/hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nativity</td>
<td>74° 3rd</td>
<td>115° 5th</td>
<td>n/a</td>
<td>40°/43°</td>
<td>≈2nd</td>
</tr>
<tr>
<td>Atanass (altitude)</td>
<td>[46°] 3rd/12th</td>
<td>[46°] 3rd/12th</td>
<td>n/a</td>
<td>38°/40°</td>
<td>≈2nd</td>
</tr>
<tr>
<td>Haralampii</td>
<td>82° ≈4th</td>
<td>n/a</td>
<td>188° 9th</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Archangels</td>
<td>133° ≈6th</td>
<td>n/a</td>
<td>[28°] 3rd/12th</td>
<td>56°/58°</td>
<td>≡2nd</td>
</tr>
</tbody>
</table>

Table 2. Correlation between the position of the apertures of the Arbanassi churches and the position of the sun at summer solstice.
Table 3. Correlation between the position of the apertures of the Arbanassi churches and the position of the sun at the winter solstice

These tables present an intriguing picture of the dynamics between the apertures of the Arbanassi churches and the position of the sun during the summer and winter solstice. They suggest that the sun is more or less aligned with the openings at or about the time of the canonical hours according to the Eastern Church tradition. These are matins (at the rising of the sun), the first hour (hour after sunrise), the third hour (the Divine Liturgy), the sixth hour, the ninth hour, vespers (at sunset), compline (at bedtime). In all the churches, the first three windows are aligned with the passing sun between the time of matins, through the Divine Liturgy and the sixth hour (at which the sunlight is most intense). Consequently, the natural lighting of the chambers secures the maximum possible intensity of light at liturgically significant times and especially at the culmination of the Divine Liturgy, in accordance with Christian doctrine in which God is associated with light.

The only exception is the church of the Archangels Michael and Gabriel, where there is an alignment of the second and third windows with the ninth hour. Although it may appear surprising, this distribution of illumination may be explained by the fact that the patrons of the church, Michael and Gabriel, are also known as angels of death. The accentuation of the illumination at the time of evening worship may perhaps be designed to assist when the congregation is supposed to meditate on themes of death, from that of Christ’s death (the ninth hour) to that of their own, when they finally fall asleep (compline).

Nevertheless, because of the small window openings, artificial illumination, traditionally provided by numerous lamps and candles would have dominated the areas significant to the pattern of peregrination and worship. Therefore, it could be expected that the artists empirically ascertained the perceptual value of the red, yellow and white colours and employed them most in the construction of the images, while the blues and the greens, that could be expected to appear to have reduced chromaticity, have been employed sparingly and in very light shades.

4. CONCLUSION

The orientation of the churches was done in accordance with astronomical principles, governing the path of the sun on the horizon. Moreover, the architectural design even took account of the implied theological significance of the dedication of the church, as it is in the case of the Church of the Archangels. The colours used in the decoration seem to have been selected taking in consideration the quality of the interior lighting and the ability of the human visual system to recognize colour.
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