

THE SUN RAY AS A TOOL TO DESIGN AN ARCHITECTURAL FORM

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ABSTRACT

The regularities of constructing crucial architectural forms are shown based on the architecture of Ancient Egypt, Western Europe, and Russia: obelisks, pyramids, statues, tents, and spires. It is shown that the source of projection for these and some other architectural forms was the Sun¹ or its image in the shape of a golden ball. The sun ray is serving as a tool for solar elevation.

Keywords: sun ray, solar projection, projection angle

1. INTRODUCTION

The topic of the sun, its light, the sun ray as the physical phenomena and the source of life on the Earth is studied by almost all natural sciences: astronomy, physics, chemistry, biology, etc. Its influence on the structure and properties of living and non-living matter, climate, life of animal and vegetable worlds, and, of course, on humans is being studied. It turns out that, under conditions of our recently formed industrial civilization, different kinds of solar emission influence functioning of most engineering systems.

The Sun and sunlight have formed a set of pre-scientific and religious understandings in the traditional cultures that were developing for thousands of years. These understandings have determined the evolution of the human culture in many ways.

The role of the sun and sunlight in relation to architecture, built environment, structures, and their complexes, is analysed in sufficient detail. In some instances, this role is determined by respective technical and medical standards regarding orientation, solar exposure, etc. The role of the sun in the professional architectural environment is usually considered a presentation of general and detailed appearance of buildings, which creates the best conditions for perceiving their architecture. We can talk from that perspective about the influence of the sun and sunlight on modern architectural form-making.

Apart from other obvious technical, biological, and utility factors, the role of the sun in traditional cultures for constructing any architecture was determined by a notional setting based on the natural role of the sun in the world. During many thousands of years, the system of common and religious images of a godly and creative role of the Sun was created based on that setting. The key to revealing the meaning and setting of the wide range of architectural approaches which determined the form-making from extreme antiquity to our times may be a typical image of the Sun as the creator of everything in traditional cultures.

2. THE OBELISKS, PYRAMIDS, AND STATUES IN ANCIENT EGYPT

When talking about the role of the sun in architecture-setting, it is essential to look at the architecture of Ancient Egypt where the cult of the Sun prevailed for almost 3,000 years. The beginning of the solar cult dominance is already noted in the age of *the Old Kingdom* in the days of *Pharaoh Djoser*

¹ By request of the author, *the Sun* in a number of cases is capitalized (ed. note).

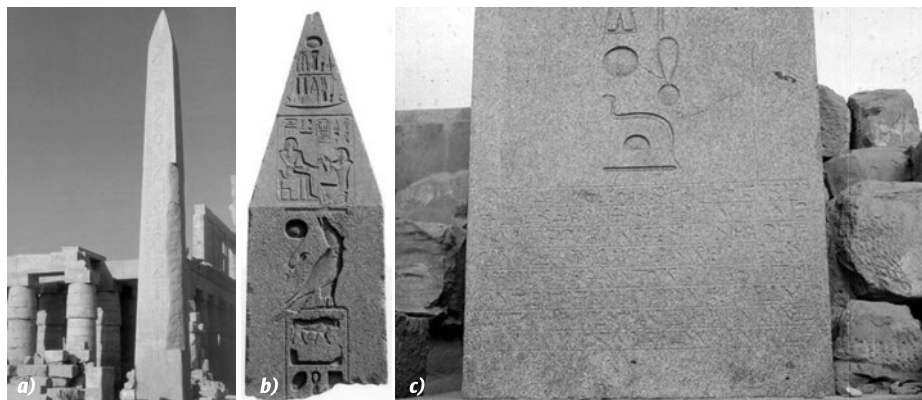


Fig. 1. The obelisks:
 a – Thutmose III;
 b – Ramesses II;
 c – Hatshepsut

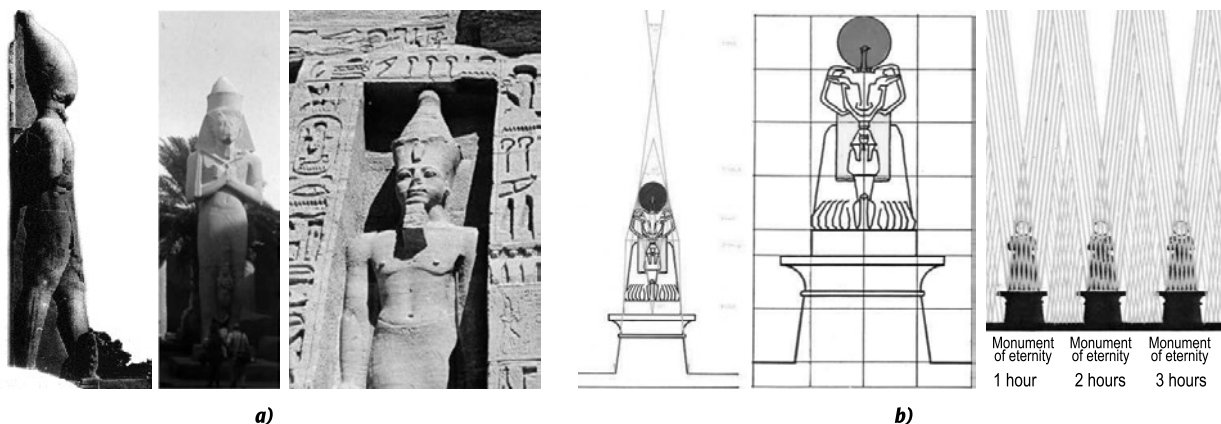


Fig. 2. a – the statues of Ramesses II in the Ipet-isut¹ Temple [1] and Abu Simbel; b – the radial and modular arrangements of the sphinxes in front of the western pylon of the Ipet-isut Temple

¹ The temple that we know as the Amun-Ra Temple in Karnak was called *Ipet-isut* in Ancient Egypt, i.e. the chosen place for the residence of the god. The temple that we know as the Luxor Temple was called *ipet resyt* in Ancient Egypt, i.e. the harem of the god.

known for his funerary complex with a first big step pyramid (28th c. B. C.)².

Let us start with the construction of an obelisk. This theme has received little attention in terms of the aspect covered by us. *Herodotus* noted an obelisk as the ray of the sun on the earth. *Marie-Henri Stendhal*, a faithful soldier of *Napoleon* and a future writer, noted that in his Egyptian diary.

Our goal is to show the architectural means that allowed to reach that effect. Let us start with the shape of an obelisk. Its tetrahedral pillar has a face widening from top downward from 1.5 to 0.5°. The classic obelisk of *Queen Hatshepsut* almost defi-

nitely has 35' which is equal to a visible angular scale of the high sun. The pyramid-shaped top of the same obelisk called *pyramidion* by the Greeks has a 30° top forming angle which is equal to 2 hours of solar motion on the horizon³. The upper part of pillar ribs was covered with white gold or *electrum* (green gold) as early Greeks called it⁴. The pyramidion was covered with similar gold.

The top of the obelisk, ribs framed with white gold in some cases, had literally represented a vertical sun ray. It was always possible to find the bearing point of the ray reflected from the pyramidion in the field. The pyramidion faces were made

² There are differences of opinion among scholars concerning dating from the 28th to 27th c. B. C. [1, p. 265; 2, p. IX; 3, p. 12].

³ Daylight time in the Ancient times and the Middle Ages was calculated with 12 hours similar to a solar year that had 12 lunar months. Daylight time had different length in different seasons before invention of a water clock in the Hellenistic period and with invention of a mechanical clock in the Middle Ages. However, it was enough to determine the mean angle of a sun dial with a sun clock which was known in Egypt in the age of the Old Kingdom, as well as with special surveys of solar motions on the horizon. There are indications of a 24-hour daytime notion appearing in Egypt in the 19th c. B. C.

⁴ So called *white gold* is still very widespread in Egypt.

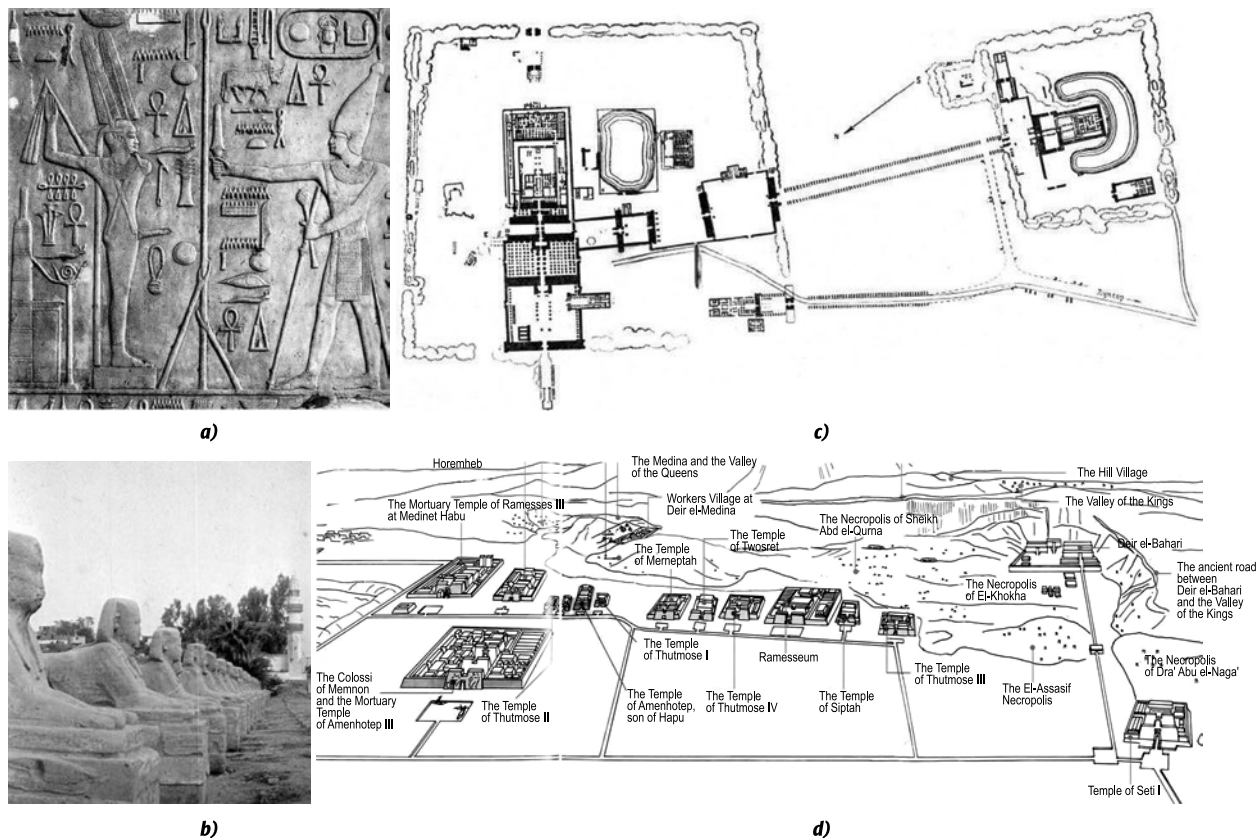


Fig. 3. Luxor: a, b – Amun-Ra as ithyphallic Min gives birth to the Pharaoh-headed sphinxes, his children, with his semen ray; c, d – the avenues of the sphinxes confirm the ritual path of the god, the giver of life, in the temple system of the eastern and western banks of the Nile

a bit out-bowed (curved) in early obelisks. As a result, the ray reflection from curved gilded face was visible almost for the whole daylight time. The obelisks at the entrance pillars of the temple created a special effect at the sunrise. They were taller than temple walls. Their tops were illuminated first by rays of the rising sun. It is not a coincidence that *Hatshepsut* wrote this at the pedestal of her obelisks: “*Their rays illuminate Both Lands when our Father rises between them.*”

The images and texts on granite faces of the obelisks are a whole new topic. The faces show the Pharaoh kneeling down in front of the throne of his Father, the god of the Sun. There is a *serekh* – a conventional design of a palace with falcon-headed *Horus* – at the top of pillar faces. The divine text flows from this palace to the pedestal of the obelisk. The Ancient Egyptians, similar to people that possessed scientific knowledge of the 20th century, considered the sun ray to contain some sort of information. It was a text of a divine and solar origin in their case. The text ended with *zet* that means eternity (Fig. 1).

The sun ray falls on the earth, petrifies, and becomes a granite pillar and the monument to eternity.

This is how the Ancient Egyptians called their sacral constructions: pyramids, temples, obelisks, steles, and statues⁵.

The son of the Sun – the Pharaoh – represented in different forms such as walking, standing, sitting, and lying statues (sphinxes) has been the obelisk in its initial form. They all fit into the contour of the obelisk, the top forming angle of which is around 30°. Many walking statues are literally coming out from the obelisk, presented in a form of a stele behind their back. The sun ray which falls on the earth gives birth to children of the Sun – Pharaohs. The sun ray demonstrably burns into the rock, and the figure of *Ramesses II* appears in the famous *Abu Simbel Temple* (Fig. 2a).

The momentum of posture usually correlates with its proximity to the sanctuary. The closer to the sanctuary: the more powerful is the creating ability of the god of the Sun and the holier is the land where it falls. The god and the Pharaoh are shown walking

⁵ Cf. generally accepted modern terms as *historical landmark*, *cultural landmark*, *architectural monument*, *ancient manuscript*, etc.

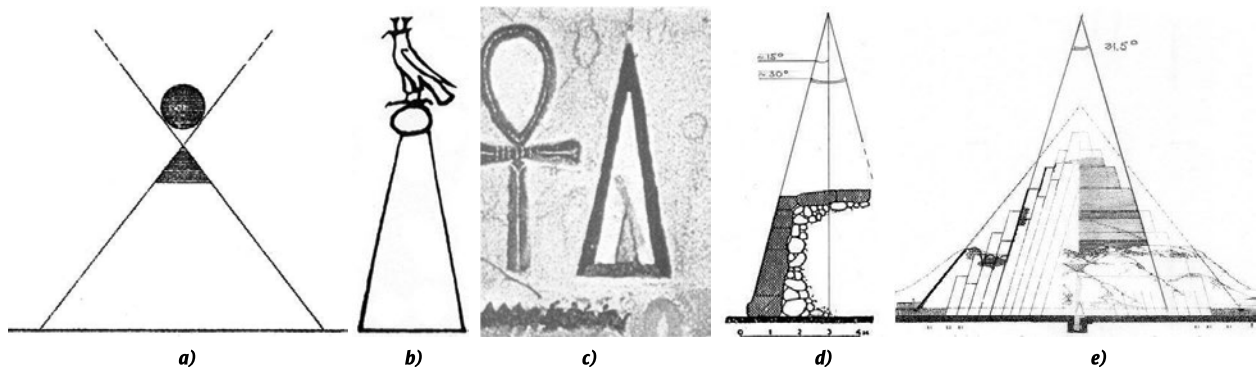


Fig. 4. The Ancient Egyptians imagined and built pyramids from the Sun, with an angle of about 30° : *a* – the scheme of from-the-Sun projection of the outer contour of the pyramid; *b* – the Ancient Egyptian images of the pyramid; *c* – the construction of the traditional tombstone, mastaba; *d* – the construction of the inner structure of the pyramid for Sneferu, the 1st Pharaoh of the Dynasty IV, 27th-26th c. B. C.

both in and before the sanctuary. The throne statue of the Pharaoh, the son of the god and the king on the earth, is put before the pylon of the temple. The Pharaoh begotten by the sun ray in the body of a lion – the king of animals – is shown at the avenue of sphinxes.

The contour of the sphinx is projected from the Sun with an angle of 15° , i.e. through hourly motion of the Sun on the horizon. The 15° contour of the solar sphinx with the head of a ram is completed with a demonstrable image of the contour of the obelisk with a top forming angle of 30° . The stone disk covered with white gold between the horns of the ram used to serve as the upper base of the contour. This golden disk demonstrably represented the Sun as the source of projection, the divine creator of the ram-headed sphinx, the patron of the image of the Pharaoh under its beard.

The sphinx was a procreation of the Sun, a solar projection, for both the architect and the worshipper of *Amun-Ra*. The golden disk was a sacral block equal to the ell of the king, 52.5 cm, for stonecutters who cut the sphinx out of the stone block using a modular grid.

The altar pedestal of the sphinx at the avenue before the western entrance to the temple, from the side of the Nile (Egypt), which shows the cosmic journey of *Amun-Ra* from east to west, is projected with a 15° top angle. The sun ray gave birth to the ram-headed sphinx when it fell on the altar pedestal, the monument to eternity. The hourly shift of the sun ray with a 15° angle was focused by 2 cornices between the pedestals. The sun ray measured 1 hour of real time, 1 hour of life, with the 15° angle between the sphinxes. One of the hymns to the god of the Sun says:

“You are far away, but your rays are on the earth. You are in front of the people, your motion.”

Amun-Ra was shown as *Min*, the giver of life, in the avenue of the sphinxes. He walked south in an ithyphallic form to the female temple: first to the temple of his spouse, *Mut*, and then to his own harem temple in Luxor (Egypt). It is interesting that, upon exiting from his own temple, *Amun-Ra* was turning left, to the South, “answering the call of his heart”, and walking down the avenue of the sphinxes to the temple of his spouse. When exiting the temple of the spouse and heading to the harem temple, he was turning left again. He was walking down the avenue of the sphinxes, passing the temple of his son, *Khonsu*, all the way to the temple in Luxor (Egypt). He was dropping not just a ray, but a seed ray, along the way. An hour-long sun ray with the 15° angle was falling there on the altar pedestal and giving birth to the Pharaoh-headed sphinx. The sun ray gave birth to real vegetation: fruit trees planted in ditches between the sphinxes. The motion of *Amun-Min*, the giver of life, was shown with a huge system of sacral avenues on both sides of the Nile (Fig. 3):

“You are walking like father, giving birth to children, bringing heirs into the world, pristine for your children. ...His spouse is the earth, which he inseminates” (Leyden Papyrus). “The semen of the god is good, coming in front of him,” said architect Ineni about Queen Hatshepsut ([5, p. 330], [8, p. 56], [6, p. 59]).

The West European Egyptology studies architectural monuments based on translated texts and archaeological data including excavations data, i.e. from the ground. The same from-the-ground approach is used when dealing with the issue of build-

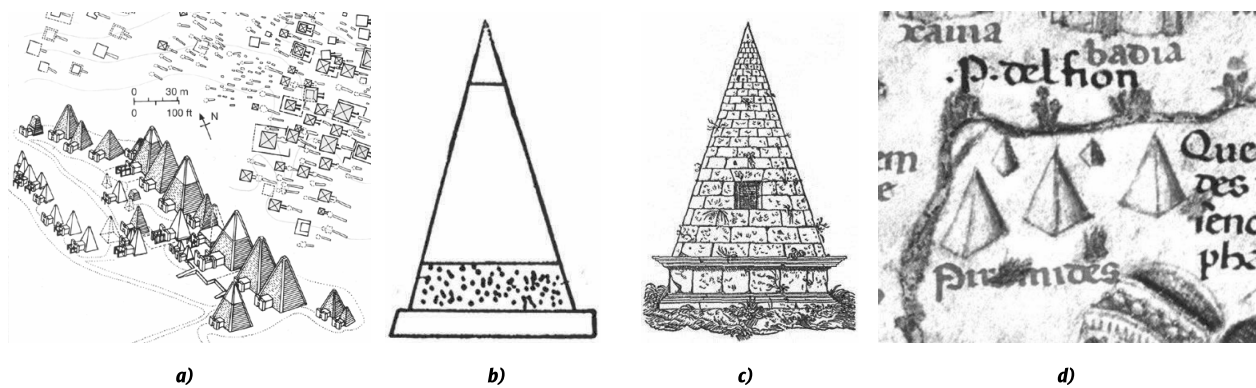


Fig. 5: *a* – the small pyramids in Meroë, first centuries; *b*, *c*, *d* – a pyramid drawn by an Ancient Egyptian artist (*b*) and by a Western European artist of the 15th c. (*c*, *d*)

ing pyramids: the parameters of the base and the angle of the face slope to the foundation are meticulously measured.

The obvious fact that the Egyptians thought about building a pyramid not from the ground but from the Sun as their main deity is somehow lost in this approach. With that approach, the top of the pyramid should be considered as a starting point of the projection, and it is necessary to calculate not the angle between the face and the base, but the forming apex angle, the angle of a solar projection that creates the pyramid.

The top of the pyramid and the top of the obelisk were ornamented with gold-covered stone, a shining pyramidion. The faces of the pyramid were coated with white limestone from stone mines in Tora located opposite of Giza, upstream of the Nile (Egypt). The top of the pyramid and the top of the obelisk shone with sunlight reflected by white gold.

It is important to note the fact which is usually addressed only through the constructive point of view when describing pyramids: the pyramid had not one but two apex forming angles.

The angle that shaped the outer contour of the pyramid is evident to everybody. This angle – the projection angle of the outer contour faces for the big pyramids of the Old Kingdom and the Middle Kingdom – oscillated about 52° within 45 to 70°.

The other angle, hidden in the body of the pyramid and forming its inner structure, usually is about 30°. This angle is evident in memorial tombs, *mastaba*, since the first dynasties. It is also important that this angle and its solar projection exist in different representations of pyramids. The life-bearing role of the sun is shown with green colour, the colour of vegetation, both inside and along the outline

of the pyramid. This proves that the ancient Egyptians built a pyramid and thought about it as a construction with an apex forming angle close to 30°.

The Egyptians could not build a big pyramid with apex forming angle close to 30° and a 200-meter foot side. The height of the pyramid would be more than doubled with such size of the base. Limestone and sandstone blocks in the base would also break down under the pressure. When there was no necessity to build huge pyramids, small pyramids with an about 30° apex forming angle and a chalkstone top were built on a massive scale (Figs. 4, 5).

3. THE TENTS AND SPIRES IN WESTERN EUROPE

The Europeans that visited Egypt in the middle of the 15th century depicted the pyramids with an approximately 30° apex forming angle, just like the ancient Egyptians designed them. Mediaeval Christian Europe did not save such a developed cult of the Sun as Ancient Egypt. But the image of a deity of the Sun that creates life with its ray lived deep inside the traditional folk-life culture from the earliest times. It is natural that tents crowned with a golden ball above the temples were seen as the sun ray which blesses the land, the church, and the man. The world perceived the European cities as the magnificence of dozens of tents and spires. There were tents with an apex forming angle close to 30°.

It is obvious that the obelisks taken out of Egypt by the Roman Caesars and *Napoleon* were naturally but not always consciously perceived by the Europeans as the procreation of the Sun. The obelisks were put up in front of the churches in Ancient Rome and later in Papal Italy. There are much fewer sunny days in Europe and even in Italy

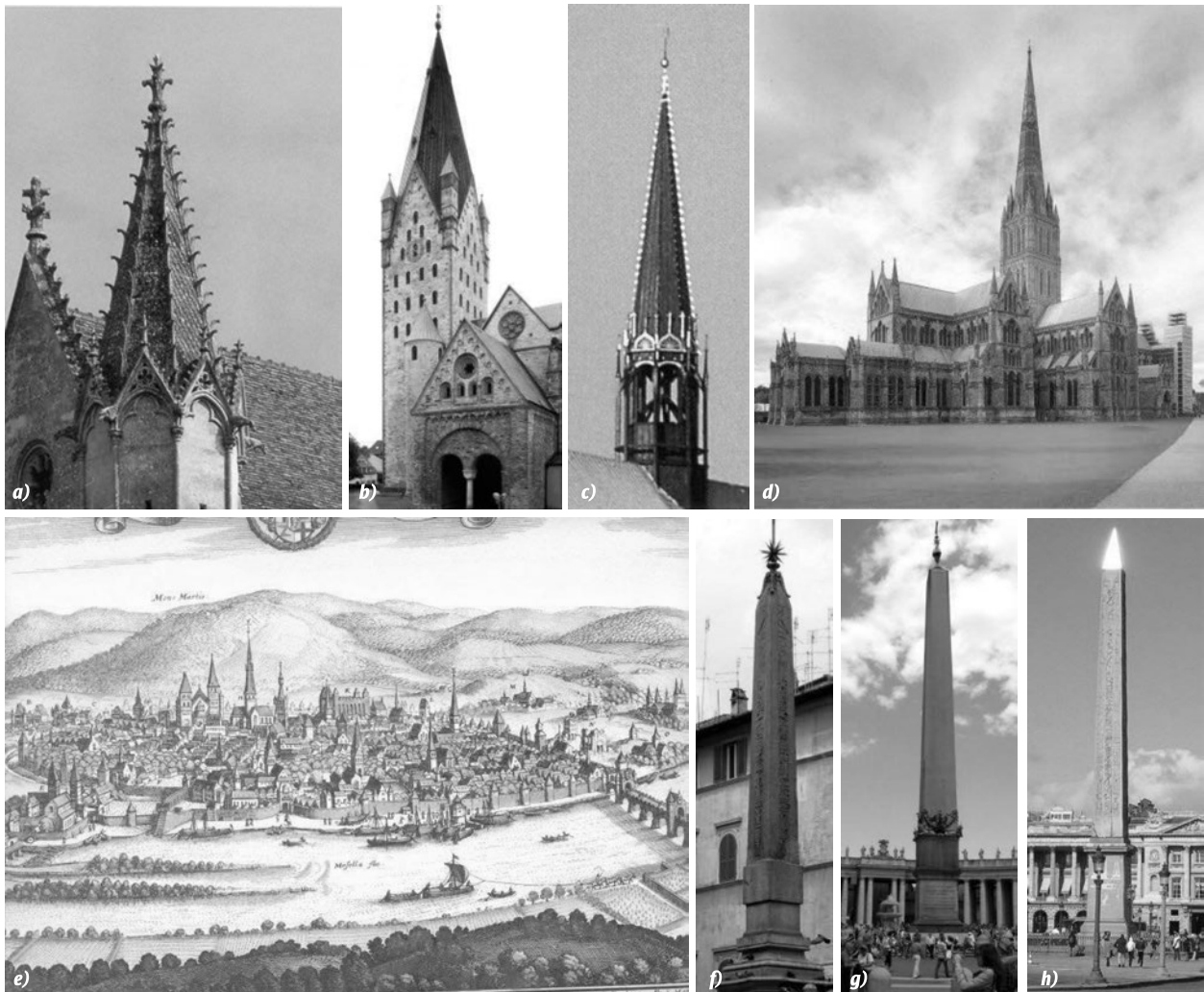


Fig. 6: *a* – the Church in Saint-Germer-de-Fly Abbey (France, 13th c.); *b* – the Church of Saint Patrokli, Soest (Germany, early 13th c.); *c* – the Saint Mary’s Church, Lübeck (Germany, early 14th c.); *d* – the Cathedral Church of the Blessed Virgin Mary, Salisbury (England, 13th-14th c.); *e* – the tents and the spires in Trier (Germany); *f*– the Egyptian obelisk in front of the City Church, Rome (Italy); *g* – the Egyptian obelisk in the square in front of the Saint Peter’s Basilica, Rome (Italy); *h* – the Egyptian obelisk in Place de la Concorde, Paris (France)

than in Egypt. The obelisks and church tents were crowned for more clarity with a golden ball or a depiction of the Sun with outgoing rays. The Egyptian obelisk was put in a place in *Paris* (France) where, during the French Revolution, stood the guillotine that executed thousands of people, and the square was renamed to *Place de la Concorde*. The pyramidion of the obelisk was made in modern time as shiny as it was in Ancient Egypt (Fig. 6).

4. THE TENTS, SPIRES, AND OBELISKS IN RUSSIA

Temples, royal mansions, and fort towers in Russia were crowned with tents from the earliest times. Russia had no white gold but aspen. Simple-shaped

roofs were covered with aspen boards, and complex-shaped roofs were covered with an aspen shingle. Aspen is a hydrophobic wood. The aspen roofing turns silvery after 2–3 years. The aspen roofing looks silver against the background of a cold northern sky and in a cold northern sun.

With stone construction, tent churches became more widespread. An apex forming angle was around 30° even more often in Russia than in Western Europe. A copper or gilded ball was put up instead of a wooden ball at the upper base of the tent. The tent was projected from that golden solar ball. It is not a coincidence that the height of the temple in texts describing the construction order and later in reports on measurements was set as *up to the apple*. The ball may have been combined with a gold-



Fig. 7. The tents in the Russian architecture: *a* – the Trinity Church in Nyonoksa (early 18th c.); *b* – the Saints Zosima and Savvaty Church, the Trinity Lavra of Saint Sergius (early 17th c.); *c* – the Church of Ilya the Prophet, Yaroslavl (middle 17th c.); *d* – the Spasskaya Tower, Moscow (Kremlin); *e* – the tents on the Palace of Tsar Alexei Mikhailovich in Kolomenskoye near Moscow (middle 17th c.), watercolour by G. Quarenghi (18th c.); *f* – the tents on the Kremlin (engraving, 18th c.)

en onion dome that shone in the sun and visibly represented the celestial body in a grey sky. The golden ball under the cross was put up not only above the tents but also above the domes.

Foreign architects who worked in Russia were brought up according to the European traditions of tents and spires and perceived the Russian tent traditions as quite natural [9, p. 140–141]. *Christopher Galloway* from Scotland built a tent over *the Spasskaya Tower* at *the Moscow Kremlin* (Russia). He put up the same golden ball in the upper base of the tent. From the golden ball down the ribs of the 8-faced tent, *Galloway* stretched a chain of out-bowed tiles which are alternating on yellow and green colours. The sparkling light ran down the ribs of the tent. This theme was now developed, and tri-chromatic illuminations are stretched over the tiles. It can be seen that the ruby star with golden strips may be perceived as a form of a golden ray star that the Catholics put up on the Egyptian obelisks.

The Russian cities were reaching to the sky towards the Sun with many tents crowned with

a golden ball as representation of the sun up until the 1930s (Fig. 7).

Peter the Great built Saint Petersburg (Russia), imitating traditions of Northern Europe where spires were preferred over tents. The desire to pierce the grey sky with the sun ray can be understood since there are just over 60 sunny days in Saint Petersburg just as in Northern Europe. The crowning of spires for *the Saints Peter and Paul Cathedral* and *the Admiralty Building* with a golden ball and their projection from top downwards, from the sun, even unconscious, is also understandable. The golden ball also appeared under the royal eagle at the top of the obelisk that was put up in honour of victories by *Count Rumyantsev* over the Turks. Spires found their own perception in Russia. Commoners viewed them as a peculiar form of a tent.

The spire fashion reached the outlying north provinces in the first half of 18th century. The architect put up 3 copper spires on the top of *the Saint Gate of the Archangel Michael Monastery* in Veliki Ustyug (Russia). Copper acidifies and turns green

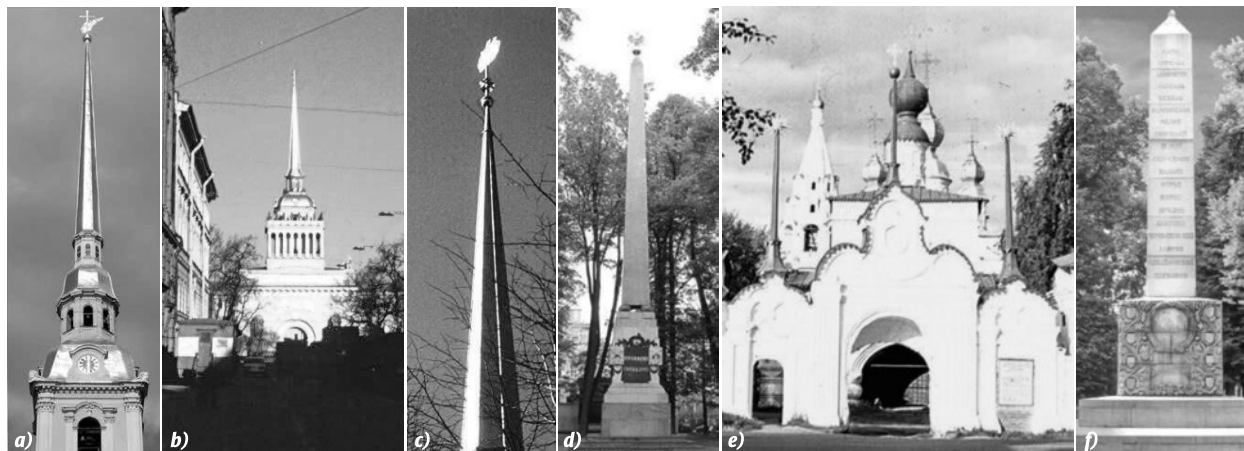


Fig. 8. The spires and obelisks in the Russian architecture: *a* – the spire over the Saints Peter and Paul Cathedral, St. Petersburg (early 18th c.); *b*, *c* – the spire over the Admiralty Building, St. Petersburg (early 19th c.); *d* – the Obelisk in Honour of the Victories by Count Rumyantsev-Zadunaisky, St. Petersburg (late 18th c.); *e* – the Saint Gate of the Archangel Michael Monastery in Veliki Ustyug (early 18th c.); *f* – the Obelisk in Honour of the 300th Anniversary of the House of Romanovs, Moscow (early 20th c.)

with time, and the sound keeper paints it green with no extra thought. The spire was crowned with a copper ball and a cross above the central span. The ray celestial bodies, the same as on the Egyptian obelisks in front of the Roman churches, are still shining above the side entrances even after their restoration (Fig. 8).

The obelisks were put up as monuments in honour of heroes and important historical events in Russia of the 19th and 20th centuries. Even the weird-shaped *Obelisk in Honour of the 300th Anniversary of the House of Romanovs* is crowned with some sort of a stone ball. The plywood obelisks were put up as tombstones for fallen soldiers during and shortly after the World War II. They were of-

ten crowned with a plywood star that was hastily sawed-out. They were eventually substituted with concrete obelisks crowned with a gilded star. The grave of the hero fallen for his nation should be illuminated by the sun ray (Fig. 9).

The only thing left to understand is why an apex forming angle of an obelisk, a pyramid, and a tent was tilting to 30° in Ancient Egypt, Medieval Europe, and Russia. There is one fundamental regularity that exists not only in the architecture. This mathematical regularity is usually called the golden ratio. The golden ratio is simply represented with a bisected line segment where the small part is related to the big part as well as the big part is related to the whole segment. This correlation is numeri-

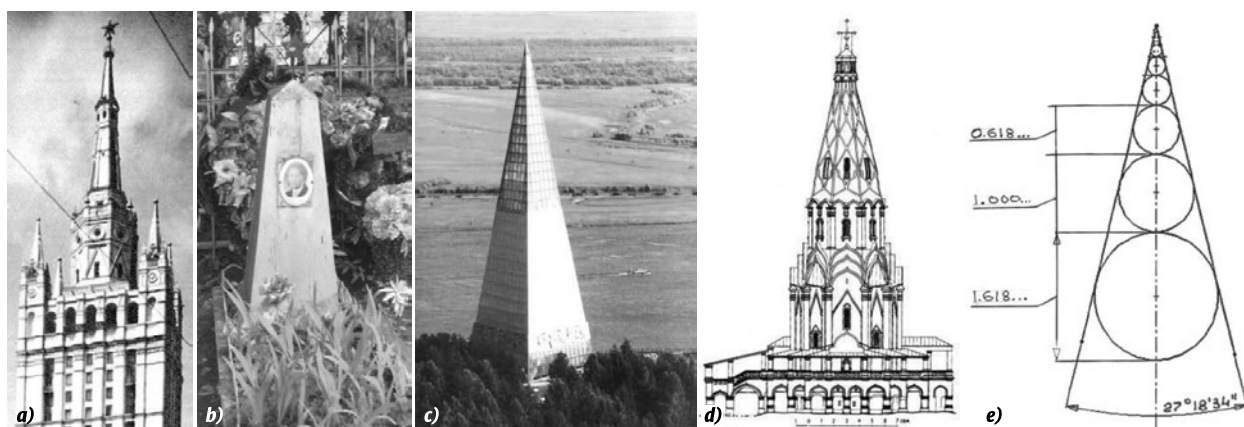


Fig. 9. The spires, the obelisks, and the tents in Russia (from the latter half of the 20th c. to the early 21st c.): *a* – the Kudrinskaya Square Building, Moscow (middle 20th c.); *b* – the obelisk on the grave of a country policeman, Vologda Region (early 21st c.); *c* – the Memorial to Yugra Oilers, Western Siberia (late 20th c.); *d*, *e* – the upper corner of the projection in the tent construction from the golden apple: the tent of the Church of the Ascension, Kolomenskoye, Moscow, (middle 16th c.) (*d*) and the scheme of the projection angle of the golden ratio (*e*)

cally represented as 0.618...: 1.00: 1.618... The Ancient Greeks knew about this harmonious correlation, and it was empirically used even before that. The theoreticians of the Renaissance in the 19th and 20th centuries perceived the golden ratio either mono-dimensionally – by a linear series – or bi-dimensionally – by a dimensional ratio of rectangles.

This proportional regularity was constantly found outside of the architecture and art in the construction of natural bodies: crystals, plants, animals, and human. This regularity is now found in the structure of the planetary orbits in the Solar System [4, p. 256–284]. Pavel Florensky, a great Russian scientist and a philosopher, wrote in 1916: “... the golden ratio is an ONTOLOGICAL LAW; as understood before, it expresses the construction of a WHOLE BODY as such” [7, p. 485].

When imagining a three-dimensional correlation of the golden ratio, one will get an infinite series of spheres in the same common axis with their radii correlating as... 0.618...: 1.00: 1.618...: ... (Fig. 9e). The apex forming angle for such a series of spheres will be about 27° 18' 34", i.e. 30° in rough approximation. This is one of the ontological aspects of this topic. The other aspect is determined by the construction of our eyeball, an optimum sight angle which has approximately the same angular dimensions. The whole perception of the outer world by the human is determined with these parameters. The human system of the land navigation and the choice of the motion path are based thereon. If that assumption is correct, it means that the nature created its ontological construction in the course of evolution, including the construction of people which determines their space impression of the outer world. That explains the universal human tendency to projecting architectural forms from the universal human celestial body, the Sun, with an apex forming angle of about 30°.

5. CONCLUSION

The presented set of observations allows to make some generalisations since it is based on the broad spectrum of cases from different cultural traditions related to different historical eras.

We see two factors in terms of the universal history – similar perception of natural events and their representation in human culture, including the architecture, – are naturally created by the universal essential living bases and the similarity of human

reasoning. Many scientific and technical discoveries were made almost simultaneously and totally independently from each other in different countries, as we know from the recent history.

One can say in terms of a specific subject of research that the human felt a life-giving role of the Sun from the very beginning and perceived it as the source of life. This ancient belief which created a simple and natural solar cult in some historical situations and a well-developed religious system in other situations is fully proven by the modern science. It is natural that the sun ray was perceived as the bearer of the prizes of life, first unconsciously and then consciously, in some cases as the bearer of the celestial information and, of course, as a divine weapon that can give life, warm, or burn, and that can also create. There is no better example of the universal creating natural phenomena expressed in culture than the Sun and its rays.

Plutarch, a famous Greek historian of the 1st and 2nd centuries, said: “*There is only one sky above all nations, and one god has many names.*”

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