sciendo

Acta Materialia Transylvanica 6/1. (2023) 01–08.
DOI: Hungarian: https://doi.org/10.33923/amt-2023-01-01
English: https://doi.org/10.33924/amt-2023-01-01

ACTA MATERIALIA TRANSYLVANICA

The Reconstruction of the Creation of the Holy Crown

Miklós BARABÁSSY

KEMPELEN Tudósakadémia Alapítvány, https://barabassymiklos.academia.edu, Budapest, Hungary, miklos.barabassy@gmail.com

Abstract

Determining the place and time of an artefact's origination starts with archaeometry surveys. The aim of the study of the Holy Crown is to characterise in detail the parts of the crown – the frame, the filigree and the sockets, i.e. the metal parts – and the decorations (enamel, gemstones, beads), to determine the exact composition of the materials and to discover the place of origin. Archaeometry also includes the reconstruction of the technical and technological processes associated with artefacts. The absolute age of the artefacts can be determined using organic materials such as adhesives. This is basically a natural science. If we include the auxiliary sciences - photo-optical data recording, 3D modelling, which allows us to continue the study on the computer – it is possible to determine the relative date and place of the crown parts, using parallels with applied art, palaeography, etc. To date, no systematic archaeometry study has been carried out on the Holy Crown. There have been photographs, geometric measurements, visual inspections and descriptions by jewellers and engineers. If we want to write a scientific summary, we have a lot to draw on. The present article is such a summary, in which we attempt to reconstruct the technology of the Holy Crown, with the aim of pointing out the need for a complete archaeometry study.

Keywords*: Holy Crown, technology, archaeometry.*

1. Introduction

The Holy Crown shown in **Figure 1** is made up of two distinct parts; these are shown in **Figure 2**. The first is the vault, also known as the Latin crown, a cross-strap, which, judging by visual inspection, is made of a purer (less alloyed) material. The surface of the cross-straps is densely decorated. It is a common representation of the techniques and styles used in the jewellery workshops of Western Europe and the northern Alps. Latin inscriptions appear on the enamel designs.

The other part is the hoop crown, also known as the Greek crown, which reflects the shape of an open crown without the cross-strap. The material of the hoop appears to contain more alloying material than the support plates of the cross-strap. The enamel images belong to two strikingly different groups. One group consists of figural enamel designs with Greek inscriptions, while the other group consists of translucent glazed enamel, i.e. an ornamental element in the form of scales.

The technique is not very uniform, sometimes rough; the metalworkers described it as a work without a workshop.

From the early 1800s, when it became possible for the general public to view the crown, the names Greek and Latin crowns became widespread, and with them the two-crown theory. The essence of this is that there was an open crown originating in Byzantium and an attached vault of western origin. Before this, there was a consensus belief that the Holy Crown had been handed down to us from St Stephen, our first king, and that only those who were crowned with this crown could be kings. Already from the 13th century onwards, the Holy Crown doctrine, which is a legal system and a constitution, is gradually being developed. According to this view, the supreme sovereign authority belongs to the Holy Crown, and for several hundred years the people of the Holy Crown have been the Hungarian nation.

Habsburg absolutism could not tolerate this, and continually tried to diminish the freedom of

Figure 1. *Front view of the Hungarian Holy Crown. (Photo: György Bence Kovács)*

Figure 2. *Two separate structural units of the Hungarian Holy Crown: the crossband (top) and the rim (bottom).*

customary law, and subsequent communist and socialist governments tried to abolish the respect that had been built up around the Holy Crown and to adopt a constitution to reflect this.

When the Holy Crown was returned to Hungary at the beginning of 1978, a Crown Commission was set up, which did indeed take a scientific approach to the Crown, but some historians, influenced by the political methods of the time and of the past, anticipating the conclusions of the Commission, published several studies and books: all of them to prove the two-crown theory. Yet a group of five goldsmiths **[1]** managed to examine the crown twice. They, however, came to a position contrary to that of the historians, namely the unitary crown theory. The result was that the then Minister, on the recommendation of the Crown Commission, ordered all publications and films on the Holy Crown to be edited by historians **[2]**.

This move led to a split in the interested public. The Department of Humanities of the Academy of Sciences is the hallmark of one part, the smaller one: the adherents of the two-crown theory and the belief that the Holy Crown could certainly not have been the crown of St Stephen. This, let's face it, is destructive to the nimbus of the Holy Crown. The other part, the larger part, is represented by the so-called alternatives, who, whatever the philosophers may say, still consider the Holy Crown to be the crown of St Stephen, which is still the basis of the unity of the Hungarian nation and the foundation of our Constitution.

Well, it is this strong opposition that got me thinking. By their very nature, the humanities are not an exact science, and indeed, they deliberately exclude the representatives of exact science from their circles. In my opinion, whatever the results of the exact sciences may be, it will not destroy respect any more, but it may open up the possibility of a convergence of views in the light of established facts.

The only proof of the creation of the Holy Crown is the crown itself. My work is aimed at using the possibilities of applied scientific investigation to point out the technical regularities, and at using the interdisciplinarity of the natural sciences to bridge the gap between the results of the investigations offered by modern technology and those of the humanities.

2. Experimental and computational methods and source materials used for the thesis

As a project and process engineer, I have gained extensive experience in the creation of CAD models for engineering. As a first step, I created a 3D model of the Holy Crown using a CAD program. To do this I obtained, mainly from the photographer Károly Szelényi, a series of photographs of the Holy Crown taken twice, 20 years apart. I also used the data actually measured with a caliper by the goldsmith's group [1]. I also had access to photographs by Joachim Szvetnik [2]. During the months of modelling I had the opportunity to learn about the challenges that a 9th-13th century goldsmith and enameller had to face. So I looked for procedural descriptions from that period.

In the early 12th century, Theophilus Presbiter [3] summarised this. Again, it was of high importance to learn about enamel making and the soldering process of the time, which had been forgotten. Fortunately, Eghart Brepohl, the internationally renowned goldsmith, reconstructed Theophilus Presbiter's techniques and explained them in a book. But also of great help was Bosselmann Ruibicke, who compared Theopholus' technology with the technical descriptions of the Byzantine goldsmiths of 100 years earlier [4]. I also found a detailed description of the soldering process used to solder the filigree and the various settings [5]. It was a great help to take advantage of the facilities offered by my second home, the university library in Cologne.

It is important to underline the activities of the Crown Commission, which was founded in 1978 and which has produced a great deal of work and results. I have also been able to obtain the protocols of the Crown Commission thanks to the heritage of Joachim Szvetnik in Tiefkút [2]. Of course, there is not enough space here to list all the source material, but I must mention the important material of two Holy Crown conferences. One was held in Budapest in 1983 [6], the other in Paris [7]. Their papers were published, unfortunately only in foreign languages. I later published edited versions of the more important lectures on academia.edu, where I now have a following from more than 100 countries (more than 16,000 readings), including byzantologists, historians and art historians from universities around the world.

All my claims have been verified by experiments. I have obtained specimens in pure gold, but I have also used copper to test for fracture or other external influences. I describe these in detail in my book *The Holy Crown through the eyes of an engineer*. [8]

Last but not least, in order to verify the scientific validity of my claims, I have made a replica of the crown myself, which is an exact copy of the original, including the particularities that deserve special attention in the creation of the crown.

3. The key features of the manufacturing of the Holy Crown

The shape of the hoop ring is almost circular, with the cross-strap attached centrally (**Figure 3**). The other features are described separately.

3.1. Feature 1

The angles between the stems of the cross-strap are different from each other, in this sense the strap is inaccurate.

The rim is divided into eight wedge fields by eight enamel image sockets, with high precision. The front and rear wedge fields are wider, which suggests that this ring was probably made as a crown ring. The width of the other gem fields is identical (**Figure 4**).

3.2. Feature 2

The partition of the hoop is independent of all other crown parts. Thus the hoop ring could be a semi-finished piece used to make the crown.

If the sockets and gemfields on either side of the centre line of the frontal field are placed side by side, extended from the centre line, it is visible that the Kon side is 4.7 mm shorter (**Figure 4**). The distance between Kon and Damian is 1 mm nar-

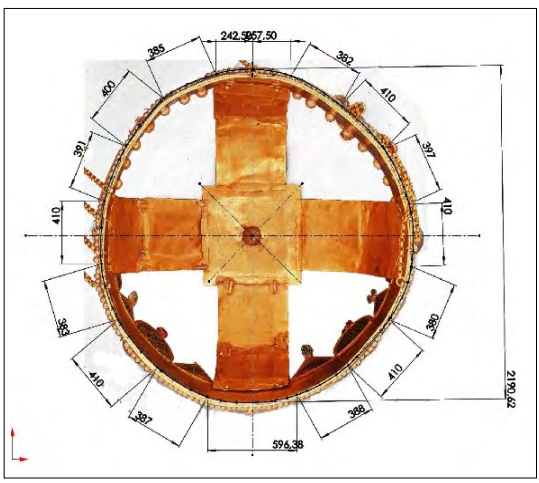

Figure 3. *Fit of the cross strap to the hoop.*

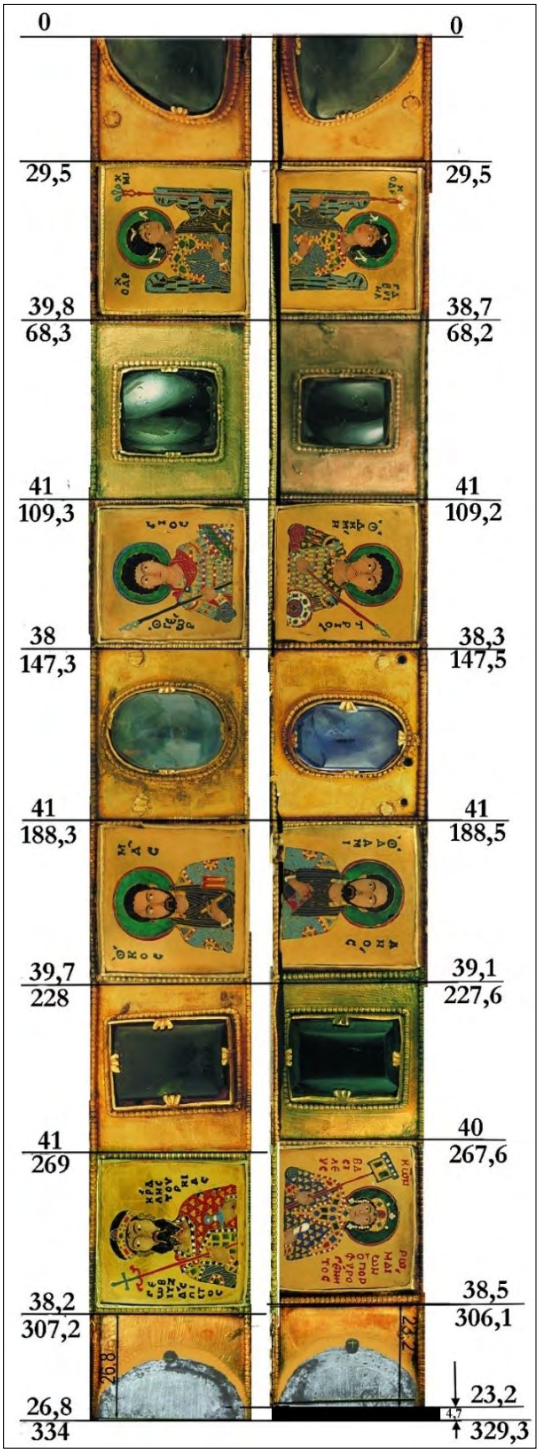

Figure 4. *The crown of the Hungarian Holy Crown lay out, with the size of the individual parts holding the decorations and the position of the circumference measured from the centre line of the frontal part.*

rower than the other gemfields. This means that the narrower side of the solder line of the stone field is increased by 1 mm, which optically reduces the asymmetry (**Figure 5**).

3.3. Feature 3

The solder line of the cross-strap ends visible in the back stone field is asymmetrical and is centered on the centerline of the back cross-strap stem.

Looking at the rear view of the crown (**Figure 5**) it is noticeable that the centre line of the rear panel is not in the centre line of the rear stone field, but is exactly in front of the rear stem of the cross-strap, in line with it. It can also be seen that the starter ring supporting the rear spike is also in line with it. These discrepancies are not accidental, however, but are related to other features.

3.4. Feature 4

The rear pediment element and the starter ring which supports the rear pendilias, although fixed to the hoop, are not aligned with the hoop but with the rear stalk of the crossbar.

This asymmetry is also repeated in the frontal part. The central socket of the frontal part is the Christ socket, which has triangular and curved pediment elements on either side, with the same common spread. Thus, their position is determined by the Christ socket, which, like the back moulding, is aligned with the front cross straps stem rather than with the central axis of symmetry of the front (front) field (**Figure 6**).

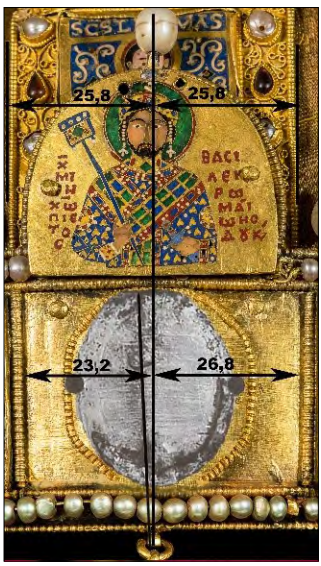

Figure 5. *Deviation from symmetry in the back field.*

3.5. Feature 5

The central image of Christ on the front of the frontal pediment is aligned with the forward stem of the cross-strap, so it is also asymmetrical in relation to the ring of the hoop; it is positioned exactly in front of the stem of the cross-strap. But the image also shows that the rings holding the true pearl string are also in line with the axis of symmetry of the cross-strap stem.

As a complement, it is also worth studying the welding of the hoop ends (**Figure 7**).

The joining of the ends is rather rudimentary and appears to be an afterthought. The two small holes that hold the ends together are not filled with solder and only a spot solder joint is visible (**Figure 7**). This is explained by the alignment required during assembly. It can also be seen that there was originally an oval gem, now replaced by an octagonal one. On the inside, the holes used for joining are clearly visible (**Figure 8**). The above features allow us to establish the technology used to produce the Holy Crown as a unique handcrafted product. A flowchart of the production process is shown in **Figure 9.**

4. The technology of the Holy Crown

The Holy Crown has two parts, the hoop ring and the cross strap, which do not fit to any other part of the crown, they were created independently. Like a hat, a crown has only one important dimension: the diameter of the hoop. So a hoop had to be first designed. In the case of the Holy Crown, the present-day hoop was divided into 8s with geometrical precision. Therefore, it can be argued that this does not necessarily prove that it was made for the cross-strap, but it does not rule it out.

In the next stage of crown creation, because of the features described in the previous chapter, it is not possible to imagine that the decoration of the hoop could have been made without the cross strap. Thus, the third part, the pediment, the rings holding the pendilias, the large stone at the back and the rings holding the string of pearls below the image of Christ form a separate crown part, since they are attached to the hoop ring but fit the cross-strap. The style of decoration of the cross-strap is coherent and was also created independently of the rest of the crown. It is important to note that the process used for the construction

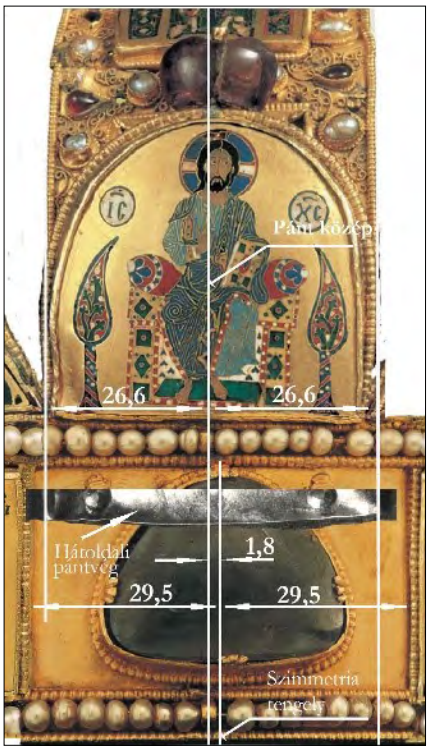

Figure 6. *Symmetry deviations of the frontal fields.*

Figure 7. *Tyre end weld location.* **[7]**

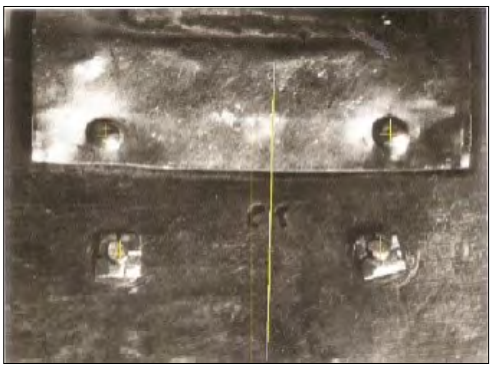

Figure 8. *Solder line of the hoop ends as seen from the inner side.* **[2]**

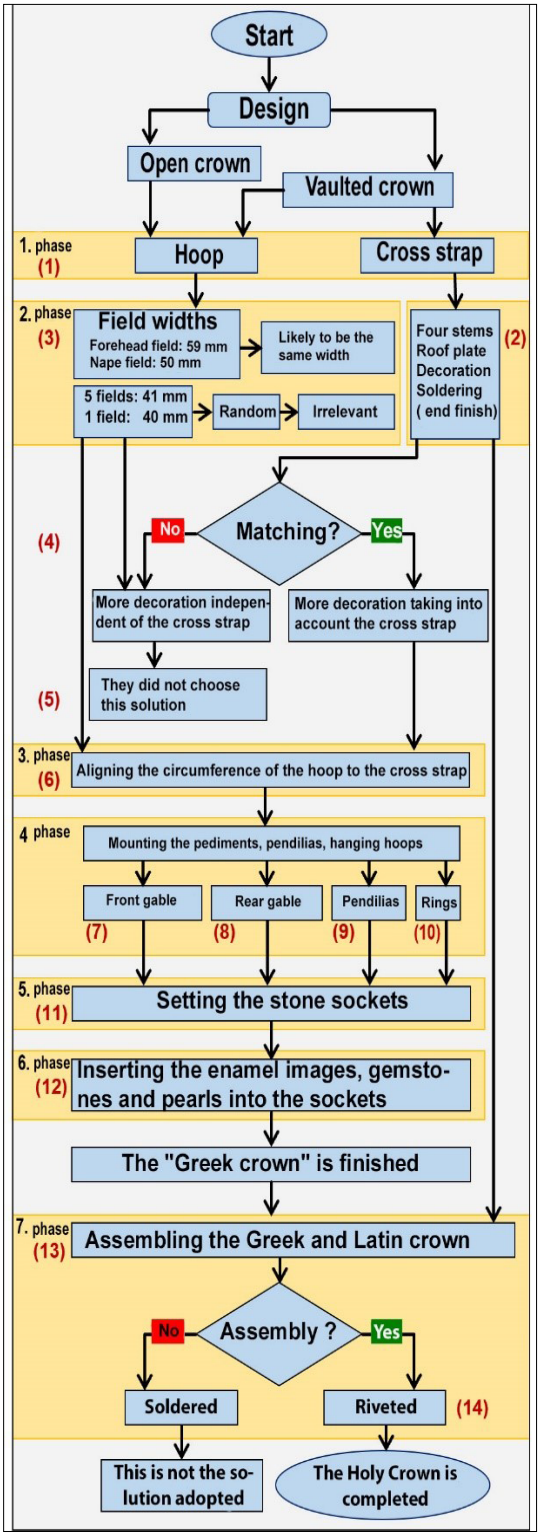

Figure 9. *Reconstruction of the technological flowchart of the manufacturing of the Holy Crown.*

implies not only a high level of expertise, but also a much higher degree of artistic expression than the „workshop-less" eclectic solution of the hoop. These two parts are assembled in the last step by riveting. The cross-strap was joined to the semi-finished tyre ring. A fitting direction had to be chosen, which in the case of the crown was the transverse direction, because space is tighter there and the asymmetry is less apparent in the case of wider fields. The fitting possibilities for the cross strap do not extend to the angles between the stems. Also, fitting the hoop could only be done by shortening the length of the hoop by cutting it out. Indeed, a piece was cut from it so that the ends were welded together exactly on the centre line of the cross-strap; this is shown in **Figures 5.**, **6** and **7**.

The rear cushion socket element is also not on the centre line of the field below it, but on the centre line of the rear crossbar. In the grayscale image, the dismantled current back stone is shown behind in **Figures 5.**, **7**.

The socket of the central image (Christ) of the pediment is clearly visible just in front of the front stem of the cross-strap. But it is equally visible that the rings holding the bead strings are also exactly aligned with the centre line of the cross-piece (**Figure 6**). Of course, the contemporary goldsmith had the possibility to place the pediment and the other ornamental elements listed symmetrically to the hoop division, but he did not do so; he aligned them with the cross-strap for a better appearance.

The back stone is secondary. After dismantling, you can see that the soldering is very rudimentary, spot soldered, and the material has not even flowed into the holes where it is being joined.

Figure 7 and **Figure 8** show the slightly inclined orientation of the hoop ends and the mounting holes from the outside and inside. The front ring supporting the rear pendilias is also aligned with the solder line of the ends in the direction of the rear cross strap stem.

5. Theses

The creation of the lower part of the Holy Crown is therefore not necessarily linked to a workshop or a specific time. It follows from the scientifically proven technological reconstruction that, although the pediments, the pendilias, the string of bead holders and the large stones are all part of the hoop crown, they were aligned with the cross-piece. So, in the process of creation, the place-

ment of the moulding and the dangles preceded the creation of the crossband, as they are aligned with it. A reproduction of the crown was made to verify the technology. By following the technological process, the creation can be repeated as often as you like and the result will always be the same. The condition of scientificity is thus verified.

The novelty of the thesis is related to the technology described. Knowing and using it, it is possible to determine what further investigations are needed to elucidate the place and time of the manufacture of the Holy Crown.

6. Application

The technological process described above cast doubts on the current mainstream philosophical opinions. Of course, the humanities cannot be the subject of this thesis, but my work opens up for the first time a justified possibility to involve the exact sciences in the study of the Crown and to point out what further investigations are needed to determine the production of the Holy Crown. These investigations are identified and defined by standard archaeometry.

In this context, I must highlight the most widely used for artefact examination, the XRF examination. Knowing the trace elements of gold plates can help to determine the place and time of their production, as there are already databases of tests carried out on artefacts. This alone, however, is not enough: art history and historical verification are also needed. It is, however, possible to determine, for example, whether the material of the pad and the tyre are the same. XRF tests can be used to determine the chemical composition of the enamel and jewel settings, thus making it possible to determine whether the parts of the Holy Crown belong together. By grouping the same gold alloy settings in the same group, it is possible to determine which parts were made in the same workshop at roughly the same time.

Along the same lines, if the blue and green enamel on the pediment matches with the blue and green enamel on the apostles of the cross-strap, it is highly probable that the whole crown was assembled in the same workshop.

Organic materials have been found in other prestigious museums. Dendrochronological or carbon isotopic analysis of the organic material may be able to infer certain repairs or dates of manufacture. These studies would make a major contribution to our understanding of how the Holy Crown was made.

7. Verification of the technology

In order to verify the correctness of the technology used, I have also found it necessary to make a crown copy. This copy is shown in **Figures 10** and **11**.

Even with the tools of the time (calipers, rulers), the exact division of the hoop was not particularly difficult. The crosspiece, on the other hand, was made in five parts by first soldering the filigree, the bead wire and the sockets to the stems and the roof plate, and then by riveting them together and soldering them. The cross strap dome shape and the soldering together are always done with some inaccuracy. The question arises, before the pediment is constructed or fitted, to what should it be fitted: to the hoop or to the cross strap?

The early goldsmith chose the cross strap. If this decision is followed for each crown made, the re-

Figure 10. *Copy of the Holy Crown from the front .*

Figure 11. *Copy of the Holy Crown from behind.*

sult will always be the same. Although the pediment and other ornamental elements are part of the „Greek crown", they are still aligned with the cross strap! This justifies the correctness of the technology of reconstruction

References

[1] Csomor L.: *Magyarország Szent Koronája*. Vay Ádám Múzeum Baráti Köre, Vaja, 1986. 29–34.
[2] Szvetnik Joachim hagyatéka: Koronabizottsági jegyzőkönyvek, jegyzetek, előadások anyaga, a mélykúti könyvtárból. A polgármester engedélyével. Mélykút 2017.
[3] Brehpohl E.: *Theophilus Presbyter und die mittelalterliche Goldschmiedekunst*. Böhlau, Wien, 1987.
[4] Bosselmann-Ruickbie A.: *Das Verhältnis der „Schedula diversarum artium" des Theophilus Presbyter zu byzantinischen Goldschmiedearbeiten: Grenzüberschreitende Wissensverbreitung im Mittelalter?* In: *Zwischen Kunsthandwerk und Kunst. Die „schedula diversarum artium"*. (eds.: Mauriège M., Westermann-Angerhausen H., Speer A.), DeGruyter, Berlin, 2014, 333–368.
[5] Eilbracht H.: *Filigran- und Granulationskunst im wikingischen Norden: Untersuchungen zum Transfer frühmittelalterlicher Gold- und Silberschmiedetechniken zwischen dem Kontinent und Nordeuropa*. Rheinland-Verlag, Köln, 1999.
[6] Köpeczi B., Székely Gy., Buckton D.: *Insignia Regni Hungarie I. Studien zur Machtsymbolik des mittelalterlichen Ungarn*. Magyar Nemzeti Múzeum, Budapest, 1983.
[7] *Acta Historiae Artium 43*. Akadémiai Kiadó, Budapest, 2002.
[8] Barabássy M.: *A magyar Szent Korona mérnöki szemmel*. PenClub, Budapest, 2020.