Stone Setting Practiced by the Masons of the Naumburg and Meissen Cathedrals—a Comparative Look at Stone Setting Techniques[1]

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If one aims to take a closer look at a medieval building site, it is inevitable to pay careful attention to the traces that were left on the stones set and built. This article presents a detailed study of the stone setting techniques applied during the construction of the Naumburg west choir and a comparison with the techniques applied by the masons who built Meissen Cathedral. The question of how building stones were moved to their final positions is of particular relevance, specifically as the solution of the logistic and technical challenges, which were connected with it, and the available machines were of major importance for the realisation of a construction project of this dimension. For this reason it is necessary to clarify the details of the various setting techniques that were used on the building site. The basic categories here are vertical transport and horizontal transport. It was above all the physical power of the workers that was decisive for the horizontal movement not only of the stones but also of all other building materials across the building site, using e.g. barrows or baskets. What is even more interesting is the vertical movement of the stones since it was far more complex in terms of organisation and the available technology. It was only by vertical movement that the building stones were hoisted into place. Tools were used to move the stones, e.g. so-called lifting gears and fastening means. Lifting devices are mechanical appliances for hoisting loads, e.g. a crane, a winch, or a pulley. The fastenings, e.g. ropes, chains, lewis or kerb lifter, form the connection between the load attachments and the load, i.e. the ashlar, and are not part of the lifting equipment. A load attachment, however, is permanently attached to the lifting device and may be a chain, a hook or a rope.

Vertical stone lifting devices are basically divided into three groups according to the fastening used, namely ropes, lewis and kerb lifter.[2]

Ropes used as fastenings are assumed to be the oldest stone setting technique. It was possible to pass them through specially devised canals or to fasten the ropes to bosses or other projections of the workpiece. If, however, the ropes were simply laid around the outer edges of the stone, setting the ashlar required an intermediate step. The stone was first bedded on wooden dunnage to be able to remove the ropes, before it was lowered onto the mortar bed. If the ropes were tied

[1] An extended version of this paper is being published in Krohm, H. and H. Kunde forthcoming. *Der Naumburger Meister. Bildhauer und Architekt im Europa der Kathedralen*. Ergänzungsband zum Ausstellungskatalog der Landesausstellung Sachsen-Anhalt 2011, vol. 3 (Petersberg).

[2] Summarized in: Leistikow, D. 1982. "Aufzugsvorrichtungen von Werksteine im mittelalterlichen Baubetrieb: Wolf und Zange," *Architektura* 12, 20-33; Ganßauge, G. 1937. "Hebeklaue und Wolf," *Deutsche Kunst und Denkmalpflege*, 199-205; Schröck, K. 2010. "Darstellungen und Spuren des Steinmetzgeschirrs," in B. Klein and S. Bürger (edd.), *Werkmeister der Spätgotik. Personen, Amt und Image* (Darmstadt), 26-43.

around well hewn blocks of stone, it was advisable that the edges were protected by straw, boards or strips of wood to prevent the edges from spalling.

The second lifting technique was to use the lewis.[3] There are small and large lewises (Fig. 1). A small lewis is used for bedding rather small stones. It consists of a dovetail middle leg with a hanger and two prismatic outer legs.

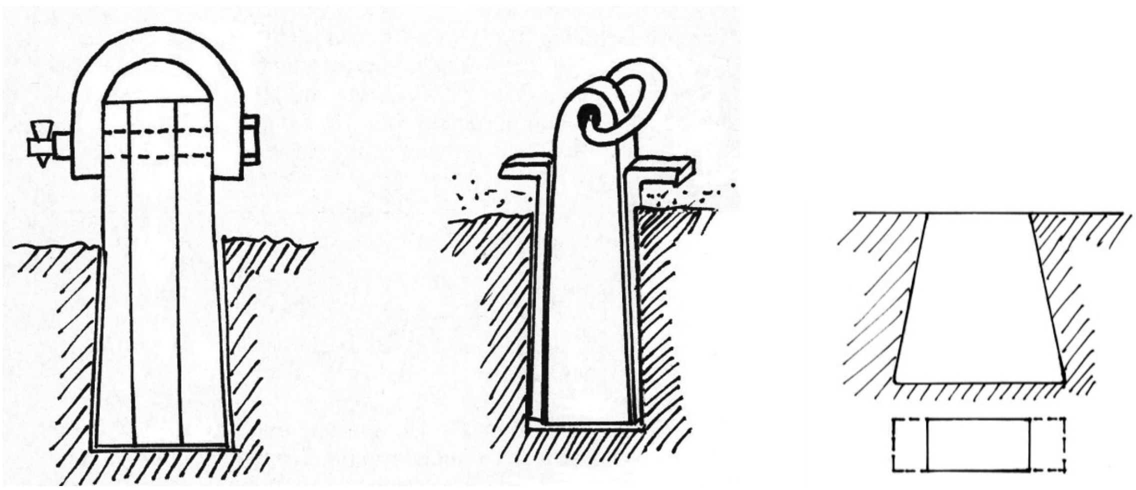


Fig. 1: Big Lewis Small Lewis Lateral Cut

As a rule, the hole, in which the lewis is inserted, is found in the upper face of the ashlar. It is necessary that the hole is dressed and is only slightly larger than the broad bottom end of the middle leg. The stone is fixed by inserting the outer legs after the dovetail middle leg; the stone is released in reverse order. Setting very large stones calls for the big lewis. It consists of three parts, too. However, the parts are connected by a bolt with clevis and pin or by a screw connection. The two outer legs are thinner at the top and flaring towards the bottom. The outer legs are inserted into the lewis hole first, while the prismatic middle leg is put in last; the removal procedure is again in reverse order. When using a lewis, one should pay attention to some important details. First, it is necessary that the lewis holes are always worked into the stone above the centre of mass. Second, if fastenings are used for stone setting, the stone material should be of very good quality in order to prevent risks. Moreover, the ashlar must hang in a horizontal position thereby preventing it from tilting and from being drawn, in particular sudden drawing, since uneven loading of one edge of the hole may result in the lewis being torn off. As soon as the ashlar is being hoisted, the lewis may go up by approximately 10 mm before it starts to take effect. The lewis is packed in the seating in a coarse-grained water/sand slurry to improve frictional resistance.

[3] More detailed information about the different variations: Leistikow (supra n.2) 22ff; Kraut, T. and F. S. Meyer 1982. *Das Steinhauerbuch. Die Bau- und Kunstarbeiten des Steinhauers* (repr. of Leipzig 1896 edn., Hannover) 196-97.

Another type of fastening is the kerb lifter or external lifter (Fig. 2).[4] It consists of a pair of S-shaped, forged arms that are fastened together with a bolt and pin or a rivet. At its top end, the kerb lifter has eyes that can take up several chain links. They are tied together with a ring; this ring serves to take up the load attachments.

Fig. 2: Kerb Lifter

As a rule, the holes for the lifter are hewn into the face of the stone—i.e. in the front surface—and the rear face of the stone, always above the centre of mass. As the stone is hoisted, the lifter gets stuck in the holes and can be released only after discharge, i.e., after the stone is set down. The shapes of the lifter holes vary and depend on the shape of the ends of the kerb tongs. If we presume that the stone is set using kerb tongs, it was necessary to precisely mark off the lifter holes in advance to ensure the smooth setting of the stones. Such traces of using kerb lifters, i.e. the holes in the ashlar, can be discovered in many constructions. Until now, only these striking traces have been considered. However, I came across a very interesting finding in the Naumburg Cathedral which brings us to the actual subject.

The novel and not yet described finding I am talking about is that I found stones in the east choir of the Naumburg Cathedral in which the position of the lifter hole is exactly marked off but the holes were not dressed. For this purpose, a circle with internal cross was scraped into the surface above the centre of mass (Fig. 3).

[4] Other appellations: Leistikow (supra n.2) 21.

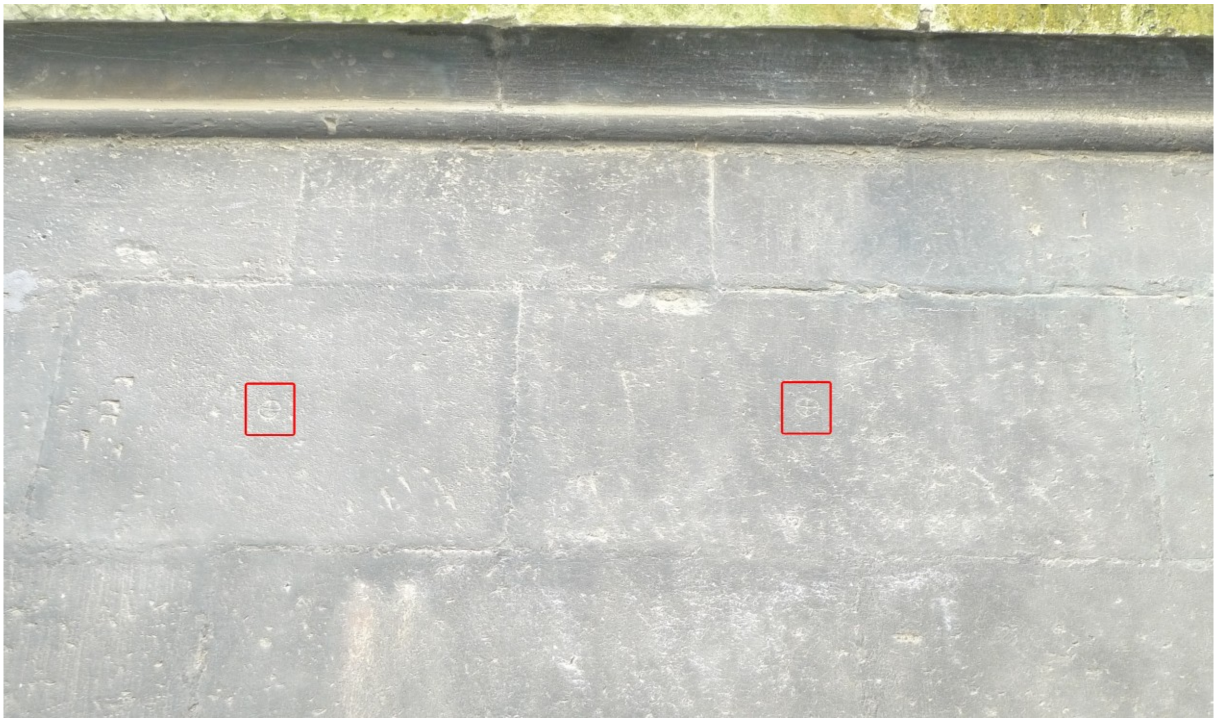


Fig. 3: Marked Lifter Holes which were not dressed

It can be seen that the stones were set without a kerb lifter, although the markings give rise to the assumption that the kerb lifter was the original choice. Now we may ask why the stonemasons did not immediately cut out the hole if they anyway intended to move the stones with the kerb lifter. One answer may be that the ordinariness of cutting out the lifter holes did not require the skills of a qualified stonemason so that unskilled stone workers hew out the holes directly on the site. Marking could have been a way to prevent the holes from being placed improperly.

However, I have found only one such hole drawing in a stone on the south wall of the west choir, and it is moreover, rather weathered. If however no lifter holes can be found, this does not inevitably mean that the stones were embedded with the lewis just because it seems more likely to us today. A good example for this is the Halberstadt Cathedral. The three westernmost buttresses on its north side were dismantled and rebuilt. According to the master builder of the Halberstadt Cathedral, not a single lewis hole was found, although most of the stones were not set with the kerb lifter; hence they must have been lifted into place with ropes. Since we now know about the setting techniques, it is high time to read the Naumburg and Meissen Cathedrals using this knowledge.

Fig. 4: Meissen Cathedral and Albrechtsburg

It is no secret that the Meissen Cathedral is one of the most significant and best known medieval buildings in Saxony (Fig. 4). It was built on a prominent site on the castle hill and rises above the city. The Gothic cathedral is a hall church with three naves; a five-eighths polygonal apse completes the extended choir. A narrow ambulatory with a second external walkway on top nestles around the polygonal termination. In the west, the high choir, which consists of a rectangular bay, the so-called bay of the donors, and a six-partite bay, borders to the jube in the crossing (Fig. 5).

Enormous substructures were necessary in the easternmost portion of the building to build the new polygonal choir; they were erected on the rock face towards the Elbe River. The Romanesque predecessor building remained intact and could be used during this building phase. Spiral staircases were inserted between the rectangular and the six-partite bay on the north and south sides. They lead to the external ambulatory we have already mentioned.

Inconsistencies in the masonry are an indication that the demolition of the Romanesque choir must have begun after the construction of the bay of the donors and before the six-partite bay (Fig. 6).[5] What we can observe is not only an inconsistency in the masonry but also a change in technology (Fig. 7). There is clear evidence that there has been a change in the stone setting technology on the south wall of the donor bay. Diagonally stepped stone layers beneath the sculptures of Saint Donatus and Saint John the Evangelist are an indication of the change in the stone setting technique—from setting without using kerb lifter to setting with it.

[5] Magirius, H. 2005. "Ev. Dom St. Johannes Evangelista und Donatus,“ in *Georg Dehio Handbuch der Deutschen Kunstdenkmäler – Dresden* (München/Berlin) 246; Donath, G. 2011. "Zum Ablauf der ersten Bauphase des gotischen Meißner Doms,“ in H. Krohm and H. Kunde (edd.), *Der Naumburger Meister. Bildhauer und Architekt im Europa der Kathedralen*, vol. 2 (Petersberg) 1292-1300.

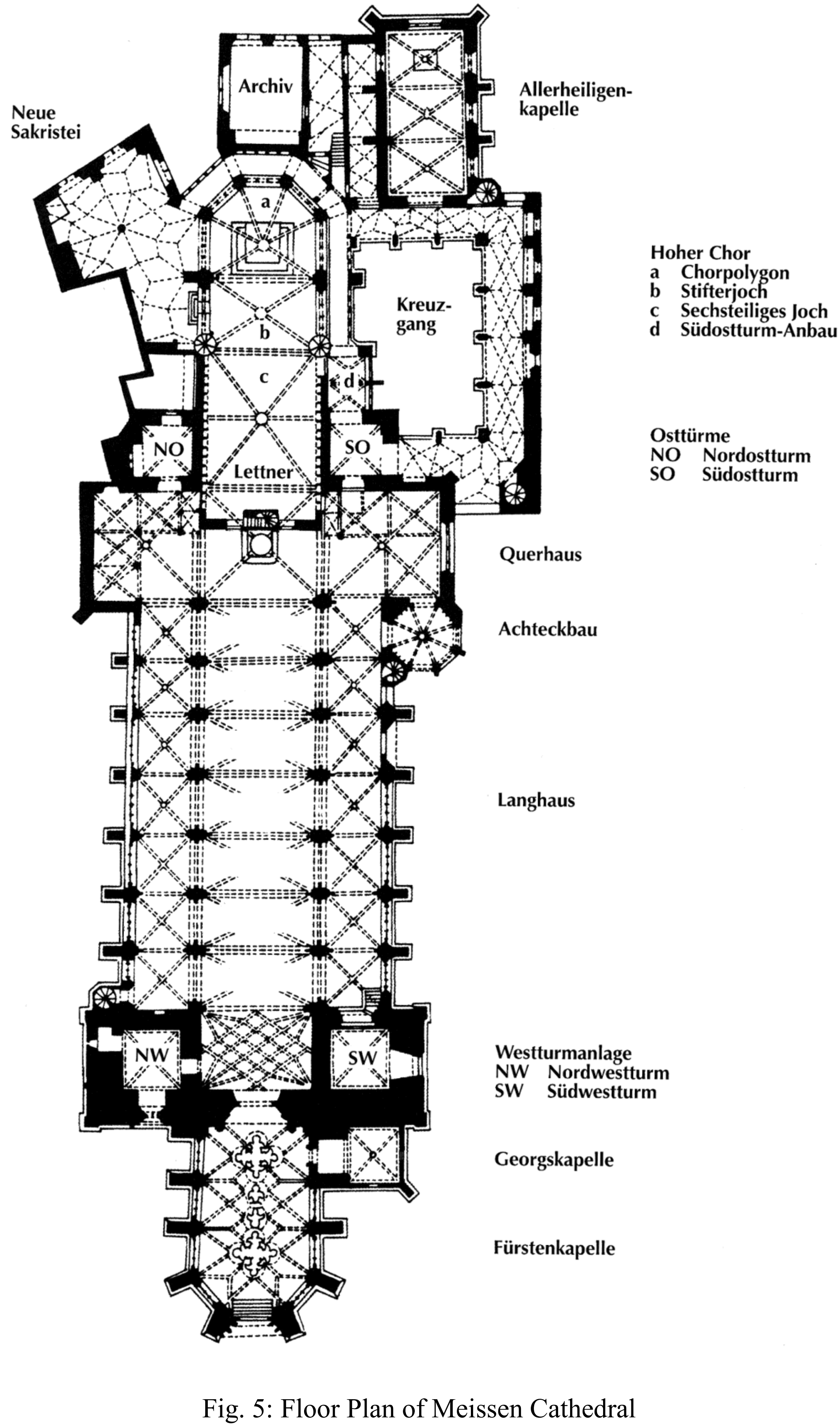


Fig. 5: Floor Plan of Meissen Cathedral

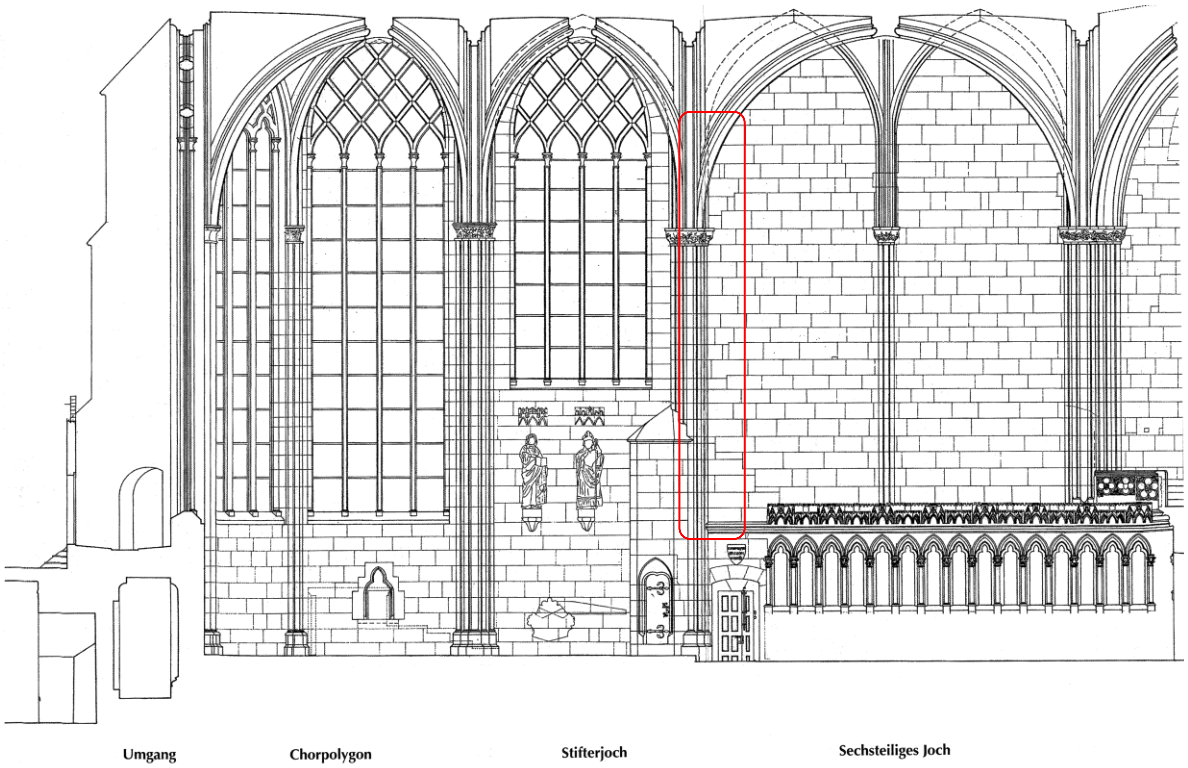


Fig. 6: Meissen Cathedral, High Choir

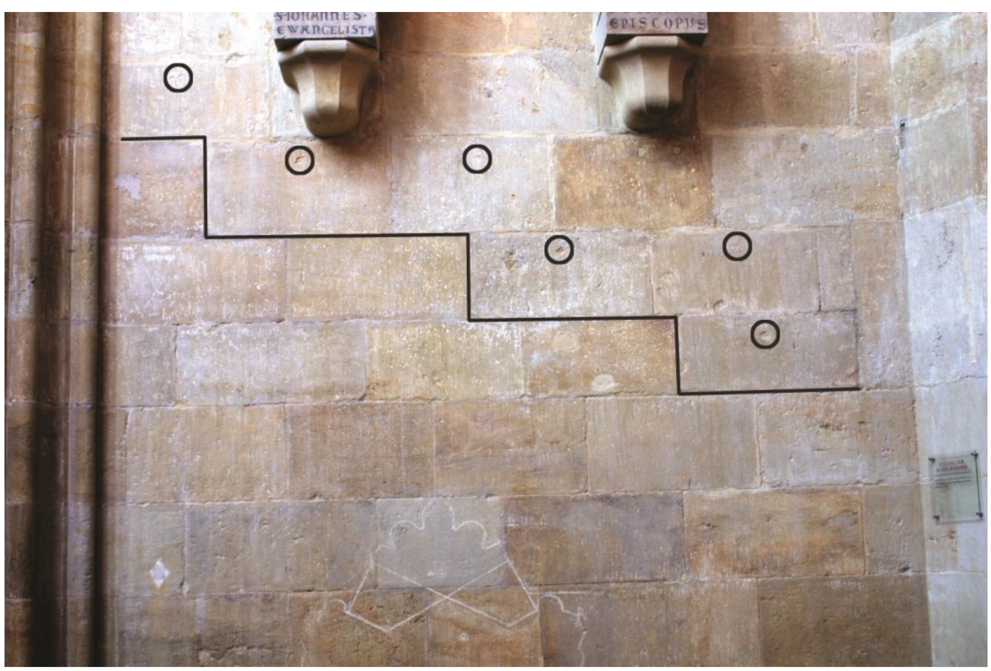


Fig. 7: Change in Technology

On the north wall of the bay of the donors, an exact reconstruction is no longer possible since the stonework was greatly altered as the door was inserted. Only in the six-partite vault the use of the kerb lifter can be proved without the shadow of a doubt. In the polygonal choir, lifter holes are found only on the external wall. They can be seen only at a height of several stone layers above the window sills of the choir windows. Starting from the diagonal cut described, the group of masons decided to adopt a different stone setting technique and stuck to it throughout the process. From that point, the masons used the kerb lifter even in the lowest stone layers, although it was quite possible to set the stones without fastenings. The kerb lifter was used not only for simple ashlars but also for the voussoirs in the southern portal. Finally, the lifter holes in the facing were filled with mortar that was coloured to match the stone. To achieve this, the fine rock powder that was produced as a by-product of hewing was mixed with mortar. Inside the cathedral, the filled holes are visible only to the keen observer, but on the outer walls the holes are easily identifiable nowadays since the stone developed a patina while the mortar did not. As a result, the lifter holes contrast with the stone in terms of colour (Fig. 8).[6]

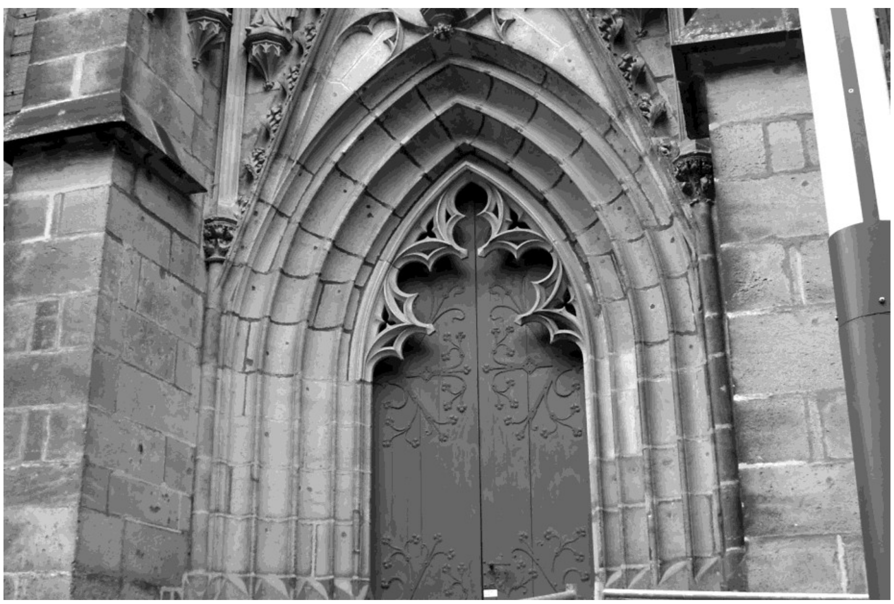
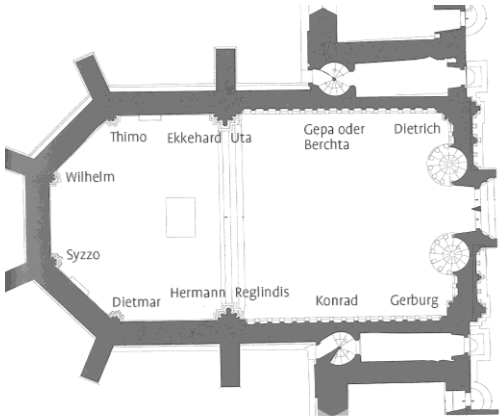


Fig. 8: Filled Lifter Holes on the Outer Walls

How did the stonemasons work in Naumburg?

Upon close examination of the west choir (Fig. 9a, 9b) of the Naumburg Cathedral, one will soon discover that the kerb lifter was used only now and then. Regular use of the kerb lifter started only very late in the process.

[6] See also Schröck (supra n.2) 35-9.



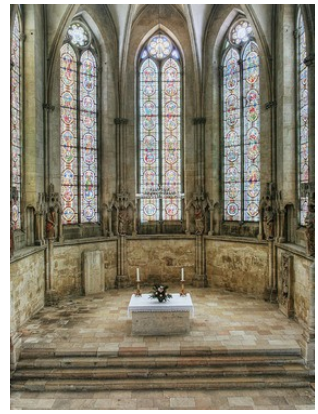


Fig. 9a: Naumburg, West Choir, Floor Plan 9b: Naumburg, West Choir

In the polygonal choir and also on the walls, it is impossible to identify a systematic usage of this means of fastening. It is interesting, however, how the stones were set. Upon close examination of the area around the donor figures, the walkway behind them, and in the adjacent tracery windows, we can clearly see the already known markings (Fig. 10).[7] There are deep scratches with clear contours on the stone surface.

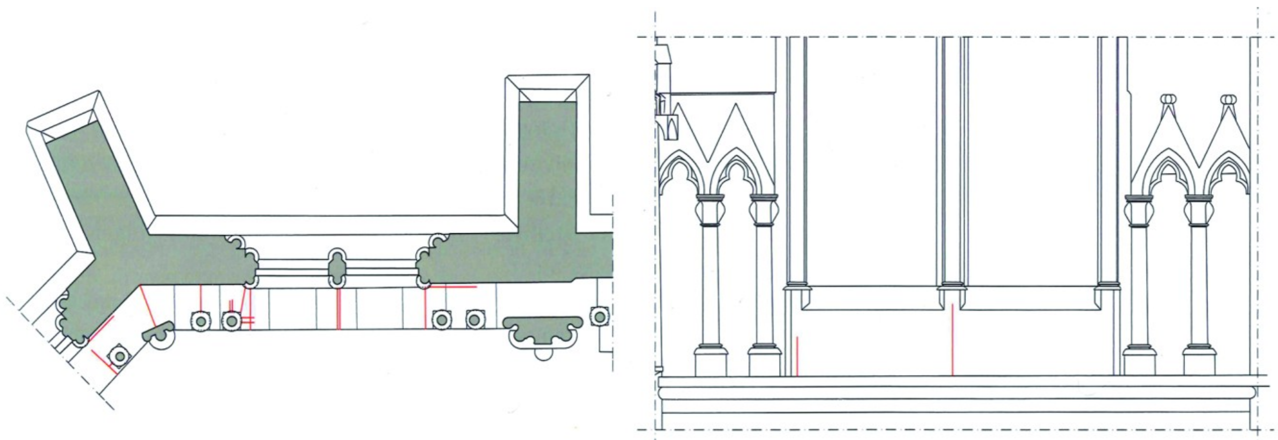


Fig. 10: Naumburg, West Choir, Markings (red)

These markings have evidently been used to set large stones and adjust them on-centre more easily. Apart from this, what else can these markings tell us about the construction?[8] The west

[7] Donath, G. and M. Donath 2011. "Zeugnisse mittelalterlicher Bauplanung und Bauprozesse an den Chorbauten von Naumburg, Schulpforte und Meißen," in H. Krohm and H. Kunde (edd.), *Der Naumburger Meister. Bildhauer und Architekt im Europa der Kathedralen*, vol. 2 (Petersberg) 1275-91, fig. 21 and 22.

[8] "Eingeritzte Konstruktionshilfslinien dienten als Arbeitsanweisung zum Versetzen der Werksteine. […] So findet man auf der Oberseite der Steinplatten des Laufganges im Westchor ein ganzes Netz von orthogonalen Hilfslinien, mit denen nicht nur die Achse der Stabwerke der oberhalb des Laufganges beginnenden zweibahnigen Fenster und

choir of the Naumburg Cathedral provides evidence that the hewn stone was prepared in serial prefabrication. Examining the masonry provided definitive proof that the joints between the stones did not leave enough clearance to allow for tolerances. However, a levelling layer must have existed and in my opinion it is located in the area of the walkway of the Naumburg Cathedral. That means that the markings were not only aligning aids for stone setting but they, above all, served to recover the geometry of the floor plan. Hence, in this level the geometric system of the entire plan was re-drawn, with the aim to recover the correct position of the walls. They also served to accommodate tolerances of the prefabricated stones. Primary importance was given to the target position; the continuity of the wall surface was obviously considered a secondary matter—a decision which helped to reduce the risk of accumulating errors.

Maren Lüpnitz provided convincing proof of a new alignment in her doctoral thesis on the clerestory of the Cologne Cathedral.[9] She proved that the dimensional tolerances were accommodated in the ground plan in the triforium zone. "Before the stones were set, the triforium plan was surveyed and the outlines of the walls, the piers of the inner choir and the balustrades were completely marked on the walkway plates. This resulted not only in the definition of the position of the constructional elements but also in the accommodation of the dimensional tolerances in the ground plan."[10] However, quite often it cannot be validated that the markings actually represent the whole floor plan—like in Cologne; they can be explained only in the differing positions or by chance. In Amiens, too, the outlines of the balustrades, walls, and piers were also marked in the walkway plates. Part of the markings would not be visible, however, if the pier feet, which lie directly on the walkway plates, had not been worked on to put tension anchors in place.[11]

A compensation of the dimensional tolerances in the floor plan can be observed in Naumburg as well. The columns, which are located on both sides of the donor figures, were also re-adjusted. While the column bases on the south wall were shifted into the walkway by approximately 4 cm (Fig. 11), they had to be drawn back by approximately 1.5 cm beyond the walkway plates in the northwest corner next to the sculpture of *Thimo* (Fig. 12).

Starting on the south side, the measure of correction gets smaller until it reaches the left side of *Syzzo*. There, the base is nearly congruent with the front edge of the walkway plate, which was observed earlier on the side of the donor *Dietmar*.

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der Säulen links und rechts der Chorfiguren, sondern sogar deren Mittelachse findet auf den abgearbeiteten Rückseiten der Skulpturen ihre Fortsetzung […]." Donath, G. and M. Donath (supra n.7) 1289.

[9] Lüpnitz, M. 2011. *Die Chorobergeschosse des Kölner Domes. Beobachtungen zur mittelalterlichen Bauabfolge und Bautechnik* (Köln).

[10] "Vor dem Versatz wurde der Triforiumsgrundriss eingemessen und Umrisse der Wände, Binnenchorpfeiler und Brüstungen wurden in die Laufgangplatten komplett eingeritzt. Dadurch war nicht nur die Lage dieser Bauteile festgelegt, sondern auch der Ausgleich der Maßtoleranzen im Grundriss: Die Pfeilerquader mit den angearbeiteten Stäben der Maßwerklaibung sowie die Laibung der Außenwände mussten so ausgerichtet werden, dass die vorgefertigten Maßwerke exakt dazwischen gesetzt werden konnten, um Abarbeitungen und Passsteine zu vermeiden." Lüpnitz (supra n.9) 81.

[11] Lüpnitz (supra n.9) 83-4 and 124 (fig. 51-53).

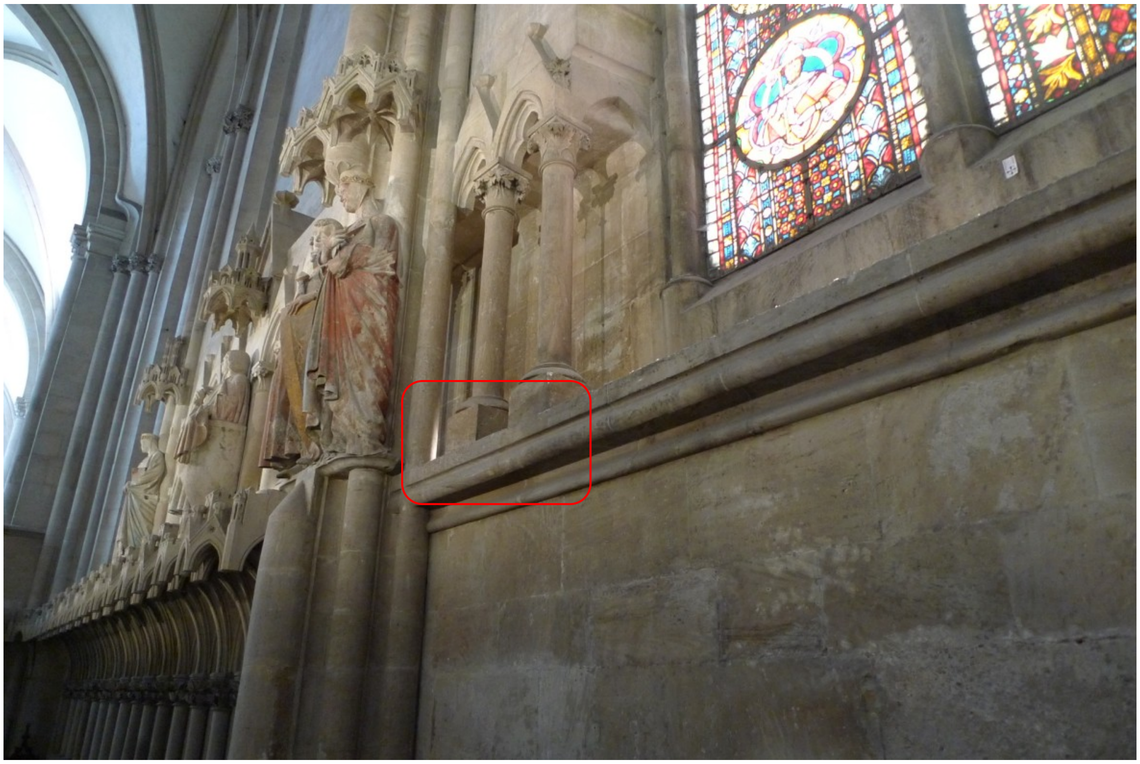

Fig. 11: Naumburg, West Choir, South Wall, Walkway

Fig. 12: Naumburg, West Choir, Northwest Corner Next to Thimo

While the base to the right of *Syzzo* is again slightly pushed into the walkway, the measure obtained at the statue of *Wilhelm* is slightly more than 1 cm. The correction of 1.5 cm beyond the walkway plates on the East side of *Thimo* decreases immediately afterwards to a projection of 0.5 cm and recedes again by approximately 2 cm west of the donor figure of *Ekkehard*. The stones of the arcades, which are arranged on both sides of the donor figures and are connected with the rear masonry, also accommodate the tolerances. As a result, only the block east of *Thimo* shows a projection. The other noticeable interruptions can be explained by the fact that the stones of the arcades were prefabricated and were not accurately fitted to the size of the rising stonework.[12]

Some other levels where the target position of the plan was recovered are: in the area of the capitals—with an exception on the north side because there the equalisation was begun only one layer above—and then again at the imposts of the lancet window.[13]

The adjustment was not begun in these zones but much earlier at the foot of the choir. Three-cornered pedestals, which take up the shafts and also the donor figures, alternate with straight walls. However, the pedestal is not congruent with the rising stonework; instead it forms a verge across all of the polygonal projection. It is conspicuous that the pedestal on the south side projects by approximately 5 cm (Fig. 13), on the north side only by 2 cm, however. It is observable that almost none of the three-cornered, cut pedestal stones fits accurately on top of another, with one exception, which is the cornice of the pedestal below the figure of *Wilhelm*. There, the outer edge of the stone fits exactly the layer beneath.

Another interesting phenomenon can be observed in the points where the shafts are connected with the masonry walls under the walkway. At first glance one could assume that the bed joints close to the piers are continuous. Taking a second glance, we can identify slight offset between the cut stone, which is part of the shaft, and the straight, rising stonework. The different heights of the stone layers close to the piers are kept up stringently. In other words, if the fourth layer of stones of the round shafts on the south side measures 24 cm, this thickness is maintained until the north side is reached. But what follows from this fact?

[12] See also Jelschewski, D. 2011. “Die Stifterfigur des Syzzo und ihre Einbindung in die Architektur des Westchors,” in H. Krohm and H. Kunde (edd.), *Der Naumburger Meister. Bildhauer und Architekt im Europa der Kathedralen*, vol. 2 (Petersberg) 1317-19.

[13] That the equalisation takes place at these levels is not surprising since they were used as reference levels. Norbert Nußbaum and Sabine Lepsky have shown this already in Altenberg: “Pfeilerkanten, Fensterlaibungen, Gesimse und Wasserschläge bilden am Außenbau der Kapellen ein festes Netz vertikaler und horizontaler Bezüge, das möglichst präzise realisiert werden musste. Die Senkrechten ließen sich durch Abloten recht einfach kontrollieren, und Fluchten waren durch Richtschnüre definiert.” Lepsky, S. and N. Nußbaum 2005. *Gotische Konstruktion und Baupraxis an der Zisterzienserkirche Altenberg*, vol. 1: *Die Choranlage* (Bergisch Gladbach) 143.

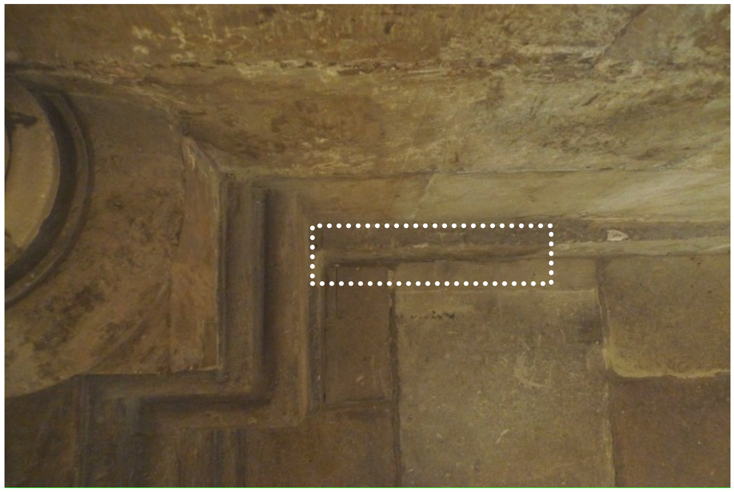

Fig. 13: Naumburg, West Choir, South Side Pedestal

If we resolve to use Dieter Kimpel's[14] theoretical concepts on the Gothic technological development, no clear traces of "stack system or horizontal design" can be found in Naumburg.[15] If the wall and the adjacent shafts are built using the stack technique, the prefabricated shaft ashlars are stacked on each other first in order to allow the walls then to be filled with masonry. Normally, this results in offset joints or sometimes in continuous vertical joints. In case of horizontal construction, ashlars of the same height are prefabricated and "set layer by layer with continuous horizontal joints."[16] In Naumburg, however, we detect the dimensional deviations described earlier which result in slightly offset joints on either side of the shaft stones. The slight corrections were marked and cut into the ashlars directly on the building site (Fig. 14).

These insignificant dimensional deviations could have been caused by defects in dimensional transfers that could not be compensated in the narrow bed joints of the masonry. And although small pieces of slate were inserted into the bed joints, which served as spacers between the ashlar, to prevent the joint mortar from complete bulging, the bed joints in Naumburg are considerably thinner than the joints built in Meissen.

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[14] Kimpel, D. 1981. "Ökonomie, Technik und Form in der hochgotischen Architektur," in K. Clausberg *et al. Bauwerk und Bildwerk im Hochmittelalter. Anschauliche Beiträge zur Kultur- und Sozialgeschichte* (Gießen) 103-25; Kimpel, D. 1984. "Die Entfaltung der gotischen Baubetriebe. Ihre sozio-ökonomischen Grundlagen und ihre ästhetisch-künstlerischen Auswirkungen," in F. Möbius and E. Schubert (edd.), *Architektur des Mittelalters. Funktion und Gestalt* (Weimar) 246-72.

[15] The idea of an exhaustive bed-joint-plan ("Lagerfugenplan") that predefines the whole stonework of a building has to be questioned, as occurred in e.g. Nußbaum, N. 2010a. "Form und Technik auf getrennten Wegen? Zum Transfer architektonischer Konzepte im Hochmittelalter," in *Berichte über die 45. Tagung für Ausgrabungswissenschaft und Bauforschung, Koldewey-Gesellschaft, Vereinigung für Baugeschichtliche Forschung e.V.* (Dresden) 41-50; Nußbaum, N. 2010b. "Kunst des Konstruierens – Die gotische Architektur als technisches Projekt," in N. Nußbaum (ed.), *Die gebaute Kirche. Symposium und Vortragsreihe anlässlich des Jubiläums der Hochaltarweihe der Stadtkirche Unserer Lieben Frau in Friedberg (Hessen) 1306-2006* (Stuttgart) 169-82.

[16] Nußbaum 2010b (supra n.15) 178-79.

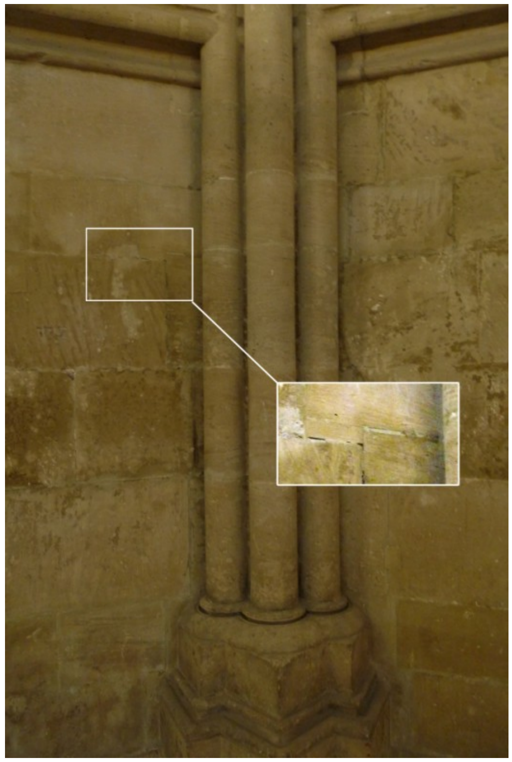

Fig. 14: Naumburg, West Choir, Slight Offset Joint

What conclusions can be drawn from these findings?

First, the two pedestal stones beneath the figure of *Wilhelm* fit exactly. Second, in some parts there are major corrections as regards the adjustment of the ashlar. In my opinion, the west choir of the Naumburg Cathedral was measured in the same way as the one in Altenberg as Norbert Nußbaum has already proved. Since it was necessary to sheathe the predecessor building and therefore it was not possible to trace the plan in full size on the building site, a pedestal which served as reference for the leveling, was built around the existing construction and then this pedestal was adjusted. Henceforth the pedestal served as the reference point.

The fitting accuracy in the western part of the polygonal termination can be explained by the fact that this was the starting point of the elevation. If the tracing of the plan, however, was started in the northern part, the source of errors could have grown significantly as the dimensions were marked towards the south. For this reason, a point is chosen in the centre from where compensation is started to minimise potential errors. Thus variations may occur not only in the geometry, but they may also arise during prefabrication on the building site.

Unfortunately, a similar approach cannot be identified for Meissen; it is assumed that adjustment was done at the level of the first outer ambulatory and presumably at the height of the above walkway.

As a final note we might add that the comparison of the cathedrals in Meissen and Naumburg turned out to be complex. After all, it is a comparison of two different construction concepts and technical implementations. Nevertheless, a contrasting analysis may make scholars more sensitive for these phenomena. Only by critical comparison one can discover the differences that make each cathedral a unique accomplishment of its time.[17]

References

Donath, G. 2011. "Zum Ablauf der ersten Bauphase des gotischen Meißner Doms," in H. Krohm and H. Kunde (edd.), *Der Naumburger Meister. Bildhauer und Architekt im Europa der Kathedralen*, vol. 2 (Petersberg) 1292-1300.

Donath, G. and M. Donath 2011. "Zeugnisse mittelalterlicher Bauplanung und Bauprozesse an den Chorbauten von Naumburg, Schulpforte und Meißen," in H. Krohm and H. Kunde (edd.), *Der Naumburger Meister. Bildhauer und Architekt im Europa der Kathedralen*, vol. 2 (Petersberg) 1275-91.

Ganßauge, G. 1937. "Hebeklaue und Wolf," *Deutsche Kunst und Denkmalpflege*, 199-205.

Jelschewski, D. 2011. "Die Stifterfigur des Syzzo und ihre Einbindung in die Architektur des Westchors," in H. Krohm and H. Kunde (edd.), *Der Naumburger Meister. Bildhauer und Architekt im Europa der Kathedralen*, vol. 2 (Petersberg) 1317-19.

Kimpel, D. 1981. "Ökonomie, Technik und Form in der hochgotischen Architektur," in K. Clausberg *et al. Bauwerk und Bildwerk im Hochmittelalter. Anschauliche Beiträge zur Kultur- und Sozialgeschichte* (Gießen) 103-25.

Kimpel, D. 1984. "Die Entfaltung der gotischen Baubetriebe. Ihre sozio-ökonomischen Grundlagen und ihre ästhetisch-künstlerischen Auswirkungen," in F. Möbius and E. Schubert (edd.), *Architektur des Mittelalters. Funktion und Gestalt* (Weimar) 246-72.

Kraut, T. and F. S. Meyer 1982. *Das Steinhauerbuch. Die Bau- und Kunstarbeiten des Steinhauers* (repr. of Leipzig 1896 edn., Hannover).

Krohm, H. and H. Kunde forthcoming. *Der Naumburger Meister. Bildhauer und Architekt im Europa der Kathedralen*. Ergänzungsband zum Ausstellungskatalog der Landesausstellung Sachsen-Anhalt 2011, vol. 3 (Petersberg).

Leistikow, D. 1982. "Aufzugsvorrichtungen von Werksteine im mittelalterlichen Baubetrieb: Wolf und Zange," *Architektura* 12, 20-33.

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Lepsky, S. and N. Nußbaum 2005. *Gotische Konstruktion und Baupraxis an der Zisterzienserkirche Altenberg*, vol. 1: *Die Choranlage* (Bergisch Gladbach).

Lüpnitz, M. 2011. *Die Chorobergeschosse des Kölner Domes. Beobachtungen zur mittelalterlichen Bauabfolge und Bautechnik* (Köln).

Magirius, H. 2005. "Ev. Dom St. Johannes Evangelista und Donatus," in *Georg Dehio Handbuch der Deutschen Kunstdenkmäler – Dresden* (München/Berlin) 244-58.

Nußbaum, N. 2010a. "Form und Technik auf getrennten Wegen? Zum Transfer architektonischer Konzepte im Hochmittelalter," in *Berichte über die 45. Tagung für Ausgrabungswissenschaft und Bauforschung, Koldewey-Gesellschaft, Vereinigung für Baugeschichtliche Forschung e.V.* (Dresden) 41-50.

Nußbaum, N. 2010b. "Kunst des Konstruierens – Die gotische Architektur als technisches Projekt," in N. Nußbaum (ed.), *Die gebaute Kirche. Symposium und Vortragsreihe anlässlich des Jubiläums der Hochaltarweihe der Stadtkirche Unserer Lieben Frau in Friedberg (Hessen) 1306-2006* (Stuttgart) 169-82.

Schröck, K. 2010. "Darstellungen und Spuren des Steinmetzgeschirrs," in B. Klein and S. Bürger (edd.), *Werkmeister der Spätgotik. Personen, Amt und Image* (Darmstadt), 26-43.

Schröck, K. 2012. "Steinversatz des Naumburger Werktrupps im Vergleich zum Meissner Dom" in Krohm, H. and H. Kunde forthcoming. *Der Naumburger Meister. Bildhauer und Architekt im Europa der Kathedralen*. Ergänzungsband zum Ausstellungskatalog der Landesausstellung Sachsen-Anhalt 2011, vol. 3 (Petersberg).

Schubert, E. 1997. *Der Naumburger Dom* (Halle/Saale).

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