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Remarkable historic timber roofs. Knowledge and conservation practice. PART 1 - Construction history and survey of historic timber roofs

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Cover illustration: Lattice roof trusses in the nave of Jät church, Småland, Sweden, 1225–1226 by Robin Gullbrandsson. © Robin Gullbrandsson (2022)

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LOST ROOFS – CASE STUDIES FROM MUNICH

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Abstract

The article presents the results of the author's research on *lost* roofs in Munich. The importance of Munich rose continuously over the centuries. Talented master builders met demanding clients. This resulted in prestigious buildings with ambitious constructions. Today, most of them are lost due to the destructions of the Second World War. The aim of this study was to reconstruct the most important roofs on the basis of archival sources and building archaeological research on the remains. The results show a great variety, always reflecting the current developments in roof construction. Among them, there are also quite experimental solutions. The results are presented as detailed scale models.
The models allow getting a lasting impression of the lost structures. They serve to illustrate this essay. Finally, special attention is given to some constructions that have a link to Italianate designs.

Keywords

Roof constructions, Reconstruction, Scale models, Timber construction, Knowledge transfer.

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1. INTRODUCTION

This paper gives a short overview of a study on roof constructions that were destroyed during the Second World War in Munich. The whole research was published in 2019 [1].

There have been systematic studies on roofs within cities (e.g., Bamberg, Basel) [2–4] or regions (e.g., Thuringia and Lower Saxony) [5]. They brought valuable results, especially concerning the development of constructions in a comparable setting. A study on lost roofs is, apart from single objects (e.g., Vienna cathedral) [3], a new approach in this field. Due to the preconditions, the study had to focus on the most prominent objects.

The old town of Munich was widely destroyed in the air raids of 1944 and 1945. The important architectural monuments, such as the Residence of the Bavarian Dukes and Kings, the medieval *Frauenkirche*, and many of the other large churches and secular buildings, were mostly destroyed. In any case, they lost their roofs.

Munich was first mentioned in 1158. In that year, the Bavarian Duke Heinrich built a bridge over the river Isar. The city finally became the capital of the Wittelsbach duchy of Upper Bavaria in the second half of the 13th century. The growing importance of Munich was reflected by the rise of prestigious and large-scale architecture. Thus, also ambitious roof constructions were built. However, there is no more evidence of roofs from the 13th century. The oldest traceable example dates back to the 14th century [6]. From then on, a manifold development set in.

A glance at a historical veduta or model reveals how much the city was shaped by its roofs. The model of Munich from 1570 shows a roofscape as it exists nowadays

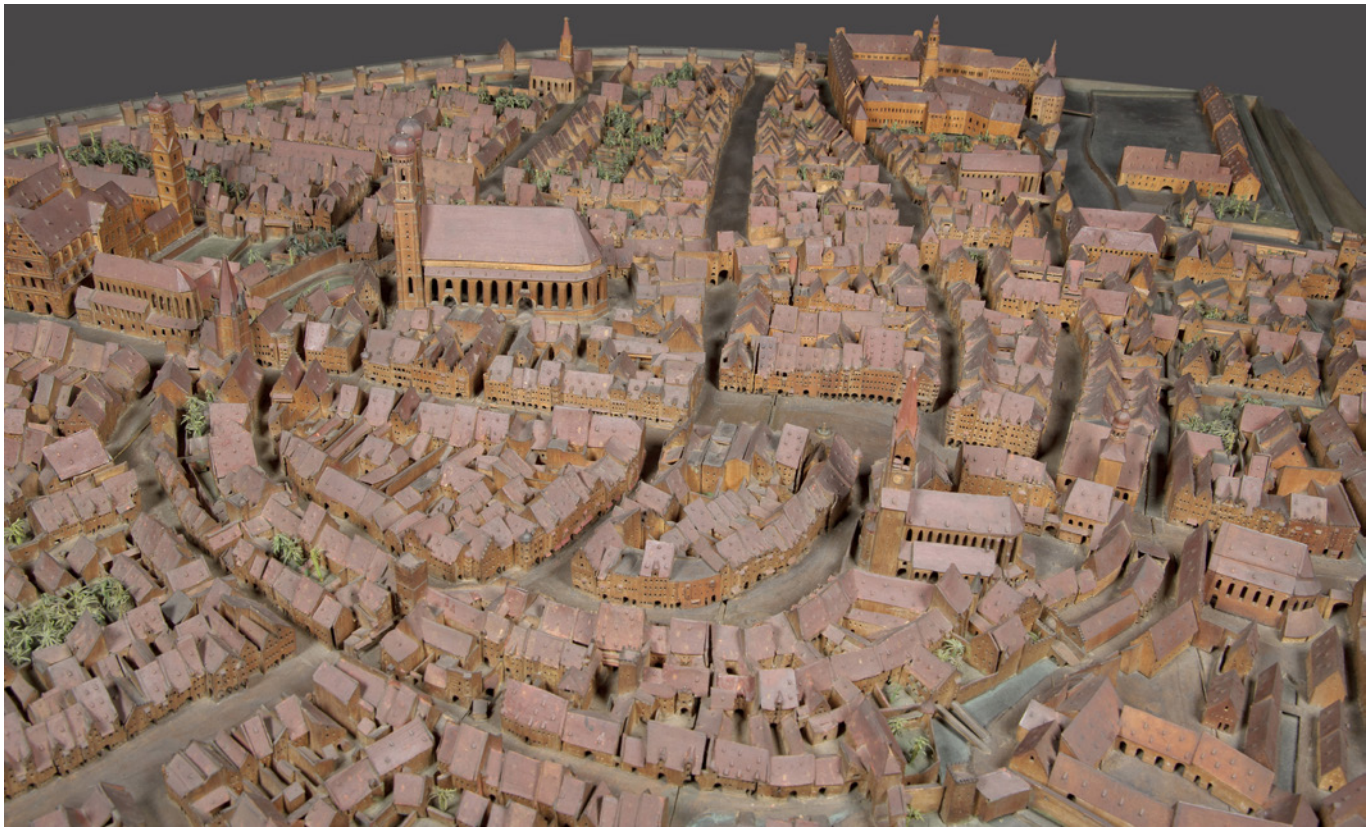

Fig. 1. *Model of Munich, built by Jakob Sandtner in 1570. (Picture: I. Mühlhaus).*

only in a few historic places. The variety of constructions is considerable. Besides the prevailing steep rafter roofs, there are also purlin roofs, which are typical for the rural architecture around Munich. In many cases, the roofs take up more than half of the building cubature. This also implies that roofs were considered to be a representative part of the house [2], like a "fifth façade".

Especially the large roofs of the southern German hall churches dominate the city silhouettes and thus also the distant view of a city. In many places, even in Munich, this is still evident today. When the cities were still sharply defined from the countryside by walls, this effect must have been even more striking.

In emerging cities like Munich, experienced master builders always faced ambitious clients. Thus here was an ideal breeding ground for innovative achievements in architecture and construction. This also affected roof structures: only what could be roofed could be built.

2. METHODOLOGY

All reconstructions of this study are based on archival sources. In a second step, the buildings were inspected to look for traces and relics of the former roof structures by means of building archaeology (all roofs were rebuilt with modern structures after the war – none of the lost roofs was reconstructed in their original state). Further references, e.g., roof structures related to the objects studied, could contribute to the answering of open questions [1].

The reconstruction as a model or drawing was only done if sufficient sources could be found. Further selection criteria were if the roofs represent a challenge in terms of span and construction. In addition, the objects (the real, now destroyed roofs) should illustrate an important stage in the evolution of roof constructions, e.g., representative examples from the Middle Ages with vertical struts (*Stehender Stuhl*) or raking struts (*Liegender Stuhl*), examples from the early modern period, the 19th century, etc.

The result is the documentation and reconstruction of 14 roofs on churches and secular buildings. Ten of these were destroyed during World War II, while two others (the *Turnierhaus am Hofgarten* and the wooden vault in the pilgrimage church of *Maria Ramersdorf*) were lost much earlier. Two roofs from the survey (*Salvatorkirche* and *Ludwigskirche*) were never destroyed but are considered to be important for the overall context. This is

why they were nevertheless included in the study [1]. However, they are not discussed in this article.

Eleven roofs were built as wooden scale models in 1:20, some of which include two different constructions (*St. Peter*, *Marstall*). An additional model was built for the large roof of the hall church of St. Martin in Landshut. It demonstrates great similarities to the roof of the *Frauenkirche* in Munich – a very interesting aspect of the development of late medieval hall churches in southern Germany.

The requirements for the model building were set high – every single component of a roof structure was to be represented in the model. The timber joints had to be reproduced realistically. So the models can be assembled, disassembled, and reassembled again. This means that the data in the archival sources had to be sufficient enough to reconstruct the lost roof structures down to the last detail. During the research, two historic scale models of St. Michael and Welsche Hauben of the Frauenkirche were also found. In those two cases, no new models were built.

Models allow the large and sometimes very complex constructions to be experienced in a three-dimensional and haptic way, at least on a small scale. The reconstruction models were presented to the public in a highly acclaimed exhibition at the Munich City Museum in 2018.

In the following, the results of the reconstructions are briefly presented in chronological order.

3. RESULTS OF THE RECONSTRUCTION OF LOST ROOFS

Church of St. Peter

The roof of the nave of the Basilica of St. Peter, built after 1327, consists of identical trusses stiffened by scissor braces. There is no longitudinal bracing except the roof

Fig. 2a. *Church of St. Peter*

Fig. 2b. *Roof constructions of St. Peter – the medieval roof of the nave (left) and early modern roof of the presbytery (right). (Model: C. Knobling, Picture: I. Mühlhaus).*

covering. Only for the erection process, diagonal timbers were nailed to the inner sides of the rafters to hold the spacing between them. Thus, it represents a common case in medieval roof construction [7, 8].

Scissor-braced roof trusses are quite typical for this time and region. The former Augustinian church, built around 1340 (choir) and 1440 (nave) [6], had an almost identical roof and illustrates the prevalence of this construction for basilical churches.

Subsequently, a reinforcement was installed in every fifth roof truss of *St. Peter*. An iron bar, attached to a truss, carried a girder providing additional support for the existing tie beams. The reinforcement cannot be dated exactly but was apparently built in the 19th or early 20th century.

The presbytery of St. Peter's Church was rebuilt in 1630-36 as a baroque triconchos [6]. Its roof construction with raking struts (*liegender Stuhl*) and king post is quite common in the early modern period [2, 7]. The joint at the intersection of the king post, collar beam, and straining beam is very complex since the king post cannot be interrupted. The will to bring all elements together in one layer caused such difficulties, which can also be seen in other early modern roofs (e.g., *Michaelskirche*, see below). Unlike the medieval roof of the nave, the presbytery roof is braced lengthwise by St. Andrew's crosses. To align it with the medieval roof of the nave, it has an unusually steep slope of 61°. The reconstruction is based on sources from the parish archive of St. Peter, i.a. detailed photographs from the destroyed church with the roof partly still in place.

Church of the Assumption of Mary (*Mariae Himmelfahrt*) in Ramersdorf

The roof of the pilgrimage church *Mariae Himmelfahrt* in Ramersdorf was built around 1360 [9]. A wooden vault was once integrated into the roof structure. It had the form of a half quatrefoil, i.e., it consisted of a central barrel vault and lateral half-barrel vaults. The vault was resting on longitudinal beams, two on consoles at the side walls and two fixed with tenons at the interrupted tie-beams of the roof. The interrupted tie-beams are supported by king posts. Bent ribs, made of interlocking pieces of wood, supported the cladding. They were fixed on the longitudinal beams with tenons. Scissor braces stiffened the trusses and transferred the tensile forces above the vault.

The construction of the vault was not based on Nordic models, where such forms were shaped primarily by the addition of short beams bevelling the lower angles [5] – the Ramersdorf vault was an independent structural unit

Fig. 3a. *Pilgrimage church St. Mariae Himmelfahrt in Munich-Ramersdorf.*

Fig. 3b. *Roof and timber vault of St. Maria Ramersdorf. (Model: C. Knobling, Picture: I. Mühlhaus).*

(but firmly connected to the roof). This refers more to the wooden vaults of the Veneto (e.g., San Zeno in Verona, see below) [10, 11]. As early as 1445, the timber vault was dismantled and replaced by the still-existing solid vault [12].

The reconstruction is based on the results of building archaeology. Traces of the lost vault were found on the still-existing roof and walls, e.g., mortices, former wooden joints or imprints of the planks of the vault in the mortar of the side walls and gable walls and on the beams of the roof. In this way, it was possible to find out not only the geometry but also the dimensions of the single components of the construction.

The Old Town Hall

The roof of the Old Town Hall (*Altes Rathaus*) was built in the years between 1470-75 [6]. It covers the large assembly hall of the town, spanning over 18.40 meters without supports. The roof construction contains a timber vault, which was supposed to be the prestigious ceiling for this most important room of the municipality. Since the view of the wooden vault was not to be disturbed, the construction also had to work without a continuous tie beam. The vault is made of wooden ribs, forming a segmental arch. It sets on below the eaves and extends to the lowest collar beam of the roof construction.

The structure above is formed like a conventional roof with struts, diagonal bracing, and king post. The lower part, which had to contain the vault, needed a specific solution: master builder Heinrich von Straubing [13] placed half-timbered walls alongside the vault, which had to stand inclined due to the limited space. The vault was connected to the roof structure with short beams and punctually supported by the king post.

Fig. 4a. *Old town hall (Altes Rathaus) in Munich, exterior (left) and great hall with wooden vault (right).*

Fig. 4b. *Roof and timber vault of the Altes Rathaus. (Model: C. Knobling, Picture: I. Mühlhaus).*

The construction survived for more than 400 years. Unfortunately, the roof was destroyed in 1944 before it could be repaired. The reconstruction model still illustrates the builder's eagerness to experiment, which led to such an unconventional and unique construction.

The reconstruction is mainly based on archival sources from the public works service of the city of Munich – among them drawings made for a renovation that did not take place due to the war. The vault was also discussed in the "*Bürgerliche Baukunde*" by Carl Friedrich von Wiebeking (1826). A drawing of the roof was published by Friedrich Ostendorf [10], but incorrect in some details.

Municipal Stables and Armoury

The roofs of the Municipal Stables and the Municipal Armoury were built around the middle of the 15th century (Stables) and 1491-93 (Armory) [6]. They are good examples of prestigious buildings of late medieval citizenship. The constructions had large base widths (Stables: 20.30 m; Armoury: 16.30 m). Since the roofs could be supported by intermediate walls, the spans were nevertheless small. Both the stables and the armory used a combination of vertical struts (*stehender Stuhl*) and raking struts (*liegender Stuhl*), which is common for roofs of this period and size. The elaborate construction of both roof structures indicates that the attics were used as storage floors and were, accordingly, heavily loaded.

The reconstruction is based on archival sources from plans from the 18th century, which could be found in the collection of the City Museum. Further sources like schematic drawings and historic photographs could be found in the municipal archive of Munich.

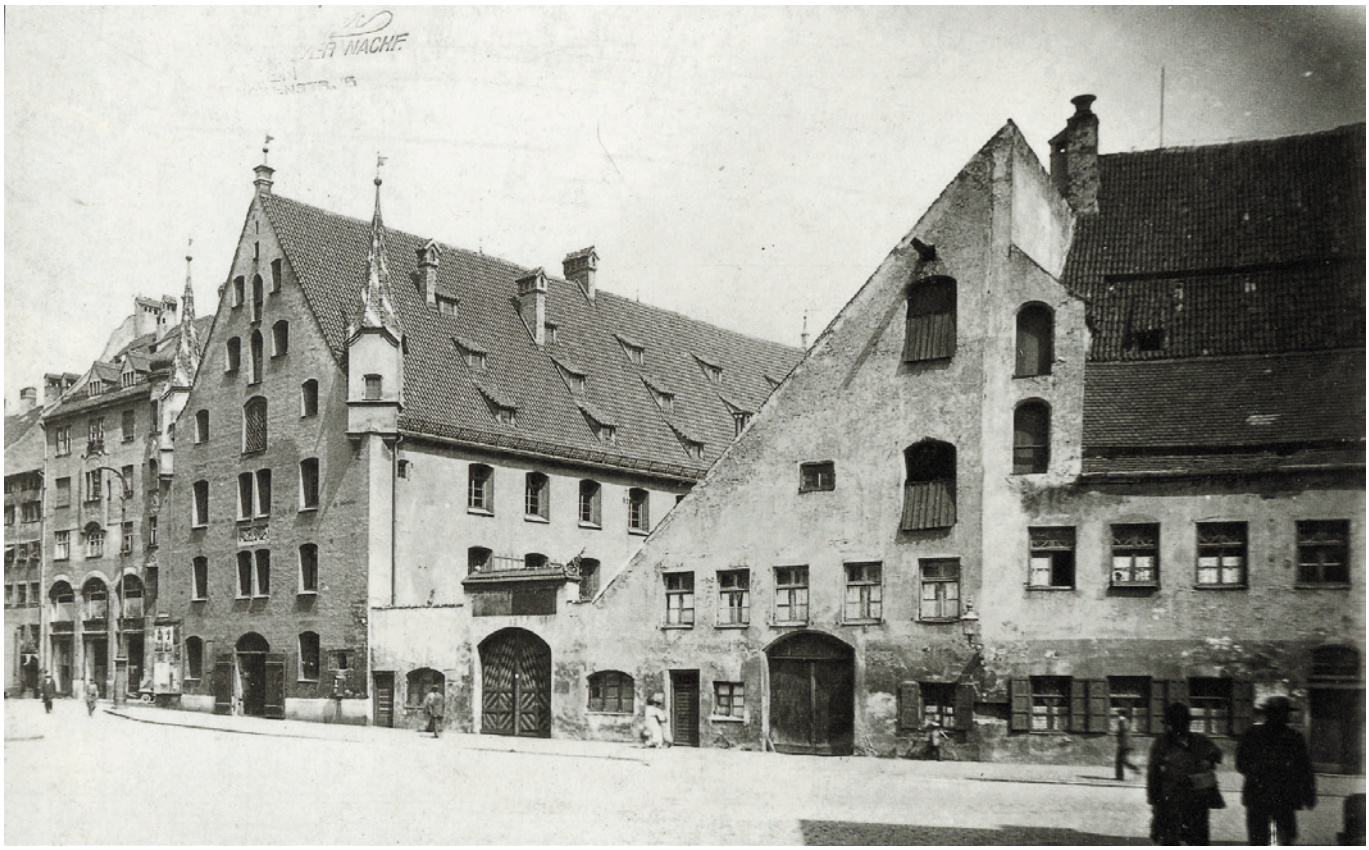

Fig. 5a. *Historical image of the municipal armory (left) and stables (right), G. Pettendorfer (R. Bauer / E. Graf, Der Stadtfotograf, Munich 1989); the building in the middle represents a typical half-gabled house.*

Fig. 5b. *Municipal stables (left) and armory (right). (Model: C. Knobling, Picture: I. Mühlhaus).*

Church of Our Lady (*Frauenkirche*)

The roof of the *Frauenkirche* (1468-88/94), built between 1473 and 1475 [6], represents one of the highlights of late medieval carpentry. The 31.60 m wide construction was one of the largest roof structures of the Middle Ages [3]. The 22 m high construction is supported on the side walls and the partition walls of the aisles. There are 12.80 m high vertical struts (*stehender Stuhl*) placed in the axes of the partition walls. On those, a collar beam divides the roof into an upper and a lower section. The careful bracing with St. Andrew's crosses in the lower section is particularly striking. The high struts are thus a rigid central structure to which the lateral struts could be easily connected. The central strut is partially suspended by St. Andrew's crosses in order to get the middle part of the tie beam free from heavy loads. The approx. 10 m high upper part of the roof represents a conventional construction with struts stiffened by raking braces [10].

The high *stehender Stuhl* in the middle allowed the huge dimensions to be handled. It was both a rigid core and an aid for the erection of the roof structure. Similar constructions can be found, among others, in Wasserburg, *St. Jakob* (1417), in Laufen an der Salzach, *Stiftskirche* (1436), in Amberg, *St. Martin* (before 1442), in Wasserburg, *St. Jakob* (1417) and Landshut in the churches of *St. Martin* (after 1475) and *St. Nikola* (1481). Especially the similarity to the roof of *St. Martin* in Landshut indicates a close relation between the builders [13].

The reconstruction of the roof of the *Frauenkirche* is mainly based on sketches from students from the 1930s from the archive of the *Architekturmuseum* of the Technical University of Munich and drawings and photographs of the ruined roof from the archive of the diocese and the archive of the Bavarian state office for heritage conservation. The roof was also published in the books of Gottgetreu [24] and Ostendorf [10], albeit with minor inaccuracies.

Fig. 6a. *Frauenkirche, roof and tower roofs ("Welsche Hauben").*

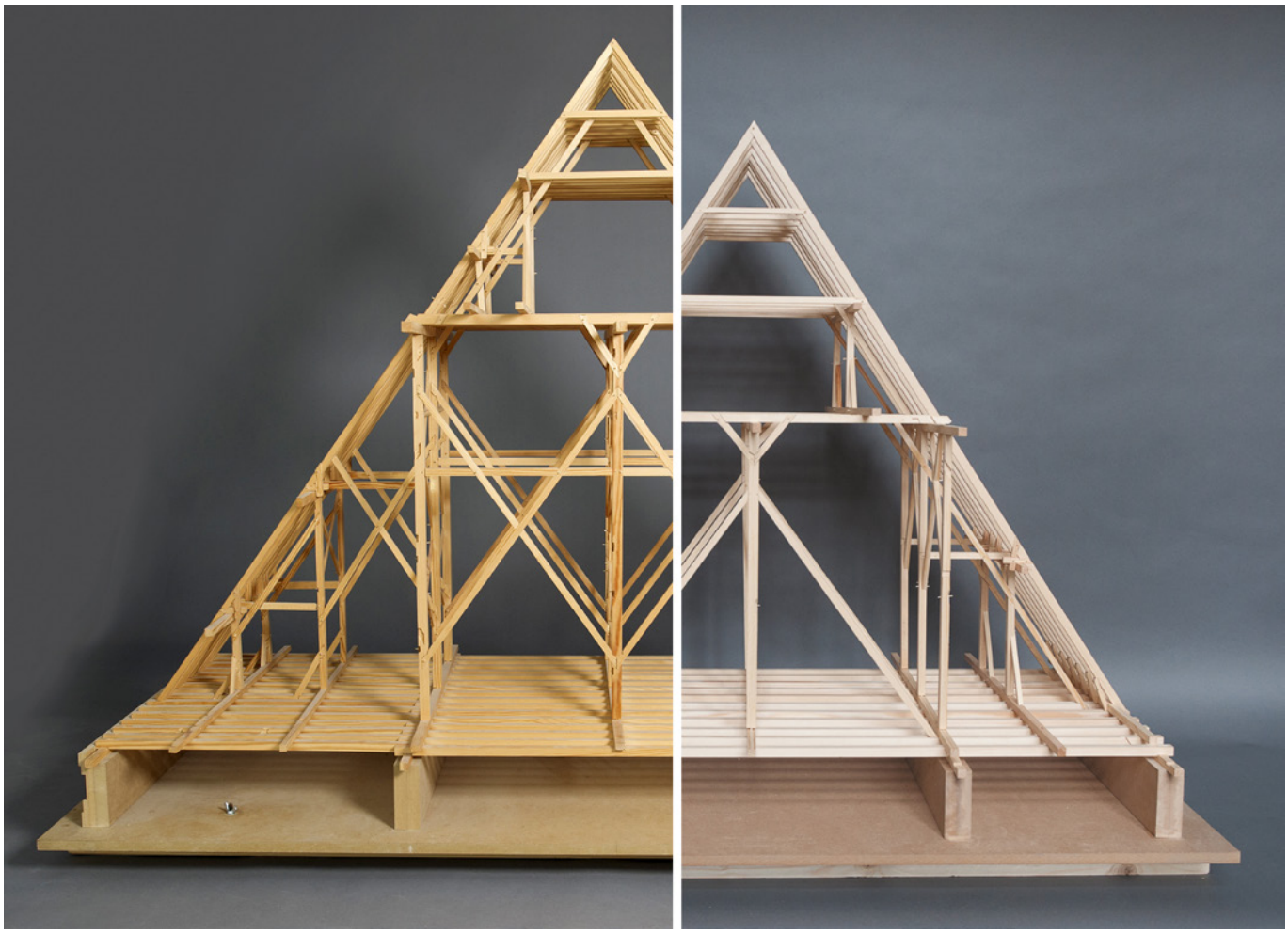

Fig. 6b. *Roof constructions of the Frauenkirche (left) and St. Martin in Landshut (right). (Model: C. Knobling, Picture: I. Mühlhaus).*

The tower roofs (*Welsche Hauben*) of the Church of Our Lady

The roofs of the towers of the Frauenkirche have become Munich's landmarks. The "Welsche Hauben" built in 1524-25 [6] even indicate by their name (*Welsch* means "foreign", especially from the South) a close relation to Italian models. However, this refers mainly to the form, less to the construction, which is based on an element from "ordinary" longitudinal roofs: struts (*stehender Stuhl*) with collar plates. Those were arranged octagonally in three storeys. Thus, they provided three intermediate supports for the radially arranged girders, which were made of planks assembled in two layers.

The form of the *Welsche Hauben* was new in Bavaria, apart from some forerunners in Augsburg [14], and was to become a landmark element in the whole country, especially in the Baroque period.

The sources for the reconstruction were sketches by students from the 1930s from the archive of the *Architekturmuseum* of the Technical University of Munich

Fig. 7. *Model of the helmed roof (Welsche Hauben) of the towers of the Frauenkirche. (Model: Architekturmuseum TUM, Picture: I. Mühlhaus).*

and historical photographs from the archive of the Brannekämper company, which rebuilt the destroyed Frauenkirche after the war. There are also two models of the construction, one in the *Architekturmuseum* of the Technical University of Munich and one in the *Deutsches Museum*. Today´s *Welsche Hauben* are thin concrete shells.

The Jesuit Church of St. Michael

The roof of the Jesuit Church of St. Michael, built in 1583-97 [6], set new standards in Munich. The task was to span the single nave with its 20-meter-wide barrel vault without supports. Although free spans of up to 20 m had already been achieved in some isolated cases (e.g., in Stuttgart, *Lusthaus*), this construction should become exemplary for many roof structures of the 17th and 18th centuries.

With high effort, the master carpenter combined all elements of the truss in one layer. The resulting intersections of the beams caused large losses of load-bearing capacity in some elements of the construction (at the intersections with the collar plate and collar beam, the king post is reduced to one-third of its actual thickness). This was obviously not considered a problem – neither here nor in many other roof structures of the 17th and 18th centuries.

The raking struts (*liegender Stuhl*), which extended over two levels in the lower part, were the basic element of the structure. King and queen posts bore the loads of the tie-beam and the lower collar beams.

A special feature was the "vault stamps" – beams lying on the vault and connected to the roof structure by v-shaped struts. These were intended to counteract deformations of the barrel vault by means of the load of the roof [15]. This kind of construction is also used in other Jesuit churches (e.g., in Landshut).

The reconstruction is based on sketches by students from the 1930s from the archive of the *Architekturmuseum* of the Technical University of Munich and historical photographs from the archive of the Bavarian State Office for the Preservation of Monuments. A model of the construction is preserved in the Deutsches Museum, but its details are inaccurate.

Fig. 8a. *Jesuit Church of St. Michael (Michaelskirche).*

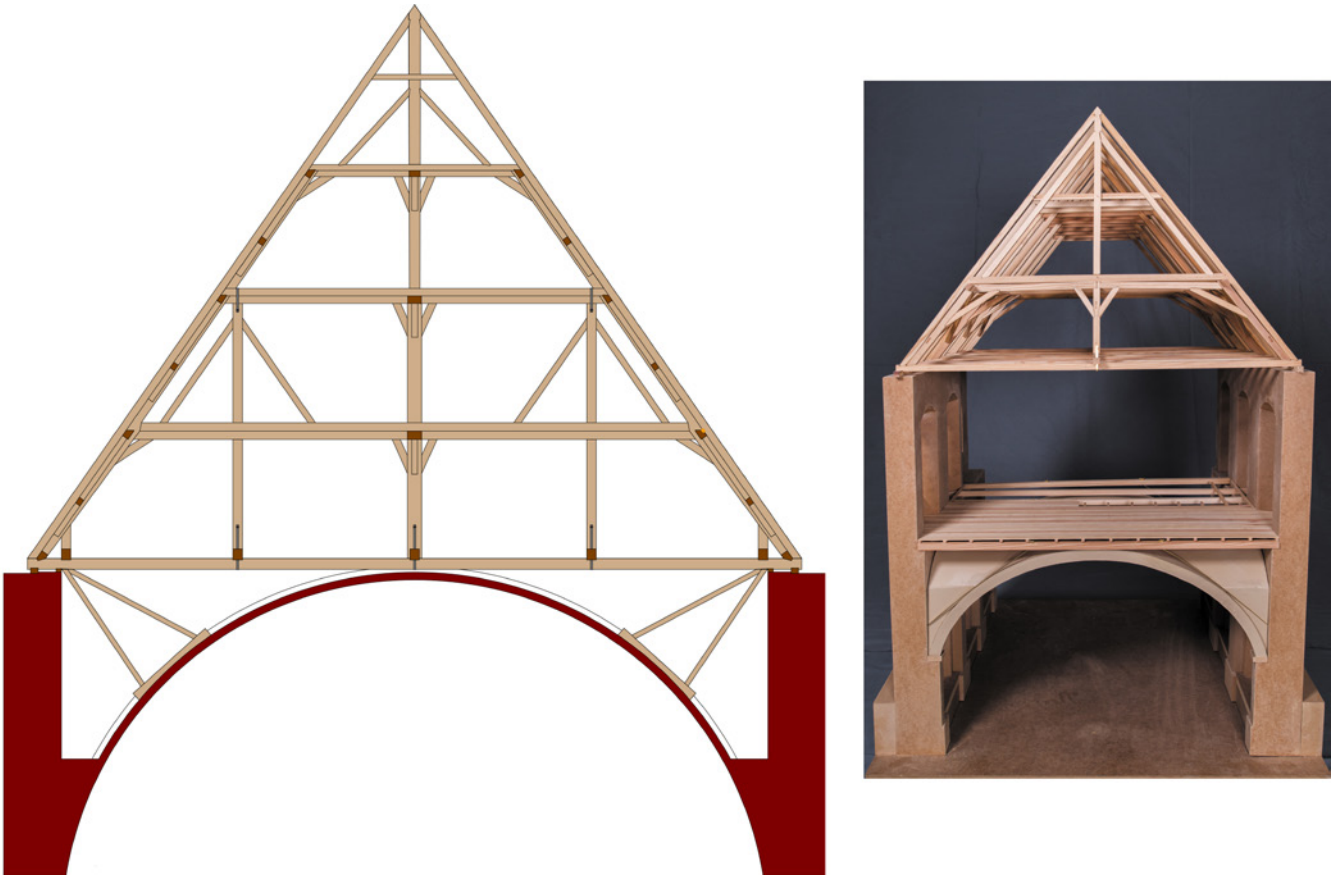

Fig. 8b. *Roof construction of the Michaelskirche (left) and of the Antiquarium (right). (Model and drawing: C. Knobling, Picture: I. Mühlhaus).*

The *Antiquarium* of the Munich Residence

A smaller, quite an ordinary roof of the early modern period was once located above the Antiquarium of the Munich Residence. Built around 1600 [6], the structure with raking struts (*liegender Stuhl*) and king post had a span of 13 meters. Here again, it was intended to arrange all structural elements flush in the same layer. As in *St. Michael*, this also weakened the cross-section of the king post considerably.

The archival sources (State Archive of Bavaria) suggest that the Antiquarium, built already in 1570-71, once had a much flatter roof of Italianate design, which, however, was removed in the course of the reconstruction of the entire Residence around 1600 [16]. Next to this source, there were also drawings from 1932 and photographs of the destroyed roof from the archive of the Bavarian Administration of State Palaces, Gardens, and Lakes.

The Tournament House

The roof of the Tournament House at the ducal gardens was perhaps the most unusual of all Munich roof constructions. The building was erected in 1660-61 as an indoor riding arena and venue for tournaments on horseback [6, 17, 18]. Accordingly, the width of 25.70 m had to be spanned without supports. Although just this being already a challenge, it was also intended to integrate a platform for spectators into the roof structure. This resulted in an "open" construction, i.e., a roof without continuous tie-beams to not obstruct the view from the ranks onto the arena. The spectator platform could then be placed on the interrupted tie-beams. In order to redirect the loads across the central void, the carpenter arranged inclined doubled braces. These connected the interrupted tie-beams with the collar beams and thus with the queen posts.

The elements of this unconventional design are, once again, taken from the traditional repertoire of roof construction: struts, raking struts, king and queen posts. After all, this roof lasted until at least 1720. A painting from the 19th century (Domenico Quaglio: *Der Abbruch des alten Turnierhauses*, around 1822, *Neue Pinaktohek*, Munich) shows the demolition of the whole building.

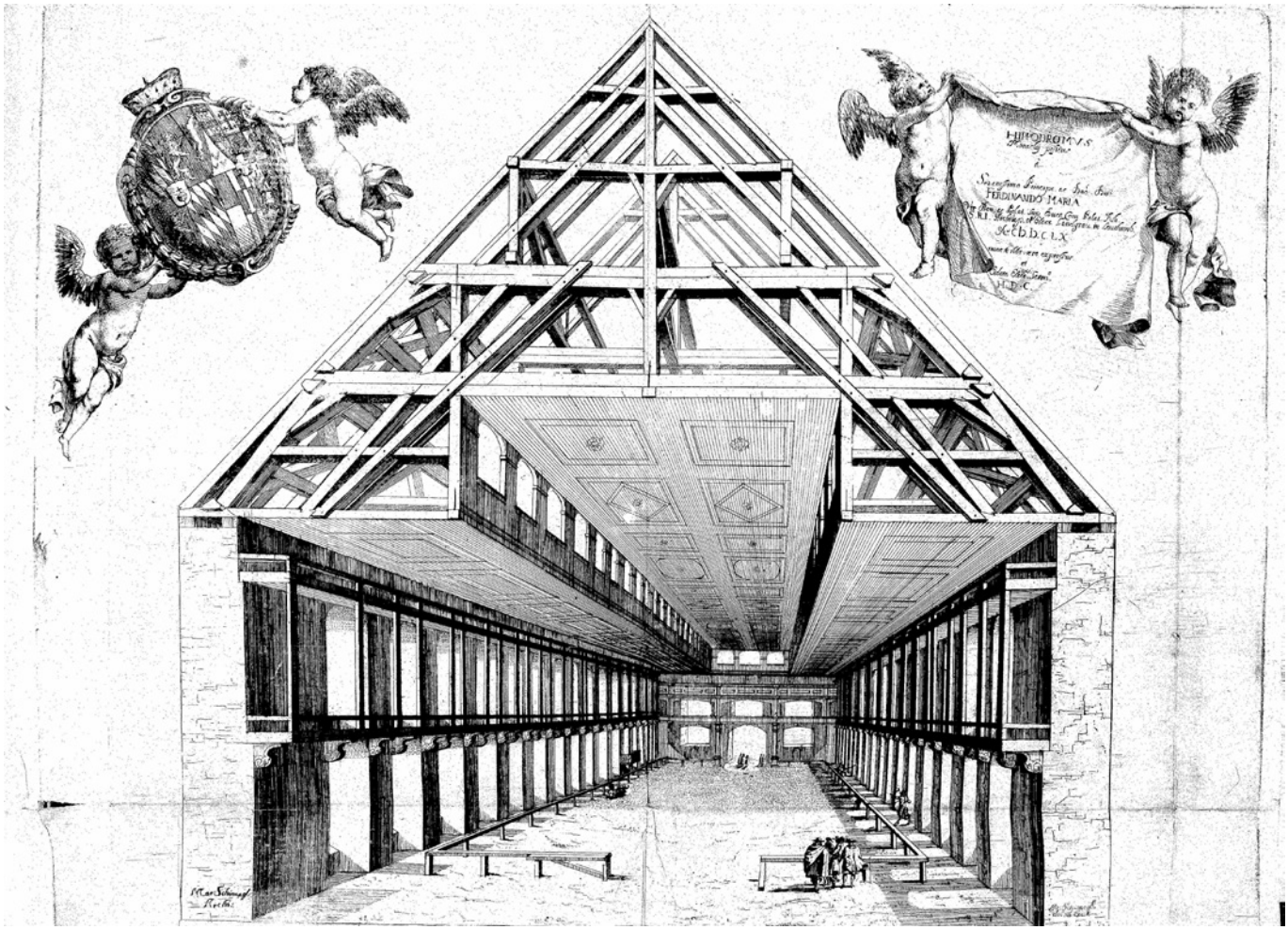

Fig. 9a. *Tournament house, plan drawn by master builder M. Schinnagl, 1660. (Bayerische Staatsbibliothek München).*

Fig. 9b. *Roof construction of the Tournament House at the ducal gardens. (Model: C. Knobling, Picture: I. Mühlhaus).*

There, a different roof structure is shown. It had continuous tie-beams and was most likely erected due to the conversion of the building into a grain store. However, this new roof showed striking similarities to the construction of 1660-61 and maybe was just a restructuring of the existing roof. The building was finally replaced due to the neoclassical redesign of the area around 1825 [6].

There were just a few sources available for the reconstruction: a drawing from master builder M. Schinnagl from 1660 (published in 1662; Bavarian State Library) and a not dated plan from the State Archive, which was obviously drawn in the 18th century. A further drawing from 1720 (Jeremias Wolf) shows the interior of the building and the shape of the ceiling.

Theatine Church (*Theatinerkirche*) of St. Kajetan

The Italianate roof of the *Theatinerkirche St. Kajetan*, built in 1668 (the whole church was built 1663-88), was still "exotic" north of the Alps in the 17th century. The later Electress Henrietta Adelaide of Savoy wanted a thoroughly Italianate architecture for the church [6], including also a flat-pitched roof. The master builder, Agostino Barelli from Bologna, accordingly made designs that foresaw a "Palladiana". Probably this was never realized. Sources from the Bavarian State Archives show a modified construction – a structure consisting of a central king post and two laterally queen posts, each with raking braces. The archival sources indicate that this was the construction of the 17th century. Similar schemes have already been handed down from earlier times, e.g., by Serlio and Bernardino Baldi [19]. It can be assumed, however, that the construction was substantially strengthened in the 19th century, at least at the base points. When it was built, an "Italian" purlin roof was still highly unusual in Bavaria [20]. While carpentry was mastered, sheet metal roofing still caused problems. The reason for the design of a flat-pitched roof was not only the incompatibility of a steep roof and the Italianate facade (which was not completed until the 18th century).

Fig. 10a. *Theatinerkirche.*

Fig. 10b. *Italianate roof of the Theatinerkirche. (Model: C. Knobling, Picture: I. Mühlhaus).*

Also, the dome should stay visible, and thus its tambour not be impaired by a roof [6].

The reconstruction is mainly based on drawings from the State Archive from 1944 and a drawing from A. von Voit from the 19th century, preserved in the archive of the *Architekturmuseum* of the Technical University of Munich. There are also drawings from Agostino Barelli from 1663 and 1667, preserved in the Bavarian State Archive. These plans show the original design, which differs from the construction preserved until the war.

National Theatre

In the 19th century, Italianate purlin roofs became part of the repertoire of southern German master builders. A neoclassical influence played a role, as well as technical and constructional aspects did [7]. Purlin roofs with trusses could bear heavy loads and be adapted for large spans. These aspects were the requirements for the design of the roof of the National Theatre. The building was re-erected by Leo von Klenze after a fire in 1823-25 [6]. He was also responsible for the 31 m wide (span 29.10 m) roof construction. In order to create the necessary construction height and flat pitch of 23° at the same time, Klenze used a trick: the actual base of the roof construction was located behind a flap-tile. So the outer segments of the assembled principle rafters could be inclined somewhat steeper at 29° while the common rafters continued to the eaves at the same inclination (23°). This was also applied in other buildings of Klenze [21]. Four king posts were placed in each truss. A rod polygon transferred the loads from the king posts to the supports. The king posts were assembled of two parts each. Thus, they could embrace both the rafters and the rod polygon. The tie beams were assembled of five individual parts, which were connected with dowels [22–24].

Underneath the roof, there were further trusses to carry the floor of the painters' hall as well as the vaulted ceiling of the auditorium below. Since the trusses rested on the circular enclosure of the auditorium, each had a different free span. Thus, Klenze constructed different types of constructions for each span. A ring, which held the girders of the plafond of the auditorium, was fixed in the middle of the two central trusses. The vaulted plafond

Fig. 11a. *Nationaltheater (State Opera House).*

Fig. 11b. *Roof construction and trusses of the ceiling of the auditorium of the Nationaltheater. (Model: C. Knobling, Picture: I. Mühlhaus).*

was constructed according to the system of Philibert de l`Orme, a model dating back to the 16th century. The roof and ceilings of the National Theatre were a remarkable example of the variety of timber constructions in the 19th century, some of which also make use of historical models.

At the end of World War II, the National Theatre was also destroyed. However, the nearby *Gärtnerplatztheater* survived. Its roof construction is a smaller replica of the larger but lost one from the National Theatre [21].

The reconstruction is based on several sources – among others, on building surveys from 1929, preserved in the archive of the *Architekturmuseum* of the Technical University of Munich, on the original plans by Leo von Klenze, and additional drawings preserved in the Bavarian State Archive. The roof construction was also published by Gierth (1840) [22], Romberg (1833 and 1847) [23], and Gottgetreu (1882) [24].

4. CONCLUSION

The study shows that the Munich roofs were among the most innovative constructions of their kind. The huge roof of the *Frauenkirche* was one of the largest structures of its time. Unusual buildings such as the *Turnierhaus* could probably only be erected in an up-and-coming ducal (and later royal) residential city that had a need for large representative buildings. Also, a building like the *Nationaltheater* could only be realized in such an environment. The court also attracted other institutions to settle in Munich and build prestigious and thus also constructively demanding buildings like the Jesuit Church of St. Michael.

The importance of the city and the international relations of the court are also reflected in the architecture of the city and even in the roof constructions. Italian influences are particularly evident. This already began in the 14th century with the vault in *Maria Ramersdorf* (around 1360). Its construction is not based on the numerous wooden vaults in northern France and northern Germany, which are mostly just formed by cladding the trusses, which were shaped by some additional beams. Rather, it follows a different path by having its own supporting structure. Similar solutions can also be found in some wooden vaults of the Veneto, especially in San Zeno in Verona.

The Italian references then become obvious with the tower roofs (*Welsche Hauben*) of the *Frauenkirche* (1524-25). The inspiration for these constructions came from the Veneto – or directly from Venice – via Augsburg [25]. A glance at the veduta of Venice by Jacopo de Barbari from 1500 reveals numerous helmed roofs of this type. Nevertheless, the construction of the Munich roofs was still geared towards local techniques.

A veritable copy of an Italian roof was then erected on the *Theatinerkirche St. Kajetan* (1668). The master

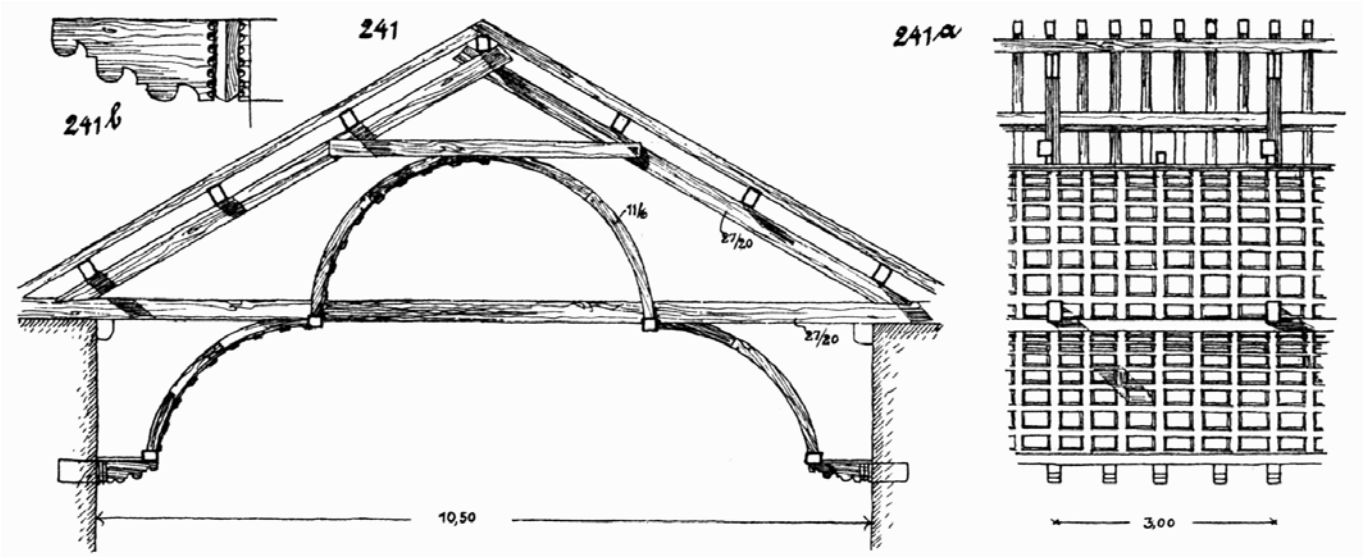

Fig. 12. *Roof and vaulted ceiling of San Zeno in Verona, drawn by F. Ostendorf, 1908.*

builder, Agostino Barelli from Bologna, provided an Italianate design for the entire church. The roof was built by German carpenters, who were apparently trained in Italian carpentry. With the single-shell dome, the *Theatinerkirche* enriched Munich's skyline with another specifically Italian element.

The roof of the *Theatinerkirche* was still a prototype. Although flat-pitched purlin roofs have always been the predominant type in the Alpine and Pre-Alpine region, their occurrence was mainly limited to residential buildings and, thus, to smaller spans. For churches, the rafter roof has always been employed. Thus, the need to develop wide-span purlin trusses was just not given for a long time. As soon as the need arose (due to stylistic and constructional demands) – especially in the 19th century – people often fell back on the Italian models that had been matured for centuries [7]. The National Theater and the *Gärtnerplatztheater* in Munich are good examples of this.

Many roof structures were lost in the Second World War before the rise of interest in this hidden heritage and before any comprehensive documentation. Thus, many blank areas remain in research on historic roofs, especially in heavily destroyed city centers. Yet this is exactly where some of the most important buildings and the largest spans were to be found. Therefore, this first in-depth study on "lost roofs" is an incentive to address this significant lacuna and investigate missing roofs in other urban centers.

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A list of the catalog signatures can be found in the printed version of the dissertation [1].

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