Theorizing the roof. «New» roof constructions in German countries at the end of the 18th century

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In the 16th century the Frenchman Philibert de l’Orme invented a new method of roof construction in which planks were nailed or pegged together in a semicircular form. This method never vanished totally in France. However, the starting-signal for a new fashion was marked by the erection of the dome of the Halle au blé in Paris in 1783 by Jacques-Guillaume Legrand and Jacques Molino, who used de l’Orme’s method. Its rise and decline can be pursued in an exemplary manner in Germany, where research over the last twenty years gives an excellent overview of the architects involved, expert discourses and the fabrication methods. In the following I will concentrate on Prussia and Saxony and discuss one example in greater depth. This allows an insight into the transfer of new technological knowledge, in this case from France via Prussia—the most important German region associated with this construction method—to its southern neighbour Saxony. The archive material similarly supports the discussion of the case study—one of the largest preserved German roofs constructed with de l’Orme’s method—providing details of the work programme and of authorities and individuals involved in its administration.

TECHNOLOGICAL PROGRESS AND THE 18TH-CENTURY ENERGY CRISIS

In 1797 David Gilly (1748–1808), chief of the Prussian building administration, published a book about curved plank roofs. He not only presented Philibert de l’Orme’s invention to a greater number of experts, figure 1. He also propagated building such roofs and developed on de l’Orme’s construction principles. His main argument for the use of this ‘new’ construction was the reduction of needed timber.

Figure 1
Gilly 1797 (fig. 5)
However, Gilly was not the first to use this economical argument for the introduction of a new construction method for roofs. Friedrich August Krubsacius (1718–1808), Professor of architecture at the Academy in Dresden, in 1784 had already published his invention of a new roof construction system, figure 2. Inspired by William Chambers’ treatise on Chinese architecture, he proposed to build a roof without rafters. The Chinese roof seemed to him to be an accumulation of horizontal wooden beams and a simple construction. But he criticized its need for a large quantity of material. Moreover, it was only practicable for small span widths and the attic could not be used. Consequently, he imitated only one aspect, that of the limitation of the construction on purlins:

Therefore I do not demand for the construction of a roof more timber, than a certain number of beams, which will lay on two strong stepped end walls up to the ridge. On the edges of the beams I will fix strong laths . . . and nail roof battens on them, this way the roof will be finished except for covering.

For this no rafters and harmful eave boards, no collar beams, span pieces, top beams, struts, angle hinges, gable posts, wall plates, pole plates, . . . king-post or leaning roof trusses including their walls, yes, not even structural beams . . . are necessary. Doesn’t this mean saving enough timber? 1

David Gilly in his treatises about the plank roof also argued with the reduction of needed material. With exemplary calculations he showed how much less timber — about one-third less — would be needed for a plank roof in comparison to traditional constructions. Moreover, he stressed that only short planks are used, so that valuable tree-trunks must not be touched. Carl Gotthard Langhans (1732–1808), who was not only the architect of the Brandenburg Gate in Berlin, but also the constructor of the first plank roofs in Prussia,

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Figure 2
Krub sacius 1784 (fig. 2)
already operated with this method of argumentation, which emphasized the economic aspect by offering ‘proofs’ with calculations. He compared the dome of St. Blasien in the Black Forest (erected in 1777 by Nicolas de Pigage as a traditional wooden construction) and his alternative project with the rediscovered method of de l’Orme. This allowed him to show that the consumption of timber could be reduced by more than 70 %.

Prussian plank-roof propaganda was strongly related to a new esteem of rural architecture (Landbaukunst). Plank roofs were especially recommended for barns and other (rural) buildings, which needed a big attic. Since the development of bureaucratic structures for royal buildings an instrument existed to enforce the aims of settlement policy in the field of architecture. Farmhouses and barns were no longer only vernacular architecture, but building types that the representatives of the royal building administration had to take care of. In terms of the theorization that took place in construction methodologies, pisé-construction must be mentioned alongside the use of plank roofs. As with the reinvention of the plank roof, the revival of building with loam started in France and is related to François Contereaux. David Gilly was again the most important German advocate. His argument was similar: He was convinced that by using cob walls timber could be saved, not only in the construction itself but also in the reduced requirement for heating material because of better insulation.

But was the argument for decreasing the consumption of timber more than a topos?

The arguments of Krubsacius, Langhans and Gilly—all of whom tried to introduce new and different roof construction methods—were based neither on structural arguments (firmitas), nor on aesthetic arguments (venustas), but mainly based on saving timber. Certainly the reduction of costs was attractive to both private customers and the Prussian or Saxon states. But the attentiveness to this argument signifies more than a concentration on the economic aspect. Krubsacius and Gilly could both count on a contemporary awareness of wood scarcity. In the 18th century German literature and newspapers we find many treatises and articles that present inventions to decrease the consumption of timber. These discussions were primarily related to ovens and other heating systems. The genre of timber-saving literature (Holzspartiteratur) culminated during the 1790s following the French Revolution. A general feeling of crisis may have been the background. Through these publications the scarcity of timber—more often caused by commercial legislation and transportation problems than by forestry—became a widely known problem discussed by representatives of the Enlightenment. This also cleared the ground for architects to depart from the Vitruvian arguments and address them in the context of an existing discussion. Technological innovations and new construction methods became the subject of architectural scholarship.

A NEW ROOF FOR THE CASTLE OF AUGUSTUSBURG IN SAXONY (1797–1801)

The reception of Gilly’s treatise is exemplified at castle Augustusburg in Saxony, which was originally constructed between 1568 and 1573 by Hieronymus Lotter, figure 3. By the end of the 17th century the Saxon Electors no longer regularly spent their summers at the castle. As a result the building went to ruin. The decay was accelerated by several constructional elements—such as the valleys of the pavilion roofs—and also by the topographic situation. Standing on the top of a hill the building suffered from the strong winds. Unfortunately on the outside walkways the lead sheets, which lay under floor plates of sandstone, were taken away during repairs in 1670. One consequence was that the entering rain damaged not only the brick walls.

The decay of castle Augustusburg in the 18th century

The subsequent stages of increasing decay and of the final repair between 1797 and 1801 are documented by rich archive material. In the Sächsisches Hauptstaatsarchiv three dossiers are conserved. They give an insight into the various attempts to repair the roof. The drawings one can find at the archive of the Landesamt für Denkmalpflege Sachsen in Dresden and the repair work can be analyzed through a documentation of the existing roof.

In the second half of the 18th century dozens of notices detailing the poor condition of castle Augustusburg were received by the responsible
A new roof for castle Augustusburg

In October 1797 Weinlig traveled to Augustusburg and inspected the construction together with the local carpenter and bricklayer. He came to the conclusion that the building could be rescued. The walls were found to be in a comparatively good condition and the damages to the vaults, which were caused by humidity, could be easily repaired. The reason for the damage was the shape of the roof, especially the valleys. Weinlig illustrated his proposals for rebuilding with eight coloured drawings—plans, sections and roof plans— which contrasted the actual state with the rebuilding project. He proposed to

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cover the walkways of the connecting buildings with a new roof. A simplification of the roof shape of the pavilion roofs could be realized by eliminating the problematic valleys. In his proposal he also referred to the «light roof», which the Elector had mentioned:

Had not on one hand the expense, which the complete pulling down of the former roofs would cause, and on the other hand doubts about introducing a system, which is totally different from the one carpenters are used to, kept me off, I would have decided to propose the roof construction of posts or planks nailed together, instead of rafters, which Philibert de L'Orme invented already two hundred years ago and which was executed by him and in our days in Berlin on many buildings with good success. The Ober-Bau-Rath Gilly in Berlin has published a description of these roofs, which he calls Bohlen Dächer (plank roofs, italics added) and of their advantages some time ago.12

Weinlig demonstrated that he was very well informed on the newest developments: David Gilly's ‘Ueber Erfindung, Construction und Vortheile der Bohlen-Dächer' was published one year before. He hesitated to emphatically propose a plank roof due to the cost of pulling down the roofs, a lack of confidence in the skills of the carpenters and the seemingly impossible task of making a precise estimate. In June 1798 the authorities forwarded his proposal to the Elector; they now rejected the demolition option and recommended to repair and to preserve the castle «as a monument of former times».13 The authority also mentioned:

that the remark in the report of the Hof Baumeister Weinlig about the roof system with curved posts or planks, with which the big dome of the Halle aux Bleds in Paris is constructed, in these days deserves special attention, and that because of the connected timber-saving for further projects, the authority [Geheimes Finanzkollegium] will take it into consideration, as this year it has already ordered the construction of a new harness-barn in the back courtyard of the electoral stables near Friedrichstadt with this system.14

The plank roof under discussion was erected in Dresden in 1798 and is probably the first example of the new roof construction in Saxony, it is to be noted that the first curved plank roofs had already appeared ten years earlier in Prussia.15

Nevertheless the preparation for alteration work in castle Augustusburg started at the end of the same year with the intention to repair the traditional rafters. The site-supervisor was Kaden, who took care that the craftsmen rebuilt the old roof carefully. The hope was that much of the timber and roof slate could be re-used for the repair work.

In May 1799 Weinlig, together with the carpenter Johann Carl Bergauer,16 traveled to Augustusburg because Kaden had informed him that much more timber than expected was rotten. Aiming to keep within the cost schedule, Weinlig was forced to rethink the proposed repair. The final decision was made on the site on 30th May 1799. As far as possible the old rafters should be restored, but the new lean-to roofs, where formerly had been gabled windows, should now be constructed with plank rafters, which should also substitute for totally rotten rafters in other parts of the roof.17 The most important argument was again the reduction of needed timber. Kaden also argued that it would be easier for the citizens, who had to fulfill their statutory building labour, to transport the short planks up the hill instead of heavy timber.18

The typical curved shape of plank roofs is not found at castle Augustusburg, and this may be the reason that Günter Hutschenreuther did not discuss this building in his 1957 thesis, which still gives the best overview of Saxonian plank roofs.19 The ‘new’ construction can be seen at the lean-to roofs of the corner buildings, figure 4. Both the pavilion roofs and the roofs of the connecting buildings have traditional constructions. The plank rafters are connected to a tie-beam using a mortice and tenon joint and their upper part leans to a beam, that is part of a substructure, figure 5. The curved part is nearly a quarter circle. Long eave boards form the roof shape. The roof has a pitch of 44 degrees and covers the rooms below with a width of nearly 9 m. The planks are about 3 cm thick, 27 cm wide and 1.58 m long. A rafter is constructed by a set of six planks that is nailed to a set of five planks with their whole length and two half planks at the end. Only forged nails were used not wooden dowels. And there were many nails: at every joint not less than two, and between two joints not less than one. At the documented rafter we find 129 nails. Also noteworthy are the cross braces on three levels. The laths of 3.5 x 7 cm normally strut three plank rafters, figure 6.
Early lean-to plank roofs and the question of bracing

In his dissertation Eckart Rüsch estimated the existence of lean-to plank roofs as proof that this ‘new’ construction method was used for nearly all roof shapes and documented the development of this construction in Prussia. Gilly’s 1798 proposal is one of the oldest examples. He suggested to construct this plank roof with quarter-circular rafters, jointed to posts at the level of the ridge. Bracing is lacking, but Gilly recommended the construction of a strong wall able to take the shear forces of the rafters. No preserved example of these early lean-to plank roofs without bracing is known, so that we can assume that all of them broke down because of structural damages. But the Saxonian example, which was
designed only one year later, still exists. The cross braces between the plank rafters seem to fulfill their structural function and provide steadiness. Even if the quick reception of the construction method in Saxony can be estimated as a success of the Prussian propaganda, it should be accentuated that this reception was characterized by a critical approach and independent further development. Documentary evidence provides an unpublished treatise written in 1798 by Weinlig.\(^2^1\) It demonstrates not only Weinlig’s profound study of Gilly’s publications during the construction of the new roof of castle Augustusburg, but also a critical attitude towards specific details and his attempts to improve them.\(^2^2\) From this document we also learn that the first Saxonian plank roof over the harness-barn, of which the architect is unknown, diverged from Gilly’s proposals. It was «strut only with laths and due to this achieved a nearly imperturbable steadiness».\(^2^3\) It is probable that Weinlig’s decision to brace the roof of castle Augustusburg traces back to the early example in Dresden. Perhaps it also resulted from a study of the treatise of Philibert de l’Orme, from which Gilly had reprinted the figures. Whatever caused a divergence from the Prussian model, whether it was the experience of carpenters and architects or a study of the French prototype, the bracing initiated an autonomous development in Saxony.

The classification of some Saxonian plank roofs — all of them with bracing— has caused problems until now, figure 7.\(^2^4\) Most were designed by Karl Mildenreich Barth. Barth, who became Landbaumeister in 1816, certainly knew the plank roofs that had been erected by the building authority: both the example in Dresden and the roof of castle Augustusburg. It may be that he was even familiar with Weinlig’s unpublished treatise. It is obvious that the bracing of plank roofs in Saxony goes back to the first examples and is correlated to a discourse taking place in the building authority, led by Weinlig.

**The expensive repair**

The repair of castle Augustusburg, which was finished in 1801, cost more than expected. There were
many attempts to stick to the estimate and to «take into consideration a maximum of savings». As well as the decision for the presumed timber-saving roof construction, it was planned to re-use most of the building materials. Soon it became clear that not only most of the timber was rotten, but also that the roof slate could not be used again. In this difficult period of revising the cost schedules Weinlig, the architect responsible, died on 25th November 1799. The sitesupervisor Kaden tried to reduce the exploding expenses. He searched for near-by slate quarries and reduced transportation charges. However, the alteration work finally cost 9272 Taler, 1 Groschen and 5 Pfennig, which doubled the expected amount. In 1800 the responsible authority sent the Landbaukomissar Wilhelm Traugott Verlohren to Augustusburg to check the estimates. He exonerated Weinlig because the damage, which caused the increasing costs, would not have been visible when he made his first appraisal. Verlohren’s only critical note referred to the nails used to fix the planks together. They caused an unexpected expense of some hundred Taler. The authority did not forward this particular comment to the Elector. This may have been, because the critique concerned the plank roof construction itself, a construction with which considerable timber saving was associated. If timber saving was more important to enlightened financial administrators than an economic use of nails, and somehow led to a tolerance of rising cost, one can probably diagnose a ‘timber saving ideology’.

CONCLUSION: THE DECLINE OF A FASHION

The case study of castle Augustusburg has shown that in German countries the revival of de l’Orme’s construction method was not limited to specific building types, e. g. barns and drill halls, which took an important place in Prussian propaganda. The timber-saving construction was also used for roofing churches and castles, even if it is to admit that in the case of castle Augustusburg the decision for the plank roof was the last possibility to save the building considering the financial situation. The range of built roof shapes and of construction details is richer than a study of the treatises would lead one to expect. Nevertheless by the 1830s the construction method had already lost its importance, even if we know of plank roofs that were constructed at the end of the 19th century, such as the building of the co-operative La Obrera Mataronense in Mataró (Antoni Gaudí, 1878-82), and of the 20th century. The latest known German example is the Luckenwalde settlement in Berlin (1932).

Which were the causes responsible for the decline of this roof construction?

The argument for timber saving was no longer as important as at the end of the 18th century. With the beginning of the industrial revolution, coal started to substitute for timber as a primary heating material. In addition, a rationalization of working processes and technological developments reduced the consumption of timber. Finally, transportation systems changed and the transport of materials became cheaper.

The main factor, however, was that iron became an alternative building material for roofs, bridges and greenhouses — all those constructions we associate today with the rise of civil engineering in the 19th century. Indeed, the second dome of the Halle au blé, which replaced the burned-down plank roof in 1811/12, was an iron construction by Belanger and Brunet. But also new constructions were developed, such as the Emy-system (1819), a mixed timber-iron structure: Customary planks were horizontally laminated, curved with the help of a template and connected with iron plates and bolts.

But there were additional causes for the decline of plank roofs, that were related to the construction itself. One problem of this system was the cost — castle Augustusburg seems to be an example. In 1845 Gerhardt compared estimates for the erection of a traditional rafter roof and a plank roof — a method with a long tradition remembering Langhans and Gilly. He came to the conclusion that the limited use of plank roofs for the construction of agricultural buildings is a result of the fact that they are «not cheaper, but more expensive». Another factor, as well as the structural deficiency of the early examples, was the skeptical attitude of carpenters. Even if the construction of plank roofs was part of the exams of craftsmen in Prussia — a consequence of the Prussian propaganda — carpenters disliked the construction method because of a higher rate of accidents during the erection. A construction that is not accepted by the craftsmen will never become vernacular. But before mechanization took command vernacular constructions were the most successful in terms of survival of form over long periods.
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NOTES

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Concentration on German countries means that nearly all (archive) sources and research reports are written in German. I decided to translate the cited parts and give the original version in the notes.

1. The roofs of the Rue de Rivoli in Paris became famous (Szambien 1992, 78–119, concentrated on the urban aspect but gave a lot of figures). In 1803 the fashion had even arrived in the United States of America with the discussion about the roof of the Hall of Representatives of the Capitol in Washington (Norton 1977, 67–68; Deming 1984, 184). The roofs constructed by Christopher Wren provide examples of the use of de l’Orme’s method outside France before the erection of the Halle au blé (Yeomans 1992, 57).


5. Beside the publication of 1797 Gilly took on the argument in 1799 and added the treatise about plank roofs to the later editions of Handbuch der Land=Bau=Kunst.


9. For the notices about the decay see SächsHStA, loc. 492, 1–12 (Report of Geheimes Finanzkollegium, 21st June 1797).


11. SächsHStA, loc. 492, 43° (Elector Friedrich August, 2nd October 1797): «allenfalls unter einer leichten Bedachung und durch sonstige schickliche Veranstaltungen conserviert werden könne». 


13. SächsHStA, loc. 492, 57° (Report of Geheimes Finanzkollegium, 20th June 1798): «als ein Monument alterer Zeiten, vorzügt in Dach und Fach herzustellen und erhalten zu laßen.» This is obviously less connected with the idea of protection of historical monuments as it developed around 1900 but a sign of castle Augustusburg’s value for the dynastic memory.
14. SächsHStA, loc. 492, 57° (Report of Geheimes Finanzkollegium, 20th June 1798): «daß die von dem Hof Baumeister Weinlig in seiner Anzeige gemachte Bemerkung über die Dachverbindung mit bogenförmigen Pfosten und Bretern, nach welcher auch das große Kuppeldach der Halle auf Blids zu Paris construit ist, in dermaliger Zeit, besondere Aufmerksamkeit verdient, und es wird das Geheime Finanz Kollegium auf Anwendung dieser Bau Art in Rücksicht des damit verbundenen beträchtlichen Holz Ersparnisses bey vorkommenden darauf schicken, füllen, thunlichsten Bedacht nehmen, wie den auch bereits im heutigen Jahre, die Erbauung eines neuen Geschirr-Schuppens bey Ihr Chur Fürstl. Durchl. obwohl der Friedrichstädter gelegenen neuen Ställen, im hinteren Hofe, nach dieser Bau Art, angeordnet worden ist.» The harness-barn in Dresden, which was constructed in 1798, does not exist any more. The authority probably knew of the construction of the Halle aux blé since 1796, because in this year Carl Gottlob Döhne published an article about it in the ‘Anzeigen der Churfürstl. Sächsischen Leipziger ökonomischen Societät‘: Döhne 1796. Two members of the authority — Peter Carl Wilhelm Graf von Hohenath and Andreas von Wagner — were also associated with the society in Leipzig.


16. Johann Carl Bergauer was ‘Hof-Zimmer-Polirer’ — foreman of the carpenters — at the electoral building authority.


21. SächsHStA, loc. 34565, Rep. XLI, Gen. 475. Because of the shortened autograph [C. T. Wilg.] and the chronological coherence this description, which dates from 12th September 1798, may be attributed to Weinlig.

22. Weinlig proposed — opposing Gilly — to erect the rafters and cog a thinner ridge beam.


29. Meschke 1989, 105–107; Gould 2001, 76–78; Yeomans 1992, 199. The Em-System was often used for railway stations, e. g. that of Munich (1848) and the more famous King’s Cross Station in London (1852). Normally the arches supported saddle roofs.

30. Gerhardt 1845, 106: «die geringe Anwendung der Bohlendächer bei Landwirtschaftsgebäuden erklären sich einfach daraus, weil sie nicht wohl finden, sondern . . . wie geradlinige Sparren — oder Satteldächer seien . . . .» I owe my debt to Ulrich Maximilian Schumann, who drew my attention to this article.


ARCHIVE SOURCES

Sächsisches Hauptstaatsarchiv = SächsHStA
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SächsHStA, loc. 492: Die Wiederherstellung der Schloßgebäude zu Augustusburg betr., Ao. 1797 sq.

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