

## The Construction of the Iffland-Theater in Berlin by Carl Gotthard Langhans, 1800

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**ABSTRACT:** The Prussian architect Carl Gotthard Langhans specialized in the construction of acoustic rooms and auditoria like theaters, churches, and amusement-halls. He publicized his theoretical conceptions in 1800 in an essay in which he summarized his lifelong experience with optic and acoustic principles in theater design. Langhans developed a systematic structure for acoustic rooms, based theoretically on the books of Pierre Patte and Gabriel Pierre Martin Dumont of the Académie d'Architecture in Paris and practically on the architectural principles of traditional German baroque churches like Steinhausen and Steingaden by Dominikus Zimmermann.

### THE ARCHITECT CARL GOTTHARD LANGHANS (1732-1808)

#### Biography

Little is known about the first thirty two years of Carl Gotthard Langhans' life until he was engaged as architect by the princes of Hatzfeld in Zmigrod (German: Trachenberg) and Wroclaw 1764. The only biography until today was written before World War I by W. Hinrichs. His dissertation does not reflect the importance of this architect as the dominant figure in German neoclassical architecture in the second half of the eighteenth century, when Prussia became the military and economic powerhouse in Germany. His works and the theater buildings of his son Carl Ferdinand are obscured by the attention, literature has paid almost exclusively to Karl Friedrich Schinkel and Leo von Klenze after the Napoleonic Wars. All but a few documents of Carl Gotthard Langhans were lost during World War II.

Langhans studied law and mathematics at the Prussian State University of Halle to become a state architect at the *Kriegs- und Domänenkammer* in Silesia. Soon after the Seven-Years-War, during which he made a first trip to England and Holland, he was appointed as head of the construction department for Silesia in Wroclaw. For his first projects where optical and acoustic problems had to be solved, he built a lecture hall for his alma mater in Halle in 1777 and theaters in Glogow and Wroclaw in 1782. All three rooms had elliptic layouts. The theater in Wroclaw was renowned for its acoustic characteristics. Whoever could afford it in Prussia would let Langhans build or redesign his mansion with a new entrance and an acoustically up-to-date music and festival hall, as did Prince Heinrich in Rheinsberg in 1766.

Langhans redesigned the Royal Opera in Berlin in 1787 and through the influence of Prince Heinrich, the brother of Friedrich II, he was appointed Architect to the King and head of the Royal Hofbauamt 1788 by Friedrich Wilhelm II. He organized the urban development of Berlin, at that time one of the fastest growing cities in Europe. Karl Friedrich Schinkel was never granted Langhans' title and position. When August Wilhelm Iffland became director of the Royal National Theater in Berlin, Langhans was commissioned to build a new and larger national theater at the site of the French Comedy for a capacity of 2000 spectators.

August Wilhelm Iffland came from Mannheim, where he had directed the court theater, built by Alessandro Galli-Bibiena for the same size of audience. Carl Ferdinand Langhans recorded in his *Katakustik* (katakustik means reflected sound just as katoptic means reflected light) the capacity of some theaters of the time: Theater an der Wien, 2700; Berlin Opera, 3000; Teatro di San Carlo, Naples, 3300; Scala di Milano, over 4000. Lang-

Langhans the elder publicized the principles of his theater constructions 1800 before the theater was finished two years later. Langhans being 68 years old considered this essay as his architectural testament. When the theater opened, the audience was faced with unexpected and disastrous acoustic phenomena. The problems were so fundamental, they were analyzed by the son of the architect Carl Ferdinand Langhans (1782-1869) who was then second supervising site manager for the project. He published the results in his treatise on *katakustik* in 1810, which became the leading acoustical theory in Germany throughout the nineteenth century. The theater in Berlin was the last theater ever built with an elliptic layout.

### Acoustic Rooms

Langhans constructed his first elliptical rooms after his tour to southern Germany and Italy in 1768/69, of which we have no diary. The purpose of the journey was the project of the Hatzfeld Palais in Wroclaw; it was the largest court building in eastern Prussia. Today there is only the triumphant entrance gate remaining. He presented his plans to the Prince von Hatzfeld, who was secretary of inner affairs in Vienna, and bought marble in Italy. It is very likely that he visited the ancestral region of the Hatzfeld family and the Residence in Würzburg with its oval room and the new fashioned designs of the Seinsheim chambers, as Langhans drew similar decors for the Hatzfeld Palais in Wroclaw. His tour probably took him to the Wieskirche in Steingaden, where his stucco decorator, Peter Ehtler, was born. How long the construction of oval rooms in Germany can be traced back has never been investigated. Johann Jacob Herkommer, the teacher of Dominikus Zimmermann, designed oval rooms in the late seventeenth century in Augsburg and Füssen, partly used for music performances. But in the history of theater design, the discussion of acoustic construction of rooms has been completely neglected, regardless of the fashion that the music industry of today produces supposedly original sounding records. What was the ideal original sound of an eighteenth century theater and how were they constructed? Today too much attention is paid to the baroque and rococo decorations in these halls instead of also analyzing the technical aspects of these functional halls. A first hint is given in P. Patte's *Essay sur 'architecture théâtral* when analyzing the layouts of the great theaters of Europe (Fig. 1).

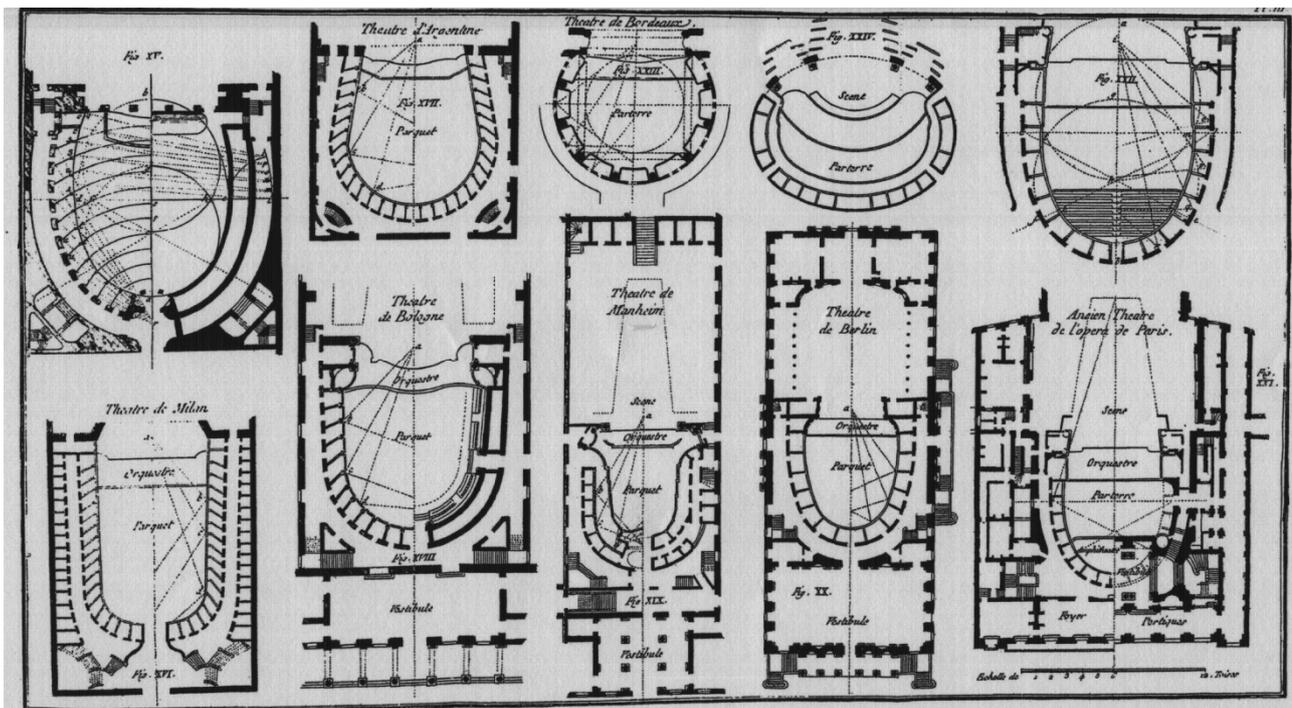


Figure 1: Layouts of theaters published in Pierre Patte's *Essay sur l'architecture théâtrale*. Much attention was given to the reflection of the sound beams. Top left to bottom right: Turin by Benedetto Alfieri, Rome, Bordeaux, theater of the Prince of Württemberg in Paris a remake of Palladio's Teatro Olimpico, Versailles, Scala di Milano, Bologna, Mannheim by Alessandro Galli-Bibiena, opera in Berlin by Wenzelslaus von Knobelsdorff, opera in Paris.

## BOUNDARY CONDITIONS FOR THEATERS OF THE EIGHTEENTH CENTURY

### The Size of a large Theater

Before the use of the Argand lamp, the strongest restrictions in designing a theater were caused by the stage lighting. This invention after its introduction 1783 solved the biggest problems in stage lighting for theaters. Before the number of candles on the sides behind the scene could not be increased above a certain level, otherwise the air would become too warm and the wax would melt down. The conventional lighting with candles and wax bowls in front of the proscenium always created clouds of smoke in the auditorium through the air movement when the curtain opened. The differently heated air masses always tried to reach a thermody-

dynamic equilibrium. Thus the stage opening was limited to about 14 meters and the architect had no possibility to broaden the scene, thus granting the audience a better view.

Before constructing his theater, Langhans sent Friedrich Gilly to London and Paris to measure the stage openings of newer theaters, to see if the Argand lamp had caused changes since his own visit to the theaters in 1775. Gilly found no enlargement of the stage openings instead they were even slightly reduced, because the costs for the decorations were crucial for the profits of a theater. A technical factor was replaced by economic decisions. The width of the auditorium could not exceed this distance by much, due to the sight of the spectators at the sides, where all the rich and noble people sat in their rented boxes. The only possible enlargement of the auditorium could be achieved by stretching the length of the auditorium and by adding balconies with or without boxes. The problems caused by boxes for the acoustics in a theater will not be discussed in detail. Basically the intersecting walls of these cabinets were considered the biggest problem for the reduction of the reverberation in a theater.

But length and height were also limited due to the sight and sound of the performance. In his *Treatise on Theatres* George Saunders publicized his experiments in 1790 to obtain the maximum length and height of an auditorium, where the audience has satisfying sight and sound. Saunders had made sound measures in an open and plain environment, to avoid reflected sound amplification. His advice for the limitation of the radius for the sound of the actors was 75 ft. Auditoria that did not meet this condition, like the Palais du Trocadéro in Paris, were doomed to face acoustic disaster before the invention of the electro-acoustic sound amplifiers. Langhans restricted the length of his theater to 17 m.

The angle of the sightline from the scene toward the spectators in the upper balconies should according to Saunders not exceed 45° due to optical perspectives of the actors. This restriction changed the arrangements of balconies in the nineteenth century as in Ferdinand Langhans's recently renovated Opera of Wroclaw.

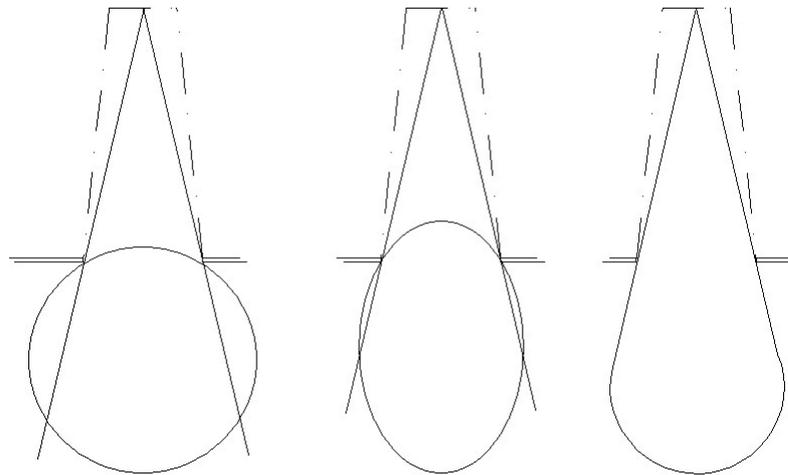


Figure 2: Sightlines for three common layouts of a theater with maximum stage opening and given length of the auditorium according to Saunders. Left: Bordeaux, London Drury Lane, Karlsruhe. Middle: Turin, Paris Opera, Versailles, Wroclaw. Right: Rome, Naples.

### Sightlines

The fixed front stage opening caused architects throughout the eighteenth century to search for the best layout of an auditorium. As Ferdinand Langhans stated, the plans were based mostly on optical and not acoustic rules (Fig. 2), but architects were very innovative in creating differently shaped theaters which were already recognized by the contemporaries. The first architects, who focused on acoustics, were the Galli-Bibienas with a bell-shaped design. However this ideal form for sound resonance did not improve theater acoustics because of the different material but rather reduced the size of the auditorium.

Fig. 1 shows the variety of designs of theaters in European cities. There was no preferred layout, because architects could never be certain, what kind of sound conditions existed in the designed auditorium. The elliptical form was favored by French architects like Pierre Patte and Charles-Nicolas Cochin from the Académie d'Architecture in Paris. There still was fought the Parisian academic battle of the Anciens versus the Modernes, if the circle (Vitruvius) or the ellipse (Kepler's Law of Orbits) should be preferred. The prototype for a modern theater formed using a circle stood in Bordeaux (Fig 1 top middle) which was famous for its sound. One of the elliptic prototypes was the Teatro Regio in Turin (Fig. 1 top left), built in 1740 by Benedetto Alfieri. The opera of Paris and the theater in Versailles along with the ideal theater of Gabriel-Pierre-Martin Dumont in his *Parallèle de plans de plus belles salles de spectacles d'Italie et de France* were Langhans' models for his theaters.

## THEORETICAL STATE OF ACOUSTICS AROUND 1800

The recent recordings of the music industry with the so-called original sound of music of the eighteenth century present a completely different approach for this music than the recordings of 30-40 years ago by the great orchestras of Vienna or Berlin based in the tradition of the music of the nineteenth century. The new orchestras like the Freiburger Barock Orchester performing the music of the Age of Enlightenment have a very dry sound with short reverberation time and terraced sound dynamics. We connect the clarity of the philosophical ideas with a sound of small orchestras. But this approach is very doubtful when we read Carl Ferdinand Langhans' 1810 treatise on the Berlin Theater and what he wrote about the sound of a hall for musical performances. The audience wanted a rich sound in a hall that was filled with music. Ferdinand Langhans wrote:

A long and slowly decreasing reverberation is pleasant and necessary to enjoy the miracles of music and sound. Without it the amusement would be reduced by much. We therefore must not suppress the reverberation on purpose. On the contrary we have to protect its nature and create it if possible. (Langhans 1810, p. 40, translations by the author)

The audience for the music of the eighteenth century clearly expected emotional shows and music which would overwhelm their senses just like any generation afterwards. Music should not be a dry and rational construction of any theoretically-correct writing composer. In the evening, the people wanted amusement, singing, dancing, or drama but not a teaching lesson after a hard day full of labor. A successful theater director had to meet these expectations, and August Wilhelm Iffland was successful. However theater was used by the authorities for moral education, and plays had to have a moral sentence at the end as required by fable theory.

The architect had to construct an auditorium with a long reverberation time but in which one could understand the actor. These are contradictory characteristics, because speech requires a short reverberation time to be understood. The development led to different auditoria for theater and opera. Today the acoustical engineer can simulate the compromised reverberation time in a model, but how did Carl Gotthard Langhans approach this problem? A book on natural science which was cited by the younger Langhans in his *Katakustik* is *Gehler's Physikalisches Wörterbuch*. There we can read what an engineer in the eighteenth century knew about echo and reverberation:

To create an echo or reverberation, it is not sufficient to reflect the vibrating air particles, because otherwise any surface of a firm and hard body would duplicate the sound. It seems necessary for the reflecting object to have a hollow vaulting which concentrates the diverging beams of sound like a concave mirror to the place where the echo can be heard. There also has to be a certain distance from the reflecting object, so the echo reaches the ear only after a while and the sound can be recognized separately. (Gehler 1787, vol. 1 pp. 662f.)

That the sound would be carried best by hollow bodies was known since Roman times as written in Pliny's Natural History. Gehler explained also the difference between reverberation and echo in his physical dictionary. The human ear can only distinguish nine sounds per second. If the difference of the propagations of direct and reflected sound is shorter than the ninth part of a second, than we hear no echo but reverberation. Today the definitions are: no perceptible reflection, 0-14 m; reverberation, 14-34 m; echo over 34 m difference of direct and indirect sound beam. The key factor is the speed of sound in calculating the acoustical properties of an auditorium. The Académie des Sciences in Paris measured the speed of sound in 1738 at 332 m/s at 0° C. The speed of sound and the acoustics vary with the air conditions of the environment. The speed increases by about 0.6 m/s for each degree Celsius. At 20° C the speed of sound is about 343 m/s. Air moisture also increases the speed of sound slightly. Isaac Newton tried to give a formula for its calculation in 1710.

$$V^2 = \frac{dp_0}{d\rho_0} = F(T_0) \quad (1)$$

Newton's calculations were not correct and this was known. But it lasted until 1816 when Pierre-Simon Laplace could publicize the correct result. Laplace changed the isothermal equation of Newton and introduced  $\gamma$  as an adiabatic correction factor.

$$v^2 = \gamma \cdot \frac{dp_0}{d\rho_0} = \gamma \cdot R(T_0) \quad (2)$$

## THE CONSEQUENCES OF THE ACOUSTIC THEORY BY GOTTHARD LANGHANS

Carl Gotthard Langhans knew that Newton's formula did not describe the problem correctly. This uncertainty made him create a feature to stabilize the air conditions of his theaters in Berlin. At the back of the auditoria he installed two chimneys which could be closed with an iron valve. In chimneys the heated air of the auditorium always moves upward and fresh air is drawn toward the lower end. This air stream from the stage also carries the sound faster, which Langhans believed would result in better hearing. He gave the example of a field in open air, where the sound of a church bell is carried with the wind over longer distances. He exchanged let-

ters with the physical scientist Ernst Florens Chladni, the young professor in Wittenberg, about this. Chladni reacted quite positive and wrote back, that this could be an important improvement in acoustics. This feature was soon eliminated in the theater, because any air draft in closed rooms is felt very uncomfortable for the human body.

Carl Gotthard Langhans calculated the reverberation time as the difference of the direct and the indirect sound beams. The measured length of the direct sound from stage to the back rows of the seats was 50 feet, whereas the indirect, reflected length was 60 feet. Langhans' calculation was  $1/100$  s and he stated that this would certainly cause no echo. Reverberation today is defined by the reduction of the noise level in a measured time. It is optimized at roughly 2.0 s for music halls. A formula for this was publicized by Wallace Clement Sabine of MIT around 1930. Any auditorium today is optimized by this factor and only by it. But even halls with optimized reverberation time often show poor acoustic results, and many theaters, which deviate from the optimized factor, are regarded as good auditoria. The best theater and concert halls are generally believed to be the Wiener Musikvereinssaal and the Festspielhaus Bayreuth and both auditoria were not constructed based on Sabine's theory but on the theories of Carl Ferdinand Langhans from 1810. But this is widely unknown among the acoustic experts of today.

Carl Gotthard Langhans explained his use of the ellipse instead of a Greek circle. He thought that it would be better if the sound beams would not be reflected back to the actor but to the back of the auditorium. He believed that the sound reflections would cause interference or disturbance, as he called it, with the outgoing sound waves. This made him place the actor on stage or the preacher in his churches in one focal point of his ellipses. The advantage of this arrangement would be that the indirect sound would reach the other focal point at the same time (Fig. 3). He hoped this would improve audibility of the speaker or singer but the reflections in a building as the sound waves would reach the listener within a very short time but keep the positive effects of reverberation and amplification.

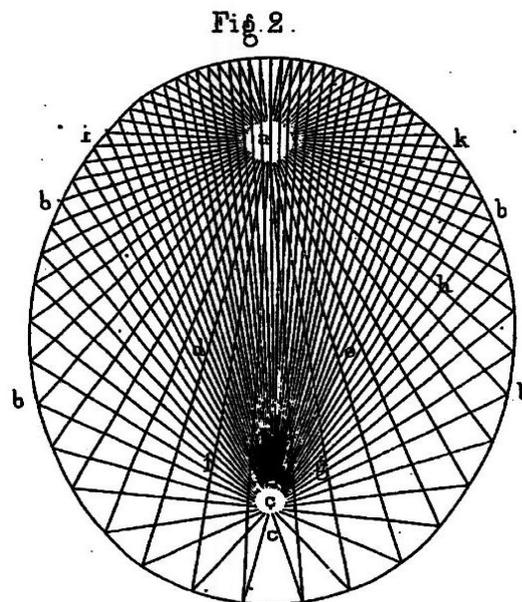


Figure 3: Reflected sound beams in an elliptical room by Carl Ferdinand Langhans

This was no exotic thinking; it was the result of practical acoustics of the eighteenth century. How this theory was used by other architects before Langhans, shall be demonstrated with the next examples.

### ACOUSTIC ROOMS IN GERMANY IN THE BAROQUE ERA

Oval rooms were not an invention of the French Académie d'Architecture around Jaques-François Blondel. They were quite commonly built in the Holy Roman Empire at the end of the seventeenth and during the first half of the eighteenth century, but nobody has ever tried to research their technical history. After retrieving the theoretical sources, it is obvious that vaulted rooms in the baroque era were built for acoustic reasons. From whom these conceptions derived is unknown. How did Langhans' rooms deviate from earlier constructions?

#### The oval Room in the Residence of Würzburg

The interior of the elliptic room in Würzburg, built after 1720, was destroyed in 1945. Only the walls were restored after the war and the former theater hall is now used as a gallery. Even the ceiling has an elliptic shape. The almost empty room today produces an extremely long reverberation time. The sound undergoes multiple reflections and is collected by the vaulted walls without any stucco decoration. This cannot be just an incidental result. The intention is quite obvious: the architects Baltasar Neumann and Johann Maximilian von Welsch constructed as many acoustical influencing vaults as possible, because they knew that the interior decoration

would reduce most of this effect. Inside stood a wooden construction of stage and auditorium and it was known e. g. by count Algarotti that an interior made of wood as a rather soft material reduced much of the sound energy. Wood was also the preferred material for musical instruments and it not only adds a soft tone to the sound, but also has the ability for resonance. The question how resonance was used in theater architecture is a very complex and hardly researched problem.

We find that the ellipse was a commonly used model for auditoria not only in Germany but also in Italy and France. The first known oval rooms were built in the seventeenth century by Johann Jacob Herkommer in Füssen and Augsburg or by Johann Bernhard Fischer von Erlach in Vrain and other residences. How widespread these ideas were, and if this knowledge possessed only a few architects, whether it was generally known or not, leaves many questions yet to be answered.

### The Churches of Dominikus Zimmermann

Dominikus Zimmermann left no documents which can demonstrate the significance he gave acoustics in the construction process, but his churches, especially in Steinhausen and in Steingaden, are some of the most fascinating rooms of his time built in 1728 and 1745. The Wieskirche in Steingaden near Füssen is frequently used in the summer for evening concerts. The sound is excellent and if today we blame elliptic rooms for their unsatisfying acoustic abilities, we have to acknowledge Dominikus Zimmermann's churches for their outstanding sound characteristics.

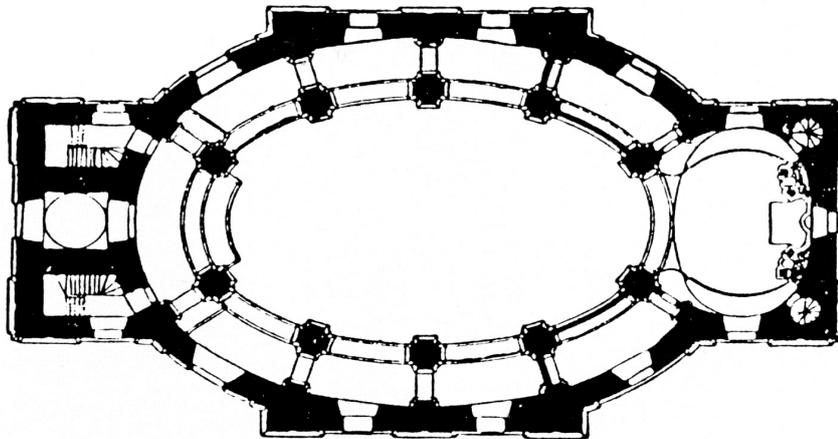


Figure 4: The layout of Dominikus Zimmermann's baroque church in Steinhausen

If we consider the acoustic phenomena, analyzed in Würzburg, we would assume along with the younger Langhans that the reverberation time in an elliptic church is far too long, because the concave vaults prolong the sound. This is what we experience in churches like St. Michael in Munich or Santa Giustina in Padua and their vaulted ceilings. Zimmermann certainly knew the acoustical properties of vaulted halls. He could not cover the interior structure with wooden panels to soften the reflections of the sound beams. So he must have used something that had a similar effect.

The younger Langhans was the first architect who in 1810 recommended convex wooden or stucco ornamentation, normally only for decorative purposes, to reflect the sound beams back into the auditorium. In the essential part of his treatise he writes, that his father used the widely accepted theory, to produce reverberation by designing concave structures. The wanted and from Plinius to Gehler and others predicted effect was, that the sound was concentrated to create reverberation. The experiments he undertook in the theater of his father convinced him to try the opposite. His advice, which he proofed in his own theaters in Berlin, Wroclaw or Leipzig, was not to concentrate the sound but to disperse the sound energy evenly into the space, using microstructures which are normally regarded as ornaments. Hollow but convex shaped fronts on the balconies were introduced instead of flat covers to resound and to reflect the incoming beams back into the hall. "If we do this," he writes, "we can give the auditorium almost any layout" (Langhans 1810, p. 41). These were the conclusions, he drew from the observations he had collected at the Iffland-theater in Berlin.

But even the rich rococo decorations in Steinhausen or the Wieskirche are not sufficient to cover the large concave structures of Zimmermann's churches. The vaults of these halls dominate the decoration. There had to be a different idea to reduce the reverberation time in his churches. The only possible explanation that can be given is Zimmermann used the pillars of his inner ellipses to distribute the sound beams through the space of the church and thus to reduce the sound concentrations of the concave walls. His model for this construction could have been the walls separating the boxes of the balconies in theaters which were known to create a similar effect. This construction contradicts Gehler's physical dictionary as much as it does Ferdinand Langhans theory, but both show better results than Gotthard Langhans' theater which was built according to the physical theories since the Roman times.

## THE ACOUSTIC DISASTER OF LANGHANS' THEATER IN BERLIN

The Theater in Berlin was destroyed by fire in 1817. Karl Friedrich Schinkel only used the ionic columns and the tympanum of the old theater for his project. When we want to know in detail why this theater was the last and maybe the only one ever to be constructed after the physical reverberation theory, we have to rely on the explanations Carl Ferdinand Langhans gave in his treatise of *katakustik*. After this publication no architect ever dared to give his theater an elliptic layout. He wrote:

Though he [meaning his father] was not satisfied to leave it [the ideal distribution of sound] up to its chance, he was eager to find the layout where the concentration of sound could be realized and which would be the most advantageous for this purpose. In this uncertainty, if this first experiment would be successful, he thought little what other consequences the use of this theory could create. The most important question at this time was, if this concentration of sound could be achieved. At that time the theater in Berlin was constructed, which was formed according to these theories. The architect was driven by this great motive to draw according to the theory and to give the theater the adequate form. And because he believed that these single partitions, formed ellipsoid, had little total effect, he tried to form several of these small partitions according to the theory and the same aim. (Langhans 1810, p. 20)

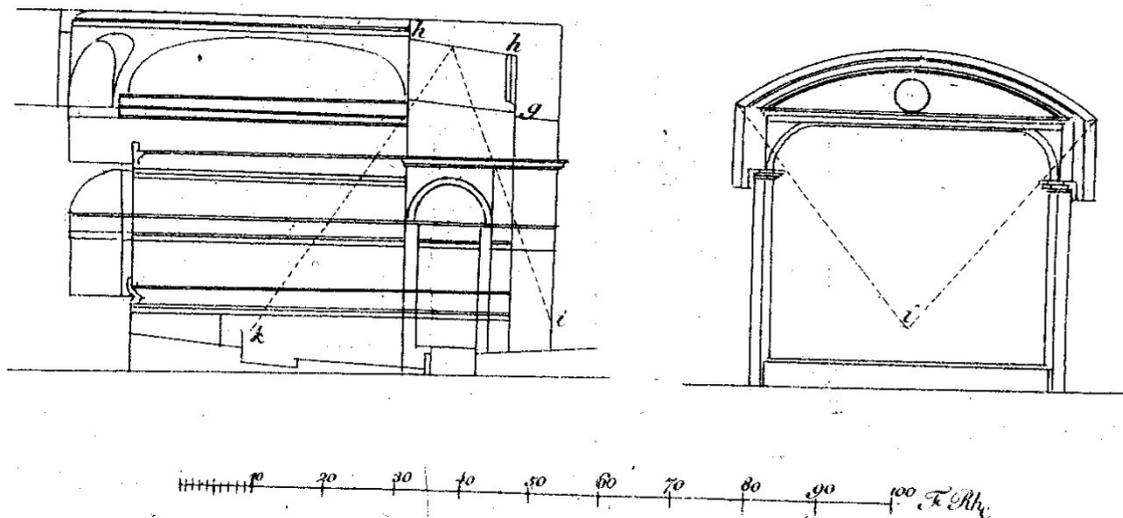


Figure 5: Carl Ferdinand Langhans' technical drawing of the Iffland-theater

After this general introduction Carl Ferdinand Langhans described the ceiling above the proscenium:

The proscenium *g* [Fig. 5] was built without boxes smooth and covered with thin wooden panels [funnel shaped] and they were placed so that the sound beams coming from stage would be concentrated in the parquet. Even the decoration of the boxes next to it was formed accordingly in the same direction like a second proscenium. In conjunction with this proscenium was the ceiling of the theater of 15 feet length vaulted in *h*, which formed the segment of a circle and linked to the first proscenium which had a horizontal ceiling. This vaulting was shaped to collect the sound beams, which were upward directed, and to reflect them toward the floor. The vaulted segment had his center in *i*, where the mouth of the actor was supposed to be. The ceiling was given an angle in *h-h* of one foot toward the stage so the beams would not be directed to the actor but had their focal point in *k* in the middle of the parquet. [...]

The effect, which was caused by this vaulting when the actor spoke in point *i* on the stage, gave the spectator in *k* the impression as if the sound created in *i* would be forced in his ears by a megaphone. This was no reverberation or echo but an amplification of the sound, which happened almost in the same moment when the actor spoke in *i*. In *k* was a real concentration of sound which came from *i* und was reflected in the vaulting *h-h*. [...] Regardless was the effect so apparent that one could follow the movement of this concentration which was in accordance with the movement of the actor on the stage from one side to the other (Langhans 1810, p. 21)

After the opening of the theater in 1802 the over more than hundred years accepted theory of acoustic construction was refuted and architects in Germany published articles to find a solution for this problem. It was the son Carl Ferdinand who wrote "the most important single comprehensive statement by a practicing architect on theater design in general, and room acoustics in particular, since rediscovery of Vitruvius' treatise" (Izenour 1996, p. 65). Langhans' theory was the leading theory in the nineteenth century until the monumental theaters of Gottfried Semper caught the attention of the people. Manfred Semper published his book on theaters without having any idea of the improvements that Ferdinand Langhans added to the construction of theaters in Germany.

## ACOUSTICS AND MONUMENT CONSERVATION

Acoustics are considered a new branch of architecture emerging since the studies of Walter Clement Sabine at the beginning of the 20<sup>th</sup> century. If one follows G. C. Izenour's book *Theater Design*, ignorance was the basic characteristic of architects after the golden ages of the Greek theaters. Out of nowhere came 1872 a young and now unknown engineer, Otto Brückwald, who remembered the basics of the Greek times and designed the first usable theater only with the help of the genius Richard Wagner. This changed the world of theaters. Optics and acoustics before were not the deciding factors in the construction of auditoria, because people were busy in gambling, gossiping and watching the high society instead of listening and watching the performances. Thousands of music halls, theaters, churches, etc. are today believed to have served for everything else but for a comfortable setting of a music performance, a play, an opera, or a sermon. If there was a good auditorium built which still outperforms the high tech computer simulated projects of today, this had to be an incident by a lucky architect. It is very strange to see that in the stores the demand for original sounding music is growing and orchestras try to do everything to create the sound of the eighteenth century. Yet nobody seems to care about the most influential factor for the audio perception, the halls, where this music was performed.

Richard Wagner never interfered or told Otto Brückwald how to construct the Festspielhaus. Brückwald was a student of Carl Ferdinand Langhans. The literature of the centuries before is not only ignored but almost completely forgotten, and the magic word of today is reverberation time. Nobody ever asks, if reverberation time is really the decisive factor, or is it more the intensity of the performance which catches the eyes and ears of the audience. The discussions of the redesign of the Berlin Opera, once designed by Wenzelslaus von Knobelsdorff, redesigned by Carl Gotthard Langhans, and again modernized after the fire 1847 by Carl Ferdinand Langhans, demonstrate the ignorance of the acoustic experts of the age of computer simulations.

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