

# BUILDING ARCHAEOLOGY



MONUMENTS AND SITES  
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VII



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МЕЖДУНАРОДНЫЙ СОВЕТ ПО ВОПРОСАМ ПАМЯТНИКОВ И ДОСТОПРИМЕЧАТЕЛЬНЫХ МЕСТ

**Manfred Schuller**

# Building Archaeology

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Front cover: Color reproduction of figure 23 showing the building phases of the medieval townhouse "Zum rothen Herz" in Regensburg. From: Peter Morsbach, Stefan Ebeling, Günther Naumann, *Zum rothen Herz. Geschichte und Schicksal eines Regensburger Hauses*, Regensburg 2000. Illustration: Stefan Ebeling (Bauforschung)

Back cover: Detail of the façade of the Ca' d'Oro in Venice with reconstruction of original coloring around 1440. Taken from Manfred Schuller's research project *Le facciate dei palazzi medioevali di Venezia*. Building survey: Thomas Eck and Ernst Schneider

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The Venice Charter which may be considered as a kind of foundation stone for ICOMOS already points out the importance of documentation: In article 16 it is said that "in all works of preservation, restoration or excavation, there should always be precise documentation in the form of analytical and critical reports, illustrated with drawings and photographs..." This obligation to document is also reflected in the work of photogrammetrists and remote sensing experts who met at the XVIIIth International CIPA Symposium in Potsdam, Germany (18-21 September 2001). "Surveying and Documentation of Historic Buildings, Monuments and Sites – Traditional and Modern Methods" was the theme of this conference, organized by the ICOMOS International Committee for Architectural Photogrammetry (CIPA), and in its new series *Monuments and Sites* ICOMOS has already presented the results of highly sensitive magnetometry, one of the most successful modern methods in archaeological prospection, as a contribution to the conference in Potsdam (H.B. Becker and J.W.E. Fassbinder, *Magnetic Prospecting in Archaeological Sites*, Monuments and Sites, vol. VI, Munich 2001).

Documentation in the sense of inventorying and researching the whole range of monuments and sites remains a highly complex task not only for photogrammetrists but for specialists of very different backgrounds. So after the results of high-tech magnetic prospecting I am happy to be able to also present here volume VII of the series *Monuments and Sites*, dealing with the progress made in a traditional method: building archaeology



based on hand-measurements of architects and engineers. Although during the Potsdam conference, which concentrated on developments in photogrammetric methods, the centuries-old tradition of documentation by drawings was only marginally treated, this classical method in the form of exact hand measurements will remain indispensable for the practical preservation of monuments and sites. Under certain circumstances drawings of pencil on paper made on the spot will even have far better information value than documentations made with an enormous technical effort.

In the meantime the methods of documenting a historic building by drawings have been further developed for conservation purposes as part of so-called "building archaeology", also well-known under the German name "Bauforschung". And especially in the field of building archaeology, where of course modern technical means are used for rationalization (as long as they make sense), depending on the individual case, the limits of mechanized and automatized methods become evident. I would like to thank especially the author, Prof. Manfred Schuller, a pioneer of "Bauforschung", who in his introduction has described the development and possibilities of building archaeology as an indispensable instrument of conservation, as well as the many colleagues who have set standards with their contributions to the plates in this publication by documenting monuments of all periods from antiquity to modern times.

Michael Petzet

◁ Henry Parke, student measuring the Temple of Castor and Pollux in Rome, drawing made to illustrate the Corinthian order for John Soane's Royal Academy Lectures, 1819 (Sir John Soane's Museum London).

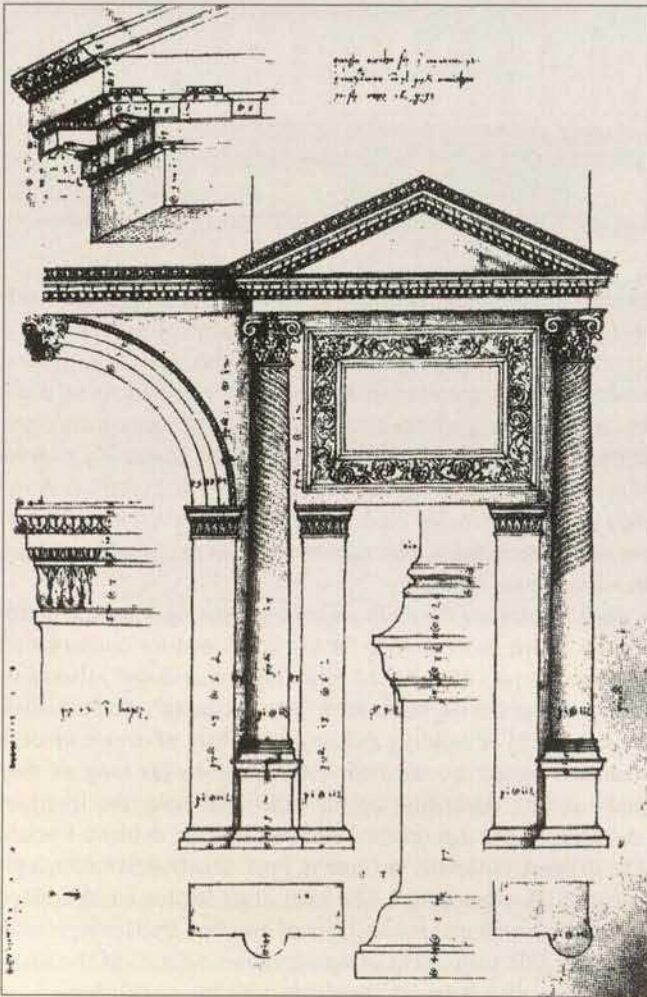
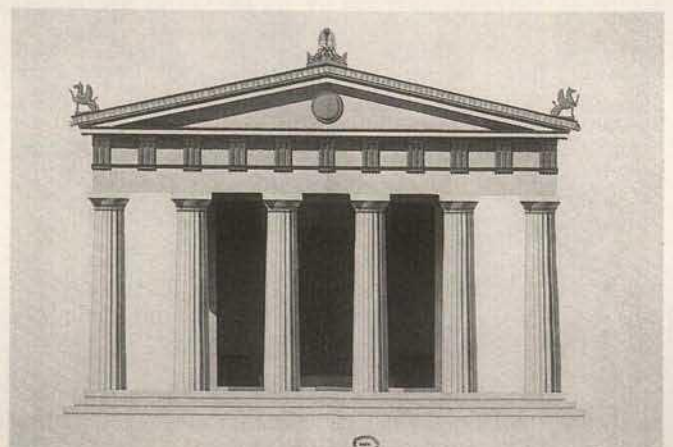
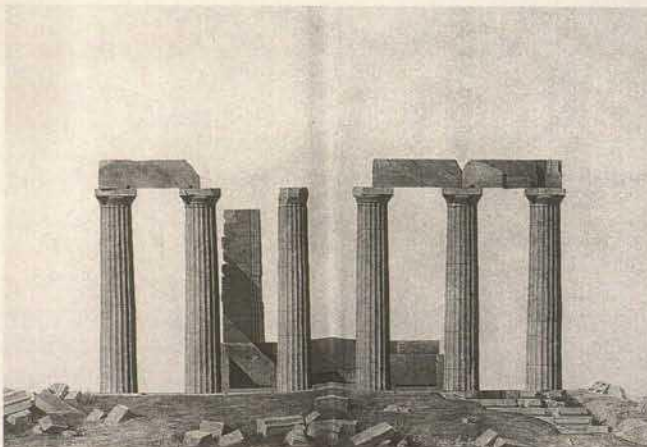


Fig. 1. Measured drawing of the Jupiter Ammon Arch in Verona, from the 16<sup>th</sup> century; Andrea Palladio? (London, R.I.B.A., XII, 22).

Fig. 2. Apollo Temple of Bassae, Greece. Drawing by Denis Lebouteux, 1853. The presentation methods clearly distinguish between the survey of the existing building (left) and the reconstruction.





## Building archaeology

The urge to build and construct is an ever present factor in the long history of our cultural heritage, testifying to the artistic force and technical abilities of entire nations. In contrast to architectural history, which uses the methods of art history to study artistically outstanding monuments, "building archaeology"<sup>1</sup> is devoted to the entire spectrum of construction. Not only great temples, cathedrals and the palaces of the wealthy are of interest, but also the cottages of the poor, military sites such as castles and city walls, and industrial structures from mills to dams and bridges. There are no time restrictions, so objects of study range from the prehistoric wooden hut to modern reinforced concrete constructions. The source of information is above all the structure itself, or its remains. Building archaeology is particularly effective as an approach when other evidence, such as written or graphic documentation, is missing or incomplete, as is often the case for historic buildings whether they date from classical antiquity, the Middle Ages or modern times. Exact knowledge of a building, always the foundation for understanding a structure, is usually acquired through the building survey, a true-to-scale graphic documentation using comprehensible measurements. With the survey as its essential basis, building archaeology aims at clarification of a structure's construction history and the planning and building process; dating of individual building phases; reconstruction of a building's function and of how it originally appeared and how it was altered; and identification of building technology issues and possible damages. Building archaeology is especially appropriate as a method for studying individual monuments, but entire settlements and urban quarters can also be dealt with, as can broad-reaching themes such as the development of medieval roof structures or dwellings in classical antiquity.

The art of building, with its diverse problems from the foundation to the roof, has, since the time of the Egyptian pyramids, required the specialist: the architect who designs and builds. Similarly a specialist is also needed for the opposite direction, from the ruin to the theoretical reconstruction, from the incomprehensible building conglomerate to a clear building history: the "building archaeologist", usually an architect with training in history who has himself learned planning and construction.

### The Roots: Historical Development until 1945

Building archaeology is an independent discipline with a long tradition. At the time of the Renaissance in the 15<sup>th</sup> and 16<sup>th</sup> centuries architects were attempting to study the remains of the monuments of classical antiquity. Alberti, Bramante, Raphael and Palladio studied ruins by making measured drawings and sketches (figure 1). It was a time of pride in a newly derived method of representation, the orthogonal projection in plan, elevation and section, which has been common practice for all plans and building surveys ever since.<sup>2</sup> Andrea Palladio used this method perfectly in his treatise *I quattro libri dell'architettura*

(1570), in which he published 25 antique buildings, reconstructed on the basis of measured drawings, together with his own new buildings. The immediate drive to study these buildings declined thereafter, but new impulses developed 100 years later in France. In 1682 the architect Antoine Desgodetz, sent to Rome by the Académie Royale d'Architecture (founded in 1671), published outstanding measured drawings of the most important antique buildings in Rome in his *Édifices antiques de Rome. Mesurés très exactement*. Subsequently the Grand Prix de Rome, a four-year Rome stipendium for the best young architects of France, became a constant challenge to produce new studies of classical buildings with magnificent measured drawings and reconstructions. Many of these "building archaeologists" were later among the best architects of their time.

In the mid-18<sup>th</sup> century interest began to develop in the Greek architecture of southern Italy and Greece itself. Giovanni Battista Piranesi's sketches of the temples of Paestum are the best known evidence of this interest. The scientific work of English architects took the lead. On behalf of the Society of Dilettanti (founded in 1732), James Stuart and Nicholas Revett traveled to then-Turkish Athens and in 1762 published their epoch-making work *The Antiquities of Athens*. Napoleon's Egyptian expedition, much more of a great scientific feat than a military one, led the predecessors of modern building archaeology into unknown territory that produced rich harvest. The *Description de l'Égypte*, published in 1809 and later, contains not only still significant depictions of Egyptian antiquities but also, surprisingly, Islamic works of art from the Middle Ages.

The first decades of the 1800s saw the rise of what we now refer to as international research groups. The Englishmen Cockerell and Foster, the Germans von Hallerstein and Linkh, the Dane Brönsted, and von Stackelberg from the Baltic provinces worked together to investigate the most important temple ruins of Greece. The combination of research with practical preservation work was also already being practiced. Leo von Klenze – both architect and building archaeologist – was involved in preservation work on ancient monuments in Athens in the 1830s, for example.

The rest of the 19<sup>th</sup> century was a critical time for development of the methods that remain valid in building archaeology today. In a reflection of the political developments of the time, however, the field split into competing nation-state projects. Through an offshoot of the Grand Prix de Rome in Athens the French continued to set standards with the magnificence of their masterfully drawn surveys of classical architecture (figure 2); the Germans excelled in the development of precise methodology, such as dating methods based on the observation of layers (stratification). The large national excavations were popular prestige objects: Delos and Delphi for the French, Olympia for the Germans and Assos in Asia Minor for the United States, to name a few examples. Given the great extent of architectural remains that were discovered during this period, a division of labor between the archaeologist and the architect (by then fully special-

ized as a building archaeologist) became a common and necessary practice. This was not always to the advantage of building archaeology as a discipline because the architect, a reluctant writer, often limited himself to excavation, measuring and drawing, leaving the written publication and thus the laurels for a project to the archaeologist.

But classical antiquity did not play the only significant role in the study of architectural history in the 19<sup>th</sup> century. Paul Letarouilly's *Édifices de Rome moderne* (published in 1849–1866), for example, represents an almost unbelievable achievement in the recording of post-medieval buildings. At the same time the great monuments in his native France, in particular the medieval cathedrals, monastery churches and palaces, had fallen into such extreme decay since the chaos of the Revolution that urgent rehabilitation work was needed to save them. Eugène-Emmanuel Viollet-le-Duc and his school produced exemplary preliminary studies of the buildings to be restored, sometimes with measured drawings detailed down to the last stone. The necessary restoration work could be determined, stone for stone, on the basis of the drawings, a methodical procedure that

is not even standard everywhere today. Here, much more than in the study of classical architecture, the bridge was already established between building archaeology and practical preservation work. At the same time remarkable knowledge of medieval building technology was being accumulated. In its text and illustrations Viollet-le-Duc's *Dictionnaire raisonné de l'architecture française du XI<sup>e</sup> au XVI<sup>e</sup> siècle* from the years 1854–1868 still offers brilliant insight into medieval construction from the foundation to the roof in the tradition of building archaeology, even if some of the individual statements and achievements of the great master must be regarded critically (figure 3).

Medieval monuments were also saved from obscurity in Germany. The Marienburg in Prussia had been investigated at a very early date (1799 to 1803) by Friedrich Gilly and Friedrich Frick, the results reproduced in a magnificent monograph that shows its reconstructed Gothic appearance.

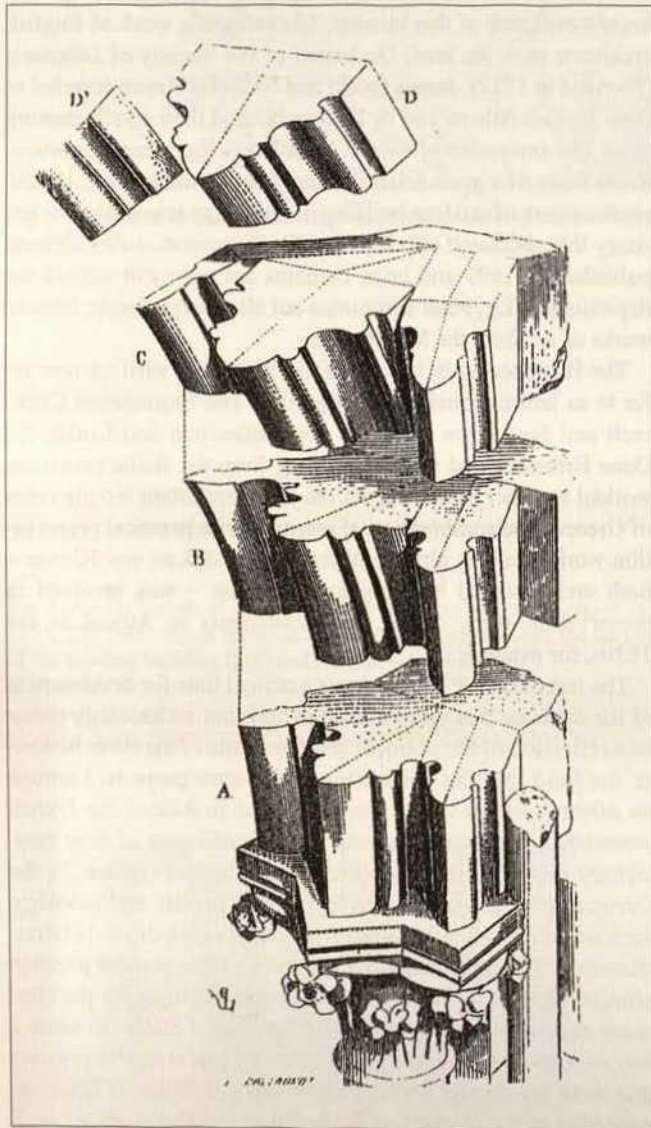
By the turn of the century the new trend to "complete" unfinished medieval cathedrals and large churches, from Florence to Prague, made extremely accurate plan materials and detailed building surveys necessary. Cologne Cathedral is the most famous example. First the medieval torso, with its segments where construction had been meant to continue, was studied closely, and the knowledge gained was brought in correspondence with the rediscovered medieval plans. With faultless methods the medieval building components which were to fall victim to the neo-Gothic extension were documented with drawings and with very early photographs. These records covered, among other components, the provisional wall of the chancel, over 40 meters in height, and the huge wooden crane on the torso of the southern tower, a technical monument of highest significance (figure 4).

Similar efforts were underway in other European countries. After a lengthy preservation controversy and under the influence of John Ruskin's writings the medieval façades of St. Mark and the Doge's Palace were restored in Venice. The restoration of the Doge's Palace by Anibale Forcellini from 1873 to 1887 could still be used today as a model for work on important historic buildings. In preparation for the project Forcellini produced exact measured drawings, which also documented foundation probes, damages of all types, and technical details such as tie rods, roof flashings, etc. His detailed work plans built on these drawings, recording necessary replacements stone for stone, new anchor systems optimized according to modern statics, varied stone formats, etc. Moreover he accomplished the basic requirement, seldom achieved today, of publishing the work that was carried out.<sup>3</sup>

An undertaking by architects in the German-speaking countries aimed in a totally different direction. In Austria, Switzerland and Germany a collection was made around 1900 of measured drawings of typical farmsteads.<sup>4</sup> The building surveys, which include plans, elevations, sections and details such as windows, doors and ovens, are of differing quality, but in all of them the simple building has become a subject of study (figure 5). Thus it was recognized that these buildings, which had characterized the countryside over the centuries, were severely endangered in the wake of the industrial revolution, and there was a desire to record them for posterity at least through drawings and concise texts. The townhouses of medieval cities were also the subject of studies throughout Europe.

The archaeology-oriented branch of historic building research meanwhile was extending its investigations far beyond the Mediterranean, into Egypt, Babylon, and even Central and South America. The situation profited from the fact that the

Fig. 3. Three-dimensional drawing of a Gothic vault springer, Viollet-le-Duc.



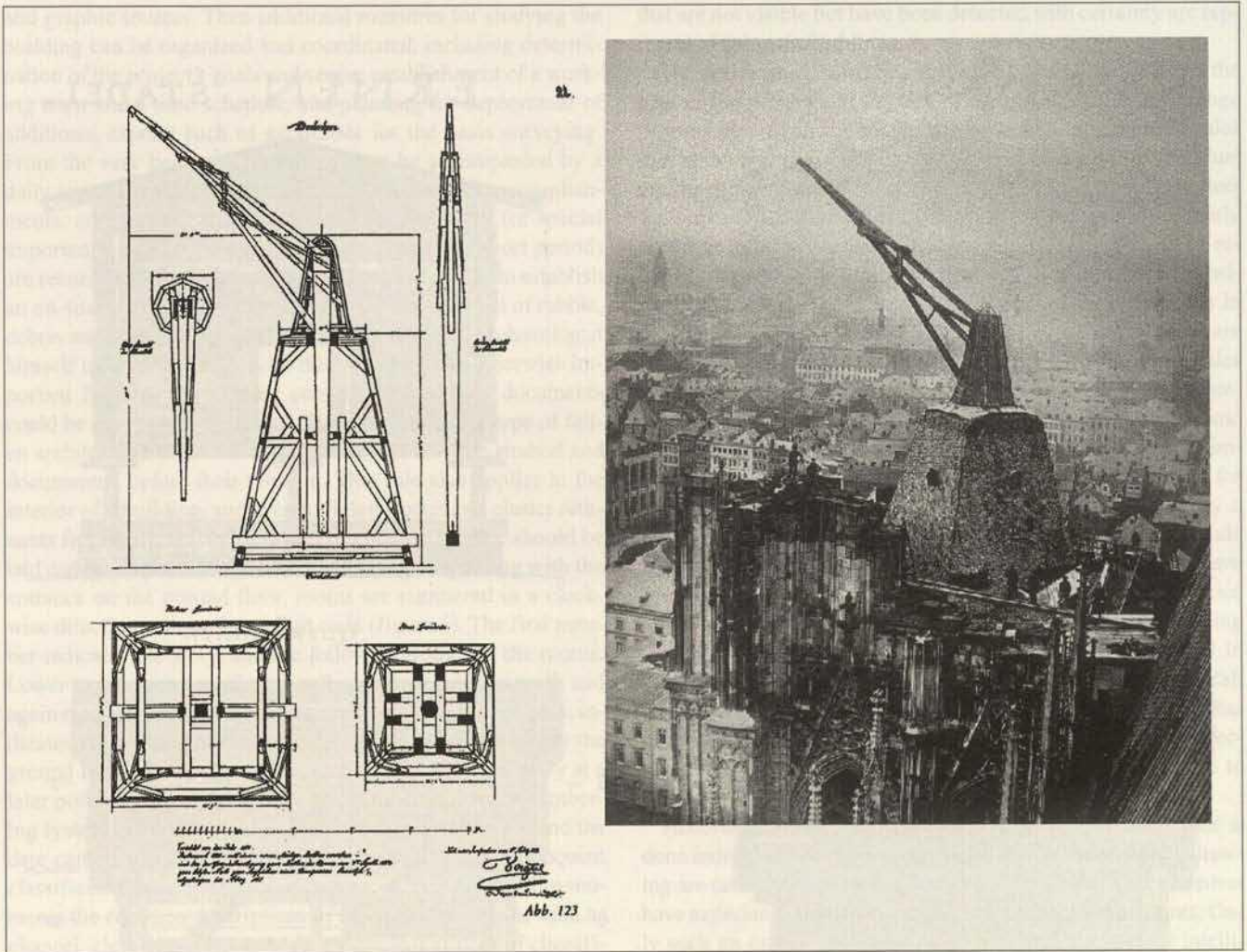


Fig. 4. Measured drawing of the medieval crane on the stub of the south tower of Cologne Cathedral. Drawn by the cathedral master carpenter C. von Amelen, 1868. Right: early photo documentation of the crane before its demolition (Th. Creifeld, 1868).

study of architectural history was included in academic teachings for architectural training in the second half of the 19<sup>th</sup> century and particularly before World War I.

This was in some respects a heyday for building archaeology, lasting into the 1920s. The crisis came when, in the course of the Modern Movement, architectural history was held to be unnecessary, even damaging, for the training of architects. The critical situation was highlighted in 1924 by Russian-born Armin von Gerkan, an important scholar and discerning teacher, in a polemic treatise. As a direct result of this treatise, in which the German term *Bauforschung*<sup>5</sup> was first coined, the “Koldewey Gesellschaft” was founded by 23 active building archaeologists. The society with its international membership is to this day the only association devoted purely to building archaeology.<sup>6</sup> World War II thwarted further efforts worldwide, and in the immediate post-war period there were other problems to be dealt with. The restructuring of entire cities was usually urged forward as quickly as possible, without the type of preliminary work that had been developed under the auspices of building archaeology and had proven successful in the 19<sup>th</sup> century. Innumerable historic buildings of importance were ruined, mostly without their significance even being recognized.

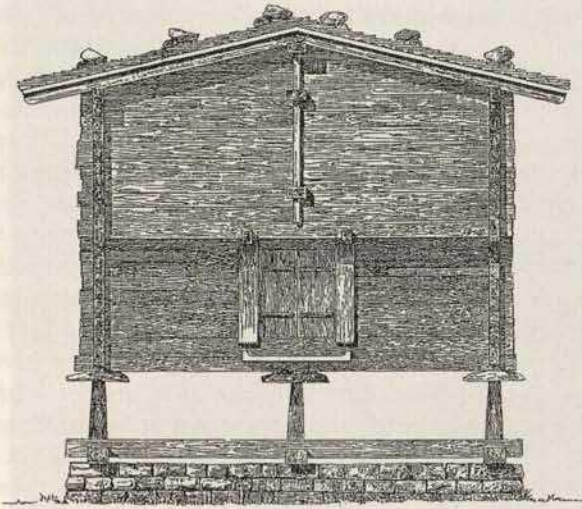
### The Tasks Step by Step. The Methodology

In order to research a building, be it a plain farmhouse or a huge cathedral, one must first get to know it. This also applies to large sites, urban districts that have been in use for centuries, or the ruins of partially-buried settlements. The first step is an inspection that reaches even the most hidden areas and spaces, with an accompanying written protocol. The building archaeologist is sometimes the first person to enter a structure for decades, so in many buildings extreme caution is necessary. Emergency safety measures for one’s own security but also for the continued protection of the building can be the first, direct results of the inspection. Initial orientation can be enhanced by the sketching of lay-out plans. These sketches and initial photographs of the existing conditions supplement the written protocol. If not already done beforehand, the next step is collection of the existing literature regarding the building and all available plans and written

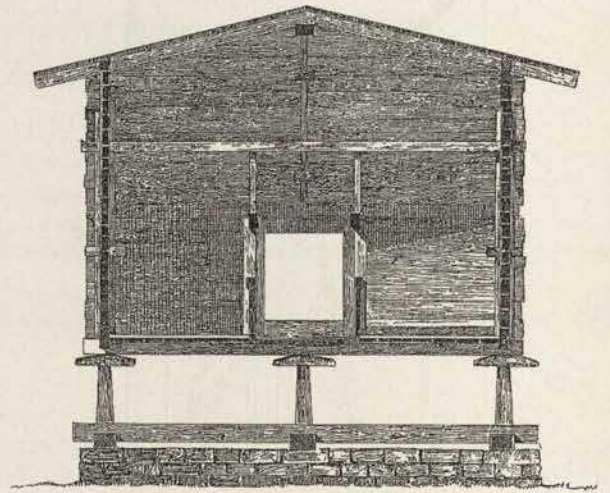
Fig. 5. Barn building in Valais, Switzerland. *Bauernhauswerk der Schweiz*, 1903.

OBER WALLIS

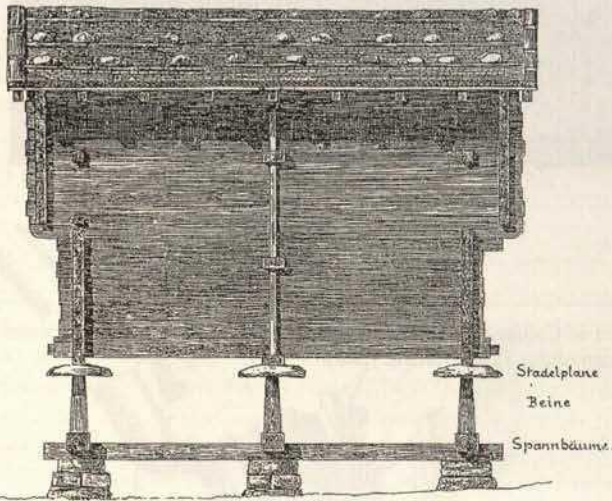
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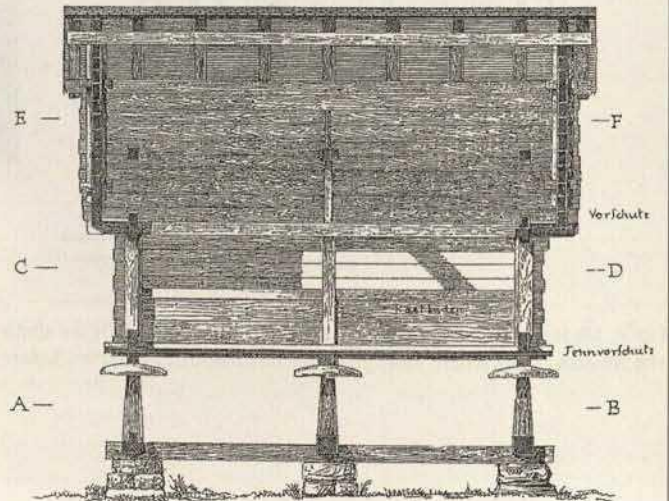
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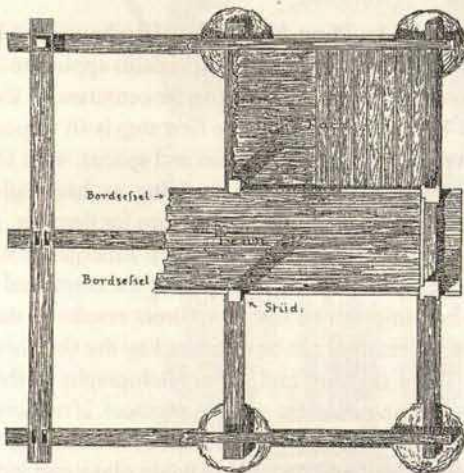
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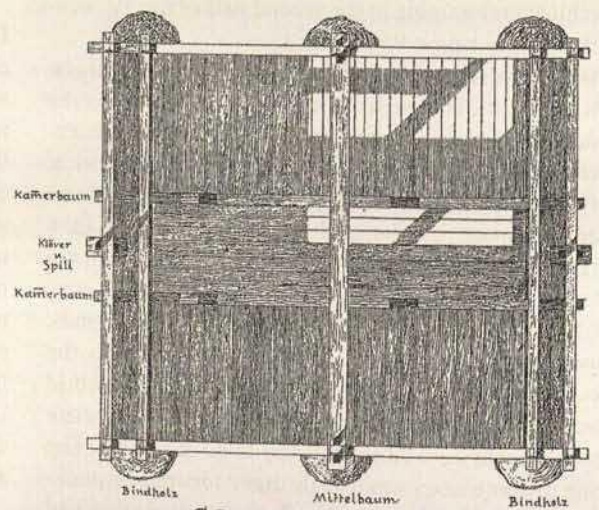
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and graphic sources. Then additional measures for studying the building can be organized and coordinated, including determination of the project's goals and scope, establishment of a working team and a time schedule, and planning for deployment of additional experts such as geodesists for the basic surveying. From the very beginning the work must be accompanied by a daily journal in which dates, workers, discussions, accomplishments, and working hypotheses about the building (of special importance, even if they may be revised within a short period) are recorded with text and sketches. The next step is to establish an on-site work place. Often the clearance or removal of rubble, debris and plant growth is necessary. The building archaeologist himself must strictly supervise this work because otherwise important findings on building components or other documents could be irrevocably destroyed. The position of any type of fallen architectural elements is inviolable and must be studied and documented before their removal. This rule also applies to the interior of a building, and even to fallen stucco and plaster remnants from walls and ceilings. An orientation scheme should be laid out for structures that are still standing. Beginning with the entrance on the ground floor, rooms are numbered in a clockwise direction using a three-digit code (figure 6). The first number indicates the story, and the following designate the rooms. Lower case letters specify the walls, beginning in the north and again moving clockwise. The designation 103b, for example, indicates the position of the east wall on the first floor (above the ground floor). In the photo documentation that is necessary at a later point in the project, panels labeled with this room numbering system and with the name of the object, the surveyor and the date can be included in every photograph, making subsequent classification much easier. For large-scale ecclesiastical monuments the common descriptions of the spatial elements, such as chancel, clerestory, etc., provide a sufficient system of classification, supplemented by notation of the axis. For ruins a numbering and cataloguing system that includes brief descriptions, approximate measurements, and perhaps a rough sketch is necessary to classify scattered surviving building elements. An inspection of the immediate surroundings can indicate if building elements have been used in other contexts.

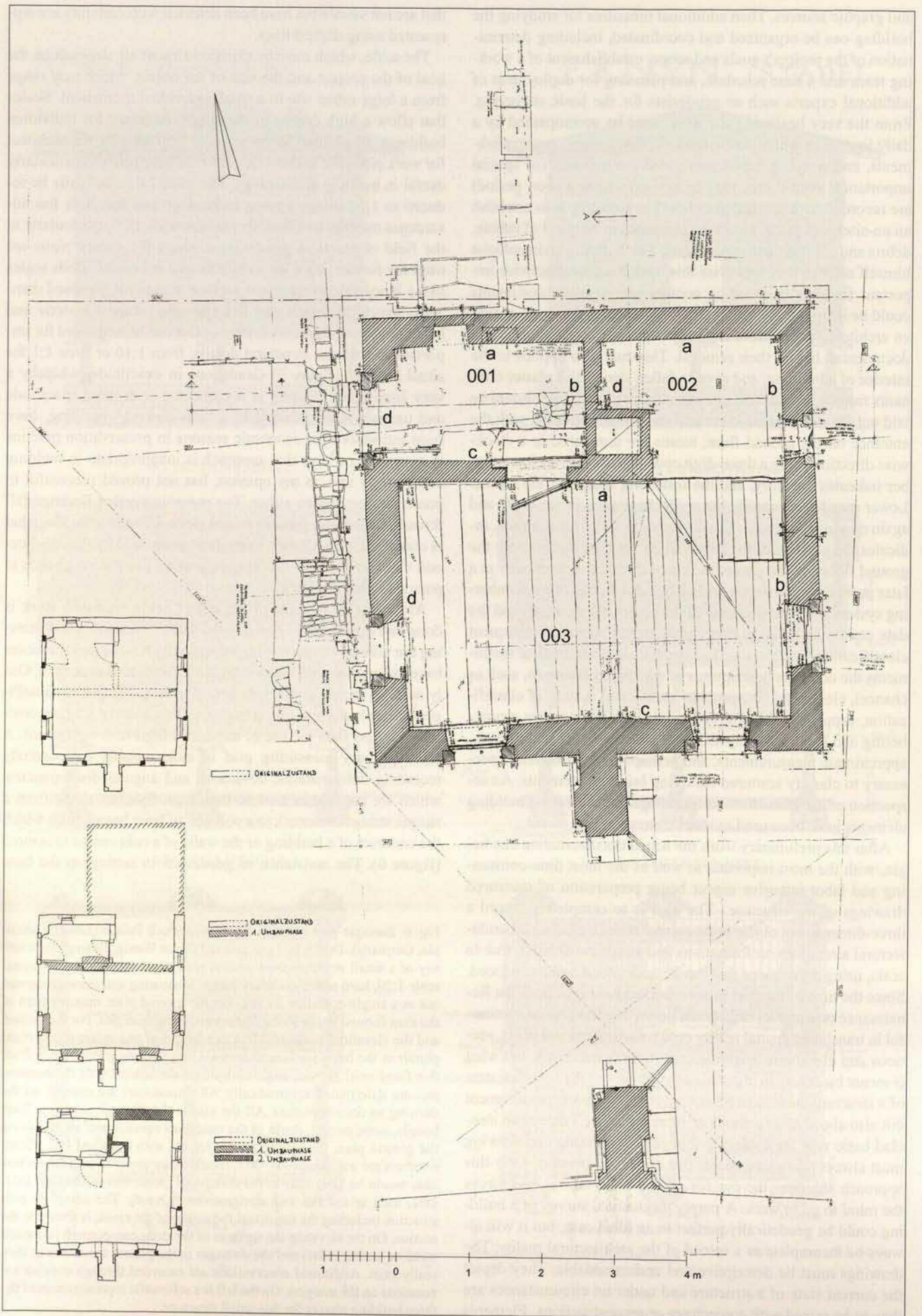
After this preliminary work the actual documentation can begin, with the most important as well as the most time-consuming and labor-intensive aspect being preparation of measured drawings of the structure.<sup>7</sup> The goal is to completely record a three-dimensional object in its current state (including all architectural alterations, deformations and structural details), true to scale, using dimensions that can be understood and reproduced. Since the time of the first historic building surveys from the Renaissance (see above) orthogonal projection has proved successful in translating spatial reality onto two-dimensional plans, sections and elevations. Extreme exactitude is necessary, but what is meant by exact? In order to correctly record the complex state of a structure there must be not only exactitude of measurement but also above all exactitude of representation. There is an iron-clad basic rule for achieving this goal: measuring and drawing must always take place on site in a combined process! Only this approach sharpens the eye for critical observations and forces the mind to go to work. A purely mechanical survey of a building could be geodetically perfect in an ideal case, but it will always be incomplete as a record of the architectural reality. The drawings must be descriptive and understandable. They depict the current state of a structure and under no circumstances are they to be mixed with conjectures or reconstructions. Elements

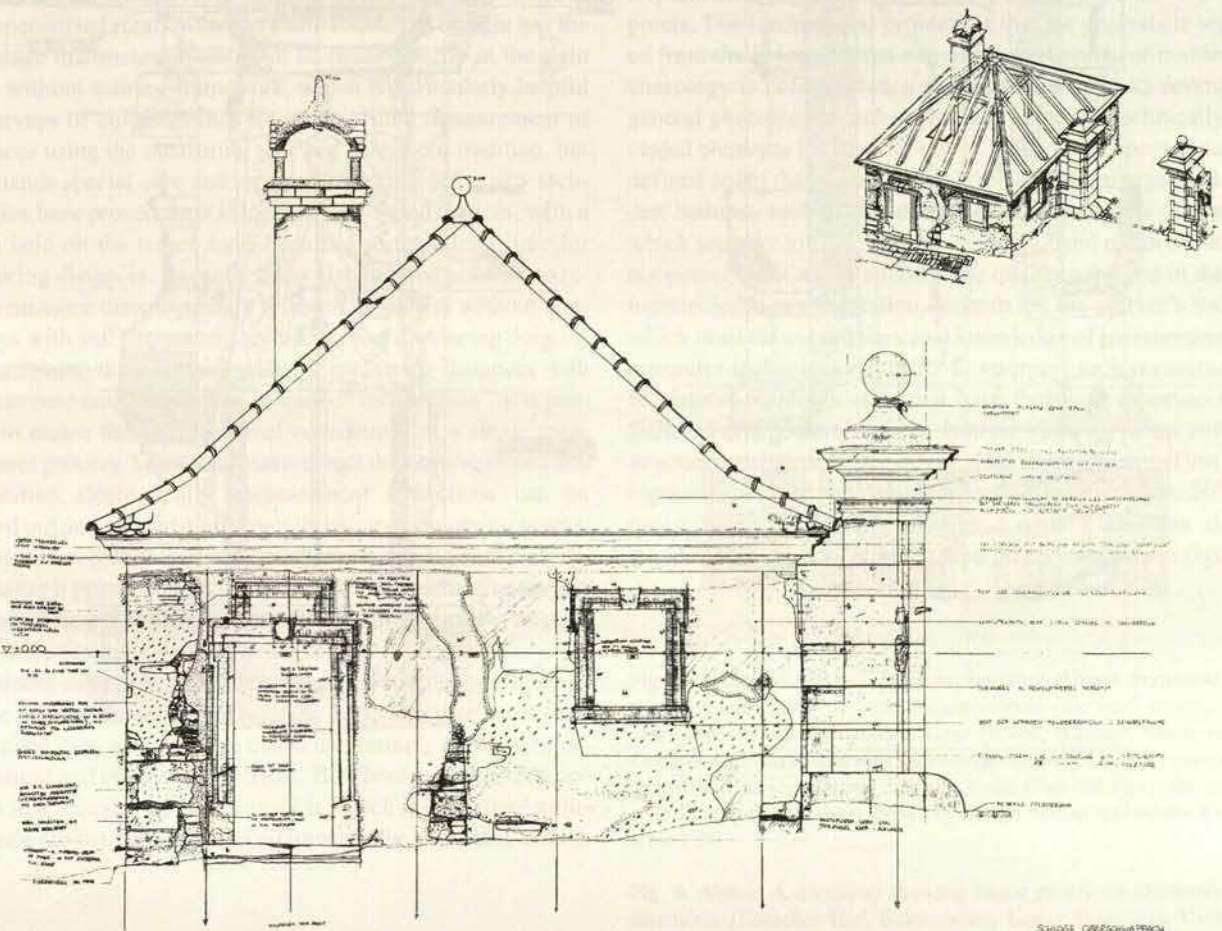
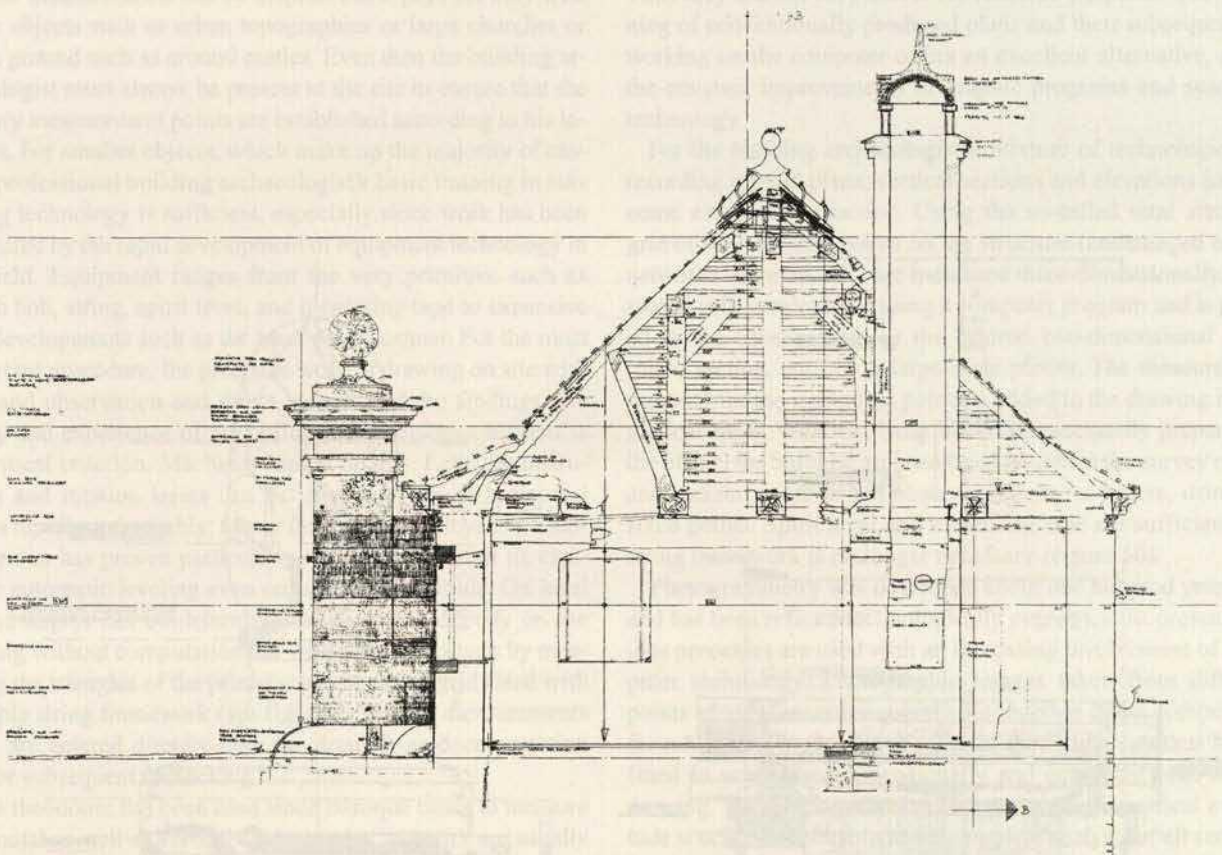
that are not visible but have been detected with certainty are represented using dashed lines.

The scale, which must be clarified first of all, depends on the goal of the project and the size of the object, which may range from a large urban site to a small individual monument. Scales that allow a high degree of detail are necessary for individual buildings. In addition to the scale of 1:50 used by the architect for work plans the scales 1:25 and 1:20 have proved particularly useful in building archaeology. The scale 1:25 can easily be reduced to 1:50 using copying technology and therefore has advantages over the traditionally popular scale 1:20, particularly in the field of practical preservation where the survey plans are used for further work by architects and engineers. Both scales make it possible to represent surface treatments, exposed damages, structural details and deformations, stone for stone and beam for beam (figure 6). Larger scales can be employed for important formal and structural details, from 1:10 or even 1:1 for small profiles (figure 7) Gradations in exactitude, whereby a very significant building is documented with more exactitude and using a larger scale than a "low-ranking" building, have been introduced for economic reasons in preservation practice in some places,<sup>8</sup> but this approach is inappropriate in building archaeology and, in my opinion, has not proved successful in preservation practice either. Too many important findings fall through the biased, predetermined sieve. Usually a building that is classified after a rough inspection automatically remains second class, since from the very beginning there is no chance to pursue hidden qualities.

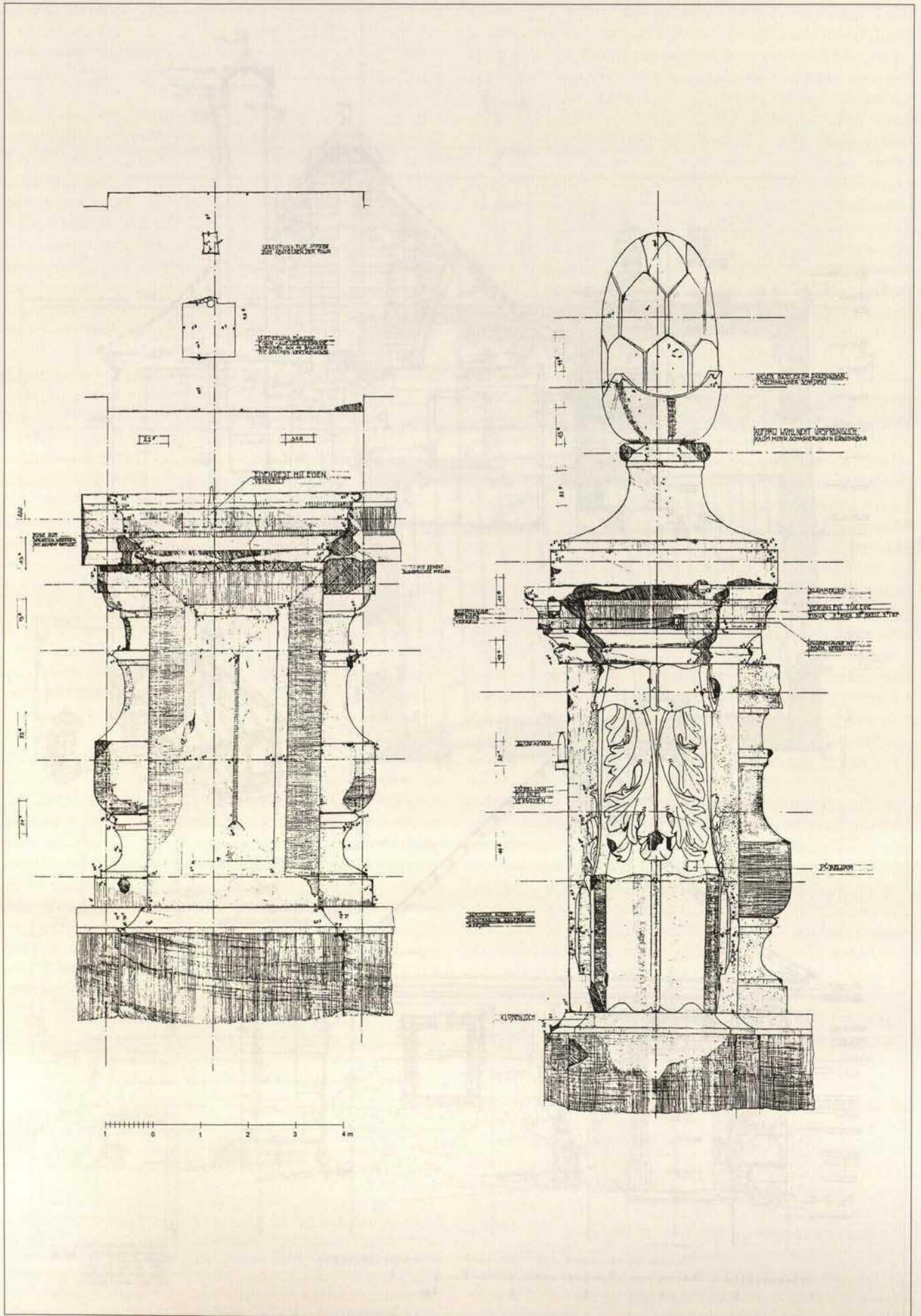
According to the size of the object being recorded, work is done individually or in coordinated teams. Measuring and drawing are tasks for experts who are specially trained and moreover have experience with historic building forms and structures. Only such an expert guarantees sound quality. Simple but intelligently employed measuring systems often achieve a higher cost-effectiveness than the use of expensive high-tech equipment. A fixed primary measuring grid is indispensable for correctly recording deformations, deviations and angular discrepancies, which are the rule in historic buildings. Systems range from a simple string framework to a polygon of laser beams from which the contours of a building or the walls of a ruin can be measured (figure 6). The assistance of geodesists in setting up the base

Fig. 6. Baroque gate house at Oberschwappach Palace (Lower Franconia, Germany). Drawn by Fritz Sell and Dieter Wenig. Example of a survey of a small structure with ground plan, elevation, section. Original scale 1:20, hard pencil on heavy paper. Measuring and drawing carried out as a single operation on site. For the ground plan: measurement of the axes formed by the string framework using triangles. For the section and the elevation: horizontal line at a height of one meter and vertical plumb as the basis for measurement. Using measurements taken from this fixed axial system, angle and plumb deviations, wall thicknesses, etc. are determined automatically. All dimensions are entered on the drawing as documentation. All the visible details such as doors, floor boards, stone paving, depth of the sandstone reveals, etc. are drawn on the ground plan; the ceiling joist is shown with a dashed line. Room numbers are indicated (001–003; rooms on an upper floor, if there was one, would be 101, 102, in the cellar K01, K02, and in the roof D01, D02, etc.) as are the wall designations (a,b,c,d). The complete roof structure including the important formation of the eaves, is shown in the section. On the elevation the surfaces of the stone components (door and window jambs, pillar) and the damages in the plaster are drawn as they really exist. Additional observations are recorded through concise annotations on the margins. On the left is a schematic representation of the three building phases for this small structure.





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 SPONKESGALL  
 WEST-ANSICHT FL. 1:50  
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grid for measurements can be helpful, but it pays off only with larger objects such as urban topographies or large churches or rough ground such as around castles. Even then the building archaeologist must always be present at the site to ensure that the primary measurement points are established according to his interests. For smaller objects, which make up the majority of cases, a professional building archaeologist's basic training in surveying technology is sufficient, especially since work has been facilitated by the rapid development of equipment technology in the field. Equipment ranges from the very primitive such as plumb bob, string, spirit level, and measuring tape to expensive new developments such as the laser radar scanner. For the most important procedure, the precision work of drawing on site with firsthand observation and direct mapping of the findings, the ability and experience of the building archaeologist himself is the critical criterion. Machines cannot do this. Leveling instruments and rotation lasers can be used to establish horizontal planes rapidly and reliably; a laser that can be employed by a single person has proven particularly successful through its electronic automatic leveling even on unsteady scaffolds. On level ground angles can be determined and entered directly on the drawing without computation but with great exactitude by measuring the triangles of the primary measurement grid fixed with a simple string framework (see figure 6). All the measurements taken are entered directly onto the drawing as documentation and for subsequent rechecking.

The theodolite has been used since Baroque times to measure horizontal as well as vertical angles; today its optics are usually combined with extensive electronics. Angles can also be read with specialized rotation lasers. Their visible ray of light has the advantage that measurements can be made directly in the light plane without a string framework, which is particularly helpful for surveys of buildings that are in use. Hand measurement of distances using the measuring tape has a very old tradition, but it demands special care and repeated checking. Here new technologies have proven their value. Infrared-based devices, with a prism held on the target, have been in use for a long time for measuring distances. Recently it has also become possible to reliably measure distances of up to about 60 meters without contact but with sufficient accuracy using laser measuring devices. By combining these technologies for measuring distances with an electronic theodolite into a so-called "total station", it is possible to create three-dimensional coordinates in a single measurement process. Since the measurement data can be stored and transmitted electronically, measurement figurations can be worked out and printed automatically using computer programs. The new laser technology with exact three-dimensional measuring makes it possible to record building components that are not accessible from a scaffold (figure 8), which previously was only possible financially with the use of photogrammetry.

Building surveys that are done purely electronically (figure 9) can be worked on immediately in the computer because of their vectorized data, an advantage that is increasingly required by architectural and engineering offices. But there is a clear deterioration in the quality of representation, which is of particular importance for the perception of architecturally important details.

Thus they are not very useful for research purposes. The scanning of conventionally produced plans and their subsequent reworking on the computer offers an excellent alternative, given the constant improvements in graphic programs and scanning technology.

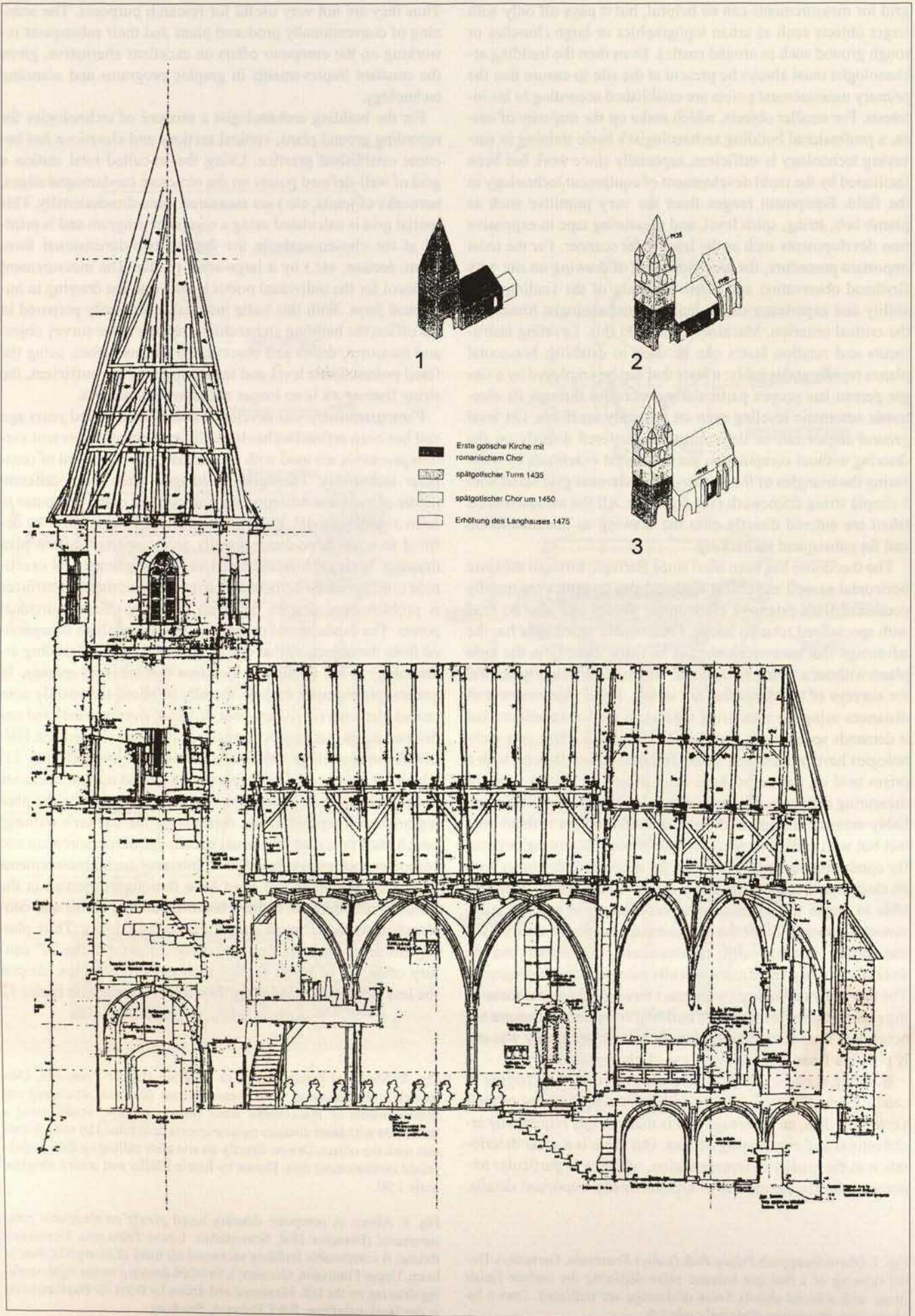
For the building archaeologist a mixture of technologies for recording ground plans, vertical sections and elevations has become established practice. Using the so-called total station a grid of well-defined points on the structure (undamaged edges, networks of joints, etc.) are measured three-dimensionally. This spatial grid is calculated using a computer program and is printed at the chosen scale in the desired two-dimensional form (plan, section, etc.) by a large-scale plotter. The measurement protocol for the individual points is added to the drawing in numerical form. With this basic material, necessarily prepared in the office, the building archaeologist returns to the survey object and measures, draws and observes on site, as before, using the fixed points. Spirit level and measuring tape are sufficient, the string framework is no longer necessary (figure 10).

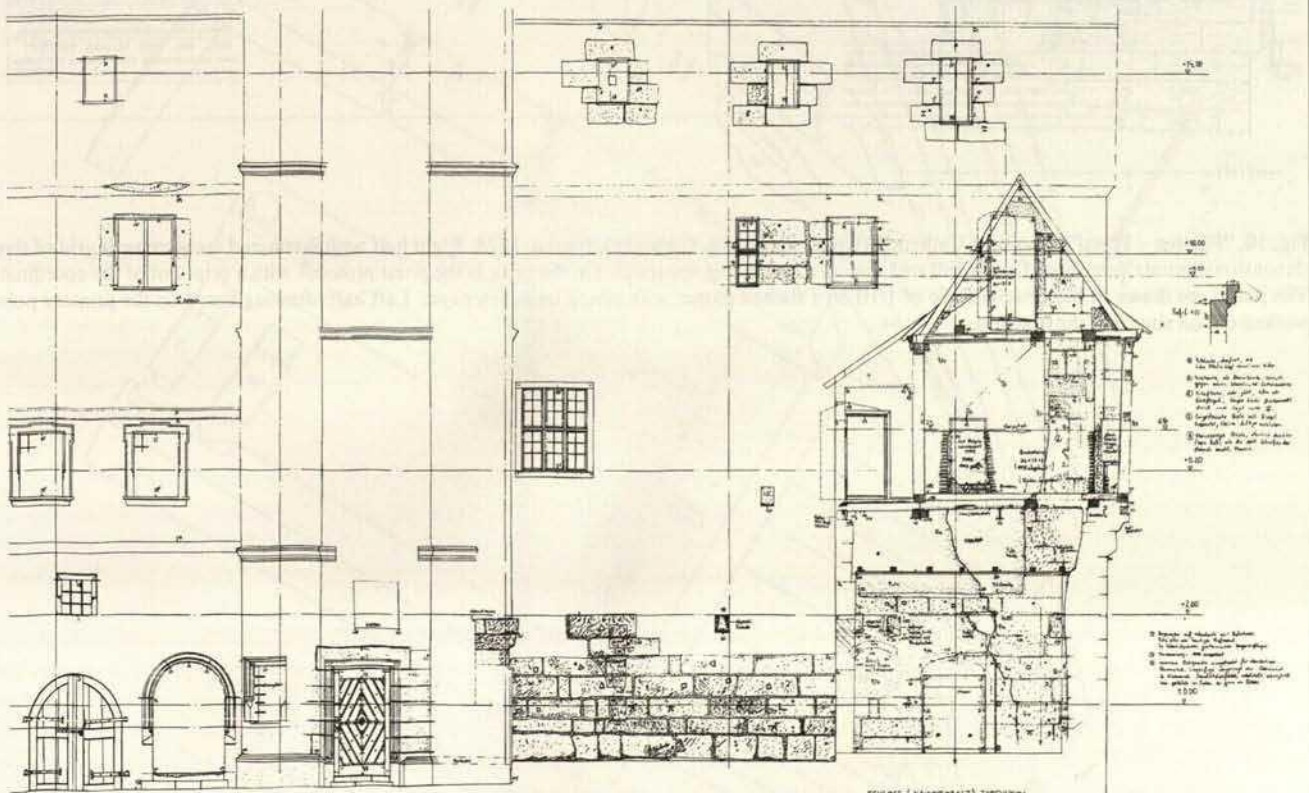
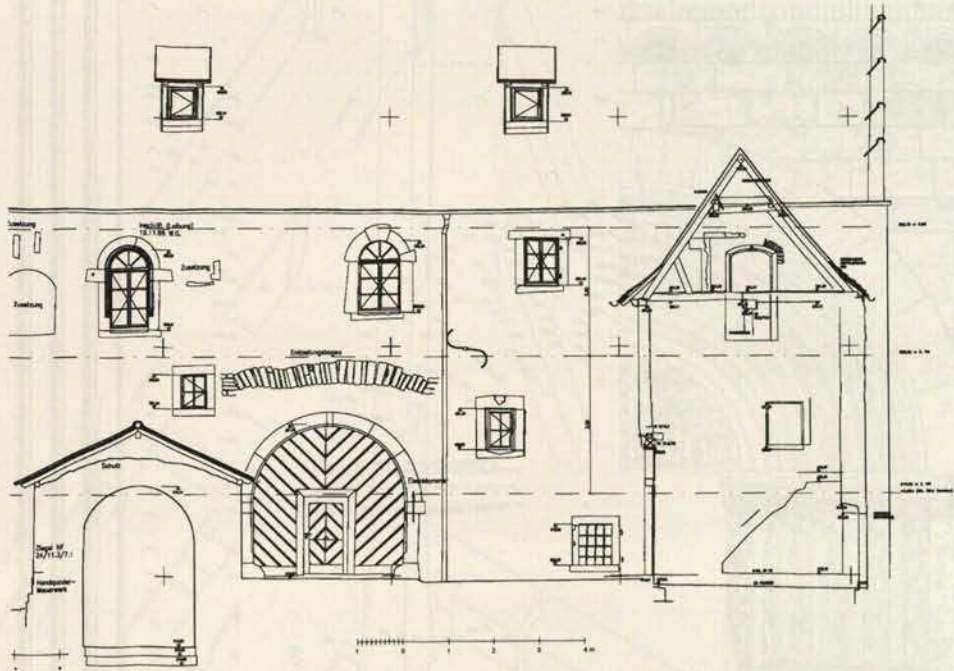
Photogrammetry was developed about one hundred years ago and has been refined technologically ever since. At present various processes are used with an increasing involvement of computer technology. Photographic images taken from different points of view are subsequently put together in the computer to form a spatial model. Each point of a building can thus be defined to scale three-dimensionally and converted onto a plan drawing. With appropriate care a very high geometrical exactitude is achieved. Nonetheless a complete analysis of all surfaces is problematical despite the great accuracy of the individual points. The fundamental problem is that the analysis is separated from the object, so that one of the basic rules of building archaeology is not fulfilled, a violation that takes its revenge. In general photographs include literally or photo-technically concealed elements (in shadow, out of focus, overexposed) and undefined zones that cannot be analyzed despite enlargement. Hidden features such as the details of wooden joints (figure 11) which are easy to find and represent in a hand measurement are not perceived at all. In addition the quality achieved in the photogrammetric representation depends on the worker's training, which must far exceed the usual knowledge of measurement and computer technology. In order to interpret such measurements of historic buildings one must have thorough expertise in the fields of architectural history, historic building forms and construction methods to an extent that is rare today. Thus photogrammetric analyses from the second quarter of the 20<sup>th</sup> century often are of better quality than modern analyses, despite the less developed technology. In a direct comparison figure 12

◁ Fig. 7. Oberschwappach Palace Park (Lower Franconia, Germany). Detail drawing of a Baroque baluster pillar depicting the surface finish (done with a broad chisel) Areas of damage are indicated. Drawn by Maximilian Waldmann. Original scale 1:5.

▷ Fig. 8. Medieval parish church in Seußling (Upper Franconia, Germany), combination of hand measurements (the roof structure) and measurements of inaccessible areas (tower, window, vault) using a theodolite with laser distance measurements determined by remote contact with the object. Drawn directly on site after calling up the computerized measurement data. Drawn by Katrin Müller and others. Original scale 1:50.

▷▷ Fig. 9. Above: A computer drawing based purely on electronic measurements (Ebracher Hof, Schweinfurt, Lower Franconia, Germany). Below: A comparable building measured by hand (Kaiserpfalz, Forchheim, Upper Franconia, Germany); finished drawing on the right, working drawing on the left. Measured and drawn by Büro für Bauforschung in der Denkmalpflege. B&T Kohnert, Bamberg.





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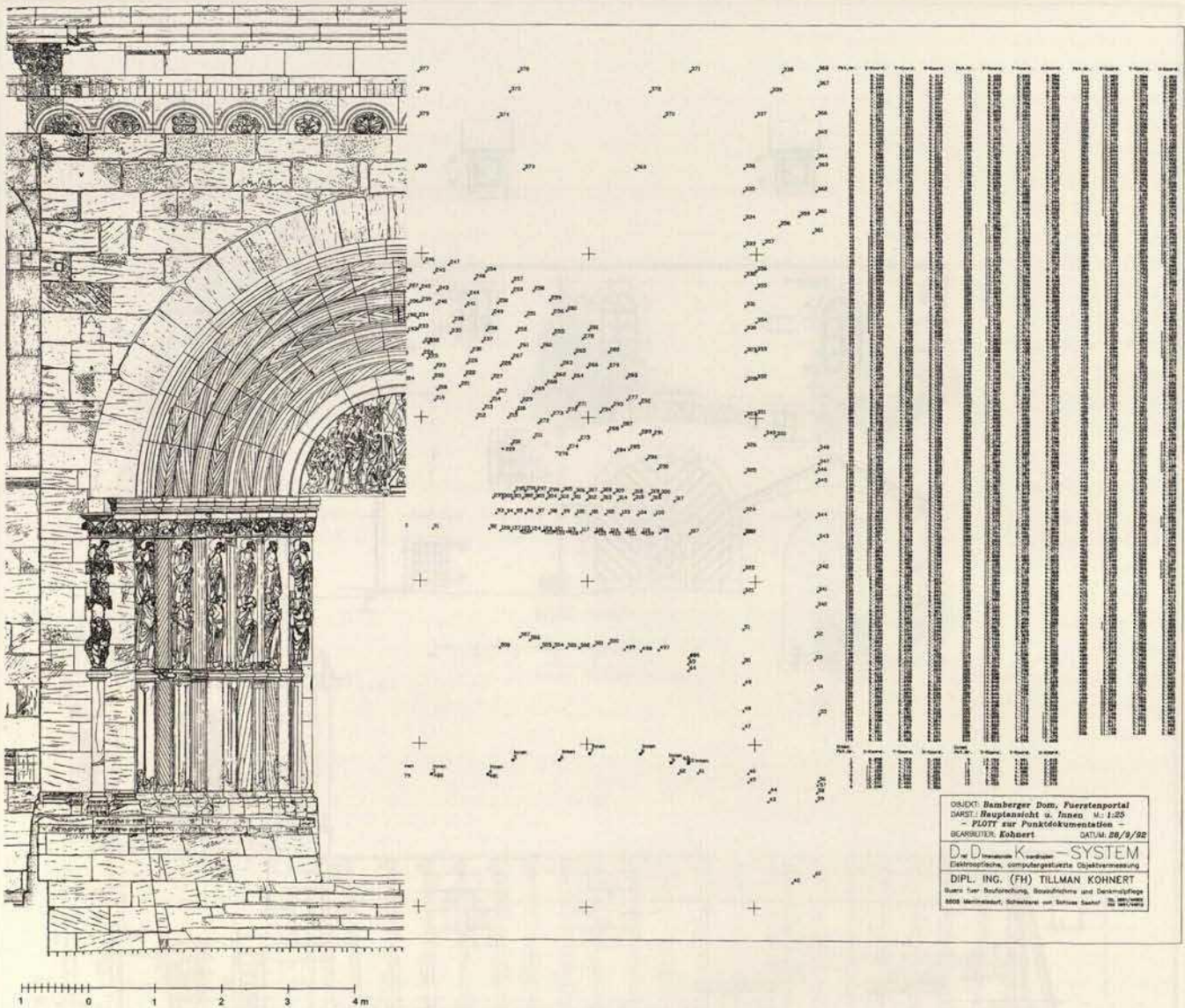
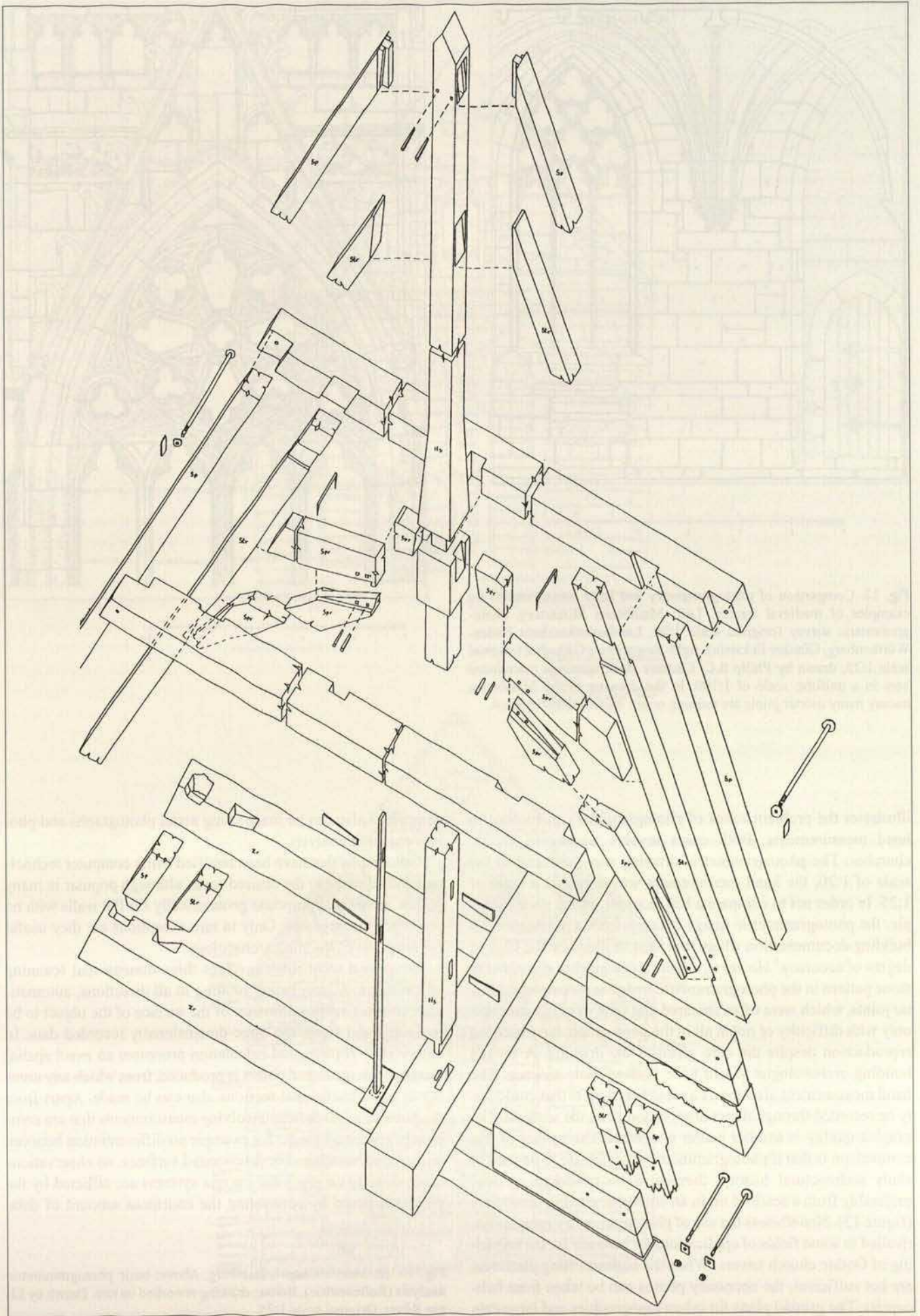


Fig. 10. "Fürsten - Portal", Bamberg Cathedral (Upper Franconia, Germany), from c. 1225. Right half with numbered measurement grid of three-dimensional points determined by an infrared distance measuring apparatus. On the right is the point protocol with a print out of the coordinates. The points are drawn in the desired scale of 1:10 on a flatbed plotter with pencil on heavy paper. Left half: drawing based on the primary points, worked out on site from the scaffold.

Fig. 11. Isometric depiction of a Baroque roof truss with information on the concealed joints. St. Elizabeth's Chapel in Bamberg (Upper Franconia, Germany). Drawn by Rolf Mauersberger. ▷



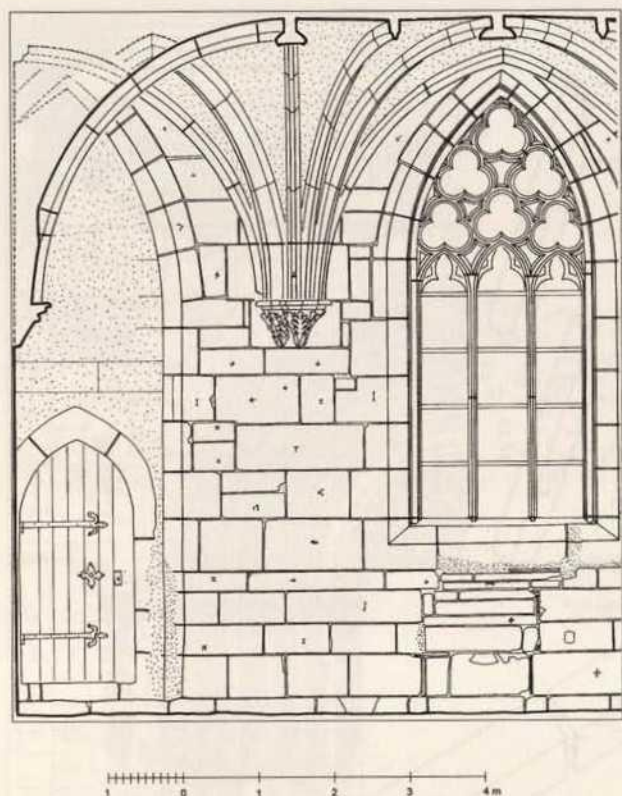
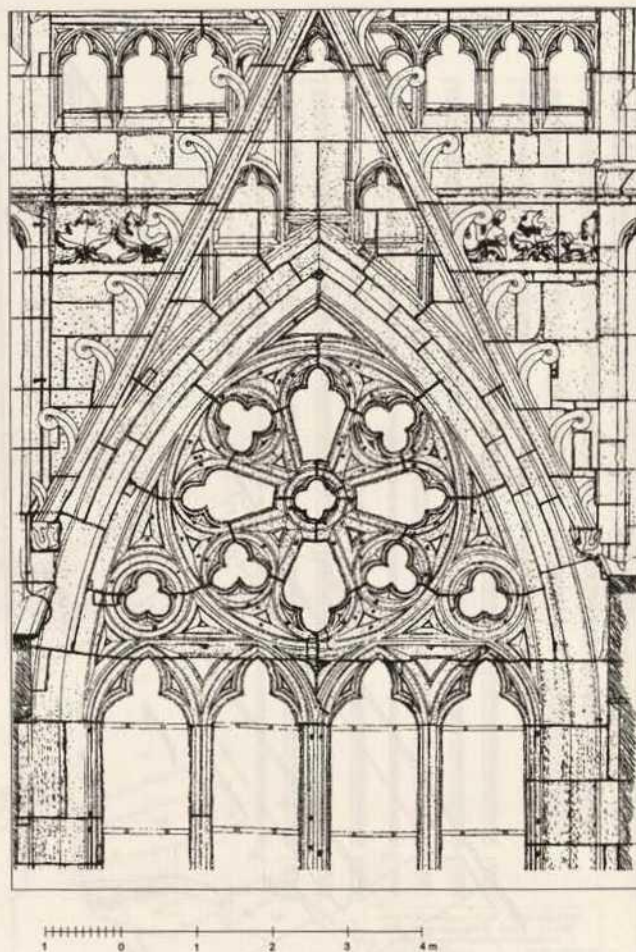


Fig. 12. Comparison of photogrammetry and hand measurements on examples of medieval tracery. Left: Maulbronn Monastery, photogrammetric survey (original scale 1:20, Landesdenkmalamt Baden-Württemberg, Günther Eckstein); right: Regensburg Cathedral (original scale 1:25, drawn by Philip S.C. Caston). Both drawings reproduced here in a uniform scale of 1:100. In the drawing of the Maulbronn tracery many mortar joints are missing or are inaccurately depicted.



illustrates the problem zones of photogrammetry in contrast to hand measurements. Both cases involve tracery in Gothic churches. The photogrammetric drawing was produced in the scale of 1:20, the hand measurement was drawn at a scale of 1:25. In order not to compare a bad example with a good example, the photogrammetric image is taken from a publication on building documentation where it is used to illustrate the highest degree of accuracy.<sup>9</sup> However, a trained eye quickly sees that the stone pattern in the photogrammetric image is incomplete. Mortar joints, which were often smeared and thus were recognizable only with difficulty or not at all in the photograph, have escaped reproduction despite the care given to the drawing. A trained building archaeologist would have noticed their absence. The hand measurement also shows a wealth of details that could only be recorded through direct observation from the scaffold. The graphic quality is another matter altogether. The upshot of this comparison is that if photogrammetric analyses are to be used to study architectural history, they must be reworked on site, preferably from a scaffold or, in an emergency, using binoculars (figure 13). Nonetheless the use of photogrammetry remains unrivalled in some fields of application, for instance for the recording of Gothic church towers. When the highest lifting platforms are not sufficient, the necessary photos can be taken from helicopters. The ground plans for urban topographies and large ruin

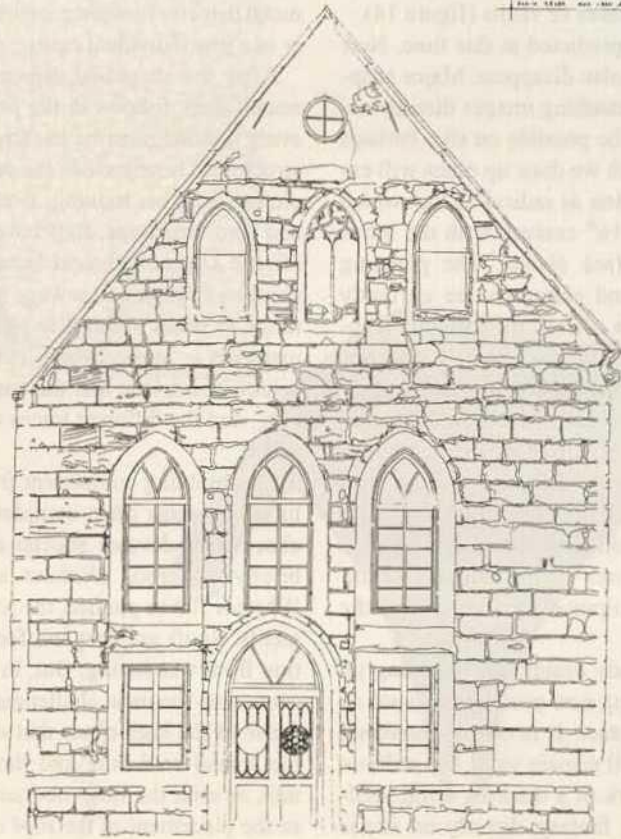
complexes also can be made using aerial photographs and photogrammetric analysis.

Photographs that have been rectified using computer technology and adjusted to the desired scale, although popular in many places, are only appropriate geometrically for flat walls with no projections or recesses. Only in rare exceptions are they useful for purposes of building archaeology.

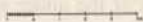
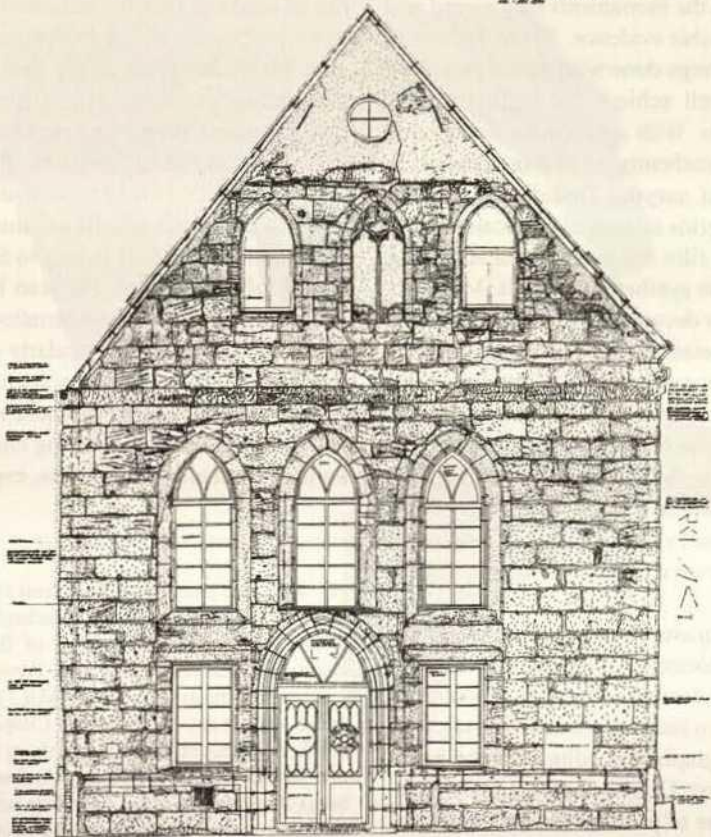
The newest technology involves three-dimensional scanning of buildings. A laser beam, rotating in all directions, automatically touches every millimeter of the surface of the object to be measured and stores the three-dimensionally recorded data. In theory after complicated calculation processes an exact spatial image of the measured object is produced, from which any number of two-dimensional sections also can be made. Apart from the familiar basic deficits involving measurements that are completely machine-based – for example no differentiation between undamaged, weathered or deteriorated surfaces, no observations made directly on site – the current systems are afflicted by the problems posed by connecting the enormous amount of data.

Fig. 13. St. Mary's Chapel, Bamberg. Above: basic photogrammetric analysis (Rolleimetric). Below: drawing reworked on site. Drawn by Elgin Röver. Original scale 1:25.

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ELEVATION NORD  
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PLAN DE LA FACADE SUD  
ELEVATION SUD  
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Nonetheless the process opens up new possibilities, in particular for measuring three-dimensional objects without geometrically definable points such as sculptures or vaults (figure 14).

Further developments cannot be predicted at this time. New technologies appear as fast as some also disappear. Major adaptations are currently underway for handling images directly using the notebook, which could also be possible on site. Perhaps in a few decades the manner in which we draw up plans will experience an intellectual transformation as radical as that which took place at the beginning of the 16<sup>th</sup> century with the introduction of orthogonal projection (see above). The planning processes followed by architects and engineers are currently changing because of the possibilities offered by computer technology. Planning is increasingly taking place in 3-D systems, rather than in the familiar two-dimensional horizontal and vertical schemes which have determined our architectural thought for five hundred years. Planners are therefore inevitably demanding computer-usable measured drawings which can immediately be worked on further. Here in particular the building archaeologist working in the field of practical preservation will have to adjust the methods he uses for his building survey. The development of measuring equipment is a portent of the changes.

Modern high technology is already easing and speeding up some fields of work and is producing new possibilities such as distance measurements without contact. It is certain, however, that the existing basic principles will remain valid and will not be overhauled in the future: the work of a thinking mind, well-trained and equipped with creative fantasy, directly on site is critical. With or without high-tech!

A special problem, usually underestimated today, is the stability of the documentation. A building survey is a valuable document which should last as long as possible. Many measured drawings have already outlasted the monuments they record and are often the only remaining reliable evidence. As old-fashioned as it may sound, measured drawings done with a hard pencil on white, acid-free heavy paper still achieve the highest proven durability of all known materials. With appropriate storage this is several hundred years. The disadvantages of this material, in particular shrinkage because of varying humidity, are easily eliminated using measurement grids and shrinkage scales on the paper. Shrinkage-free polyester film cracks or sticks according to the amount of hardeners in the synthetic materials. Many excavation plans that are only a few decades old are already ruined. Electronic storage of data, greeted so euphorically, is just as problematic because there is no guarantee of a long life. Even the extolled storage capability of data on CD-ROMs cannot be guaranteed with certainty today for longer than 30 years. Moreover there is the problem of having the appropriate hard and software available for reading the data in one hundred years. There is no way around it: traditional heavy paper is still the most long-lasting medium for building surveys. But it too must be stored and archived appropriately.

*Further investigations:* The measured drawings are of course accompanied by photographic documentation, the main portion of which – again for reasons of document stability – should be black and white photos printed on archivally stable baryta paper. Paint findings should be photographed in color with the inclusion of a standardized color chart. Digital photography will increase in importance but because of problematic document stability it will not replace the traditional photo. Videos are at the most to be used as supplementary material.

Special, often costly technical investigative methods such as radar probes, infrared images, magnetometer prospecting, and metal detector measurements will lead to additional findings only in a few individual cases.

After the measured drawings are completed the actual research work follows in the form of an analysis. All details and every context must be analyzed in terms of form, function and structure. These include the points that are so familiar to the architect from his training, from foundations, floor, wall, ceiling and roof structures, roof coverings, stairs, windows and doors (figure 15), to technical installations such as heating systems, chimneys, water and sewage systems, and much more in a great range of often unfamiliar variations. The diversity of building materials – stone, wood, clay, lime, sand, unfired and fired bricks, straw, iron and the various technologies for its processing – and the different traces of tools and machines play a large role.

One building component from this sequence which architectural historians often completely overlook but the building archaeologist devotes special attention to must be emphasized briefly: the roof. Without a roof, there is no architecture. Whether flat or pitched, the roof counts as one of the major elements. Roofs are first and foremost the most important protection from weathering. But, in addition to vaults, they are at the same time the most challenging task in normal construction because of the high spans that often must be bridged. Sometimes the spatial enclosure and the roof construction form a single unit, as with the flat wood and clay roofs of many hot climates or the placement of the roof covering directly onto the vault as in the Cistercian churches of Provence. The diversity, often dictated by the materials, is astonishing. On Greek temples constructions made strictly of stone, from the purlin to the rafters to translucent marble tiles, have been discovered. Stone and wood can be used together, for instance when wood purlins are laid on stone horizontal arched buttresses, which then carry the roof skin. For pitched roofs purely wood structures are the most common throughout the world. A maximum of 25 meters can be freely spanned; more was not attempted in early Christian basilicas, large medieval churches, Baroque palaces or Japanese pagodas (figure 16). For the building archaeologist roof constructions offer a particular advantage: they are often untouched by alterations and thus belong to the earliest building phases of a work of architecture. This can be of great importance especially for townhouses and farmhouses that have often been altered and remodeled, particularly since the wood offers a good opportunity for dendrochronological dating.

Roof coverings are even more neglected. As a unit, the roof structure and the roof covering characterize not only individual buildings but also entire cities, even regions. Thirty per cent of

Fig. 14. Laser scanned chancel vault of the Regensburg Cathedral (executed by the office of Bernd Strackenbrock, Birkenwerder) with exact three-dimensional reproduction of the vault surfaces including the slight deformations of the caps. Development of a three-dimensional vault measuring system (PeterVAULT) to record the shape and strength of the vault at any point desired. Cooperation between Bernd Strackenbrock, Staatshochbauamt Regensburg (Gerhard Sandner) and the Institute for Archaeology, Building Archaeology and Conservation (Bamberg). Above: vault of the right aisle with simplified net depiction of the surface and shell of the underside (from above). Below: the same vault with the two surfaces of the under and top side in their real distance (original in two colors)



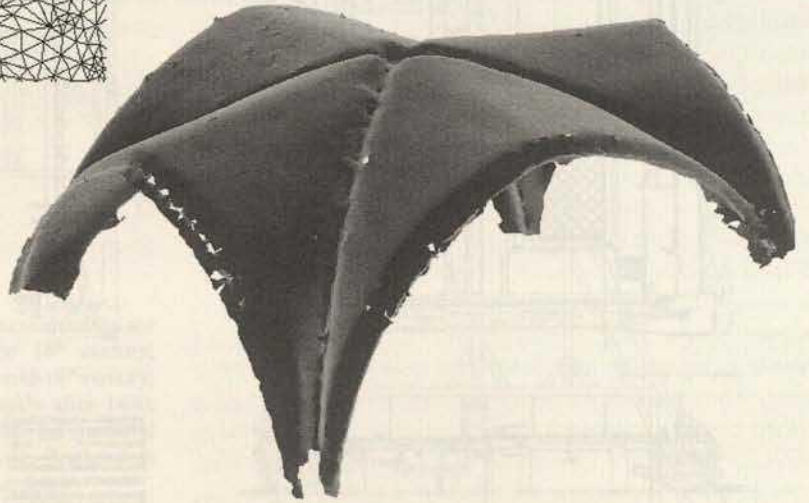
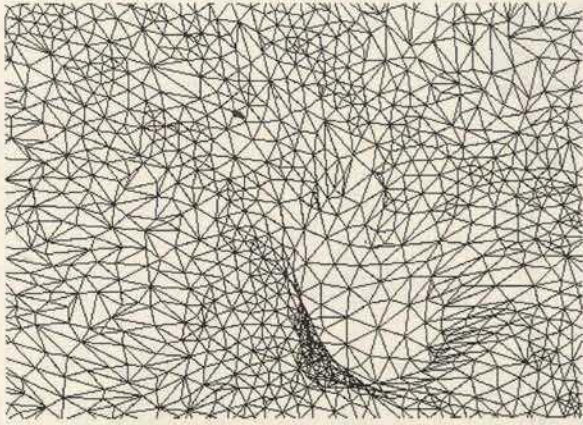
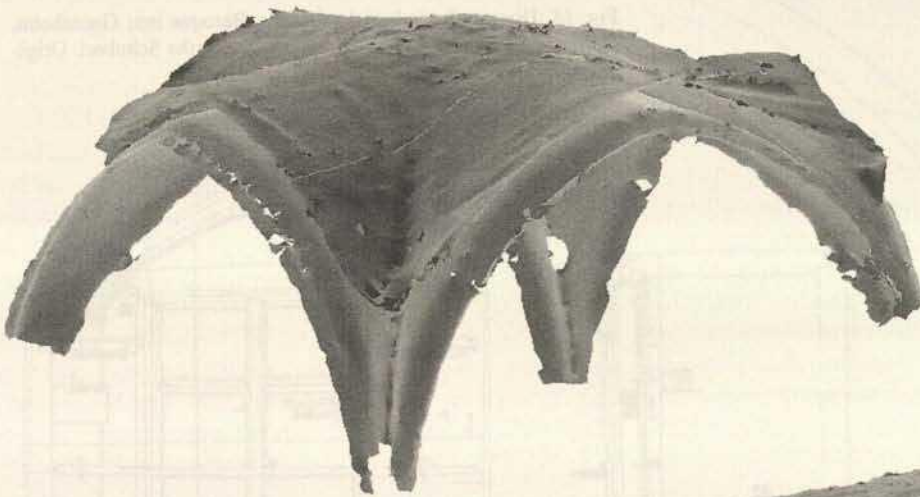


Fig. 10. Non-uniform mesh of a dome structure. The mesh is refined at the base and becomes sparser towards the top. The mesh is composed of triangular and quadrilateral faces. The mesh is used for the finite element analysis of the dome structure.



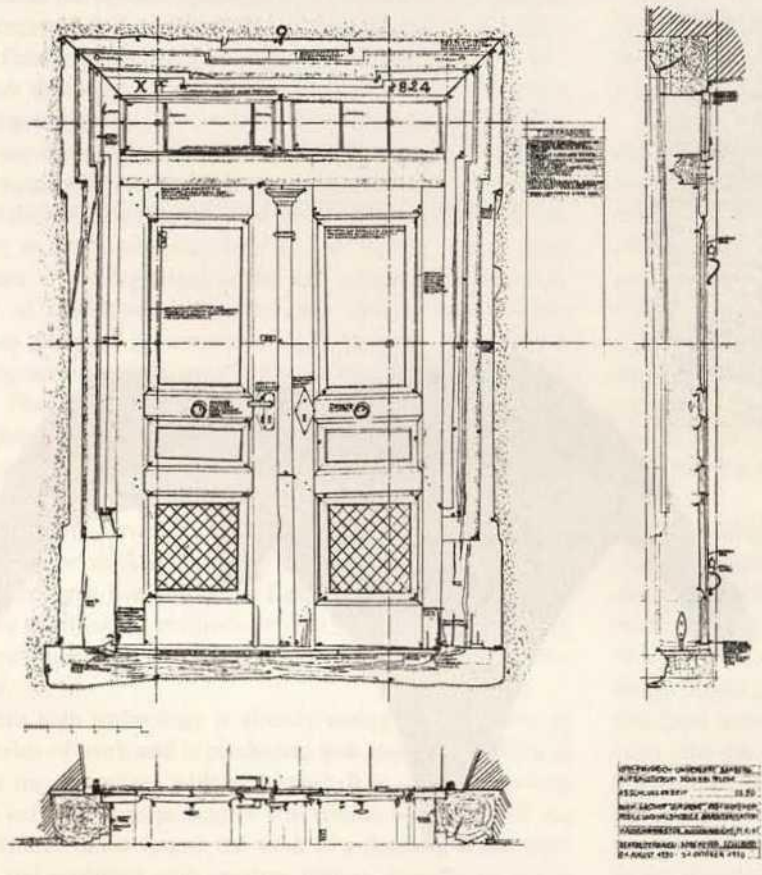
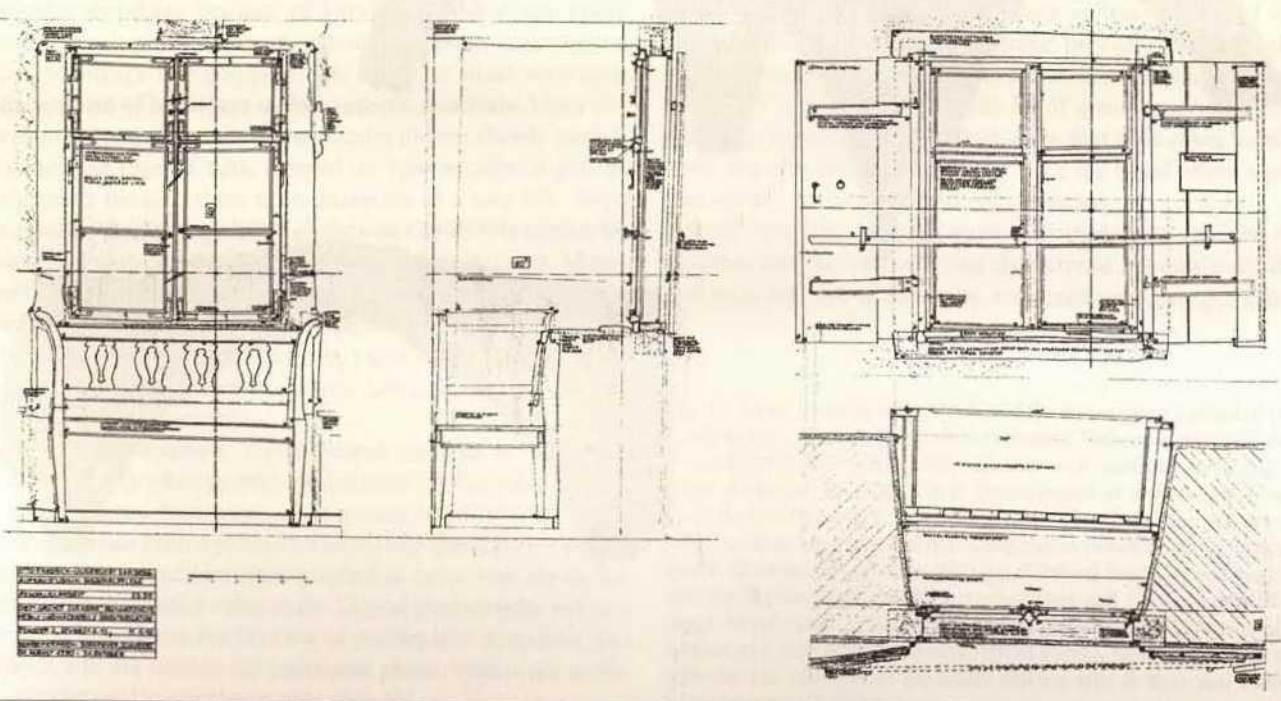


Fig. 15. Door and window details of a Baroque inn, Gnotzheim, Germany. Drawn by Anke Borgmeyer und Ulrike Schubert. Original scale 1:10.



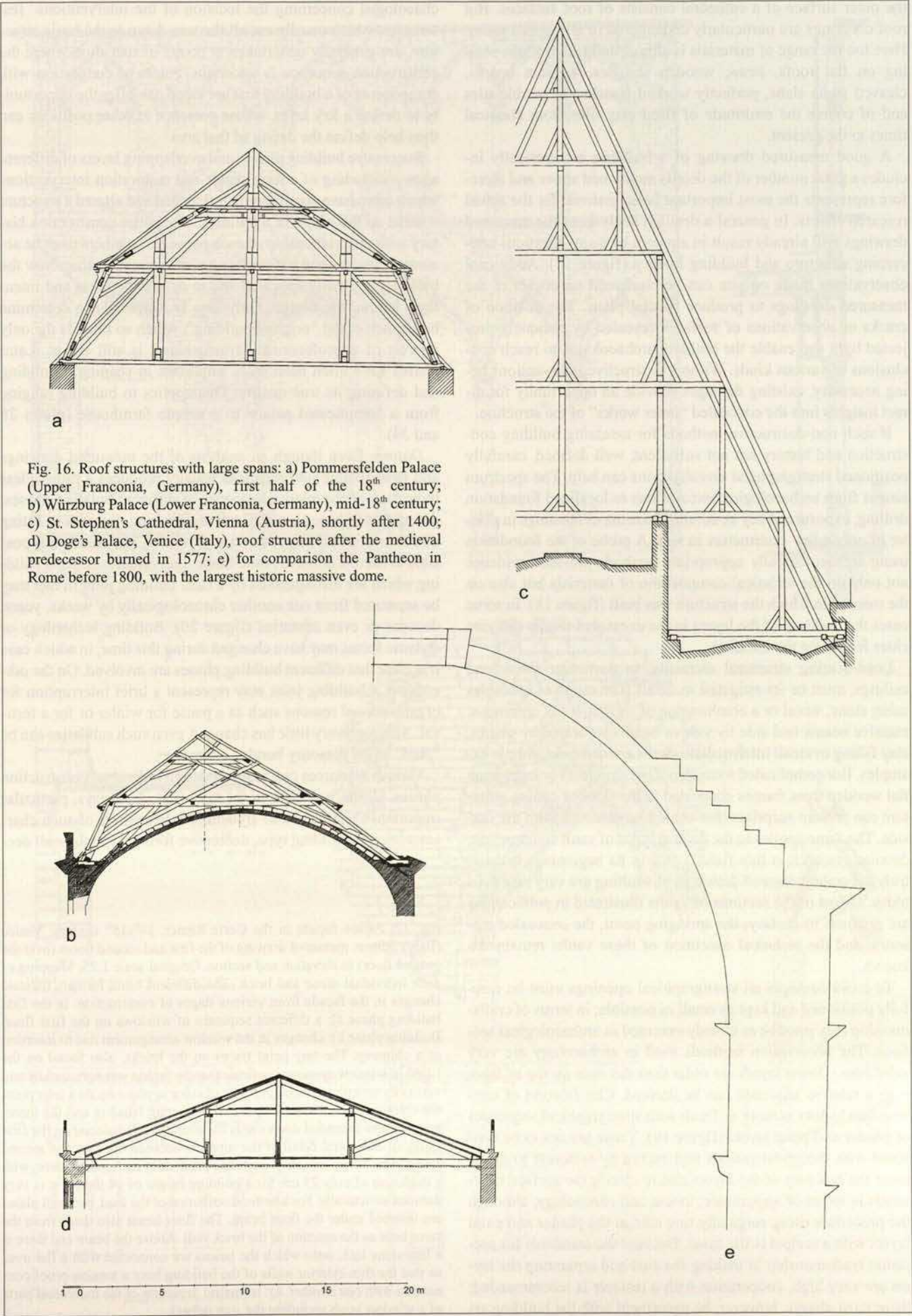


Fig. 16. Roof structures with large spans: a) Pommersfelden Palace (Upper Franconia, Germany), first half of the 18<sup>th</sup> century; b) Würzburg Palace (Lower Franconia, Germany), mid-18<sup>th</sup> century; c) St. Stephen's Cathedral, Vienna (Austria), shortly after 1400; d) Doge's Palace, Venice (Italy), roof structure after the medieval predecessor burned in 1577; e) for comparison the Pantheon in Rome before 1800, with the largest historic massive dome.

the outer surface of a cathedral consists of roof surfaces. But roof coverings are particularly endangered in all regions today. Here too the range of materials is almost unlimited: adobe sealing on flat roofs, straw, wooden shingles, wooden boards, cleaved stone slabs, perfectly worked translucent marble tiles and of course the multitude of fired clay tiles from classical times to the present.

A good measured drawing of a building automatically includes a great number of the details mentioned above and therefore represents the most important basic material for the actual research efforts. In general a detailed analysis of the measured drawings will already result in answers to many questions concerning structure and building history (figure 17). Additional observations made on site can be combined on copies of the measured drawings to produce special plans. The position of cracks or observations of surfaces revealed by obliquely projected light can enable the building archaeologist to reach conclusions of various kinds. Without destructive interventions being necessary, existing damages provide an opportunity for direct insights into the concealed "inner works" of the structure.

If such non-destructive methods for assessing building construction and history are not sufficient, well defined, carefully positioned stratigraphical investigations can help. The spectrum ranges from archaeological excavations to localized foundation drilling, exposure of key structural elements or openings in plaster of only a few centimeters in size. A probe of the foundation using archaeologically appropriate methods provides evidence not only on the technical composition of materials but also on the manner in which the structure was built (figure 18). In some cases the build-up of the layers in the excavated trench can give clues for dating the building.

Load-bearing structural elements, in particular floors and ceilings, must be investigated in detail. The range of examples using stone, wood or a combination of techniques is enormous: massive beams laid side by side or beams separated by planks, clay filling or small intermediate vaults are common, simple examples. But complicated soundproofing structures or large-span flat wooden truss frames concealed in the floor or ceiling structure can present surprises that cannot be detected from the outside. The same applies to the diverse types of vault construction; detailed research in this field is still in its beginnings because truly accurate measured drawings of vaulting are very rare even today.<sup>10</sup> Most of the sections of vaults illustrated in publications are products of fantasy; the springing point, the concealed masonry, and the technical execution of these vaults remain unknown.

To avoid damages all stratigraphical openings must be carefully positioned and kept as small as possible; in terms of craftsmanship they must be as cleanly executed as archaeological sections. The observation methods used in archaeology are very valid here – lower layers are older than the ones on top of them – so a relative sequence can be derived. Clarification of construction history is more difficult with stratigraphical sequences of plaster and paint layers (figure 19). These are not to be confused with the investigations undertaken by restorers to determine the build-up of the layers and to clarify the surface treatments in terms of appearance, extent and chronology, although the procedure using surgically tiny cuts in the plaster and paint layers with a scalpel is the same. Because the standards for precision craftsmanship in making the cuts and separating the layers are very high, cooperation with a restorer is recommended; there must always, however, be agreement with the building ar-

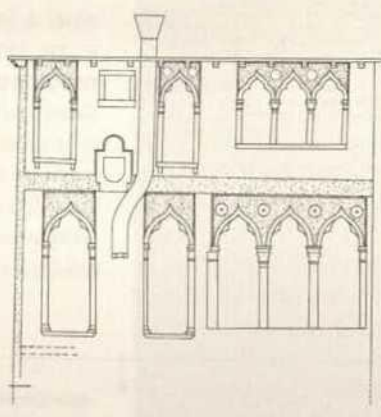
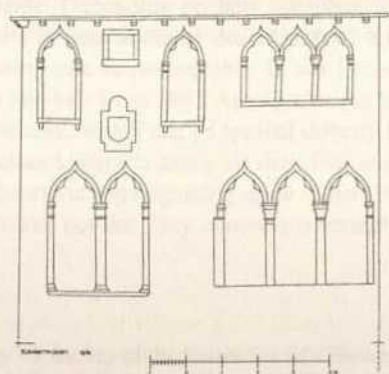
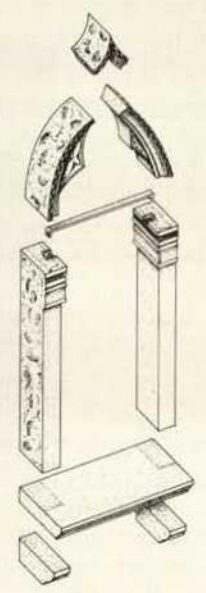
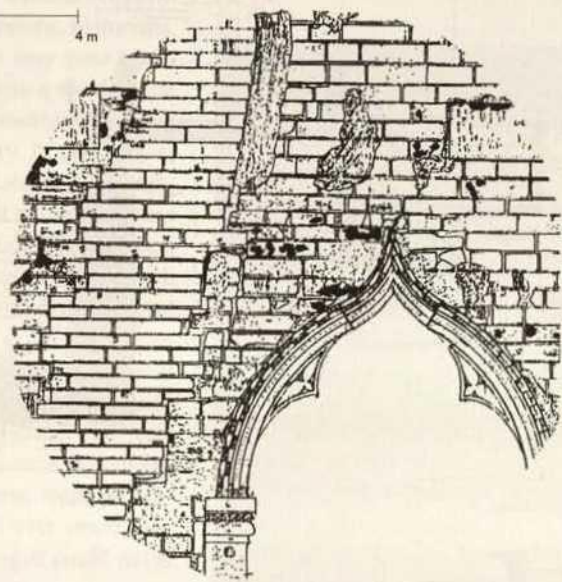
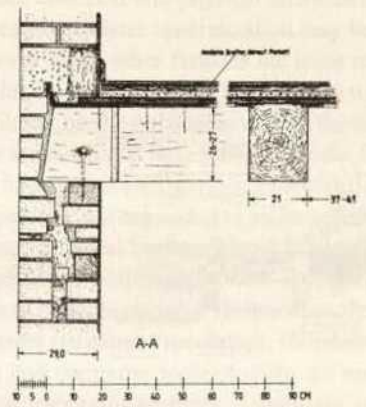
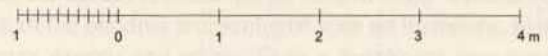
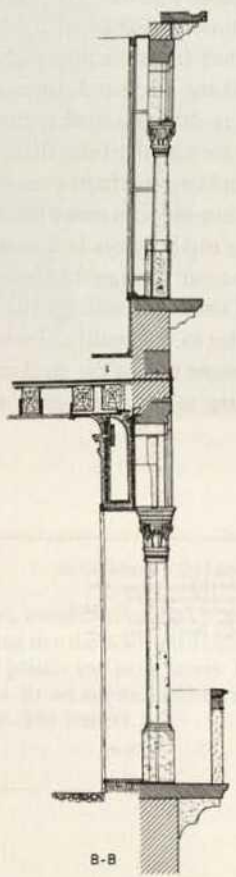
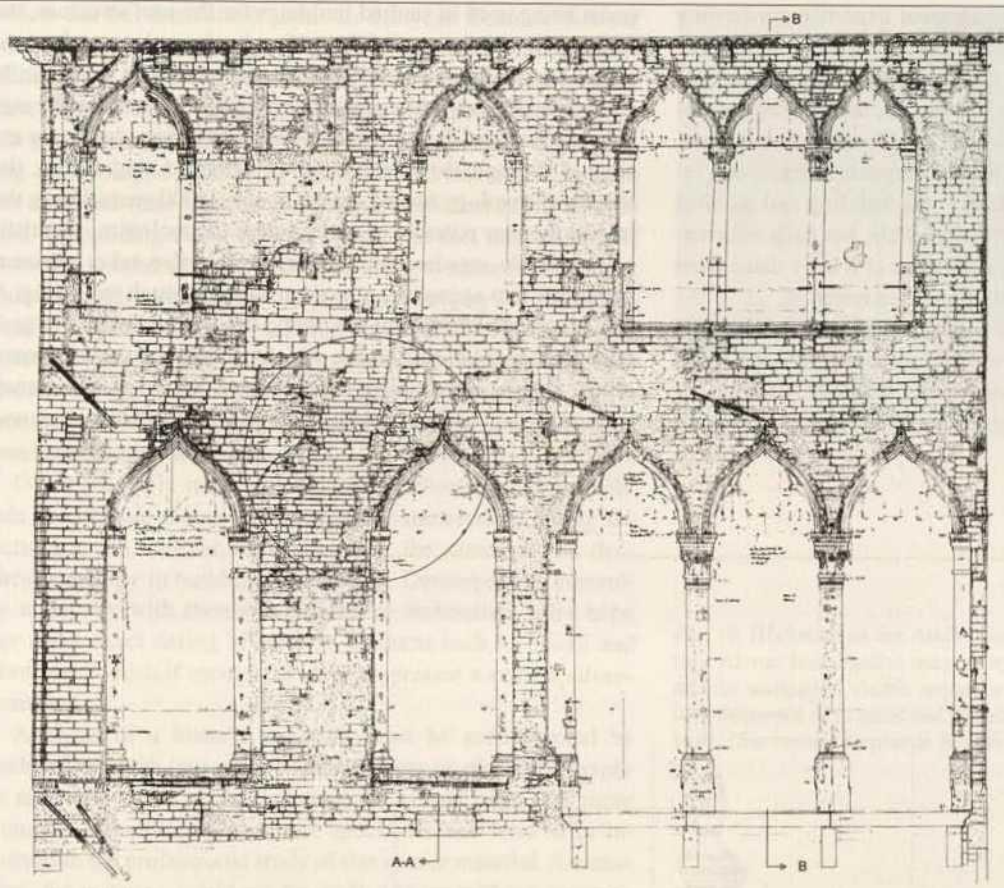
chaeologist concerning the location of the interventions. Test samples, which usually cut all the way down to the basic structure, are generally undertaken at points of transition where the construction sequence is uncertain. Points of connection with components of a building that are dated can offer the opportunity to define a key layer, whose presence at other positions can then help define the dating of that area.

Successive building phases and overlapping layers of different ages – including of course repair and restoration interventions which often have significantly influenced and altered a structure – make up the whole of a building. The entire construction history with the relationship of each phase to the others must be accurately understood before it is possible to reconstruct how the building originally appeared and to define the ideas and intentions behind the design. Only now is it possible to determine how much of the "original building", which so often is the only interest of unprofessional investigations, is still extant. Later phases have often been more important in shaping a building and defining its true quality. This applies to building ranging from a complicated palace to a simple farmhouse (plates 28 and 34).

*Dating:* Even though an analysis of the measured drawings and stratigraphic investigations usually produces a rather clear indication of the relative sequence of different building phases, dating these phases is a difficult undertaking. Success in dating all facets of a building requires a bit of luck, but usually it is possible to narrow down the time frame. Individual zones of a building which are distinguished by a clear building joint in fact may be separated from one another chronologically by weeks, years, decades or even centuries (figure 20). Building technology or stylistic forms may have changed during this time, in which case it is clear that different building phases are involved. On the other hand, a building joint may represent a brief interruption for organizational reasons such as a pause for winter or for a festival. Although very little has changed, even such subtleties can be "read" in the masonry bonds.

Various resources can assist in dating individual construction phases, all the way back to the very first. As always, particular importance is attached to stylistic classifications of such characteristics as building type, decorative forms, capitals, wall dec-

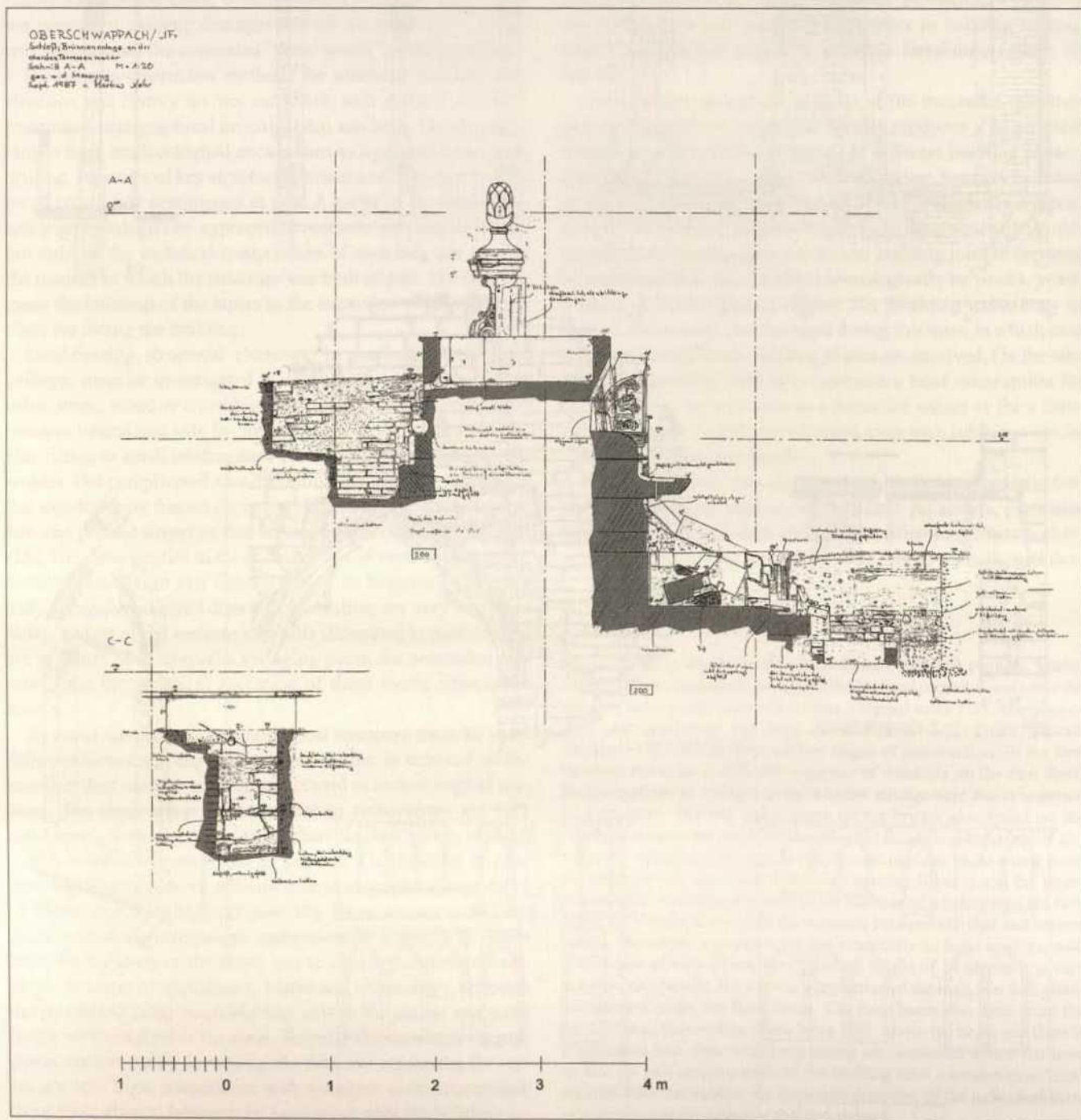
Fig. 17. Palace façade in the Corte Remer, 14<sup>th</sup>/15<sup>th</sup> century, Venice (Italy). Above: measured drawing of the first and second floors (over the ground floor) in elevation and section. Original scale 1:25. Mapping of each individual stone and brick. The different brick formats indicate changes in the façade from various stages of construction. In the first building phase a): a different sequence of windows on the first floor. Building phase b): changes in the window arrangement due to insertion of a chimney. The tiny paint traces on the bricks, also found on the filled-in window openings, indicate that the façade was horizontally and vertically articulated through bands of color in phase b). At a later point the chimney was demolished, the wall opening filled in and the three-part window extended downwards for addition of a balcony on the first floor. c): Structural detail of the supports between the first and second floors. The cavity masonry work has practically no bond headers; with a thickness of only 29 cm for a building height of 14 meters it is very dubious structurally. For a better distribution of the load, two wall plates are inserted under the floor beam. The floor beam also dates from the same time as the erection of the brick wall. Above the beam end there is a limestone link, onto which the beams are connected with a flat iron, so that the thin exterior walls of the building have a tension-proof connection with one another. e): Isometric depiction of the individual parts of a window jamb including the iron tieback.



oration, profiles, etc. This requires great expertise concerning historic buildings, also in a regional context. Further assistance comes from technical clues such as the techniques used for working wood and stone (figure 21), the use of different materials in different time periods, varying deployment of machines, the format of bricks, stone mason's and carpenter's signs, etc. Inscriptions (perhaps even with dates) on a building and archival documents can make precise dating possible, but such information must always be checked to determine if it truly dates from the same time as the building component in question.

Dendrochronology has proved successful over the last decades as a scientifically-based method of dating. Indeed, it has become one of the most important dating methods available because wood plays such a major role in historic construction

(even being used in vaulted buildings for the roof structure, the form work and the scaffolding). Dendrochronology makes use of the varied annual growth of trees according to climatically good or bad years, which can be expressed in characteristic signatures. Standard chronologies covering long periods of time are created through the overlapping of different ring series; the longest chronology for oak covers about 10,000 years. Using the largest number possible of comparative chronologies, a statistically reliable standard chronology which also takes regional variations into account can be determined through averaging. A drilled sample taken from a building timber can be used to produce an individual ring series, which can then be superimposed on the standard chronology. If the last annual ring, the waxy edge, is preserved on a building timber, the date that the tree was



felled can be determined, exact to the year. Because historic building timbers were usually used either in the summer immediately after a tree was felled or within a few years if they were first rafted great distances by a lumber merchant, a timber sample provides a date for a particular part of a building. The building archaeologist must verify that the wood was not being used for a second time and that the structural context of the sample and the building element to be dated is in fact undisturbed. If possible, several samples should be taken to ensure certainty. A rule of thumb says that five samples are necessary for every construction phase of a large building, or ten samples for a building erected in a single phase. Besides exact dating information, dendrochronology can provide the building archaeologist with a number of additional clues, including the origin of the wood, its condition, how it was worked, etc.

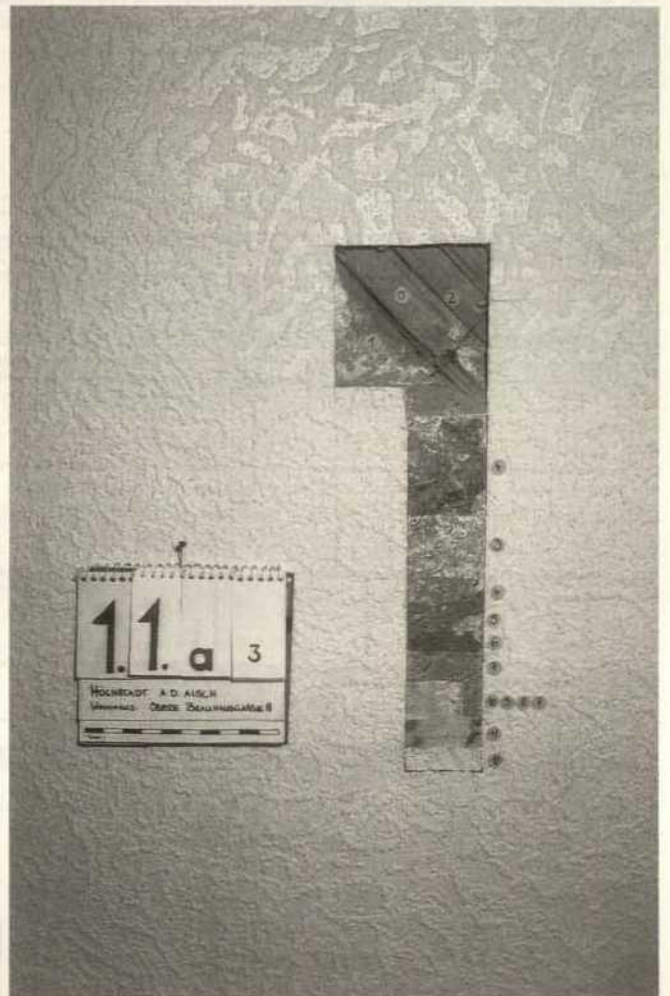
Other scientific methods, including carbon-14 dating methods for organic materials and thermoluminescence dating for ceramics, are still far from achieving the same role as dendrochronology in building archaeology. Developments currently underway with thermoluminescence technology offer hope for more exact dating of ceramic products such as bricks and roof tiles, which if successful would represent a critical advancement.

Analysis of a historic structure must be accompanied by archival research into written sources, historic plans and graphic materials to the extent that such documents exist. The more complex a building is, the more specialists will have to be involved in the professional study of this source material. A cathedral, for instance, could not be studied today without cooperation of the building archaeologist with art historians, historians, liturgy experts and others. Even a farmhouse may pose questions that cannot be answered without a folklorist; a special type of stone may require a geologist; a particular mortar layer may make chemical and physical analyses necessary. In many cases a restorer (whose specialization may be walls, stone, wood, textiles or some other field) is the most important partner because of his involvement with the surfaces which often characterize a building on the outside as well as the inside. Collaboration with the archaeologist has existed since the field began, and medieval archaeology is becoming increasingly important. As building archaeology has expanded to include extensive sites, the historical geographer has become a new partner. The study of particularly significant buildings is now inconceivable without the joint forces of art historians. Technical professionals such as civil engineers (structural specialists, foundation experts, etc.), surveyors and computer technologists are more than ever among the most important partners. A building archaeologist could never cover the diversity of questions raised alone.

All the individual investigative stages are pieces of a large puzzle. Depending on how complete the puzzle pieces are, a more or less accurate description of a building's construction history can be put together. In her famous crime thriller *Death on the Nile* from 1937 Agatha Christie describes the tasks of a detective, which can be applied directly to those of the building archaeologist: "...that's all detective work is, wiping out your false starts and beginning again. ....And it is just what some people will not do. They conceive a certain theory and everything



Fig. 19. Höchststadt an der Aisch (Germany), townhouse of the 17<sup>th</sup> century. Above: Investigative opening by cutting into the suspended ceiling and the wallpaper. Visible sequence of all plaster and paint layers. Below: Sequence of 12 paint and plaster layers. Room number, address and scale. (Surveyors: Stephanie Beutler, Ernst-Otto Weber)



◁ Fig. 18. Survey of the foundation of a Baroque fountain. Oberschwappach (Lower Franconia, Germany). Drawn by Matthias Lohr.

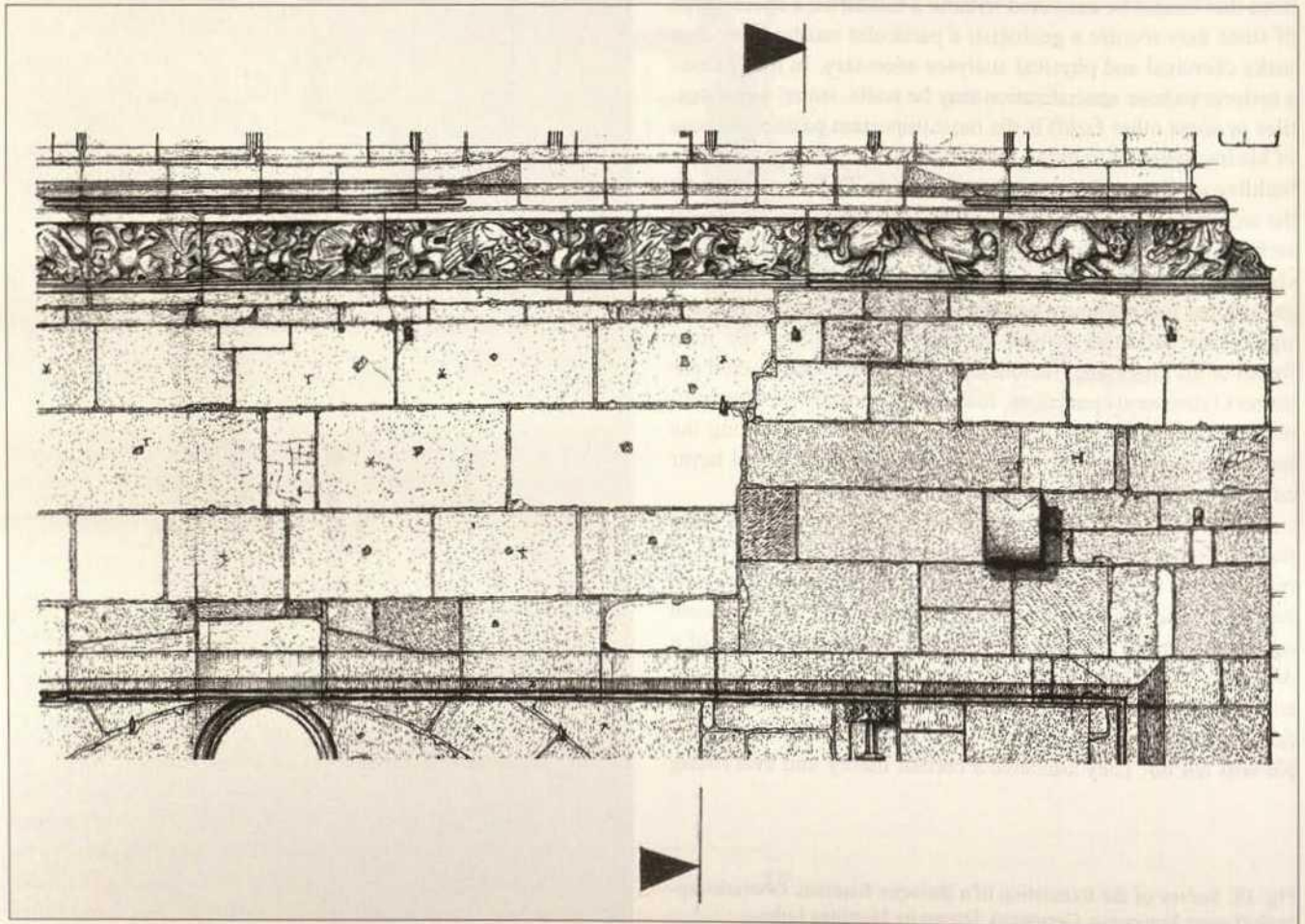
has to fit into that theory. If one little fact will not fit it, they throw it aside. But it is always the facts *that will not fit in* that are significant." It is usually not possible to complete the puzzle in all its details; the gaps that remain must be pointed out just as the clarified issues.

Building archaeology, as a science, is subject to compulsory publication. A perfect historic building survey in the archives is not sufficient for scientific purposes. Too much irretrievable knowledge, stored only in the head of the individual building archaeologist, is in danger of being lost. Even investigations that are not scientifically oriented (for instance as preliminaries to preservation work) should be summarized and archived with an explanatory text.

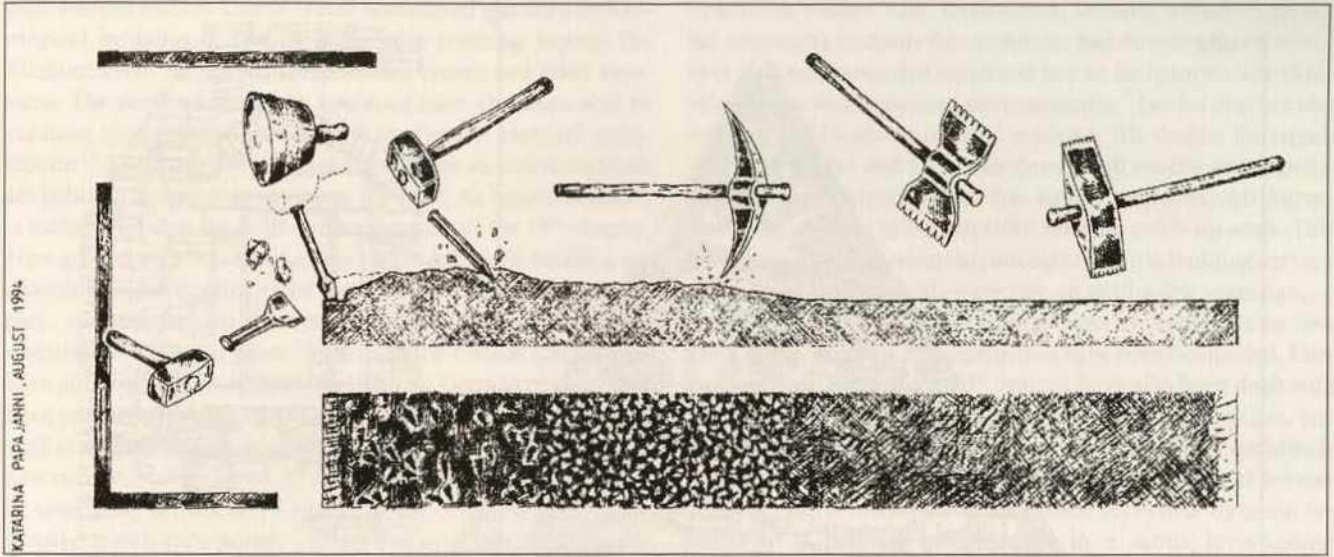
The plans drawn up for a building survey are the essential foundation for publication of a building history project: they contain the authentic scientific record, with photographs providing support. Whereas earlier plans drawn with pencil on heavy paper had to be laboriously redrawn for publication (a process which simultaneously was a source of errors), thanks to modern scanning technology pencil drawings can be copied, adjusted graphically if necessary, composed and supplemented directly on the computer (figure 22). Re-drawings are only necessary for clarifying depictions or for extreme reductions. Within a single publication the same even scales (1:20, 1:25, 1:50, 1:100...) should be used as far as possible; in any case a control scale line

must always be integrated into the drawing. As a rule the results of an analysis can be usefully interpreted through additional graphics such as plans that illustrate the relative (or if possible the absolute) chronology of building phases (figure 23). Color depictions have prevailed for this purpose, with older building phases being represented darker and more recent ones lighter. Additional special plans are devoted to drawings of structurally important details, reconstructions of the original conditions, and analyses of proportions and volumes. Isometric and perspective drawings (figure 24), produced with traditional methods or using the computer, make complicated spatial situations understandable. This graphic framework is accompanied by a scientific text. The building is described as concisely as possible but as exhaustively as necessary to do justice to the wealth of its details. Particular attention must be paid to the argumentation in the analysis of the survey findings, concerning for instance evidence from the various specialized disciplines regarding the individual building phases or reconstruction of original conditions. Here the text must provide interpretation. A carefully selected combination of supporting graphic materials (photos, isometric and detail drawings) can take the place of many complicated descriptions. Because it often takes a great effort to understand explanations of detailed findings or to follow the detective-like investigation of circumstantial evidence, it has proved worthwhile to include summaries at the beginning or the

Fig. 20. Regensburg Cathedral, Junction of two building phases. Ashlar masonry from c. 1380 (right) and c. 1420 (left). The height of the stone courses, the treatment of the surfaces and the ornament on the frieze have all clearly changed. Drawn by Katarina Papajanni.







KATARINA PAPA JANNI . AUGUST 1994

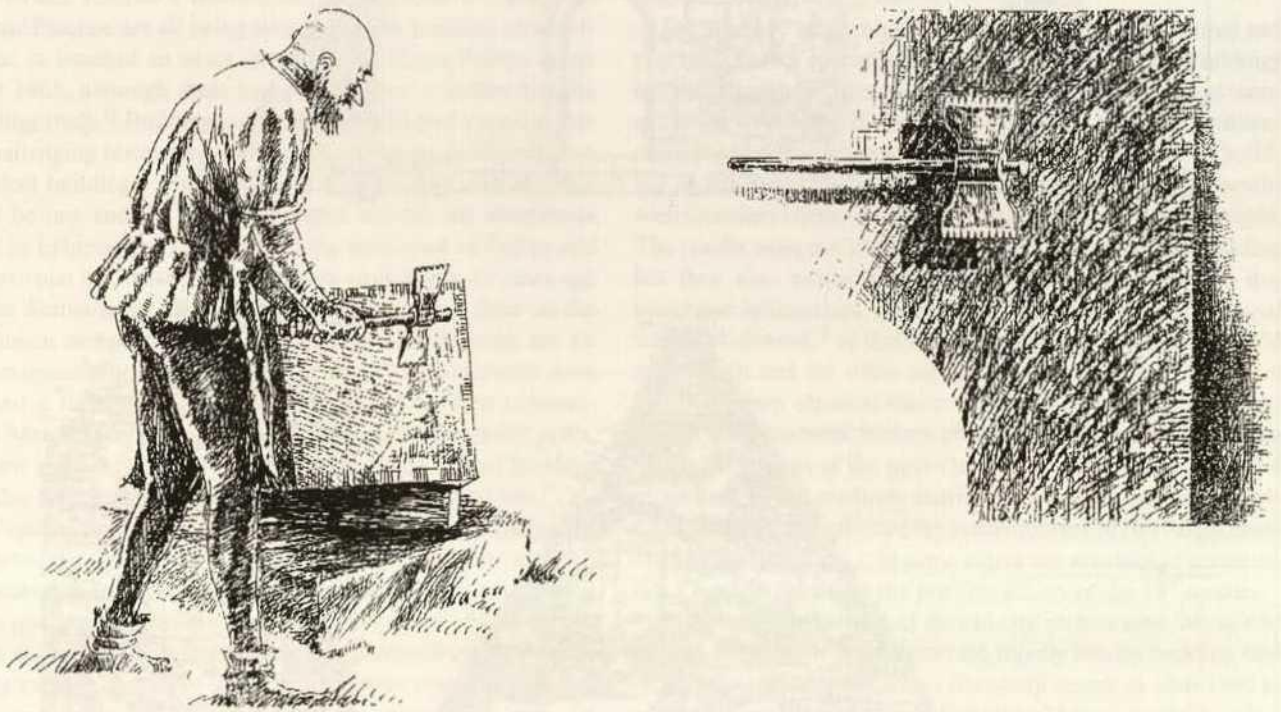


Fig. 21. Stone finishing: here showing medieval treatment with a toothed chisel, an axe-like hewing tool used with both hands. Above: steps for dressing cut stone: recessed margin, rough-hewing of the surface with a chisel and pick, final treatment with toothed chisels of different grades. Drawn by Katarina Papajanni and Apostolos Aravidis.

end of a text for those desiring quick access to a survey's results. Finally, comparisons of a structure's construction history to that of other buildings and analyses of its place in the context of the townscape or landscape represent the link to the work of the architectural historian, the house researcher or other experts who, building on this substantiated material, can explore further issues such as stylistic and historic classification, the role of the client, social processes, etc.

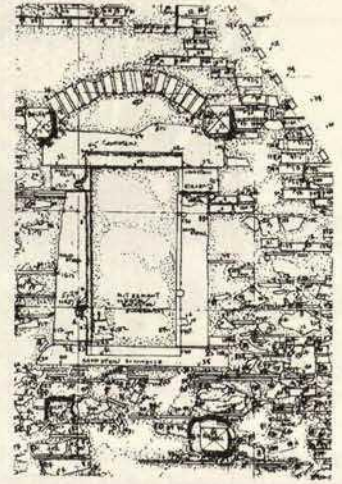
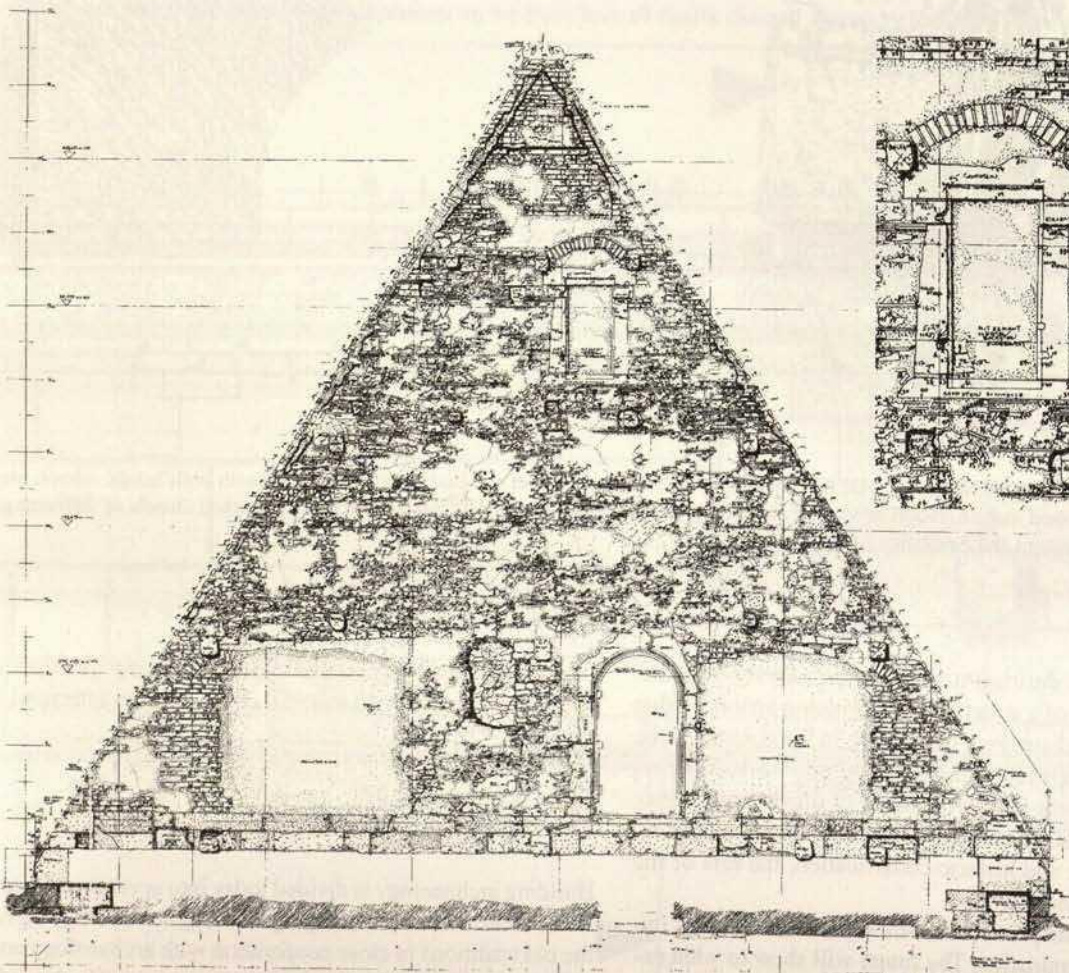
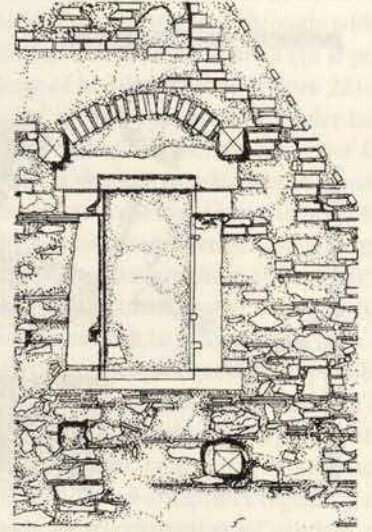
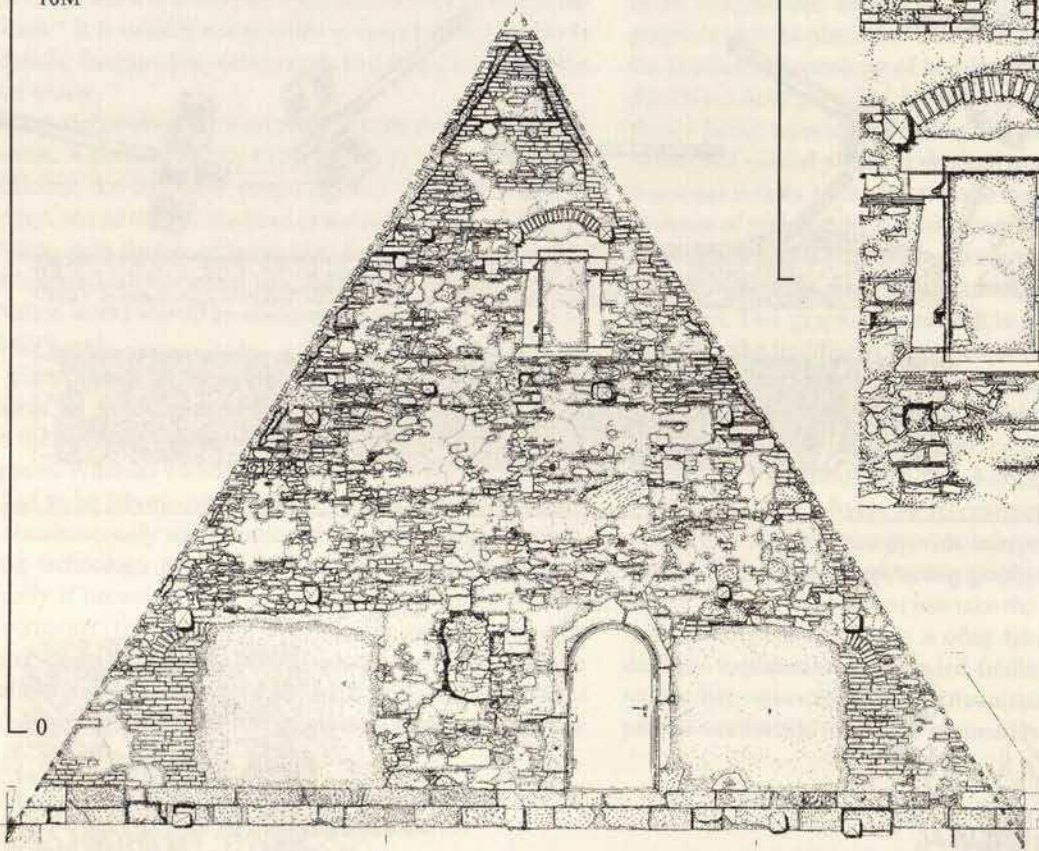
As before the classic print media still represents the most important form of dissemination. The future will show to what extent the internet will come into the equation. Various institutions

have already made it possible to access existing data banks with comprehensive archival material concerning architectural history issues.

#### The Application of Building Archaeology Today

Building archaeology is divided today into several main streams. In the field of classical antiquity building archaeology carries on the old traditions in close cooperation with archaeology and can rely on its very good organizational structure. The large Euro-

10M



pean nations and the United States continue to maintain archaeological institutes in foreign lands, also reaching beyond the Mediterranean region to Mesopotamia, Yemen and other locations. The northern European countries have also been able to continue their research traditions in the field of classical architecture.<sup>11</sup> Even small Switzerland maintains an active institute for building archaeology in Aswan in Egypt. As before, research is mainly aimed at the large excavation sites of the 19<sup>th</sup> century. New ground was broken when the methodology of building archaeology was extended to the study of entire cities and to complex issues reaching beyond individual regions, such as dwellings in classical times.<sup>12</sup> Whereas the French and Italians have put emphasis on architectural history, German research has been particularly dedicated to practical building archaeology as well as to the revision of old methods and the development of new ones. Aerial archaeology and geomagnetic prospection can be used today to track down buried urban complexes without expensive search excavations.<sup>13</sup> Cities and pyramids are being investigated even in Central and South America.<sup>14</sup> Once again studies are being undertaken of organizationally and financially demanding buildings. At the present time in Rome alone the Colosseum, Hadrian's mausoleum, the Basilica of Maxentius and the Palatine are all being investigated by building archaeologists; in Istanbul an exact survey of the Hagia Sophia exists since 1965, although there has not yet been a further historic building study.<sup>15</sup> Building archaeology has played a special role in challenging restoration and reconstruction projects involving classical buildings, where building archaeologist and architect must be one and the same. Examples include the anastylosis work in Ephesus and Pergamon on the west coast of Turkey and in particular the exhaustive restoration work begun 25 years ago on the Acropolis in Athens. In particular the work there on the Parthenon demonstrated that the highest achievements are no longer emanating only from the countries that traditionally have worked in the field. The Greek architect and building archaeologist Manolis Korres, who directed the project for many years, set new standards not only for the study of this unique building but also through his restoration and partial reconstruction.<sup>16</sup>

Of special importance is the tradition of building archaeology as part of the training of young professionals, still practiced at a few universities in Europe and the United States. Such training often goes back to benefit in particular countries that have not had a tradition of building archaeology themselves but do have a very extensive stock of monuments. Native experts in leading positions are playing an increasingly important role.

*Building archaeology in Europe with emphasis on the Middle Ages and modern times:* Despite the methodical preparatory work done in the 19<sup>th</sup> century and the intensive publishing of outstanding projects through the first third of the 20<sup>th</sup> century, this field of research suffered a long period of stagnation. Architects turned away from involvement with building history, leaving the field to other professionals. Art historians wrote about the architectural history of the significant monuments with great success but using other methodological emphases.

Folklorists studied rural architecture, initially without applying the successful methods that architects had developed, and moreover with emphases that architects had so far ignored. The study of castles is well organized internationally,<sup>17</sup> but for obscure reasons the field leads an isolated academic life despite the significance of castles and fortresses through all epochs and regions. General architectural history has largely neglected this important field, so there is considerable need for catch-up work. This is perhaps also the reason that intensive historic building surveys using up-to-date methods were rare up until a few years ago.

In the meantime a considerable number of investigations covering nearly all areas of construction have been completed. Fairly recent buildings of the 20<sup>th</sup> century have also been dealt with successfully, for instance the "Einstein Tower" in Potsdam, one of the most important buildings of Expressionism worldwide (see Plates 51 and 52). Even topics from the chamber of horrors of architectural history have been made accessible by using the methods of building archaeology: in a subtle investigation Johannes Cramer managed to prove that technical "euthanasia" installations used to exist at the German concentration camp of Hadamar, where after 1942 efforts had been made to remove all constructional traces.

The study of large, highly valued buildings, both sacred and profane, poses a special problem. The survey of such buildings involves great expenditures of time (often many years) and money. Since World War II only a few important works of architecture have been investigated in detail using the methods of building archaeology. The survey of the cathedral in Speyer (southwest Germany) from the 1960s<sup>18</sup> can serve as a solitary example. The results were not only important for that particular building but they also extended considerably our knowledge of Romanesque architecture in general. Only a few large projects of this sort followed,<sup>19</sup> so that there is a wide gap between this field of research and the often superb work that has been done on buildings from classical times. Our knowledge of the building, design and structural history of particularly important, epoch-making buildings of the post-classical period has not advanced in relation to the methods available for enhancing this knowledge. This has also affected the contemporary preservation treatment of such buildings; to some extent the standard of preservation clearly lags behind the positive efforts of the 19<sup>th</sup> century.

The international crisis of the old city centers after World War II, with extensive loss of important, mostly secular building fabric, led to initiatives in various European countries after 1980 to at least document endangered buildings. Various professionals – archaeologists, art historians, historians – were involved in an exemplary manner.<sup>20</sup> Architects were in the minority. At first the classical methods of building archaeology were only partially integrated in the work, so that this branch of research, which was concerned especially with secular buildings, can rather be classified as "house research".<sup>21</sup> Together with farmhouse studies, research into townhouses became a strong, internationally organized field with its own publication series. Meanwhile house research and building archaeology are growing together, with the methods of the latter also being applied to the former.

Switzerland has a long tradition in the study of sacred and secular architecture, with the main impulses coming from archaeology. Sensibly, archaeology and historic building studies in Switzerland are not separated,<sup>22</sup> and there is close cooperation with preservation practice. Independent institutes carry out the research work. New impulses also came from Swiss castle research, which combined historic and archaeological methods.<sup>23</sup>

◁ Fig. 22. Regensburg Cathedral (Germany). Below: original plan, pencil on heavy paper, scale 1:25 (drawn by Philip S.C. Caston), scanned with all measurement axes, dimensions, etc. Above: reworked on the computer for extreme reduction, deletion of the measurement axes, dimensions, etc.

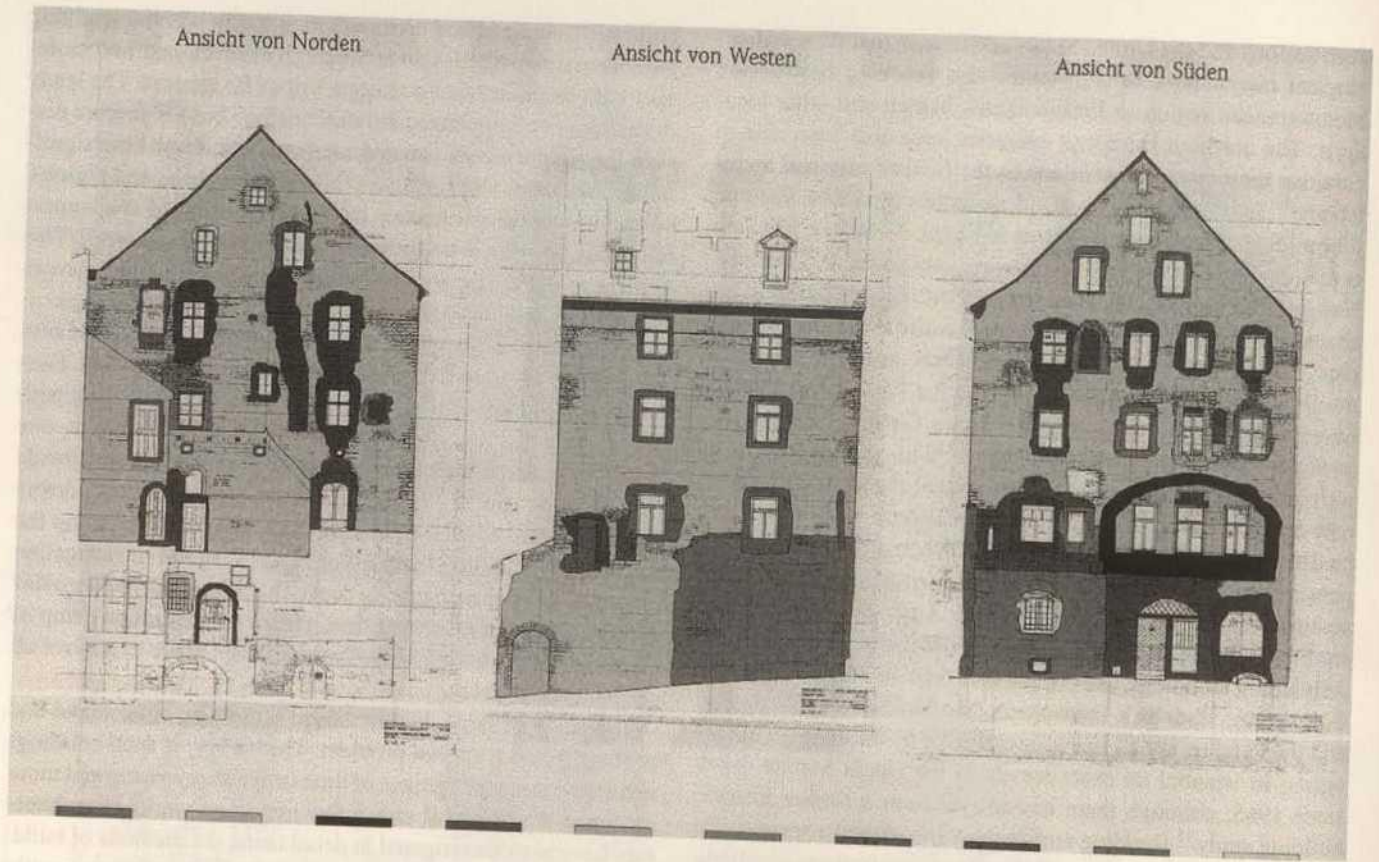
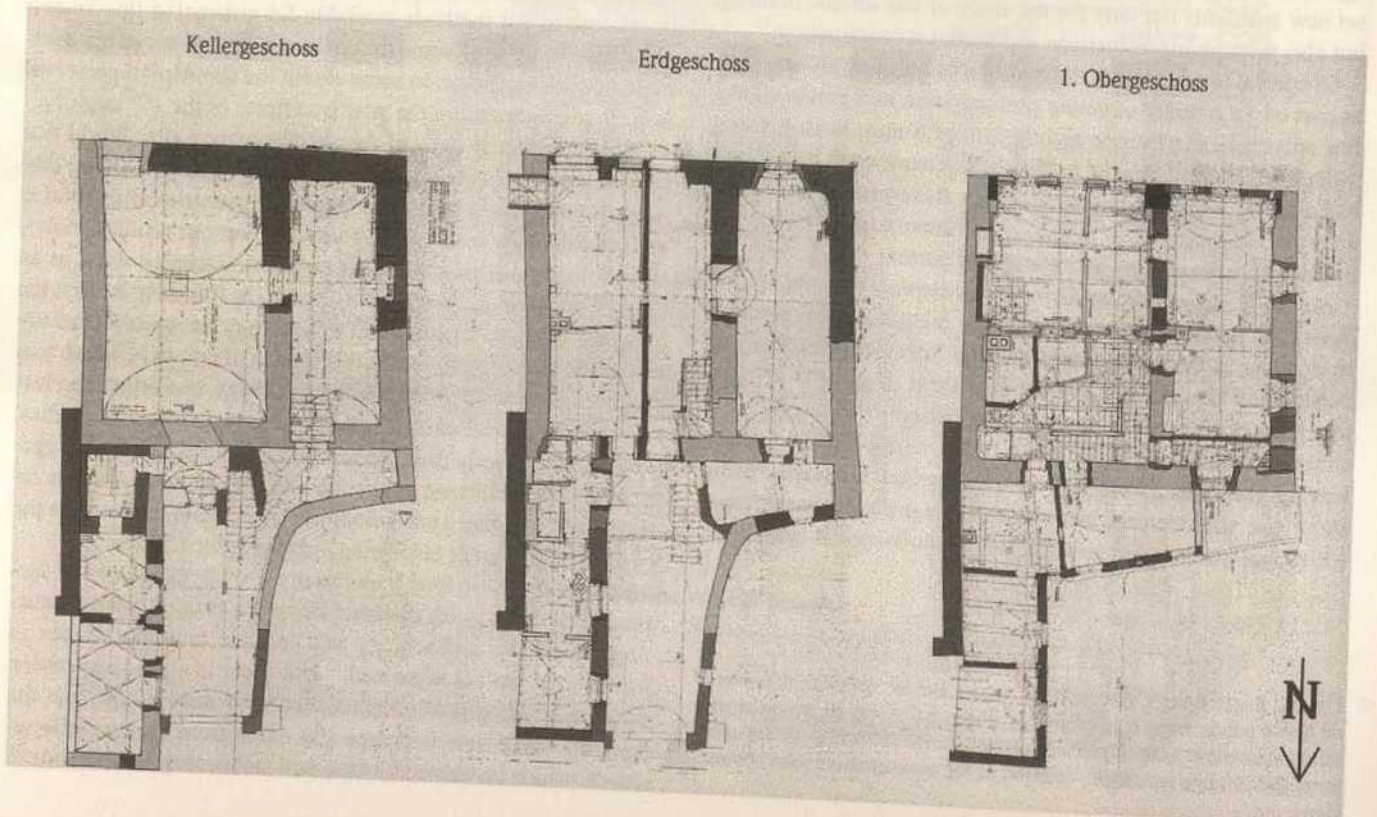


Fig. 23. Regensburg, medieval house "Zum rothen Herz", plan showing the building phases (from: Peter Morsbach, Stefan Ebeling, Günther Naumann: *Zum rothen Herz. Geschichte und Schicksal eines Regensburger Hauses*, Regensburg 2000). See original reproduction in color on front cover.



In recent years there have been active efforts in various countries to reconcile the methods used for investigating post-classical buildings. Various currents, covering the entire spectrum of research from large sacred buildings to castles, townhouses and rural structures, have come together, but so far they are not coordinated at a national or international level in terms of organization and methods.<sup>24</sup>

Training institutes which teach the specific methods of building archaeology are rare internationally. Academic training, where it exists at all, is integrated into architectural education at the technically oriented universities or in graduate programs dedicated to conservation.<sup>25</sup> Only a few conservation offices offer additional training.

Preservation has become one of the most important fields of activity for building archaeology. This has a long tradition, reaching back to the 16<sup>th</sup> century. Particularly in the 19<sup>th</sup> century the combination of practical preservation and building archaeology was cultivated. Building archaeology was recognized as an important basic informant for practical preservation work. The principle that only precise knowledge of an object leads to its sympathetic treatment is still valid today. The indispensable groundwork for any measures to be carried out on a building includes production of accurate scaled drawings for all planning work, exposition of the construction history and an understanding that penetrates to even the smallest structural detail. Projects that took up and advanced the old, proven traditions developed only slowly after World War II. A representative example is the University of Thorn in Poland, where a special approach for historic buildings was introduced into theory and practice at an early point through an interdisciplinary collaboration of preservationists, art historians, restorers and historically trained architects. The classic methods of building archaeology have been advanced and systemized for the purposes of practical preservation work by Gert Th. Mader of the Bavarian State Conservation Office. During the final two decades of the 20<sup>th</sup> century he undertook extensive practical tests, gathered and analyzed these experiences, and welded them together into an internationally recognized standard.<sup>26</sup> The introduction of exact measured drawings that depict all deformations, distortions and deviations for purposes of practical preservation work is a critical step because reliable plan material is thus produced. The analysis of the construction history which builds on these plans distinguishes important, untouchable zones, in which interventions would be irresponsible, from non-problematic areas. This approach is valid not only for buildings of great significance but also for the great number of "normal" historic buildings which are particularly endangered today. Already in the planning stage the architect can orient himself using the information from the preceding building archaeology work. Areas that are important in terms of construction and interior decoration can be integrated in the planning at an early stage. Concealed static elements are identified, as are zones that have been damaged by later additions, in which for example a staircase could be added without functional or structural problems. Without such plan material and basic information, outrageously mistaken decisions which ruin a building and bring about high costs were – and are – preprogrammed in the planning process. For further detail planning the architect or special engineer has the ideal foundation for his working plans because the existing condition of a building with all its structural strengths and weaknesses, deformations and historically sensitive areas is recorded exactly. The architect can contrive to place necessary chimneys and ventilation systems in

an existing system of historic beams and vaults so that openings are minimized and the actual structural system remains untouched. The structural engineer will recognize problem zones on the basis of the deformations; after analyzing them (optimally together with the building archaeologist) he will be able to recognize their causes and direct the appropriate security measures (figure 25). For restorers, carpenters, plasterers, painters and others involved in the building trades plans showing damages can be entered directly on the existing survey materials, and work plans can be developed stone for stone and timber for timber; this makes possible an early, targeted bidding process for the necessary conservation and rehabilitation work.<sup>27</sup> As a result, interventions can be kept to the absolutely necessary minimum, costs can be calculated accurately and kept down. The cost aspect is particularly important because calculations for work on historic buildings are generally considered problematic and inexact. With careful steering, the expenditures for the preliminary investigations, which can range from two to five percent of the total building cost, can very quickly be recovered in the execution of the work.

Preliminary investigations are also of special importance for unspectacular buildings. Great numbers of such buildings are underrated; in many cases their hidden features and concealed qualities in terms of construction history are not recognized. When the demolition ball first exposes a building's true value, it is already too late.

The building archaeologist should also remain involved during the course of practical preservation work. He is an important partner in the consultations among the owner, architect, conservationist, restorer and the specialists because he knows the building the best. Moreover it can be expected that additional information about a building's construction history will be revealed as the work is carried out, and that knowledge should also be documented.

Because more than 50 % of construction work in Europe is now concentrated on old buildings the preliminary investigation plays a very important role for a building that is to be rehabilitated. Building archaeology offers the appropriate and proven methods, but unfortunately their possibilities are not adequately known everywhere. Moreover there are not enough trained experts today. In particular positions are lacking at state institutions which could provide guidance and quality control for such work.<sup>28</sup>

An unloved special task in the preservation field is the documentation of a building before its demolition, often under extreme deadlines. Whether or not the essential characteristics of the "death candidate" can be recorded in drawings, photos and descriptive texts and important decorative details can perhaps be salvaged will depend on the experience of the building archaeologist.

Special problems arise in the field of anastylosis and reconstruction. The prospect of putting an interesting temple back together again from the rubble of a ruin or even making a medieval castle "legible" once more by rebuilding on a few foundation fragments is often too tempting. Preliminary work by a building archaeologist is especially important here because he is the specialist who studies the remnants to reach reliable conclusions about a site's appearance at earlier times. But he is also the attorney for the original, for the old structural system, the historic surface treatments, the old plasters and mortars, the traces of age and damage which have been produced by history and time. Conflicts are thus preprogrammed. At least in theory, if hardly in

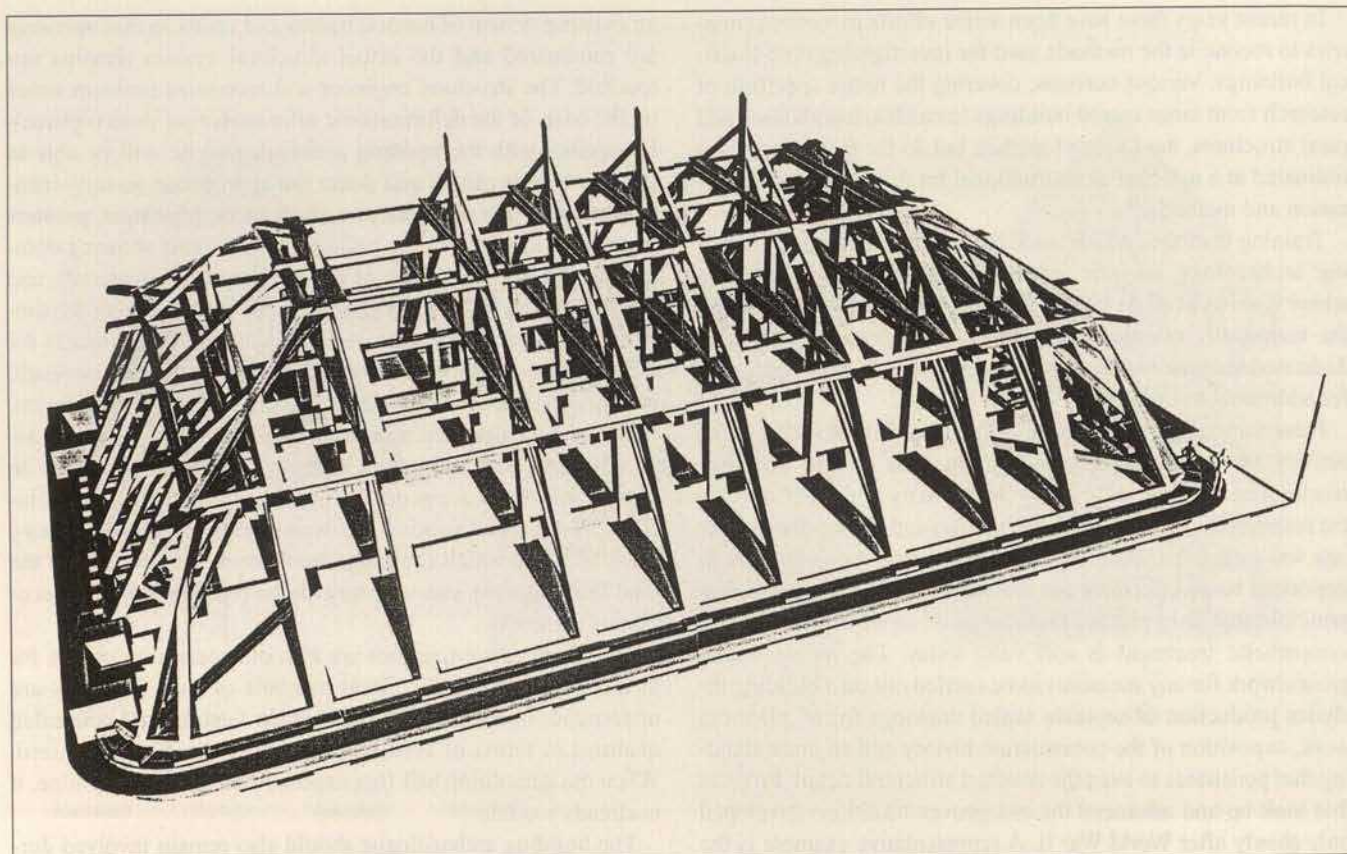
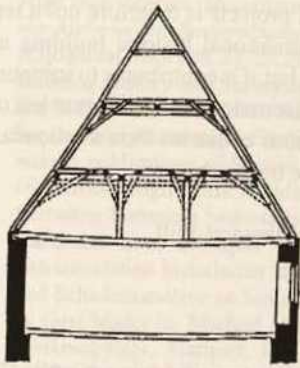


Fig. 24. Computer generated perspective of the Baroque roof structure of Weissenstein Palace, Pommersfelden (Upper Franconia, Germany). Drawn by Arnold Kreisel.

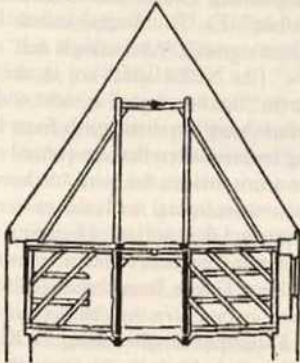
practice, dry ashlar buildings from classical antiquity could be put back together from their individual pieces like a collapsed Lego structure, assuming that a high percentage of the original building components are preserved in usable condition. Anastylis refers to partial or complete reconstruction of a building on the original foundation at the original site. The round Greek temple of Tholos in Delphi is an example of such a partially re-erected building. For most medieval and modern buildings, regardless of the region, a similar undertaking is usually already ruled out for constructional reasons and can only be justified in rare exceptions such as the world-famous Church of Our Lady in Dresden. The curious term “archaeological rubble clearance” was coined for this project, in which more than 8000 salvaged building elements were recorded by surveyors. When tourism issues influence political decisions, the pressure can be so high that restoration work is carried out which cannot be justified scientifically,<sup>29</sup> as shown by the large number of unsuccessful examples throughout the world, from concrete pyramids in the Central American jungle to concrete temples on the coast of Asia Minor or in the Egyptian desert.

Building archaeology has proved its success as a method for investigating historic architecture. Examples of various kinds from different epochs and regions document its value (see the following plates). A major advantage is that the methods of building archaeology are transferable, also to areas and countries where they have not yet become established. The laws of structural engineering and thus of building are valid worldwide.

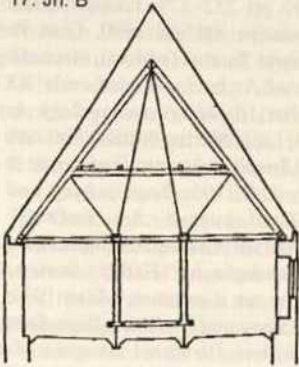
Fig. 25. Rimpar, Palace (Upper Franconia, Germany). Left: Construction phases showing the relevant main structure. A) 16<sup>th</sup> century; roof construction typical for the period. B) 17<sup>th</sup> century; construction of a hanging truss in the roof that holds up the ceiling of a banquet hall below (in combination with a half-timber wall with diagonal members). Obvious deformations show that over the course of time the historic constructions became overloaded. C) 20<sup>th</sup> century modern hanging truss by the structural engineering office of Reuter and Adelman in cooperation with the historic building archaeologist Gert Mader; adaptation of the construction idea from the historic solution used in the 17<sup>th</sup> century. The historic construction remains unchanged, leaving evidence of the construction methods, including the mistakes, of earlier times. Above right: Cross section through the roof and ceiling construction, including all deviations and deformations (Albert Hölzl) for planning and inserting the new hanging truss “C” (dotted). 5) Posts from roof structure “B” with suspension rods. 7) Diagonal members of the half-timber wall of roof structure “B”. Below right: Isometric depiction of the new roof structure. (From: Micheal Petzet/Gert Mader, *Praktische Denkmalpflege*, Stuttgart, Berlin, Cologne, 1993).



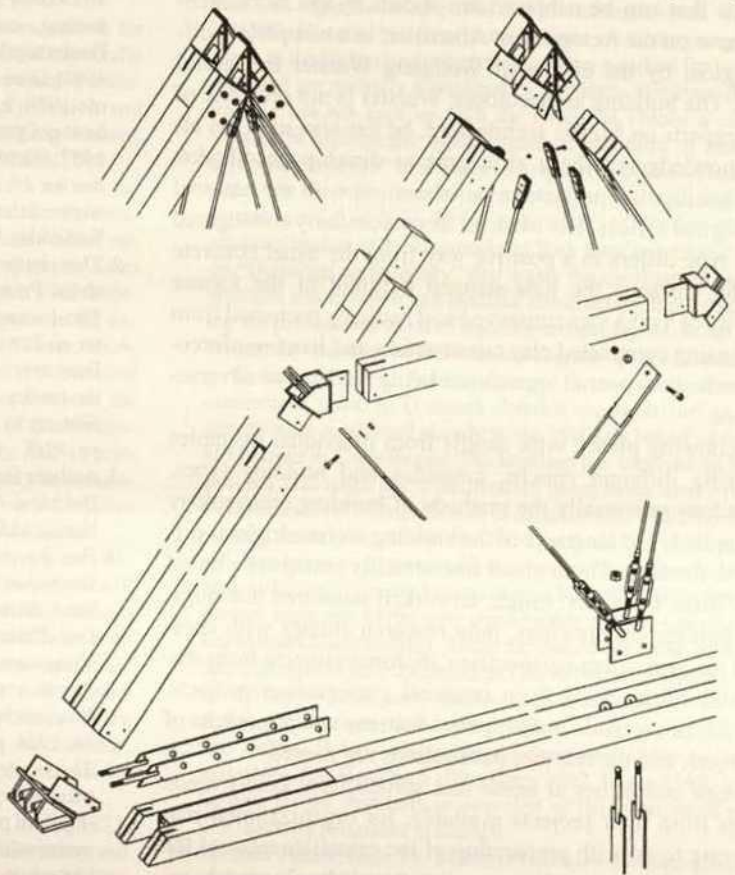
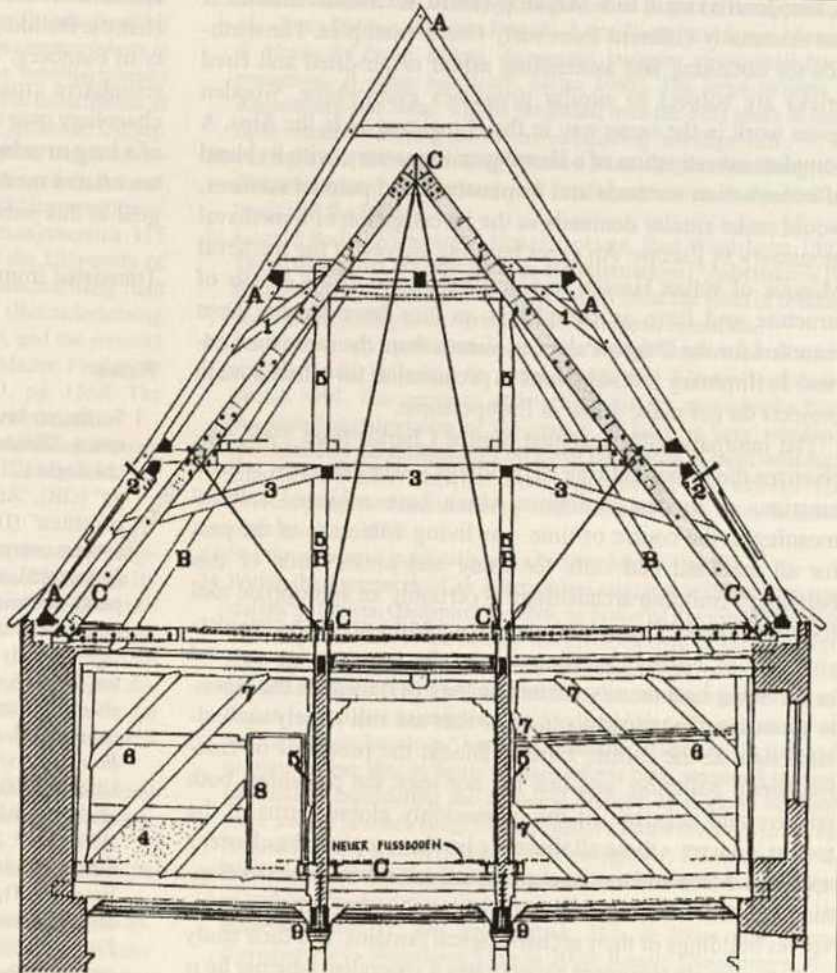
16. Jh. A



17. Jh. B



20. Jh. C



A cantilevered vault in a Mayan pyramid in Central America is not essentially different from early Greek examples. The methods for obtaining and assembling ashlar or air-dried and fired bricks are subject to similar principles everywhere. Wooden spans work in the same way in the Himalayas as in the Alps. A complete investigation of a Himalayan monastery, with its blend of construction methods and its plastered and painted surfaces, would make similar demands as the investigation of a medieval monastery in Europe. An exact building survey of the medieval Mosque of sultan Hassan in Cairo would record its details of structure and form as completely as they have already been recorded for the Doge's Palace in Venice from the same time period. Preliminary investigations in preparation for rehabilitation projects do not make sense in Europe alone.

The internationally accepted Venice Charter from 1964 emphasizes the important role of buildings – whether great artistic creations or modest structures which have achieved cultural meaning in the course of time – as living witnesses of the past for all mankind and calls for study and preservation of this heritage.<sup>30</sup> Building archaeology is certainly an appropriate tool for this purpose. The most recent crises and wars with considerable loss of historic building fabric, the pressure for renewal in surviving historic city centers be they in Italy or in the Islamic countries, the upheavals in areas that are still largely agricultural such as the former Eastern Block, the problems of environmental pollution, and last but not least the pressures, both positive and negative, of the increasingly global forms of the tourist industry – these all illustrate just how topical the charter's appeal is. More and more countries are considering the development of their cultural past, which with only a few exceptions involves buildings or their archaeological remains. But their study and appropriate treatment necessitates a specialist, whether he is to deal with an intact building or a collapsed ruin. The convincing results that can be achieved are shown by the work mentioned above on the Acropolis in Athens or, in a completely different region, by the efforts of Wolfgang Wurster in Central America. The building archaeologist Wurster is not only one of the best experts on Mayan architecture, he has also used his intimate knowledge of these structures to develop unorthodox model rehabilitation projects in collaboration with the national archaeological offices. His work on this particularly endangered building type differs in a positive way from the usual concrete orgies: for instance the nine-stepped pyramid of the former Mayan city of Yaxhá was conserved and lastingly protected from collapse using compacted clay construction and liana reinforcements, without its overall appearance being falsified or adversely affected.<sup>31</sup>

The following plates, with details from individual examples representing different epochs, countries and building types, spotlight how universally the methods of building archaeology can be applied. The language of the building archaeologist is primarily the drawing. These plates intentionally juxtapose a broad range of these materials: rough, unworked measured drawings, revised publication drawings, pure research studies with complicated reconstruction perspectives, diploma projects from students, and work sheets from practical preservation projects. Brief reference is made to the special features and the results of each project, and the relevant publications are named.

Although colleagues at home and abroad have kindly made drawings from their projects available, for organizational reasons having to do with preparation of the materials most of the plates shown here come from my own "workshop", namely re-

search and teaching projects at the Institute for Archaeology, Historic Building Archaeology and Preservation at the University of Bamberg. This selection of projects is therefore not a representative cross section of international historic building archaeology over the last decades, but if it contributes to initiation of a long overdue international discussion of the different but often related methods used in various countries then a secondary goal of this publication will have been achieved.

Translated from the German by Margaret Will

## Notes

- 1 So far no broad-reaching term has prevailed internationally. The terms "Bauarchäologie", "Bauforschung" and "Monumentenarchäologie (CH)", "Archéologie du bâti" (F), "Building(s) archaeology" (GB), "Archeologia dell' edilizia storica", "Archeologia dell' architettura" (I) and "Bouwhistorie" (the Netherlands) are in use in various countries. The German term "Bauforschung" is most widely accepted, or "historische Bauforschung" to distinguish from the purely technical, materials testing investigations that are carried out on modern buildings. Most of the terms include the word "archaeology", already making it clear that archaeological methods are a central focus. A comprehensive history and description of building archaeology has not yet been written, and the scattered literature is not coordinated. A short selection follows: G. van Tussenbroek (editor), *Bouwhistorie in Nederland. Kennis en bescherming van bebouwen*, Utrecht 2000; Gottfried Gruben, *Klassische Bauforschung*, in: *Klassische Archäologie. Eine Einführung* (edited by A. Barbein, T. Hölscher, P. Zanker), Berlin 2000, pp. 252–279; Jukka Jokilehto, *A history of Architectural Conservation*. Oxford 1999; Gian Pietro Brogiolo, Tiziano Mannoni, Robert Parenti (editors), *Archeologia dell' architettura*. Supplemento ad *Archeologia Medievale XXIII*, Florence 1997; Jason Wood (editor), *Buildings Archaeology, Applications in Practice*, Oxford 1994; Luigi Marino (editor) *Restauro architettonico*. Florence 1996; G. Ulrich Großmann, *Einführung in die historische Bauforschung*, Darmstadt 1993; *Bauforschung und ihr Beitrag zum Entwurf*, Veröffentlichungen des Instituts für Denkmalpflege an der ETH Zürich, vol. 12 (various authors), Zurich 1993; Gian Pietro Brogiolo, *Archeologia dell' Edilizia Storica*, Como 1988; Luigi Marino, *Il rilievo per il restauro*, Milan 1990; Johannes Cramer (editor), *Bauforschung und Denkmalpflege*, Stuttgart 1987; Hartwig Schmidt, *Bauforschung. Die Entwicklung der Methoden im 19. Jahrhundert*, in: *Erhalten historisch bedeutsamer Bauwerke. Jahrbuch des Sonderforschungsbereiches 315*, University of Karlsruhe, Berlin 1986, pp. 22–69.
- 2 This innovation is clearly described in the so-called "Letter about Preservation" from the second decade of the 16<sup>th</sup> century. The document is known under other interpretations as Raphael's letter, as Peruzzi's letter, as a letter to Pope Leo X and as a letter from Bramante to Julius II. It is certain that the receiver was a pope and the sender a trained architect. For details see: Georg Germann, *Einführung in die Geschichte der Architekturtheorie*, Darmstadt 1980, pp. 92ff.
- 3 Anibale Forcellini, *Sui restauri delle principali facciate del Palazzo Ducale di Venezia*, in: *L'ingegneria a Venezia nell'ultimo ventennio*, Venice 1887, pp. 14ff.
- 4 *Das Bauernhaus in der Schweiz*, Zurich 1903; *Das Bauernhaus im Deutschen Reich und seinen Grenzgebieten*, published by the Verband deutscher Architekten und Ingenieurvereine, Dresden 1906; *Das Bauernhaus in Österreich-Ungarn und seinen Grenzgebieten*, Vienna and Dresden 1906.
- 5 Armin von Gerkan, *Die gegenwärtige Lage der archäologischen Bauforschung in Deutschland*, in: *Zentralblatt der Bauverwaltung* 44, 1924, pp. 375–377.
- 6 The society publishes regular reports on the conferences which take place every two years in various countries (with contributions ranging from prehistoric and ancient times to modern times) and collaborates with the journal "architectura – Journal of the History of Architecture."



- 7 For up-to-date standards relating to building surveys see: Ulrich Weferling, Katja Heine and Ulrike Wulf (editors), *Von Handaufmaß bis High Tech: Messen, Modellieren, Darstellen; Aufnahmeverfahren in der historischen Bauforschung*. Records from an interdisciplinary colloquium from Feb. 23-26, 2000, organized by the departments of Building History and Surveying of Brandenburg Technical University at Cottbus, Mainz 2001. Basic works, although no longer covering the most recent state of technical developments, include *Baufaufnahme*, publications of Special Research Area 315 "Preservation of Historically Significant Buildings" (Sonderforschungsbereich 315 "Erhalten historisch bedeutsamer Bauwerke") of the University of Karlsruhe from colloquia in 1986 (Bestandsuntersuchung und Dokumentation historischer Bauwerke) and 1987 (Befunderhebung und Schadensanalyse an historischen Bauwerken), and the remarks by Gert Mader in: Michael Michael Petzet/Gert Mader, *Praktische Denkmalpflege*, Stuttgart, Berlin, Cologne, 1993, pp. 156ff. The handbooks available on the international market are outdated.
- 8 Günter Eckstein et al., *Empfehlungen für Baudokumentationen. Bauaufnahme – Bauuntersuchung*. Arbeitsheft 7, Landesdenkmalamt Baden-Württemberg, Stuttgart 1999, pp. 11ff.
- 9 *Ibid.*, p. 28, fig. 17.
- 10 So far investigations by civil engineers trained in structural engineering and strength theory have been relatively rare. Exceptions include projects by the Institut für Tragkonstruktionen at the University of Karlsruhe under the direction of Fritz Wenzel. Rainer Barthel, *Tragverhalten gemauert Kreuzgewölbe*, Aus Forschung und Lehre, no. 26, Karlsruhe 1993; Markus Hauer, *Untersuchungen der räumlichen Windlastabtragung durch gemauerte Kreuzgewölbe im Langhaus von Basiliken*, Aus Forschung und Lehre, no. 34, Karlsruhe 1997.
- 11 For instance the exemplary work by Erik Hansen. See: Georges Daux and Erik Hansen, *Le trésor de Siphnos, Fouilles de Delphes*, Paris 1987.
- 12 Wolfram Hoepfner, Ernst Ludwig Schwandner, *Haus und Stadt im klassischen Griechenland*, Munich 1994.
- 13 Helmut Becker et al., *Archäologische Prospektion. Luftbildarchäologie und Geophysik*, Arbeitsheft 59, Bayerisches Landesamt für Denkmalpflege, Munich 1996. Jörg W.E. Fassbinder, Walter E. Irlinger (editors), *Archaeological Prospection*, Arbeitsheft 108, Bayerisches Landesamt für Denkmalpflege, Munich 1999.
- 14 The German Archaeological Institute maintains a commission for general and comparative archaeology which is dedicated especially to ancient Central American cultures. In the meantime native architects trained in Europe are taking over direction of research and maintenance of the monuments. Oscar Quintana, Wolfgang Wurster, *Ciudades Mayas del noreste del Petén, Guatemala*, Mainz 2000.
- 15 Collaboration in Rome between the Italian antiquities office, the German Archaeological Institute and Italian and German universities. Exact survey of the Hagia Sophia by the American Robert van Nice; his life work was published as a collection of plans: *Saint Sophia in Istanbul. An Architectural Survey*, Washington 1965/1986.
- 16 A concise summary of the research results so far appears in the exhibition catalogue: *The Parthenon. Architecture and Conservation*, edited by M. Korres, G.A. Panetsos, T. Seki, Athens 1996. Detailed reports have been published since the beginning of the 1990s by the Ministry of Culture's committee for the preservation of the Acropolis monuments. Greek building archaeology already had an outstanding representative in the middle of the 20<sup>th</sup> century in Anastasiou K. Orlandos, author of excellent publications on early Christian basilicas and of the best monograph on the classical Parthenon.
- 17 International colloquia have been discussing castles throughout Europe and bordering regions for several decades now. The results will be published in an international journal, "Château Gaillard. Etudes de castellologie médiévale". The "Wartburg Gesellschaft", also with an international orientation, was founded about ten years ago; it uses building archaeology methods to study castles and palaces throughout Europe, but particularly in the eastern countries. There are also national associations, some with a very large membership, which have been in existence for a long time, such as the "Deutsche Burgenvereinigung", founded in 1899.
- 18 Hans Erich Kubach, Walter Haas, *Der Dom zu Speyer*, Mainz 1972.
- 19 Current projects include the Regensburg Cathedral in Germany and the cathedrals in Florence and Siena in Italy. The work on the Florence Cathedral has already been published in part (Giuseppe Rocchi, Anna Bebbler, Roberto Franchi, Luca Giorgi and Luigi Marino, *S. Maria del Fiore. Rilievi, documenti, indagini strumentali Interpretazione. Il corpo basilicale*, Milan 1988). The large projects in Regensburg and Siena will be published over the next years in multiple volumes covering the extensive building investigations.
- 20 For instance the outstanding "Freies Büro für Bauforschung und Dokumentation" in Marburg and similar initiatives in the Netherlands and the Baltics.
- 21 Konrad Bedal, *Historische Hausforschung*, Bad Windsheim 1993. These specialists are organized in the international "Arbeitskreis für Hausforschung", set up by representatives from the field of folklore and now including members from 15 European countries.
- 22 See the extensive publications by Hans Rudolf Sennhauser (Zurich) and his circle, including for instance: *Müstair, Kloster St. Johann*, Zurich 1996. The series of architectural history monographs from the Erziehungsdirektion of the canton of Bern is very extensive (published by the archaeology office of the canton of Bern with such authors as Daniel Gutschler, Peter Eggenberger and others). The "Vereinigung für Bauforschung" was established as a professional association in 1989.
- 23 See the extensive publications by Werner Meyer (Basel).
- 24 Within the framework of an international congress with eminent specialists in Leuven (Belgium) in 1996, in honor of Raymond Lemaire, there was an effort to harmonize the methods used in various countries. Unfortunately the conference proceedings have still not been published. Since 1998 free-lance building archaeologists who are not tied to institutions have been trying to establish a "European Forum for Building Archaeology" with headquarters in Salzburg. In Italy and to some extent also in Spain serious efforts have remained modest, particularly considering the immense amount of work to be done there; see for instance Luigi Marino (editor), *Materiali da costruzione et tecniche edili antiche. Restauro Archeologico 1*, Florence 1991. In France and in the Netherlands there is active discussion of the subject of building investigations, led above all by trained historians and art historians. See: G. van Tussenbroek, D.J. de Vries and others, *Bouwhistorie in Nederland*, Utrecht 2000; Ronald Glaudemans, *Verborgten Vakwerk. 59 bouwhistorische verkenningen in de binnenstad van Maaseik*, Maaseik 2001. The "Stichting Bouwhistorie Nederland", an organization of public and private researchers, was founded in 1992. Historic building investigations are undergoing a Renaissance in the Netherlands since they are now required for building permits and are partially subsidized by the state. However, the level of training has not kept up with the boom. In France a congress on "Textes et archéologie monumentale. Possibilités et limites d'une approche conjointe" took place in Avignon in 2000 and one on "L'architecture du bâti: Pour un harmonisation des méthodes" in Saint Romain en Gal in 2001. In Great Britain in addition to several post-graduate studies at the University of York there is a master's program on "Buildings archaeology" that treats the overlapping problems of practical conservation and building construction, but without achieving the polished methods of building archaeologists on the continent. Within the "Institute of Field Archaeologists" (IFA), founded in 1982, a "Buildings Special Interest Group" is intensively involved with comparable tasks. In Denmark detailed investigations into building history were conducted already in the 1920s on behalf of the National Museum in Copenhagen. The tradition has survived up to the present day and takes into consideration anonymous rural structures as well as medieval cathedrals and, in collaboration with other Baltic Sea nations, entire urban complexes. Emphases are laid by the universities at Copenhagen and Aarhus with their architecture schools. In Hungary archaeologically oriented research into building history has been underway since the 1970s with considerable success (see the volumes *Lapidarium Hungaricum*). Since the end of the Cold War, however, future prospects have darkened, as also in Poland, where the University of Thorn was an early trailblazer in the combination of building archaeology and practical conservation.
- 25 See Achim Hubel (editor), *Ausbildung und Lehre in der Denkmalpflege. Ein Handbuch*. Petersberg 2002. Pages 154ff. in particular give for the first time an overview of the locations of conservation teaching programs in Europe.
- 26 Michael Petzet, Gert Th. Mader, *Praktische Denkmalpflege*, Stuttgart, Berlin, Cologne 1993, pp. 127ff. At the same time a heavily

subsidized special research field for the preservation of historically significant buildings at the University of Karlsruhe, under the direction of the renowned structural engineer Fritz Wenzel with the support of the building archaeologist Wulf Schirmer, gathered and further developed information from various engineering sciences concerning materials, their properties and possibilities for their improvement, and the load-bearing actions and protective technologies of structures. (Publications: Sonderforschungsbereich 315 "Erhalten historisch bedeutsamer Bauwerke", Arbeitshefte, Jahrbücher, Praxisempfehlungen, University of Karlsruhe, 1986 onward). There are also new efforts in Italy to systematically classify the practical preservation work carried out on buildings. A seven-volume work in which various Italian authors deal with the entire spectrum of historic building preservation has recently been published by Giovanni Carbonara: *Trattato di restauro architettonico*, 1-7, Turin 2000. The historic building survey and building investigations are discussed in several of the contributions, which vary in quality, but without ever reaching Mader's standard (see above).

- 27 If necessary a so-called Room Book can also be prepared, with a room-by-room description of the visible features of the walls, floors, ceilings and interior decoration. Wolf Schmidt, *Das Raumbuch als Instrument denkmalpflegerischer Bestandsaufnahme und Sanierungsplanung*, Arbeitsheft 44, Bayerisches Landesamt für Denkmalpflege, Munich 1989, second edition 1993.
- 28 In Germany, for instance, a number of private "building archaeology" offices have set up business in response to market demands. In the absence of a system for quality control, the inexperienced and untrained can also offer their services; accordingly the spectrum of quality ranges from excellent to unacceptable.
- 29 Gottfried Gruben, *Tempel und Touristen. Über Anastylose und Rekonstruktion*, in: *Kunstchronik* 12, 1997. pp. 657-665.
- 30 International Charter for the Conservation and Restoration of Monuments and Sites, Venice 1964.
- 31 Wolfgang Wurster, *Bericht über die Tätigkeit der Kommission für Allgemeine und Vergleichende Archäologie des Deutschen Archäologischen Instituts im Jahr 1999*, in: *Beiträge zur Allgemeinen und Vergleichenden Archäologie* 20, 2000. pp. 299ff.

### Short biography:

Prof. Dr.-Ing. Manfred Schuller (born 1953) studied architecture at the Technical University in Munich. Research and publications on the Greek temple architecture of the Cyclades, Baroque gardens in Franconia, medieval secular buildings in Venice, medieval cathedrals in Bamberg and Regensburg, Renaissance architecture in Venice and Rome, medieval Islamic grave architecture in Aserbaidschan. Professor for Historic Building Archaeology and Architectural History at the University of Bamberg since 1986; teaching emphasis on historic building archaeology in a master's degree program in preservation.

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**Object:** Dionysos – Yria Temple at Naxos, Greece

**Date:** around 800 B.C. – c. 580 B.C.

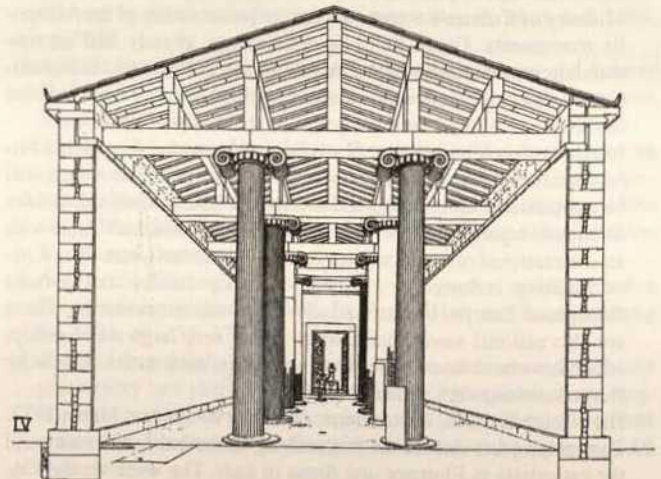
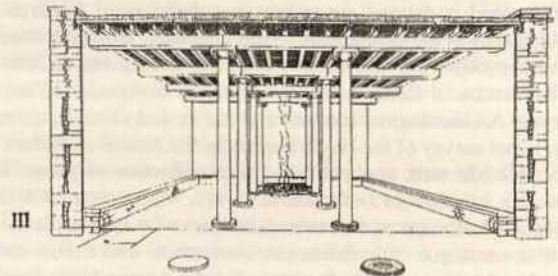
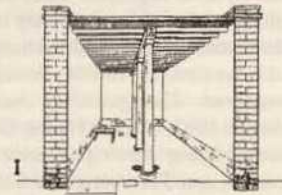
**Surveyor:** (building archaeology) Gottfried Gruben, Manolis Korres and co-workers

**Building Survey:** Hand measurements

**Explanatory Note:** Architectural evidence of the continuity over several centuries of a sacred site from classical antiquity; succession of temples at one location. Close collaboration between archaeology (director Vasilis Lambrinoudakis) and building archaeology.

**Literature:** Gottfried Gruben: *Griechische Tempel und Heiligtümer*. Munich 2001, 5th enlarged edition, p. 375 (with further bibliographical references)

Plate 1: View into the reconstructed interiors of temples I–IV: I) early 8<sup>th</sup> c.; II) 2<sup>nd</sup> half of the 8<sup>th</sup> c.; III) first half of the 7<sup>th</sup> c.; IV) 580-540 B.C.



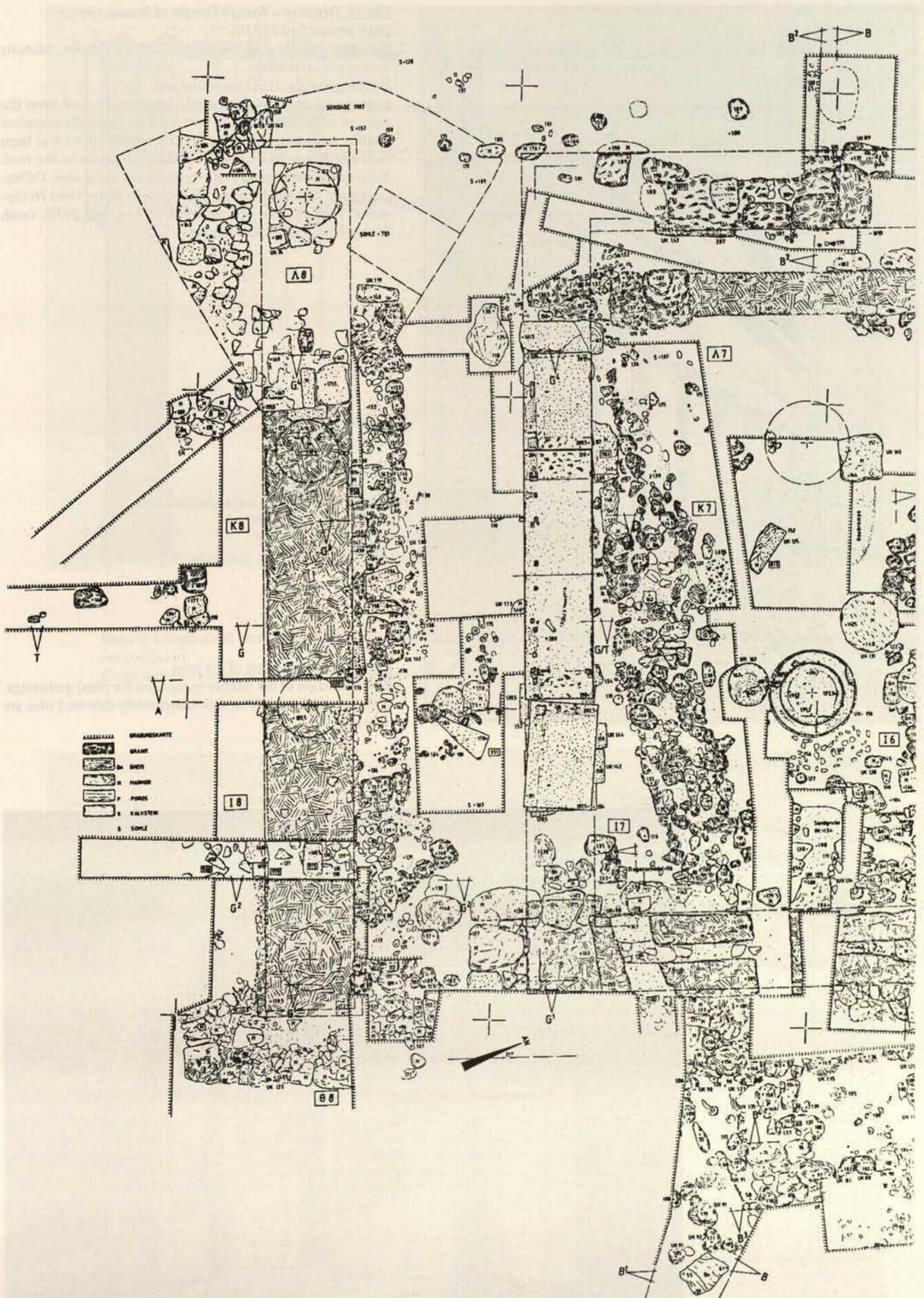
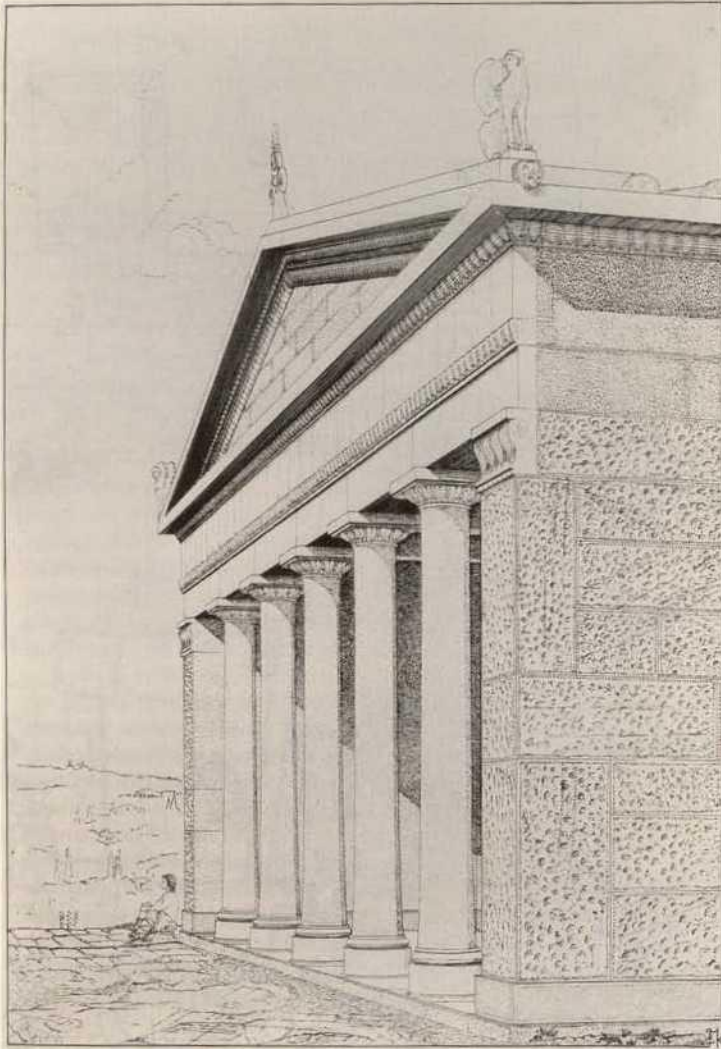
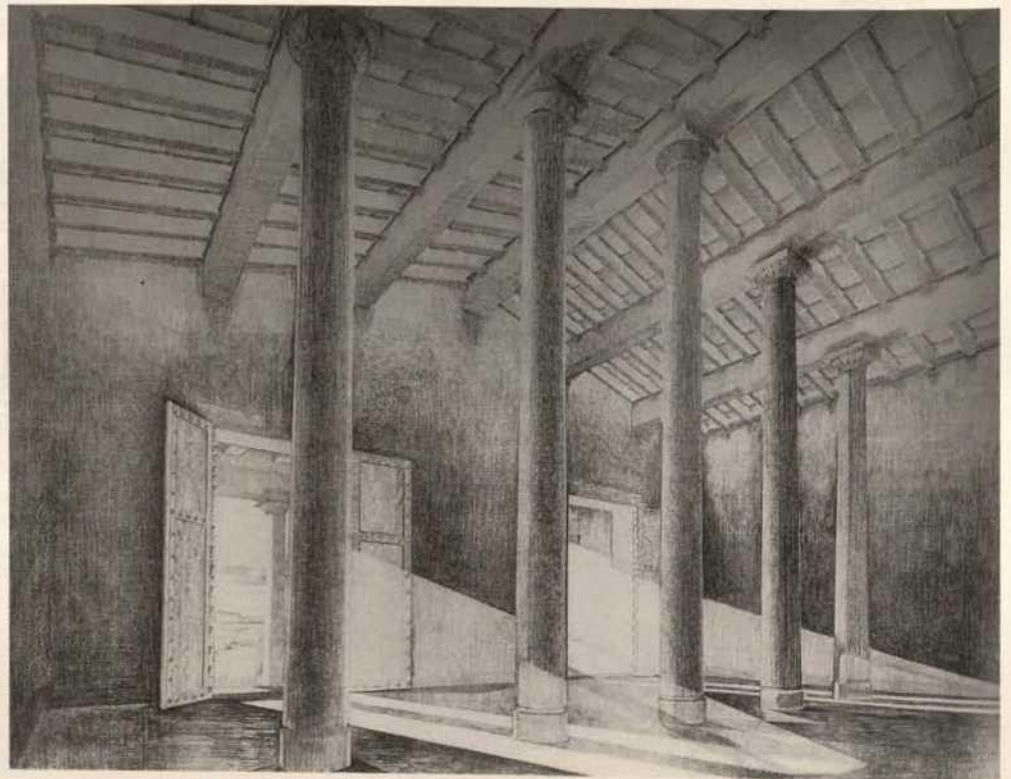


Plate 2: Plan showing excavation of the stones with evidence of four temples on top of each other



**Object:** Demeter – Sangri Temple at Naxos, Greece  
**Date:** around 540/520 B.C.  
**Surveyor:** (building archaeology) Gottfried Gruben, Manolis Korres and co-workers  
**Building Survey:** Hand measurements  
**Explanatory Note:** Architectural elements salvaged from the ruins of a Byzantine church permitted an unusually complete graphic reconstruction of an archaic temple which had been built completely of marble, from the foundations to the roof. Subsequent partial anastylosis by the Greek Antiquities Office.  
**Literature:** Gottfried Gruben: *Griechische Tempel und Heiligtümer*. Munich 2001, 5<sup>th</sup> enlarged edition, pp. 367ff. (with further bibliographical references)

Plate 3: Reconstruction of the front  
 Reconstruction of the interior space used for ritual gatherings. Columns, purlins, rafters, and transparently thin roof tiles are of marble.



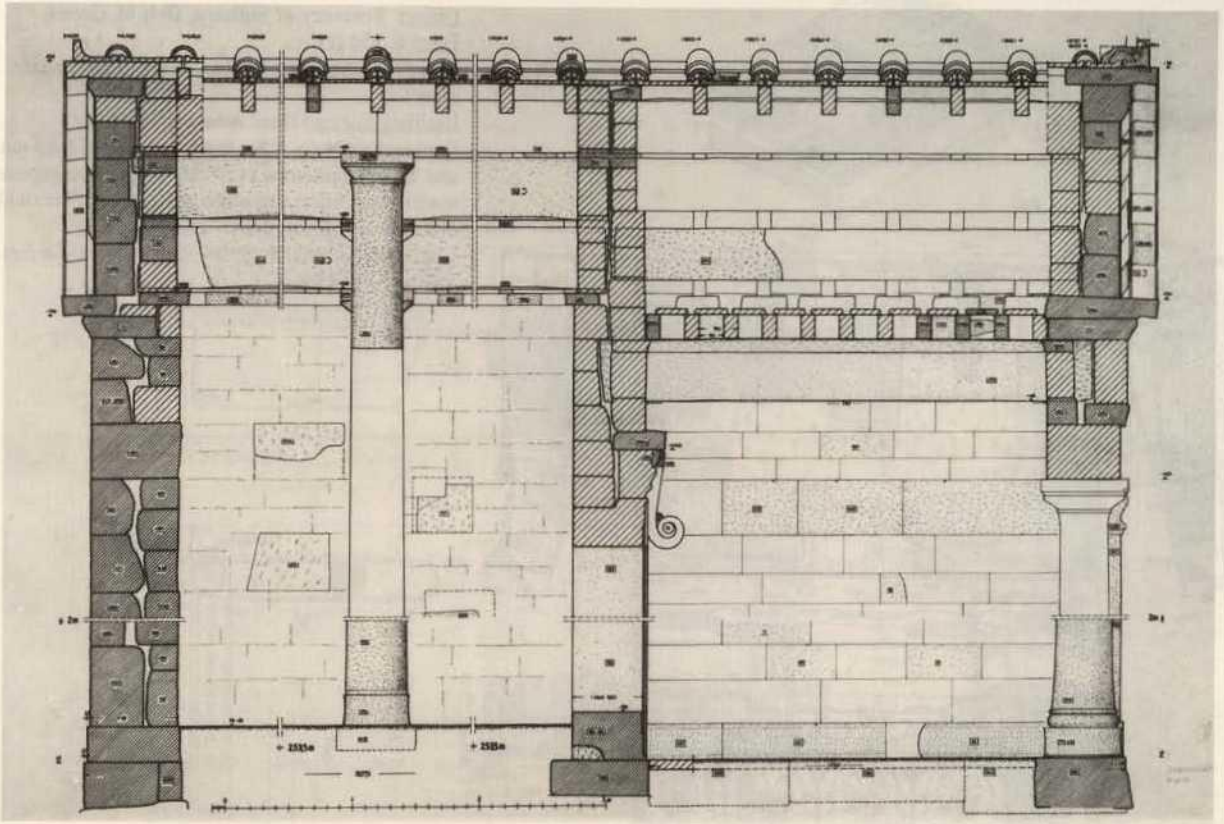
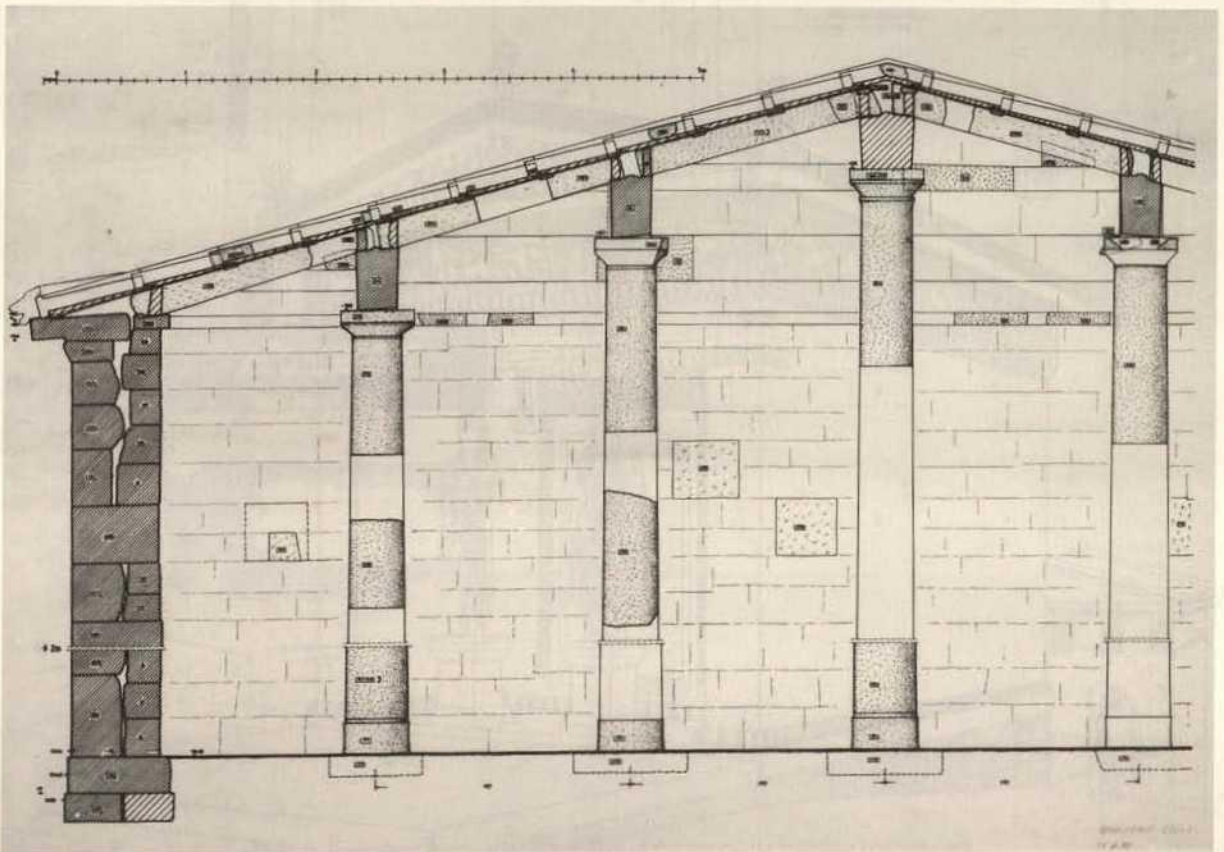
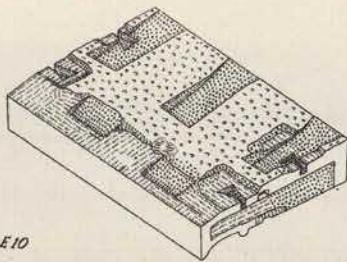


Plate 4: Longitudinal section (shortened depiction) through the temple. Closely hatched: surviving building components (above).  
 Cross section through the interior with documented roof structure in marble (below).





E.10

**Object:** Treasury of Siphnos, Delphi, Greece  
**Date:** c. 530 B.C.  
**Surveyor:** (building archaeology) Erik Hansen (Denmark)  
**Building Survey:** Hand measurements  
**Explanatory Note:** After measurements of the foundation and all the numerous surviving building components of marble were taken a new reconstruction of the richly decorated building was drawn up.  
**Literature:** Georg Daux and Erik Hansen: *Le trésor des Siphnos*. Paris 1987.

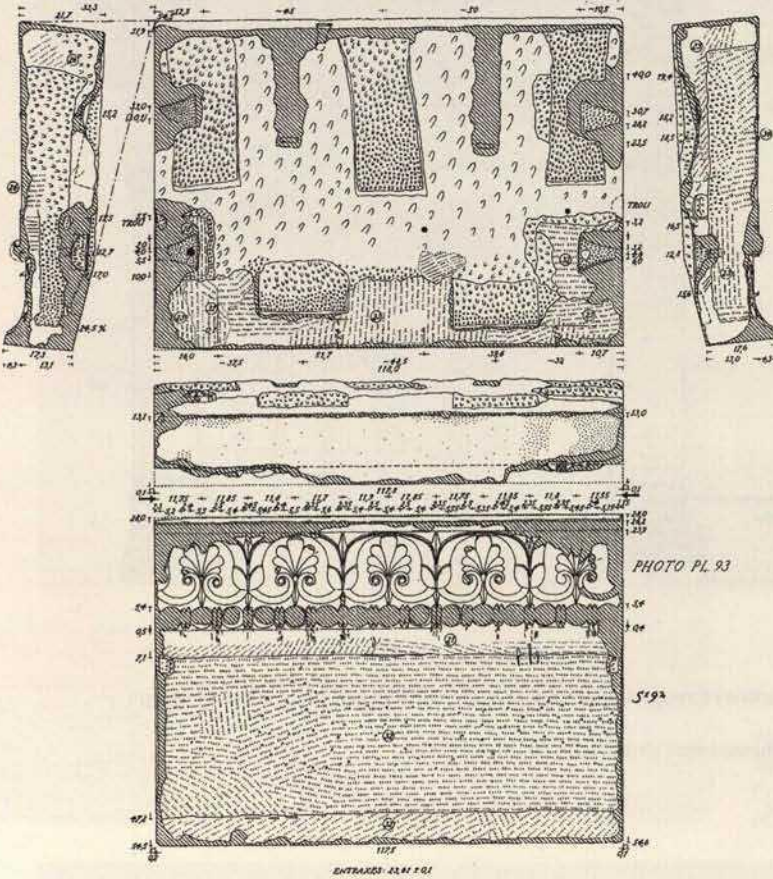
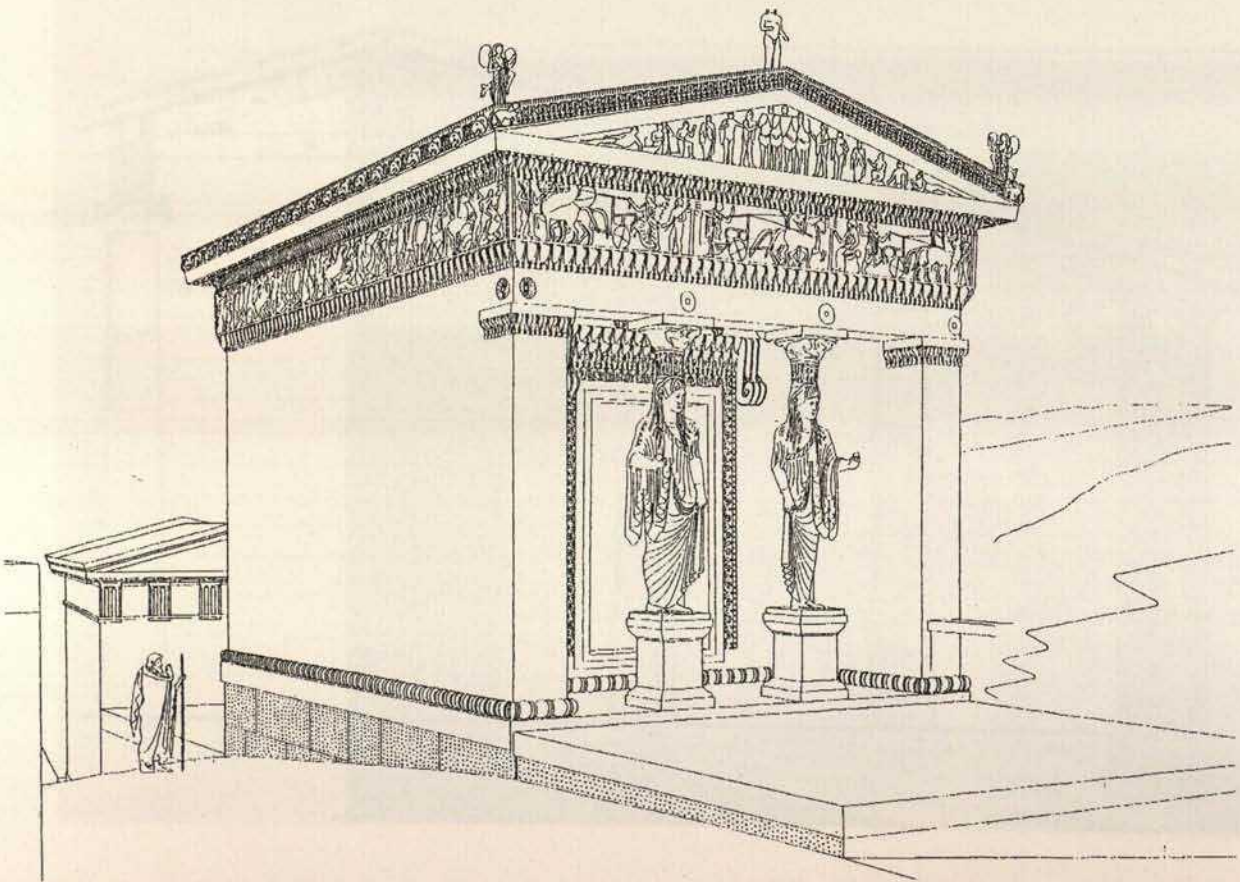


Plate 5: Measurement of all elevations of a cornice block. Damaged areas are hatched. Perspective of the reconstruction



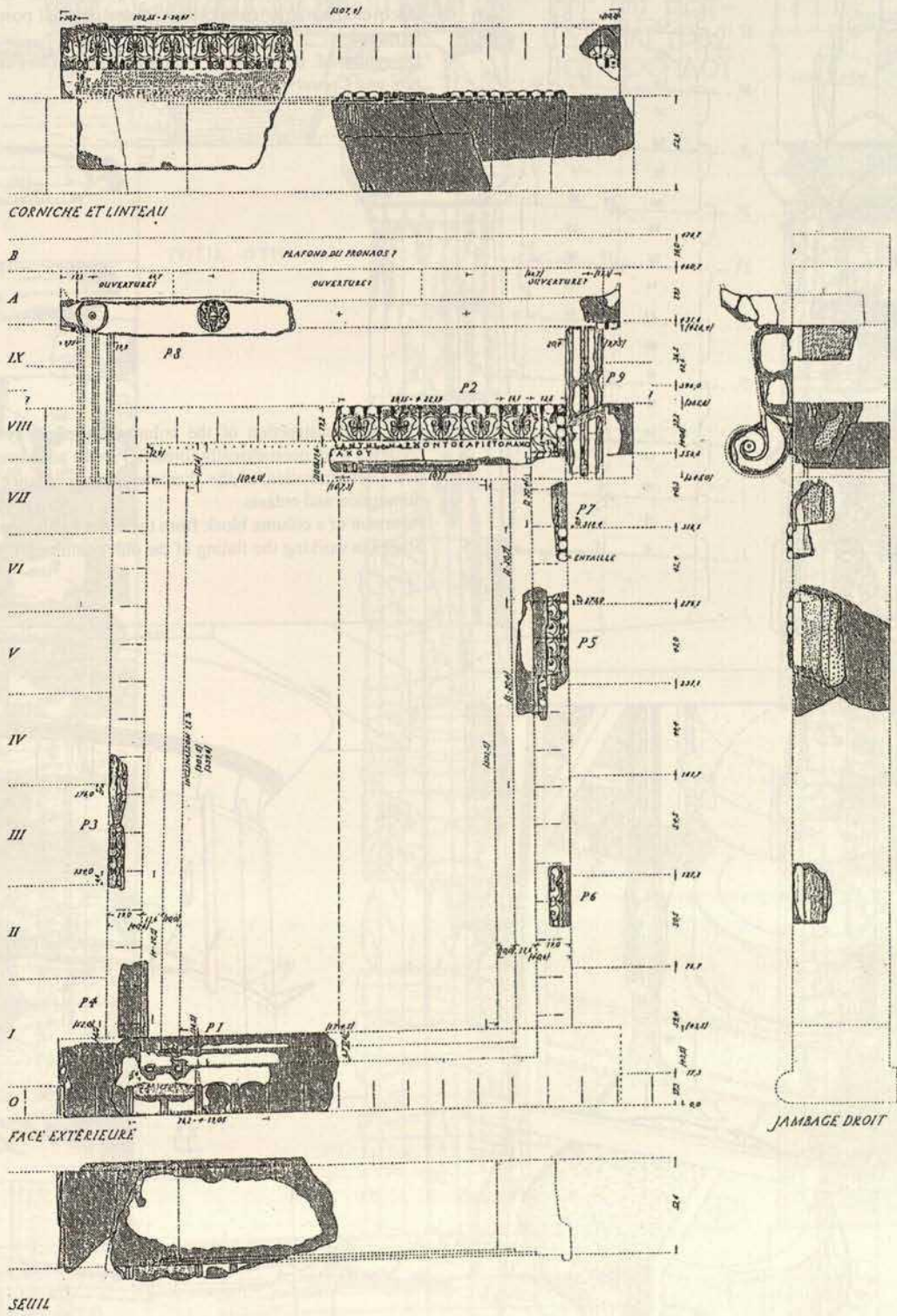
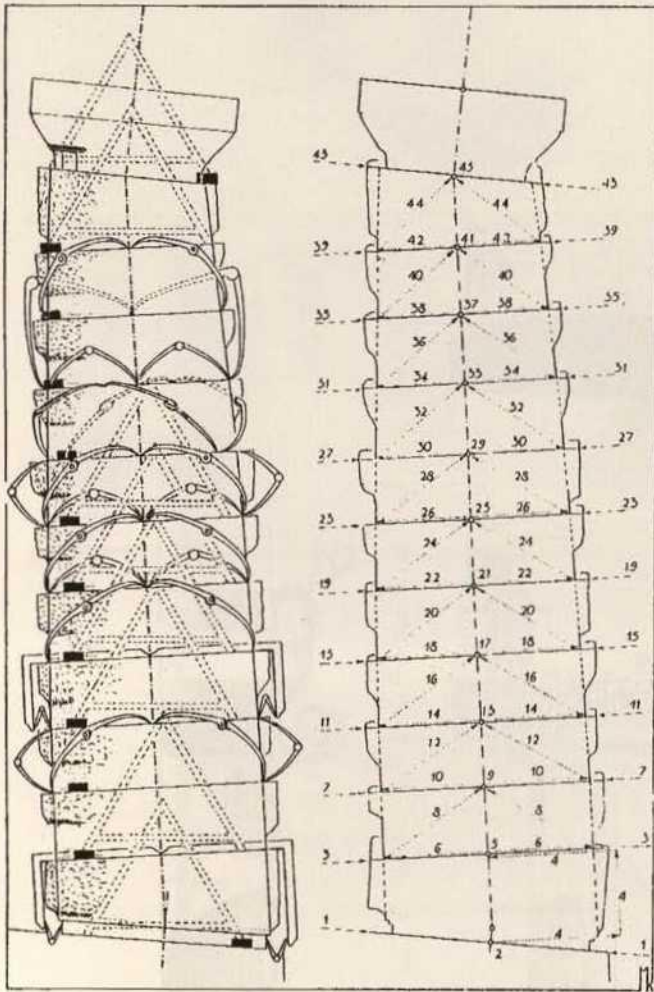


Plate 6: Ionic door frame with placement of the surviving building components.



**Object:** Parthenon, Athens, Greece

**Date:** 447–431 B.C.

**Surveyor:** Manolis Korres

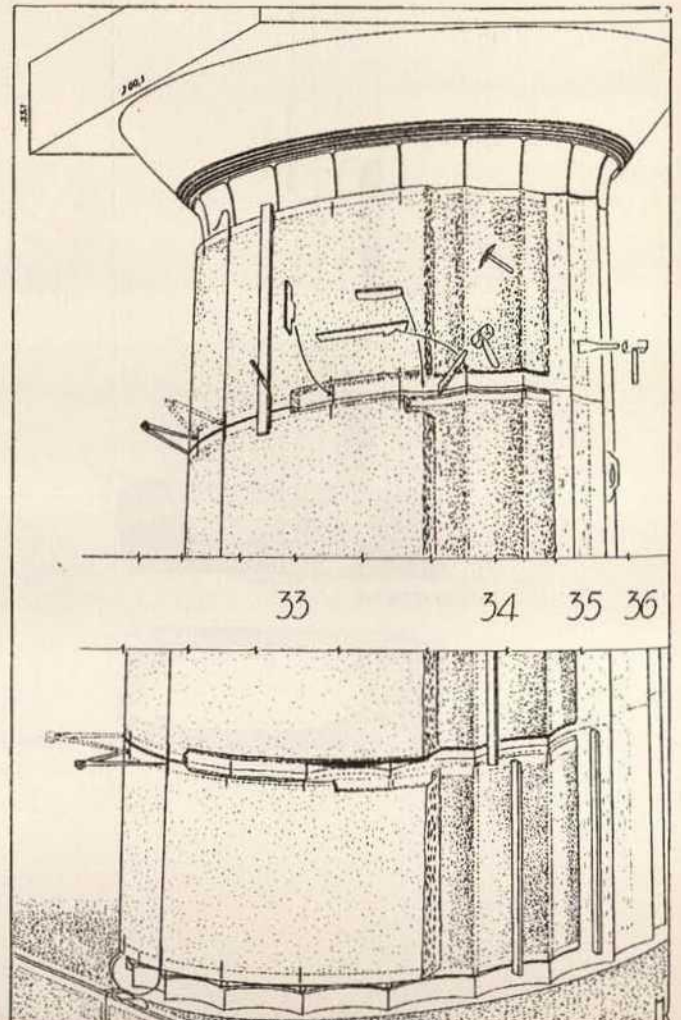
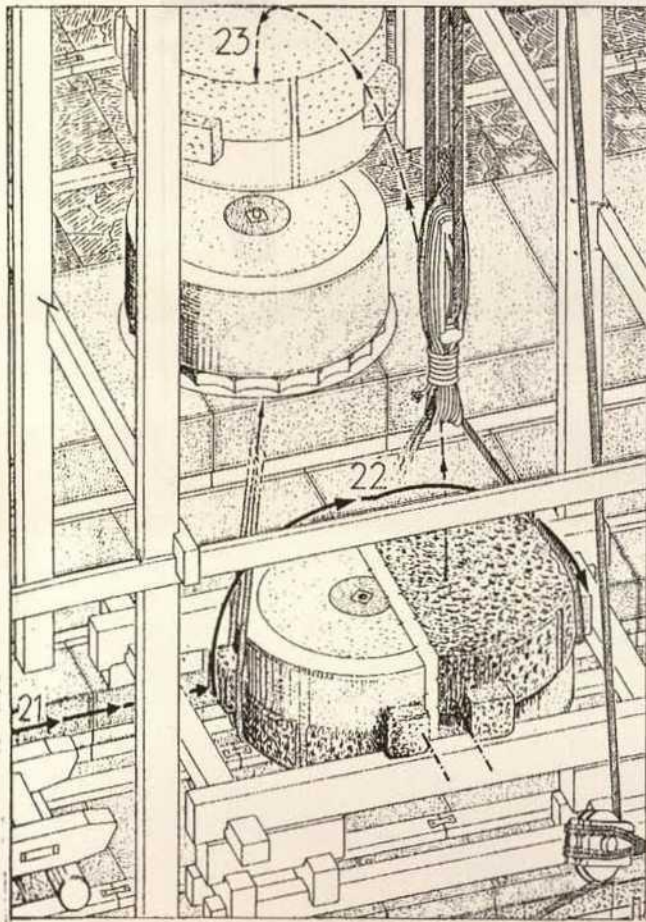
**Building Survey:** Mostly hand measurements. Scale: 1:20

**Explanatory Note:** Large-scale investigation of the architecture of the Parthenon (structural system, form, original appearance, alterations) before consolidation, restoration and conservation work following the 1981 earthquake. The work also includes partial anastylosis using re-discovered building components whose original position could be determined.

**Literature:** M. Korres, G.A. Panetsos, T.Seki: *The Parthenon. Architecture and Conservation*. Athens 1996.

Plate 7: Construction of the columns. Method by which the outer columns were geometrically formed. Precise adjustment of the inclination. Determination of the diameters in accordance with the law of diminution and entasis.

Inversion of a column block from the older Parthenon. Stages in working the fluting of the outer columns.





# ΠΑΡΘΕΝΩΝ

ΓΡΑΦΙΚΗ ΣΥΝΘΕΣΗ ΤΩΝ ΣΩΖΟΜΕΝΩΝ ΛΟΘΩΝ ΤΗΣ ΝΟΤΙΑΣ ΠΛΕΥΡΑΣ ΤΟΥ ΠΡΟΝΑΟΥ

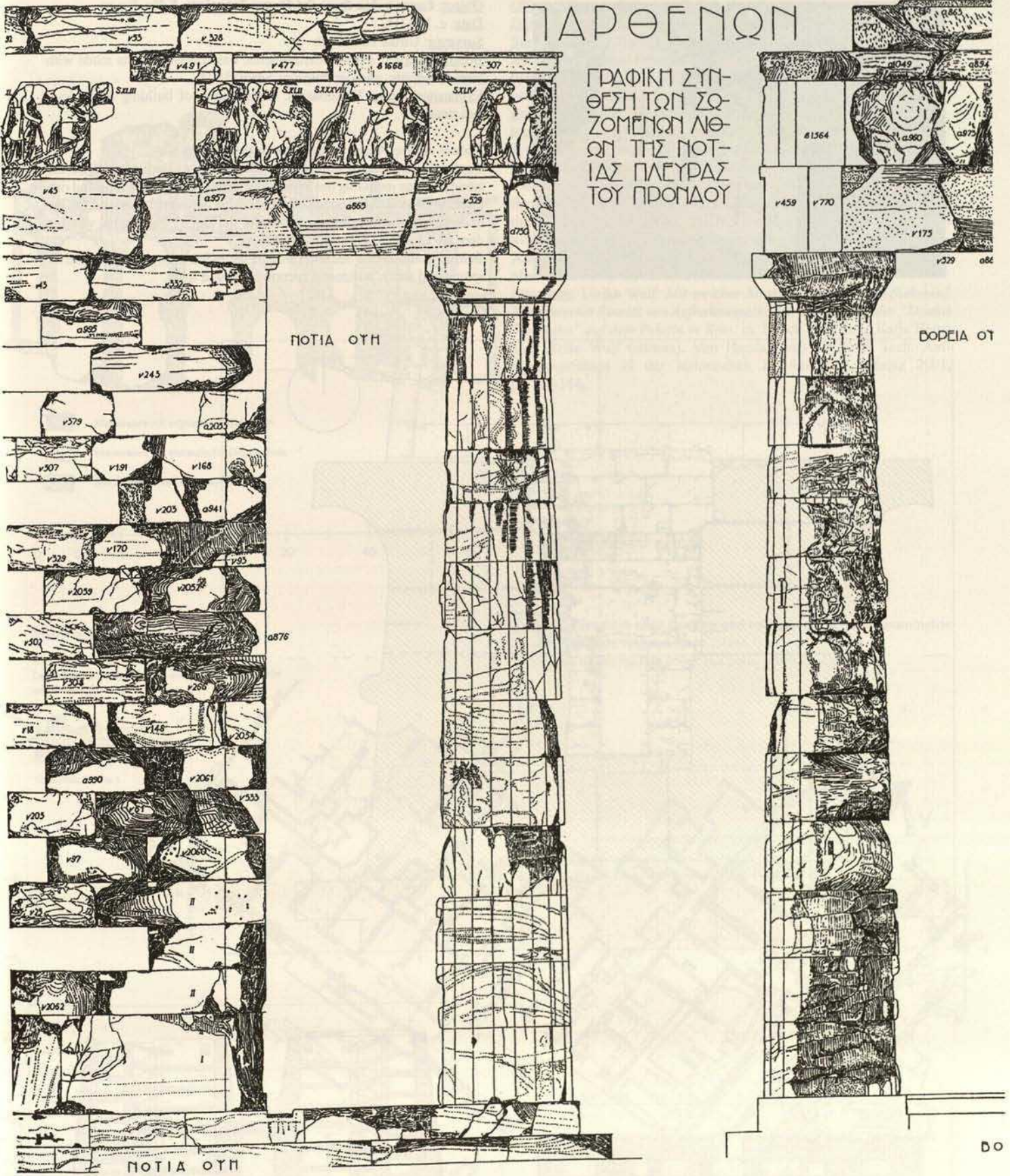
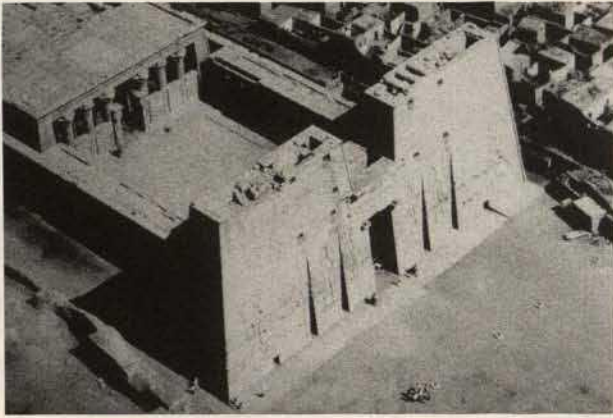


Plate 8: Proposed reassembly of the blocks in the south side of the pronaos.



**Object:** Large pylon from the Horus Temple in Edfu, Egypt

**Date:** c. 110 B.C.

**Surveyor:** Ulrike Fauerbach

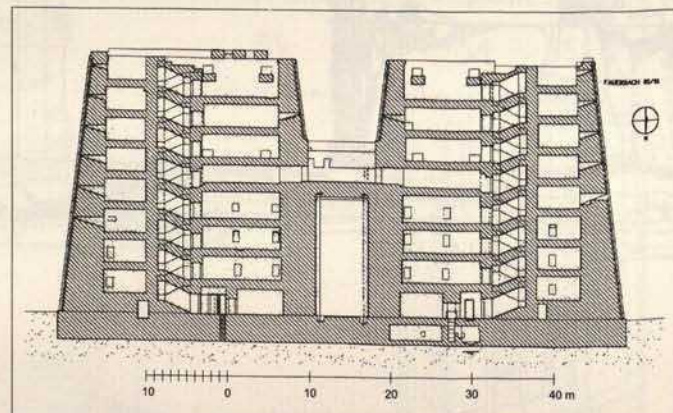
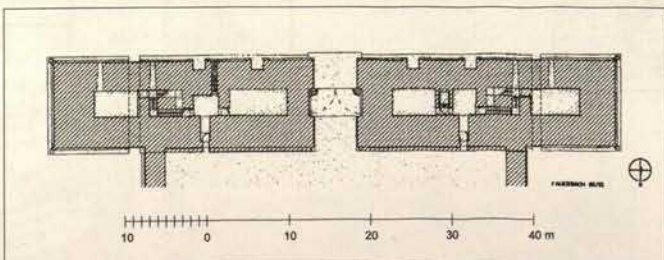
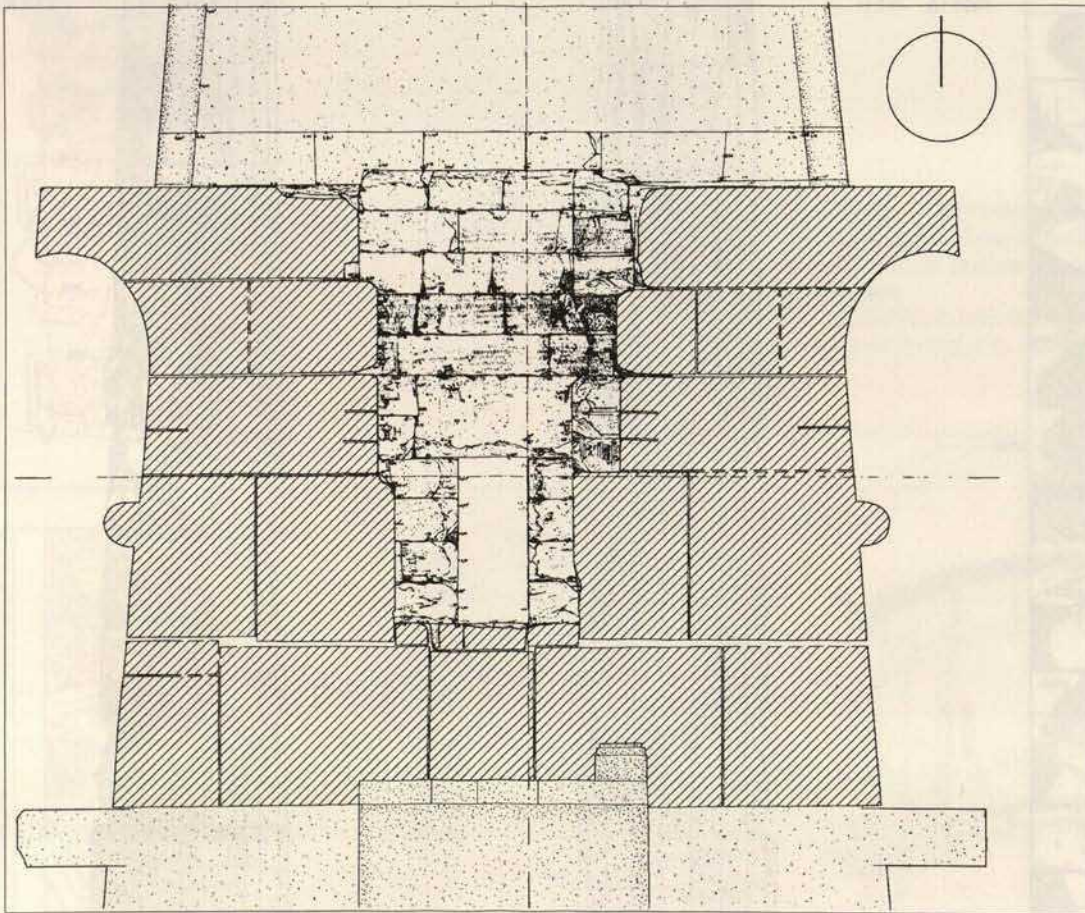
**Building Survey:** Hand measurements, base measurements made with laser theodolite, photogrammetry. Scale: 1: 25.

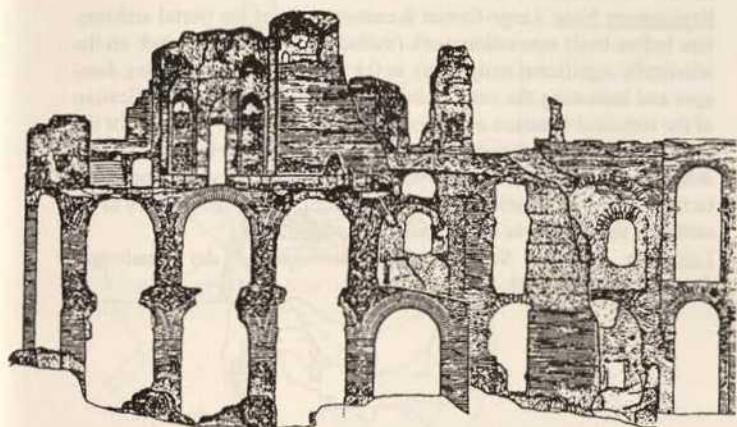
**Explanatory Note:** Dissertation. Clarification of building technology and ritual use.




Plate 9: Above: Aerial view of the Horus Temple.

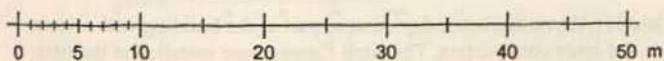
Center: Cross section through the pylon bridge. Depiction of all the stone patterns including the huge stone beams (c. 6 meters long and one meter in cross section) which bear the bridge between the pylons. On the underside of the beams is the recess for the leaf of the original wooden door (c. 15 meters high).

Below: Longitudinal section through the pylon complex with interior spaces and stairs; horizontal section at ground level.



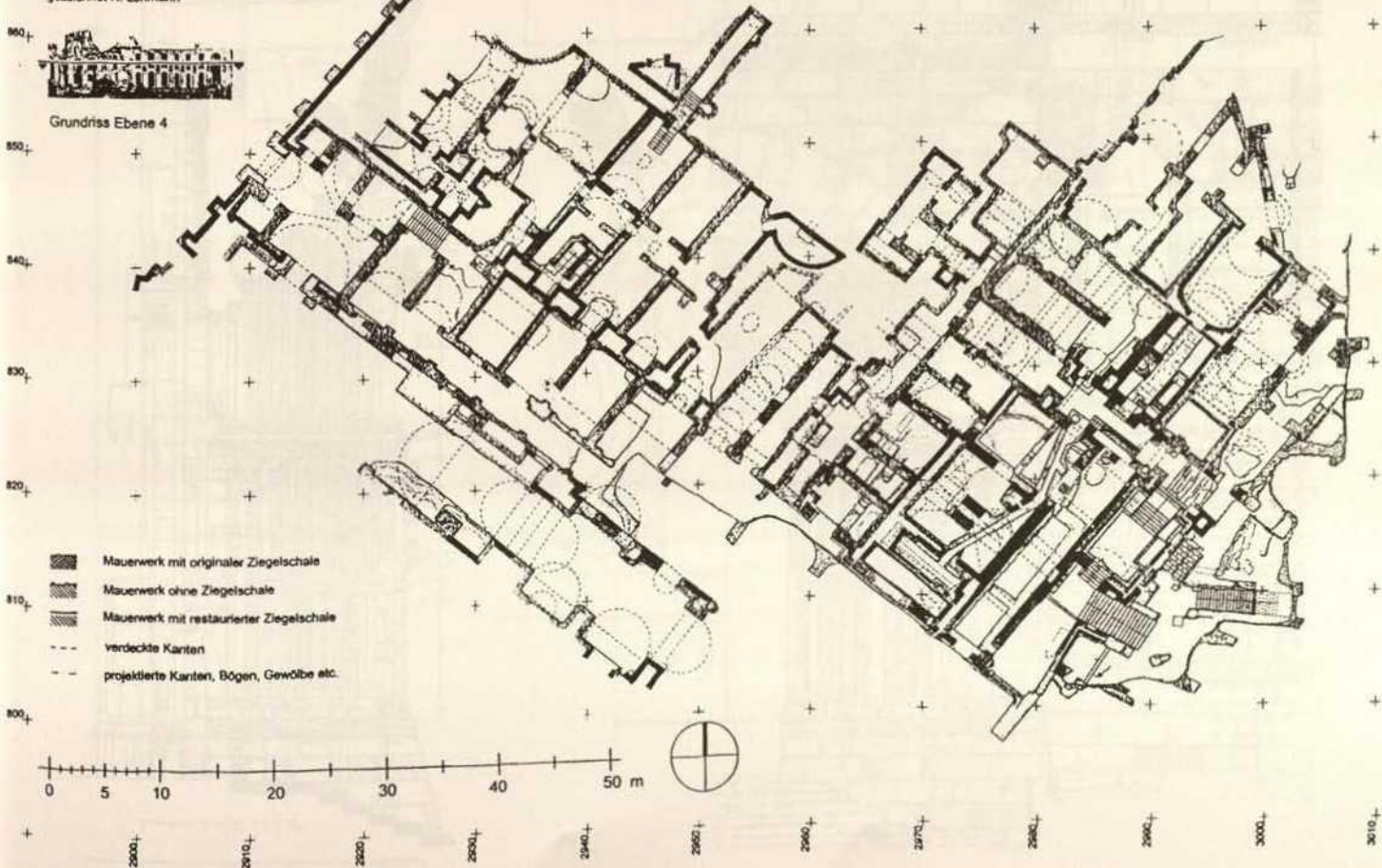







-  Mauerwerk mit originaler Ziegelschale
-  Mauerwerk mit restaurierter Ziegelschale
-  Mauerwerk ohne Ziegelschale



Rom, Palatin, „Domus Severiana“

BTU Cottbus 1999  
 Lehrstühle für Baugeschichte und Vermessungskunde  
 gezeichnet H. Lehmann



-  Mauerwerk mit originaler Ziegelschale
-  Mauerwerk ohne Ziegelschale
-  Mauerwerk mit restaurierter Ziegelschale
-  verdeckte Kanten
-  projektierte Kanten, Bögen, Gewölbe etc.

Object: “Domus Severiana”, Palatine, Rome, Italy

Date: 1<sup>st</sup>-4<sup>th</sup> c. A.D.

Surveyor: Ulrike Wulf, Ulrich Weferling and co-workers. Research project at the Technical University of Bamberg with close collaboration between the professorates for architectural history (Adolf Hoffmann) and geodesics (Bernhard Ritter).

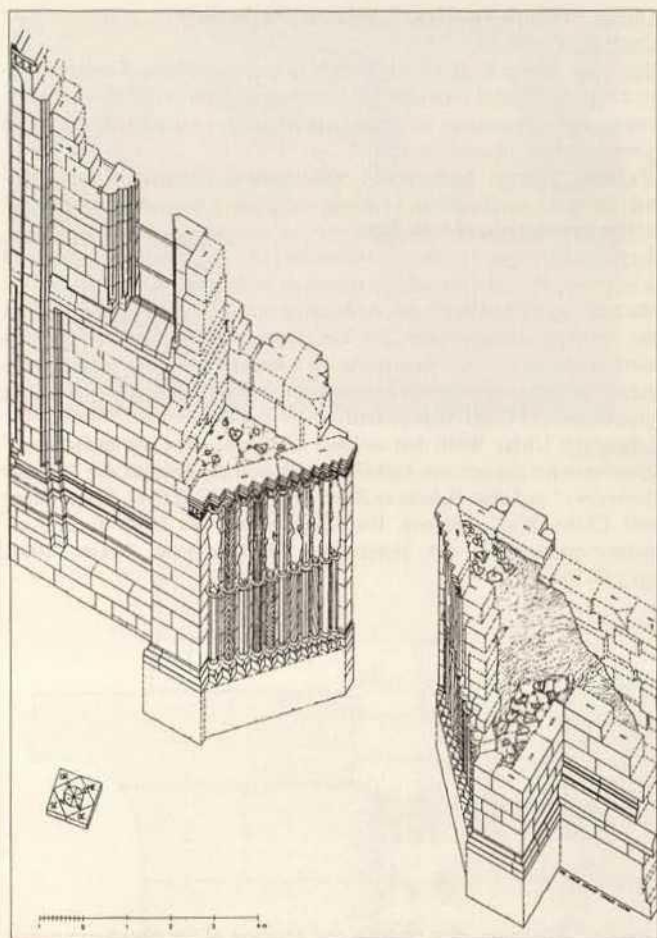
Building Survey: Tachymetry, reflector-less tachymetry and photogrammetry combined and revised using hand measurements. Scale: 1:100, in some places 1:50, 1:20.

Explanatory Note: The huge dimensions (120 x 120 meters in plan and a height of 35 meters) could be mastered in the short time available for the building survey by closely dovetailing the work of the geodesists and the building archaeologists. Six horizontal and eight vertical sections were prepared in four documentation campaigns of four weeks each. Analysis of the construction history using colored plans of the building phases and 3D-CAD reconstructions.

Literature: Ulrike Wulf: *Mit welcher Methode sollen wir aufnehmen? Kombierter Einsatz von Aufnahmemethoden am Beispiel der „Domus Severiana“ auf dem Palatin in Rom.* in: Ulrich Weferling, Katja Heine and Ulrike Wulf (editors). *Von Handaufmaß bis High Tech. Aufnahmeverfahren in der historischen Bauforschung.* Mainz 2001, pp.153-164.

Plate 10: Elevation after analysis and revision of the photogrammetric images. Ink plan, original scale 1:100.

Floor plan of the middle level. Ink plan, original scale 1:100.



**Object:** "Prince's Portal" of Bamberg Cathedral, Germany

**Date:** c. 1225

**Surveyor:** Manfred Schuller with Philip Caston, Thomas Eck, Tillman Kohnert, Ernst Schneider

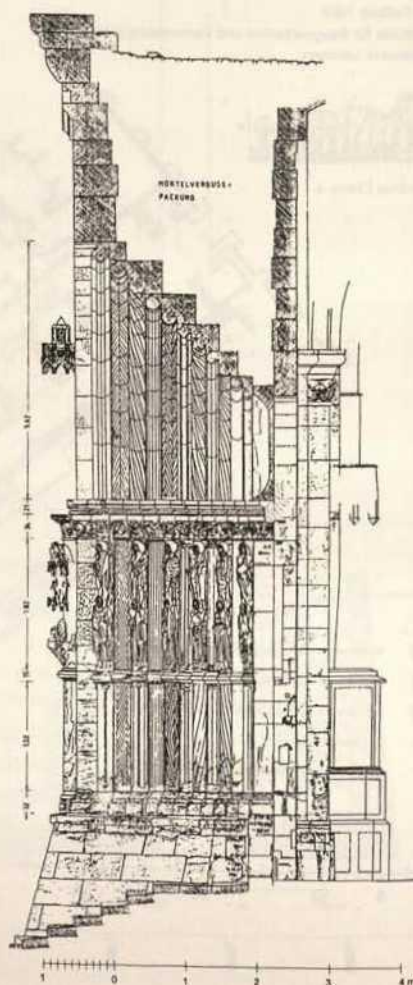
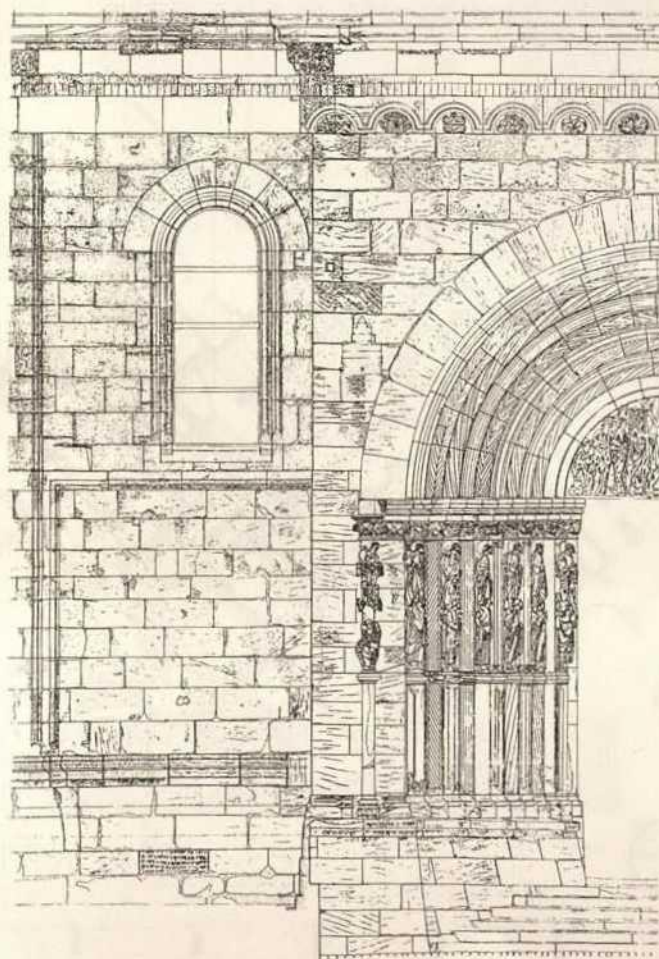
**Building Survey:** Hand measurements using electronic base measurements. Scale: 1:10

**Explanatory Note:** Large-format documentation of the portal architecture before basic renovation work (including in particular work on the artistically significant sculptures), as the foundation for recording damages and indicating the work to be done by the restorers. Clarification of the technical structure of the entire portal. Particular concern for the connection between the sculpture and the architecture in order to help determine whether and how the jamb figures and the tympanum could be taken down. Academic issue: review of the architectural history to ascertain if the sculptures might have been added later.

**Literature:** Manfred Schuller: *Das Fürstenportal des Bamberger Domes*. Bamberg 1993.

Plate 11: Above: Isometric depiction of part of the building with a view into the inner construction. The jamb figures were installed at the time of construction and were firmly joined to the wall.

Below: Elevation of the left half of the portal and cross section with the stone pattern of the archivolt and the extremely high wall above, which embeds the tympanum inextricably in the architecture.



**Object:** "Angel of the Annunciation", Bamberg Cathedral, Germany

**Date:** 1225-1230

**Surveyor:** Maren Zerbes

**Building Survey:** Hand measurements. Scale: 1:5

**Explanatory Note:** Dissertation at the University of Bamberg. Technical structure of the artistically significant sculpture from the interior of the cathedral. Survey of usually neglected "secondary aspects" such as the cut of the stone, the back of the sculpture, hooks and dowels, color scheme. Query: proof concerning the original location of the sculpture.

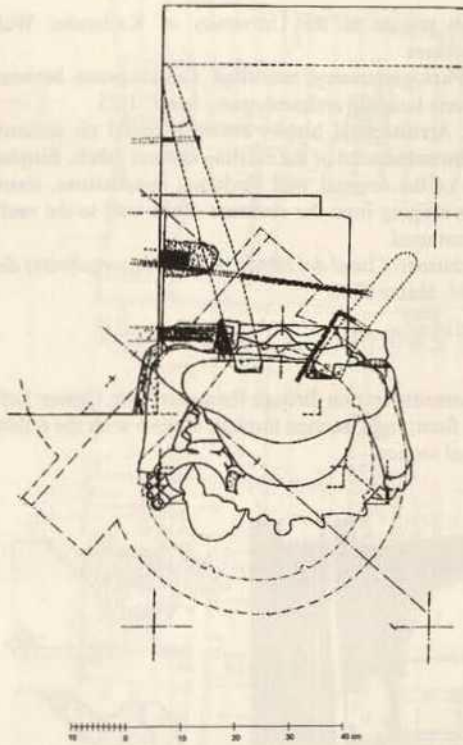
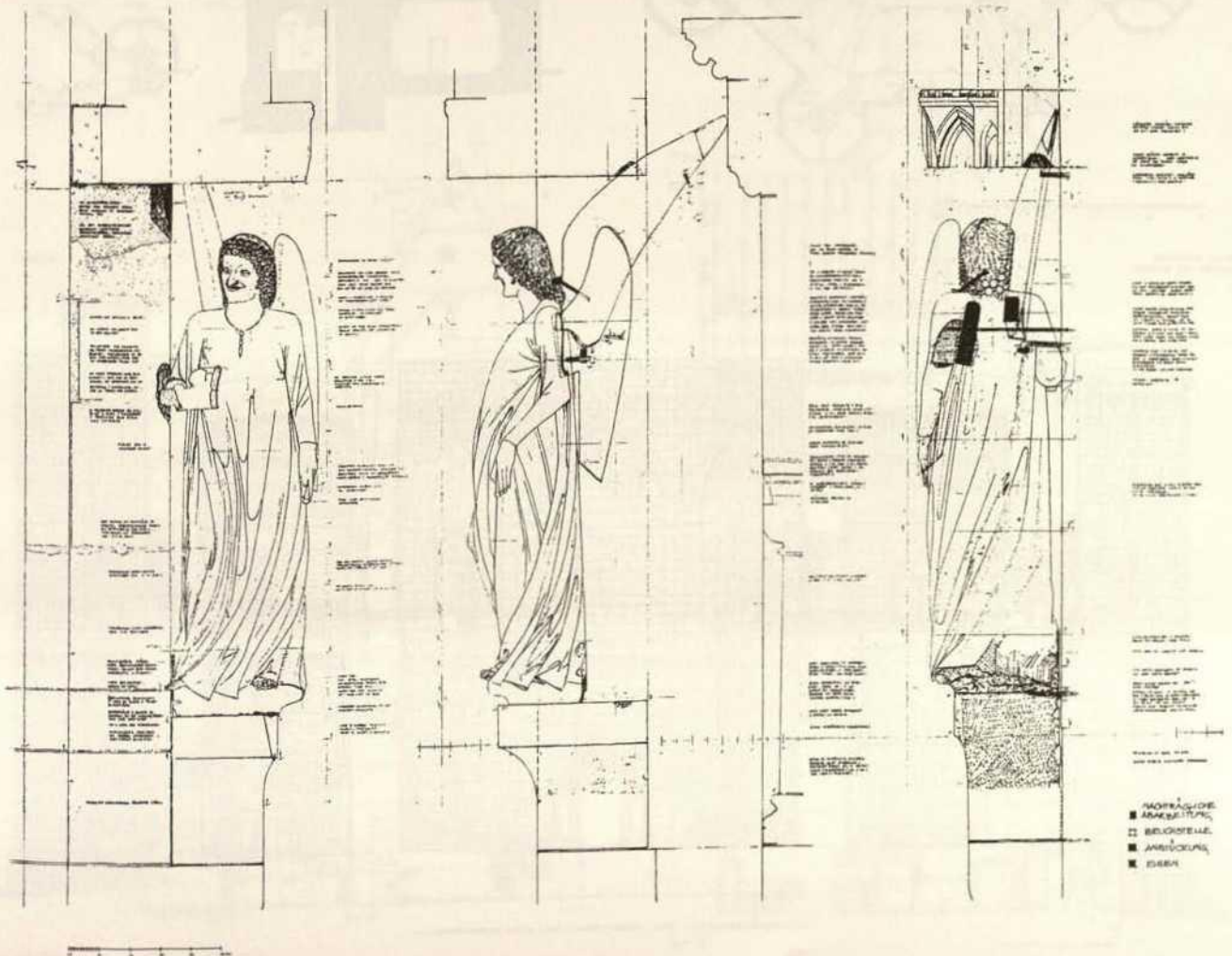


Plate 12: Above: Overlaid horizontal cross sections illustrate the rectangular form of the sandstone block out of which the figure was carved. The wings were made separately and attached to the back. Below: Elevations of the front, side and back.



**Object:** Castel del Monte, Apulia, Italy

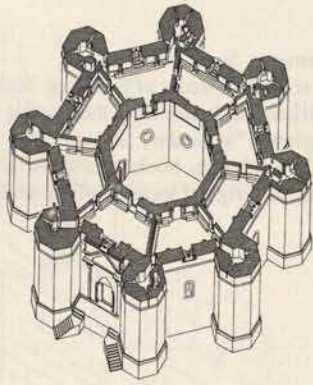
**Date:** around 1240

**Surveyor:** Research project at the University of Karlsruhe: Wulf Schirmer and co-workers

**Building Survey:** Photogrammetry, reworked. Collaboration between geodesists and historic building archaeologists. Scale: 1:25

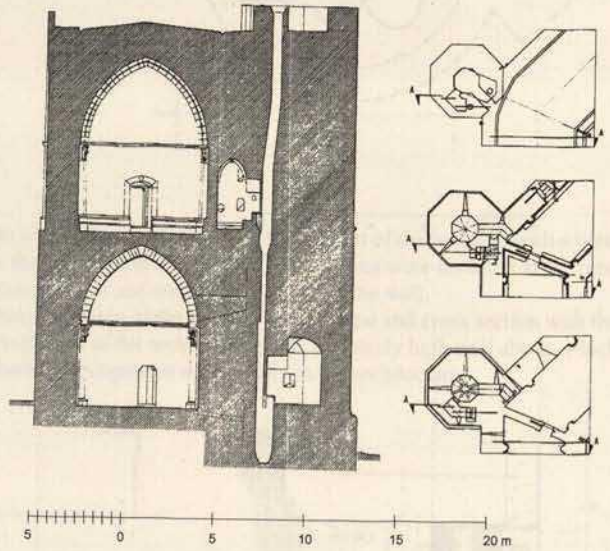
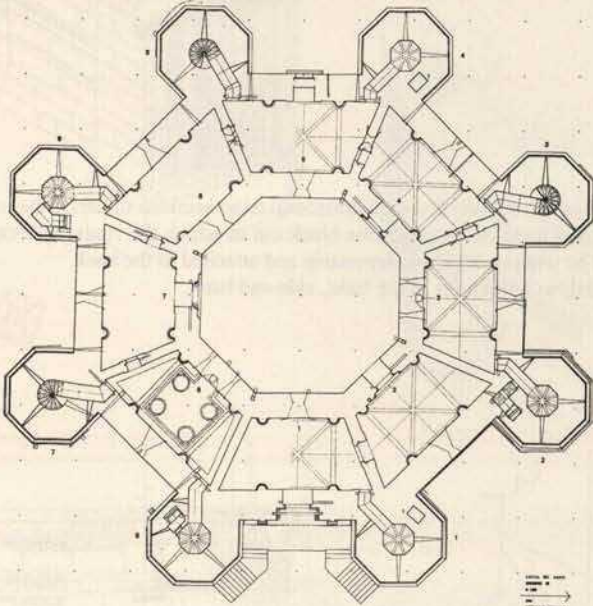
**Explanatory Note:** Architectural history research based on accurate measurement and documentation of the existing historic fabric. Emphasis: reconstruction of the original wall cladding, installations, stairs, construction details ranging from the structure of the wall to the vault, units of measurement used.

**Literature:** Wulf Schirmer: *Castel del Monte. Forschungsergebnisse der Jahre 1990 bis 1996*. Mainz 2000



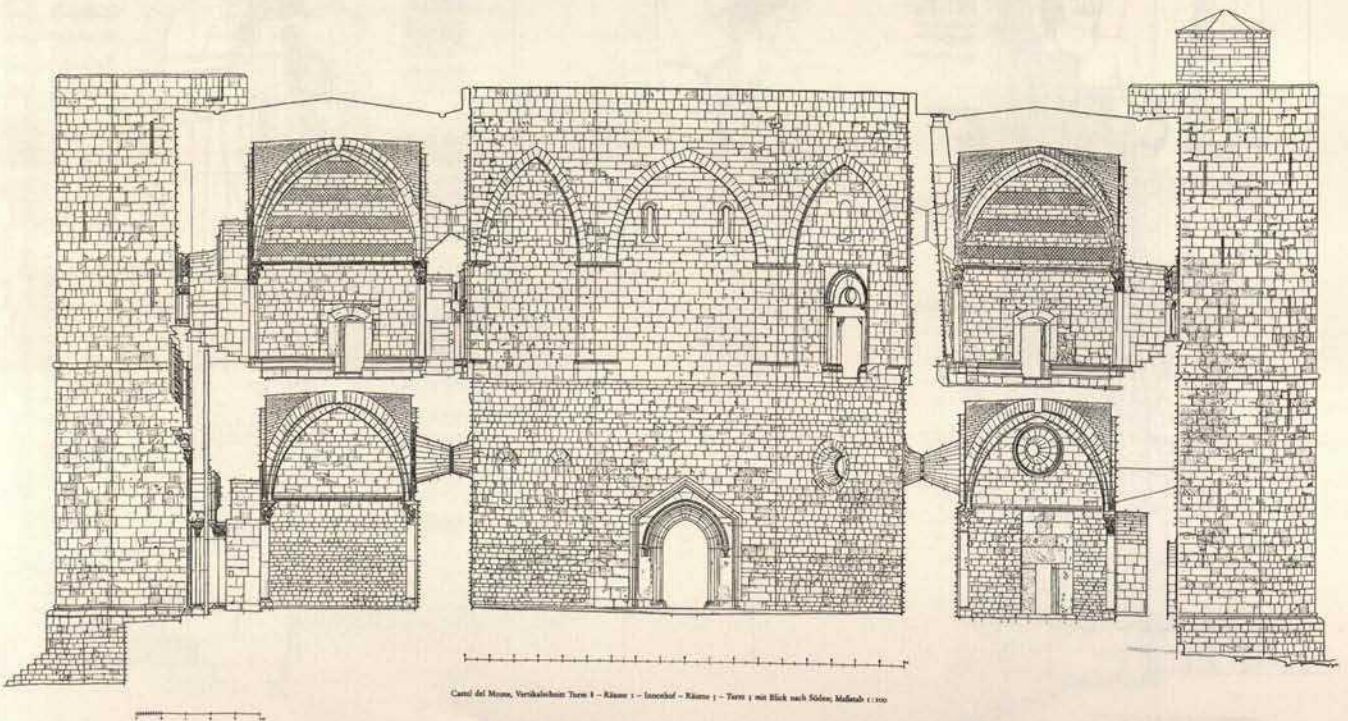
**Captions:**

Plate 13: Above: Isometric section through the upper floor. Center: Left, plan of the ground floor; right, section through tower 6 with the toilets. Below: Longitudinal section

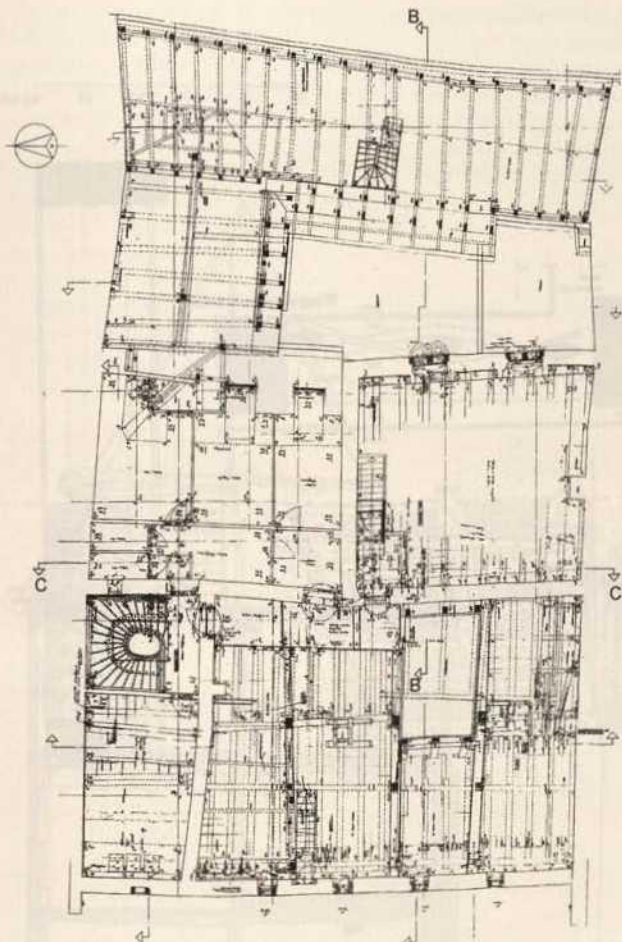


WULF SCHIRMER  
CASTEL DEL MONTE

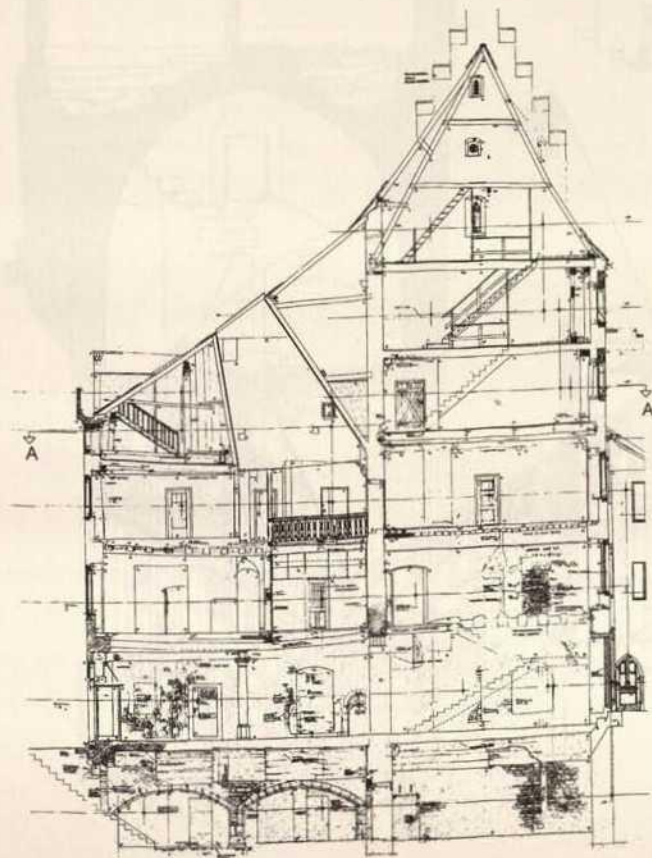
BEILAGE 7



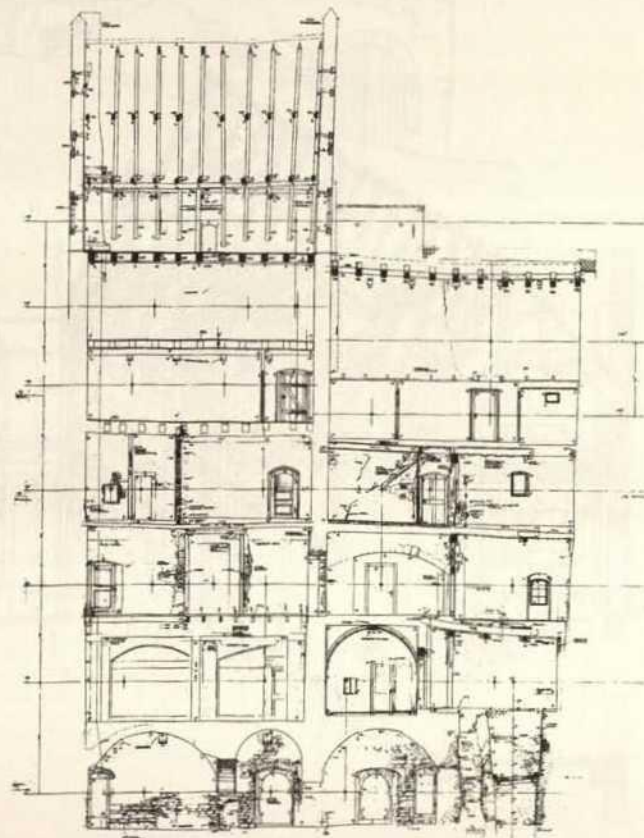
Castel del Monte, Vertriebsplan Turm 1 - Räume 1 - Innenhof - Räume 1 - Turm 1 mit Blick nach Süden; Maßstab 1:100



A - A



B - B



C - C

**Object:** Medieval townhouse ("Deggingerhaus"), Regensburg, Germany

**Date:** Last quarter of the 13<sup>th</sup> c. Built on older Romanesque remains, alterations into the 20<sup>th</sup> c.

**Surveyor:** (building archaeology) Karl Schnieringer and others

**Building Survey:** Hand measurements (Büro Rosenbaum; findings recorded by Karl Schnieringer). Scale 1:25

**Explanatory Note:** Study of the complicated building history of a large medieval townhouse through the collaboration of different specialists from the fields of art history, archaeology and building archaeology. The existing situation essentially dates back to several Gothic construction phases in short succession. Reason for the investigation: remodeling of the building as a large bookstore.

**Literature:** Stadt Regensburg-Denkmalenschutzbehörde (publisher) with articles by: Lutz-Michael Dallmeier, Angela von den Driesch, Werner Endres, Hansjörg Küster, Helmut-Eberhard Paulus, Karl Schnieringer, Angelika Wellenhofer, Norma Zavodnik: *Das Deggingerhaus zu Regensburg. Sanierung-Geschichte-Ausgrabung*. Regensburg 1994.

Plate 14: Above: Floor plan of the third story. Below: Cross section and longitudinal section through the tower of the house. Before renovation, with overlapping historic layers.

**Object:** Medieval townhouse ("Römer 2-6"), Limburg an der Lahn, Germany

**Date:** 1289 with alterations into the 20<sup>th</sup> c.

**Surveyor:** Freies Institut für Bauforschung und Dokumentation (IBD), Elmar Altwasser, Ulrich Klein, Hans-Georg Lippert and others

**Building Survey:** Hand measurements, façades in part with photogrammetry. Scale: 1:20, 1:50.

**Explanatory Note:** Detailed documentation of the archaeological situation and existing building fabric, with graphic reconstruction of the different building phases of a large inner-city half-timber house.

**Literature:** Magistrat der Stadt Limburg a. d. Lahn, Sanierungsleitstelle (publisher), Elmar Altwasser, Ulrich Klein, Hans-Georg Lippert and others: *Das Gotische Haus Römer 2-4-6*. Limburg a.d. Lahn. Forschungen zur Altstadt. No. 1, 1992.

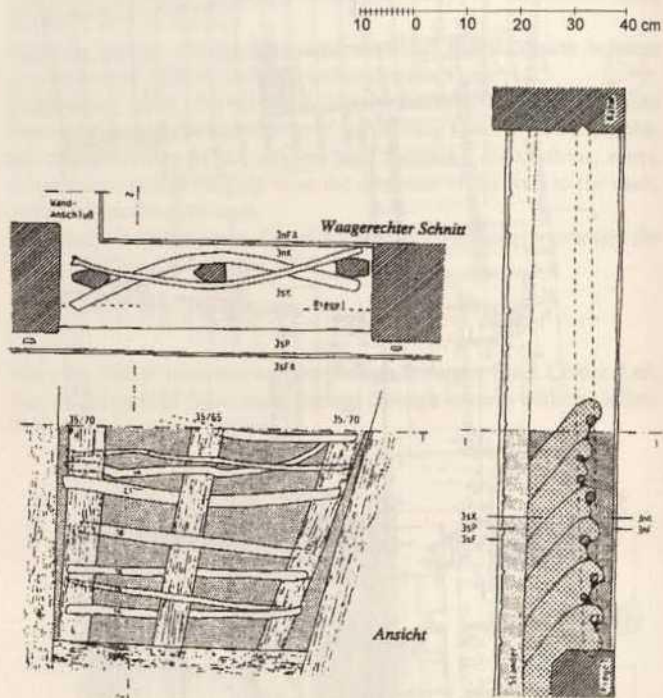
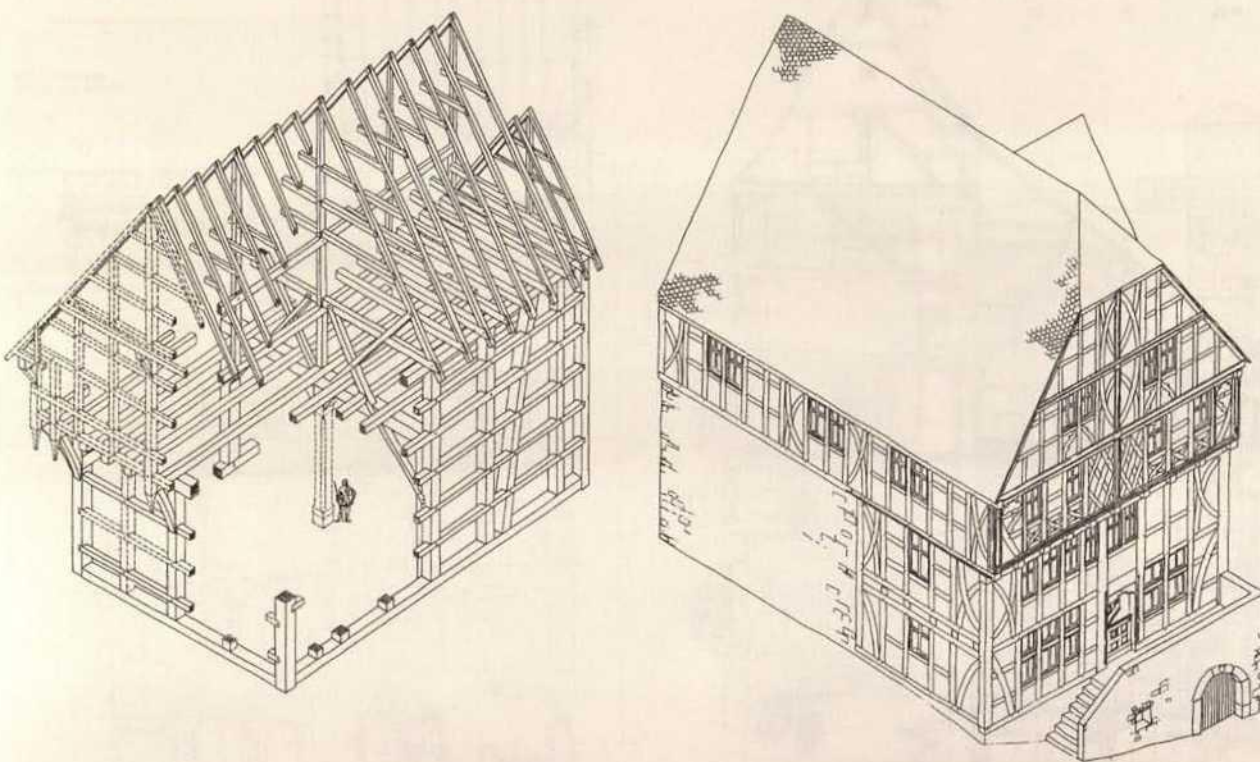


Plate 15: Detail of the wattle work in the wall from 1583. Reconstruction of the half-timber structure in 1289 (left) and the building in 1581-83 (right)





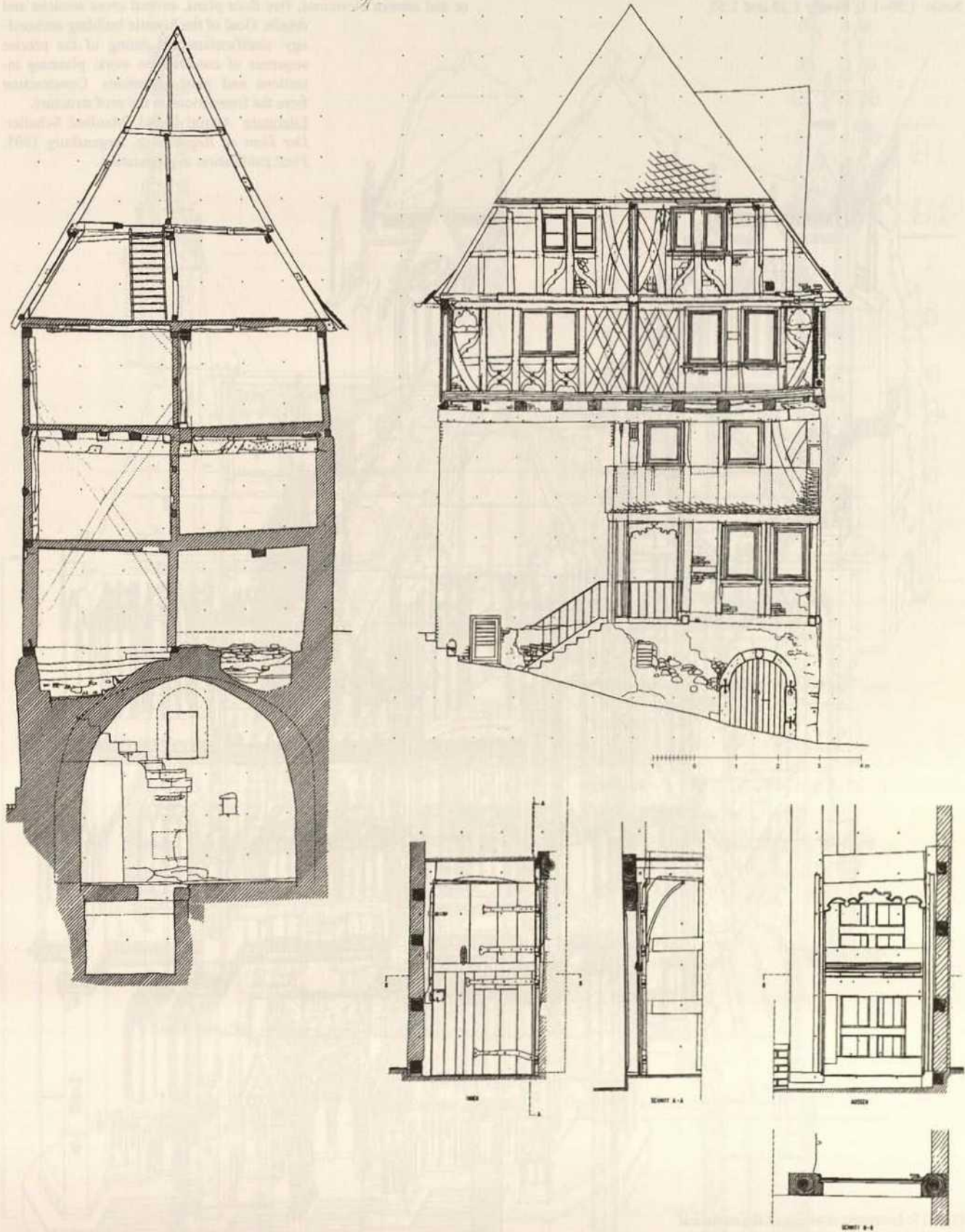


Plate 16: Above: Cross section and east façade at the time of measurement. Below: Documentation of the front door from 1581–83.

**Object:** St. Peter's Cathedral, Regensburg, Germany

**Date:** 1275–1520; 1859–1872

**Surveyor:** Research project of the University of Bamberg, 1986–2001; director of the building archaeology: Manfred Schuller

**Building Survey:** Primarily hand measurements using the most up-to-date equipment, partial photogrammetry, trial use of laser scanning.

**Scale:** 1:50–1:1; mostly 1:25 and 1:50.

**Explanatory Note:** Overall investigation of a Gothic cathedral. Interdisciplinary research project under the direction of Achim Hubel (art history) and Manfred Schuller (building archaeology) with the assistance of Peter Kurmann, Renate Kroos, Fritz Fuchs, Katarina Papajanni and many others, in particular students in the graduate historic preservation program at the University of Bamberg. Building survey with all exterior and interior elevations, five floor plans, several cross sections and details. Goal of the historic building archaeology: clarification and dating of the precise sequence of construction work, planning intentions and plan alterations. Construction from the foundations to the roof structure.

**Literature:** Achim Hubel, Manfred Schuller: *Der Dom zu Regensburg*. Regensburg 1995. Final publication in preparation.

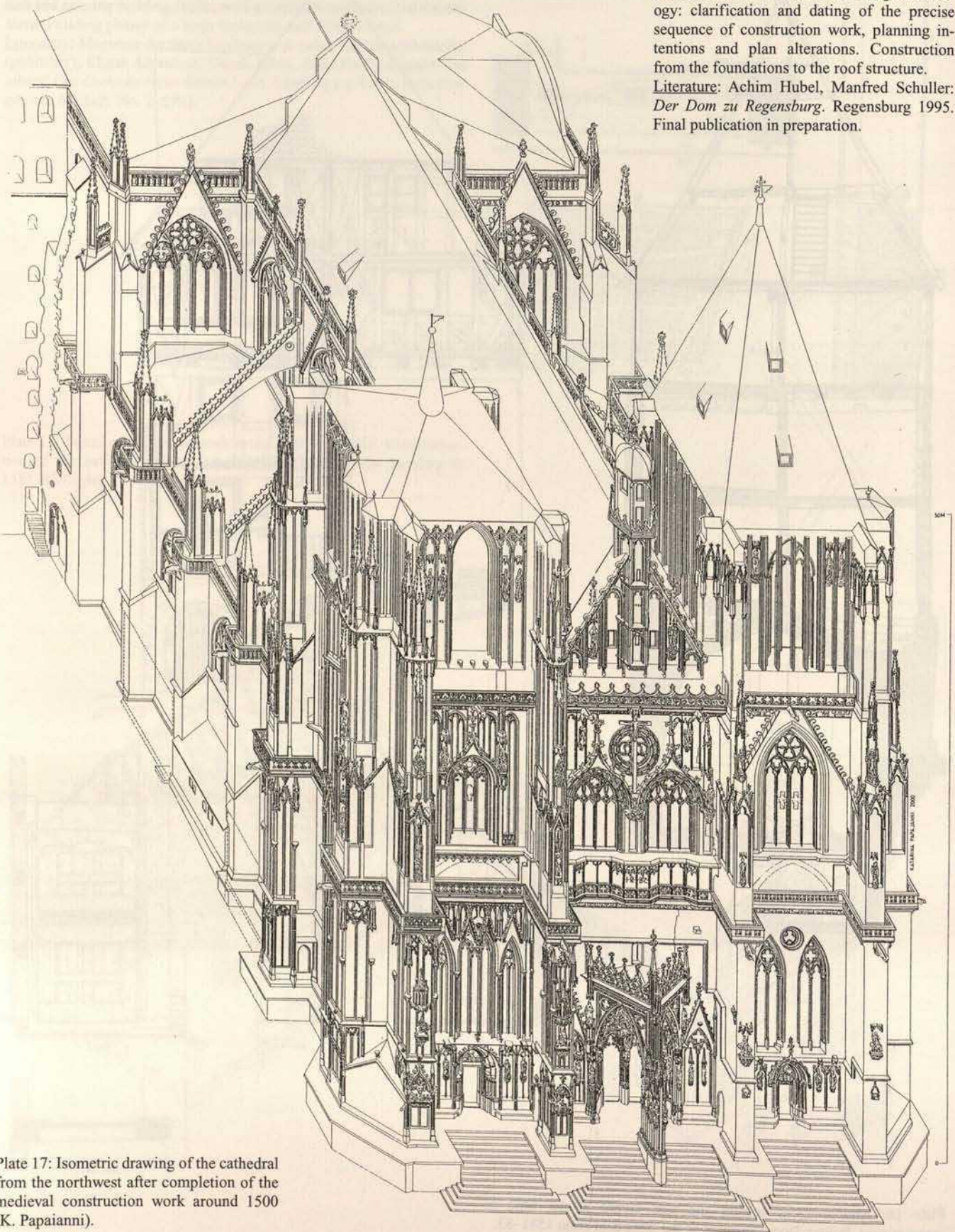
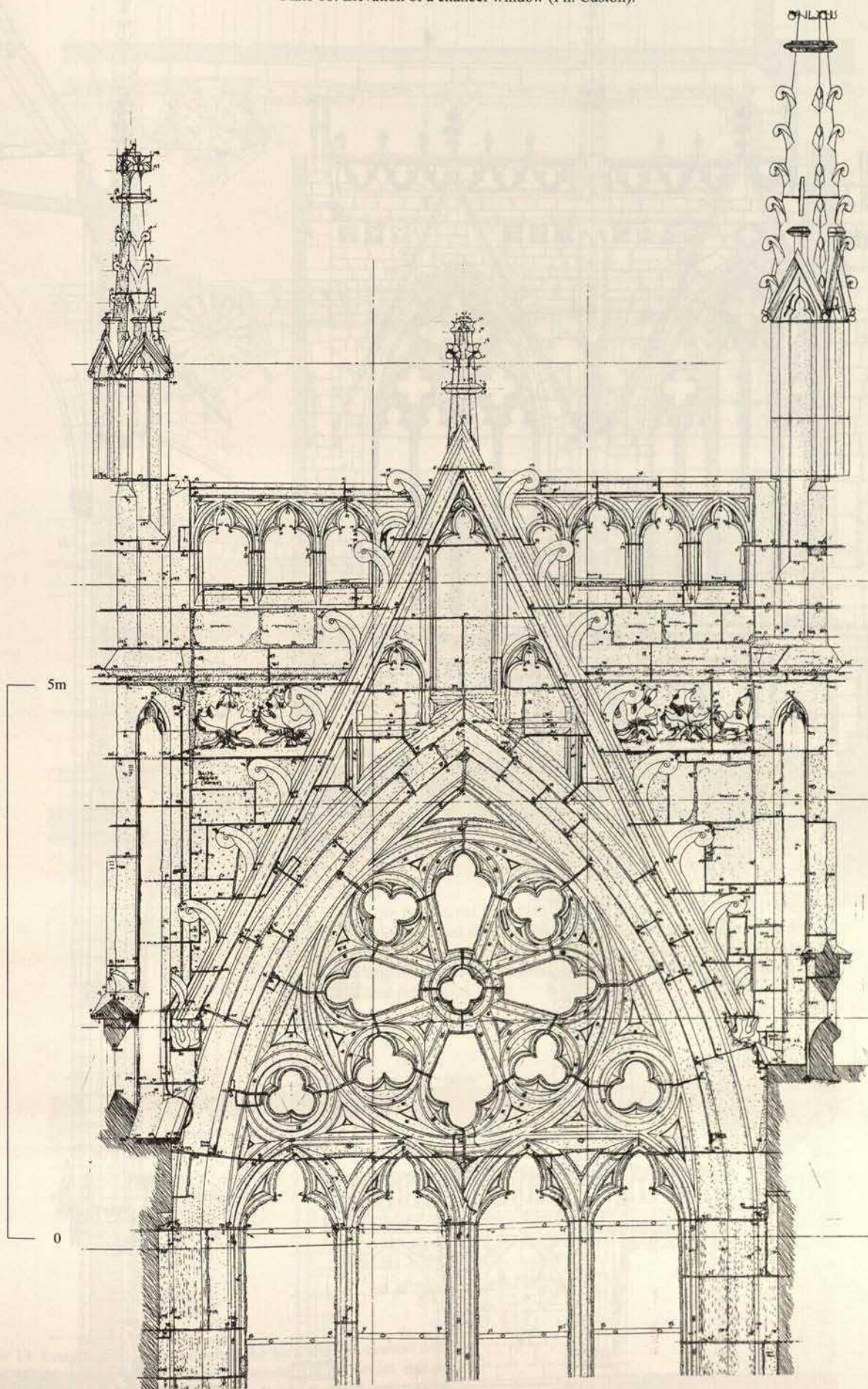
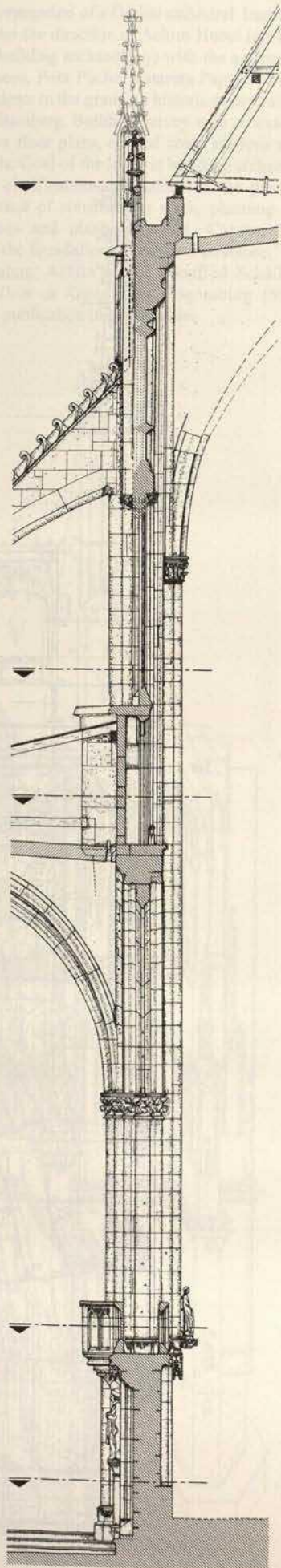
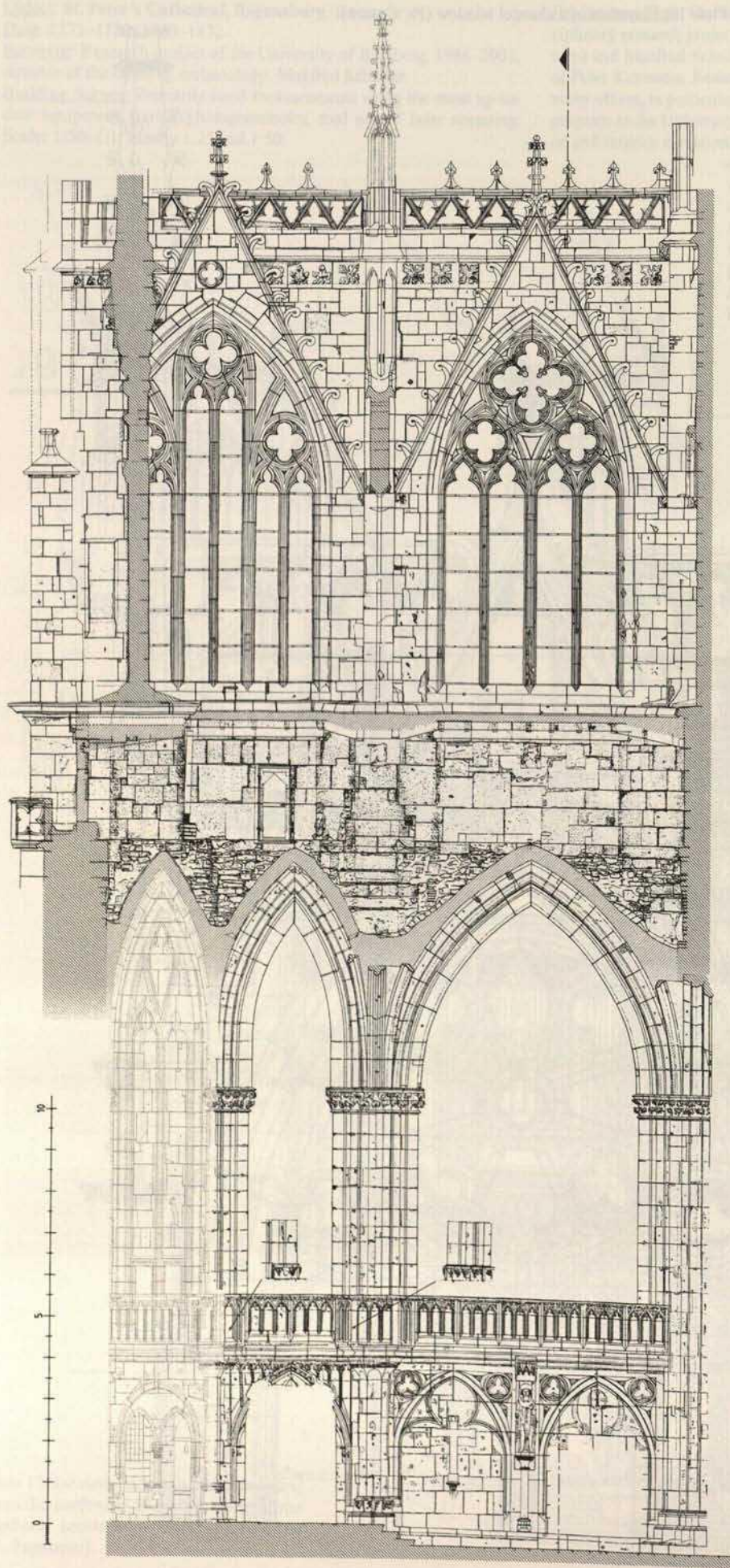


Plate 17: Isometric drawing of the cathedral from the northwest after completion of the medieval construction work around 1500 (K. Papajanni).

Plate 18: Elevation of a chancel window (Ph. Caston).





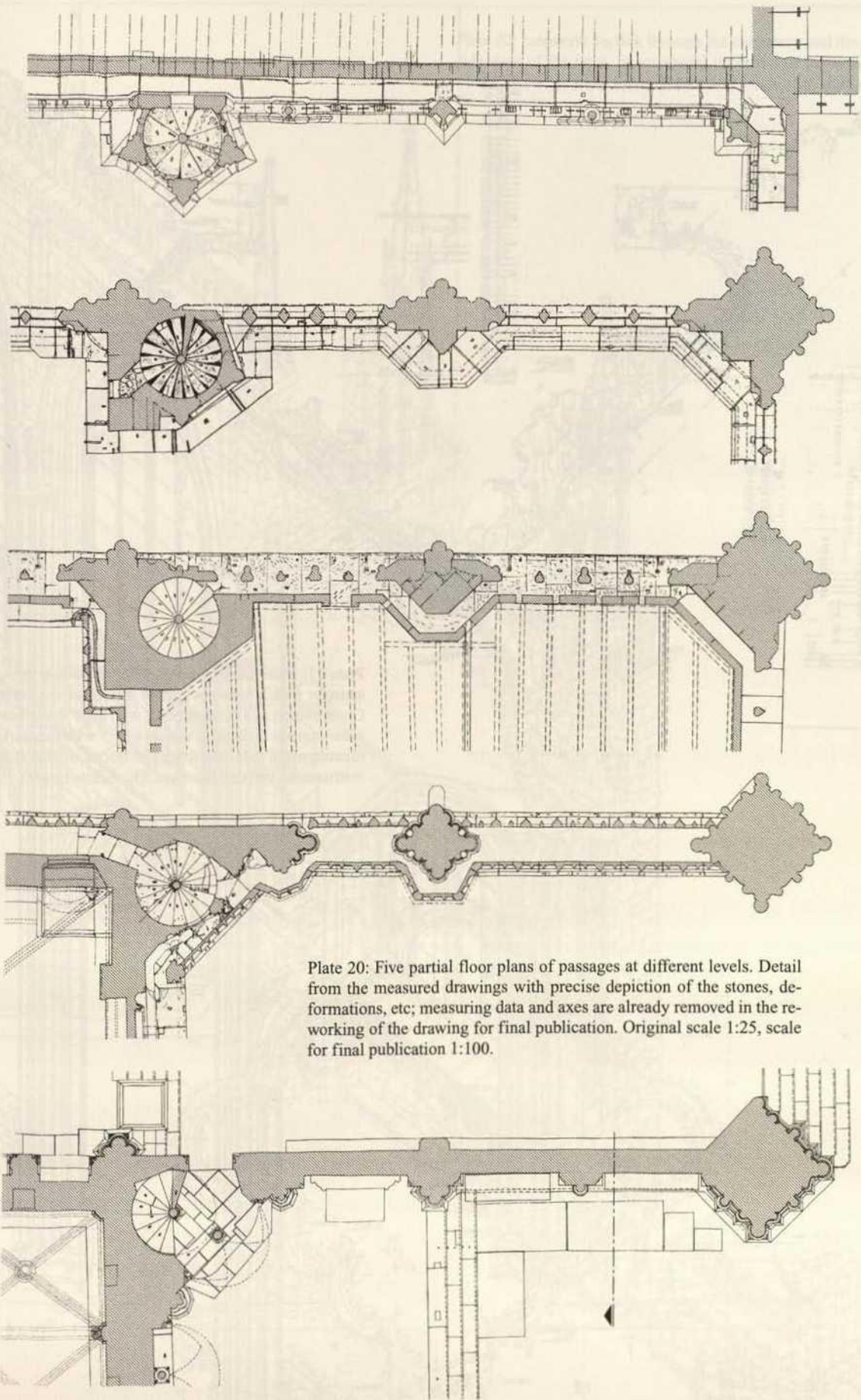


Plate 20: Five partial floor plans of passages at different levels. Detail from the measured drawings with precise depiction of the stones, deformations, etc; measuring data and axes are already removed in the reworking of the drawing for final publication. Original scale 1:25, scale for final publication 1:100.

△ Plate 19: Longitudinal section through the northern side chancel with view of the outside of the chancel clerestory; right: cross section through the entire height of the chancel wall with the vault springer and the flying buttress.

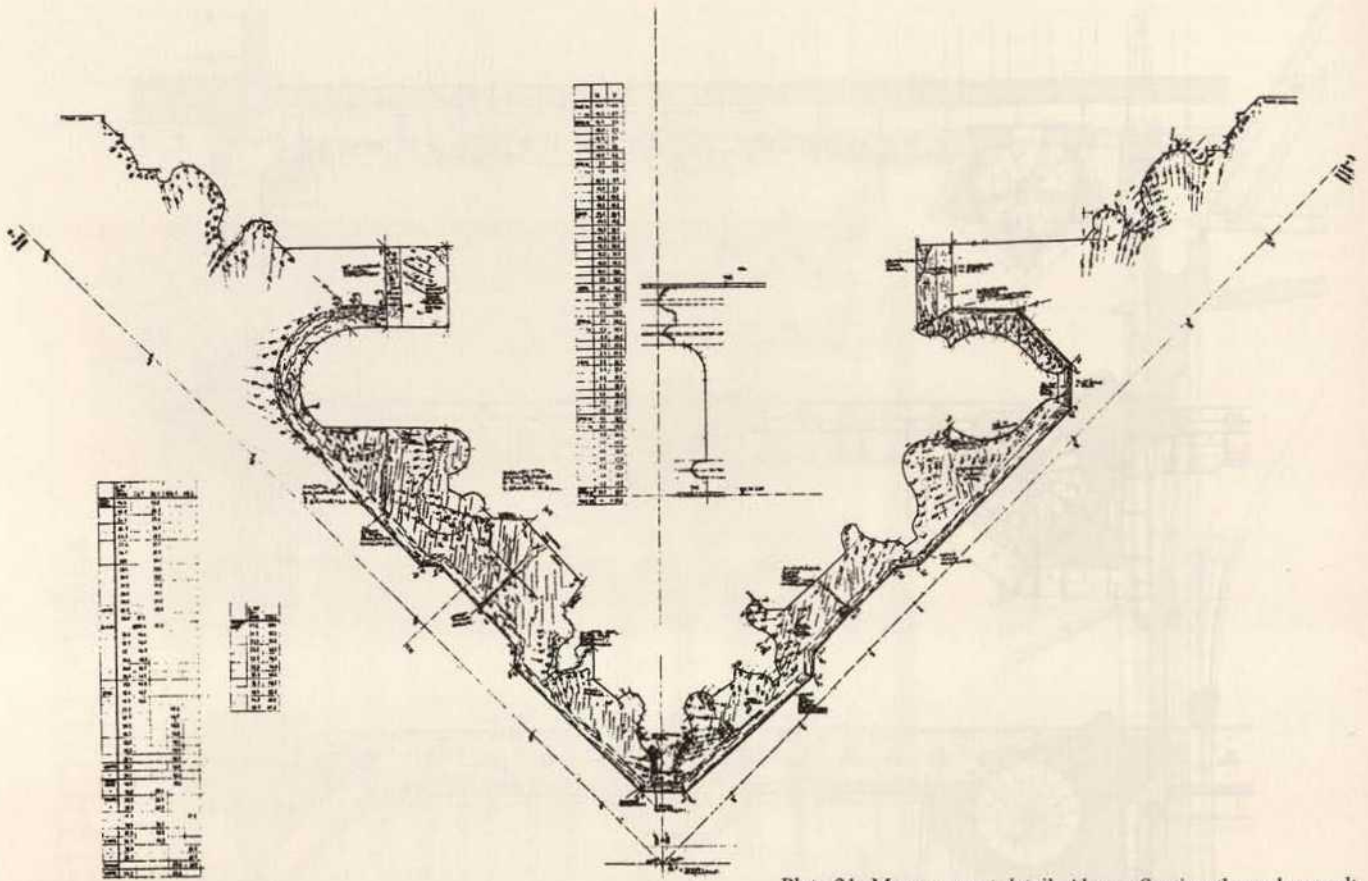
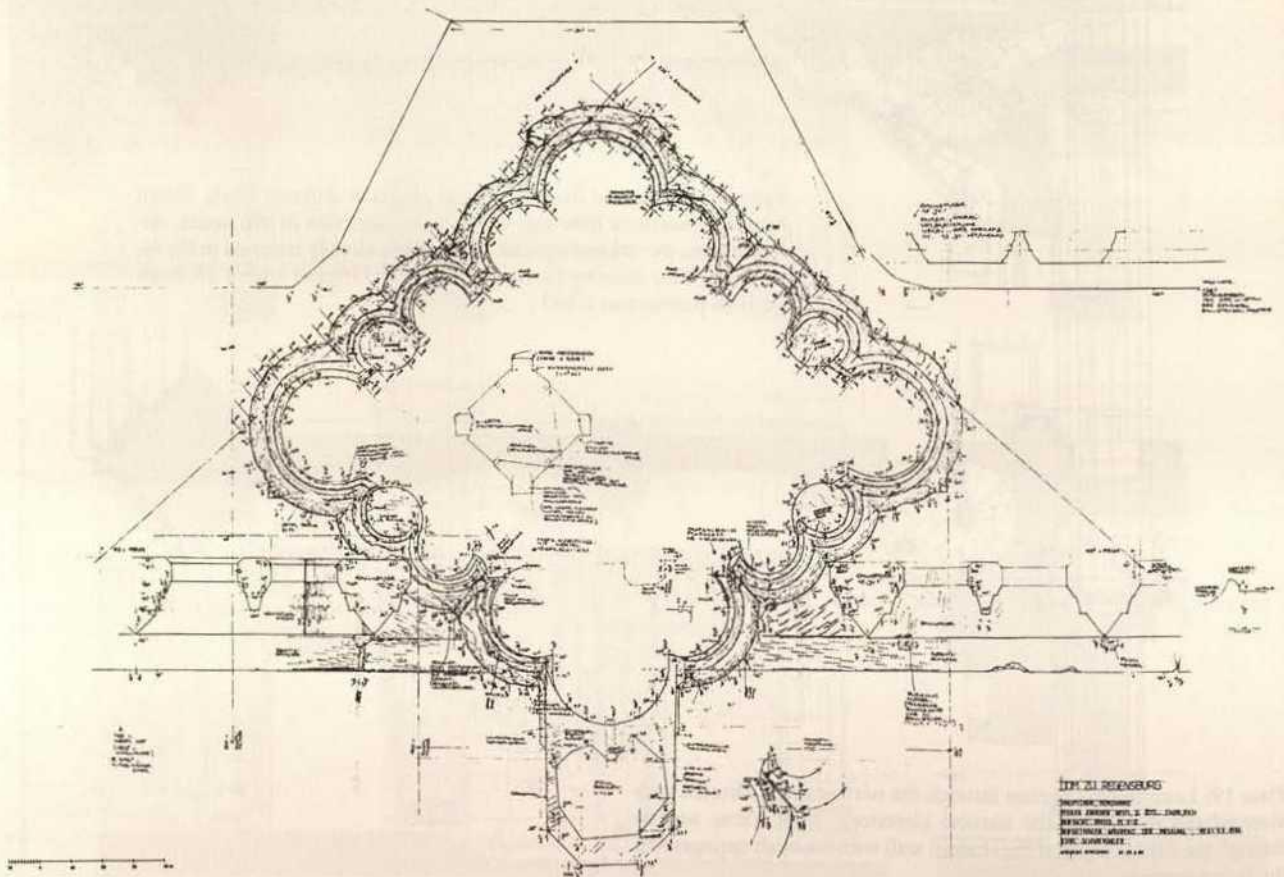
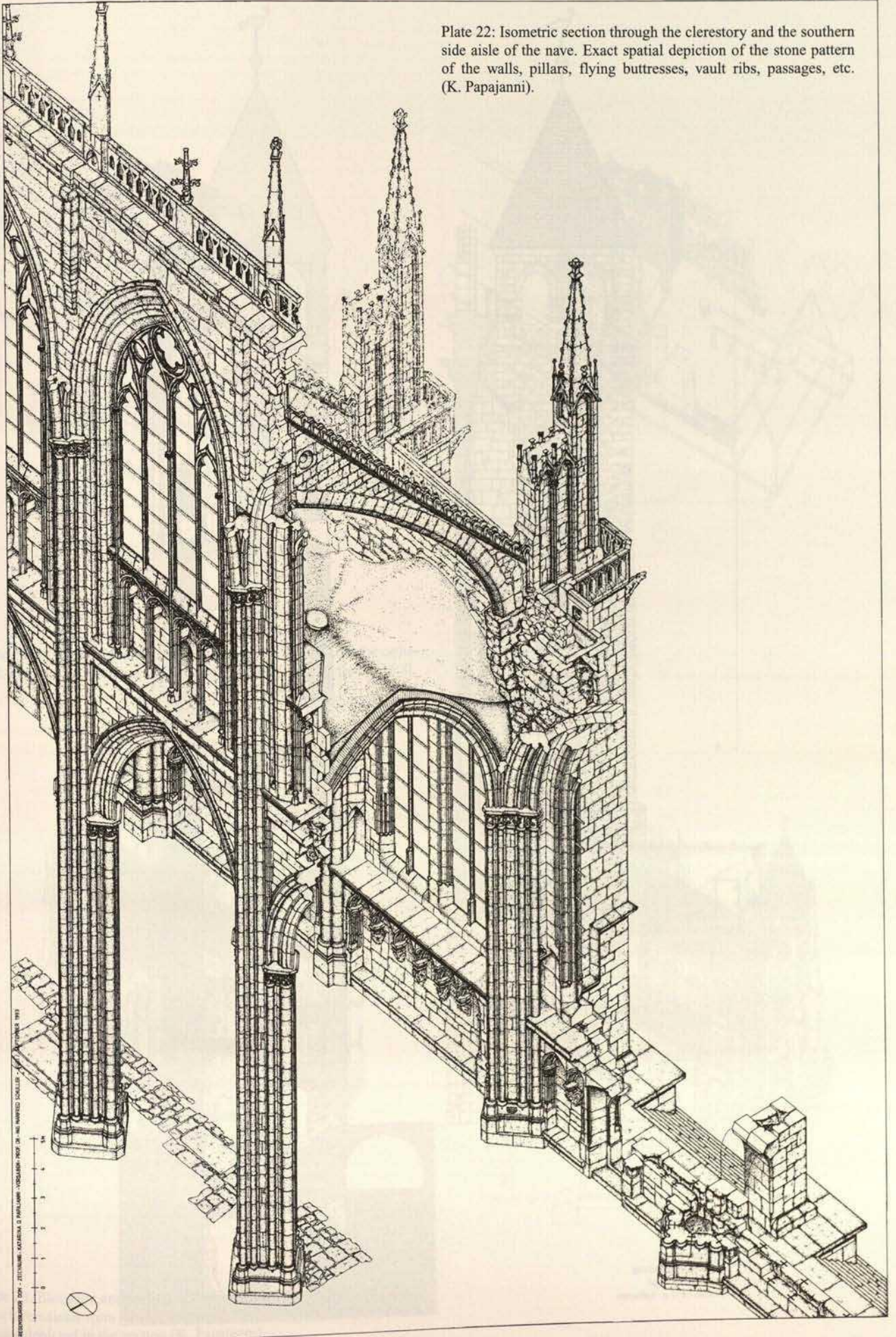


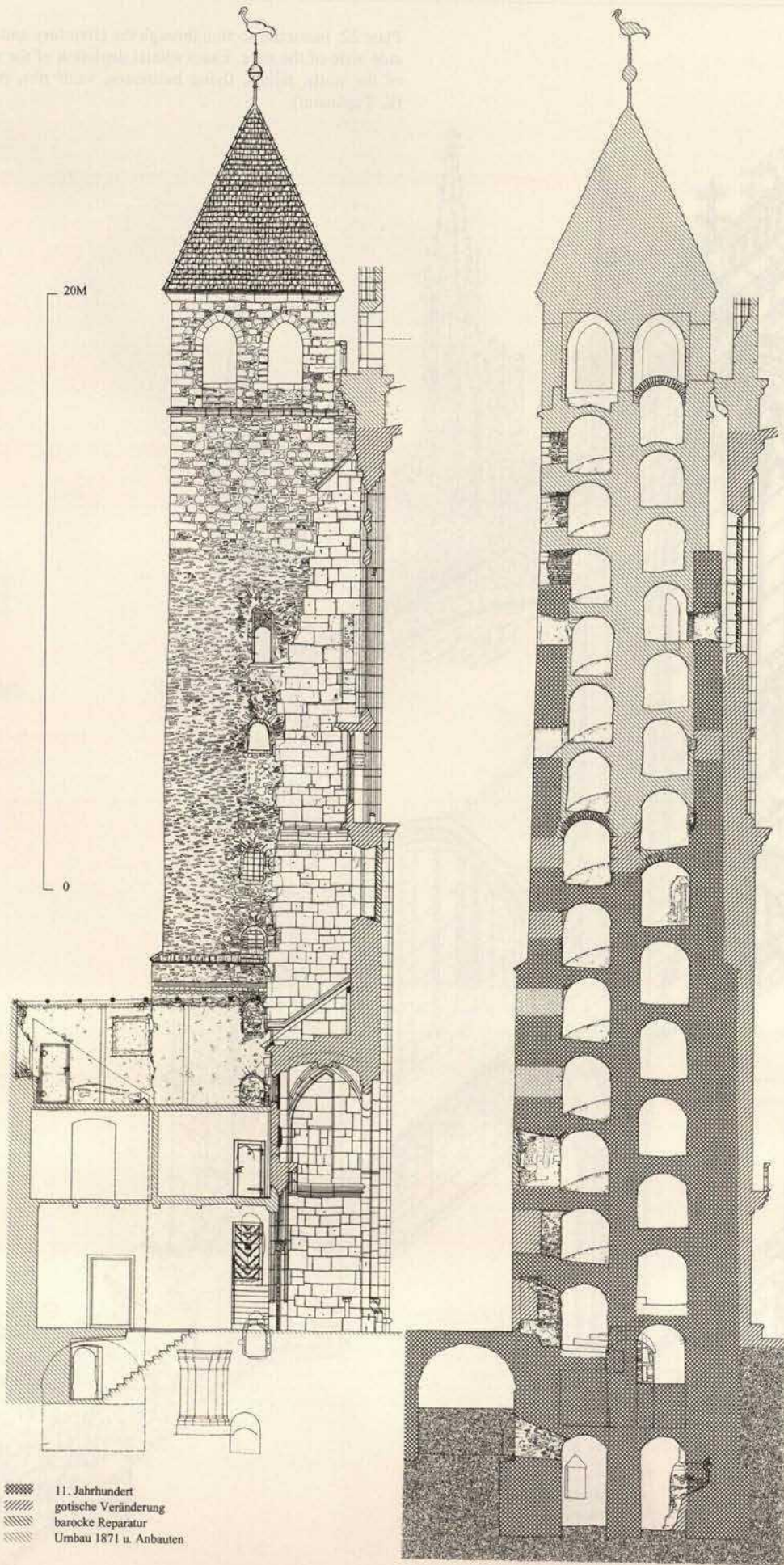
Plate 21: Measurement detail. Above: Section through a vault springer with a view toward the abacus of the capital. Below: Cross section of a chancel pillar with view to the base. Original measurement drawing at a scale of 1:5 with measurement axes, measurement data, depiction of traces of the stone carver's instruments, incising lines, etc. (K. Schnieringer).



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Plate 22: Isometric section through the clerestory and the southern side aisle of the nave. Exact spatial depiction of the stone pattern of the walls, pillars, flying buttresses, vault ribs, passages, etc. (K. Papajanni).







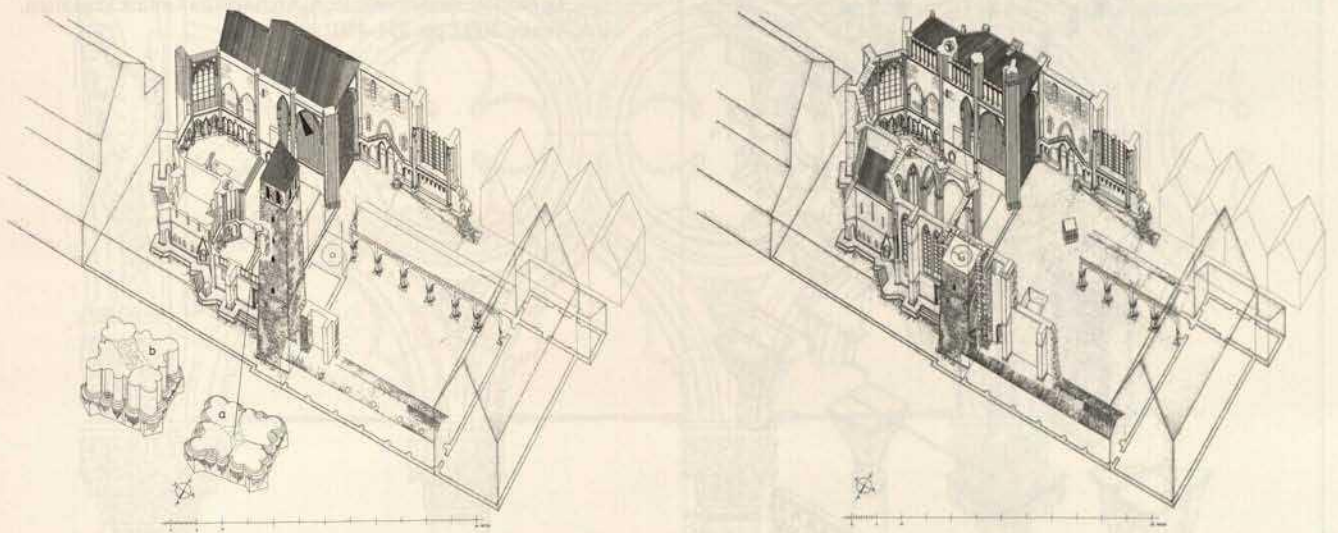


Plate 24: Isometric depiction of four construction phases for the cathedral: a) around 1300, b) around 1310, c) around 1360, d) around 1500.

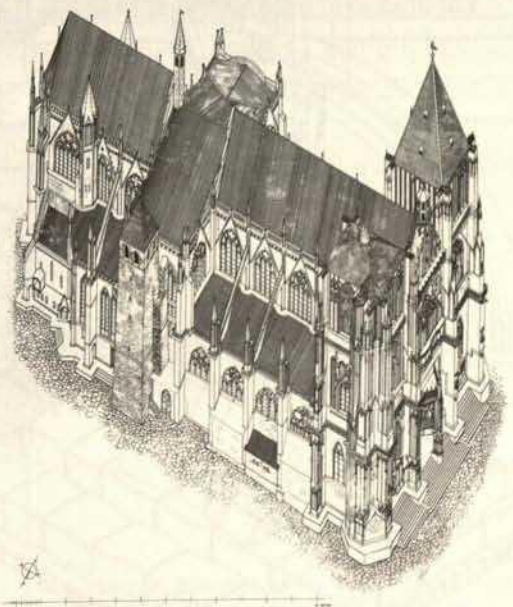
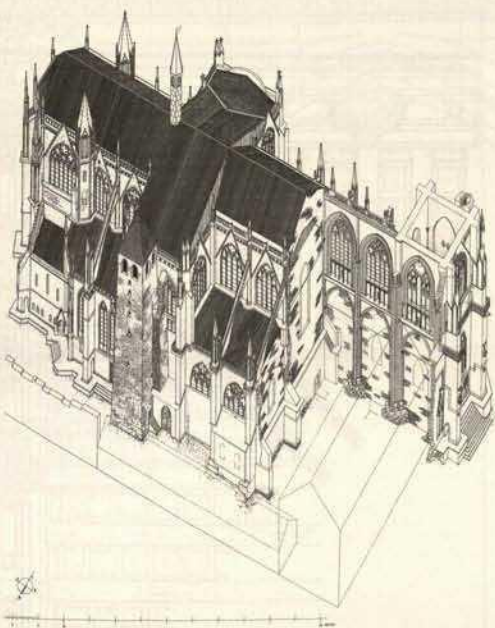
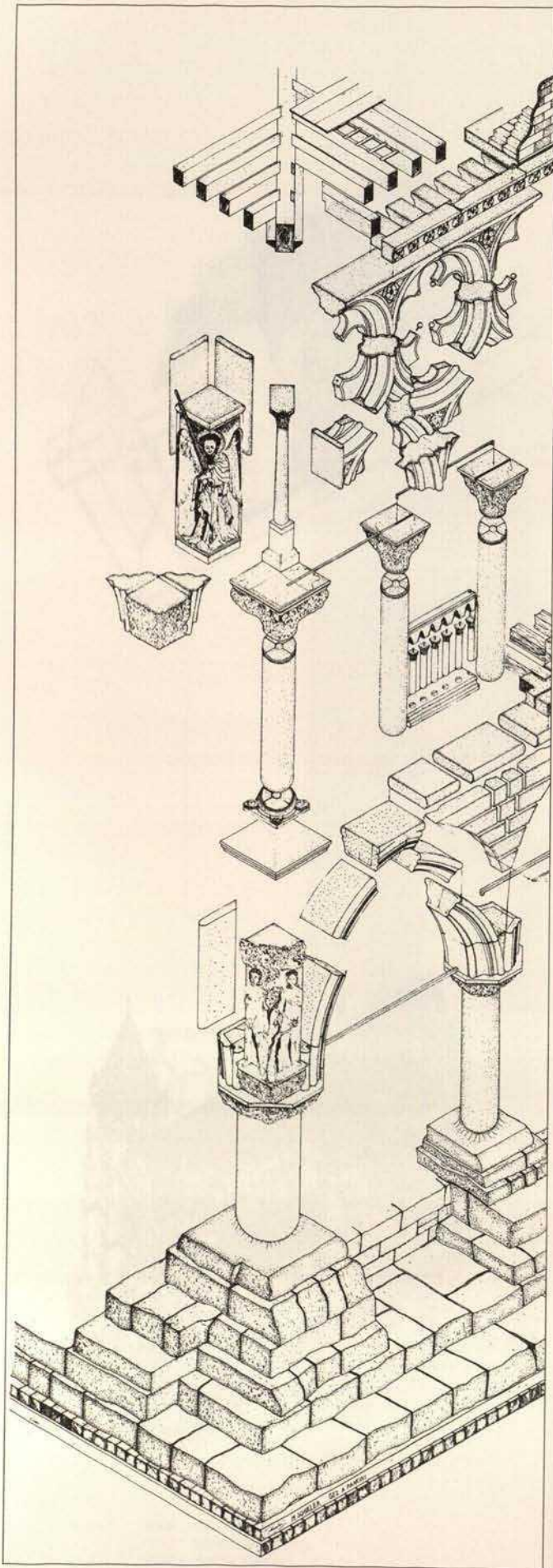


Plate 23: Elevation and section of the tower on the north transept façade which remained from the Romanesque predecessor building. Building phases depicted in the section (K. Papajanni).



**Object:** Façades of the Doge's Palace, Venice, Italy

**Date:** 1341-1438

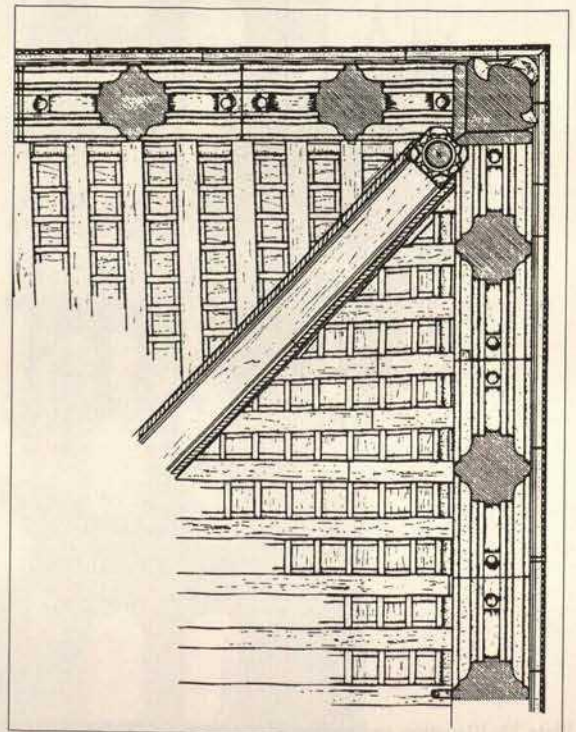
**Surveyor:** Manfred Schuller

**Building Survey:** Hand measurements. Scale 1:20

**Explanatory Note:** Research project. Clarification of the architectural history and the building technology of the façades and of the medieval palace.

**Literature:** Manfred Schuller: *Il Palazzo Ducale di Venezia. Le facciate medioevali*. In: *L'Architettura Gotica Veneziana*. Venice 2000, pp. 351-430.

Plate 25: Isometric drawing of the technical composition of the southwest corner of the Doge's Palace. Underside of a corner of the frame of joists above the loggia.



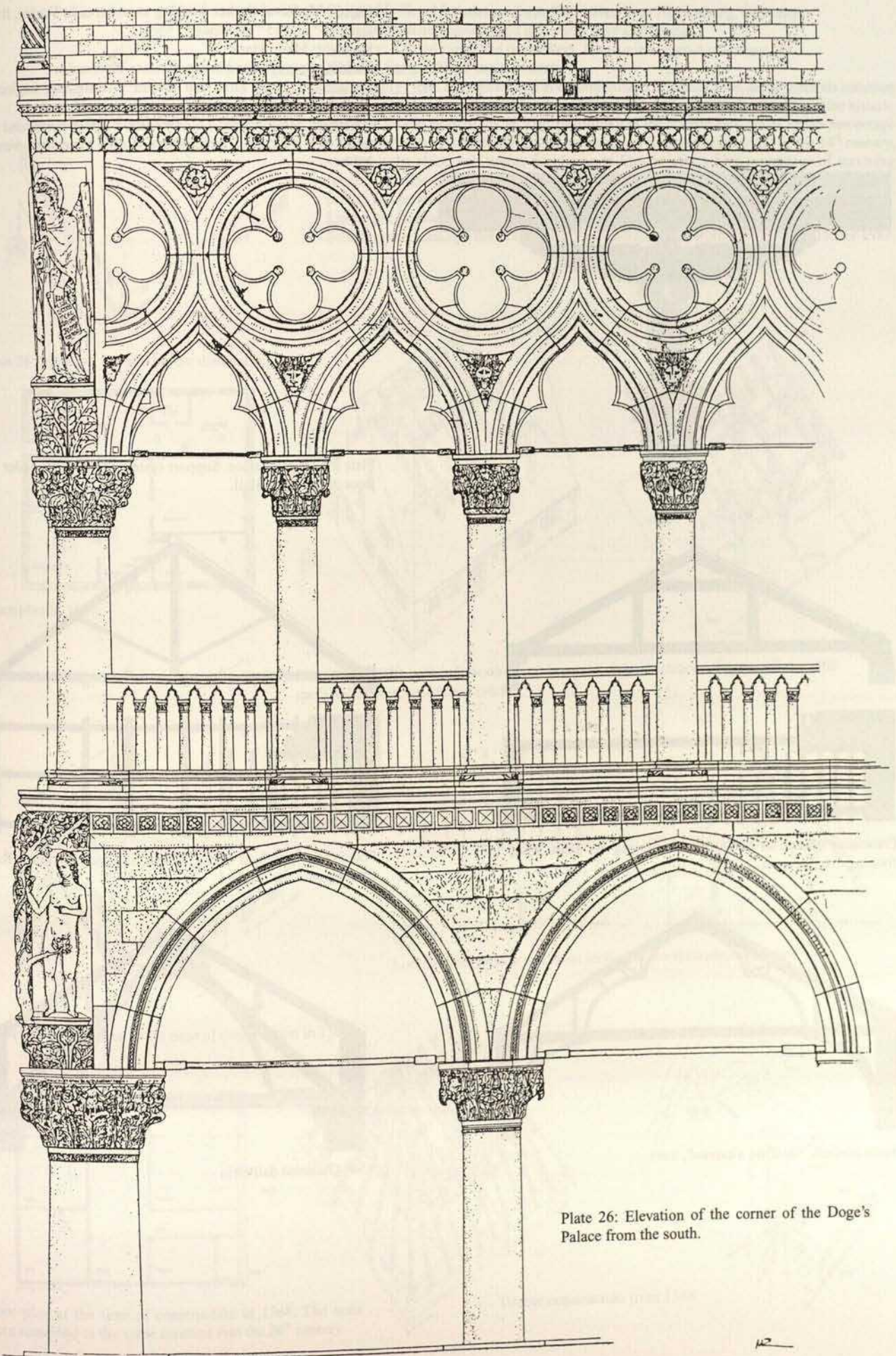


Plate 26: Elevation of the corner of the Doge's Palace from the south.

**Object:** Medieval timber bearing structures in Venice, Italy  
**Date:** 14<sup>th</sup> and 15<sup>th</sup> centuries  
**Surveyor:** Mario Piana  
**Building Survey:** Hand measurements, watercolor  
**Explanatory Note:** First step toward investigating neglected wide-spanning wooden structural systems in Venice.  
**Literature:** Mario Piana: *La carpenteria lignea veneziana nei secoli XIV e XV*. In: *L'Architettura Gotica Veneziana*. Venice 2000

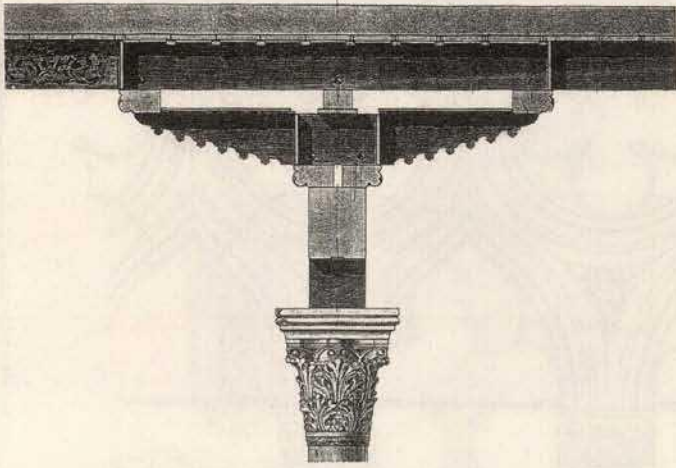
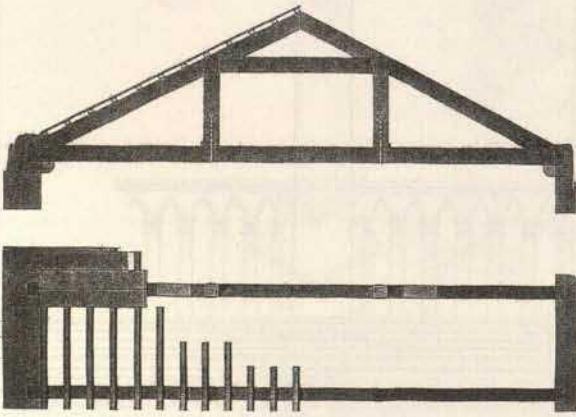
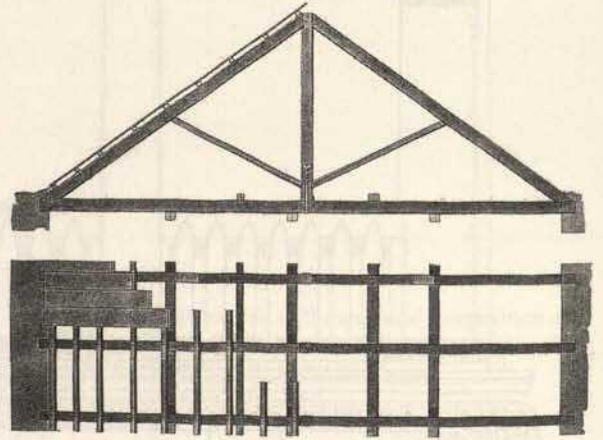


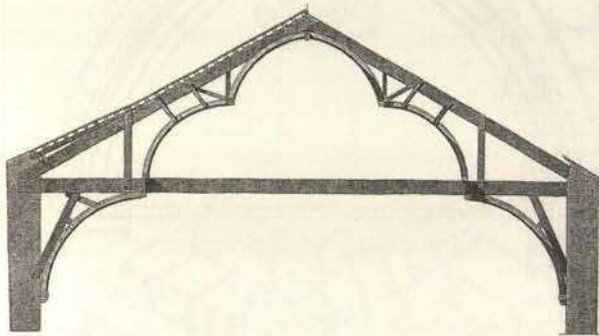
Plate 27: Doge's Palace. Support system of the joists under the floor of the Great Hall.



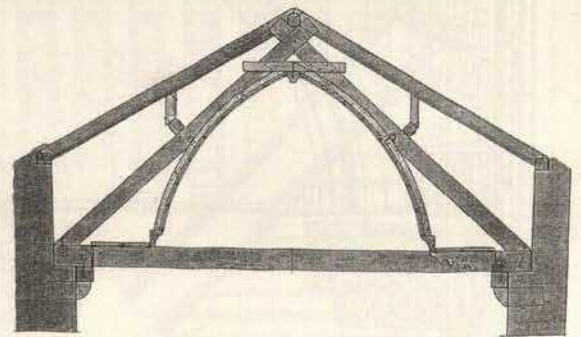
Franciscan church of Santa Maria Gloriosa dei Frari. Roof framing over the nave.



Franciscan church of Santa Maria Gloriosa dei Frari. Roof framing over the chancel.



Santo Stefano. "Soffitto a carena", nave



San Giacomo dall'Orio

**Object:** Medieval farmhouse from Höfstetten near Nuremberg, Germany

**Date:** 1368 (dendrochronologic date) with later alterations

**Surveyor:** Konrad Bedal and co-workers. Franconian Open-Air Museum.

**Building Survey:** Hand measurements

**Explanatory Note:** Documentation of a farmhouse to be demolished, using methods common in the field of house research. Massive exterior walls and gable roof, according to the historic building list dating from the 18<sup>th</sup>/19<sup>th</sup> centuries. On the interior survival of a high percentage of the interior posts of the half-timber construction from the second half of the 14<sup>th</sup> century, making it the oldest half-timber farmhouse in Europe with a high percentage of surviving fabric. The surviving building components made a complete reconstruction possible. Transport to an open-air farmhouse museum and re-erection in its 14<sup>th</sup> century form.

**Literature:** Konrad Bedal, Silvia Codreanu and others: *Ein Bauernhaus aus dem Mittelalter*. Schriften und Kataloge des Fränkischen Freilandmuseums. Rothenburg ob der Tauber 1987

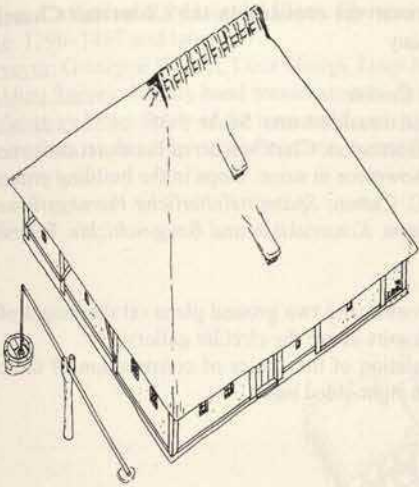
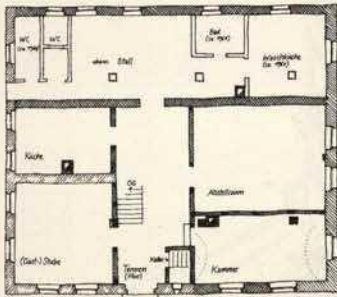
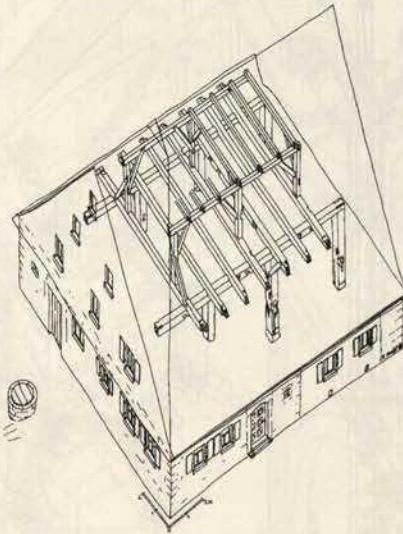


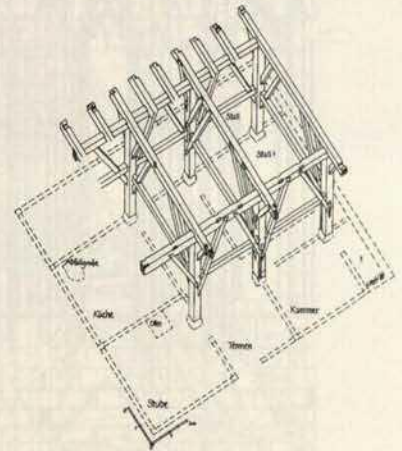
Plate 28: Situation in 1980 before dismantling



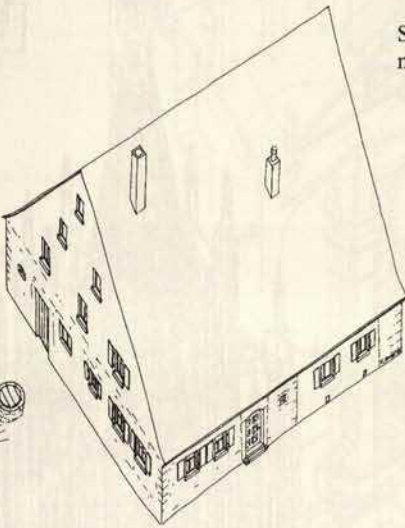
Floor plan in 1980



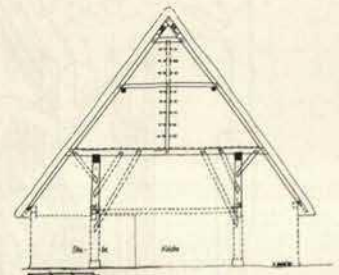
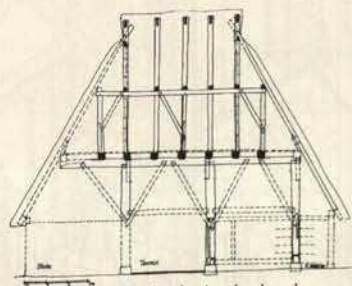
Situation in 1980, with indication of surviving medieval interior structural system.



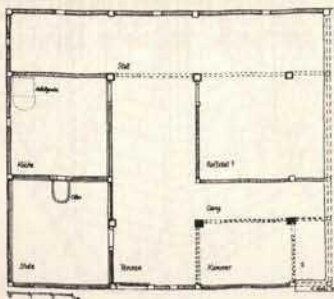
Interior structural system from 1368



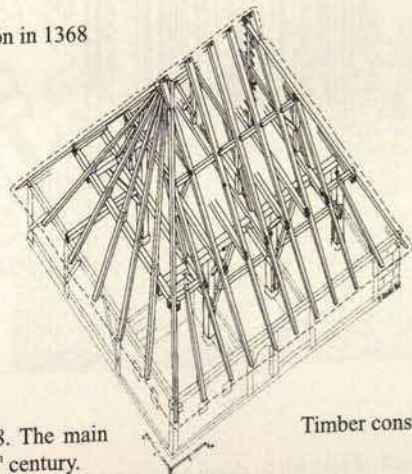
Depiction of the house at the time of construction in 1368



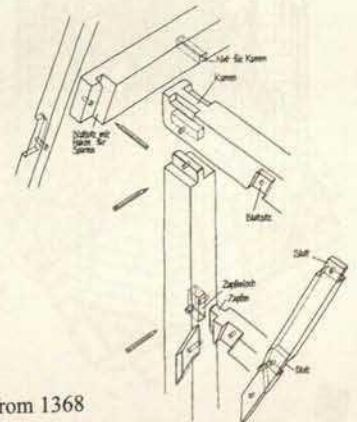
Longitudinal section and cross section of the reconstructed house



Floor plan at the time of construction in 1368. The main room remained in the same location into the 20<sup>th</sup> century.



Timber construction from 1368



**Object:** Stone tower over the crossing in the Cistercian Church in Bebenhausen, Germany

**Date:** 1407–1409

**Surveyor:** Philip S.C. Caston

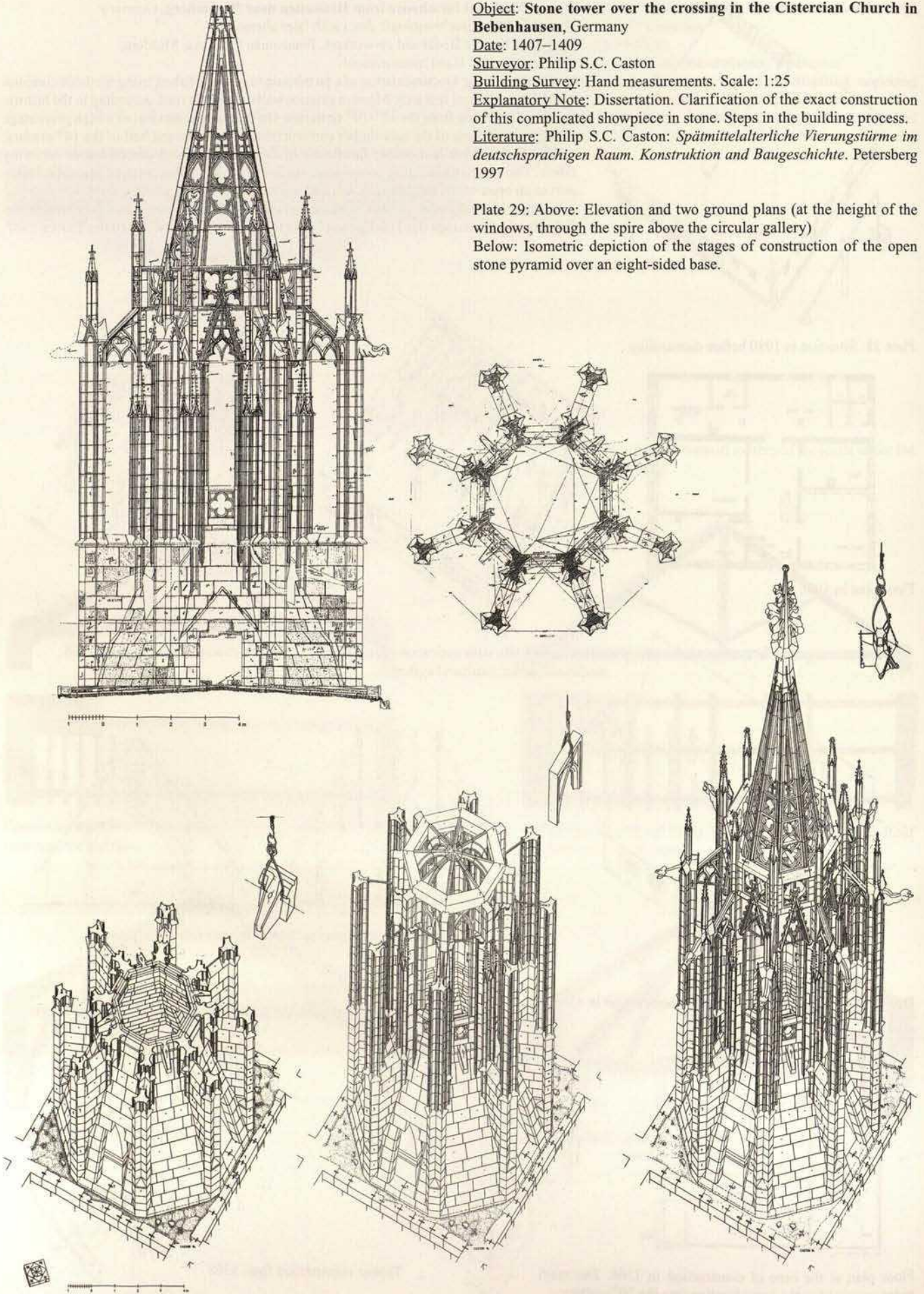
**Building Survey:** Hand measurements. Scale: 1:25

**Explanatory Note:** Dissertation. Clarification of the exact construction of this complicated showpiece in stone. Steps in the building process.

**Literature:** Philip S.C. Caston: *Spätmittelalterliche Vierungstürme im deutschsprachigen Raum. Konstruktion und Baugeschichte*. Petersberg 1997

Plate 29: Above: Elevation and two ground plans (at the height of the windows, through the spire above the circular gallery)

Below: Isometric depiction of the stages of construction of the open stone pyramid over an eight-sided base.



**Object:** Cathedral S. Maria del Fiore, Florence, Italy

**Date:** 1296–1467 and later

**Surveyor:** Giuseppe Rocchi, Luca Giorgi, Luigi Marino

**Building Survey:** Mostly hand measurements. Scale: 1:50

**Explanatory Note:** Study of the nave and façade through combination of results from archaeological excavations, scientific and dendrochron-

ological investigations and the evidence of the built fabric. Attention was paid to usually neglected zones such as the construction of the vaulting and the roof.

**Literature:** Giuseppe Rocchi, Anna Bebbler, Roberto Franchi, Luca Giorgi, Luigi Marino: *S. Maria del Fiore. Rilievi, documenti, indagini strumentali. Interpretazione. Il corpo basilicale*. Milan 1988

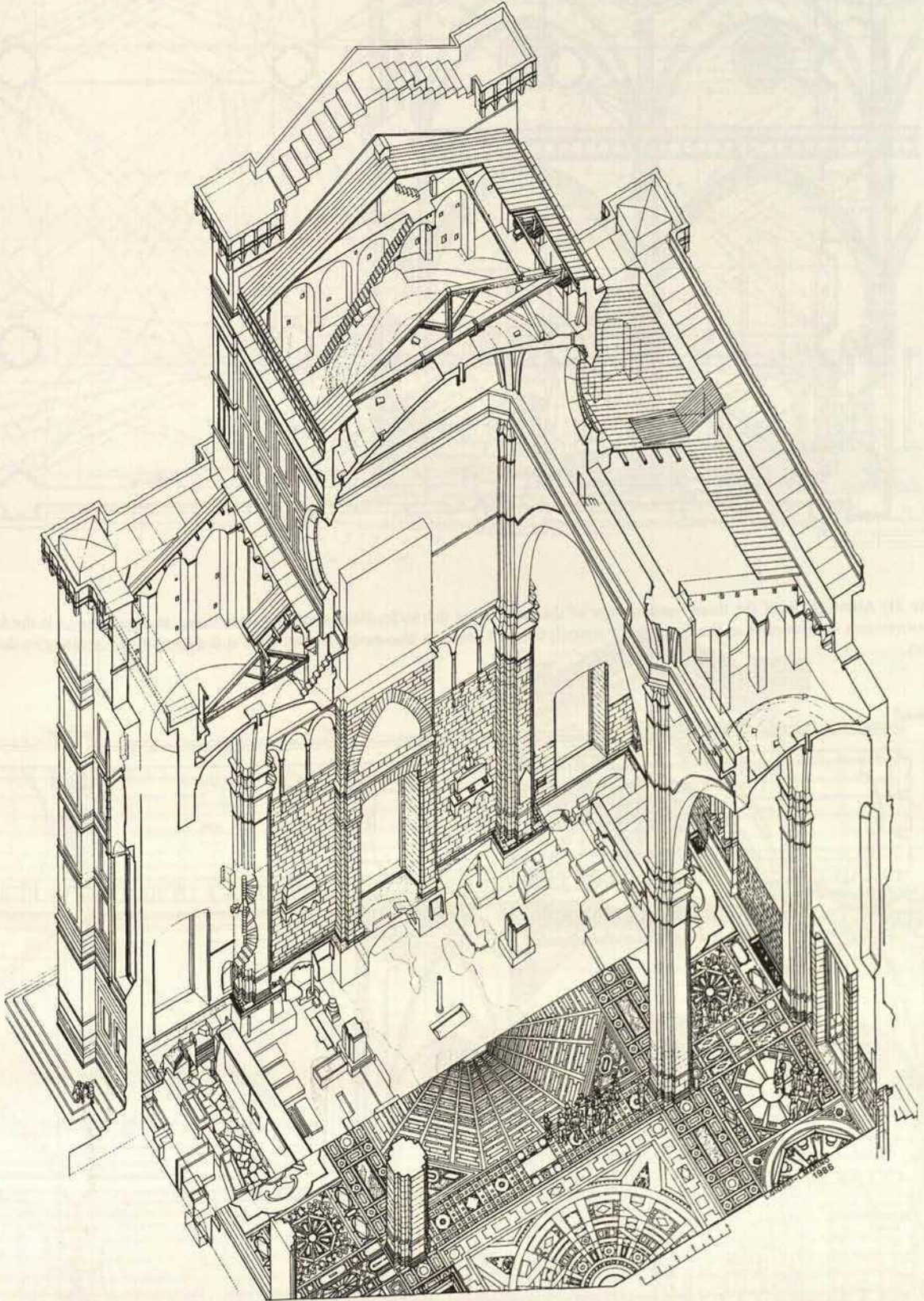


Plate 30: Isometric section through the nave with looking toward the inside of the façade. Formal and technical structural system. Partial recording of the floor and the results of excavations in the area of the façade.

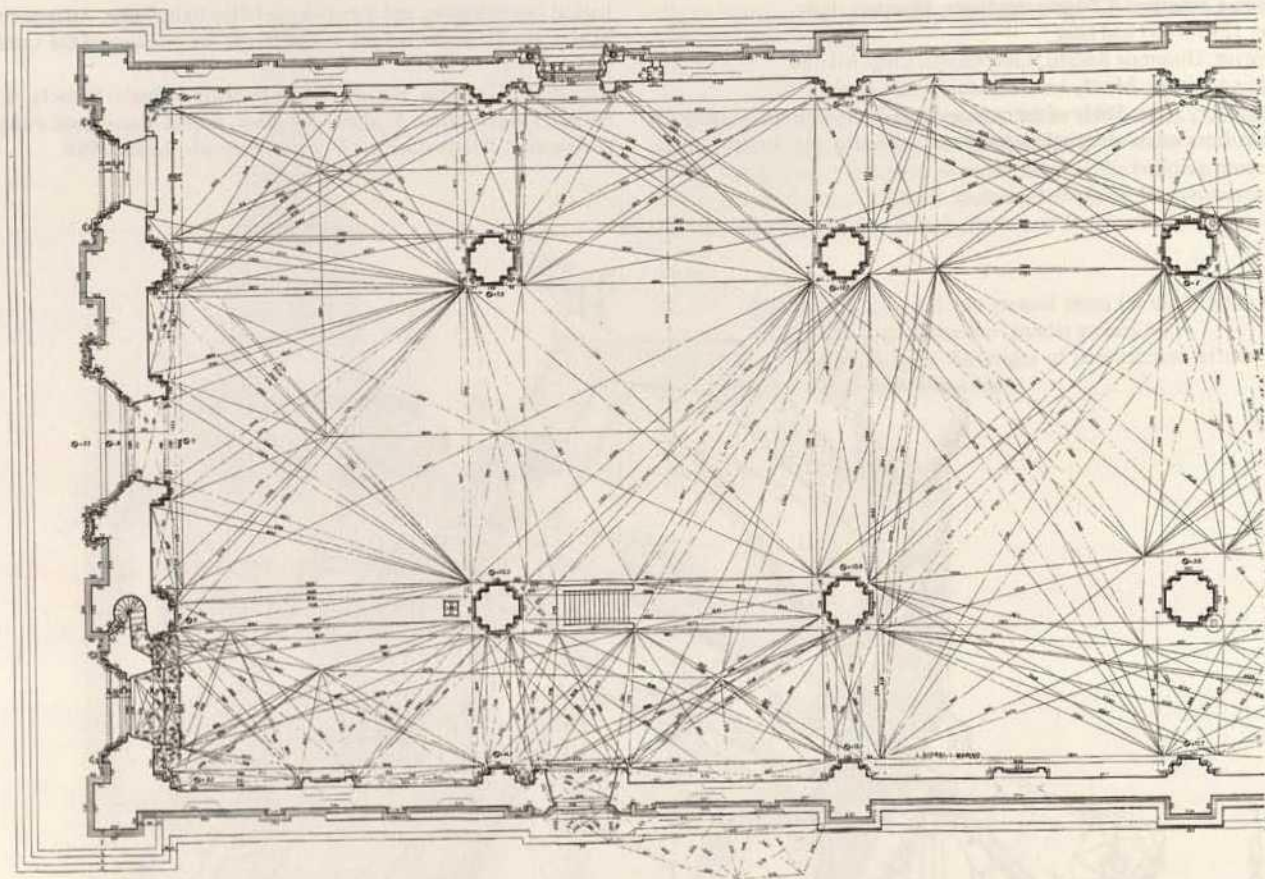
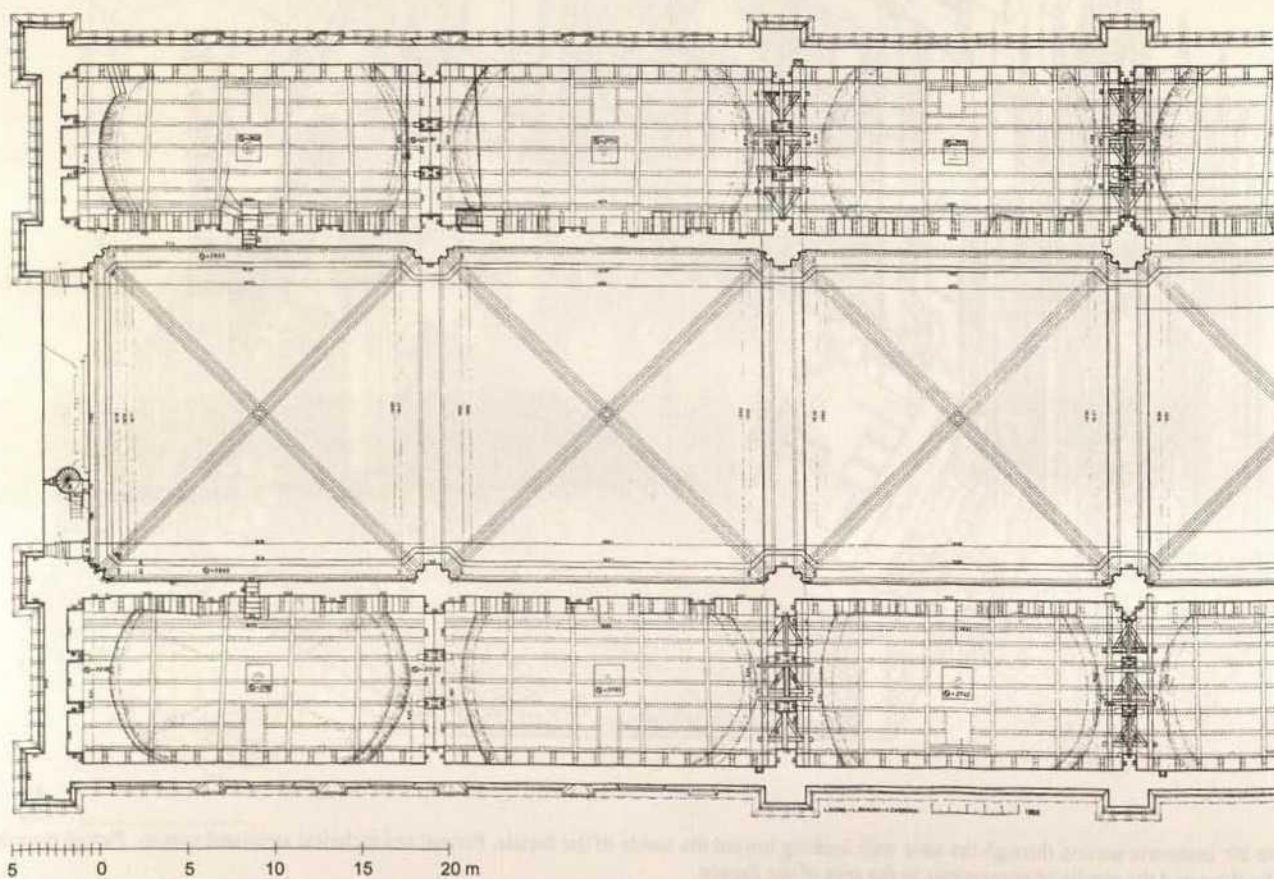


Plate 31: Above: Plan of the three western bays of the nave above the socle. Hand measurements using triangulation. All the length measurements are recorded on the drawing for control; the spot height is also noted. Below: Plan at the level of the vaulting in the side aisles.





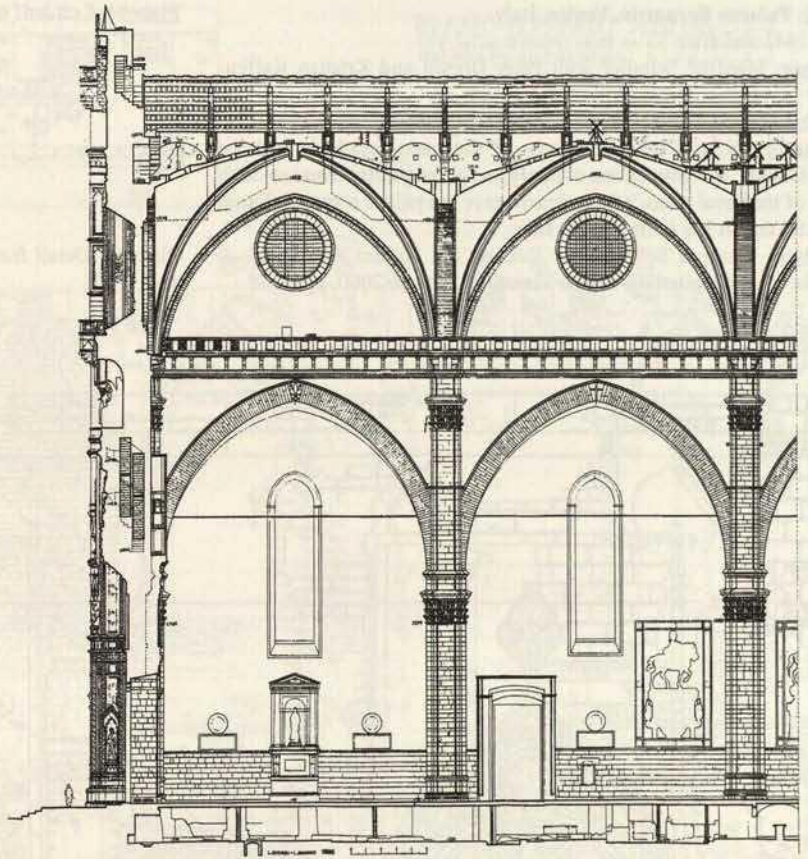
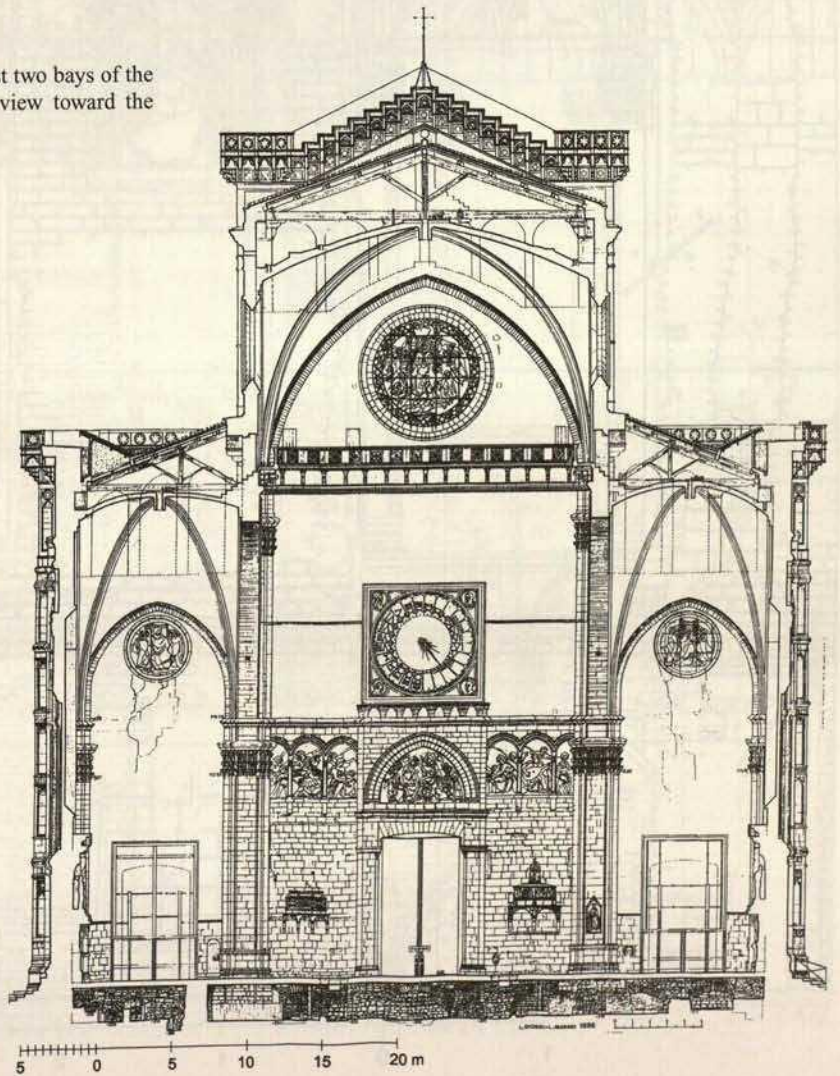


Plate 32: Above: Longitudinal section through the first two bays of the nave. Below: Cross section through the nave with view toward the facade.



5 0 5 10 15 20 m

Object: Palazzo Bernardo, Venice, Italy

Date: 1442 and after

Surveyor: Manfred Schuller with Peter Dresen and Kristian Kaffenberger

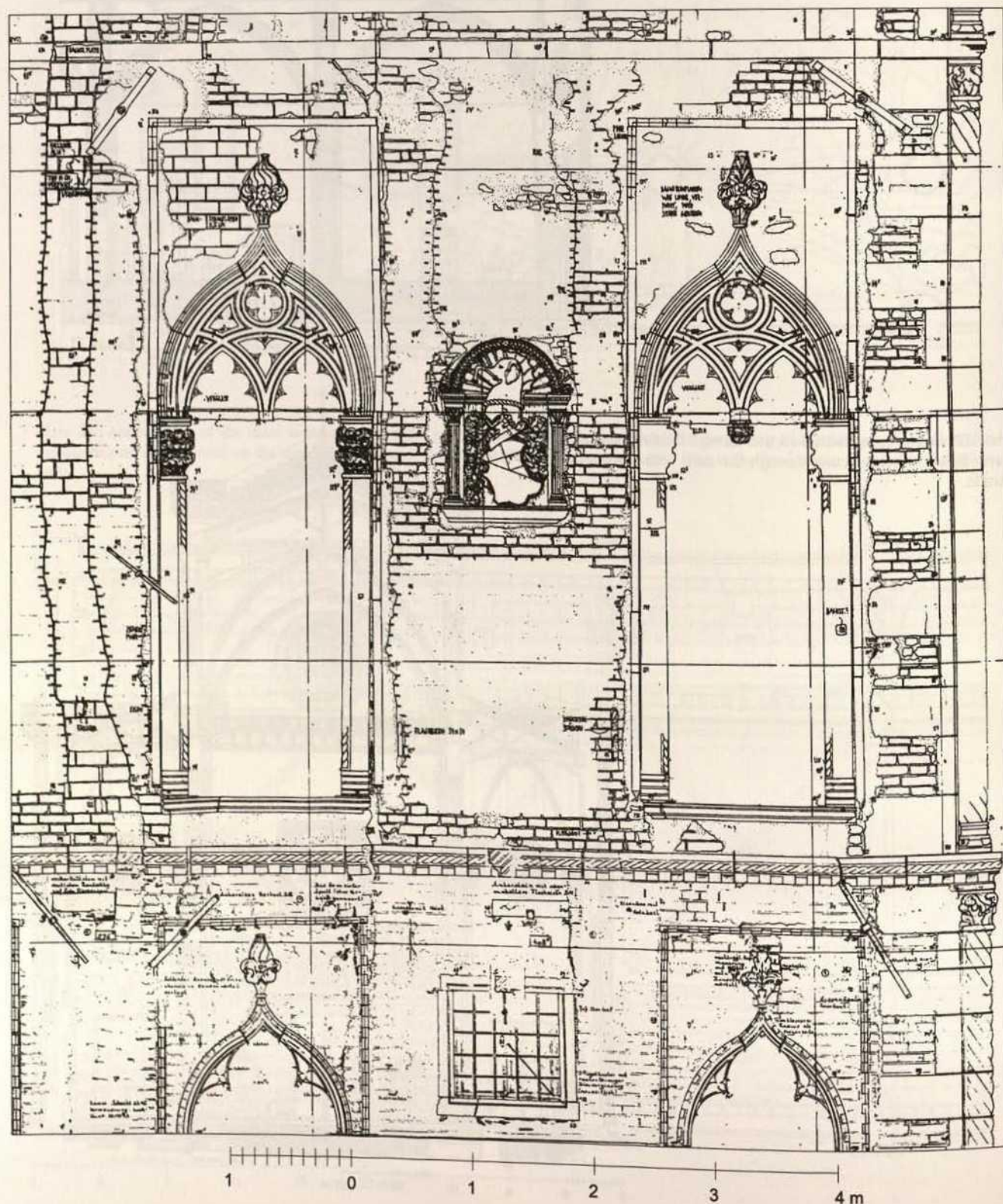
Building Survey: Hand measurements. Scale: 1:25

Explanatory Note: Complete survey of the main façade toward the Canal Grande. Documentation of rarely preserved plaster remnants with traces of medieval paint, which clearly gave the palace a very different character than it has in its present state.

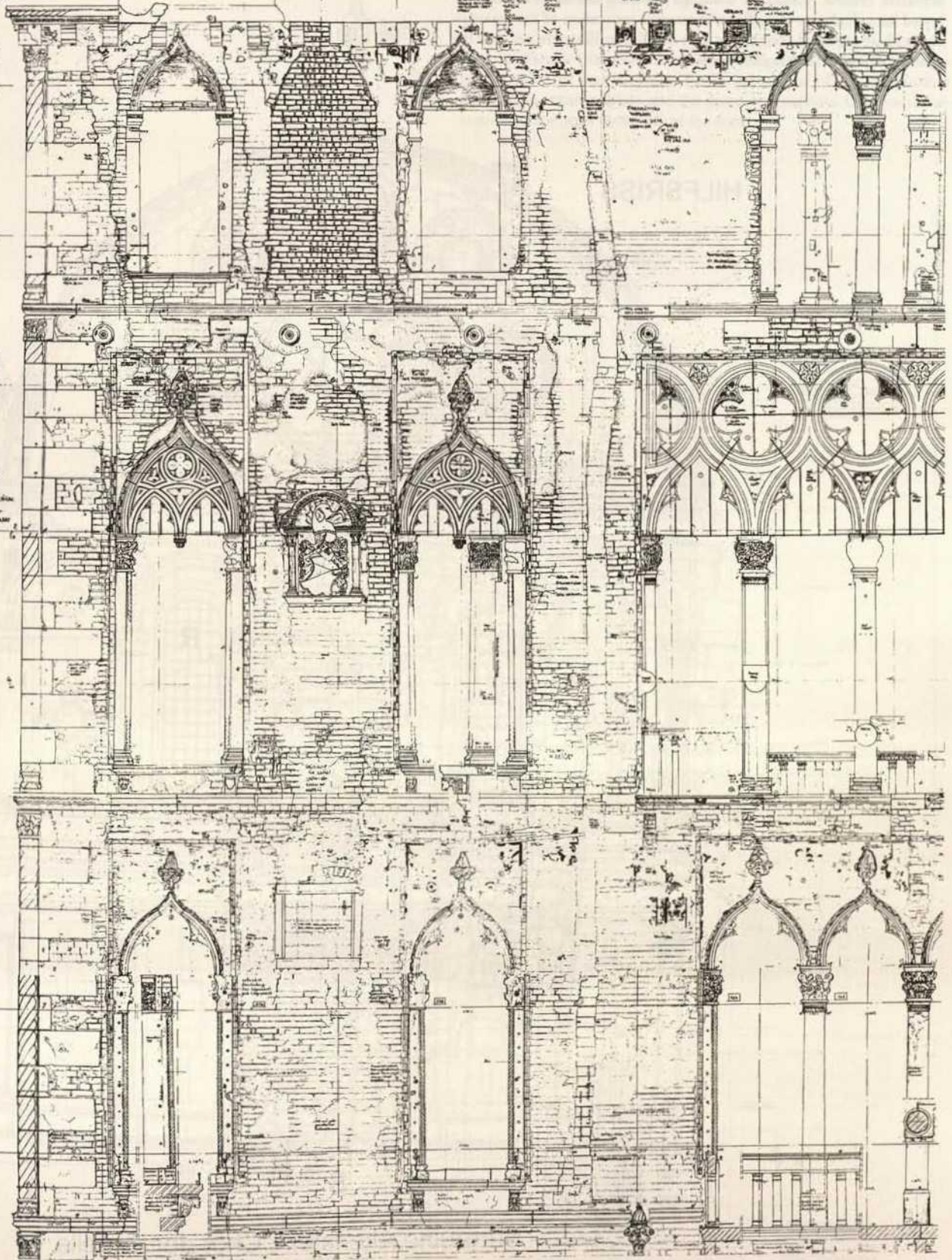
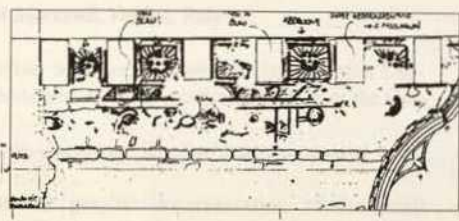
Literature: Manfred Schuller: *Le facciate dei palazzi medioevali di Venezia*. In: *L'Architettura Gotica Veneziana*. Venice 2000, pp. 323f.

Plate 34: Left half of the façade

Plate 33: Detail from the building survey at a 50% reduction. Present scale 1:50.



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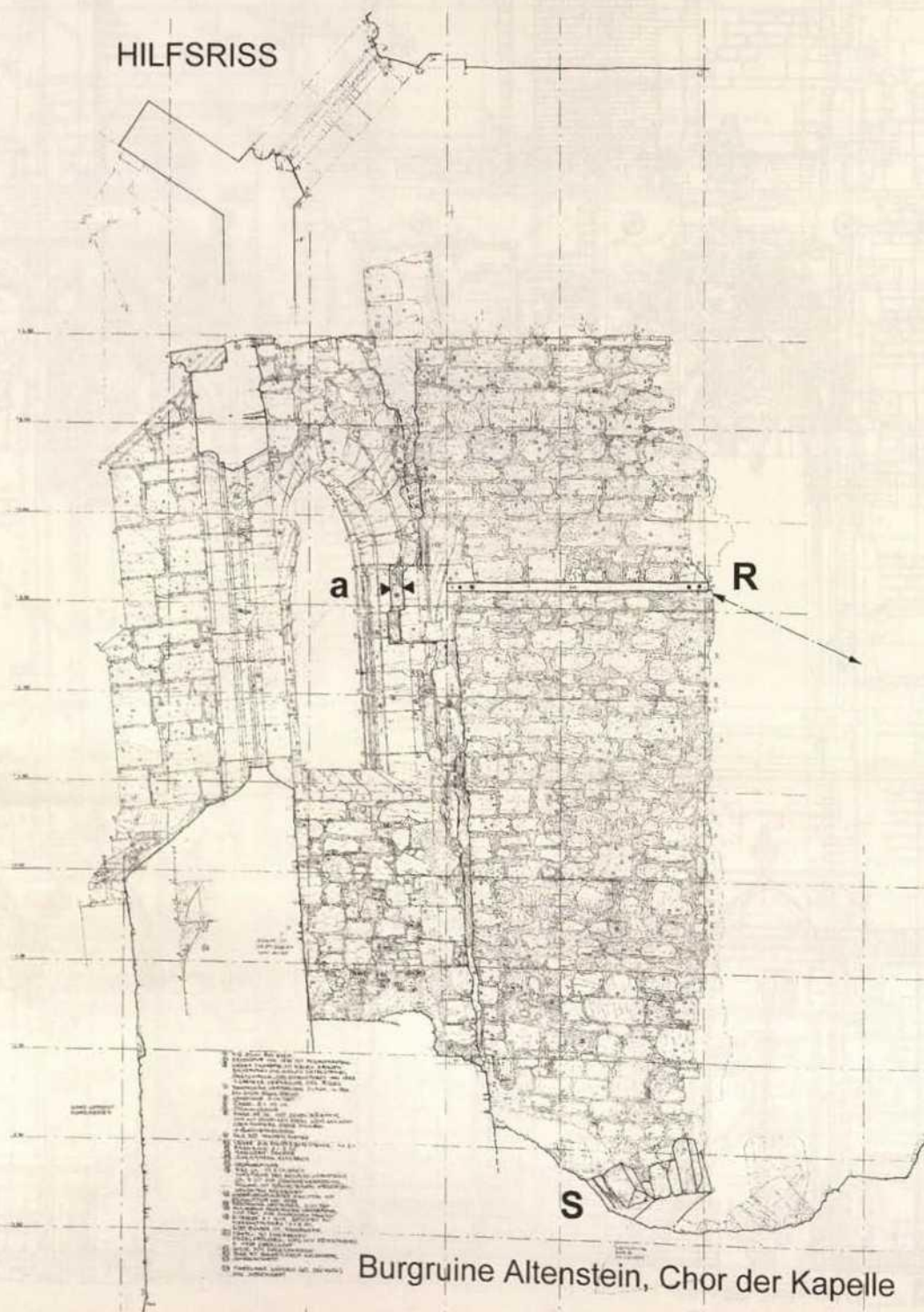
**Object:** Chapel of the ruined castle of Altenstein, Germany

**Date:** 15<sup>th</sup> century

**Surveyor:** Gert Th. Mader and co-workers

**Building Survey:** Hand measurements

**Explanatory Note:** Chapel ruin critically endangered by rock substructure drifting towards the valley. Consolidation measures of late 19<sup>th</sup> century already destroyed by continuous drift. Aim of the investigation of 2001: analysis of the building history and present condition as a basis for the installation of tension rods and needles in accordance with conservation criteria. Measured drawings showing the deformations allowed the calculation that after a successful restoration of the masonry and with an expected continuous drift of 2 1/3 millimeters per year the chance will only drop in 205 years.



**Object:** Santa Maria dei Miracoli, Venice, Italy

**Date:** 1483–1489

**Surveyor:** Director: Manfred Schuller; in charge on site: Maren Lüp-  
nitz; graduates of the historic preservation graduate program at the Uni-  
versity of Bamberg.

**Building Survey:** Hand measurements. Roof structure measured using  
tachymetry. Scale mostly 1:25.

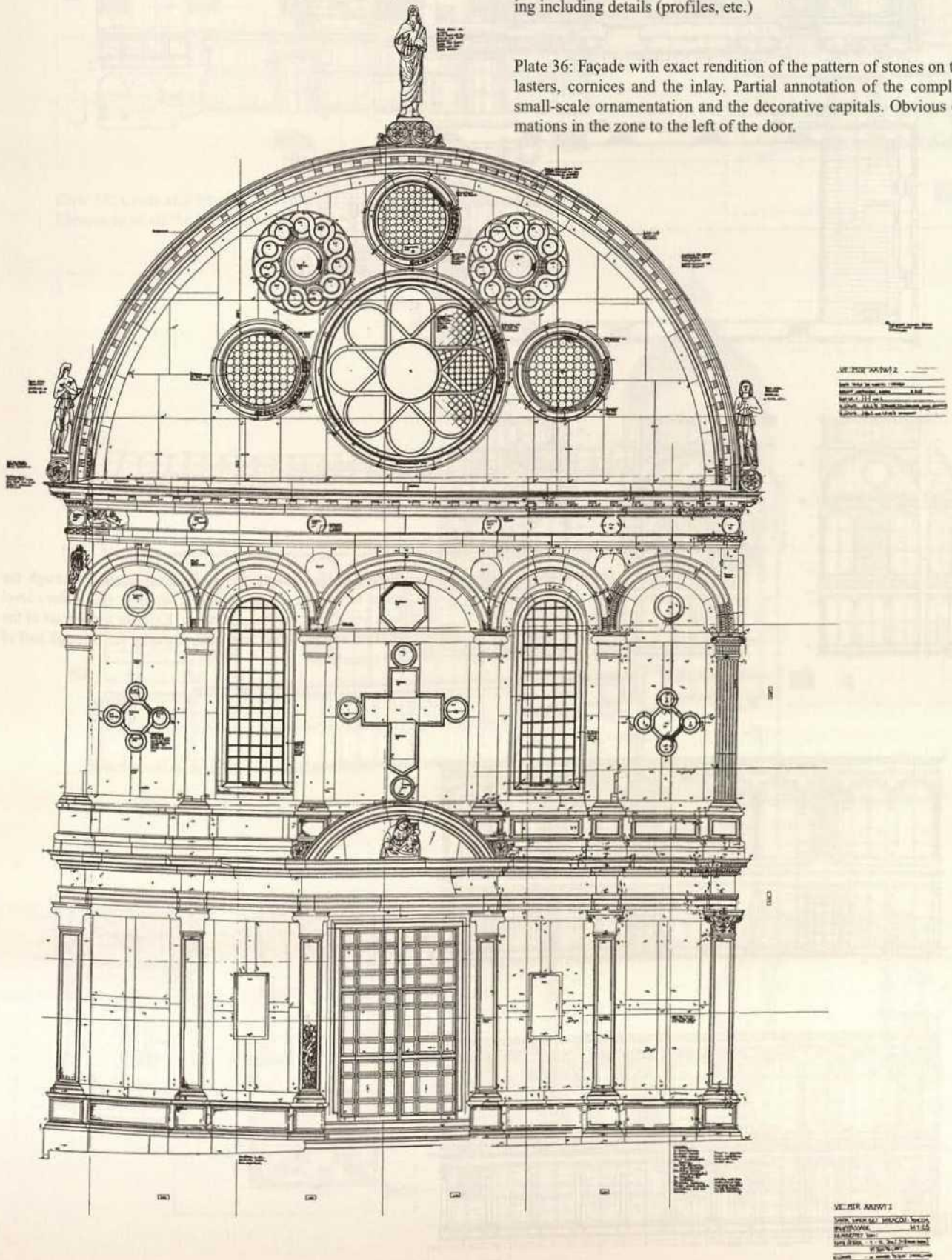
**Explanatory Note:** Complete graphic documentation of the small  
church with elevations of all interior and exterior walls, sections and

plans as the basis for comprehensive restoration work with the partici-  
pation of international specialists, financed by "Save Venice." Damages  
and restoration work plans entered on copies of the measured drawings.  
At the same time study of the structural system and re-investigation of  
the previously accepted architectural history, resulting in definite cor-  
rections.

**Literature:** Publication of the entire project in 2002 (Venice)

Presented here as an example of the complete documentation of a build-  
ing including details (profiles, etc.)

Plate 36: Façade with exact rendition of the pattern of stones on the pi-  
lasters, cornices and the inlay. Partial annotation of the complicated  
small-scale ornamentation and the decorative capitals. Obvious defor-  
mations in the zone to the left of the door.



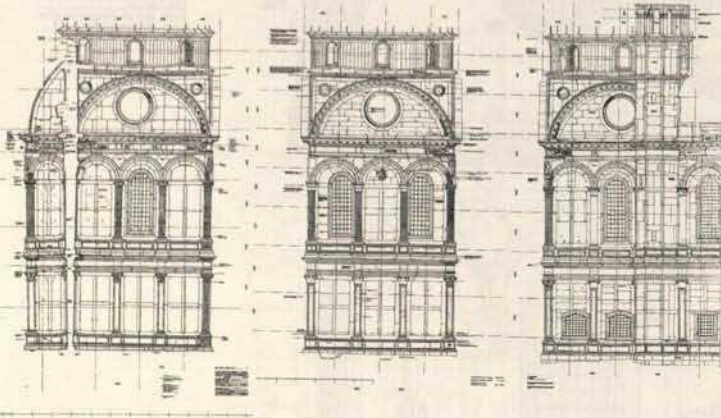
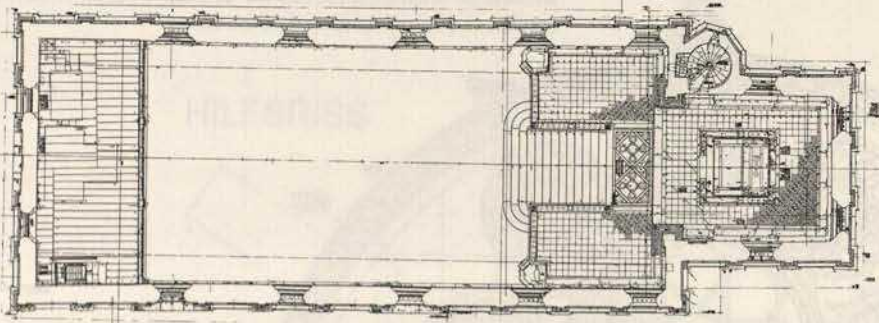
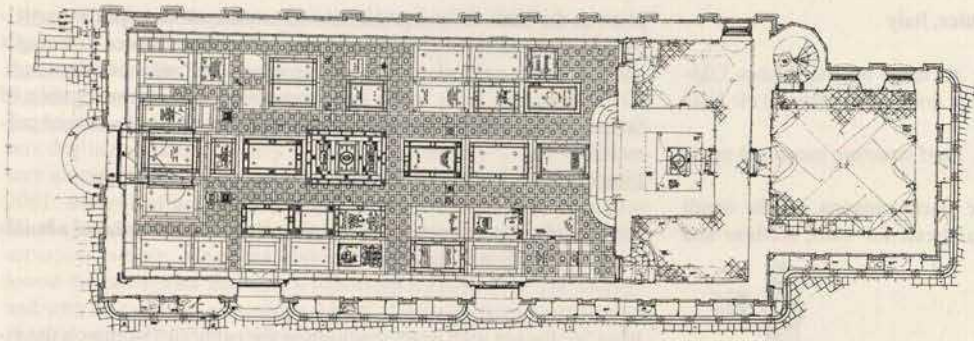
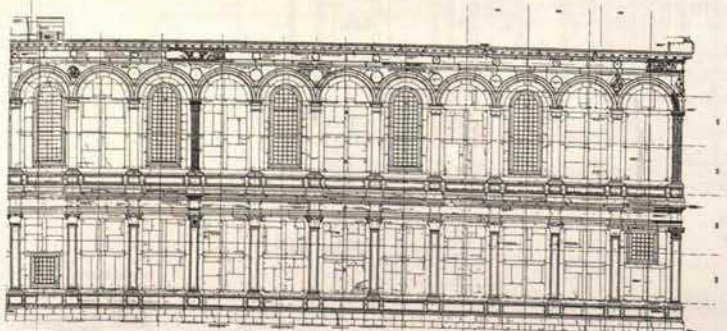
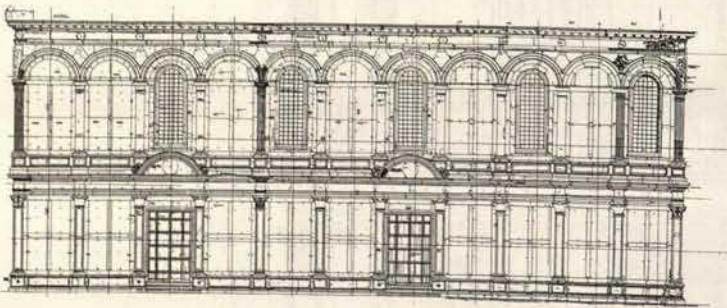


Plate 37: Plan above the socle with section through the space below the chancel. Plan at window and gallery level with view onto the chancel floor. Exterior elevations of the chancel and nave and isometric drawing cut through half of the church.



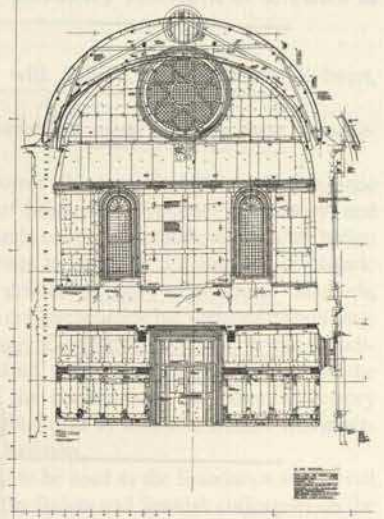
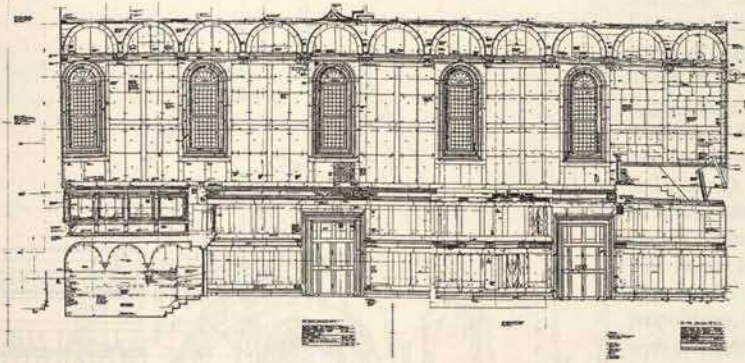
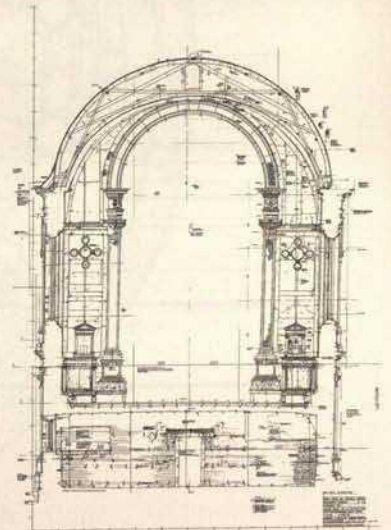
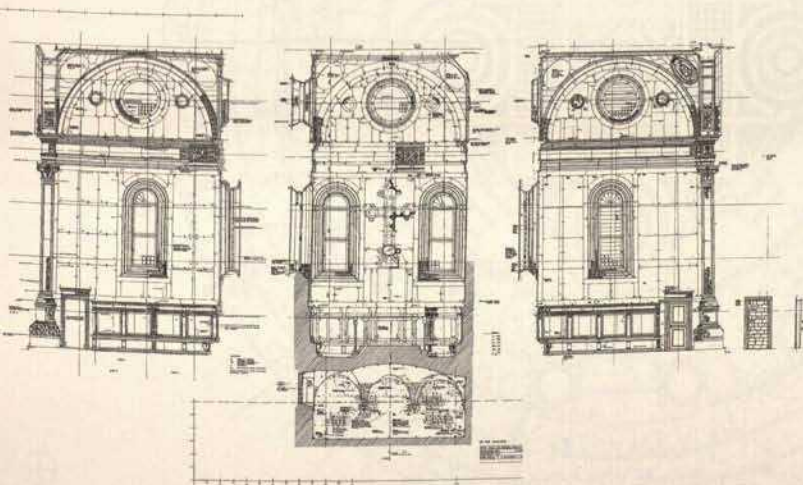
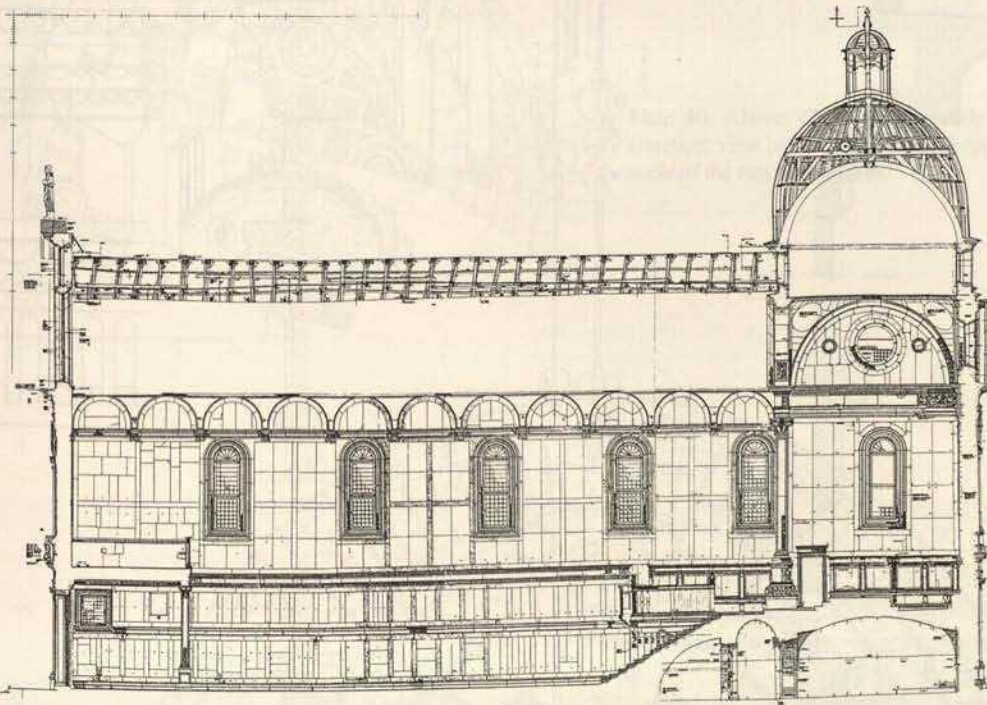


Plate 38: Cross and longitudinal sections including the unusual roof structure. Elevations of all the interior walls.



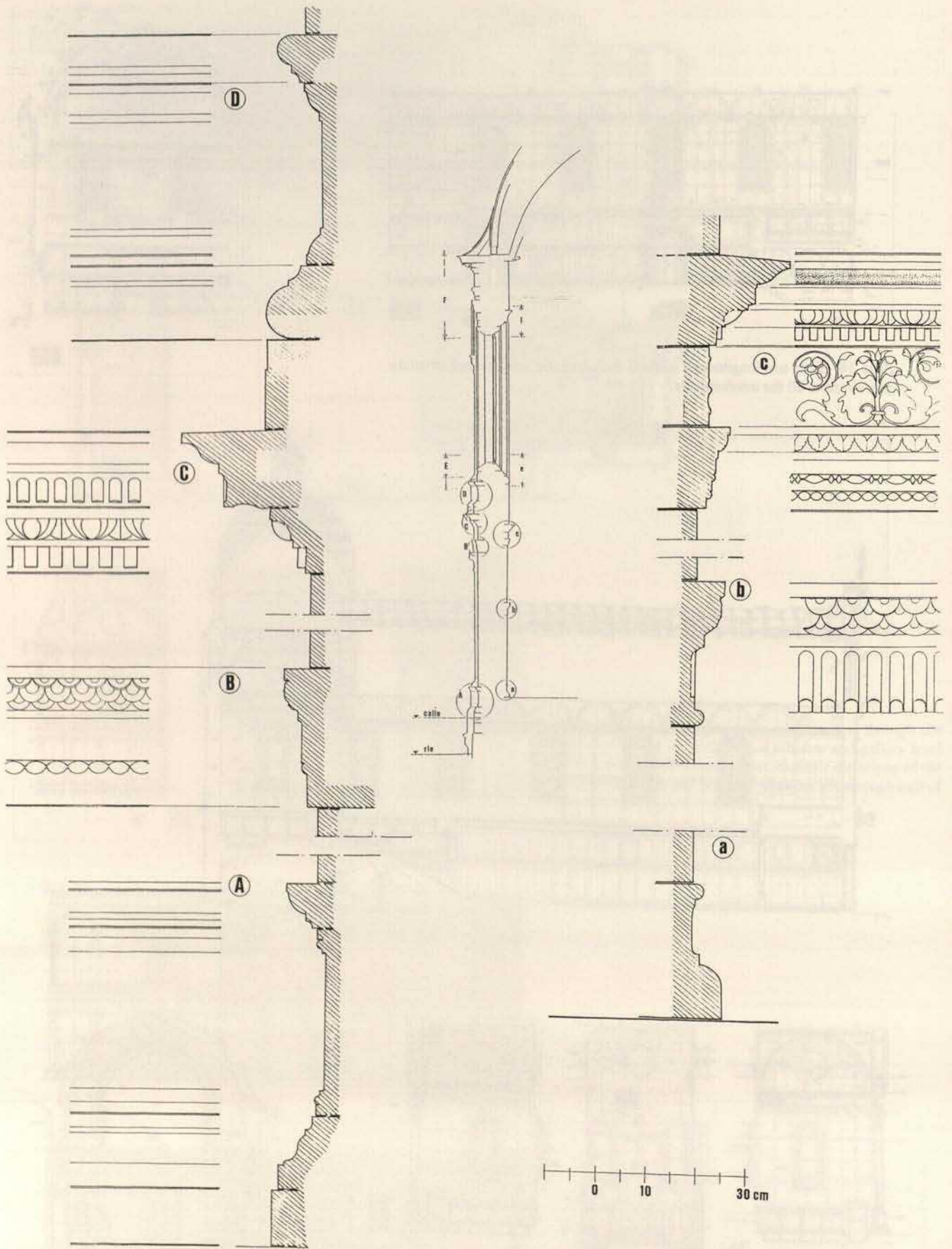


Plate 39: Sections of details with profiles of the interior (right) and exterior (left) orders.



**Object:** "Tempietto" in the monastery courtyard of S. Pietro in Montorio, Rome, Italy

**Date:** 1502 and after

**Surveyor:** Manfred Schuller with Sabine Gress, Tillmann Kohnert, Katarina Papajanni

**Building Survey:** Hand measurements using electronic base measurements. Scale: 1:20, 1:10

**Explanatory Note:** Pilot project for interdisciplinary Renaissance research under the direction of Christoph L. Frommel (art history) and Manfred Schuller (building archaeology) in collaboration with Italian and Spanish colleagues. Attempt to combine the methods of historic building archaeology and primary-source architectural research, demonstrating the results on a comprehensible but demanding building. Task for the building archaeology: Documentation of the present condition of the building with exact measurements for analysis of the proportions. Clarification of the construction and planning history with reconstruction of the original plan by architect Donato Bramante. Structural composition of the building.

At the same time plan material to be used as the foundation for overall renovation of the "Tempietto" by Italian and Spanish colleagues on the occasion of the Holy Year 2000.

**Literature:** Publication in 2002

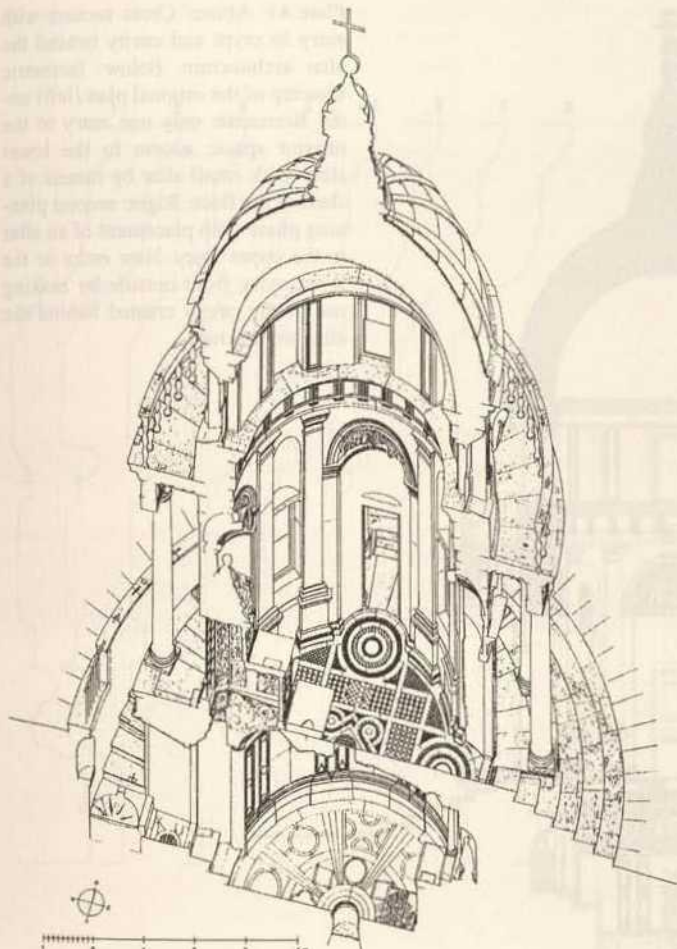


Plate 40: Above: Cut open isometric drawing showing the current situation; view into the crypt and the upper story. Below: plan above the socle of the ring of columns.

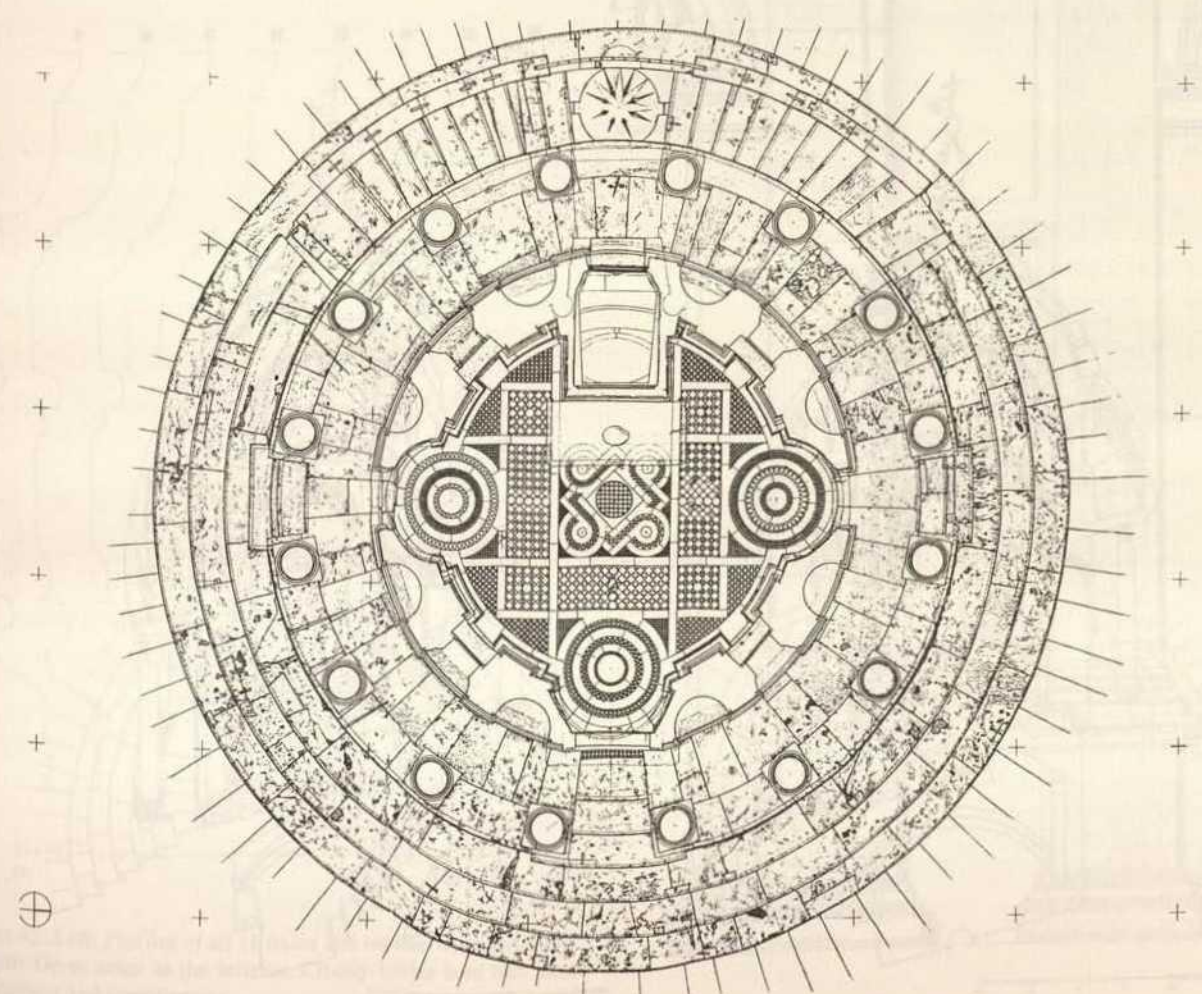
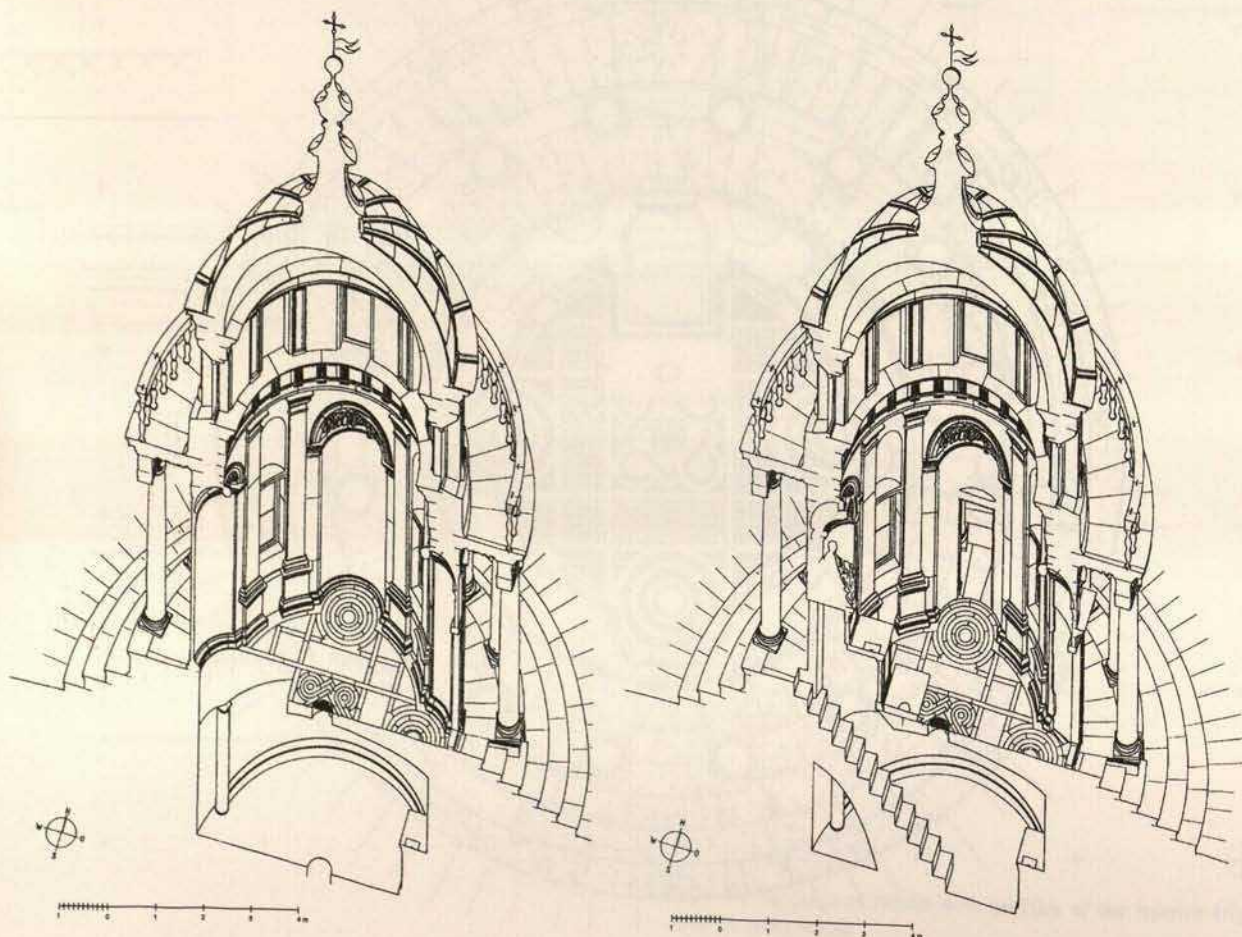
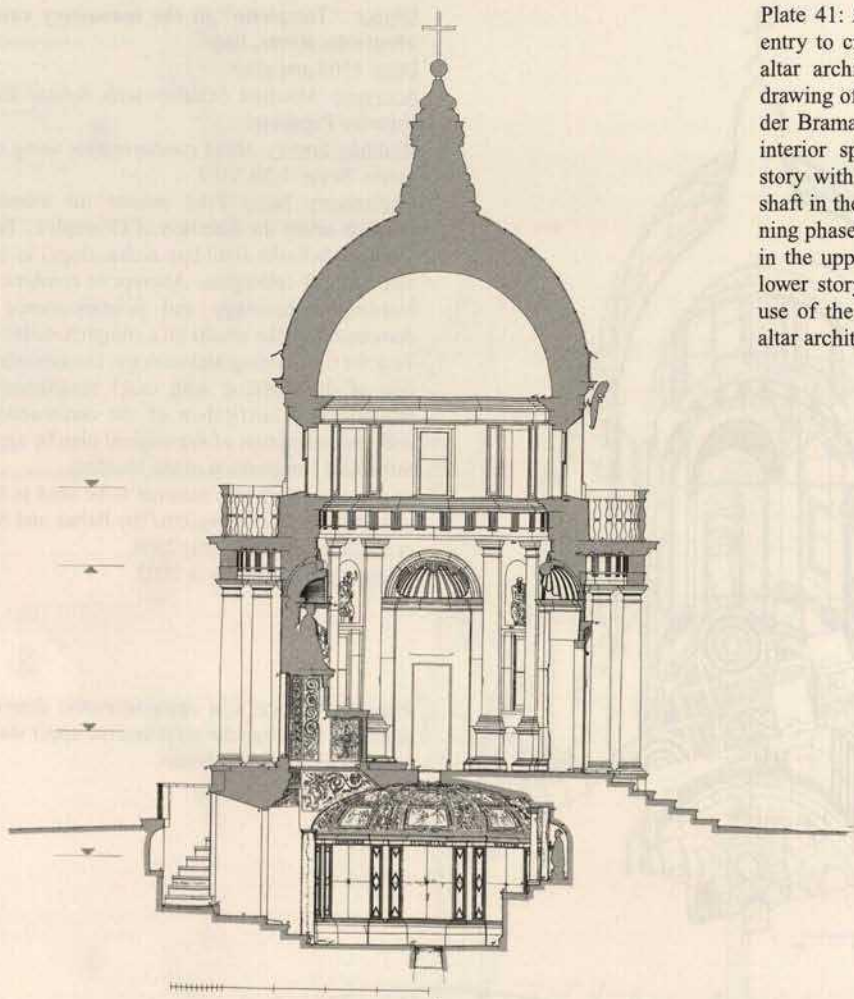


Plate 41: Above: Cross section with entry to crypt and cavity behind the altar architecture. Below: Isometric drawing of the original plan (left) under Bramante: only one entry to the interior space; access to the lower story with small altar by means of a shaft in the floor. Right: second planning phase with placement of an altar in the upper story. New entry to the lower story from outside by making use of the cavity created behind the altar architecture.



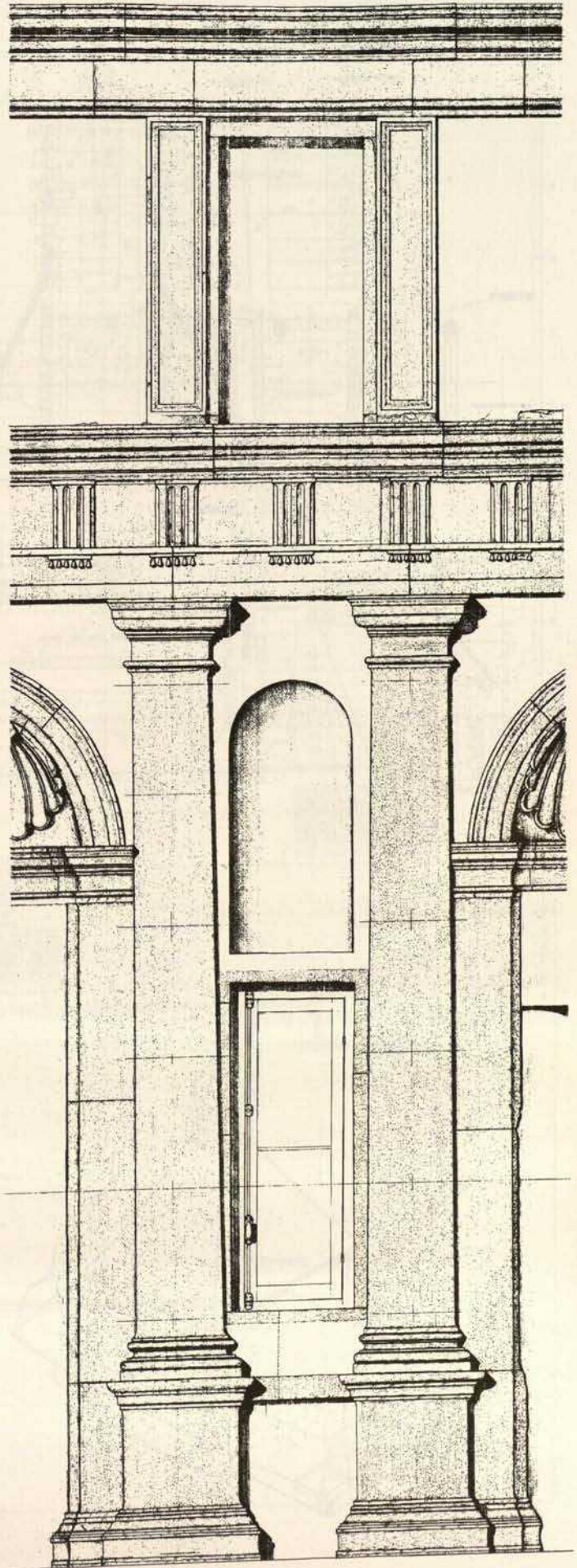
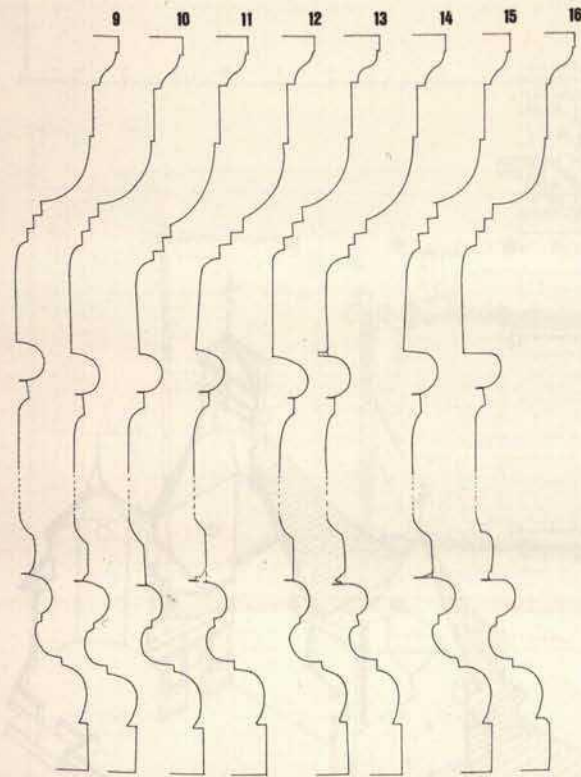
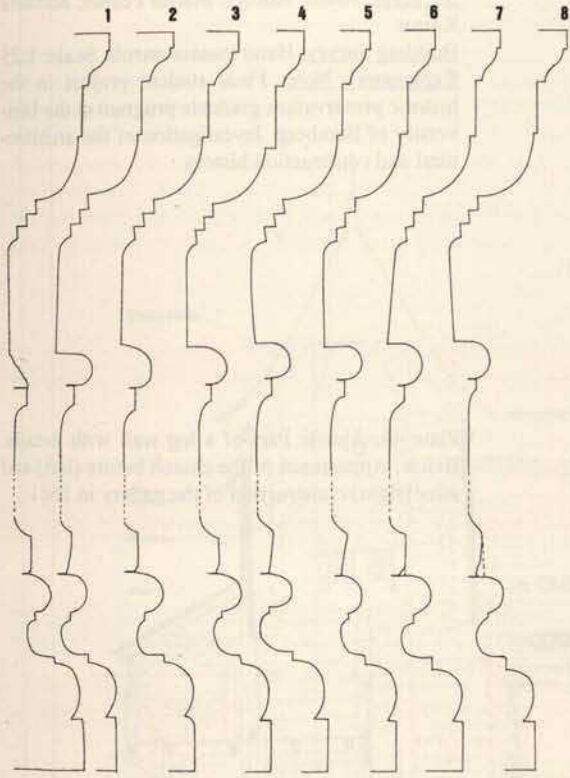


Plate 42: Left: Profiles of all 16 bases and capitals with deviations. Right: Doric order in the interior. Clearly visible here too: axial deviations and irregularities.

**Object:** Church of the Raising of the Cross in Drohobytch, south of Lviv, Ukraine  
**Date:** before 1613  
**Surveyor:** Andrij Kutnyi, Martin Fenner, Stefanie Kaiser  
**Building Survey:** Hand measurements. Scale: 1:25  
**Explanatory Note:** Final student project in the historic preservation graduate program at the University of Bamberg. Investigation of the architectural and construction history.

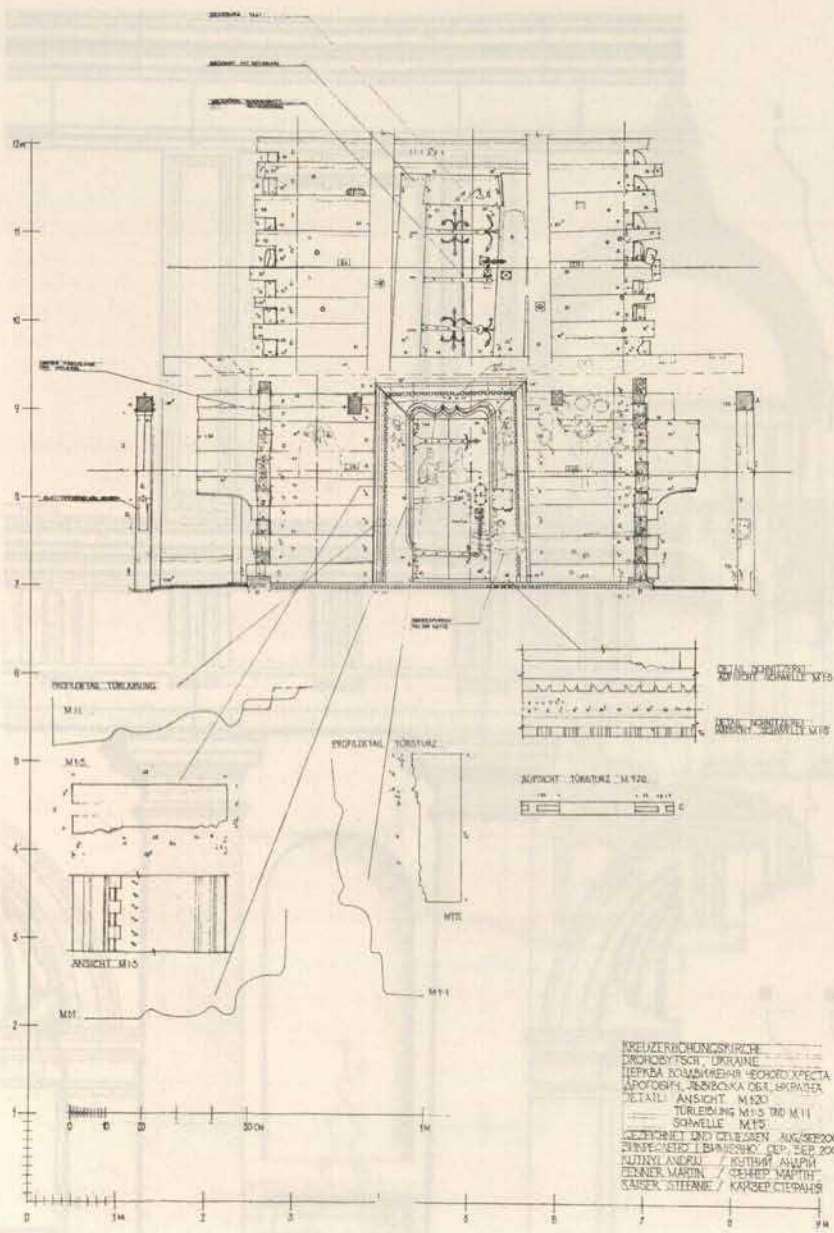
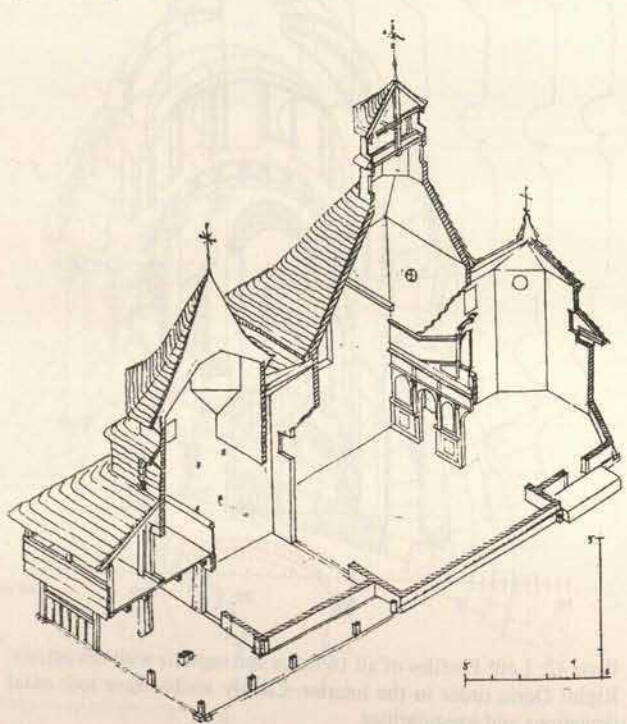
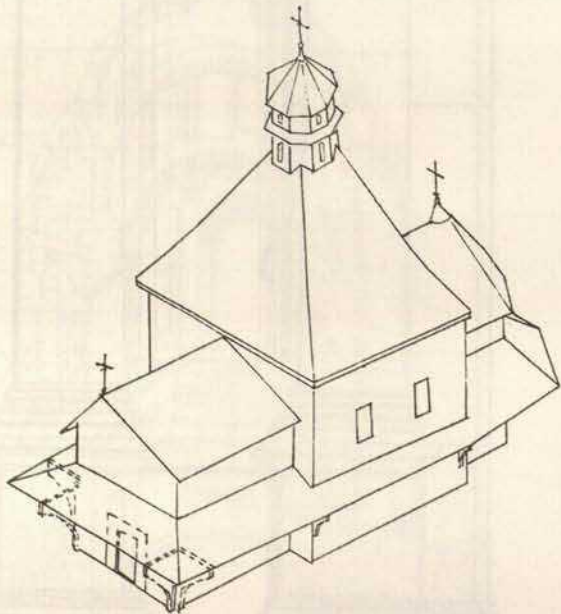


Plate 43: Above: Part of a log wall with details. Below: Appearance of the church before (left) and after (right) construction of the gallery in 1661.





**Object:** Farmhouse in Linde-Frangenberg, North Rhine-Westphalia, Germany

**Date:** 1684 with continual alterations into the 20<sup>th</sup> c.

**Surveyor:** Karl Matthias Berg, Gerhard Fitzek

**Building Survey:** Hand measurements. Scale: 1:25

**Explanatory Note:** Final student project in the historic preservation graduate program at the University of Bamberg. Depiction of the complicated construction history of a half-timber house that appears plain at first glance.

**Literature:** Karl Matthias Berg, Gerhard Fitzek: *Ein Bergisches Fachwerkhaus des 17. Jahrhunderts*. In: Arbeitskreis für Hausforschung (publisher): *Zur Bauforschung über Spätmittelalter und frühe Neuzeit, Berichte zur Haus- und Bauforschung, volume 1*. Marburg 1991, pp. 183–195.

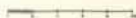
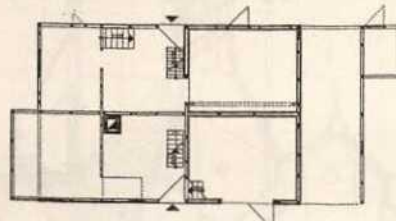
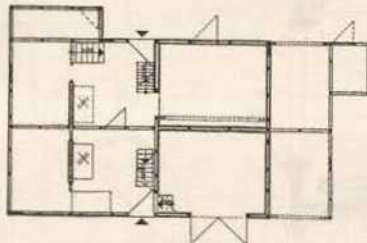
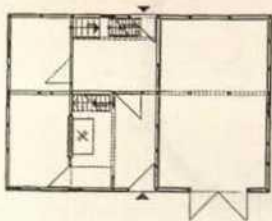
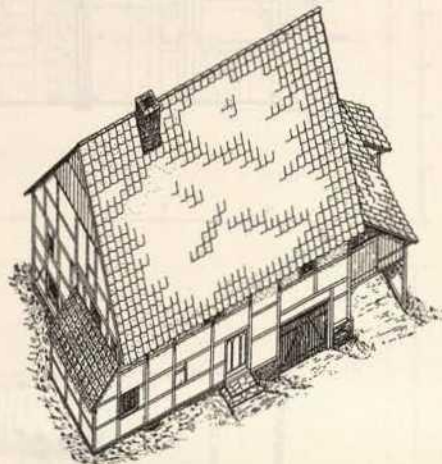
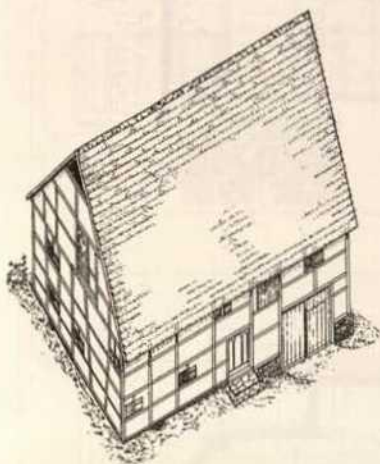
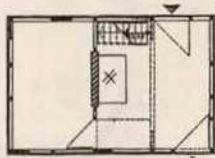
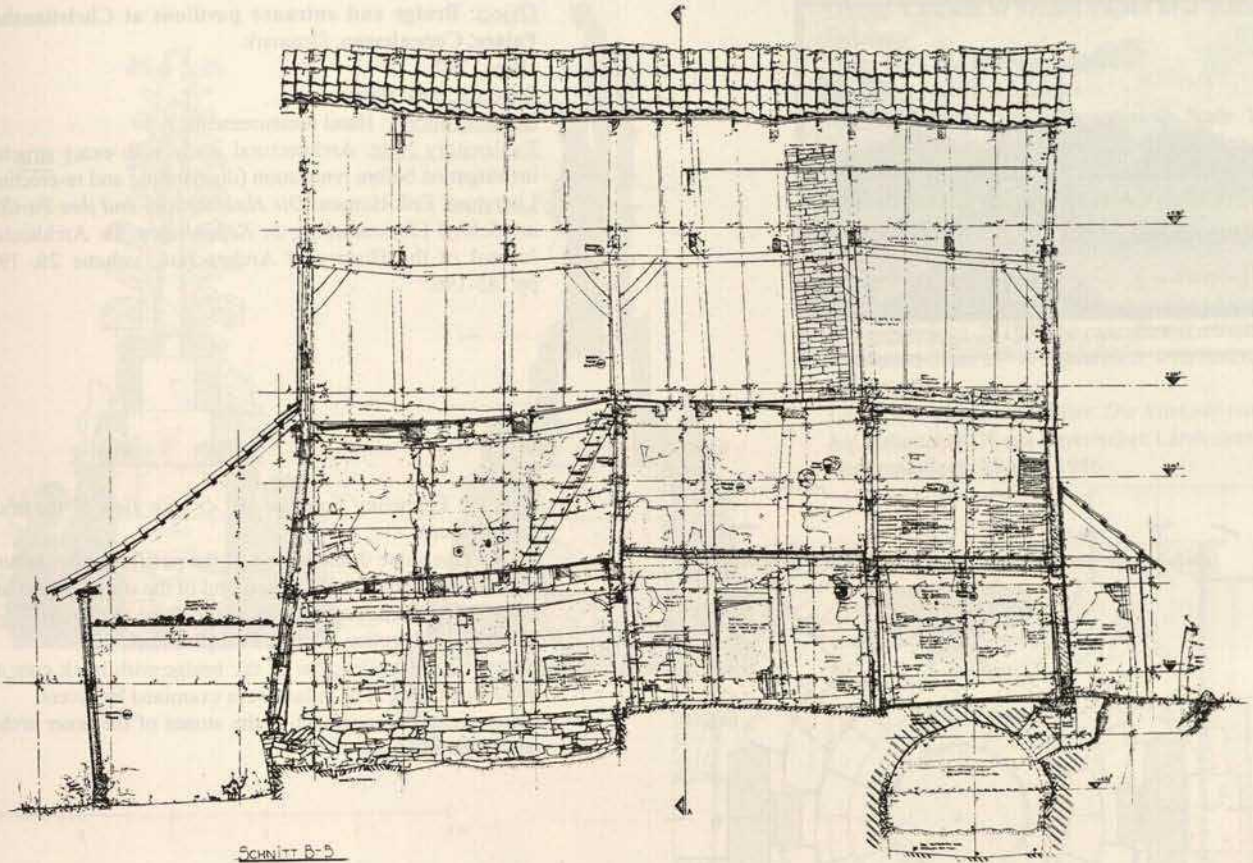


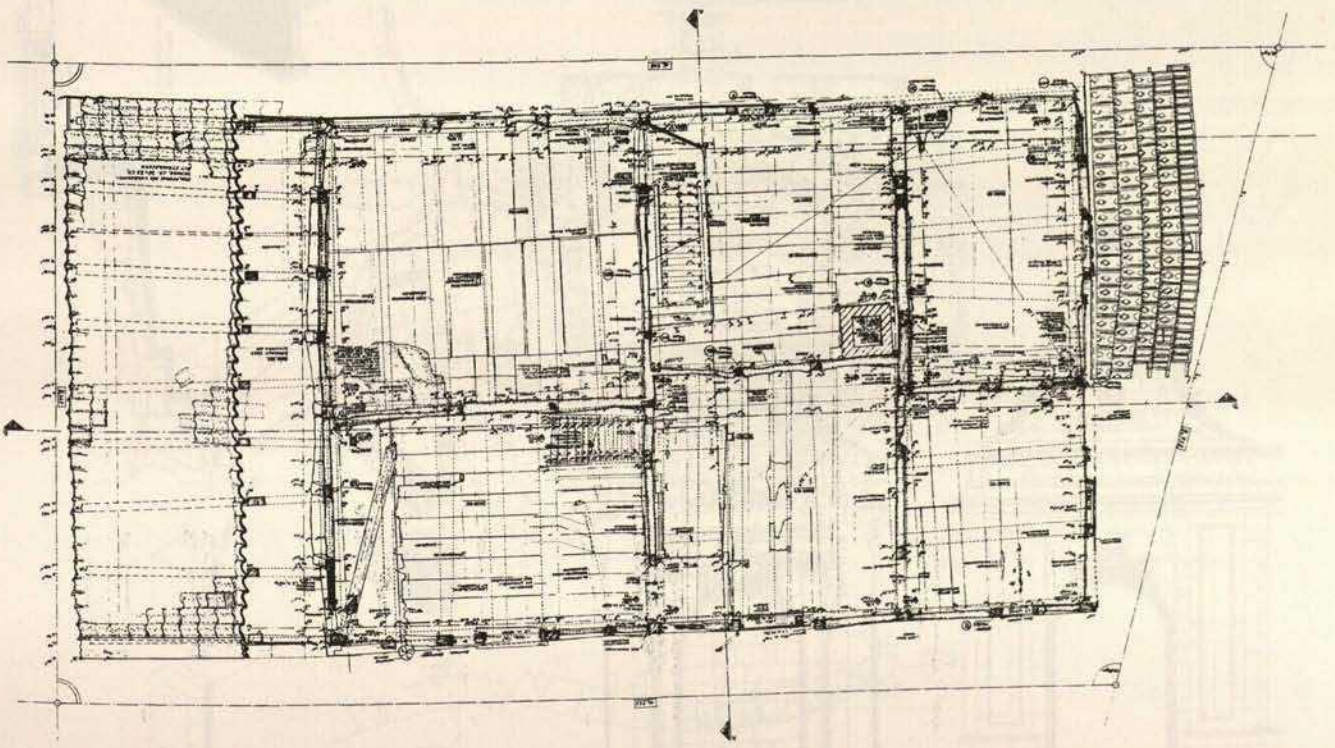
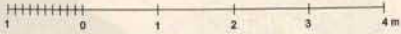
Plate 45: Depiction of the construction history with development of the floor plan and the structure. a) Original building from 1684, b) addition from 1687, c) appearance in 1829, d) appearance in 1918 after replacement of the open hearth with a chimney and change to a hard roof covering.



SCHNITT B-D

Plate 46: Elevation and floor plan of the upper story. Severe deformations are discernible.

VERFORMUNGSGERICHTES BALAUPTASS  
 LINDE-FRANZOSCHEN, BAD-LINDE  
 BLATT-NR. 3,5 M. 1:25  
 SCHNITT B-D  
 MATTHIAS BENG  
 GERHARD FITZEL  
 AUFGETRAGEN WÄHREND DER ZEITUNG  
 AUGUST / OKTOBER 1908





**Object:** Bridge and entrance pavilions at Christiansborg Palace, Copenhagen, Denmark

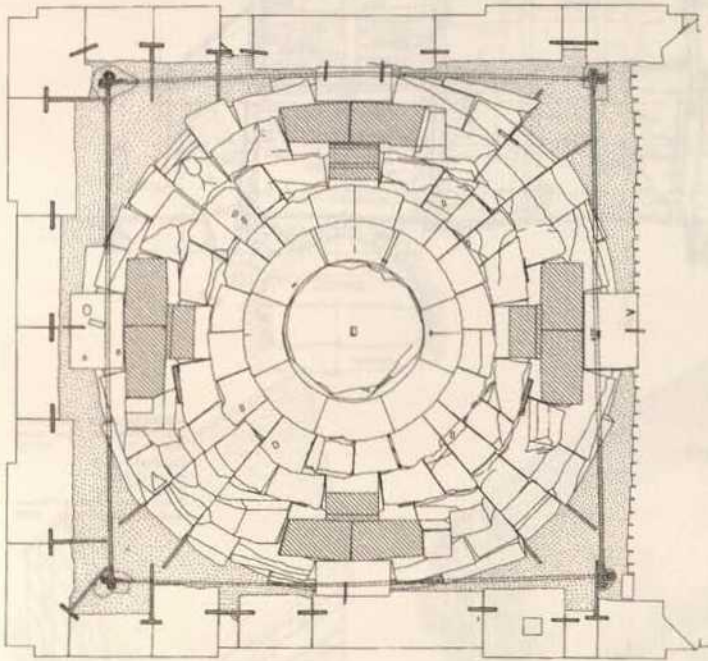
**Date:** 1740.

**Surveyor:** Erik Hansen

**Building Survey:** Hand measurements

**Explanatory Note:** Architectural study with exact structural investigation before renovation (dismantling and re-erection).

**Literature:** Erik Hansen: *Die Hauptbrücke und ihre Pavillons am Schloß Christiansborg in Kopenhagen*. In: *Architectura. Journal of the History of Architecture*, volume 26, 1996, pp.185-196.



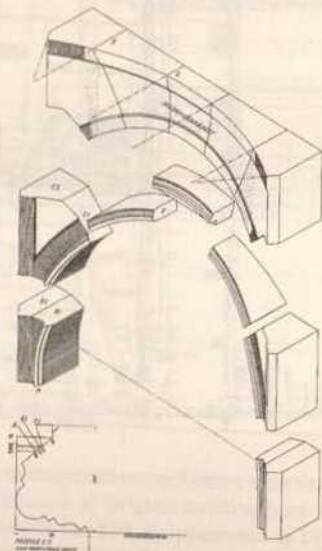
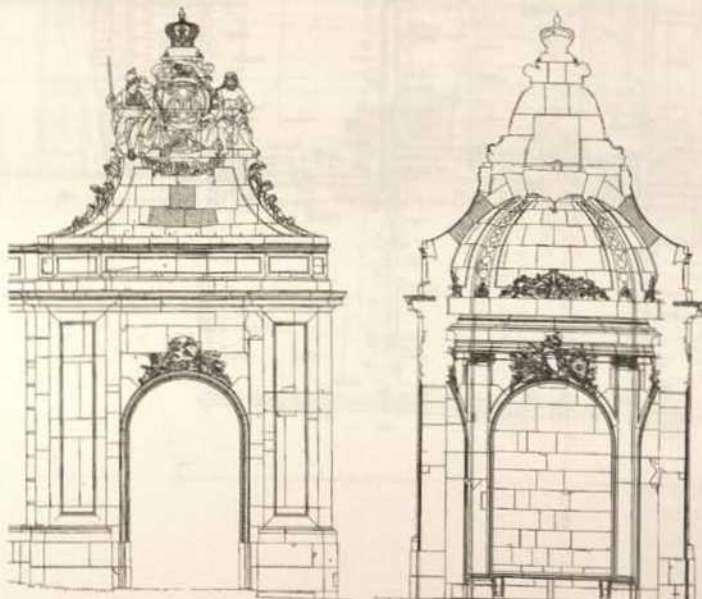
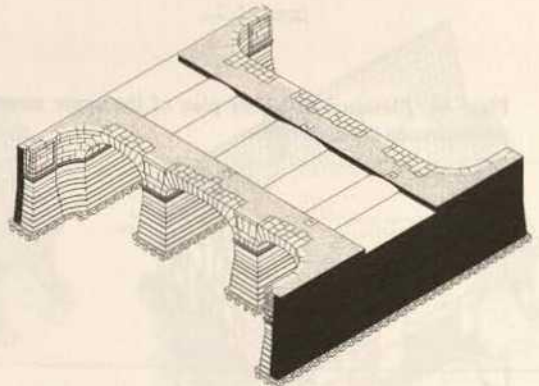
**Plate 47:** Engraving from the 18<sup>th</sup> c. with view of the bridge and pavilions.

View to the stone dome of one of the pavilions after removal of the outer facing blocks. Depiction of the stone pattern, iron anchors and the through-stones of the dome (hatched).

Elevation and section of one of the pavilions.

Above right: Construction of the bridge with brick core and sandstone facing. The pillars were examined by divers.

Below right: Arrangement of the stones of the inner arch of one of the pavilions.





**Object:** Cascade at Seehof Palace near Bamberg, Germany

**Date:** 1761 and afterwards

**Surveyor:** Manfred Schuller

**Building Survey:** Hand measurements. Scale: 1:20

**Explanatory Note:** Study of a Baroque garden structure with a combination of stairs, waterworks and sculptural center. The structure, which had been severely altered and partially filled up in the course of the last 200 years, was investigated using methods taken from archaeology, building archaeology and archival research. Graphic reconstruction of the original appearance. In 1995 the cascade was rebuilt in an adaptation of its 18<sup>th</sup> c. appearance; with functioning waterworks.

**Literature:** Manfred Schuller: *Die Kaskade von Seehof*. Arbeitsheft 29 des Bayerischen Landesamtes für Denkmalpflege. Munich 1986.

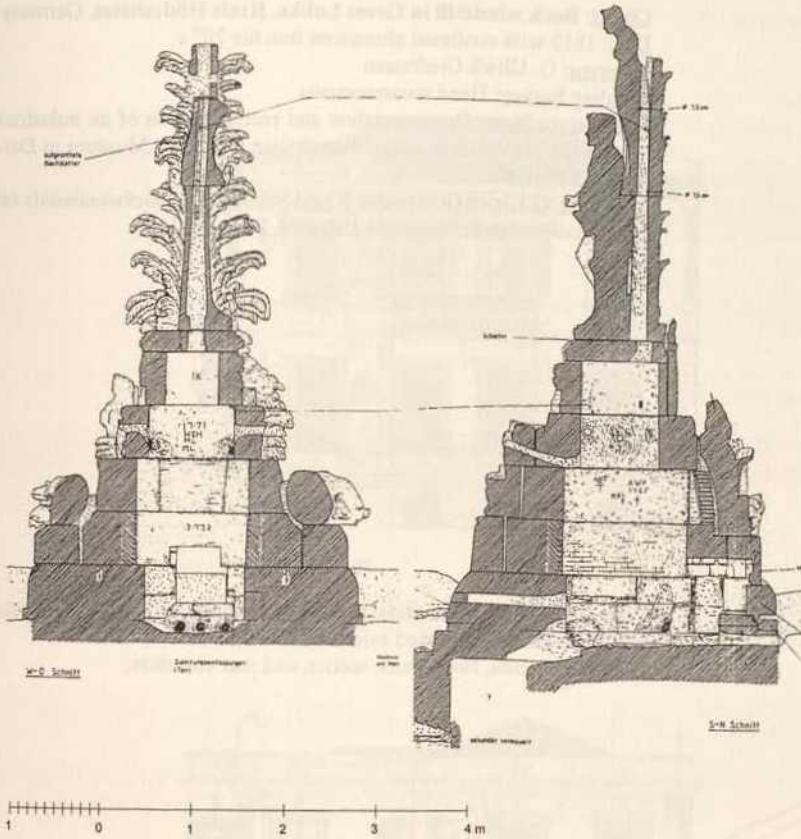
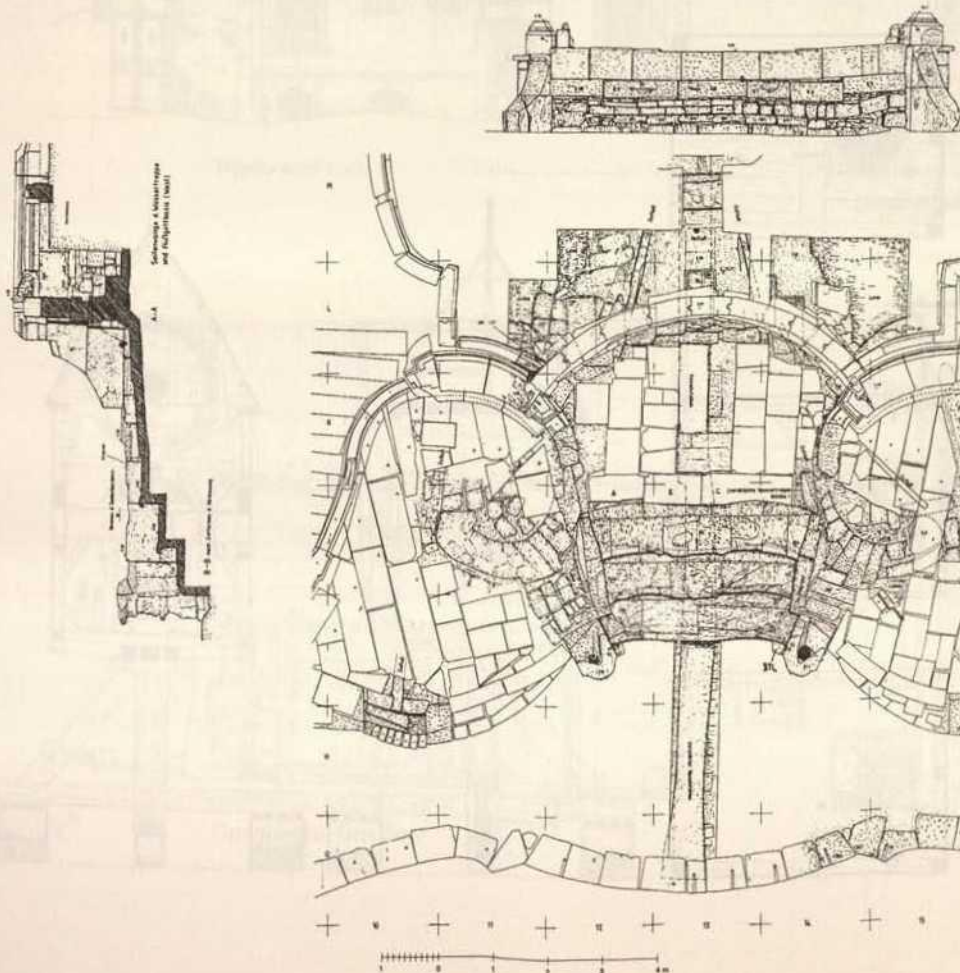


Plate 48: Plan showing the stones. Elevation toward the center of the cascade with re-exposed remnants of a water stair. Section through the "Hercules" group statue (7 meters in height) in the upper water basin with cavities for conducting the water.



**Object:** Bock windmill in Gross Lobke, Kreis Hildesheim, Germany

**Date:** 1812 with continual alterations into the 20<sup>th</sup> c.

**Surveyor:** G. Ulrich Großmann

**Building Survey:** Hand measurements

**Explanatory Note:** Documentation and reconstruction of an industrial monument. Re-erection in the Westphalian Open-Air Museum in Detmold, 1979–1981.

**Literature:** G. Ulrich Großmann, Ingrid Schulte: *Die Bockwindmühle im Westfälischen Freilichtmuseum Detmold*. Detmold 1986.

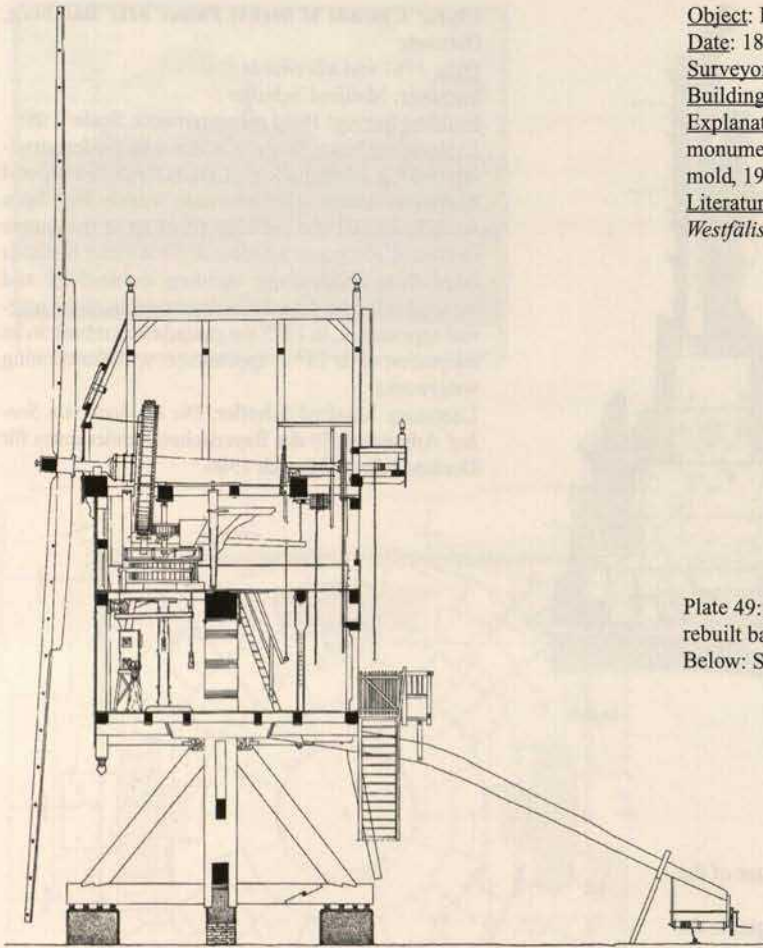
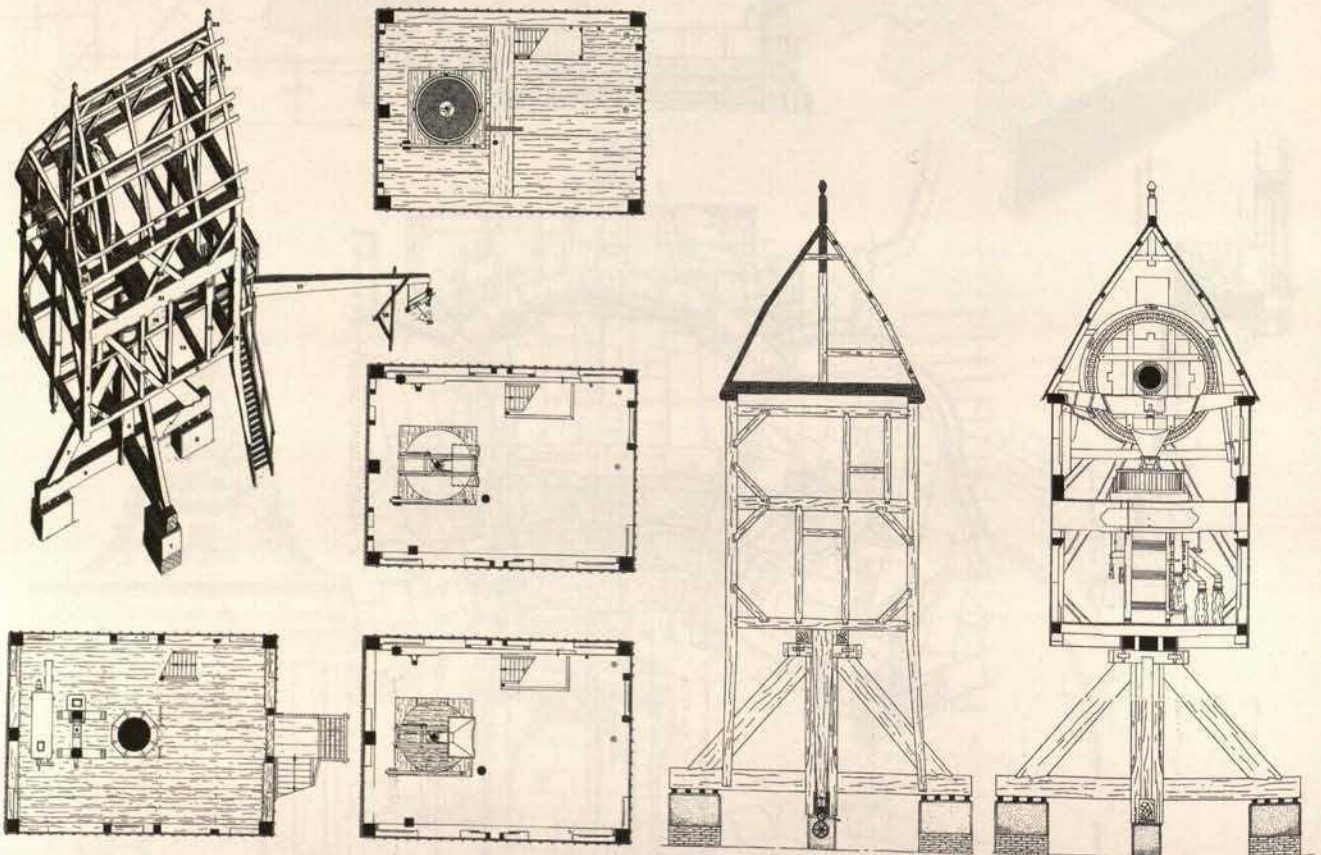


Plate 49: Above: Longitudinal section through the windmill, which was rebuilt based on discovered evidence.

Below: Structure, floor plans, section and rear elevation.



**Object:** Early 20<sup>th</sup> c. townhouse in Thessaloniki, Greece

**Date:** between 1903 and 1912

**Surveyor:** Katarina Papajanni and Olivia Schwarz

**Building Survey:** Hand measurements. Scale: 1:25

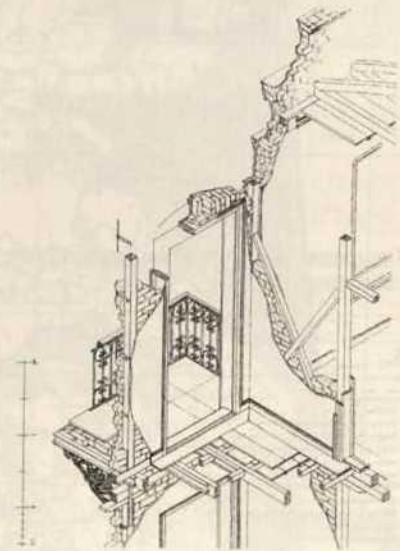
**Explanatory Note:** Final student project in the historic preservation graduate program at the University of Bamberg.



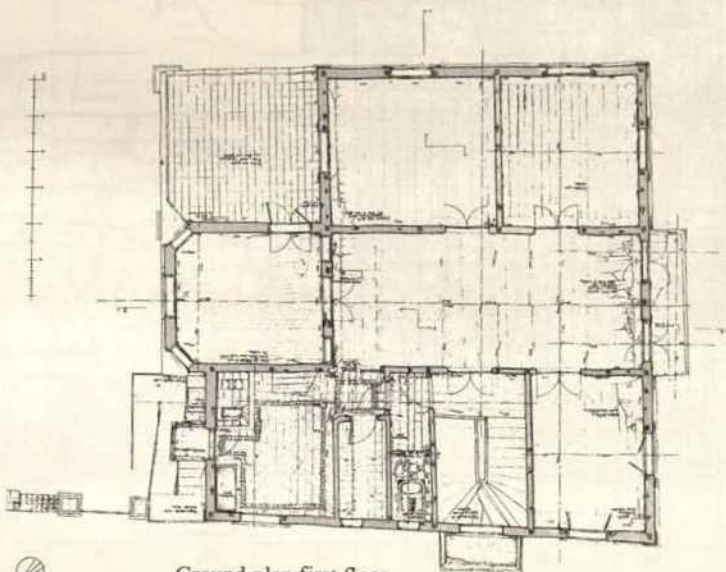
South-west view



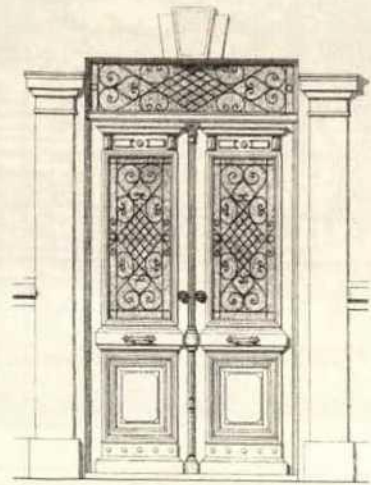
North-west view



Isometry of the construction



Ground-plan first floor



Detail of the front door

**Object:** "Einstein Tower" at the Astrophysical Institute in Potsdam, Germany

**Date:** 1921-24, designed by Erich Mendelsohn

**Surveyor:** Building archaeology: David Hooly, Gert Th. Mader. Architects of most recent renovation: Pitz&Hoh, Werkstatt für Architektur und Denkmalpflege, Berlin.

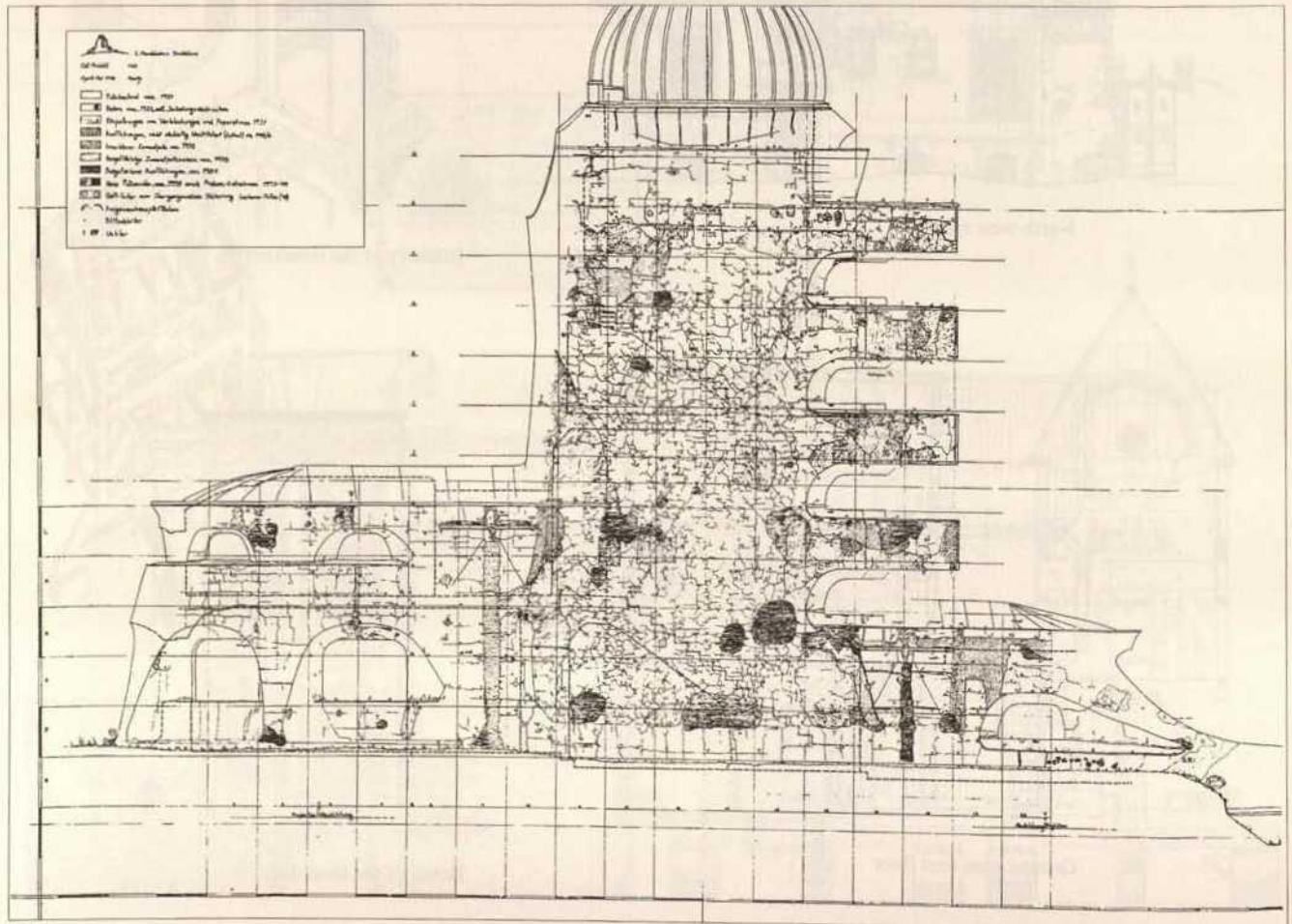
**Building Survey:** Documentation of the cracks by hand after removal of the paint layers on the basis of photogrammetric measurements.

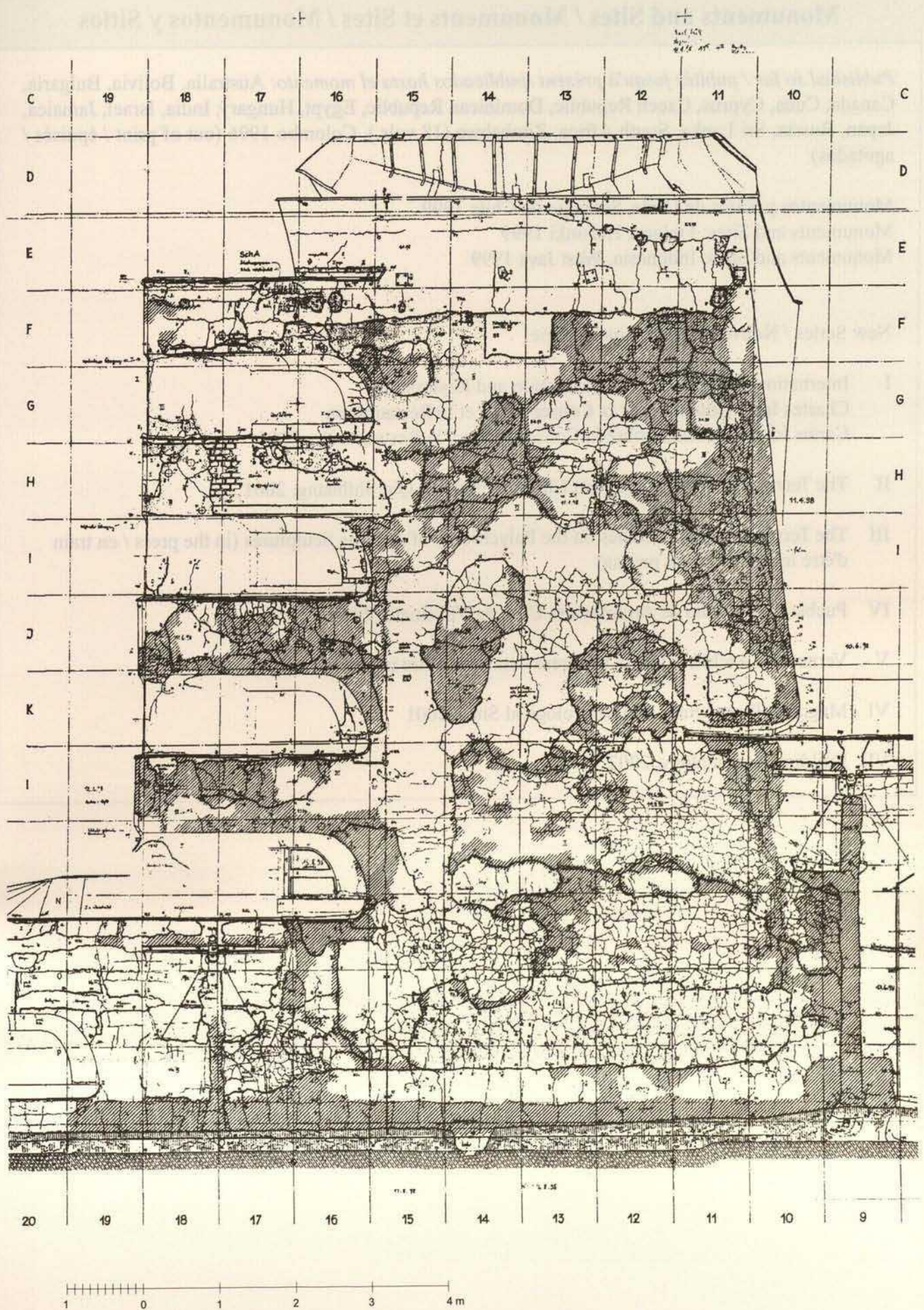
**Explanatory Note:** Major building of Expressionism as shell for a spectrograph, originally intended to prove predictions by Albert Einstein concerning his theory of relativity. The extensive damages on the surfaces are due to the problematic building technique used by Mendelsohn and the frequent renovations as from 1927. Measurements of the cracks and the concave surfaces as well as the distinction between the various periods of repair allowed a fundamental diagnosis for a differentiated conservation, also respecting earlier repairs, which have contributed to the character of the building for a long time.

**Literature:** Norbert Huse (editor), *Mendelsohn. Der Einsteinturm. Die Geschichte einer Instandsetzung*, Stuttgart, Zurich 2000.

Plate 52: Detail of the west façade with mapping of cracks and blisterings. ▷

Plate 51: "Transparent" side view of the Einstein Tower with interior construction of staircases, ceilings and walls. Mapping of cracks, mended areas, repairs and blisterings.





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