

# ALBRECHT MEYDENBAUER – PIONEER OF PHOTOGRAMMETRIC DOCUMENTATION OF THE CULTURAL HERITAGE

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## ABSTRACT

In 1858, Albrecht Meydenbauer, a young architect, had the idea to use photographic images for the documentation of buildings. From this moment he worked with great enthusiasm for the technical realization of his idea, and he fought against many obstacles for its acceptance as a documentation method. Meydenbauer was aware of upcoming risks for cultural objects. He was convinced that the most important cultural heritage objects should be recorded in such a way that they could even be reconstructed in cases of destruction. Photogrammetric images were the most effective way to reach this goal of a »Denkmälerarchiv« (Cultural Heritage Archive).

In 1885 Meydenbauer succeeded, and the very first photogrammetric institution worldwide was established in Berlin for the photogrammetric documentation of cultural heritage objects. Between 1885 and 1920 the »Meßbildanstalt« recorded about 2,600 objects in about 20,000 photogrammetric images on glass plates. This collection of historical photogrammetric images is absolutely unique. In the following decades, in particular during and after World War II, the archive passed through an adventurous history. It even was displaced for some years to Moscow, before it came back to Berlin. Now the famous »Meydenbauer Archive« is under the care of the »Brandenburgisches Landesamt für Denkmalpflege« (Office for the Preservation of Monuments of Culture of the Federal County of Brandenburg) in Waldstadt, a town about 30 km south of Berlin.

From today's point of view Meydenbauer was not only one of the successful inventors of photogrammetry, but also a pioneer of cultural heritage documentation.

## 1. INTRODUCTION

The history of architectural photogrammetry starts with Albrecht Meydenbauer. He was born in 1834 in Tholey, a little town in Germany. After his studies at the »Bauakademie« (School of Architecture) in Berlin, he became a building surveyor of the Prussian government (Fig.1). One of his first assignments was the documentation of the cathedral in the city of Wetzlar. During this work it happened in September 1858 that Meydenbauer had an accident, and he almost fell down from the side-aisle of the cathedral (Fig.2). Following this dramatic episode it occurred to him that the direct measurements at the façade could be replaced by indirect measurements in photographic images.

From now on, Meydenbauer devoted his activities to this idea. In 1860 he wrote a memorandum about the documentation of buildings through photography to the curator of cultural heritage in Prussia, von Quast. He described that photographic images can store the object information in great details and with high accuracy. Meydenbauer was also aware of upcoming risks for cultural objects. Therefore he developed the idea of a »Denkmälerarchiv« (Cultural Heritage Archive) where the most important cultural heritage objects should be recorded in such a way that they could even be reconstructed in cases of destruction. However, he had a long and difficult way to go in order to develop methods and instruments for the technical realization of his idea. And he had to fight against many obstacles and critics, until his idea was accepted as a documentation method and he found governmental support and funding.



Fig. 1: Albrecht Meydenbauer as a young architect

## 2. THE DEVELOPMENT OF PHOTOGRAMMETRIC METHODS

During the following years, Meydenbauer was working for railway construction and other offices. Therefore he had to use his free time to elaborate his method and to carry out practical experiments. His first idea was, that any good camera could be used for his method. But soon the shortcomings of such systems were evident, it became clear that commercial cameras could not fulfil the new task and that special-type cameras must be developed.



Fig. 2: The cathedral of Wetzlar, where architectural photogrammetry was invented in September 1858. Meydenbauer himself marked the place, where he nearly fell down, with an arrow.



Fig. 3: The first one of Meydenbauers's photogrammetric cameras (built in 1867)

The basic problem was to combine a photographic camera and a measuring instrument in one single system. Furthermore Meydenbauer saw that architectural objects could only be covered by wide-angle lenses. From these first findings he conceived an instrument which was built in 1867, using a Pantoskop wide-angle lens from the optical workshop of Emil Busch in Rathenow (Fig. 3). The focal length was 25 cm, the image format of the camera 30 x 30 cm. This camera realized already the main features of metric cameras, namely

- the definition of the image plane by means of a mechanical frame, against which the photographic plate was pressed before exposure;
- the integration of an image coordinate system, realized as cross hairs that are imaged on the photoplate during exposure;
- the compact design with a fixed focus in order to define the principal distance (or calibrated focal length);
- the mounting on a tripod with the possibility to adjust the camera axis horizontally, the image plane vertically, and one of the image coordinate axis again horizontally ( $\kappa = 0$ ).

These technical solutions formed the basic elements of all photogrammetric cameras later on.

With this instrument Meydenbauer performed practical tests during the summer 1867. In the town Freyburg-on-Unstrut, about 180 km southwest from Berlin, he recorded metric images from the town church and also a sector of the terrain for topographic purposes. In these tests the camera proved a success, and Meydenbauer could also provide evidence that photogrammetry is suited for architectural surveys and for topographic work as well. Despite these promising results, Meydenbauer did still not find acceptance for his method.



Fig. 4: The French Cathedral in Berlin. One of Meydenbauers experimental photographs from 1882 (40 x 40 cm). 100 years later, between 1977 and 1982, the image was used for the reconstruction of the church which was severely damaged during World War II.

It should be mentioned, that during this period Meydenbauer for the first time got knowledge about the experiments of Aimé Laussedat in France, who worked on topographic applications of his method called »*Métrophotographie*«. Meydenbauer however followed an advice of a friend and used for the first time the term »*Photogrammetry*« in an article which was published in a journal for architecture in December 1867. Later this name was generally adopted worldwide.

Meydenbauers methods applied for restitution were graphical constructions following the rules of descriptive geometry. This was made possible by the strict vertical orientation of the image plane. In his instruments Meydenbauer did not use a horizontal circle for the measurement of azimuth angles. His principle was to determine the azimuthal orientation of each individual image by at least one control point in the object. For the restitution by graphical constructions he developed and applied two different approaches. The first one made use of vanishing points. This was especially possible, if horizontal parallel lines in the object could be assumed. In order to achieve convergence of such lines in the image, he often preferred diagonal views (Fig. 4). The second and more general approach was the graphical intersection of two rays to define the position of a point. Through this method, also called »*Plane-table Photogrammetry*«, any object point which has been identified in two (or more) convergent images could be plotted in the ground plan (Fig. 5). In a second step its height could be constructed also graphically.

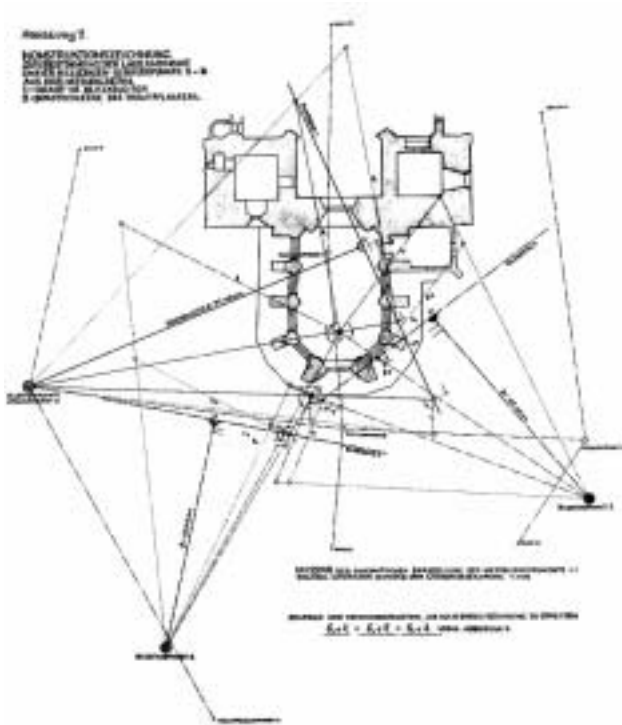


Fig. 5: The principle of »Plane-Table Photogrammetry« (after an instructional poster of Meydenbauer's institute)

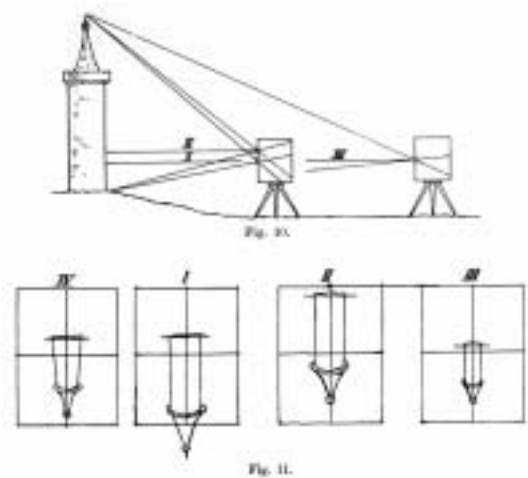


Fig. 6: The effect of a vertical shift of the camera lens; the position II makes the best use of the image format (after Meydenbauer's textbook from 1912)

Many practical experiments and technical improvements of the cameras followed. A camera of the second generation was used by Franz Stolze in 1874 during an expedition to Persia, where he performed a photogrammetric survey of the ruins of Persepolis and other archaeological objects. The third generation of Meydenbauer's cameras started in 1879. He still used the Pantoskop lenses with focal lengths of 25 cm, 35 cm and 53 cm. The image format was enlarged to 40 x 40 cm (large formats were desirable because of the accuracy to be achieved through graphical restitution). But the most interesting new feature was the introduction of a vertical shift of the lens. This enabled to achieve a better adaptation to the object (Fig. 6), a technique which was used in many phototheodolites in the following decades.

Meydenbauer continued to work on his own on the improvement of the instrumentation and the photogrammetric method. Test surveys of the church St. Castor in the city of Koblenz and at other places testify his efforts. Furthermore he tried to raise interest in photogrammetry by lectures and publications. Gradually he succeeded and the Prussian Minister of Culture became interested. As a consequence of this Meydenbauer was invited to give lectures and practical exercises at the Technical Universities of Aachen in 1881 and Berlin in 1882 (Fig. 4). Furthermore an official test under governmental control was arranged. The church St. Elizabeth in Marburg was recorded by Meydenbauer and independently by a surveyor. Even though the photogrammetric results proved to be reliable, there were still some doubters. Therefore the accuracy of photogrammetry has been subject of discussion in two debates of the Prussian parliament, and finally photogrammetry was officially accepted for the documentation of large architectural monuments.

Albrecht Meydenbauer was called to the Prussian Ministry of Culture where he became responsible for applying photogrammetry to the documentation of cultural monuments. On April 1, 1885 the »*Königlich Preußische Meßbildanstalt*« (Royal Prussian Photogrammetric Institute) was established (Fig. 7), the first photogrammetric institution in the world.

### 3. THE »ROYAL PRUSSIAN PHOTOGRAMMETRIC INSTITUTE«

More than 25 years after his first idea to apply photographs for the documentation of buildings, Albrecht Meydenbauer had reached the turning-point of his career. Now he was faced with new challenges, the establishment and management of the institute, the training of its staff, further improvements of the photogrammetric methods, and of course its application for the documentation of cultural heritage objects.



Fig. 7: The logo of the Prussian Photogrammetric Institute



Fig. 8: Schinkel's Bauakademie (School of Architecture) where the photogrammetric institute was located between 1885 and 1932

The institute was located directly in the city center of Berlin, in the building called »Bauakademie« (Fig. 8). This building, a cultural heritage object itself, was erected by Carl Friedrich Schinkel and housed the school of architecture before, where Meydenbauer had been a student thirty years earlier.



Fig. 9: Albrecht Meydenbauer in the middle of his life

Already in 1886 Meydenbauer (Fig. 9) started to build again a new generation of cameras. He abandoned the stable camera housing and introduced a camera design which was capable of being dismantled for transportation purposes. In these instruments, the exact position of the lens relative to the image plane was ensured by a system of adjustable steel rods. The camera body was replaced by a light-proof textile bag (Fig. 10). The image format was 40 x 40 cm, but for various applications, especially for expeditions, also 30 x 30 cm and even 20 x 20 cm cameras were built. Each camera was equipped with a particular transportation box. Manufacturing was carried out in the workshop of the institute by the mechanic Benndorf. The cameras were operated with great success for many decades. But unfortunately all the cameras, that have been used by Meydenbauer and his staff, were destroyed during World War II.

There are only two cameras still existing, but these have never been used by Meydenbauer and his staff. After demonstrations of his photogrammetric methods in Switzerland in 1896, the »Schweizer Gesellschaft für die Erhaltung historischer Kunstdenkmäler« (Swiss Society for the Preservation of Historical Monuments) ordered two cameras. They were built in Berlin and delivered to Basel (Switzerland) in 1898. The image format was 30 x 30 cm, the focal lengths are 20 cm and 32 cm (Fig. 11). During the following years these cameras have been operated in some cases. However, the photogrammetric activities for heritage recording in Switzerland were stopped soon and the cameras were kept in

stock. Now they are under the care of »Archiv für Denkmalpflege im Bundesamt für Kultur« (Archive for Preservation of Cultural Heritage in the Federal Cultural Authority) in Bern (Switzerland).

The activities of Meydenbauer's institute concentrated on cultural monuments in Prussia, because it was a state institution and had no competence for the whole German empire. During his period of office between 1885 and 1909, he and his staff took about 11,000 survey photographs of about 1,200 monuments. Furthermore about 1,600 photographs from 100 buildings in Germany outside Prussia were acquired. And some 800 photographs were taken from historical objects outside of Germany, mainly in Athens (Greece), Baalbek (Lebanon) and Istanbul (Turkey). After Meydenbauer's retirement his associates continued his work until 1920, and the archive increased to about 20,000 photoplates from more than 2,600 objects. The main purpose of all these activities was the documentation of the objects in photographs that can be subject to photogrammetric measurements if necessary. Photogrammetric restitution was only carried for a small minority of the buildings.

Fig. 10: An example for the new generation of Meydenbauer's cameras, ca. 1890

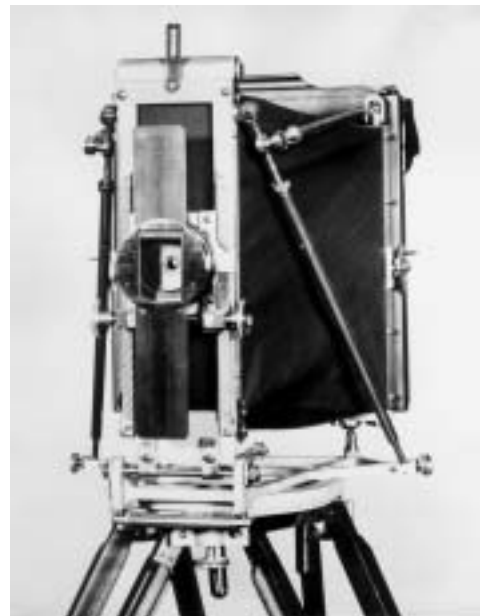




Fig.11: One of the two original Meydenbauer cameras that survived in Switzerland. This camera has been on display during the Symposium CIPA 2001.<sup>2)</sup>

After World War I the development in Germany was characterized by political changes and economic difficulties. In this situation also the status of the institute was changed. After 1920 photogrammetric operations were reduced to a minimum. The name of the institute was changed to »*Staatliche Bildstelle*« (Public Institute for Images). Its main function was to earn money by selling photographs for general purposes (such as publications about art history, postcards etc.) in cooperation with a private editor. To a certain extent also the historical images were used for such purposes, and many of them suffered from this usage.

#### 4. MEYDENBAUER AND CULTURAL HERITAGE DOCUMENTATION

Albrecht Meydenbauer was a visionary and thus much more than a photogrammetrist. His plans were to expand the photogrammetric institute for Prussia to a cultural heritage archive for all Germany. Therefore his concern was to propagate this idea by lectures and printed media, and he did this with great emphasis. It is really impressive to see, that he was aware of upcoming risks for cultural objects already very early.

One of his main publications in this context was an article, printed for the first time in 1894 in a periodical for architecture: »*Ein Deutsches Denkmälerarchiv*« (A German Cultural Heritage Archive). Two years later, in 1896, he distributed a revised edition of this article as a memorandum entitled »*Das Denkmäler-Archiv und seine Herstellung durch das Messbild-Verfahren*« (The Cultural Heritage Archive and its Creation by Photogrammetry). He argued that written or other cultural heritage documents are preserved in archives and museums, whereas the built heritage remains unprotected and exposed to natural erosion processes. He continues »*Was die Natur nicht fertig bringt, vollendet oft unheimlich schnell der Unverstand und der alles vor sich niederwerfende Verkehr*« (What nature does not make, is often destroyed extremely fast by stupidity and by the traffic throwing down everything). At the time of these statements, just a few early automobiles were operated! Meydenbauer has not foreseen – at least not mentioned – military actions. Probably he could not imagine that in two World Wars and many other military conflicts such immense numbers of our cultural heritage objects would be destroyed or heavily damaged. In his memorandum Meydenbauer described the appropriate techniques for acquisition and archiving, and also the usage of the metric photographs for various purposes. And he estimates that it should be possible to document the most important cultural monuments for all Germany within 12 or 15 years.

It must have been disappointing for Meydenbauer, that his memorandum did not cause the reactions he expected. It was left unnoticed by the members of the government and the German parliament. In 1905, when his Prussian institute celebrated its twentieth anniversary, he made a new attempt to propagate a cultural heritage archive for Germany. This proposal was again unsuccessful, he received only meaningless answers from the ministers. In 1909 – Meydenbauer was already 75 years old – he resigned and stepped down from his office as the director of the 'Royal Prussian Photogrammetric Institute'.

#### 5. THE HISTORY OF THE MEYDENBAUER ARCHIVE

The great number of survey photographs, collected in about 35 years of activity of the institute, have been stored in special shelves. In 1933 the material was removed for the first time, because the institution changed to another building nearby. But soon its real Odyssey was coming up. During World War II the complete collection was first transported for safety reasons to a cellar in the Palace of Berlin. Because of increasing aerial attacks on Berlin, in 1944 the material was again displaced and stored in the shaft of a former potash mine about 150 km from Berlin.

In 1945 the Sowjet Army put the collection in »*safekeeping*« and brought the material – altogether 935 wooden boxes – to Moscow, where it arrived in July 1946. 56 boxes, the content of which is still unknown, were brought to an art museum. The remaining 879 boxes with the photoplates were handed over to the museum of the Academy for Architecture and Building where the material was well treated. In 1958 these boxes were given back by the Sowjets to the government of the German Democratic Republic. Unfortunately catalogues and also the camera calibration and measuring documents were not part of this materials, and are therefore still missing.

In the »*Kunstgeschichtliche Bildstelle*« (Art-historical Photo Archive) of the Humboldt University of Berlin the negatives were identified and an index was prepared. The archive was stored in three floors of a building near the city center of Berlin. In 1968 the Meydenbauer negative archive was taken over by the »*Institut für Denkmalpflege der DDR*« (Institute for Monument Preservation of the GDR). In this context a new photogrammetric institution, called »*Meßbildstelle*« (Photogrammetric Institute), was established in the tradition of Meydenbauer's institute. It has been assigned to provide photogrammetric services in the field of monument preservation. From now on, also the historical photographs gained great importance in the restoration of monuments in the GDR.



Fig. 12 and 13: Albrecht Meydenbauer at the time of his retirement 1909. The certificate which documented the retirement of Albrecht Meydenbauer was signed on October 20th, 1909 in the New Palais in Potsdam by the German Emperor Wilhelm II. In this case he acted as the King of Prussia because the *Meßbildanstalt* was a Prussian institution and Meydenbauer a public servant of the Prussian state.

Because of the aging of the glass plates, structural damages in the photographic layers, attack by bacteria, damages during the many transports, and the practical use of the negatives, they were more and more endangered. Therefore, the decision was taken to safely preserve them by duplication. Since 1983 reproduction of the negative originals of the historical archive were carried out on dimensionally stable film. The format of the images was reduced from 40 cm x 40 cm to 18 cm x 18 cm.

After the political changes in Germany 1990, the famous »Meydenbauer Archive« came under the care of the »Brandenburgisches Landesamt für Denkmalpflege« (Office for the Preservation of Monuments of Culture of the Federal County of Brandenburg). The residence of this office is Waldstadt, a town about 30 km south of Berlin. Therefore the youngest of the many removals of the archive happened recently. The official name of the collection is »Messbildarchiv« (Photogrammetric Archive) and the material is now stored under modern conditions. Thus, it can be expected, that the archive – which is a cultural heritage object itself and permanently used for restoration purposes – will be well preserved for the decades ahead.

## 6. CONCLUSION

In 1909 Meydenbauer retired (Fig. 12). At the age of 75 he finished his professional activity after a life of fulfilment, characterized by many years of experimental work and struggle for acceptance, but also by great success and high appreciation. He was honoured as Dr. phil. h.c. by the University of Marburg (1885), as Dr.-Ing. h.c. by the Technical University of Hanover (1908), and he received the honorary title Professor by order of the German Emperor (1903). Furthermore he was holder of high orders and decorations (Fig. 13).

However, there is also the tragic aspect, that the *Meßbildanstalt* continued to be only a photogrammetric institution of the Prussian state. His great dream, the establishment of a national cultural heritage documentation center for the German Empire, was unachievable. Nevertheless, from today's view Albrecht Meydenbauer was the successful inventor of photogrammetry, and a far-seeing protagonist of cultural heritage documentation as well.

Fig. 14: The »Albrecht-Meydenbauer-Medaille« of the German Society for Photogrammetry and Remote Sensing (DGPF)



In 1985 the »*Deutsche Gesellschaft für Photogrammetrie und Fernerkundung* (DGPF)« (German Society for Photogrammetry and Remote Sensing) established the »*Albrecht-Meydenbauer-Medaille*« as an award for outstanding contributions to the development of photogrammetry and remote sensing (Fig. 14).

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## NOTES

- <sup>1)</sup> The actual address of the »Meydenbauer Archive« is: Brandenburgisches Landesamt für Denkmalpflege (Messbildarchiv), Wünsdorfer Platz 4, D-15838 Waldstadt, Germany.
- <sup>2)</sup> The kind cooperation with Mrs. Jeanette Frey, Archiv für Denkmalpflege im Bundesamt für Kultur in Bern (Switzerland), and the assistance of Mr. Christoph Eidenbenz, formerly Bundesamt für Landestopographie in Wabern (Switzerland), is gratefully acknowledged.