Orthophotographic survey procedure for the interior façades of the Van Buuren Museum

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Abstract: The present article focuses on the creation of digital archives of historical buildings (built heritage) rather than on the processing of the archives themselves. Eventually, our work aims to develop an inexpensive process based on the use of quick and easy equipment for the creation of multi-use documents-surveys, which can be used as a restoration tool and architectural and historical analysis, and finally, for the archiving or storing of digital imprints of common or unusual Brussels typologies, in collaboration with the Department of Historical Sites an Monuments of the Brussels Region, and as a support tool for that body. Although the topic in question falls within the scope of archiving or information storage, we do not actually become involved in the processing of those archives. The process which we are developing here seeks to be rigorous, well-documented and conforming to current usage in terms of the exchange and lasting quality of the data. Nevertheless, while carrying out the survey process, we will give some thought to the problem of accessing the documents produced via the very schematic interactive 3D representations of the architectural object under study. Our line of thought is therefore at a stage upstream of the archive classification procedures, and relates to the relevant transcription of the architectural heritage object into digital archives, in accordance with specifically defined available resources and according to the exact potential use of the documents produced. Generally speaking, our survey process consists of systematically producing images which are a hybrid of the geometrical elevation and the photography, in other words, an orthophotograph. By way of a reminder, orthophotography, as we understand it, may be compared to a geometrically corrected photograph, enabling the coordinate points of the photograph to match the corresponding point on the surveyed elevation. The result obtained is equivalent to a photographic orthogonal projection of this elevation.

Key words: Orthophotography, photogrammetry, survey method, heritage buildings, digital archiving, architectural representation, Art-Deco.

Description of the item and the problems faced

Located in Brussels, the Van Buuren museum is a luxurious house, built in 1928 and an icon of the Art-Deco style, which belonged to the Dutch banker and patron David Van Buuren. Every room inside the building involved the work of contemporary Belgian, French and Dutch cabinet-makers, wrought-iron craftsmen, upholsterers and designers. The building includes, for example, furniture and finishings by the Paris house of interior designers-decorators, Dominique, or stained glass windows and tapestries from the Dutch designer Jaap Gidding. These areas make up an homogenous and unique style, and also accommodate a significant collection of sculptures, engravings and canvas paintings (Braque, Permeke, Spilliaert, van Gogh, van de Woestyne, Bruegel...) which became the property of the Van Buurens. A select group of people and famous international personalities from the world of culture stayed in the house from the late 1920s to the 1940s. Thus, in the music room, around the piano belonging to Eric Satie, we could have come across Jacques Prévert, René Magritte, Christian Dior, Queen Elizabeth of Belgium, or Golda Meir and David Ben Gourion. The building is in a way a « complete work of art » where each architectural component or piece of furniture is designed down
to the smallest detail and created in a manner which is consistent with the general style as a whole, each work of art incorporated into an overall avant-guard setting. The house is also surrounded by gardens designed by Jules Buyssens et René and Pechère.

A listed historical monument placed under the control of the Department of Monuments and Sites of the Brussels Region, the building is expected to be restored very soon. In spite of the attention given to the conservation of this private house that became a museum, a number of fragile and precious works of art, such as the horsehair canvas paintings hanging on the walls or pieces of decorative woodwork or ironwork, have suffered the effects of time and become damaged. On the other hand, modifications have been carried out on the building during the course of the last three decades, and during these interventions certain details were modified without any great finesse and without remaining faithful to the original design of the house. Ever conscious of these issues, we have used orthophotography to carry out an exhaustive survey (floors, ceilings, inner façades)... of the existing status of the main rooms in the house. The main idea is, on the one hand, to produce a working document for the art historians and architects in view of the restoration work due to be carried out, and, on the other hand, to gather and file information digitally and very accurately about the current status of the house’s remarkable rooms, including metric and colimetric data for each view or image. In the longer term, the project could also be used as a starting point for developing a rapid survey procedure, relatively quick and easy and low-cost, requiring little equipment and applicable to the main typologies of Brussels houses, according to specific criteria - determined by the Department of Monuments and Sites - relating to classification or listing, archiving/documentation or surveying prior to restoration.

The main aims and objectives of the work are therefore:

- Mapping the current status of the building, which can then be used as a processing and analysis tool during the research work carried out by the historians and architects responsible for renovating the building, and, thus, produce easily manipulable documents capable of recording in detail the materials and their textures, as well as the dimensions of the surveyed spaces. This implies the need to produce documents that combine a high level of photographic accuracy (high definition) with a high level of metric precision, i.e. a document that combines a very accurate flat projection with the actual photography.
- Producing reference documents which can lead to the documentation of the remarkable interior architecture of the Van Buuren Museum by “freezing” a digital imprint of the surveyed areas, these same documents also being used for the purpose of dissemination and communication.

Methodology

Approaches to the problems of data acquisition

The lavish ornamental layout of the museum, combined with a spatial configuration made difficult by the lack of space in the inner rooms, has forced us to take the following two potential problems into consideration when planning the survey: on the one hand, the technical difficulties of such a layout, and on the other, the architectural typology of the site. Even if the general layout of the internal spaces
compels us to resort to some technical adjustments which can be appreciated later, we believe that it is essential to consider the object as a whole, i.e. its geometrical, historical and symbolic dimension. These different aspects are just some of determining factors used in the choice and quality of the items to be represented.

Although the orthophotographic productions, through their photo-realistic content, convey objective information about the item surveyed (dimensions, colours, shapes…), the acquisition and production processes tend to move away from that very objectivity since it is up to the operator to define his own particular approach to the object. Given the pointless, even unachievable, nature of an absolutely exhaustive survey of a building, a cognitive interpretation of the edifice is a necessary prerequisite when classifying and identifying coherent architectural layouts or spaces of high aesthetic and symbolic value, compared with those which are basically just a part of a global architectural entity, for which a diagrammatic or straightforward metric representation would be sufficient. In this respect, the orthophotographic survey has not, therefore, been considered for rooms formerly allocated for use as outhouses and services, reincorporated today, moreover, by the administration of the Van Buuren Museum.

It is not intended that an observation of the inner façade will be omitted from the general interpretation. Even if it would be useful to adopt a cognitive approach before undertaking the set of surveys, in order to specify which spaces will be selected for the project, it is also essential to determine the semantic value of the view or image appearing on the orthophotograph. For example, it is assumed that, when acquiring the data of an inner façade, its limits can be defined very precisely. Thus, on the vertical axis, where does the elevation begin? Where does it stop? At the exposed joists or beyond? Under the ceiling? Do the joists belong to the “ceiling”? A systematic interpretation or reading of the object made according to these different levels of perception (spatial, geometric, historical, semantic…) should be considered as a quality guarantee of the information contained in the final orthophotographic documents.

**Choice of data acquisition technique**

The orthophotographic survey of the Van Buuren Museum is the result of much thought given to contemporary survey and representation methods for a typical architectural object. The choice of this type of representation is the response to a request and operational challenges put forward by the Department of Historical Monuments and Sites. Among the tools accepted and used nowadays in the field of cultural heritage surveys, a number of data acquisition methods, such as lasergrammetry, total station surveys or photogrammetry, allow data to be recorded, which, after processing, can produce representations with an informational value that varies according to the type of acquisition. We, therefore, need to look at the relationship between which the type of data acquisition and the final representation of the processed item. Considering the document thus obtained as a multidisciplinary study tool should allow us to establish the quality and type of information to be obtained. Thus, there is no doubt that the orthophotograph, with its high graphic value, will not be the most appropriate tool for studying the geometry of all the components of the spatial unit. In the same way, a lasergrammetric survey of the inner façades of the Van Buuren Museum will not really enable us to fully appreciate any damage or deterioration (dampness, deterioration of the paintwork…) which may have been caused by the ageing process. Our choice of orthophotography and photogrammetric processing is, therefore, based on the fact that the Department of Historical Monuments and Sites firstly needs to obtain appropriate documents for...
a research study to be carried out prior to future restoration work, this process, secondly, enabling that body, as we have already mentioned, to freeze images of the existing status of the remarkable rooms in the house.

A brief description of the acquisition process

As we have just pointed out, the orthophotographs have been produced through photographic acquisition and photogrammetric processing of the images. To remind ourselves, orthography, and thus the corrections of the photographs, is made possible in a large number of cases by measuring the control points via a total station. The points obtained on the elevation allow us, by matching them to the photographs, to apply the necessary distortions to the image in order to transform it subsequently into a geometric view. By virtue of their exclusively virtual treatment, our orthophotographic techniques do not require the manual process involved in a total station photographic survey. The identification of the control points, in addition to corrections that do not require conventional instruments (too cumbersome and awkward for the spatial configurations that concern us here), have been made possible through a specific form of photogrammetric processing or treatment of our photographic sources. (This technique was recommended to us by a member of the Gamsau-MAP team).

By triangulation or by identification of the common points on each photograph converging on the surveyed imaged, convergent photogrammetry allows a referential space to be defined in which the lines of sight and the space of this scene are present. With this operation, it is possible to determine with precision the coordinates of the points identifiable in at least two of the convergent and calibrated photographs. One or even several other images are associated with the ensemble of these first lines of sight, taken perpendicularly on the plane of elevation. These latter images, the perspective effects of which are naturally toned down, are also calibrated within the referential space to match the convergent photographs. The projection of these on the planes corresponding to the depths of the surveyed object allows the corresponding data in the photograph to be separated out in actual size. This process allows for the general deconstruction of the image’s perspective system and thus its geometrical reconstruction (see figure 1).

Even though, unlike the strictly dimensional data acquisition process, orthophotography offers a full representation of metric and colimetric information, its implementation requires - as far as possible - the use of telephotography for taking the images at a significant distance from the subject. This technical factor is explained by the distortions that are produced by the lens in wide-angled lines of view. In order to get around the major optical distortions induced by confined spaces, we have considered each elevation as a mosaic of photographs.

Comparison with a laser sensing (survey) to verify the method

In order to validate and thus determine in the best possible manner the metric quality of the processed orthophotographic documents, we have endeavoured to make a comparison between the dimensional data obtained and those acquired via a lasergrammetric survey of the interior elevations studied. Starting off with the notion that the laser station is correctly calibrated, we are able to ascertain that this former method is accurate (within a space of comparable dimensions to those that concern us here) to within one centimetre. After checking with the conformity of
Figure 1:
- #1 to #3: converging photographs and calibration
- #4: orthographic photographs and calibration
- #5 to #7: depth planes identification and corresponding photographic data projection
- #8: scaling and graphical treatment of the acquired data

Orthophotographic survey procedure for the interior façades of the Van Buuren Museum
D. Lo Buglio & D. Derycke
a whole range of coordinates, we are able to comment that on average each orthophotograph is accurate to within two centimetres over a large distance, a margin of error that is quite acceptable for the preparatory reading and studies related to the restoration work of the façade. If we do not take into account the time factor involved here (more significant for an orthophotographic survey than for a simple laser survey), we have accepted that the technique used for the acquisition and production of the interior elevations of the Van Buuren museum appear to be the most appropriate, considering our initial problems and the informational quality of the documents achieved.

Constraints and Artefacts

The results obtained at the end of the orthophotographic acquisition and production work should also be moderated by the technical limitations of the procedure. These limitations do, in fact, have an impact on the final quality of certain documents. Therefore, it is also necessary to call to mind the factors that have led us to make certain choices with regard to the graphic indication of the boundaries markings and anomalies contained in the documents. We are able to identify two major criteria responsible for these:

Occlusions related to the shaded areas

The conical perception of a wall (as seen) through the lens of a camera does not allow all the constituent components of the elevation to be captured in one shot. A piece of fitted furniture, a basement shelf, the thickness of the joinery, exposed joists... are just some of the components that, by projection, can obscure the background. These instances also occur when selecting the information relevant to the respective scale, and when considering our orthophotograph as the synthesis and assemblage of a whole range of shots. However, the mere fact of moving the camera and adding a new image to the overall picture is not always enough to capture all of this. In many instances it is impossible, either to shift the object obstructing the field of view, or to obtain a new photograph containing, at the same time, the missing information and enough points that are common to the other survey photos, so as to be able to link them to the general calibration. This fact forced us, by adopting a strategy based on a measured selection of surveyed components and position control of the camera, to identify and select information which could be prioritised over and above that of a lesser value. In the event that we are unable to capture a part of the façade, it is essential to display the hidden area during post-production processing in order to ensure a precise and clear reading of the final document. Apart from having to make a choice of shots according to their relevance, we are also faced with the problem of selecting the appropriate graphic coding for indicating or marking out the unknown or unsurveyed information.

Resolution and quality variations in the non orthographic shots

The orthophotographic survey of the interior rooms of the Van Buuren house was considered not only for the interior façades, but also for the floors and ceilings between each façade. The non orthogonal shot of a plane to be surveyed involves a reduction of the photographic resolution insofar as the surface becomes more distant from the lens. If it seems a good idea to stand perpendicular to a wall when taking a shot of it, this would make it more difficult to obtain sufficient
distance when taking a photograph of the floor or ceiling surface. It was deemed
impossible to use a camera tower or other equipment in an environment as delicate
and full (of paintings, etc.) as the Van Buuren house. In spite of significant
adjustment and touching up, these orthographic photos have certain metric
inaccuracies and a very poor density of colorometric information.

These basically technical limitations forced us to be very careful about the
architectural typologies dealt with here. The reason is that, even though it is
conceivable to determine a cognitive approach and adopt a number of technical
solutions for each orthophotographic survey, the relevance of these reading tools still
effectively depends on the object being processed and its typology, orthogonal or
otherwise. In our case, we were eventually able to make a reasoned decision about
its semantic and spatial dimensions without too much difficulty. It is not at all
certain that in the other configurations, such as those of an organic style of
architecture, it would be so easy to determine precisely the semantic value of a wall
or a ceiling. This poses the problem of finding a link between the system of
representation and the form represented.

Representation and interpretation of the architecture

A stand-alone orthophotograph can be compared with a section in which the
surrounding space represents an infinity of dark material. A single orthophotographic
image, without any interpretation, without any coding of the architectural design,
has very little meaning, given that the context which links it to the architectural
ensemble is not or only slight readable. It is, therefore, necessary to transform a raw
orthophotograph - an acquisition of data - into a relevant architectural representation
that responds to a specific set of problems and focuses on the fundamental issues of
architectural representation and design. According to Pierre Boudon: «In
architecture, a projection technique is the method of achieving a graphic
representation of volumes in a plane; in this rabatment or plan rotation process the
sense of an implicit depth should be preserved or the (3-dimensional) representation
will be reduced to an ornamental (2-dimensional) shape (...).”. The process of
deconstructing a perspective system that constitutes the rectification of a photograph
in order to obtain an orthophotographic image falls within the same comparable
logic: the photograph - once rectified - has a value as a geometrical image or
drawing, and its photographic aspect reinforces the implicit depth described by
Boudon. In fact, even when flat, the photograph conserves the information relating
to matter and light, suggesting the notion of space. If we superimpose the
information of the geometrical architectural drawing on to the corrected or rectified
photograph, we will obtain a sectional line drawing image in which the obscured or
missing components are sketched in (rectified) and the background components are
very detailed. In short, we will have an architectural representation which is very
similar to the classical architectural drawings of the 19th Century, but produced a
posteriori. It is, therefore, quite interesting in the production of this type of image to
place, side by side, the photographic medium showing the surface, the external
aspect of the items and the architectural design which, through its codes, brings a
quite different type of information, constituting a symbolic representation of the
reality, mainly as far as the hidden components and missing or obscured items are
concerned (see figure 2). The architectural drawing also inevitably implies a
geometrical understanding of the object, and thus, in this sense, we return to (or
continue with) a preliminary analysis of the survey described above. For example,
Figure 2: section combining orthophotography and architectural design

Orthophotographic survey procedure for the interior façades of the Van Buuren Museum
D. Lo Buglio & D. Derycke
the critical determination of the measuring mark (outline or line) of the rectified (obscured or missing) elements on the orthophotographic image depends on a semantic reading of the spatial aspect and the decoration plan in which the constituent elements are clearly identifiable: walls, joists, panelling, plinths, mantelpieces, frames... The processing of the orthophotographic images together with the architectural drawings, therefore constitutes a representation process which is indistinguishable from a rigorous coding of the architectural object.

Thus, on the basis of a one-off survey and having specific data for each space, the reconstruction of cross-sections for the whole building allows us to create images for archiving that are far more complete than the situation actually surveyed photographically. The combination of orthophotography for the interior and total station surveying for the exterior (already available in this case) and the use of “classical, constructed and cognitive” architectural design (drawings) allows us, by manipulating these different supports and codes of the architectural representation, to obtain certain analytical views or images which provide a still unrecorded interpretation of the construction, and thus we will be able to proceed with a digital imprint, making the connection between the image or views themselves and placing them within the overall context of the architectural work. The reconstitution of the sections therefore offers a vision of the whole decoration plan of the Van Buuren house and thus, in terms of coherence, colours, materials, alignment, mood..., a very thorough analysis can be made of the furniture, tapestry, panelling and woodwork, representing a way of rediscovering the building. The recording or archiving of the architectural work is, of course, thus improved, the views produced incorporating an analytical value inherent to the representation.

In consideration of the prime objectives of digital backup and documentation of the building, as well as any possible distribution of this information, special attention has been paid to the homogeneity and graphic value of the views produced, due to the fact that the orthophotographs are carriers of the magnificence of the sites surveyed. We have, therefore, decided - insofar as possible - to reconstitute by image manipulation a whole range of “shaded areas or occlusions” due to the complex spatial configuration of the rooms or the immovable items of furniture (such as the Eric Satie piano, for example), for which it is impossible to provide a coherent geometric representation. Nevertheless, each of the reconstituted areas is indicated in detail in each one of the orthophotographs.

**Organization and accessibility of the acquired data**

The survey and archiving work undertaken by us has led to a set of different types of digital files being produced, for which it is essential that the format is managed according to proposed use. We have differentiated between the “native” formats, on the one hand, which are reliant on the programmes used and contain all the editing data, and the so-called “universal” formats, on the other, which ensure the lasting quality of the data, its accessibility and distribution, but from which the editing information is absent. Insofar as possible, each stage of the process benefits from a (safety) backup by means of these two types of format:

- After data acquisition, the original photos are captured in raw then in jpeg.
- The calibration of the photos for perspective rectification is carried out in the programme **Realviz ImageModeler** (now part of Autodesk). These files can only be read in this programme, but without any possible exports containing the
essential calibration information. These files are thus, in principle, the most fragile part of the process in terms of lasting quality.

- **Adobe Photoshop** is used for the recomposition and graphic processing of the corrected photos, the scratch files are saved in native file format, with copies and annotations, and come with an uncompressed **tiff** export file.

- **Adobe Illustrator** is used for the vector graphics processing of the photo, the scratch files are preserved in native format, with copies and annotations, and come with two **PDF/A** export files, one in high resolution at a 1/10th scale and the other at a lower resolution for printing.

- The schematic model of the building is formed with **Autodesk 3D Studio Max** then exported to **VRML**.

- The interactive access to data is coded in **HTML** with **W3C** validation.

The survey of the museum represents a wealth of information. Therefore, the interpretation or reading of a stand-alone orthophotographic document obviously does not take into account any association with its own spatial context. Starting from the principle that, in addition to the acquisition work, it is important to take a stand regarding access and intelligibility of the documents, and the manner in which the images can be linked to the context, the creation of an interactive representation of the building can be presented as a possible solution for the hierarchical regrouping of the documents within one and the same spatial environment. The organisation of the data files is, therefore, achieved firstly within a system of directories structured according to the architectural logic of the surveyed building: according to level, then by room, then in a North-South-East-West direction, ending up with the floor and ceiling. Then an interactive schematic spatial representation of the Van Buuren museum will allow us to locate precisely within the building each of the images produced, and be able to access the orthophotographs stored in this same structure of directories (see figure 3). The information contained in each of the documents has, in effect, an informational value limited to the single components to which the representation relates; however, more than a fragmented reading of each elevation, we need to be able to appreciate the spatial association of each orthophotograph within its general context. Apart from focusing on the survey procedure, we therefore intend to give consideration to the organisation and methods of accessing the orthophotographs so as to facilitate the reading process for the different parties involved in Historic Monuments and Sites (architects, conservationists, art historians,...). This method of accessing the data also enables us to face up to the issues associated with ergonomics, and forms the basis of a wider train of thought, such as, for example, coupling the views produced with metadata, or a regrouping of the different kinds of information available about the object under review.

As the heritage buildings held under the responsibility of the Department of Monuments and Sites can be considered as being experimental sites, this project represents a first stage in the development of a surveying-archiving protocol for the use of simple and easy-to-use equipment, which is not cumbersome or expensive. While taking into account the typological limitations described above, the process seeks to be adaptable and suitable, either for very detailed surveys carried out for major archiving and documentation projects, or for rapid surveys carried out on buildings with access that is limited within the time available or minor objects of heritage for which only a brief record is required, without the need for a major operation.
Figure 3: accessing the orthophotographs through an interactive schematic spatial representation of the object under study
Bibliography


Orthophotographic survey procedure for the interior façades of the Van Buuren Museum
D. Lo Buglio & D. Derycke