SURVEY DRAWINGS CONSISTENCY: THE USE OF MATERIAL-BASED LAYERING SYSTEMS IN COMPUTER AIDED DESIGN AND DRAFTING

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Abstract:
Multidisciplinary collaboration, in particular with reference to the organization of survey work, can prove challenging for obtaining a high quality output. Finding a working methodology, based on few principles and rules, to respond to these challenge is the objective of this paper.
By studying the survey process implemented by the Authors for the Hof te Leysbroek, a brickwork farm complex located in Vollezele, Flemish Brabant, Belgium a working process has been extrapolated.
This project was developed in the context of the IPW3 Module of the Master of Conservation of Monuments and Sites, Raymond Lemaire International Centre for Conservation, KULeuven, Leuven, Belgium.
In our opinion it represents a valuable case study for the achievement of consistency in survey drawing in an academic multidisciplinary team.
Basic information to be included in each survey stage and the procedure for setting up an xref-based AutoCAD drawing system, are discussed in this paper.
The results are addressed and limited to the experience of students in an academic environment but are, nevertheless, instrumental to enable non-architecturally trained students to have simple guidelines for the achievement of a basic standard of survey drawings quality.

1. INTRODUCTION

In the context of a Conservation project, developed in academic environment, the need of highly specialised theoretical and practical approach is required in a conspicuous number of applications. The complexity is given by the great variety of the spectrum of studies.
In the conservation project the historical research, the precision of the survey, the in-depth knowledge of materials, the elevated familiarity with architectural and urban planning matters, legislations and sociological issues are essential.
The collaboration of different professional with high developed skills is hence required.
Several difficulties can be encountered during the multidisciplinary collaboration, in particular with reference to the organization of the survey work. This implies that the survey can be carried out by students with little knowledge of measuring/drawing techniques. The result could be a poor technical outcome of the architectural survey drawings.
Setting up quality control measures, from the very beginning of the survey, could be a mean of ensuring better final results.
In addition, the possibility of achieving high quality intermediate survey drafts is necessary in order to discern which information is outstanding and should be checked again on site.
Correct intermediate survey drafts must show already all the graphical conventions which allow architects and engineers to fully comprehend the realm of the surveyed object.
The aim of this paper is hence to suggest a working methodology, based of few principles and rules, for the achievement of a better coordination and survey drawings' consistency throughout the survey process.

The use of a *material-based* layering system in computer aided design and drafting is normally used in architectural and engineering practices and could be set up as a basic reference for similar cases in academic studies.
The methodology will be drawn from experience obtained in the context of the IPW3 Module in the Master of Conservation of Monuments and Sites at the Raymond Lemaire International Centre for Conservation, KULeuven, Leuven, Belgium.
In particular, the case study analysed is a project carried out, during the academic year 2009-2010, by:

- Saskia Boom, Architectural Historian (The Netherlands),
- Pierangelo Cacciotti, Architect (Italy),
- Maud De Voght, ir. Architect (Belgium),
- Luca Visconti, Architect (Italy).

The project consists of a brickwork farm complex, named Hof te Leysbroek, located in Vollezele, Flemish Brabant, Belgium.
The complex is composed by a three storey house with rear extensions, a two storey house with an annex, a stable wing and a barn, grouped around a rectangular courtyard and surrounded by a moat. The different volumes date back to the 18th, 19th and 20th century (Fig. 1).

Figure 1- North elevation, Hof te Leysbroek

2. METHOD

The final objective of any survey is to produce precise scaled drawings of the existing physical conditions of the site and buildings.

In the case of Hof te Leysbroek there were no existing drawings available of the building complex. Therefore the survey was started from scratch; the following method was used:

SOURCES OF INFORMATION	
DIRECT	INDIRECT
Building	*Cadastral maps*
	Geographical context
	Bibliographic references
	Iconographic references
	Aerial imagery

Table 1 – Sources of information

EQUIPMENT		
DRAWING ENVIRONMENT	TOOLS	MEASURING DEVICES
Sketching paper	*Pencils & pens*	*Measuring tapes*
Graph paper	*Chalk*	*Profile comb*
AutoCAD software	*Level & laser level*	*Laser Disto*
Rectifying photography software	*Metal L-square*	*Total station and tablet PC*
	Plumb-line	
	Paper targets and glue	
	Digital camera	

Table 2 – Equipment

INFORMATION ACQUISITION TECHNIQUES			
PLANS	ELEVATIONS	SECTIONS	DETAILS
Triangulation	*Rectified photography*	*Total station*	*Hand survey*
Total Station	*Total Station*	*Disto*	*Study of indirect sources*
Study of indirect sources	*Hand survey*	*Study of indirect sources*	*Photography*
Photography	*Study of indirect sources*	*Photography*	
	Photography		

Table 3 – Information acquisition techniques

All information thus acquired was transposed into AutoCAD for the production of the final drawings.

3. RESULTS

The following drawings were produced:

- DWG E1-North Elevation; 1:50@A1 (Fig. 2)
- DWG E2-South Elevation; 1:50@A1(Fig. 3)
- DWG PD1-Basement Plan; 1:50@A1(Fig. 4)
- DWG PD2-Ground Floor Plan; 1:50@A1(Fig. 5)
- DWG PD3- Mezzanine Plan; 1:50@A1(Fig. 6)
- DWG PD4-First Floor Plan; 1:50@A1(Fig. 7)
- DWG PD5-Attic Plan; 1:50@A1(Fig. 8)
- DWG PD6-Roof Plans; 1:50@A1(Fig. 9)
- DWG S1-Section AA; 1:50@A1(Fig. 10)
- DWG S2-Section BB; 1:50@A1(Fig. 11)
- DWG PG1-Site Layout Plans; 1:200@A1(Fig. 12)
- DWG PG2-Site Layout Plans; 1:200@A1(Fig. 13)

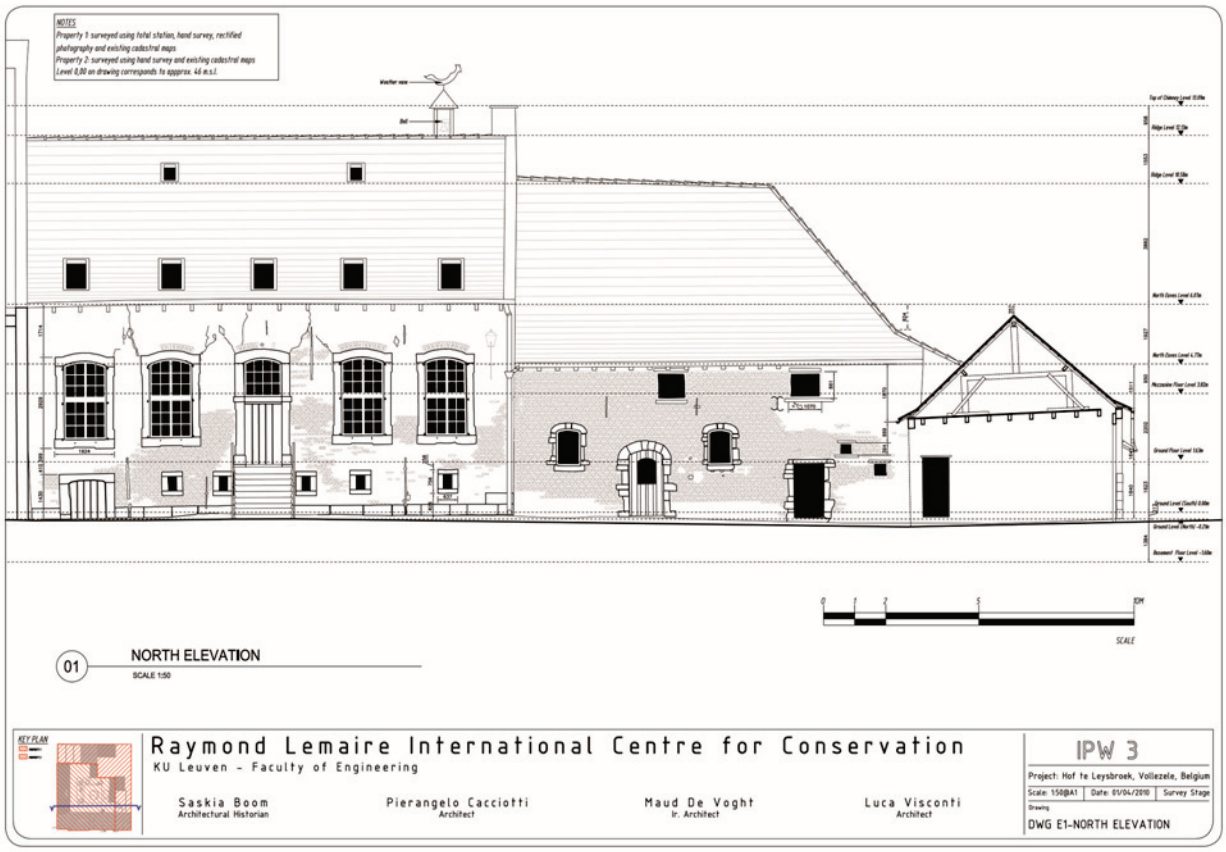


Figure 2 – North elevation

Figure 3 – South elevation

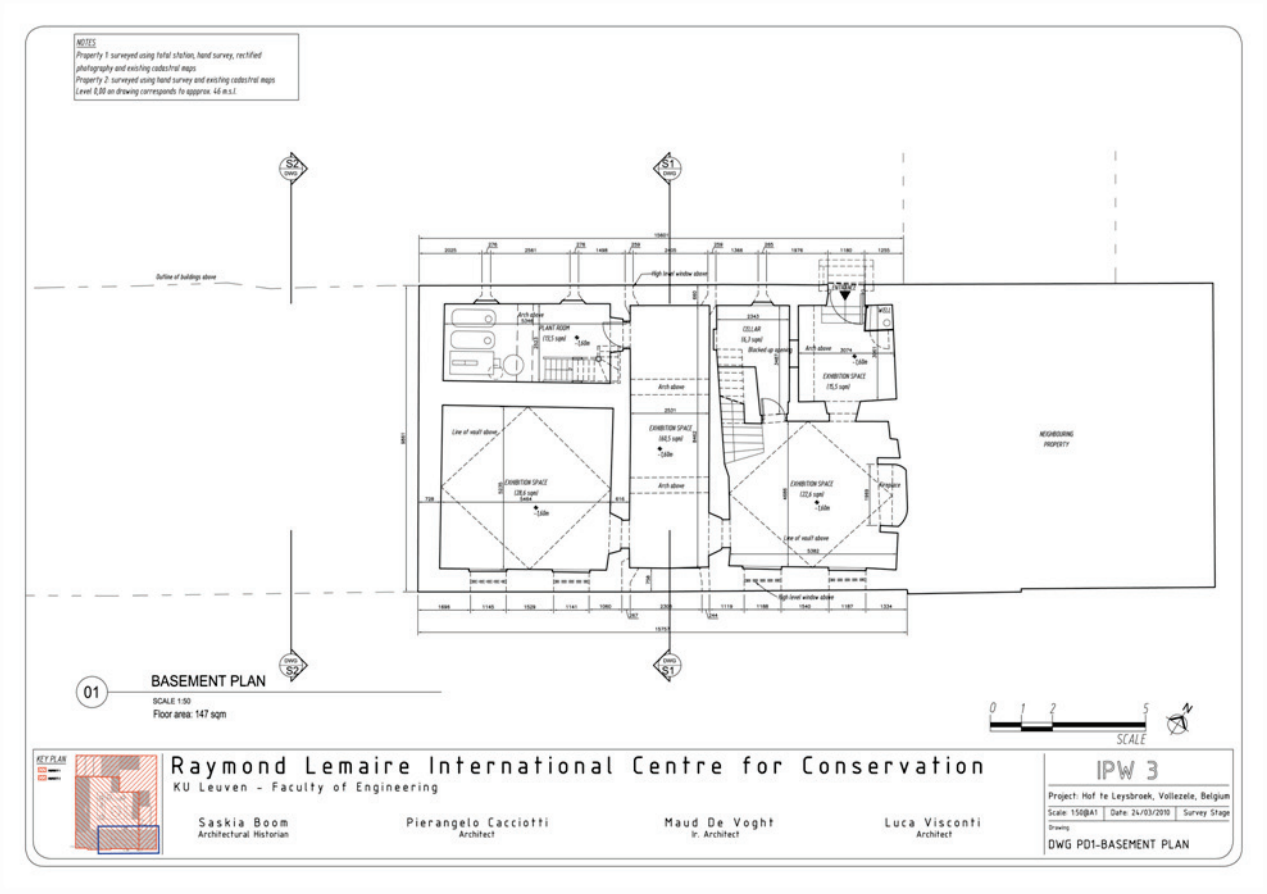


Figure 4 – Basement plan

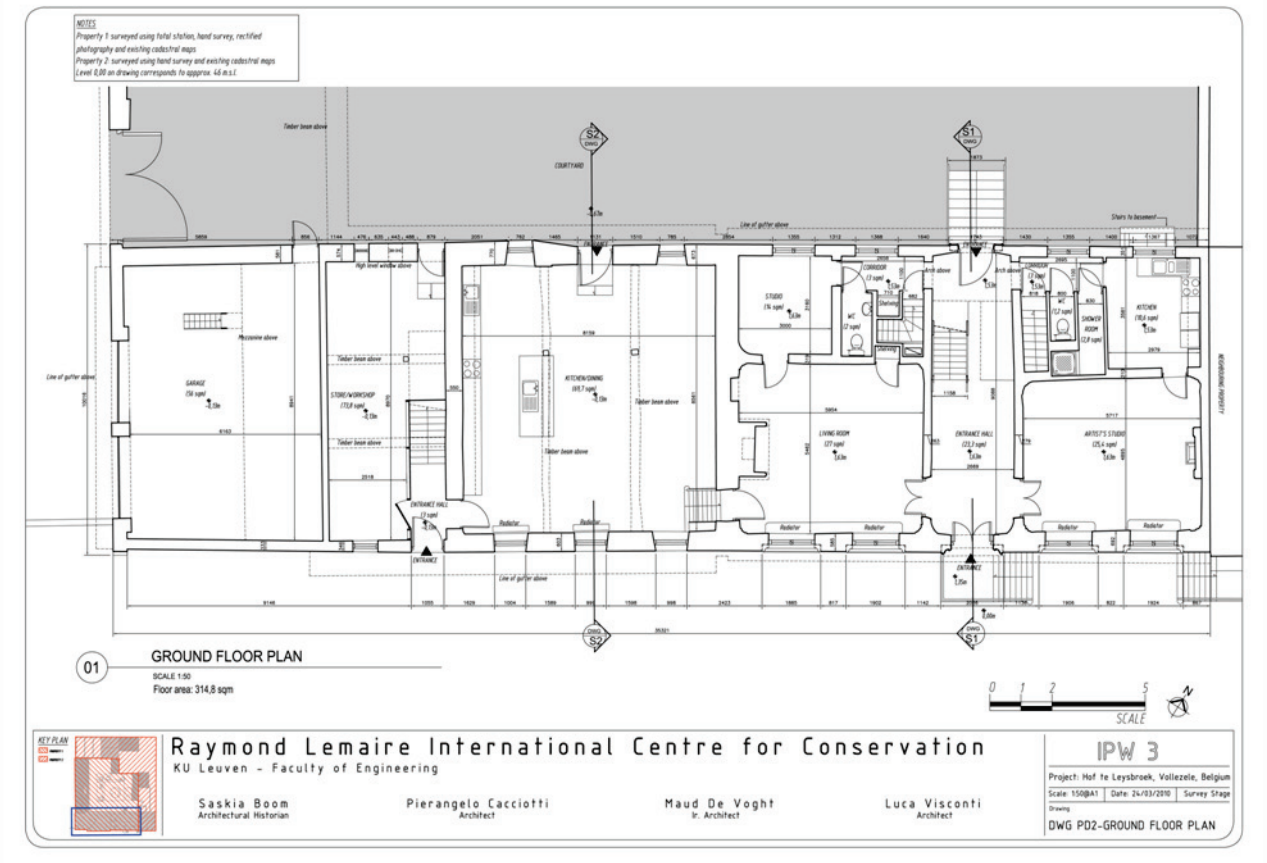


Figure 5 – Ground floor plan

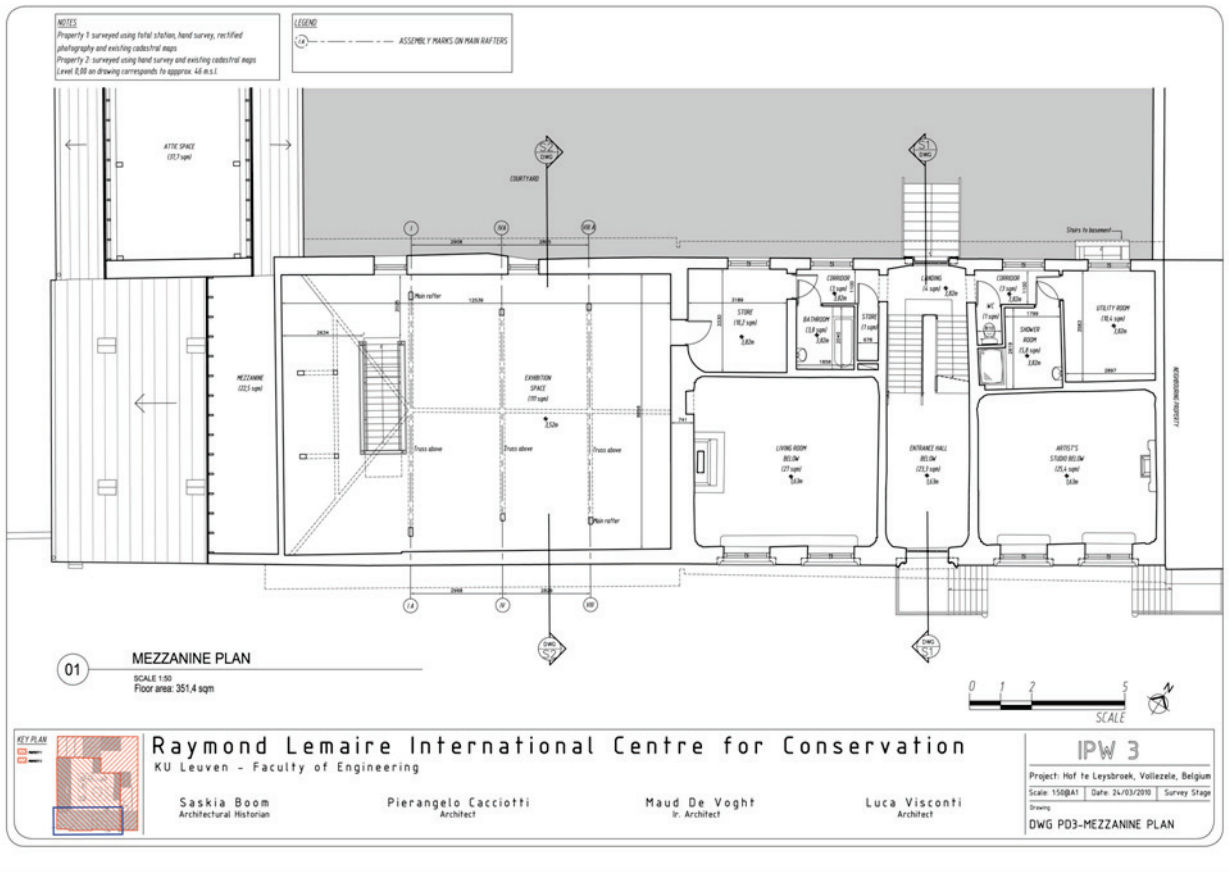


Figure 6 – Mezzanine plan

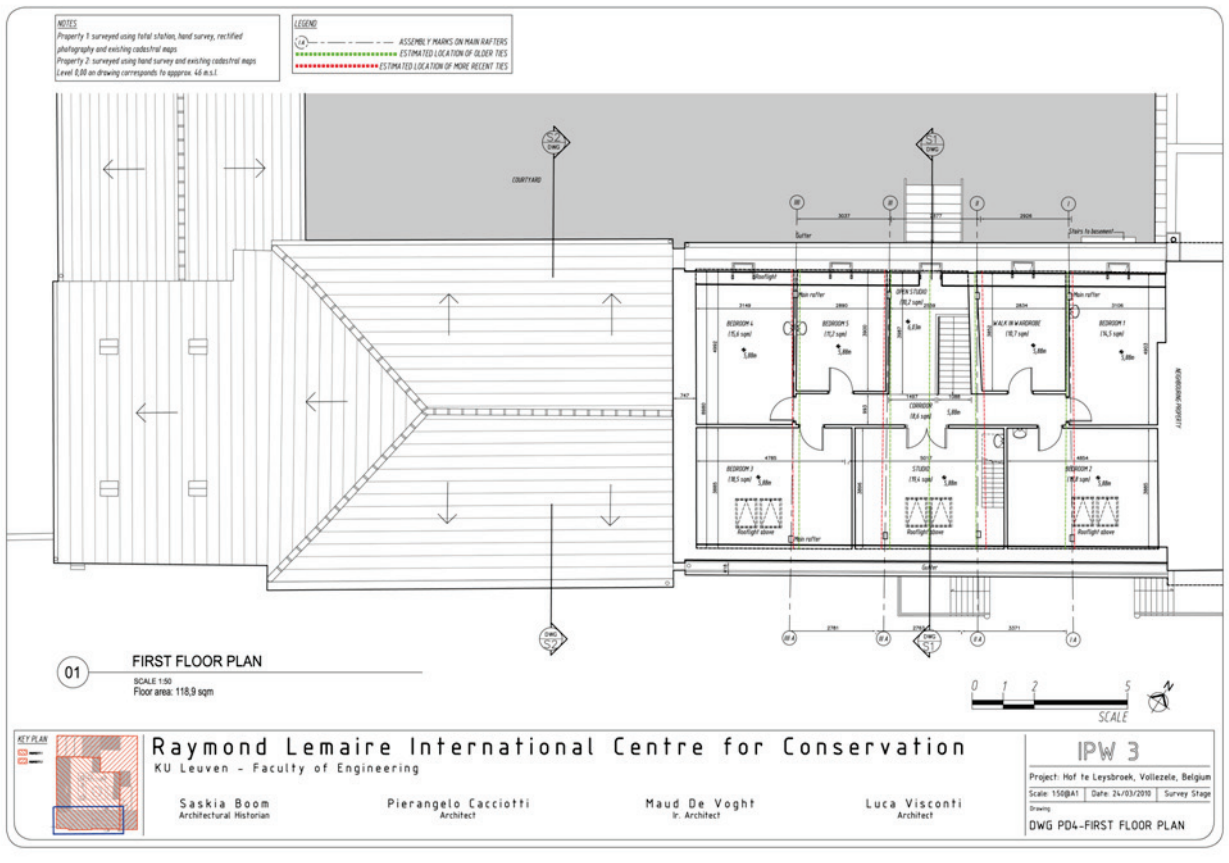


Figure 7 – First floor plan

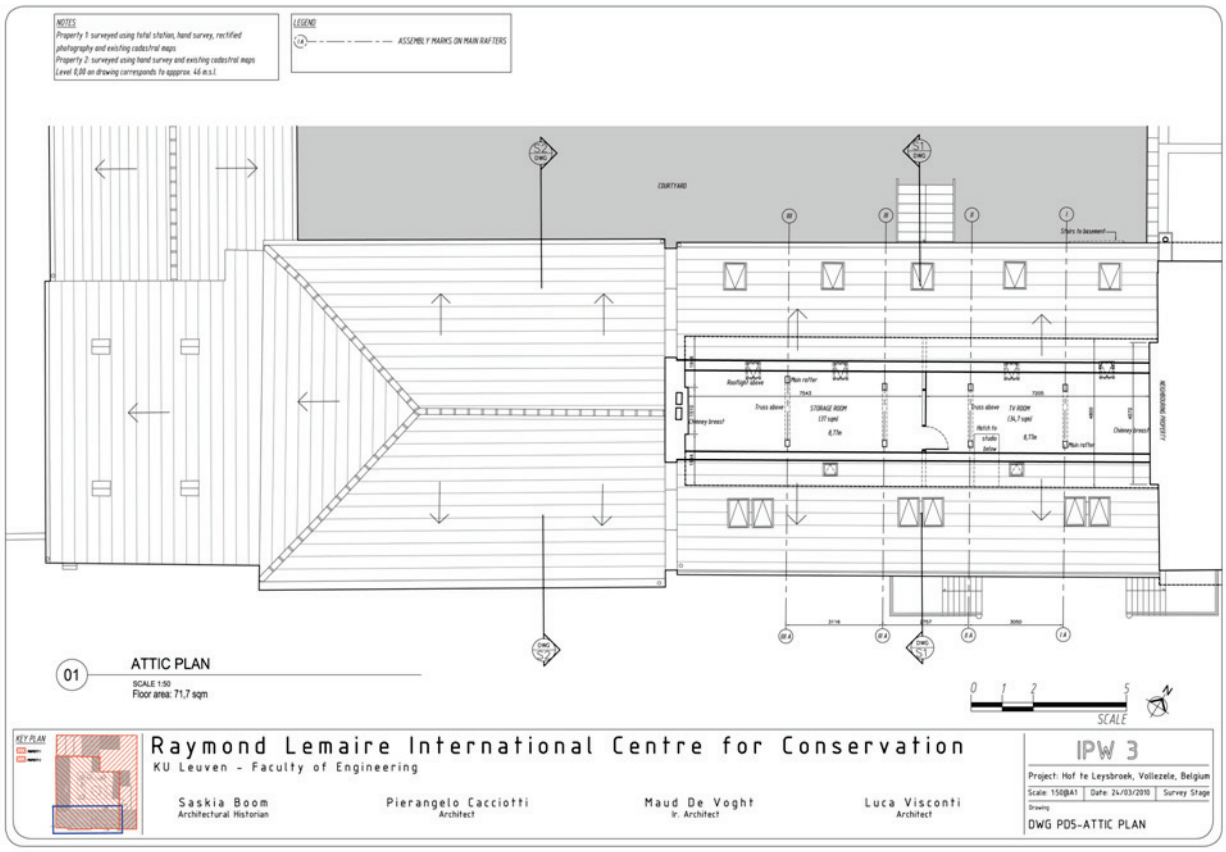


Figure 8 – Attic plan

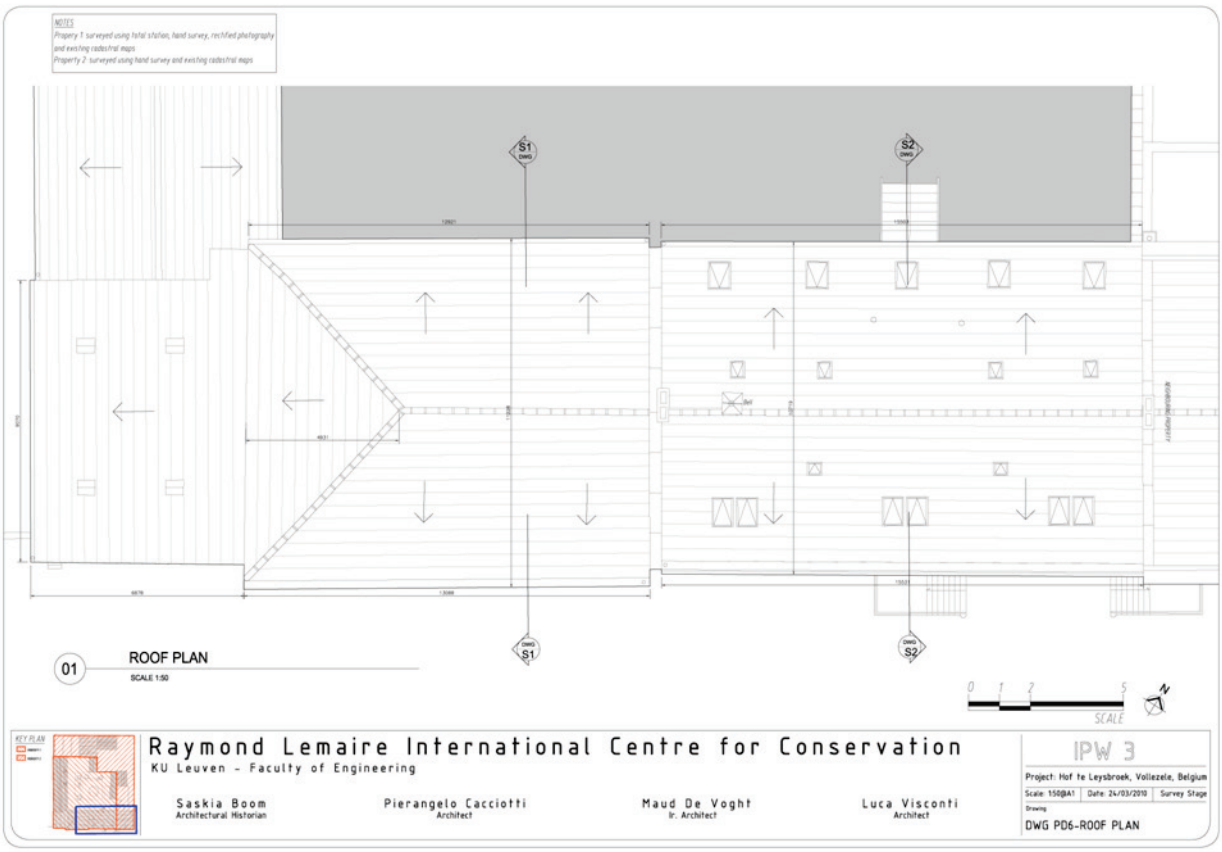


Figure 9 – Roof plan

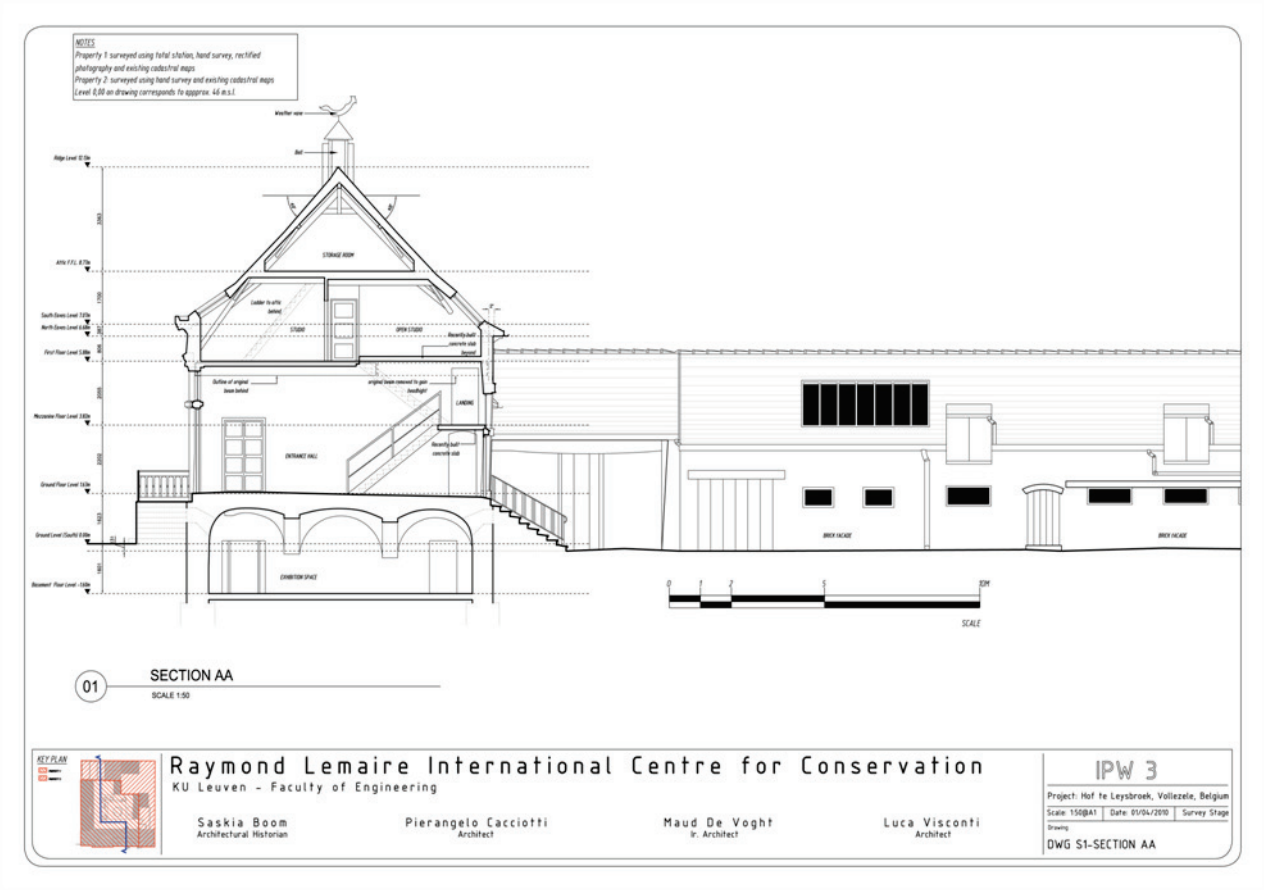


Figure 10 – Section AA

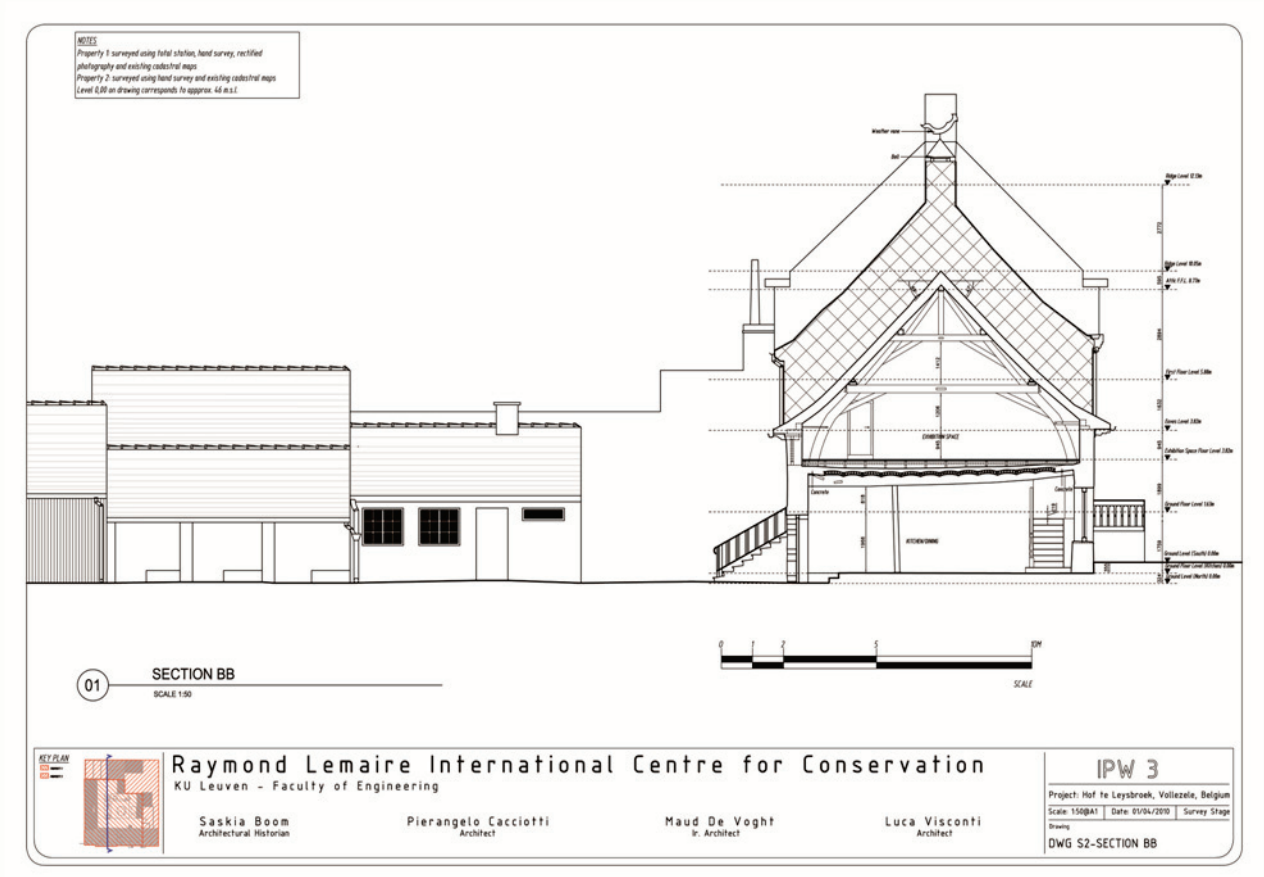


Figure 11 – Section BB

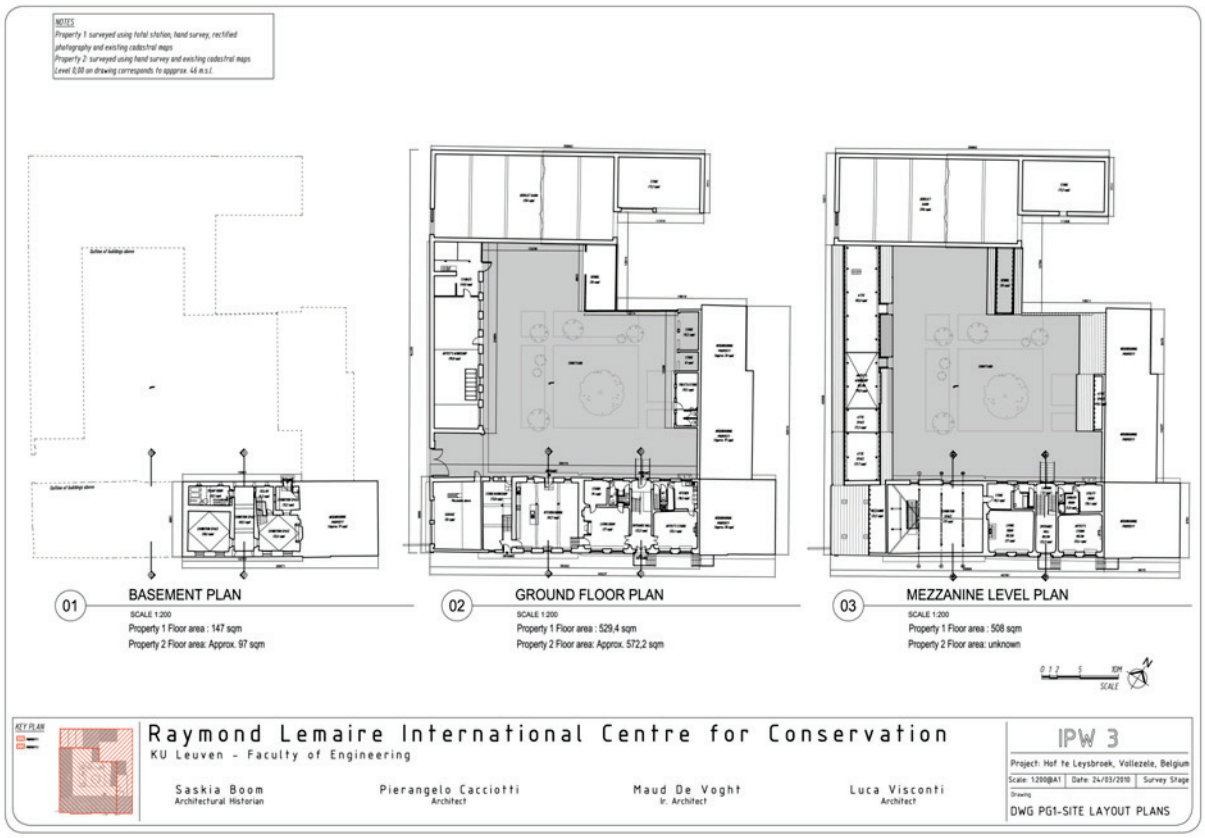


Figure 12 – Site layout plans

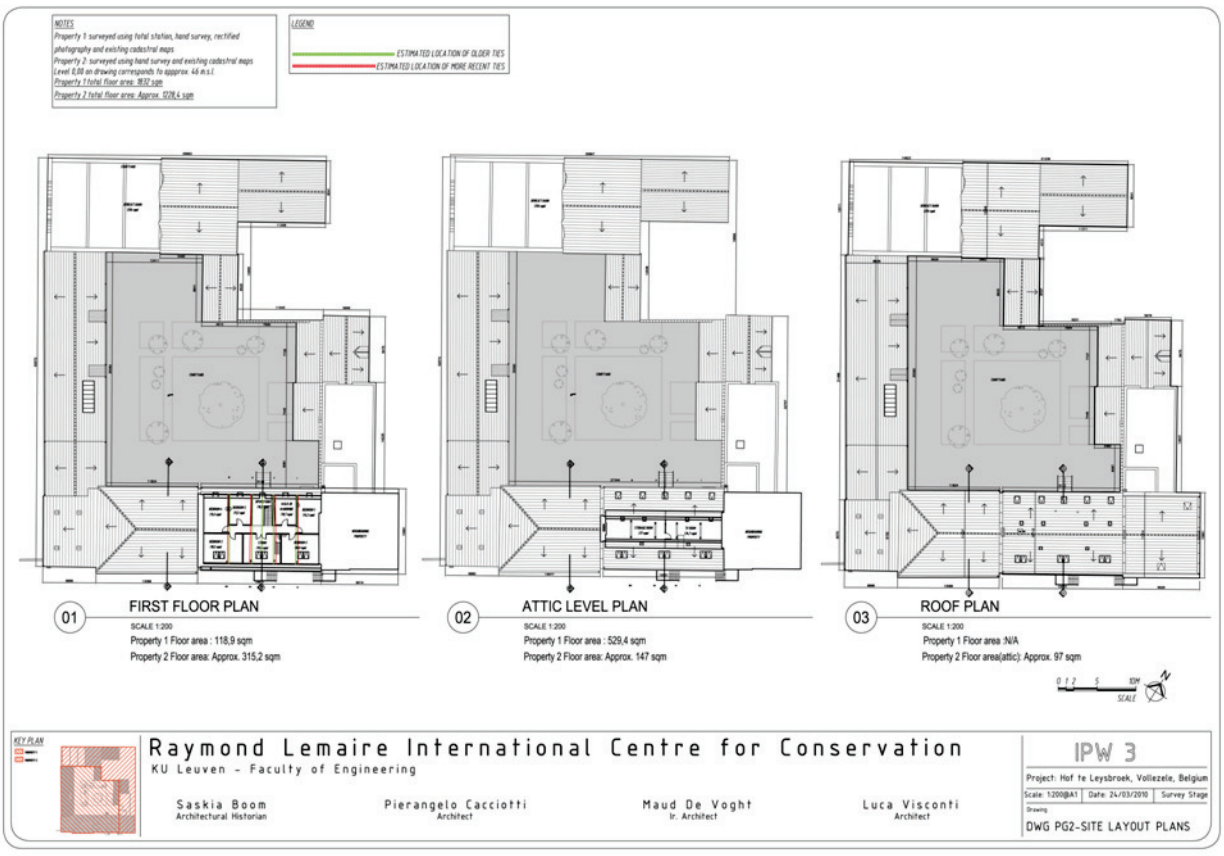


Figure 13 – Site layout plans

4. DISCUSSION

In a multidisciplinary/academic context, as the one we have worked in during the survey, the coordination of the workflow of information represents a crucial issue in order to obtain consistency in the results. We have found that ensuring a constant legibility of the survey drawings at different stages was fundamental in deciding how to proceed with the information acquisition process.

For this reason we have developed a working methodology based on the following principles.

4.1 Sketches

All hand sketches should include information as per Fig. 12.

PROJECT	
STAGE	
DATE	
SCALE	
AUTHOR	

Figure 14 – Example of drawing stamp

4.2 Photographic survey

A complete photographic record has been made to give an insight in the building complex. This record not only serves as a helpful tool in the development of a conservation project proposal, but can also be considered a valuable record of the current state. Whenever, due to any circumstance, the building might be damaged, the record could be used as a reference for conservation and restoration works.
In a first phase photos are organized based on the following file naming:

(date YYYYMMDD)(photographer initials)(photo no.)

A Photo Log Form is updated by each photographer as images are added to the record (Fig. 13).

HOF TE LEYSBROEK, Vollezele, Belgium - RLICC (KU Leuven) - IPW3 – 2010

Photo Log Form

Authors: Saskia Boom, Pierangelo Cacciotti, Maud De Voght, Luca Visconti

Photo REF*	Location	Photographer
HTL20100209_SB001	North elevation	Saskia Boom
HTL20100209_SB002	North elevation	Saskia Boom
HTL20100209_SB003	Kitchen	Saskia Boom
HTL20100209_SB004	Bathroom 1st floor	Saskia Boom
HTL20100210_PC001	North elevation	Pierangelo Cacciotti
HTL20100210_PC002	South elevation	Pierangelo Cacciotti
HTL20100210_PC003	Front door	Pierangelo Cacciotti

*REF: (project initials)(date YYYYMMDD)(photographer initials)(photo no.)

Figure 15 – Example of Photo Log Form

In a second phase the most significant pictures for the survey are organized in boards with a key plan, showing the location from which the photo was taken and a date (Fig. 14).

Figure 16 – Photographic record's board

4.3 Total Station

4.3.1 File naming

(project initials)(date YYYYMMDD)

4.3.2 Layering system

A new layer is created according to the building element surveyed on site (i.e. windows, gutters, etc…).

4.4 Final elaboration of data

In order to have survey drawings that are continuously updated and ready for a revision throughout the drafting process, an xref-based system was used. This system exploits the xref AutoCAD function and entails working with two sets of DWG files:

- Working files
- Final drawing files

4.4.1 Working files

The final working files represent the in-progress results of the survey work. These files are set up according to the following principles:

a) Create a file named:

(project initials) xref_base

b) The layering system contained in the *xref_base* file can be organised as follows:

- Decide how many and which line weights are needed and assign a colour to each one, for example:

(red) (0.25)
(blue) (0.15)
(white) (0.18)
(yellow) (0.13)
Etc...

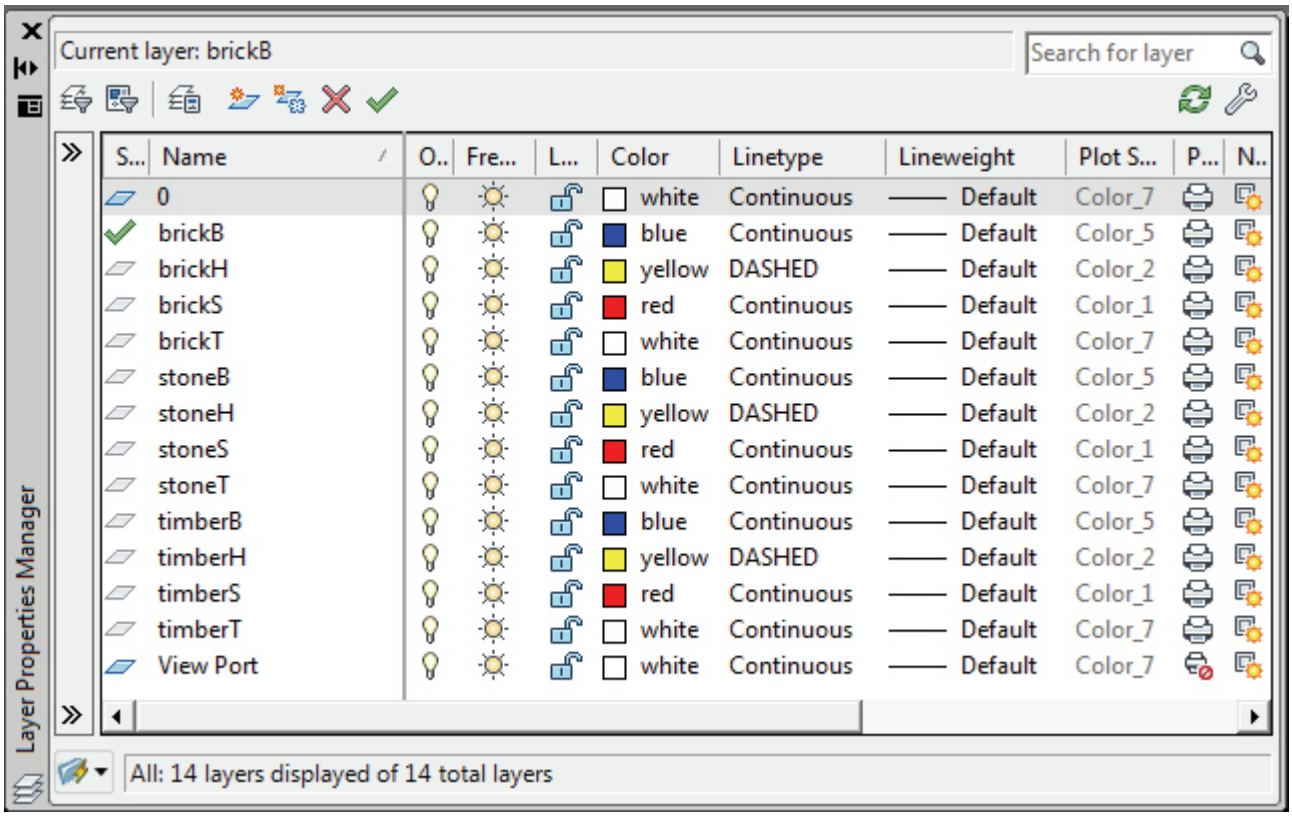
- Define the layers according to the following principle and decide which colour to assign on the basis of the desired line weight:

(material) (sectional/background/text/hidden information) (colour) (line type)

For example (Fig. 15):

BrickS *[sectioned bricks] [red] [continuous]*
BrickB *[background bricks] [blue] [continuous]*
BrickT *[notes bricks] [white] [continuous]*
BrickH *[hidden bricks] [yellow] [dashed]*
StoneS *[sectioned stone] [red] [continuous]*
StoneB *[background stone] [blue] [continuous]*
StoneT *[notes stone] [white] [continuous]*

StoneH *[hidden stone] [yellow] [dashed]*
Etc...



S...	Name	O..	Fre...	L...	Color	Linetype	Lineweight	Plot S...	P...	N..
	0				white	Continuous	Default	Color_7		
✓	brickB				blue	Continuous	Default	Color_5		
	brickH				yellow	DASHED	Default	Color_2		
	brickS				red	Continuous	Default	Color_1		
	brickT				white	Continuous	Default	Color_7		
	stoneB				blue	Continuous	Default	Color_5		
	stoneH				yellow	DASHED	Default	Color_2		
	stoneS				red	Continuous	Default	Color_1		
	stoneT				white	Continuous	Default	Color_7		
	timberB				blue	Continuous	Default	Color_5		
	timberH				yellow	DASHED	Default	Color_2		
	timberS				red	Continuous	Default	Color_1		
	timberT				white	Continuous	Default	Color_7		
	View Port				white	Continuous	Default	Color_7		

Figure 17 – Example of layering system from AutoCAD

c) Using the *save as* command create a separate file for each working drawing (i.e. plans, sections, elevations, etc...) named as follows:

xref (drawing typology) (drawing number)

For example:

xref_e_001 *[north elevation]*
xref_e_002 *[south elevation]*
xref_p_001 *[ground floor plan]*
Etc...

All drafting work is carried out on these files.
This system allows to draft and sort the surveyed information using a common layering structure shared among the different team members.

4.4.2 Final drawing files

The final drawing files represent the end result of the survey work. These files are set up according to the following principles:

d) Create a file named:

(project initials) final_base

This file should contain:

- A title block reporting at least the following fields (Fig. 16 & 17):
    - University/Organization
    - Project name
    - Drawing scale
    - Date
    - Stage
    - Author
    - Drawing title
    - Key plan

Figure 18 – Example of title Block

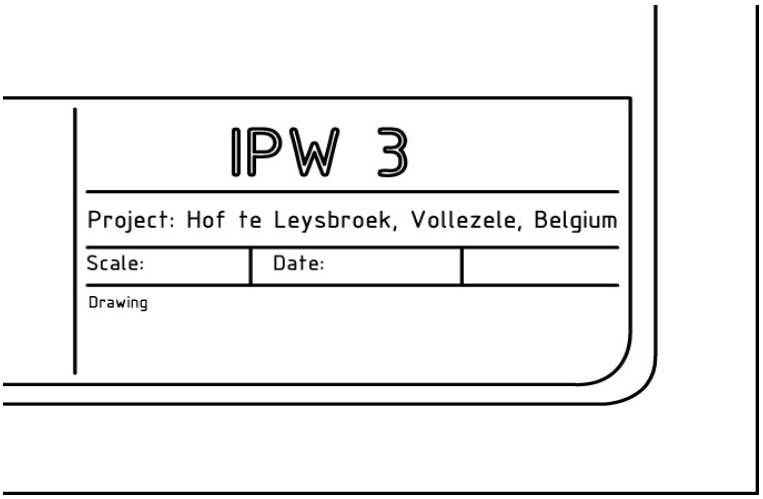


Figure 19 – Example of Title Block label

- A plot file, attached to the drawing, set up as per point 4.4.1(b) (Fig. 18).

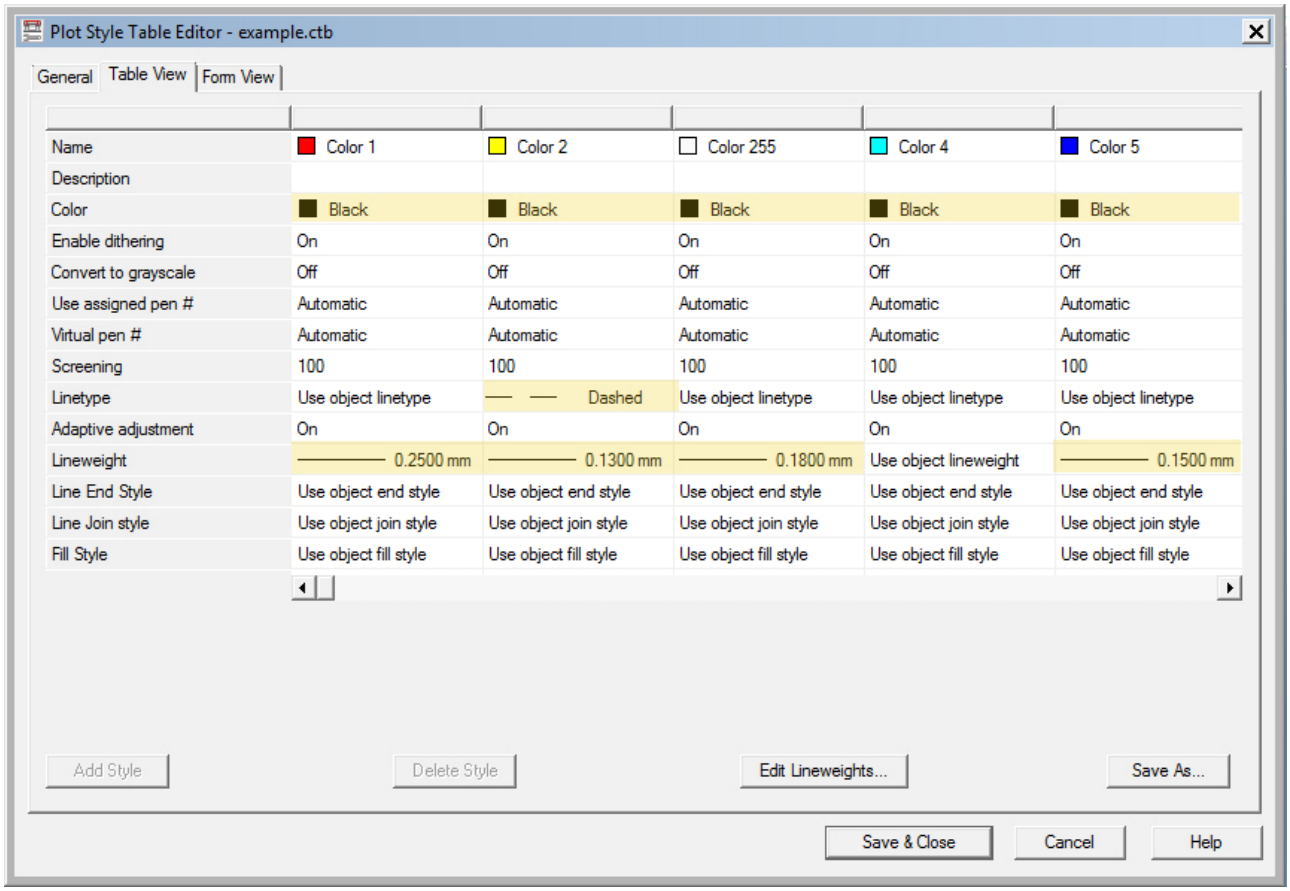


Figure 20 – Example of Colour Dependent Plot Style Table printout from AutoCAD

e) Using the *save as* command create a separate file for each final drawing named as follows:

   (project initials) (drawing typology) (drawing number)

   For example:

   HTF_e_001 *[Hof te Leysbroek elevations]*
   HTF_e_002 *[Hof te Leysbroek elevations]*
   HTF_p_001 *[Hof te Leysbroek plans]*
   HTF_p_002 *[Hof te Leysbroek plans]*
   HTF_pd_001 *[Hof te Leysbroek plan details]*
   Etc...

f) Using the *xref* command, insert the latest working files as necessary and arrange the final layout of the drawings.

It is important to set up this information at the very beginning so that the drawings are already set for progressive revision and final printing.

5. CONCLUSION

This paper has tried to identify, through the case study of Hof te Leysbroek, a workflow methodology to ensure consistency of survey drawings in a multidisciplinary environment.

It has been demonstrated that the coordination of students with different background is possible if a standard sets of procedures is furnished at the very beginning of the survey process. These procedures can be summarized as follows:

a) Basic information to be included in each hand drawn sketch on site.

b) Basic information to be included for efficient organization and storage of photographic records.

c) Basic organization of Total Station AutoCAD files.

d) Set up of an *xref-based* AutoCAD drawing system relying on:

- Working files and final files.
- A common, homogenous layering system.
- A common Colour Dependent Plot Style Table.

9. ACKNOWLEDGEMENTS

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8. REFERENCES

Santana, M.: *Recording, Documentation and Information System in Conservation* presented at RLICC, KULeuven, Leuven, September 2011.

Bryan P., Blake B., Bedford J.: *Metric Survey Specifications for Cultural Heritage* (Hockley: English Heritage, 2009)