Aggeliki Natsikou, Konstantina Tsantiri and Spiros Zervos*

Survey Methodology for a Collection of Technical Drawings

Methode zur Bestandsaufnahme einer Sammlung von technischen Zeichnungen

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Abstract: The YAMP (Projects and Specifications Archive Department) historical collection is part of the collections of technical drawings owned by the Historical Archive of Athens Water Supply and Sewerage Company (EYDAP S.A.). The survey of the collection, which is presented here, was commissioned by the Company to the Department of Archival, Library & Information Studies, University of West Attica, Greece. The objectives of the survey were the documentation of the condition of the collection, the determination of the technical specifications, and the cost estimation for its conservation. Several aspects of the survey methodology are presented, mainly the documentation step, which was planned to collect all the essential data, and the process of the cost estimation. Automation and parameterization of the calculations necessary for the documentation and the cost estimation are discussed in detail. The results of the survey and the recommended best practices for the optimization of the management of the collection are briefly outlined.

Keywords: archives, conservation, cost estimation, documentation, photoreproduction, technical drawing, tracing cloth, tracing paper

Zusammenfassung: Die historische Sammlung YAMP (Abteilung Archiv für Projekte und Spezifikationen) ist Teil der Sammlung von technischen Zeichnungen,

***Corresponding author: Spiros Zervos**, Department of Archival, Library & Information Studies, School of Administrative Economics and Social Sciences, University of West Attica, Athens, Greece, E-mail: szervos@uniwa.gr

Aggeliki Natsikou, Department of Archival, Library & Information Studies, School of Administrative Economics and Social Sciences, University of West Attica, Athens, Greece

Konstantina Tsantiri, Department of Conservation of Antiquities and Works of Art, University of West Attica, Egaleo, Attica, Greece

die sich im Besitz des Historischen Archivs der Athener Wasserversorgungs- und Abwasserentsorgungsgesellschaft (EYDAP S.A.) befindet. Die hier vorgestellte Bestandsaufnahme der Sammlung wurde von der EYDAP bei der Abteilung *Archival, Library & Information Studies, University of West Attica* in Auftrag gegeben. Die Ziele der Bestandsaufnahme waren die Zustandsdokumentation der Sammlung, die Bestimmung der technischen Einzelheiten und die Kostenschätzung für ihre Konservierung. Es werden mehrere Aspekte der Erhebungsmethodik vorgestellt, vor allem der Dokumentationsschritt, der geplant war, um alle wesentlichen Daten zu sammeln, und der Prozess der Kostenschätzung. Die Automatisierung und Parametrisierung der für die Dokumentation und die Kostenschätzung notwendigen Berechnungen werden ausführlich diskutiert. Die Ergebnisse der Erhebung und die empfohlenen *best practices* für die Optimierung der Verwaltung der Sammlung werden kurz skizziert.

Schlüsselwörter: Archiv, Konservierung, Kostenschätzung, Dokumentation, Fotoreproduktion, Technische Zeichnung, Pauscheleinen, Transparentpapier

1 Introduction

Technical drawings constitute an important part of the archival legacy of the world, since they document the planning and the construction of all kinds of buildings, industrial facilities, machinery, vehicles, ships etc., depicting the technical progress but also the evolution of human ingenuity (Cook and Dennin 1994; Price 2010). They are of great evidential and informational value for the scientific community, but also for large and small corporations, the state, and the public (Schrock 1996; Van der Reyden, Tennison, and Tsai 1996). The importance and usefulness of architectural drawings extends indefinitely in the future, for the lifespan of the structures they depict, and often beyond that. Technical drawings are ubiquitous and plenty. They exist in archival organizations, technical corporations, state organizations, and private collections. Apart from evidential, intrinsic, artefactual, and cultural values, they are also often recognized to possess medium to high artistic value (Schrock 1996).

Technical drawings have been executed on various supports. Tracing (translucent) paper is the most prevalent. It was produced by three main processes (impregnation with resins and oils, overbeating, and sulfuric acid treatment), which defined the appellation of the final products (impregnated papers, overbeaten papers, and genuine parchment papers, respectively) and their properties (Homburger and Korbel 1998; Laroque 2000, 2004; Price 1995; Price 2010; Van der

Reyden, Hofmann, and Baker 1993; Wilson 2015; Yates 1984). Tracing cloth, drawing paper and other substrates are also common (Price 2010). A large variety of media were also used, including India ink, iron-gall ink, pencil, crayons, ink washes, watercolors, and felt-tip markers (Price 2010). The need of construction and architecture firms for fast and accurate copy creation led to the introduction of a large variety of photoreproduction processes such as the blueprinting, diazo, Pellet, Van Dyke, and several others (Glück, Brückle, and Barkhofen 2012; Price 1995, 2010; Reed, Kissel, and Vigneau 1995). Original drawings and copies suffer from various types of damage, depending on their intrinsic vulnerabilities, handling, and conditions of storage (Cook and Dennin 1994; Hamill 1993; Wilson 2015; Yates 1984). Because of their size, large numbers, and the coexistence of various types of substrates, photoreproductions, and media in technical drawing collections with different needs and vulnerabilities, the management of such collection is not an easy task.

For the past 30 years, there has been an increasing interest in technical drawings (Alper 1992; Hamill 1993; Price 2010; Tait and Sterlini 1999; Wilson 2015). Important publications and projects have advanced our knowledge on the history, the construction, the materials, the deterioration, the copying processes, the conservation treatments, and the preservation of technical drawings (Glück, Brückle, and Barkhofen 2012; Kissel and Vigneau 1999; Price 2010; Reed, Kissel, and Vigneau 1995; Steiner 1999; Van der Reyden et al. 2011). They also advanced the awareness that they are fragile cultural objects of great importance that need to be preserved.

Greece follows that international trend, and a growing concern is apparent amongst the scientific community, the owners, and the curators of technical drawings collections for their study, documentation, and preservation. Nevertheless, a background search in Google Scholar with the terms “technical/architectural drawings” and “Greece/Greek” returned many results, some concerning ancient Greek architecture, but none of them relevant to the study and management of technical drawings collections in Greece. Relevant literature or lack thereof, personal knowledge, and anecdotal evidence indicate that despite the abundance of such collections in Greece and the increasing interest in them, very few relevant organized initiatives exist. Several organizations, private and public, are known to possess large numbers of technical drawings. However, their accurate numbers, their significance and value, and their condition are largely unknown.

In this paper, we present the survey of one of the collections of historical technical drawings owned by the Historical Archive of Athens Water Supply and Sewerage Company (EYDAP S.A.), aiming at the documentation of the condition of the collection, the determination of the technical specifications, and the cost

estimation for its conservation. Apart from presenting an outline of the results of the survey, this publication mainly focusses on the methodology of the survey process itself. It describes the documentation step, which was planned to collect all the essential data necessary for the determination of the technical specifications and the cost estimation of the conservation of the collection. It also presents the process of the cost estimation step. We believe that the methodology described here can be useful and applicable to similar surveys concerning technical drawing collections, and with some adaptations to other archival collections.

2 Background

The Historical Archive of EYDAP preserves various collections of documents, which capture the long and evolving operation of the Company (through the “Hellenic Water Company S.A. of Athens and Piraeus” and the “Greater Athens Sewerage Organization”), and the relationship between the evolution of the water supplying and sewerage systems with the evolution of the Athenian society. The collections include paper documents (administrative, legal, technical drawings and projects), photographs, negatives, audiovisual material, and various objects, which are documented by use of the international metadata standard “Dublin Core”. The Archive applies the internationally suggested best practices for the preservation of the originals and employs a digitization program for the preservation of the digitized collections of historical and cultural value. The constant cooperation with academic institutions, archival organizations, and experts guarantees the effective management of the historical material through the use of best certified practices, which incorporate the required scientific knowledge and set the framework for access and exploitation of the archival material. Since 2018, the “Management Policy of the Historical Archive of EYDAP” is in effect, which sets the rules for the management (including documentation, acquisitions, and preservation) of the Archive and the public access to it.

The Historical Archive of EYDAP owns a large number of technical drawings, many of them related to emblematic infrastructure construction projects such as the Marathon Lake Dam (Figure 1). This publication concerns one of its historical collections, the YAMP (Projects and Specifications Archive Department) historical collection of technical drawings. The curator of the collection, during a quick first survey undertaken in 2017, provided us with the following information:

- The collection comprises around 2600 important technical drawings dating from 1920 to 1970, with a few newer additions

- About 70% of the drawings are originals on tracing cloth (Figure 2) or tracing paper, 20% originals on drawing or cartridge paper of various qualities, and 10% copies¹ (most of them blueprints)
- The most common size is A0 (approximately 1.20×0.84 m)

That first survey (2017) showed that while the general preservation condition of the collection was good, a fair number of drawings suffered from small to medium mechanical damage (mostly tears). A large but unknown number of drawings had a stapled cardboard extension that served as a hanger. Biological damage was not detected.

The collection was stored in a large lobby at the EYDAP headquarters building, housed in four wooden drawer chests with a total of 53 drawers. The drawings were stored mostly flat, sorted in succession according to their accession number, with no dividers between them. Some of the drawers were jam-packed, which could cause mechanical damage to the drawings when the drawers were opened or closed. The environmental parameters were not monitored or controlled.

Figure 1: Marathon Dam – Drainage system with Foundation Piles – Details of Contraction Joints. Drawing on tracing cloth. © 2021 EYDAP SA Historical Archive. Published with permission from EYDAP S.A.

¹ Throughout this article, the term copy is used for photoreproductions of any kind, not manual copies.

Figure 2: Tracing cloth (left), and verso (right). The pattern of the fabric is discernible on the recto. The verso is smooth and glossy.

The documentation of the collection lacked important details. For most of the drawings, only the accession number and the title of the drawing were documented, while an undefined number of drawings were not documented at all. The survey of the collection was commissioned by EYDAP to the Department of Archival, Library & Information Studies, University of West Attica, Greece, and concerns the documentation of the condition of the collection, the determination of the technical specifications, and the cost estimation for its conservation. In this communication, we focus on the survey methodology.

3 Methodology

The survey team comprised two undergraduate students, both in the last semester of their studies, one studying Information Science and the other Conservation, which were trained for the needs of the project and supervised by professor Spiros Zervos. The survey was completed in about two months (October and November 2019), under the supervision of the team's coordinator. Before the survey, an intern student from the Department of Archival, Library & Information Studies cataloged the collection in ISAD (International Standard Archival Description).

The project started with a thorough literature review, concerning most aspects of technical drawings documentation and management, such as construction, types of substrates, damage, photoreproduction techniques, conservation, and preservation. A lot of time and effort was dedicated to the training of the survey team in identifying the various kinds of drawing substrates, the photoreproduction techniques, the types and degree of damage, and possible conservation treatments. To that end, the contribution of several bibliographical sources must be

acknowledged, such as the books authored by Price (2010) and Kissel and Vigneau (1999), the Preservation Self-Assessment Program (PSAP) website (Institute of Museum and Library Services n.d.) and others which will be cited below. Particularly useful was the “Flow-Chart for the Identification of Architectural Archives Reproductions of Drawings and Documents” (Kissel and Vigneau 1999; Reed, Kissel, and Vigneau 1995).

3.1 Documentation

Before the start of the survey, it was essential to decide which data should be recorded, according to the aims of the survey, the specifics of the collection, and the relevant literature (Glück, Brückle, and Barkhofen 2012; Kissel and Vigneau 1999; Price 2010; Wilson 2015), as discussed below. A spreadsheet was prepared, with predefined fields pertaining to all the data deemed necessary, classified under the following categories: identification data, primary physical data, data pertaining to copies (photoreproductions) only, data about the damage and the preservation condition, necessary conservation treatments, and photographic documentation (Table 1).

The first category, relevant to the **identification** of the drawings, comprises data such as the classification (accession) number, isolation drawer (for drawings that needed immediate isolation because they affected neighboring objects), storage drawer number, title, date, collection, and stamp (of the construction firm of engineer). This category is used for the identification, retrieval, and dating of the drawings.

The category of **primary physical information** comprises data such as the dimensions, if the drawing is original or a photoreproduction (field 10, Table 1), what is the original if the drawing is a duplicate (field 11), the support material, details for the support, writing and drawing media, and further information. The dimensions of the drawings were recorded because, in the future, they will be used for the determination of the space required for the storage of the objects and the dimensions of sleeves, envelopes, or boxes. Field 10 is marked with an X if the object is a copy, and the copying technique used is recorded in the next category, since photoreproductions require special treatment. The support material, together with the media used in the drawing, often dictate the choice of the most suitable conservation technique (for example, aqueous or non-aqueous), and determine the vulnerability of the object against light and water; this is important for storage decisions and the risk management of the collection (Homburger and Korbel 1998; Price 2010).

Table 1: A brief presentation of the documentation fields.

Category	Field	Content
Identification	1 Classification number	Number
	2 Isolation drawer	Number
	3 Drawer	Number
	4 Title	Text
	5 Date	Date
	6 Collection	Text
	7 Stamp	Text
Primary physical information	8 Width	Number
	9 Height	Number
	10 Copy	X or blank
	11 Duplicate of	Classification number of original
	12 Support	Text
	13 Details for the support	Text
	14 Media	Text
For copies only	15 Comments	Text
	16 Watermark/stamp	Text
	17 Copying process	Text
	18 Line/image color	Text
	19 Background color	Text
	20 Verso	Text
	21 Details	Text
Condition	22 Comments	Text
	23 Folded or rolled	F or R
	24 Staples	X or blank
	25 Backing material	X or blank
	26 Attached hanger cardboard	X or blank
	27 Tape in the perimeter	X or blank
	28 Adhesive tapes	1–3, blank for 0
	29 Brittleness	1–3, blank for 0
	30 Creases and distortions	1–3, blank for 0
	31 Tears	1–3, blank for 0
	32 Losses	1–3, blank for 0
	33 Stains	1–3, blank for 0
	34 Discoloration	1–3, blank for 0
	35 Mould	X or blank
	36 Overall condition	1–3, blank for 0
	37 Comments	Text
Conservation treatments	38 Flattening	X or blank
	39 Cleaning	X or blank
	40 Lamination	X or blank
	41 Mending	X or blank
	42 Filling of losses	X or blank
	43 Comments	Text
	44 Isolation	X or blank
Photographic documentation	45 Photo	Hyperlink

The third category **for copies only** consists of data such as the existence of a watermark or stamp on the support indicating the photoreproduction process, identified photoreproduction process, line/image color, background color, color of the verso, other details that contribute to the identification of the process and comments, such as additions and modifications in the text and image, and media used. These data are important for the identification of the reproduction process used to create the copy, which affects the storage and conservation of the drawing, since it can also dictate the choice of the most suitable conservation technique and determine the vulnerability of the object towards acidity or alkalinity, light, and water (Glück, Brückle, and Barkhofen 2012; Homburger and Korbel 1998; Kissel and Vigneau 1999; Price 2010; Reed, Kissel, and Vigneau 1995; Steiner 1999).

The identification of the photoreproduction process was assisted by visual criteria described in the literature, especially from the flowchart discussed above (Kissel and Vigneau 1999; Reed, Kissel, and Vigneau 1995). The questions in the flowchart (such as: “what color is the line?”, “is the ground spotless or does it seem dirty?” etc.) can be answered by visually examining the copy. A similar workflow was developed for the supports and writing and drawing media found in the collection. Simple questions were formulated as criteria from findings in the literature, such as: “is the support translucent?” and “does it have white creases?”. The white creases are a noticeable feature of impregnated tracing papers.

The category **condition** documents the preservation condition and the damage of the drawing. The field “folded or rolled” (field 23) is left blank if the drawing is stored flat or filled with an F or R if it is folded or rolled. An X is used in the corresponding fields (fields 24–27) to document if the drawing has staples, backing material, attached hanger cardboard, or perimetrical tape. Fields 28 to 34 record with the aid of a predefined arithmetic scale the damage caused by or related to adhesive tapes, brittleness, creases and distortions, tears, losses, stains, and discoloration. Brittleness was estimated by observing the behavior of the substrate when rolled and bent, and some damage characteristics such as cracks and clean tears (with no protruding fibers) at the perimeter, since testing for brittleness, even by non-destructive methods (Hall, Plaut, and McGuiggan 2019) was out of the scope of the survey. The manual fold number (Mijland, Ector, and van der Hoeven 1991) was deemed too intervening and destructive and was not used. Field 36 documents the estimated overall preservation condition of the drawing.

The four scores in the condition scale range from 0 (no damage, in which case the cell was left blank) to 3 (severe damage). The eight “damage severity values” reported by Wilson (2015) were considered too complex and detailed for the needs of this project. Four categories of damage are also reported by Schrock (1996). The exact definitions of the four scores, depending on the type of damage and in the context of this specific collection, are further elaborated in Table 2. The scores corresponding to the levels of damage, relative to its intensity and extend, should be explicitly defined to ensure uniformity of the survey results.

Table 2: Definitions of the four scores indicating the preservation condition of the drawings, depending on the kind of damage.

Damage in- tensity/extent	0 (no damage)	1 (small)	2 (medium)	3 (severe)
Adhesive tapes	Not present	Up to 3, <5 cm long	More than 3, or one up to the middle of the drawing, or a combination	Many, a few may reach the middle of the drawing or extend from one end to the other
Creases and distortions	Not present or minor distortions – no treatment needed	Small, localized	Medium, localized or few larger ones	Severe, global
Tears	Not present or up to 3 very small (<1–2 cm)	Up to 5, <5 cm	More than 5, or one up to the middle of the drawing, or a combination	Many small ones, or two or more, medium or large, or some that reach the middle of the drawing or from one end to the other, or a combination
Losses	Not present	Small (<2 cm diameter), up to 5	Some small, or a few larger ones (less than 1/5 of the area of the drawing in total)	a large part (>1/5) of the drawing is missing
Stains	Not present or tiny and few	Small (<2 cm diameter), some localized	Many small stains or larger ones, sized over 2 cm, which cover up to 1/5 of the substrate	Many large dark stains, which cover more than 1/5 of the drawing and impede its readability
Discoloration	Not present	Small, yellowish	Medium, yellow	Severe, brownish, brown

The recommended **conservation treatments** are recorded in the next category. They include flattening, cleaning, lamination, mending, and filling of losses (fields 38–42). Two other treatments, removal of attachments (staples and cardboard hangers) and adhesive tape removal were not recorded here but were included in the recommended treatments for the drawings with such issues. Field 44 was marked with an X if the drawing had to be immediately isolated because it could adversely affect neighboring objects.

Finally, in **photographic documentation**, links to one or more photographs of the object were inserted in case something unusual should be documented, or if visual documentation was deemed necessary to support identification or damage description.

When possible, the fields were filled with terms from predefined lists, allowing for the addition of extra terms. For example, for field 12 (support), the choices included the terms *tracing cloth*, *tracing paper*, *cartridge paper*, and *drawing paper* and for field 13 (details for the support) the terms *impregnated*, *contemporary impregnated*, *overbeaten*, *vegetable parchment*, and *millimeter*.

3.2 Cost Estimation

Two factors were considered paramount for the process of cost estimation: automation and parameterization. Automation was important because of the large number of the drawings and the necessary calculations. It can be accomplished fairly easily, since all spreadsheets offer functions that automatically execute basic and advanced calculations. Parameterization was also important because the cost estimation heavily depends on informed assumptions about the person-hours required for each kind of conservation treatment, a matter which is further complicated by differences in the extent and intensity of damage. Cost also depends on the remuneration of the personnel, which is related to the cost of person-hour, which can change. Through parameterization, miscalculations due to wrong assumptions can be very easily corrected by just modifying the relevant parameter.

In order to maximize the usefulness of this paper to practicing colleagues, we will elaborate on the details of both automation and parameterization. To that end, the structure of the spreadsheet will be briefly explained. The documentation fields were used as labels at the top of the spreadsheet. Every category was assigned a different background color for easy orientation in the huge spreadsheet. Each drawing was registered horizontally, constituting a record. Thus, each column of the spreadsheet corresponded to a documentation field, and each row to a drawing.

When documentation ended, the total number of various items, such as the drawings presenting a specific kind of damage, was calculated by use of Microsoft Excel® formulas. These calculations were done vertically, that is, they applied on the contents of one column.

The next step was the determination of the person-hours required for the conservation of each drawing. To that end, more columns were added to the spreadsheet, each for the person-hours calculation for each type of conservation treatment, plus two for the removal of adhesive tapes and cardboard hangers, and one more for the documentation of the conservation treatments themselves. For every treatment and depending on the severity of the addressed damage, a different value was given to the required person-hours. Here enters parameterization. Instead of setting that value directly to the calculation formula, it was defined once in a different spreadsheet, and a reference to the cell containing the value was used for the calculation. This way, if the value was not realistic and needed to change, the change could be done in one place only instead of 2626 places, the total number of all drawings. Apart from that, parameterization reduces the possibility of errors and makes the whole effort easier to present and manage.

Table 3 summarizes the values of the person-hours required for each type of conservation treatment. Mending, filling gaps, and tape removal person-hours were related to the extent/intensity of the damage (scores 0–3). The rest of the conservation treatments were assigned specific values, independent of the damage scores. Because of the specific nature of the collection, the documented damage, and the conservation treatments (flattening, cleaning, and lamination), it was decided that there was no need for more complexity since significant variations in the required person-hours were not expected. Of course, under different circumstances, parameterization can apply to these conservation treatments as well.

Table 3: Definitions of the parameters (person-hours), depending on the kind and the score of damage.

Conservation treatment	Score	Person-hours
Mending/filling of losses/tape removal	0	0
	1	0.3
	2	0.8
	3	2.5
Flattening		0.5
Cleaning		0.5
Lamination		2
Documentation		0.1
Cardboard hangers removal		0.2

Concerning the automation of the cost estimation process, some more complex formulas were created that checked if a specific treatment was recommended (by detecting an X in the corresponding cell), and then according to the score of the damage related to that specific treatment, the corresponding work-hours value was used for the calculation.

The assigned values of person-hours were decided after a market research, consultation with practicing paper conservators, and from the personal experience of the coordinator of the project. A medium range of treatment intensity was assumed, between minimal treatment and maximal intervention, which was implied in the project report by the detailed description of each treatment. By the same process, the cost of one person-hour was set. The cost of the materials was also set to 25% of the total cost of person-hours. Both were set as parameters, so that can be easily changed, and the final cost automatically recalculated.

By applying the above-described methodology, the total number of the drawings presenting a specific kind of damage and recommended for a specific conservation treatment, as well as the person-hours needed for the conservation of each drawing were determined (Figure 3), allowing for the cost estimation of the conservation treatment of the whole collection. In summary, 1634 items are scheduled to receive at least one, and a number of them will receive a combination of conservation treatments. The total number of unique treatments will be 2484 and the estimated total person hours 1096.

Figure 3: Person hours and number of objects per treatment.

4 Brief Overview and Discussion of the Survey Results

A total of 2626 technical drawings were surveyed. The distribution of substrates and copying processes are presented in Figures 4 and 5.

The most common media encountered in originals and in additions to photoreproductions included India ink, pencil, various colored inks, watercolors, and felt tip markers.

The general preservation condition of the collection is good. Only a small percentage of drawings suffer from medium to severe damage (scores 2 and 3). In the collection, 137 drawings were rolled and 99 were folded, these will be flattened and stored flat. The types and intensities/extent of damage are summarized in Figure 6.

Figure 4: Distribution of substrates.

Figure 5: Distribution of copying processes.

Figure 6: Types and intensities/extent of damage.

Most of the damage was manifested as tears and stains. Tracing papers were found to be in a worse condition than the other substrates, with a high percentage of tears and adhesive tapes. Tracing cloth suffered mostly from stains, with fewer cases of mechanical damage. As suggested in the literature, tracing cloth seems to be more durable than tracing paper (Price 2010). Concerning photoreproductions, tears were the main damage of blueprints and diazotypes. Mechanical damage seems to have been caused by poor storage conditions and careless handling. Biological damage, especially that caused by fungi, was not observed.

The average time for the documentation of each technical drawing was 8 min since it took 50 days and 7 workhours per day for a team of one archivist and one conservator to document 2626 drawings.

5 Recommendations

One of the objectives of the project was to suggest best practices for the management and preservation of the collection, which were included in the project report and are briefly outlined here. They pertain to policies, storage and handling of the collection, environmental conditions and personnel, and were based on the

relevant literature (Glück, Brückle, and Barkhofen 2012; Hamburger 2004; Price 2010; Steiner 1999; Velensek et al. 2014), common sense, and personal experience.

Concerning preservation, it was stressed that the storage conditions of the collection were inappropriate, and that a new storage facility should be obtained, with appropriate environmental control and monitoring, new housing furniture, such as steel or aluminum plan chest drawer cabinets, and security installations. Concerning the storage practices, the use of archival paper or polyester sleeves and dividers between the drawings was advised.

The proposed conservation treatments, compiled from various bibliographic sources concerning the conservation of technical drawings (Alper 1992; Bedenikovic, Eyb-Green, and Baatz 2018; Cook and Dennin 1994; Ferrari et al. 2018; Flamm et al. 1990; Flieder et al. 1988; Glück, Brückle, and Barkhofen 2012; Hamill 1993; Homburger and Korbel 1998; Laroque 2000; Page 1997; Price 2010; Van der Reyden, Hofmann, and Baker 1993; Yates 1984; Zervos and Alexopoulou 2015), were presented in detail in the project report and will not be included in this article. Washing in water and deacidification were not recommended but were described in the report and left open as options. Literature, experience, and preliminary testing during the survey indicate that extreme caution must be exercised concerning the application of aqueous treatments or adhesives. Careful testing on an individual basis must precede all such applications. This, among others, is a basic precaution applicable to all the recommended conservation methods. The vulnerabilities of the several types of substrates, media and photoreproductions are also stressed in the report, and that the application of water on tracing cloth is out of the question.

6 Conclusions

Concluding this survey, several aspects of the applied methodology must be highlighted:

- The sources from the literature, which greatly assisted the recognition and correct documentation of the different types of substrates and photoreproductions (Kissel and Vigneau 1999; Price 2010)
- The importance of the preparation step, which entailed the choice and the accurate definition of the fields used for the documentation
- The use of existing flowcharts or the creation of new ones for assisting the recognition of the different types of substrates and photoreproductions
- The need for a trial application of the survey process, which enables optimization and troubleshooting

- The use of accurately defined values (scores) for the classification of damage, which must be verbally described in detail and if possible, with images and sketches, to ensure uniformity of the results
- The training of the survey team in recognizing the types of substrates and photoreproduction techniques, and also the types and intensity/extent of damage, as defined by the damage scores
- The need for automation in the calculations, especially for the cost estimation, by using a spreadsheet and formulas
- The need for parameterization in the cost estimation, by assigning values for the person-hours parameters and for the cost of person-hour and materials, outside the calculation spreadsheet, and referring to them in it
- The previous two points require working knowledge of Microsoft Excel® (or of a similar computer program), or collaboration with an IT specialist
- The necessity to consult and cooperate with colleagues and the curator of the collection

The total amount of hours, as expected, depends on the values of the parameters in Table 3, and is particularly sensitive to changes in the value of person hours pertaining to damage category (score) 1, since this is the most common (Figure 6). An increase of that parameter from 0.3 to 0.5 increases the total person hours up to 14%. This fact indicates the importance of objectivity in the estimation of the parameters in Table 3, as well as the importance of parameterization.

Concerning the results of the survey, the distribution of the various substrates and photoreproductions were accurately determined. Tracing cloth and tracing paper were the most common substrates (60 and 21% of the 2626 drawings respectively) and from the 764 photoreproductions in total, 434 were diazotypes and 229 blueprints. The distribution of the scores of damages indicates that the condition of the collection is generally good. The most common types of damage are tears and stains. The results of the survey allowed for the cost estimation of the conservation of the collection. They will also be used for the proper storage of the collection, and for the compilation of the emergency plan of the Archive, according to the recommendations included in the project report.

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References

- Alper, D. 1992. "Archives Preservation Update; Making a Molehill Out of Mountain: The Olmsted Plans and Drawings Processing Project." In *AIC Book and Paper Group Annual*, Vol. 11, 173–8.
- Bedenikovic, T., S. Eyb-Green, and W. Baatz. 2018. "Non-aqueous Facing Methods in Paper Conservation—Part II: Application of a Facing on a Seventeenth Century Ink Drawing." *Restaurator* 39 (3): 215–31.
- Cook, P., and J. Dennin. 1994. "Ships Plans on Oil and Resin Impregnated Tracing Paper: A Practical Repair Procedure." *Paper Conservator* 18: 11–9.
- Ferrari, P., D. Chelazzi, N. Bonelli, A. Mirabile, R. Giorgi, and P. Baglioni. 2018. "Alkyl Carbonate Solvents Confined in Poly (Ethyl Methacrylate) Organogels for the Removal of Pressure Sensitive tapes (PSTs) from Contemporary Drawings." *Journal of Cultural Heritage* 34: 227–36.
- Flamm, V., C. Hofmann, S. Dobrusskin, and G. Banik. 1990. *Conservation of Tracing Papers. ICOM Committee for Conservation, 9th Triennial Meeting, Dresden, German Democratic Republic, 26–31 August 1990*, Preprints: 463–7.
- Flieder, F., B. Guineau, C. Laroque, B. Liebard, and P. Richardin. 1988. *Analysis and Restoration of Old Transparent Papers. Conservation of Historic and Artistic Works on Paper: Proceedings of a Conference, Ottawa, Canada, October 3 to 7, 1988 = Conservation des oeuvres historiques sur papier: les actes de la conférence, Ottawa, Canada, 3 au 7 octobre 1988*, 235–44.
- Glück, E., I Brückle, and E.-M. Barkhofen, eds. 2012. *Paper-Line-Light: The Preservation of Architectural Drawings and Photoreproductions from the Hans Scharoun Archive*. Berlin: Akademie der Künste.
- Hall, A. K., R. H. Plaut, and P. M. McGuiggan. 2019. "Comparing Non-destructive Mechanical Testing Methods for the Assessment of Brittle Papers – The Cantilever, Hanging Pear Loop, and Clamped Fold Tests." *Restaurator* 40 (1): 15–34.
- Hamburger, S. 2004. *Architectural Records: Arrangement, Description, and Preservation*. Pennsylvania: Mid-Atlantic Regional Archives Conference.
- Hamill, M. E. 1993. *Washingtoniana II: Conservation of Architectural Drawings at the Library of Congress*.
- Homburger, H., and B. Korbel. 1998. "Architectural Drawings on Transparent Paper: Modifications of Conservation Treatments." *The Book and Paper Group Annual* 18: 25–33.

- Institute of Museum and Library Services. n.d. "Architectural Drawing Reproduction." In *Preservation Self-Assessment Program (PSAP)*, 2019, University of Illinois at Urbana-Champaign. Also available at <https://psap.library.illinois.edu/collection-id-guide/archdrawingrepro> (retrieved February 14, 2019).
- Kissel, E., and E. Vigneau. 1999. *Architectural Photoreproductions: A Manual for Identification and Care*. New Castle, DE: Oak Knoll Press.
- Laroque, C. 2000. "Transparent Papers: A Technological Outline and Conservation review." *Studies in Conservation* 45 (1): 21–31.
- Laroque, C. 2004. "History and Analysis of Transparent Papers." *Paper Conservator* 28 (1): 17–32.
- Mijland, H. J. M., F. F. M. Ector, and K. van der Hoeven. 1991. "The Eindhoven Variant: A Method to Survey the Deterioration of Archival Collections." *Restaurator* 12 (3): 163–82.
- Page, S. 1997. "Conservation of Nineteenth-Century Tracing Paper: A Quick Practical Approach." *The Book and Paper Group Annual* 16: 67–73.
- Price, L. O. 1995. "The History and Identification of Photo-Reproductive Processes Used for Architectural Drawings Prior to 1930." *Topics in Photographic Preservation* 5: 41–9.
- Price, L. O. 2010. *Line, Shade and Shadow: The Fabrication and Preservation of Architectural Drawings*. New Castle, Delaware: Oak Knoll Press and the Winterthur Museum.
- Reed, J., E. Kissel, and E. Vigneau. 1995. "Photo-reproductive Processes Used for Duplication of Architectural and Engineering Drawings: Creating Guidelines for Identification." *The Book and Paper Group Annual* 14: 41–9.
- Schrock, N. 1996. "Preservation Factors in the Appraisal of Architectural Records." *American Archivist* 59 (2): 206–13.
- Steiner, K. L. 1999. *Architectural Photoreproductions: A Manual for Identification and Care*. Oak Knoll Pr.
- Tait, J., and P. Sterlini. 1999. "Care and Conservation of Architectural Plans: A Survey of Current Practice in the UK and Ireland." *Journal of the Society of Archivists* 20 (2): 149–59.
- Van der Reyden, D., C. Hofmann, and M. Baker. 1993. "Effects of Aging and Solvent Treatments on Some Properties of Contemporary Tracing Papers." *Journal of the American Institute for Conservation* 32 (2): 177–206.
- Van der Reyden, D., C. Hofmann, M. Baker, and M. Mecklenburg. 2011. "Modern Transparent Papers: Materials, Degradation, and the Effects of Some Conservation Treatments." In *MRS Proceedings*, Vol. 267, 379.
- Van der Reyden, D., H. Tennison, and F. W. Tsai. 1996. "Publish, Then Perish: The Reclamation of a Collection of Scientific Illustrations." *Restaurator* 17 (2): 104–15.
- Velensek, N., F. Meyer, E. Hummert, and I. Brückle. 2014. "Stacked Storage System for Large Works on Paper." *Restaurator* 35 (3–4): 287–314.
- Wilson, H. 2015. "A Decision Framework for the Preservation of Transparent Papers." *Journal of the Institute of Conservation* 38 (1): 54–64.
- Yates, S. A. 1984. "The Conservation of 19th-Century Tracing Papers." *Paper Conservator* 8: 20–39.
- Zervos, S., and I. Alexopoulou. 2015. "Paper Conservation Methods: A Literature Review." *Cellulose* 22 (5): 2859–97.