CONSERVAR PATRIMÓNIO

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Design and implementation of protocols for monitoring the condition of vast collections: the case of the treasure of the Spanish Civil War

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Conceção e implementação de protocolos de monitorização do estado de conservação de coleções numerosas: o caso do tesouro da Guerra Civil Espanhola

Abstract

Cultural heritage institutions, such as archives, libraries, or museums commonly own collections composed of numerous objects, which, due to their large number are not subject to regular and systematic condition monitoring. In the industrial field, inspection standards to evaluate the quality of products have already been developed and certified, based on the evaluation of random pieces. The present research aimed to adapt one of those industrial standards to monitor the conservation condition of vast cultural heritage collections. We used, as a test subject, a numismatic collection composed of 22777 iron coins minted during the Spanish Second Republic. In our first inspection (2018), 1520 coins were sampled according to the industrial standard. Assessment and recording of the conservation condition was carried out through image analysis and coin weighing. In our second inspection (2020-2021) no significant deterioration of the coins was detected. This second inspection also corroborated the effectiveness of the implemented monitoring protocol.

KEYWORDS
Cultural assets
Condition assessment
Inspection
Numerous collections
Image analysis
Preventive conservation

Resumo

As instituições detentoras de património cultural, tais como arquivos, bibliotecas ou museus, contêm frequentemente coleções compostas por inúmeros objetos, os quais, pelo seu elevado número, não são sujeitos a uma monitorização periódica e sistemática do seu estado de conservação. No âmbito industrial, já se encontram desenvolvidas e certificadas normas de inspeção para avaliar a qualidade de produtos, baseadas na avaliação de peças de forma aleatória. A presente investigação teve como objetivo adaptar uma dessas normas industriais à monitorização do estado de conservação de coleções patrimoniais numerosas. Esta adaptação foi testada numa coleção de numismática, composta por 22777 moedas de ferro cunhadas durante a Segunda República Espanhola. Na primeira inspeção (2018) amostraram-se 1520 moedas, seguindo a norma industrial. A avaliação e registo do estado de conservação foi feita através de análise de imagem e pesagem das moedas. Na segunda inspeção (2020-21) verificou-se que não havia ocorrido agravamento significativo do estado de conservação das moedas. Nessa inspeção foi também possível comprovar a eficácia do protocolo de monitorização implementado.

PALAVRAS-CHAVE
Bens culturais
Avaliação de estado de conservação
Inspeção
Coleções numerosas
Análise de imagem
Conservação preventiva

Introduction

The Spanish Cultural Heritage Institute (from now on IPCE) [1] keeps a collection known as the Archive of the Civil War. An objective of the institution is to design a preventive conservation strategy based on sustainable working methods. In this context, a maintenance program of the Civil War Treasure has been conceived. This program includes the protocol dedicated to the monitoring and the control of numerous collections exposed in this article.

Preventive conservation methodologies are in constant review. In this context, it is essential to underline the work carried out by the Network of European Royal Residences within the framework of the project European Protocol in Preventive Conservation [2]. Their experience included the difficulty of heterogeneous collections, dispersed in vast spaces such as palaces. The methodology they chose has similarities with the one shown in this paper. It involved the definition of lots of items, zoning spaces where necessary, and sampling of the items using pre-selected deterioration indicators [3].

The maintenance program of the Treasure of the Civil War includes two specific protocols. The first one, entitled "Monitoring and Control of Biodeterioration", is designed for the early detection of biodeterioration of organic items, based on the use of different biosensors [4].

The second protocol, presented in this paper, is named "Monitoring and Control of Vast Collections of Movable Assets". Its objective is to design a strategy that consists of a statistical sampling that will allow a reliable registration of the conservation state of vast collections, in this particular case of a numismatic collection. The protocol consists of two phases: firstly, a random sampling is carried out by following the indications of a UNE-ISO standard for the industrial field [5-7]; secondly, the samples are registered by scanning and processing the images.

The program started in 2017 with a first inspection in 2018. The second inspection was carried away during December 2020 and January 2021. The aim was to have a global vision of the condition state of the collection by using straightforward tools. This evaluation would help to identify alterations and prioritise actions to limit interventive restoration procedures. This paper shows a reproducible and transferable method that aims to be helpful to other institutions dedicated to the care of cultural heritage collections.

Materials and methods

Description and conservation state of the Treasure

The Spanish Civil War Archive (July 1936-April 1939) arises from the effort made by different organisations entrusted with the care of Spanish cultural heritage on both sides of the armed conflict. It is composed of an enormous amount of documentation and a photographic archive, in addition to the objects contained in a big wooden chest, appointed as Treasure because of the existence of an extensive numismatic collection.

The relevance of the Treasure collection is due to its warlike nature. It contains documentation of the 26th Mixed Brigade military unit of the Somosierra war front, which belonged to the Spanish Republican Army, including soldiers' wages that never got to their destination.

In the bottom of the wooden chest, three hemp sacs contained over 22777 five-cent Republic coins (Figure 1), probably preserved until our days due to the low profitability of iron. The coins were minted by the Spanish Mint and installed next to Castellón due to the advance of the National Army [8].

The rest of the space in the chest contained three smaller trunks with 633 "cardboard coins" with the post stamp and over 2000 banknotes of the Republic [9], as well as other items, such as brass badges, a pair of boots and two flags (one Spanish and another one from the Falange).

In terms of conservation condition, the banknotes showed signs of usage (e.g., rips, tears, folds) and some repairs made with adhesive tape and other everyday use elements (e.g., Sellotape). The five-cent coins, on the other hand, were still inside the sacks from the Spanish Mint and had the original

Figure 1. Bottom of the wooden chest with the original sacks of the Spanish Mint and Stamp with the coins of five-cent of iron.

stamping on, so they were never under circulation (Figure 1). The coins, despite not having been in circulation, showed active corrosion.

Besides frequent usage, other factors were contributing to the deterioration of the items, such as inadequate manipulations, precarious packages, and at least one flooding that affected the bottom one-third part of the chest. This event was the main cause of deterioration in the collection, as can be inferred from the stains derived from biological attack on organic objects, or from the corrosion observed on metallic objects.

During 2013, interventions were conducted to curb the active deterioration processes on the collection [10-11]. The treatments, applied massively, consisted on the removal of the excess moisture and stabilisation of the organic items' biodeterioration via anoxia. Afterwards, specific conservation-fit packaging was made to store the objects. Currently, the Treasure is stored at the deposits of IPCE, under monitored conditions [12] within adequate stability parameters.

The maintenance program and the design of the mentioned protocols started only after the collection was placed under stable conditions, and after mitigating the deterioration suffered during the war and the inadequate storage.

Inspection protocol

The protocol for the inspection of numismatic collections was adapted from a previous publication [13] and consisted of a sampling method, followed by inspection, using an international standard (UNE) from the industrial field [5-7]. This international standard was easy to apply thanks to the fact that the collection consists of objects manufactured in series, although this condition is not essential. The standard regulates an evaluation system to manage the quality of a product. The evaluation consists of the inspection of random pieces to eliminate defective products during the manufacturing process.

Firstly, a division into lots of the set of objects needs to be performed. A pre-established percentage of items has to be extracted randomly from each lot. The selection of this percentage is what is called the "limiting quality" that is to say; the higher the limiting quality accepted by the client, the higher is the risk assumed by the client, so the sampling has fewer requirements. Hereafter, inspection by attributes is established. By using this inspection, items are defined as conforming or non-conforming with regards to a specified condition.

Coin inspection started by establishing lots. Since the 2013 intervention, coins are clustered according to their conservation state. They are packed in 19 bags containing 1250 coins each (except for the last bag). We considered as a 'lot' each one of the 19 bags.

The selection of the volume of the sample is decisive for accomplishing the objectives and is directly related to time and human resources. In our case, we have established a limit quality of eight, so, according to the norm, we must scan 80 units for our interval. This value is defined in a table included in the standard (Table 1).

Sample coins were randomly taken out from the lots, divided into four smaller groups of twenty units, chosen at random and introduced together in a polyamide mesh bag. Every coin was marked on the rim. Then, the groups were placed in contact with the rest of the coins to ensure identical environmental conditions (Figure 2).

The transposition of the international standard to our case consisted in establishing an alteration indicator as an attribute. This indicator is selected according to its representativeness, easily recognisable, responsive to the environmental changes, and, finally, measurable, allowing an easy measurement with scientific validity. The chosen

Table 1. Determining the number of units to sample, following the international standard UNE-ISO 2859-2 (2014) [6]. The limit quality and respective lot size established in this study are in bold.

	Quality limit %									
Lot size	0.5	0.8	1.25	2.0	3.15	5.0	**8.0**	12.5	20	32
51-90	→	→	90	50	44	34	24	16	10	8
91-150	→	150	90	80	55	38	26	18	13	13
151-280	200	170	130	95	65	42	28	20	20	13
281–500	280	220	155	105	80	50	32	32	20	20
501-1200	380	255	170	125	125	80	50	32	32	32
1201-3200	430	280	200	200	125	125	**80**	50	50	50
3201-10000	450	315	315	200	200	200	126	80	80	80
10001-35000	500	500	315	315	315	315	200	125	125	80
35001-150000	800	500	500	500	500	500	315	200	125	80

Figure 2. Coin lots with sample coins in mesh bags.

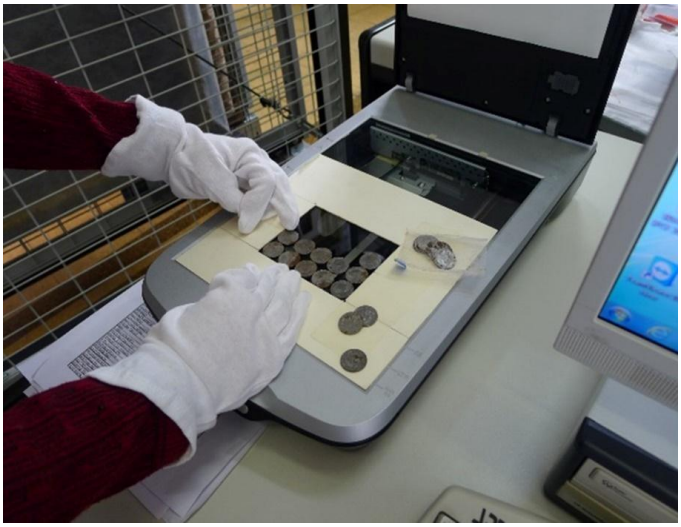

Figure 3. Process of scanning the sample coins.

indicator was "corrosion", as all the coins had a grey metallic surface finish that makes the colour and the texture of iron corrosion distinguishable.

Registration and calculation

The strategy to document the conservation state of the sample coins, which would serve as a reference in further revisions, consisted of scanning both sides of these coins. The scanner used was an Epson Perfection V500 Photo R and the scan parameters were 300 ppi resolution and 48-bit colour (Figure 3).

The option of 20 coin lots for each scanning, with a 300 ppi resolution, results in an adequate detail level for the forward revisions. In addition, 20 coins of 5 cents sum up 1 peseta, nostalgia of times before euro. To reach the methodology described hereafter, tests were performed using the images of the coins.

Over the image obtained by scanning, a map of the corrosion is drawn using the program Adobe Photoshop CS4. To achieve the map, the brightness is increased to +50 and then a selective correction of -100 is applied to all colours except red, which is adjusted to +100. To finish the map, a 238 threshold is applied to the resulting image, which allows viewing in black all the pixels that supposedly indicate corrosion.

The red/brown colour changes are determined by measuring the number of black pixels in the grey colour using the average filter. This way, the grey balance is obtained. The bulk of the amount of white, expressed in numbers, is obtained using the eyedropper tool and is used as an index of the corrosion observed (Figure 4). These operations can be performed automatically by the program.

The designed protocol foresees an alarm threshold, which indicates the necessity of adopting corrective actions to ensure the conservation stability of the collection. The reference

Figure 4. Reverse side of coins sampled from lot 16_1: *a)* scanned image with tiff format and 31.3 MB size; *b)* corrosion mapping obtained through Photoshop CS4 software.

Figure 5. Weighting process of a sample.

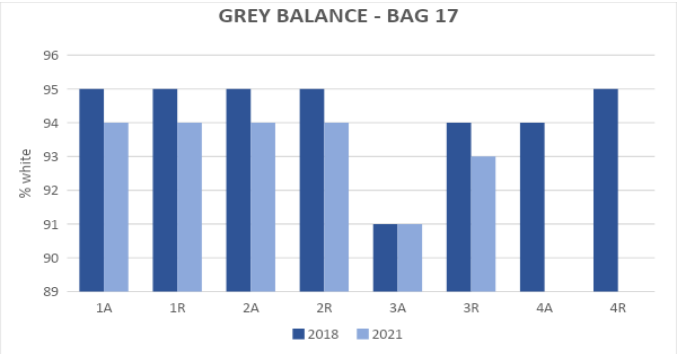

Figure 6. Results of the grey balance of the obverse and reverse of the coins in the four sampling bags of lot 17, done in 2018 and 2021 (sample bag 4 only in 2018).

standard considers a number of non-conforming products, according to the amount of the sample, as an alarm threshold, or "acceptance number".

With cultural heritage objects, risk should always be kept to a minimum, so an alarm was developed based on the grey balance index. To estimate the grey balance index, scanning tests were made to identify when the increase of the corrosion resulted in a reduction of the percentage of the white colour of the image. According to these previous tests, a decrease of white colour equal to or greater than 3% compared to the former measurement corresponded to increased corrosion, and so, a 3% limit was determined as the alarm threshold for the collection.

Additionally, the twenty-coin sample bags were weighed (Figure 5) to obtain another indicative parameter of the increased surface corrosion. It is understood that the variation in weight indicates a change in the state of conservation [14-15]. The weighing was carried out in 2018 with the implementation of the protocol. However, it was not necessary to repeat this process in the following revision, since this procedure is only to be performed if during the revisions the image scan exceeds the accepted limit of white percentage variation.

Results and Discussion

An example of the results obtained with image analysis is shown in Figure 6, representative of what happened in the rest of the sample coins. The variations in the percentage of whites at both inspections (2018 and 2020-21) were always under 2%, which do not correspond to significant increased corrosion, according to our previous tests.

Based on the results obtained in 2018 (below our 3% accepted limit) and following the rules for the changes of inspection that the standard establishes, in the inspection made in 2021 the fourth bag from each lot (Figure 6, bars 4A and 4R) was not scanned, and the weighting procedure was skipped. The reduction in the number of scanned sample coins and elimination of the weighing step in 2020-21 decreased considerably the time employed in the inspection.

Bag number four was still stored in the same conditions as the rest of the coins, so that, if we know a better form of inspection in the future, we will be able to check that group without altering the rest of the protocol. This bag will be weighed every two revisions as a guaranty measure of the protocol operation.

In addition to carrying out the explained protocol, it was visually verified that the coins had not undergone any change in the increase in the corrosion surface, compared to the images scanned in 2018. The stability in their state of conservation is most probably due to the low relative humidity levels verified on the IPCE warehouse (Figure 7). The climatic conditions of this warehouse are measured by an automatic sensor that provides continuous values (1 measure / hour) of temperature (T) and relative humidity (RH). This sensor is located in a zone that is representative of the climatic conditions of the warehouse. Through the data obtained by the room measuring device and the T and RH graphs made with these data, it can be pointed out that the environmental conditions of the context in which the pieces are found are quite stable and continuous over time. There are no fluctuations or sudden changes in the conditions that could be a determining factor for alterations in its state of conservation (Figure 7).

Conclusion

While scheduled maintenance is considered an essential procedure for built heritage conservation, it is not so for movable cultural objects. Nevertheless, the difficulty to conserve vast collections and the need for monitoring, make revision and control operations indispensable.

In this paper we describe how the condition of large collections can be efficiently assessed by adapting a protocol

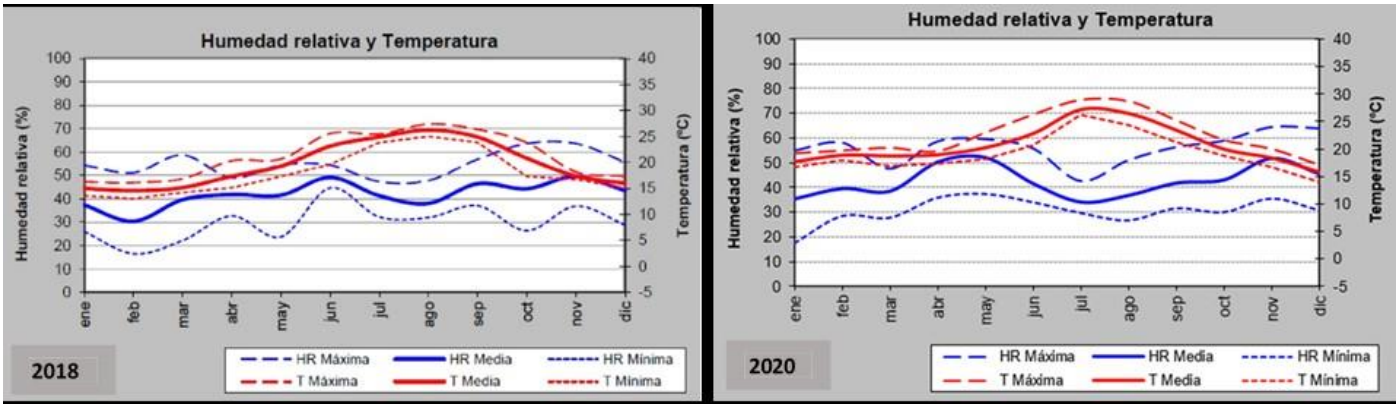

Figure 7. Comparison of the temperature and RH parameters of the warehouse in the years 2018 and 2020. (Source: Departamento de Conservación Preventiva. IPCE).

that is used in the industrial field to statistically evaluate the quality of products.

For the application of the condition assessment protocol here described, the choice of an appropriate indicator and sampling strategy is of great importance and needs to be determined after a risk assessment. Indicators reflect pathologies that appear after modifying environmental parameters and have to be selected according to their representativity in the collection. In the same way, sampling needs to be statistically sufficient and located in vulnerable areas.

The method explained in this article is instrumentally simple and flexible and could be applied to access the condition of other collections, as long as they allow a bidimensional scanning with a high contrast of the attribute, e.g., glass photographic plates.

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