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Proactive Collaborative Conservation: Museums and Companies Working Towards Sustainability

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Abstract

This article describes a system of collaboration between cultural institutions, conservation scientists and companies focused on achieving global sustainability in museum and heritage sites through proactive conservation. The aim is to propose the Proactive Collaborative Conservation (ProCoCo) as a viable tool to accomplish this objective.
The lack of degradation studies on contemporary materials, such as composites, was identified as an issue for the future of cultural heritage. Developing new approaches to heritage and conservation becomes vital and it is in this landscape that ProCoCo is inserted.
A concise review of the literature is reported and the process that led to the development of ProCoCo is explained. Backcasting and forecasting were used to develop different parts of the approach.

ProCoCo consists in studying parameters of the new materials, manufactured by the commercial partner, then simulating the ageing and, finally, re-studying the same parameters in order to predict lifetime changes. During the case study, it was confirmed that such an approach helps identifying weaknesses in the material, which can then become useful for conservators and manufacturers.

The approach allows conservation scientists and conservators to measure the conservation state of materials and to detect degradation at an early stage.
ProCoCo offers a different vision of the long-term issue of funding accessibility faced by museums and suggests a way of improving heritage global sustainability. It proposes a pragmatic and lasting solution to the insufficient public economic support in the Arts which runs parallel to government aid.

Background and key concepts

The cultural heritage sector has always been dynamic and characterised by rapid responsiveness to surrounding changes. Managerial vitality, exhibitions and conservation practices represent some of the receptive areas where changes occur constantly. Here the influence of new ideas coming from other sectors is a central part of the change and sustainability has emerged as a key issue. In this paper sustainability and sustainable development (SD) have been used as a leverage to promote a holistic vision of materials. In the meantime, this vision would provide museums with new knowledge to effectively preserve the material side of cultural heritage and with new financial means to support these institutions.

The potential of using cultural heritage as an instrument to achieve SD has been investigated by various authors and organisations (UNESCO, 2012; Mergos and Patsavos, 2017). Broadly speaking cultural heritage is a collective patrimony able to remind people of their cultural background, of social and historical struggles and achievements. Hence, efforts have been made to preserve such a patrimony and transmit it to the next generations. More precisely, according to UNESCO (United Nations

Educational, Scientific and Cultural Organisation), the major categories of cultural heritage are tangible and intangible heritage. The latter refers to performing arts, traditions and rituals, while the former refers to objects that testify significant cultural and social events or shifts in the forms of expression (UNESCO, 2017). Compared to tangible, the intangible heritage is subjected to different types of processes that can help its preservation or lead to change or loss of the heritage itself. Such processes will not be discussed in this context. Tangible heritage can be subdivided in movable, immovable and underwater heritage (UNESCO, 2017). Because objects tend to degrade with time, this also happens to tangible heritage, thus institutions that collect this type of items strive for slowing down their deterioration process with the aim of allowing their enjoyment to present and future generations.

Conservation, in its many facets ranging from immaterial and material aspects, is crucial in order to preserve tangible cultural heritage. Organisations such as ICOM-CC (International Council of Museums – Committee for Conservation), ICOMOS (International Council on Monuments and Sites) and ICCROM (International Centre for the Study of the Preservation and Restoration of Cultural Property) set principles and boundaries in the field and promote the use of reliable conservation practices (ICOMOS, 1964). Moreover, these organisations develop guidelines for the long-term preservation of cultural heritage and promote their application in museums (Alcántara, 2002; Canadian Conservation Institute, 2015). These guidelines are particularly effective in the case of traditional materials, though modern and contemporary ones are often characterised by different degradation pathways. In the past decades, the unknown deterioration pattern of innovative substrates such as plastics has led to overlook several effects of degradation resulting in permanent damage to collections (Keneghan, 1996; Lavédrine et al., 2012; Baker et al., 2015). For this reason, ideally investigations should be conducted on new materials entering collections to promptly provide guidelines for other museums that handle similar items, but the variety of innovative products and their manifold forms (e.g. rigid objects, foams and fibres) complicate the situation. Consequently, different approaches and collaboration agreements should be developed to enhance the current knowledge on the degradation of innovative materials. It is in this framework that sustainability may play a main role.

According to the International Union for the Conservation of Nature (IUCN), the term sustainable development (SD) was initially used to link economic growth and environmental respect, but soon it also started to assume a social meaning. Over a few years the overall concept of SD, together with its three pillars of economic growth, environmental protection and social progress evolved and became a feature of government and institutional vocabulary (Adams, 2006). Subsequently, the concepts of sustainability and SD have spread into most research fields and industrial sectors, although sometimes the understanding of the concepts differs (Lele, 2013).

SD is sometimes instrumental to deliver effective and durable economic management. Consequently, sustainability is often thought to be achievable only by means of efficient economic plans and thrifty financial management, without sufficiently considering environmental and social aspects. Despite economic and financial themes being central to almost all human activity, there is still the need to recognise social and environmental variables. The level of importance of these two

factors strictly depends on the type of approach to SD. Baker et al. (1997) described the different approaches to SD through a 'ladder' structure which starts from the Treadmill viewpoint (based on a more anthropocentric model), passes through weak and strong SD, and ends with the Ideal Model (based on ecocentric or biocentric viewpoints). The Ideal Model represents the optimal position where human impact on the planet is minimal. In this paper the Ideal Model has been used as guidance and a source of inspiration.

The interconnection between the three SD pillars is clear when considering cultural heritage. Sites and museum are meaningful for their communities and frequently are also essential for their countries by virtue of the historical significance of their collections. Art, as a facet of culture, influences communities and is influenced by them and can be related to the social and cultural aspect of SD. Artworks and assets are able to trigger curiosity and stimulate change and, through tourism, they are also able to generate significant revenue which contributes to the growth of the gross domestic product (Heritage Lottery Fund, 2009). This can be related to the economic facet of SD. Moreover, historical buildings and objects in collections need to be carefully preserved considering the interaction between asset and environment (de Silva and Henderson, 2011). In addition to this, the cultural heritage sector is reducing its carbon footprints in agreement with the global commitment to lower carbon emissions (Lambert and Henderson, 2011; British Standards Institution, 2018). Here the connection with environmental sustainability is obvious. This high level of interconnection is even more evident when culture is considered in its new vest of fourth pillar of SD (Nurse, 2006; United Cities and Local Governments (UCLG) Committee, 2010).

Due to the primary focus on the economic aspects, social and environmental issues have become secondary. The reduction in public funding allocated to the Arts sector from 2010 onwards (Harvie, 2013) has exacerbated this tendency and, accordingly, art and culture are currently experiencing a growing need to find support elsewhere (Lusiani and Zan, 2013). In this climate, it has become essential to find alternative private and public orientated initiatives that can boost the Arts and reinforce the pillars of SD in cultural heritage. Settembre Blundo et al. (2017) reviewed the mechanisms of private sponsorship and patronage in cultural heritage, their different motivations and aims, as tools to undertake social responsibility by investing in public assets. This interesting review points out that these mechanisms deal with two aspects of sustainability (social and economic) but are less considerate about the third one (environmental). Consequently, it is important to use forms of collaboration that could be more effective in satisfying these requisites all together.

The Danish PRIMI (Plastic Research and Innovation for Museums and Industry) Project was the first attempt to establish a pattern for collaborations between artists, industry, conservators and polymer scientists (Lundbye, 2013). This represented an innovative project in terms of conservation theory, because it aimed at bridging the worlds of art and science through innovation and conservation. Here the public and private sector collaborated to understand issues related with plastics, examining artworks degradation and evaluating manufacturing processes that could have led to the material deterioration. However, to date conservation of heritage materials only considers the action of conservators necessary when degradation has started following

manufacture, and when the artwork value has been recognised. No one has as yet considered a proactive and predictive approach by characterising new materials before they become art objects or sociocultural assets. Along with endangering valuable goods, late interventions introduce the risk of losing assets that are meaningful for a part of the public before they even reach their value recognition. Could conservators and companies work together to become more aware of materials and their degradation, consequently reducing these risks?

This paper describes the design of a collaboration model through the adoption and application of a preventive conservation procedure called 'proactive collaborative conservation' (ProCoCo). The backcasting approach was used in this context to visualise an ideal plan for future industry-museum collaborations. In ProCoCo, the conservation department of museums and heritage sites engage with companies involved in new materials manufacture. One of the key features of this engagement is that all the project partners collaborate as equal partners and all can draw valuable scientific and commercial information from the project. This paper presents ProCoCo as a possible strategy for assessing the potential degradation of new materials entering the museum sector and as a powerful tool for achieving materials sustainability.

Key Terminology

'Resilience'. It is regarded as one of the key objectives of sustainability and refers to the ability of a system, or organisation, to anticipate and change according to economic, social and environmental transformations (Arts Council England, 2013). The ability of the cultural heritage sector to react quickly to evolving environments constitutes an essential starting point for the flexibility and resilience of the whole sector. However, that flexibility must be based on a logical and structured response rooted on best practice and knowledge.

Resilience is also essential in commerce where an awareness and agility in recognising market fluctuations, the appearance of new products, and the influence of new trends is vital. Moreover the increasing awareness of environmental and social issue due to greater consumer interest in production processes, eco-credentials and the long-term stability of products is leading companies to review their manufacturing processes in order to become more globally sustainable. Changes often require investments and research, thus companies not only need data and ideas but also researchers and money to develop research (COTANCE & Industrial All, 2012; Scottish Leather Group, 2013).

'Diversity'. In the case of environmental sustainability, diversity refers to biological variability, whilst in a social context it refers to the cultural diversity and the right to self-determination of communities (UNESCO, 2005; Macmillan, 2006). In a broader sense, it constitutes the basic need to maintain species' variability and the equilibrium deriving from it. Similarly, Holden's report on 'The Ecology of Culture' (Holden, 2015) considered the idea that culture and nature have similar structures, emphasising that diversity represents a focal point of this system. By viewing culture as an ecology, it is possible to understand how essential the presence of each component is to the whole.

In research, diversity permits ideas to come into contact, opens discussions and allows cross-fertilisation. It becomes apparent that, whatever the sector, diversity should be guaranteed permitting both humanity and science based activities to be pursued. The

importance of diverse artistic activities and cultural attractions is invaluable. Art and culture are two of the most powerful engines of creativity and can be considered as intrinsically important as science in any modern society. Diversity can increase ideas sharing, providing the opportunity to improve methodologies and articulate thoughts. Furthermore, by acknowledging diversity it is possible to recognise the validity and worth of different aspects or visions of the same problem and that none of these visions is necessarily wrong.
The same viewpoint can be applied to private companies and it can be symbolised by the flourishing of start-ups and dynamic companies, many of which work in cutting-edge technologies. They can bring fresh perspectives and products to the market, revive price competition, and enhance the quality offered to users. The range of the offer stems from the variety of the research and is an essential part of any vibrant market.

'Value'. The range of variables that influence the definition of an object value can be large and the significance of each variable can vary. In terms of cultural heritage, the complexity of carrying out consistent calculations for different assets or contexts has led to the need for more reliable tools. In an attempt to provide an overview of the cultural heritage typologies, Mason (2002) gave a summary of these typologies as they were described by various researchers. Aesthetic, economic, educational and symbolic value represent some of the categories reported by the author, who finally also provided his typological division. Each of these categories is characterised by a certain degree of importance, though its relative weight and the total value can be difficult to estimate. While various researchers agree on the development of a "toolbox approach" (de la Torre, 2002, p. 16), others are more open to the idea of a "humanities-based approach" and criticize what is defined as an "excessive simplification" (Belfiore and Bennett, 2010, p. 122). Despite the number of publications in this area, at present there is still no agreement on the most suitable method to perform the measurement.
Commercial enterprises also use value as a key indicator of the products' material features as well as an indicator of the economic value generated or lost by their products. In general terms, companies use quantitative analysis and mathematical formulae to calculate market volumes and revenues. This is perhaps one of the main reasons why the dialogue between the cultural world and the financial or business world is so difficult. Art and culture do not only apply an economic value but more importantly they apply an aesthetic and cultural value which does not tend to be monetary.
In this paper, the inherent value of cultural heritage will be assumed and it will be not qualified or quantified. However, these aspects will become significant within the proactive collaborative approach and thus an understanding of the different perceptions of value will become essential.

For all these reasons, resilience, diversity and value can be treated as part of the same ideal mechanism which relates museums.

Sustainability and Its Impact on Cultural Heritage

The evolution of sustainability as a concept started in the 1950s with the beginning of the sustainability movement and continued with Rachel Carson's book, *Silent Spring*, in the early 1960s (Madan, 2011). Organisations and programmes such as the World Wildlife Fund (WWF) and the United Nations Environmental Programme (UNEP) were funded in those years and became active in promoting the need for safeguarding species

diversity and a balanced use of ecosystems. Only following the Brundtland Report (1987), though, SD and sustainability were recognised as internationally important topics. After the report there has been a proliferation of interest which has been beneficial but has also created some further challenges. On the one hand, governments, institutions, companies and users became more aware of the three SD pillars and policies have been introduced in an attempt to reduce the impact of mankind on the ecosystem. On the other hand, there has been an increasing ambiguity as the terms became used in a variety of contexts (Richardson, 1997). The result is that, despite the great resonance of these words and their use in official documents, e.g. Agenda 21 (United Nations, 1992) and the Millennium Declaration (United Nations, 2000), they have turned into a confusing mix of ideas (Pereira Roders and van Oers, 2011) which is often viewed with scepticism. Similar issues have also emerged in cultural institutions.

Indeed, in the last decades museums, galleries and heritage sites have been evaluating from different points of view how to promote SD from their perspective. Pereira Roders and van Oers wrote that the 2005 Convention on the Protection and Promotion of the Diversity of Cultural Expressions was the only document released by UNESCO that clearly stated that culture has an impact on SD (Pereira Roders and van Oers, 2011, p. 8). Further steps forwards have been taken in the following years, again thanks to UNESCO and other institutions that provided further guidelines (UNESCO, 2012; World Heritage Centre, 2012). However, various factors affect the successful integration of SD as a multi-dimensional concept, in particular the type of asset considered (tangible/intangible, movable/immovable) and the clear identification of the goals that want to be achieved. This means that different managerial plans should be made if institutions wanted to achieve, for example, exclusively economic sustainability or economic and environmental sustainability while promoting social inclusion.

Efforts of national and international organisations must be therefore recognised because they encourage the integration of sustainability in heritage management. Nevertheless the actual impact of the current guidelines is often difficult to both measure and put into practice. The success of managerial plans can due to manifold reasons. The Natural History Museum represents an example of how big institutions paved the way towards sustainability for other institutions. The museum was the first in the United Kingdom to receive accreditation for its environmental and energy policies in 2003, testifying that the input of international guidelines was translated in the desired output. Unfortunately, since then the difficulty of planning effective actions towards sustainability that comprise the pillars of SD has become visible, especially for smaller institutions. Such difficulties are likely to be a direct consequence of the insufficient specification of the practical goals cultural institutions should aim for. Some steps forwards have been made and, for instance, the Arts Council England issued in 2013 a report that outlined its ten year plan identifying both economic and environmental sustainability within its strategic goals (Arts Council England, 2013). Even if social sustainability was not clearly cited in the text, its inclusion seemed to be implied throughout the body of the report. This represented an essential step toward the achievement of the guidelines for museums based on sustainability that Throsby (2002) called for. It is to be hoped that in the next few years also social sustainability will be included in any report on the subject

Another example of how difficult the process of integration of the SD pillars in heritage management can be is provided by tourism. As indicated previously, cultural heritage is closely linked to tourism, and heritage-based tourism has increased since 2007 contributing in 2012 more than £5 billion to the UK GDP and providing 134,000 jobs (El Beyrouty and Tessler, 2013). Also, the term *sustainable tourism* was coined in the tourism sector. Again, as seen in the case of cultural heritage, there is no clarity in the function of the word 'sustainable' (Pforr, 2015) and the effect of policies activated in the field is not always clear (Estol and Font, 2016). Although cultural heritage in any of its forms is among the main reasons to determine the presence of tourism, the funding provided to this sector is frequently insufficient to maintain sites or objects. Wear and tear is a logical consequence of the number of visitors who visit famous sites and is also the result of prolonged use of design objects prior to entering museum collections. However, the income generated by these assets is only partly accessible and the funding necessary to conduct the remedial action necessary to address damages is not available. Therefore, novel ways of generating incomes are necessary in order to implement heritage sustainability.

Indeed, these examples emphasise the need for policies that integrate all the facets of SD with those of heritage, and conservation can constitute the bridge able to connect these facets.

Conservation of Cultural Heritage and Sustainable Development

Conservation of objects in collections and cultural assets is vital because it guarantees the existence of the heritage itself. It is self-evident that conservation can be associated with SD because it requires long-term decisions that do not compromise the items' future. This is similarly argued by Brundtland *et al.* that, talking about SD, stated that it entails 'meeting the needs of the present without compromising the ability of future generations to meet their own needs' (Brundtland et al., 1987, p. 15). In the light of this, heritage conservation can act as the engine of a mindset change.

As already seen for institutions that collect heritage, also organisations active in the promotion of cultural heritage conservation have gradually started to introduce sustainability and SD to define guidelines and principles to guide local and global decision making (English Heritage, 2008; Jokilehto, 2011). Pereira Roders and van Oers (2011) offered a summary of the essential documents that had a worldwide impact on the way cultural heritage, tangible and intangible, is conserved and managed. In particular, they mentioned early conventions such as the one produced by UNESCO in 1972, where the centrality of protecting and conserving all heritage was clearly affirmed (UNESCO, 1972), and those created in 2003 (UNESCO, 2003) and 2005 (UNESCO, 2005) to respectively safeguard intangible heritage and further promote its protection. While this attempt to induce a shift is evident in the case of immovable and natural heritage (Selfslagh, 2002), the perception of a shift is more difficult for movable heritage and intangible heritage – the latter not further discussed in this context.

A lack of policies in the field of movable heritage conservation if compared with those focused on immovable heritage was highlighted by Ashley-Smith (2002) and only in recent years this gap is starting to be filled. The *Movable Heritage Principles* published by

the New South Wales Heritage Office and the New South Wales Ministry for the Arts represent a unique example of documents focused on movable heritage conservation (New South Wales Ministry for the Arts and New South Wales Heritage Office, 2000). Here, attention to the social sphere of SD is particularly evident even if not explicitly stated, though the economic and environmental aspects are not considered. Again, this constitutes a risk because it jeopardises the survival of valuable items.

Objects Conservation

The importance of conserving cultural assets is recognized, yet it is not straightforward to reach an agreement on when, where and why to intervene. There are two main challenges which are associated with the physical deterioration of heritage: damage to the social and artistic value of the object, which can become difficult to perceive in its totality; economic damage linked to both the subsequent conservation treatments and the limitations in exhibiting the object. It is essential to prevent/minimise any damage.

Some considerations are necessary:

- *When*. The decision of performing conservation treatments on a specific object is related to the value of the object and its degradation state. The total value can be difficult to determine and its assessment can become more complex in the case of contemporary art or recent collections of objects. Moreover, the degradation state is a frequently underestimated variable and also in this case the poorest outcomes occur with modern and contemporary materials. In addition, there is no general agreement on the stage of damage at which the conservation treatment should be performed. Unfortunately, on some occasions the damage is so serious that disposal represents the only option (National Museum Directors' Conference, 2003);
- *Where*. Cultural heritage comprises movable and immovable assets. Obviously, only samples of immovable heritage such as historical buildings can be transported to a laboratory and examined, otherwise they require to be treated in situ. Movable heritage could be theoretically transported, but again it is not always possible. Hence it can be difficult to perform treatments and conduct laboratory analysis on these objects and the development of methods to treat or investigate cultural heritage quickly and reliably is becoming essential;
- *Why*. Conservation helps to convey the message and the value of cultural objects. Losing an object today can erase a significant footprint of the cultural evolution for future generations. When viewing these objects in the context of an 'ecology of culture', the loss of a specific artefact can influence wider areas of the culture. The responsibility therefore lies with the current stakeholders and keepers to preserve art and assets both for people living today in other parts of the world and for subsequent generations.

These considerations point out that even if heritage conservation has existed for many centuries there are still unanswered questions that overlap with new problems. Such questions need to be faced and innovative ways of answering must be found, thus sustainability and SD can provide new perspectives and solutions.

In order to better understand the pending questions, it is also essential to consider the current types of conservation approaches used in cultural heritage. For starters, in the past there was not a worldwide agreement on the exact definition of conservation and associated terms. Substantial efforts have been made to address the need for a consistent terminology (ICOM-CC, 2008) and it is likely that the results of these efforts will become more and more apparent in the next years. This has allowed professionals working in the conservation field to effectively communicate among themselves and to identify two main approaches to face objects degradation. 'Passive' or preventive and 'active' or remedial (also interventive) conservation represent the two categories in which conservation practices can be divided (British Standards Institution, 2012). Figure 1 schematically shows the two practices and their relation with time.

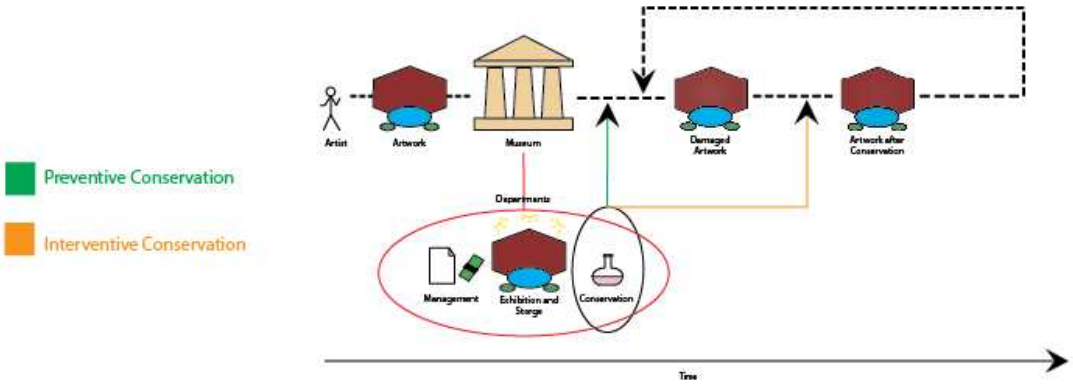

Figure 1: Schematic illustration of preventive and interventive conservation

The term passive refers to those actions which, applied prior the degradation appears, aim at preventing certain types of damage (ICOM-CC, 2008; ICOMOS, 2017). These actions are generally discussed before the objects or assets are exhibited or when they are stored. The prevention of degradation is performed by assessing the type of materials which compose an object and implementing specific storage or exhibition procedures (passive conservation). The word active, in contrast, covers all the practical interventions applied to reduce existing signs of degradation (ICOM-CC, 2008; ICOMOS, 2017). It examines the nature of the degradation mechanisms and acts to lower the damage (active conservation).

Both approaches are focused on objects and assets that exist and are considered 'valuable' enough to deserve conservation consideration. But these items have already been potentially subjected to forms of damage during handling, workmanship or transportation. Therefore, different methodologies need to be investigated with the aim of minimising all preventable damages. Another advantage of new conservation methodologies would be the possibility to handle materials without endangering assets that are not considered valuable today, but may become valuable in the future. In light of this, private partners involved in product manufacturing could become crucial.

Examples of Collaborations between Institutions and Private Partners

Forms of partnership between museums or other institutions and private companies are not totally new and Settembre Blundo et al. (2017) offered a detailed overview of this

topic. Often these collaborations do not involve museum conservation departments or conservators external to the institution and, even if they are involved, the type of collaboration between the partners is scarcely regulated.

Higher education and research programs where heritage conservators or conservation scientists and companies collaborate have been promoted in the last five to ten years, mainly by universities. The Centre for Doctoral Training in Science and Engineering in Arts, Heritage and Archaeology (SEAHA), created by University College of London, University of Oxford and University of Brighton, is an emblematic examples of such a type of collaboration. According to SEAHA's website, projects under their umbrella must guarantee 'tripartite supervision' consisting in one academic, one industrial and one heritage supervisor (SEAHA, 2017a). Industrial partners that participate in this program are listed in the university website. Based on the information retrievable online, these collaborations seem more oriented towards the development of instruments for the effective investigation of heritage. Suppliers or developers of analytical instruments and practices responsible for control or maintenance of buildings represent the majority of the listed partners (SEAHA, 2017b). There seemed to be less interest on the part of materials manufacturers, but this does not mean that there is no potential interest.

When looking for collaborations of this kind within or outside of the academic realm in the internet environment, hardly any case was found. This might be an indication of one of the following: existent collaborations are not openly advertised, which appears unlikely because private investments in cultural heritage are normally declared, since they have a beneficial effect for the investor image (Settembre Blundo et al., 2017); or these collaborations are extremely rare and not systematically organised. The PRIMI project, mentioned in the introduction, could be considered as the first example of such a collaboration. PVC Information Council Denmark and Plastics Europe were involved in the PRIMI project, side by side with Statens Museum for Kunst (SMK) of Copenhagen, artists, conservators and conservation scientists. Each of the partners involved reported its opinion regarding the beneficial impact of the project. Ole Grøndahl Hansen, Director of the PVC Information Council, remembered that existing environmental issues require innovative problem solving abilities, in particular in sectors such as plastics (Lundbye, 2013, p. 10). Jørgen Wadun, Keeper of Conservation and Director of Centre for Art Technological Studies and Conservation, CATS, at the SMK of Copenhagen, stated that the project was realised 'on the belief that dialogue between the artist, conservator and industry can create new values' (Lundbye, 2013, p. 12).

The introduction of a clear and systematic approach that promotes collaborations between industries and museums, reinforcing the sustainable development pillars interconnection, appears to be a valuable addition to the tools in the hands of cultural institutions. To respond to this need, ProCoCo is proposed as an approach that views all modern materials as potentially significant future cultural materials, and therefore their current manufacturing and usage requires a level of future-proofing for their second life as cultural assets.

Towards a Novel Approach

Backcasting is a methodological approach that was described in 1990 by Robinson (1990) and is used today in planning for sustainability, urban transports and some areas of business. The method requires understanding of the context, visualisation of a target future scenario and definition of a list of actions necessary in order to achieve that scenario. Forecasting –as opposite to backcasting– describes the use of data to predict an event that will take place in the future. Therefore, while backcasting entails visualising a desired scenario and look for possible ways to make the scenario happen (Robinson, 1990), forecasting takes a more passive role. The use of backcasting in sustainability planning is of primary importance because it activates creativity helping to find solutions for old and new problems. For the same reason it was also used to develop the ProCoCo approach.

Madan (2011) proposed the use of backcasting in museum sustainability planning and she reported a series of case studies where the method has already been successfully used. Madan continued by explaining how the method works when it is used within museums. It normally requires to run a workshop that involves any level of the museum, both managerial and non-managerial members, and where everyone expresses its perception of the institution. Then possible scenarios particularly designed for that institution are drawn, and questions on the newly imagined museum, such as criticalities and obstacles found along the way, are asked (Madan, 2011).

Backcasting was fundamental to inspire the first stage of the ProCoCo, more related with policy design aspects, whereas the second phase of the approach, more analytical, required the use of forecasting methods. Backcasting principles were also useful to define initial needs and limitations of ProCoCo that will be investigated in greater detail during future workshops with possible partners. These workshops will permit to assess additional weaknesses of the approach and to set up its actual implementation.

Proactive Collaborative Conservation (ProCoCo)

ProCoCo can be defined as a novel form of conservation, established between the conservation staff of a cultural institution, the institution itself and a partner in the private sector, which has the aim of increasing the understanding of materials degradation. ProCoCo aims at recognising the early signs of degradation and their effects, a type of information that becomes essential for manufacturers in order to design development plans, disposal or re-use strategies and end-of-life procedures. Indeed, this information is also incredibly valuable for institutions that collect objects, which for their intrinsic nature have the unavoidable tendency to deteriorate with time.

In order to make ProCoCo a reality, it is necessary that national governments and national/international funding agencies recognise the importance of promoting a holistic vision of materials. Hence, these agencies should acknowledge that museums can have a fundamental role in forging new development perspectives and not just in preserving the past. To some extent, museums have already been recognised as agents of change, but this recognition has primarily considered social, political and economic aspects (Sandell, 1998). In reality these institutions could provide unlimited and unprecedented data on the long-term behaviour of materials and their interaction, paving the way to insightful discoveries on the actual mechanisms of deterioration when

objects are in use. Conservation departments affiliated with museums would operate as material testing laboratories with the difference that the former would focus on the early stages of degradation, whilst the latter are normally interested in quality control and failure analysis. In addition, the conservators' experience, on both the actual long-term behaviour of materials and their simulated ageing, would be extremely beneficial to assess degradation patterns that mimic those of other materials. Museums would, therefore, also be considered agents of change in technical and scientific fields and, as a result, access to funding in these areas should be guaranteed. New funding scheme that resemble the ones aimed at encouraging sustainability actions promoted by Arts Council England (Arts Council England, 2016), Association of Independent Museums (AIM, 2017) and Museum Development North West (MDNW, 2015) should be established.

The following paragraphs will explain how this approach should work, starting with the request of the budget to the funding agencies and finishing with the limitations of the method.

What ProCoCo is?

The significance of proactive conservation has already been recognised to some extent (Drdácký et al., 2005; Rozell, 2014). However, this definition was often used as a synonym for preventive and does not appear to have a unique meaning. To avoid confusion, in this paper the term indicates a need for the characterisation of the potential degradation process of materials before they become art objects. 'Collaborative' has been added to 'proactive' because this approach involves stakeholders external to museums that will actively collaborate with conservators and conservation scientists.

The potential impact of this approach extends from architecture to archaeology, but its significance becomes even more apparent when the latest generation of materials are considered. Items made out of plastics and composite materials used for buildings, automotive and aerospace or textiles represent only a portion of the future challenges that conservators need to assess today, for treatment tomorrow. Otherwise, unfortunately the fate of previous generations of materials will be repeated where their long-term behaviour, both in use and during museum storage, has been difficult to predict and address. Despite the delay in identifying this issue, a growing number of studies are available (van Oosten et al., 2011; Shashoua, 2012) and the work conducted by conservators could undoubtedly be useful also to manufacturing industries. There is every possibility that the financial impact of conservation or restoration treatments would be partly reduced by understanding the factors which have the most harmful effects on the materials.

ProCoCo aims at increasing the dialogue with and the participation of manufacturing companies that, working with museums, will investigate possible degradation patterns and ways to minimise or face possible damages in the short to long term. Companies involved in production might not have sufficient resources to individually investigate the materials degradation because of production and financial constraints. Therefore, the collaborative approach with museums and conservation scientists could be a viable solution to initiate research of significant commercial partners with the help of expert personnel. This beneficial joint approach will secure a sustainable source of income for

museums and will satisfy the need for studies on the long-term behaviour of emerging materials into a framework of environmental and social sustainability.

ProCoCo could provide insights into the parameters which have the worst effect on specific properties of materials, permitting museum staff to take action promptly when necessary. Moreover, it could guarantee the consumers improved performances in the company's products and reinforce a culture of sustainability.

Main Actors

ProCoCo can somehow resemble the Public Private Partnership (PPP) because it involves the collaboration between public and private sectors. In PPP private capital is invested to carry out operations in the public sector, a method used in areas such as infrastructure and services and recently also introduced in cultural heritage (Settembre Blundo et al., 2017). However, while in PPP privates provide funding and often knowledge that are used in the public sector, in ProCoCo museums/institutions can be both public and private and they actively collaborate with the manufacturing company in order to achieve the mentioned goals.

There are three main participants in the ProCoCo framework, the first participant being the public or private organisations and institutions who manage cultural assets. They will have an internal, or in some cases external department, which performs diagnostics, conservation and restoration. In both cases the conservation department constitutes the second participant to the framework. Conservation scientists have the requisite knowledge of the artefact which encompasses the broader chemistry, materials science, art history and humanistic studies. This resource and expertise could become essential for institutions looking for collaborations with companies. The third essential participant to the project is represented by manufacturing companies. Being located in the manufacturing sector, they also have access to a wider spectrum of national and international funding compared to the cultural institutions, with the possibility to reinvest their profits into other business opportunities or sectors.

Some leading museums in England and Europe accept donations from companies and this can draw criticism relating to the nature of the association. However, this engagement could be viewed more favourably if the investment/donation was focused on purely philanthropic conservation. Young businesses, start-ups and certain types of well-established industries could be the right partners for establishing collaborations with museums, galleries and artists. Young or relatively small companies are characterised by less rigid structures that allow to react quicker than big industries to any market change. Even if their size may constitute a problem because of the difficulty in facing changes that are independent from the company itself, this type of companies has shown high resilience (Smallbone et al., 2012).

How ProCoCo Works

The first stage of ProCoCo should consist in confirming the possibility to get access to the funding. The manufacturing company should contact the government, or the funding body, that will evaluate the suitability of the request and will then provide a list of museums and institutions potentially interested in the collaboration. Museum

Association is an independently funded association active in the UK that constantly updates its list of affiliated museums, and its database could represent a reference in this early stage of the process (Museum Association, 2017). The company will then contact the institutions potentially interested in the project and, once found the best match, the three actors (comprising the conservation department) will work together to secure the funding. The application should identify the type of ageing procedures to be carried out on the materials, the time frame, and a research plan describing the benefits for the partners. The plan should also point out the importance of conducting this project in the long-term and how it would promote sustainability in the specific case of the material. The budget agreed between the partners and confirmed by the funding body should be divided so that one-third of it will be assigned to the manufacturing company and two-thirds to the museum/institution (if the conservation department is internal). In the case an external practice is in charge of the conservation operations, the budget should be divided in three equal parts.

At this point the second phase of the project takes place. When a material is studied for production purposes it is common to apply invasive techniques. This is typical in the evaluation of tensile strength and elongation (physical/mechanical tests) or moisture content and pH value (chemical tests). In contrast, in the cultural heritage context it is much more common to utilise non-invasive or non-destructive techniques, which respectively allow no sample collection and no destruction of the sample during studying.

In the ProCoCo approach (Figure 2) both invasive and non-invasive techniques must be used. Initially the materials are studied using both approaches and are coupled with one or more types of accelerated ageing which have been previously agreed with the company. Then the conservation scientists and company specialists explore the interaction of multiple factors on undamaged material, understanding how these factors influence the behaviour of the final object. The difference between the investigations before and after the ageing generates the data which are collated, evaluated and the presence of degradation markers demonstrated. The markers represent the most significant finding for conservators involved in this type of conservation because they can be used, in future investigations, to assess the material's state of preservation. Indeed these degradation markers can potentially help to detect early signs of damage by mean of non-invasive or non-destructive techniques and aid decision making of conservation scientists. The study of the material at different level of ageing would be used as a benchmark for new products and it would be useful both from an industrial and museum perspective.

The final outcome of these tests will be a Joint Protocol (Figure 2) that will be stored in a dedicated databank for companies and museums. A registration number and a title will be assigned to the Joint Protocol and this number will be archived for use in the future.

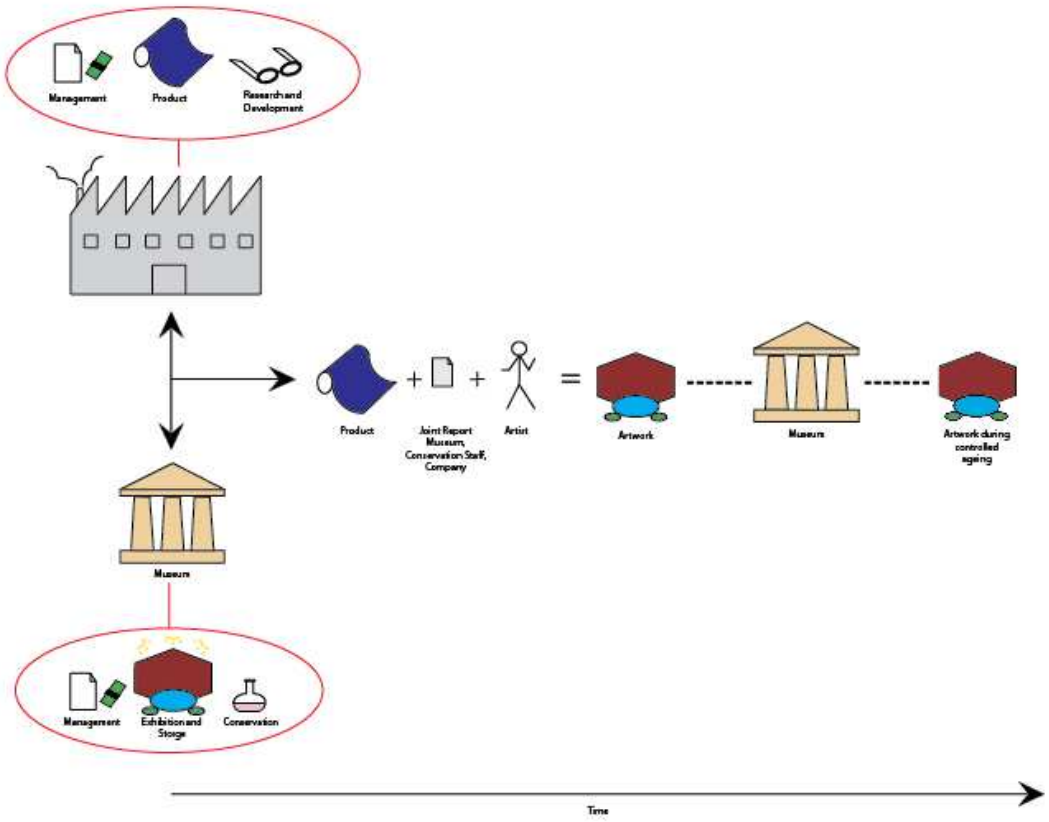

Figure 2: Schematic illustration of the Proactive Collaborative Conservation Approach

Many advantages can be achieved through this approach:

- museums increase the knowledge of materials which could become part of their collections;
- the problem of patents, faced during the conservation of newly produced materials, can be overcome through non-disclosure agreements between museums and companies;
- artists gain unprecedented information regarding how to treat, manipulate and choose the most appropriate material for their need;
- companies gain information on the degradation of their products which would be difficult to obtain otherwise.

It is obvious that ProCoCo may become an integral part of the bigger sustainability strategy by investigating the patterns of degradation and assessing the most influential factors which induce degradation. This has the advantage of lowering the danger of compromising socio-cultural values associated with objects or assets. Moreover, it minimises the need for expenditure in remedial conservation treatments which, along with their economic cost, may require the use of questionable solvents or other chemicals.

Similarly ProCoCo may provide companies with valuable data to improve products and increase the knowledge of the material, supplying crucial evidences on its response depending on the sources of damage. Furthermore, the increased focus on the material's long-term behaviour will improve the company's understanding of interaction and

degradation mechanisms and, hence, it will help to accomplish environmental sustainability. Highly engineered products would result in less material going to the landfill, which in turn translates into delivering sustainability.

Risk of Interference and Limitations

As previously indicated the first two of the participants in the ProCoCo framework are museums and conservators, the long term guardians of cultural heritage. The inclusion of a company into an art gallery or museum management could create conflicting scientific and financial pressures.

In the past, art has mainly been collected and donated by single private collectors and philanthropists, and subsequently fostered by public institutions (Streets, 2015). Today, as a consequence of the reduction in public funding, the problem of financial shortfalls in heritage management is only partially addressed by private donations and investments. The system does not work effectively enough to guarantee all the required funding and alternative sources of investments are needed. In recent years the intervention of companies, in particular large corporations, has been seen as a partial solution, but on occasions the result has been an ambiguous relationship between museums and companies. Indeed, some have considered that industrial corporations may have overly influenced the direction of art institutions in focusing on specific goals (Macalister, 2015). Further, some have been sceptical about the financial motivations of companies or industries (Harvie, 2013) and the effect on political, conceptual, social or cultural positions taken by the relevant institutions. In addition, there has been concern that commercial support can influence both artistic direction and museum management (Collins, 2015) as well as benefitting from corporate placement/advertising, tax breaks as well as the institutional association. The ProCoCo framework would establish an alternative funding structure that is mutually beneficial. By establishing a three-part collaboration there would be equality and every project participant would gain from the collaboration.

Limitations of ProCoCo can also be related to the large amount of energy required to initially set up the program and to the number of hours required to carry out the project. This would necessitate conservation departments to be involved in time-consuming accelerated ageing procedures and operations to assess the progress of the degradation. On the one hand this would reduce the time that conservation staff can use to conduct actual conservation and restoration activities on museum collections. On the other hand accelerated ageing is characterised by downtimes that would consent the staff to be involved in routine activities. In addition, in the long term the understanding of materials degradation would become more complete, gradually reducing the number of treatments necessary to preserve cultural assets.

Another limitation of the approach is that it requires the availability of facilities such as laboratories, analytical instruments and accelerated ageing devices. Despite this could represent an issue, in particular for smaller museums or institutions, the investment on some basic instruments could be covered by part of the income from the ProCoCo funding or other funding schemes.

Finally, the risk of exposing sensitive information connected to the industrial partner can be a matter of concern for both industry and institution. The protection of this type of data represents one of the most important points that must be clarified in the next stages of the process for the ProCoCo implementation, possibly during the workshops with selected partners representing the three parties involved.

ProCoCo in Practice: an Example

The case reported here represents one out of many examples where museums and conservation professionals can work with private companies to achieve novel results. This example stems from an ongoing doctoral research that sees the collaboration between a company and a conservation scientist. The same research has also engaged in meetings with museums that could be potentially involved with the conservation of products manufactured by the partner company. However, in this preliminary phase museums were not active partners of the project. Due to non-disclosure-agreements the results of the study cannot be reported, but it is possible to provide some relevant outcomes of the research. An overview of the materials selected, together with methods and research outcomes relevant for this paper will be described.

Materials and Methods

Collections of modern objects or modern and contemporary art often contain items made of multiple components, in particular in the area of transportation. Polymeric materials are commonly found in these environments and, in the last few decades, some of these materials have shown their long term instability. The ProCoCo philosophy lends itself to aircraft collections where the materials vary from the carpeting and the cladding to the paints and the metal used for hoses. Aerospace or automotive upholstery, more specifically a type of imitation leather, was considered in this study. Preliminary investigation of materials can be achieved through accelerated ageing studies.

An initial dialogue among the two participants to the project (conservation scientist and private partner) was indispensable to define the types of ageing that were considered as relevant. Accelerated ageing protocols involved:

- UV radiation;
- Heat exposure;
- Heat and humidity cycling.

It is apparent that the ageing should not be restricted to individual degradative environments but should consider combinations of extremes. Generally, the severity of exposures is greater for the first lifetime experience but still should shape the material understanding and conservation environment understanding. Therefore, in order to deliver this synergy between museums and manufacturers a range of simulated environmental conditions should be considered to provide a complete lifetime investigation.

The type of analysis to be performed to characterise the ageing process depended on the material under examination, the quantity of material available and the use of non-invasive (NI), destructive (D) and non-destructive (ND) analyses. The range of techniques used depended on the research question as well as the relevancy and sensitivity of the technique to the ageing process. For the purpose of this research,

photographic examination coupled with image processing (NI) and 2D scanning (NI) were used to assess variations of the imitation leather perceived roughness. Spectrophotometry (NI) was performed to measure variations of the L*a*b* values associated with the colour of the material. Electron Microscopy (SEM, ND technique) allowed examination of changes in thickness and compactness of the samples, while Energy Dispersive X-ray (EDX) spectroscopy (ND technique) identified the presence/absence of elements ascribed to flame retardants present in the composite matrix. Fourier Transform Infrared (FTIR) spectroscopy in Attenuated Total Reflectance mode (NI) permitted to identify changes in the molecular groups occurred after exposure to the selected ageing conditions. Bending, compressional and surface properties were measured using the Kawabata Evaluation System (KES) and tensile properties (ND and D) data were collected.

Research Outcome and Implications

The response of the materials to the degradative medium had to be determined over relevant time periods. Appropriate statistical analysis was applied, e.g. as correlation tests and variance analysis, to identify degradation markers and measure correlation between some of the parameters identified. Figure 3 provides a schematic representation of the ProCoCo procedure that led to the Joint Protocol.

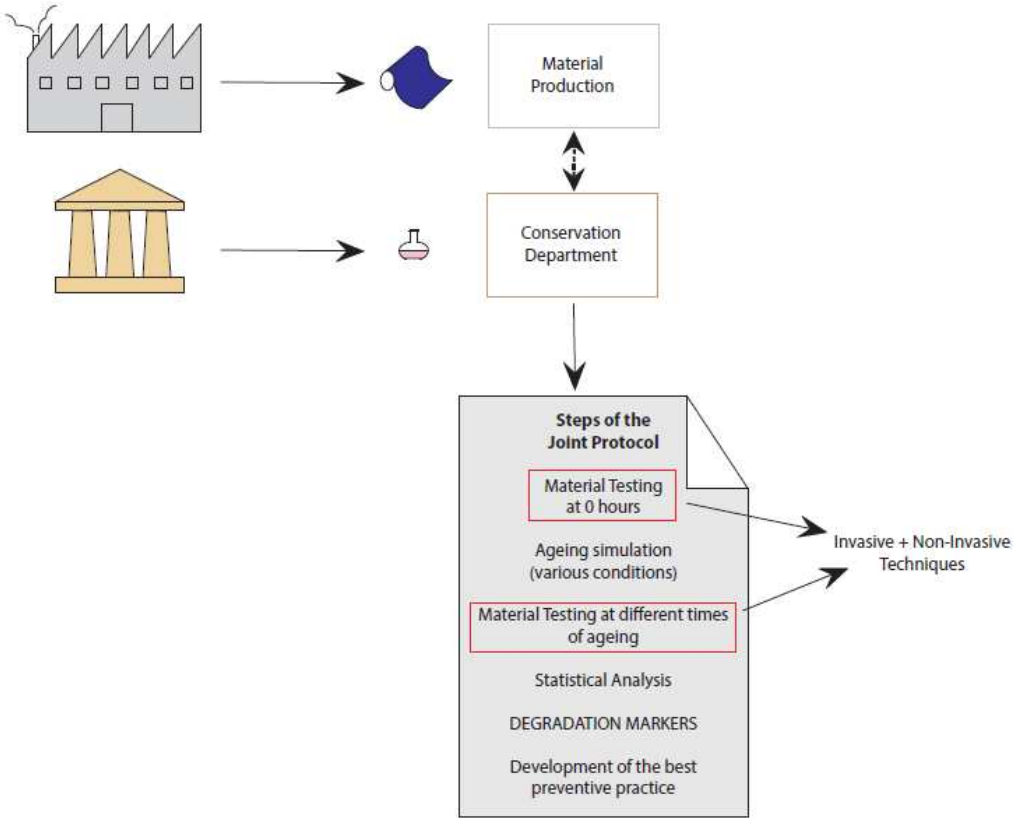

Figure 3: Representation of the ProCoCo methodology in the case of innovative imitation leather material

Accelerated ageing treatments conducted for this research permitted to identify a list of degradation markers. These markers were obtained after considering the effects of

each ageing procedure on the properties of the material under investigation. Heat and humidity cycling caused the worst effects. An increase of the imitation leather perceived roughness, determined with greater precision via 2D scanning, and a worsening of the physical properties, particularly obvious after bending and compressional tests, constituted the most relevant markers. Other variations were identified due to ATR-FTIR, which detected shifts in absorbances and intensities of the signals of typical molecular groups attributed to the material's components. The remaining accelerated ageing affected the material to a much lesser extent.

These markers represented the first important outcome of this research because they may facilitate the early detection of degradation phenomena taking place within the material that is a potential candidate to become part of museum collections. Ideally, once ProCoCo will become a reality, if the material enters a collection it should be tested using the same techniques used in this research, both immediately after acquisition (e.g. set as time 0) and after regular time intervals (e.g. set as time 1, 2 and 3). The identification of degradation signs will be then possible by comparing the parameters collected at different times (e.g. time 0 and time 3) using the same device settings. Indeed, the degradation markers list will be essential to determine the extent of the degradation. Once the markers were identified, it was possible to evaluate if a correlation existed between NI and D or ND techniques. The existence of this correlation would have allowed to virtually link mechanical properties that require sampling with other properties that do not need sampling. The correlation between roughness via 2D scanning and bending rigidity via KES was therefore evaluated. It was found that a strong positive correlation existed between the two parameters, meaning that bending rigidity increased when roughness increased. This represented the second finding of the research and it may be potentially used in the near future in museum environments.

The industrial partner was able to obtain an insight on the behaviour of its product that will be than used to optimise the material stability. The tests highlighted some weaknesses of the product due to specific components and these weaknesses may be studied by the research and development department of the partner (outside of the ProCoCo scheme), to enhance durability or improve end-of-life disposal.

The two findings described above testify that a convergence of aims can be found between industry and museums. The Joint Protocol may be considered as the key outcome of a new system of collaboration that places sustainability at the heart of the human-environment interaction. ProCoCo would play a central role in designing more environmentally friendly products and, in the meantime, would reshape the identity of museums. Along with being the custodians of social and cultural values, they would become an industrious engine of the change of society.

Conclusions

Through this paper an overview of the proposed Proactive Collaborative Conservation (ProCoCo) framework has been discussed and a novel approach to conservation based on a collaboration between museums, conservation scientists and manufacturing companies outlined.

In developing this collaborative framework the nature of SD and sustainability within the museum and cultural heritage environment has been highlighted and the

importance of resilience, diversity and value identified. A need for a recalibration of the term sustainability in connection with the museum sector has been proposed in order to allow social and environmental aspects to be positioned at the same level of importance of economic factors.

A review of the literature on sustainability, its impact on cultural heritage and heritage conservation was provided. Some examples of collaborative programmes were also reported, with a focus on the type of type of companies involved and the outcomes of the projects. This review led to the identification of areas of convergence between cultural institutions, conservation professionals and product manufacturers that can be used to increase the interconnection between the SD pillars.

ProCoCo is focused on studying new emerging substrates and products and characterising their ageing degradation in use, prior to entering and subsequently on display in museum collections. ProCoCo was developed by using a combination of backcasting and forecasting to embrace sustainability. Once a commercial partner has contacted an institution and its conservation department, a funding proposal can be drawn to obtain the financial resources required for the research. The evaluation of specific critical properties of the unaged and aged material is performed using invasive and non-invasive techniques and the conclusions drawn from the data using appropriate statistical analysis. The outcome of the study is ideally a range of non-invasive degradation markers which can be used to understand the state of degradation of the material when it becomes part of a collection. Moreover, manufacturing companies can obtain a comprehensive knowledge on the nature of degradation and characteristics of their product.

This collaborative approach allows museums to be more flexible and resilient in identifying new materials and funding research to underpin the characterisation of first life products and their subsequent presentation and conservation in museums. It also responds to new questions arising in the ecology of culture, where diversity and value pose new challenges to the fairness of conservation for cultural heritage materials based on emerging technology. ProCoCo studies will sensibly reduce the need for subsequent chemical conservation treatments and will foster the investigation of new exhibition designs able to minimize the environmental impact of physical preservation. Social sustainability can be achieved by avoiding the loss of new artworks and culturally meaningful objects and ensuring that their cultural value is maintained without significant interventions. In addition, their economic sustainability will be maintained as there will be less need for expensive restoration practices, because ProCoCo will allow the detection of the early signs of degradation.

A possible disadvantage of the collaborative approach could be the potential risk of corporate interference. Therefore, before establishing a ProCoCo framework on a larger scale, it is essential to define the boundaries of the collaboration. The definition of these boundaries should be one of the topics of future workshops with a delegation of the three parties representing the ProCoCo partners. Here possibilities, limitations and concerns will be examined and a plan to implement the approach developed.

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