Chapter 1.1

Introduction: The Challenges of Archaeological Conservation

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The Nature of Archaeological Artefacts

Archaeological artefacts[1] can be defined as those objects of the past, which have been recovered from the ground, normally by archaeological excavation: a technical process which unearths and records artefacts, structures and soil features in their stratigraphic sequence. Archaeological research correlates the objects, structures and soil features with known examples to determine what activities took place on the sites and fit this evidence into the existing sequence of material culture and historically recorded events which define the human past[2]. The artefacts recovered, as well as human remains and associated structures are not simply archaeological evidence, they may also be ancient relics venerated by different peoples of the present. Consequently the artefacts have a duality as part of an investigative, knowledge producing process (archaeology) and as material culture which has significance to a wider public; often defining their tribal/regional, national and religious identity.

The care and repair of venerated ancient artefacts which have had a symbolic and educational (museum) role, rather than a function dictated by their form and original use, is attested as early as the Roman and Greek period (Strong 1973). However, the conservation of archaeological artefacts we practice today (ICON 2020)[3] has a clearly identifiable foundation in the 19th century activities of antiquarians cleaning objects from their excavations with carborundum and vinegar and the scientific enquiries of such scientists as Sir Humphrey Davy (Caple 2000: 50-55). Although we might occasionally consider the 19th century treatment of artefacts as inadequate or even cavalier, judgements about the past using the ethical standards and knowledge of the present demonstrate a fundamental lack of understanding about the past. For them it was essential to see the shape and decoration of the object in order to construct the earliest artefact typologies which were often their only means of dating. The cleaning and conservation work undertake in the 18th and 19th century describes the level of knowledge, availability of resources, and the value which ancient artefacts had for that society. In the same way, the conservation processes described in the following case studies represent the state of knowledge, the resources available and the public expectations of museum objects in the opening decades of the 21st century.

Archaeological artefacts come with a range of challenging attributes (Figure 1.1). Unlike objects in museum collections, which are already regarded as worthy of study and preservation, archaeological excavations produce numerous fragments and corroded lumps covered in soil which may or may not be objects, and may or may not have value (Caple and Garlick 2018).

Issue	Consideration
Is it an object?	Concretions soil and corrosion come in from archaeological excavations. It is unclear if they are identifiable artefacts, so they must be investigated and their status determined.
Fragments	Complete objects are rare from excavation, normally only fragments are unearthed. These are often unidentifiable or unsuitable for display unless joined with other fragments (6.3). If the object from which the fragment derives can be identified, valuable information such as an activity, a people, or culture that was once present on the site can be established.

Context	Every fragment has an archaeological context, which associates it with other objects, structures and events. This context may provide date, functional and cultural associations. It is essential that archaeological conservators understand the archaeological context (Berducou 1996, 256-7; Pye 2001, 136).
Decayed	The surface layer, which usually contains the most information, is often altered or removed through decay or corrosion; consequently, archaeological artefacts require extensive but careful cleaning as the corrosion layer may contain mineral preserved organics, traces of gilding or paint, and the original surface within it. Whilst it may be considered desirable to retain such evidence, the corrosion products may be unstable and act as catalysts to promote further decay.
Soiled	Objects are often covered by soil, and may have mineral concretions (lime, iron oxides, gypsum) as crusts or staining on their surface, or soluble salts within the artefact. Occasionally the crust materials can be stronger than the original artefact.
Unknowable	The more chronologically and culturally distant an object from the present, the more difficult it is to accurately interpret (5.3). Objects from prehistoric cultures, where there is no written and little pictorial record can be very challenging to correctly identify and fully interpret.
Unstable	Archaeological artefacts have usually reached equilibrium with the burial environment. Many excavated objects, especially those from waterlogged conditions and archaeological ironwork may become unstable in a museum as the environmental conditions differ from those of burial.
Resources	Whilst some excavations are well funded with specific budgets for conservation, others have little or no funding for post-excavation work.
Preservation in Situ	Some archaeological artefacts such as wall paintings, mosaics, decorative stonework, inscriptions and structural timbers have significance because of their presence within a structure. Consequently, it is often considered desirable to preserve the material in situ; either buried in the ground or exposed on display (Caple 2016).

Figure 1.1: Attributes of Artefacts from Archaeological Excavation

The Conservation Process

The archaeological process transforms the physical evidence of the past into knowledge which is normally articulated in written and image form. In unearthing the past, archaeology largely destroys it. Often the only parts of the archaeological process to survive are the recovered artefacts and even these are not stable. Obscured by decay products and soil, they require a conservator to investigate, reveal and preserve the object (Caple 2000: 33-5). Once retrieved from archaeological sites, the steps involved in the archaeological conservation process, Figure 1.2, start with a full appreciation of the object; detailed recording, analysis of the materials and researching the object. This leads to an understanding of the way in which the object was created, used, and the values it has for people in both the past and the present[4]. A statement of significance can usefully be created which encapsulates this. The decay processes affecting the object, and desired aims of any conservation process are also clearly identified at this point in the process. Conservation can often be the only point, at which the archaeological artefact is examined (and recorded) in detail (Cronyn 1990: 9).

The conservation process invariably seeks to transform an unstable and unreadable object into a stable information source. If interventive (remedial) conservation processes such as cleaning and stabilisation are not appropriate, objects may be recorded, assessed, researched and preventive measures such as suitable storage undertaken to preserve them in the long term. It is important not to see conservation simply in terms of the object's present appearance, but to recognise it as a process, creating and preserving an information source which recognises and preserves values beyond physical appearance. Increasing the information known about an object can for example increase its value to the point where preserving the remains are justified (Caple 1999).

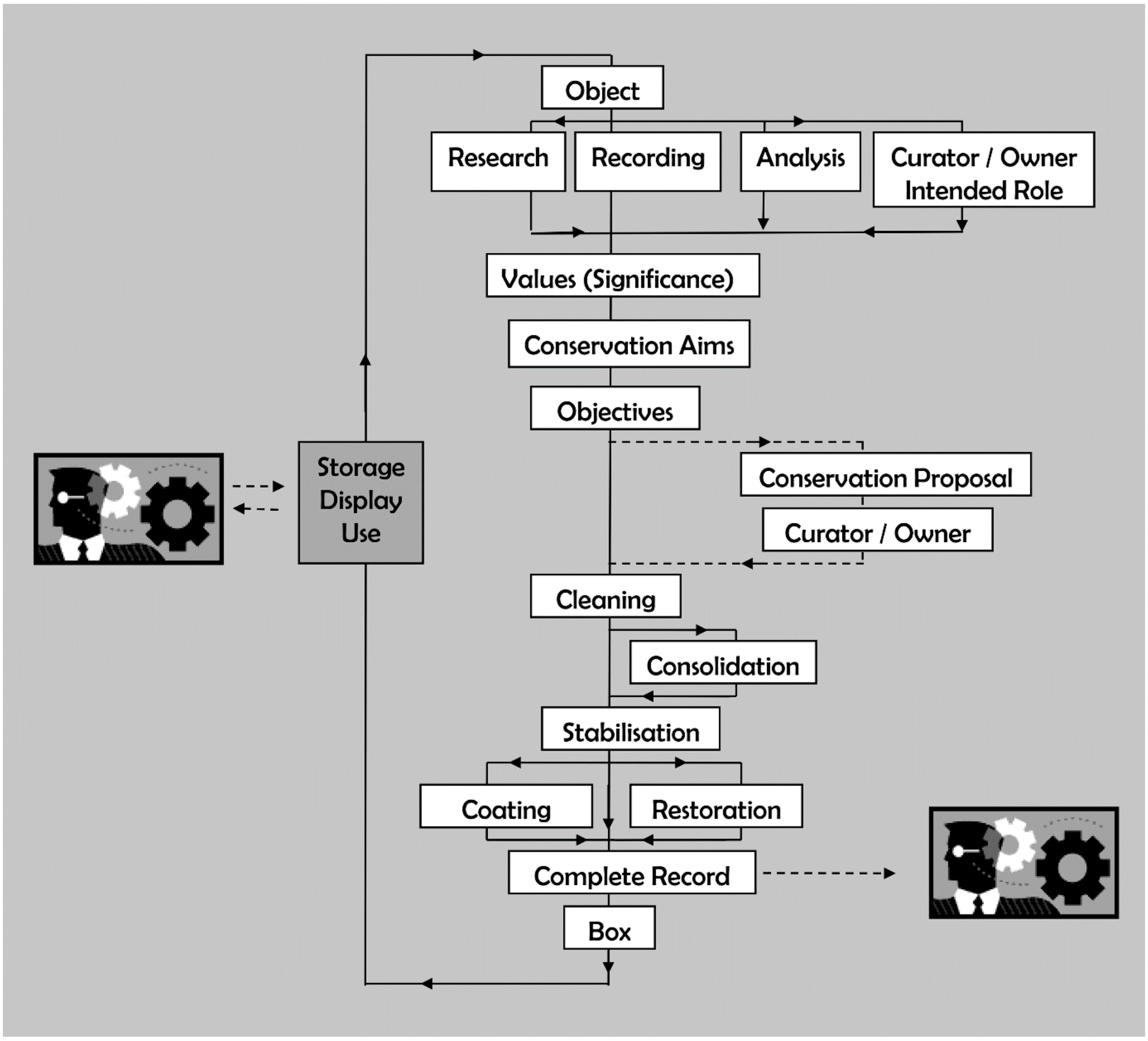

Figure 1.2: Flowchart of the typical conservation process, emphasising the points of output. Through the conservation record, information is abstracted to inform the finds researcher / archaeologist and future conservators. Through the display of the completed object the museum informs the public, whilst the stored object is available for future study.

The capacity to successfully conserve an object depends on the skills and knowledge of the conservator. In some instances there may be very little published information to aid the conservator (5.3). Frequently, conservation literature focuses on new developments presented at conferences or published in journals; there is little published on actual practices. In the absence of published details, and given the differing nature of artefacts, conservators routinely experiment with different treatments and materials in order to achieve the greatest benefit for the object with least risk to the artefact, conservator and viewing public. It remains challenging to employ good experimental technique so that only a single variable is altered and a true comparison between differing materials and techniques is made (4.2), (5.2), (5.3). Even with such information, making the appropriate balanced decision, especially when faced with artefacts composed of several materials which require different treatments and storage conditions can be problematic. Exercising professional judgement using the relative evidential value and pragmatic consideration of the robustness and rarity of materials leads to an informed decision (5.1), (6.2).

Whilst it may be appropriate to undertake differing amounts of conservation work on artefacts, the quality of the work should always remain as high as possible. Given finite resources, standardised batch treatments may be appropriate for dealing with large volumes of archaeological material (Pye 2001: 132).

Archaeological conservators receiving material from excavations are responsible for aiding and informing the archaeological process as well as conserving any artefacts that are considered worthy of becoming part of permanent collections and / or the archaeological record. The conservator's responsibility in the archaeological process requires assessment (investigation and identification) and selection of the objects for retention and conservation from this excavated material. This is normally achieved by collaborating with colleagues such as archaeologists and finds researchers (Cronyn 1990: 10-13). The archaeological conservator is part of the team which turns physical remains into knowledge. Excavators recover the object, conservators clean, reveal and stabilise, illustrators and photographers will capture the cleaned object, specialist finds researchers identify the objects, and archaeologists pull all the information into a coherent explanation of the past. However, where teams are smaller, conservators may find themselves recording the object and undertaking finds research. Consequently it is important that the archaeological conservator has a clear appreciation of the whole process and develops the skills, where necessary, to undertake all these tasks.

It has been argued that conservation is a balance of revelation (cleaning and restoration), investigation and preservation activities (Caple 2000: 3-35). In the case of archaeological artefacts there is a particular emphasis on preservation resulting from their value as scarce evidence of the past. In recent years the abundance of images (replicas, 3D printers, heavily restored objects) has increased the value of many older objects from regimental, religious, art history, textile, social history and transport history collections as genuine evidence of the past. Consequently there is a greater emphasis on their preservation (4.2), (5.6) and they are treated more as archaeological artefacts.

The Organisation of Archaeological Conservation in Practice

Although an object's individual attributes determine the nature and level of conservation it receives, the needs of the collecting institution also impact the extent and emphasis of the conservation work carried out and the conservator's role in the process. Institutions which impact the organisation of archaeological conservation generally fall into three categories.

- Museum Collections: the educational/ display value of objects is derived from conservation work revealing decoration, pigments, soiling and wear from use etc. The object usually already has a date, culture and function attributed to it, which was why it was originally brought into the museum collection. In large museums conservators may work in specialist collection areas and develop considerable skills dealing with specific materials. In smaller museums, a single conservator may work on a range of materials and so requires a more varied range of skills and experiences.

- Large scale research excavations: invariably take place on sites of a known date and aim to solve research questions and reveal remains for future display. They unearth objects, which have, through their stratigraphy and associations with other objects and structures, the potential to contribute to our understanding of the past. This information may change the existing perceptions about the date, cultural associations and use of specific objects. Such high potential archaeological (evidential) value (as well as the fragility and instability of the objects) justifies the costly presence of a conservator on large excavations. Typically conservators on excavations need the skills to deal with a wide range of materials, especially in on-site conditions. Familiarity with the archaeological process is important.

- Cultural Resource Management: in countries with commercial archaeology organisations there are often many small excavations ahead of development; the date, extent and nature of the site is often initially unknown. The number of artefacts unearthed and their archaeological value, which depends on the stratigraphy, structures and associations, will often not be known until after the excavation has been completed. In such circumstances heritage agencies normally build in an assessment phase, where the excavation records, excavated artefacts, historical information etc. is assessed and the level of post excavation resources assigned depends on the assessed value[5]. This means that the archaeological conservator normally undertakes a large volume of initial assessment work e.g. X-radiography, packaging and storage of a large quantity of freshly excavated material, and only undertakes conservation work on a selected group of objects which have been assessed as significant. Such conservators need skills for dealing with a wide range of archaeological materials and artefacts.

The greater the distance in physical or intellectual terms, between the archaeologist and the conservator, the less the values and concerns of the conservator can impinge on the archaeologist, the primary interpreter of the site. On large expedition excavations – the conservator may be physically closer to the archaeologists and so routinely feeds information directly into the understanding of the site. Where there are large numbers of small scale excavations without conservators, who are often only involved later through commercial contracts organised by the finds specialist, there is greater distance and potentially less input into the site report. Overriding this basic reality is the relationship between the archaeologist and the conservator. Where there is a good working relationship and frequent communication, distances can be overcome and key information provided either from the archaeologist to the conservator (4.7), (6.1), (6.2) aiding the interpretation of the objects or from the conservator to the archaeologist aiding the interpretation of the site (2.2), (3.2) (4.6), (6.4). To facilitate this, the conservator needs to understand the site and its archaeological context, thus archaeological experience remains an important element in the training of archaeological conservators.

On Site

Though on many small sites archaeologists recover artefacts from the ground, on large excavations or those with large numbers of delicate finds archaeological conservators undertake this work, such as:

- Lifting. Using techniques such as block lifting and similar methods (Payton 1992) (6.4), freeze lifting (Logan and Tuck 1986) or consolidating artefacts with materials such as cyclododecane (Rowe and Rozeik 2008), to lift soil blocks and fragile artefacts from the excavation site and take them back to the laboratory for micro-excavation.

- On-site Stabilisation. Only steps taken immediately upon recovery of artefacts from the ground can reduce reactions with oxygen or loss of water which can irrevocably physically and chemically damage artefacts (5.1). Suppression of biological activity, the physical protection and support of objects and the prevention of continued metal corrosion are also essential to long term survival of artefacts. (Watkinson and Neal 1998).

- On large scale, well founded 'expeditions', some basic cleaning, reassembly and stabilisation such as desalination activities may be undertaken to allow artefacts to be identified and recorded.

Object Biography and interpreting objects – even fragments

Conservators in their initial assessment and recording of the object and any subsequent cleaning of the object, produce a large amount of information about the object. One way of ensuring that all the physical information about an object is gathered and made available to the archaeologist, curators and wider public is to create an object biography. This technique is often used by conservators, as it encourages detailed observation and recording of the object, requiring evidence of manufacture, repair, use and wear be noted and then considered in an holistic manner as part of the object's life (Caple 2000) (3.3, (3.5), (4.5). This form of description; the journey from raw material to object to discard has a long standing tradition; the earliest surviving example, the song of the Rood, was written in the 8th century AD. It is also a format which is understandable and familiar to archaeologists, and can be integrated into the interpretation of the site or wider appreciations of life in the past (Gosden and Marshall 1999).

Although many archaeological objects are small and appear inconsequential, they are often microcosms of the society which created them. Specific materials, trades, skills, technology and potential use all needed to be present at a particular moment of time to bring them into being. Provided they are accurately researched and recorded, this hidden world springs into view with the unearthing and identification of the object (4.3), (4.5) and is exemplified by the humble dress pin (Figure 1.3).

From the 13th to the 19th century in Europe, dress pins were made of brass wire with a twisted wire head. They were widely used for holding together garments (Beaudry 2007) with secondary uses such as attaching documents and in witch-bottles. Making a pin required over 30 trades spread across Europe. Copper, smelted in Hungary and Austria, was used with zinc ore from Belgium to make brass, to which lead from England was added. Metalworkers made sheet brass, cut it into ribbons for wiredrawers to use, which formed the wire from which pin-makers made pins. Subsequently coated in tin, which was mined and smelted in Cornwall, these 'bright' pins were then sold directly, or through haberdashers, to the users. All these trades relied on iron and wooden tools and fuel created by other trades and all these products were moved by an army of merchants, sailors, waggoneers and labourers. Thus, thousands of people undertaking numerous trades and skills, spread across medieval Europe, needed to exist for this small, 'trivial' archaeological artefact to exist. We can also see that subtle changes in the size, material used and method of manufacture of pins describes the move from hand made by the craftsmen of a medieval guild to the mass produced machine based manufacture of the Industrial Revolution. These changes in size also indicate the evolving nature of post-medieval fashions which used finer fabrics and thus needed thinner, smaller pins. Thus, pins document key changes from the medieval to the modern world (Caple 1986: 1992).

In many cases the archaeological context can be crucial in informing the research process about the date and context of the object thus aiding the interpretation of the site (2.2), (5.1). However, objects with little or no archaeological context recovered from metal detecting[6], rivers or unplanned surface finds such as those picked up after ploughing, (which should in England and Wales be reported to the Portable Antiquities Scheme) can, following conservation cleaning and research, be highly informative (4.3), (4.5) (Kelleher 2012).

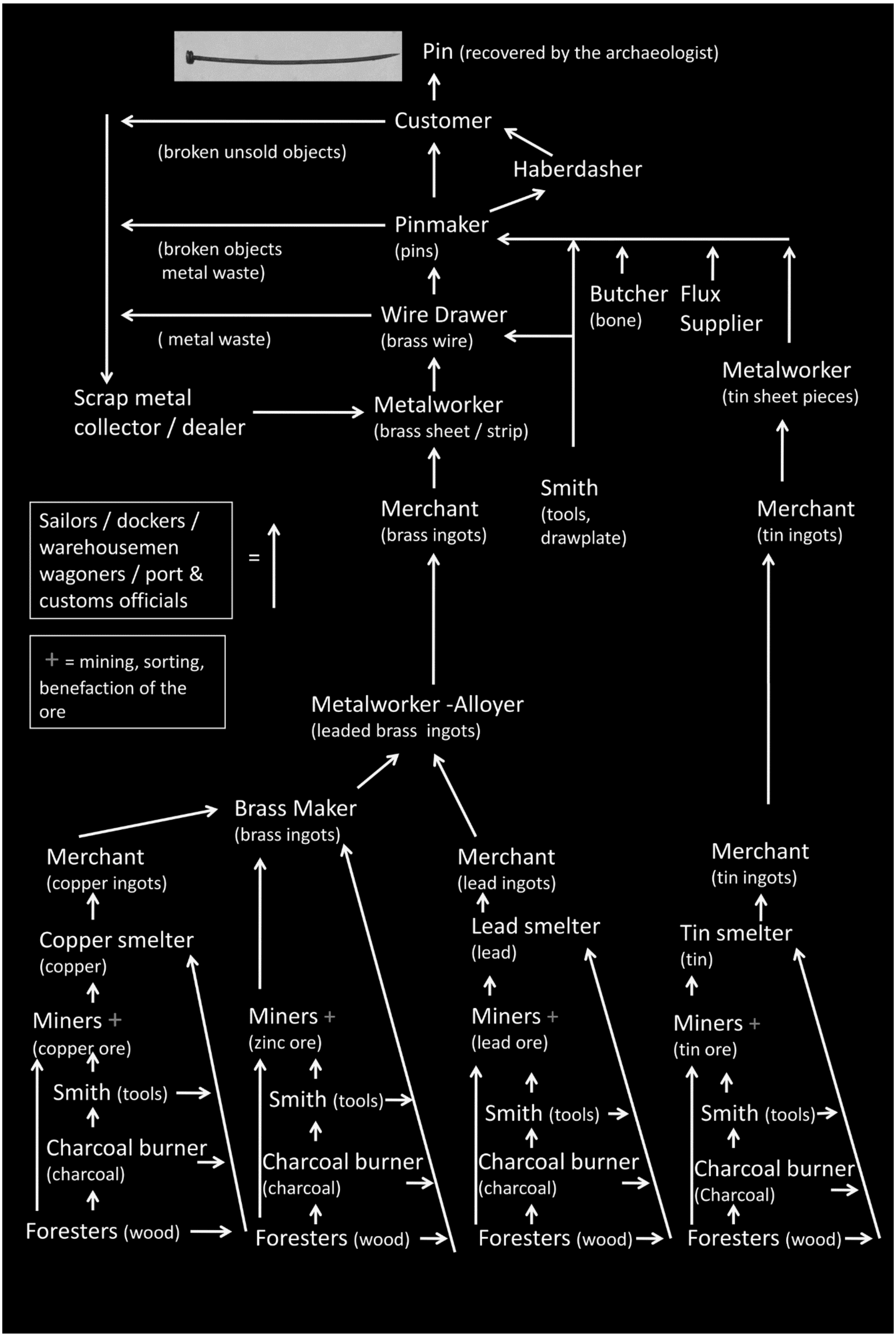

Figure 1.3: Steps in the manufacture of a medieval wound wire headed pin and their associated trades.

In recent years greater recognition has been given to the intangible values of objects and places, which were highlighted in *The Nara Document on Authenticity* (1994), *The Burra Charter* (1999), and the *UNESCO Convention for the Safeguarding of Intangible Heritage* (2003). Whilst there is already sensitivity around human remains (6.3) which are held to be worthy of particular respect by many religions and societies, it is often challenging to recognise such aspects in archaeological artefacts, especially when they are not associated with graves or other sacred site contexts. Research has noted that the damage inflicted at the end of an object's life is often intentional; it is ritually bent or broken (killed) so it is no longer usable in this world only in the afterlife. Such beliefs can be manifest even in small everyday objects - the bending of pennies thrown into water (wishing wells) or inserted into shrines or rocks indicates an important symbolic role for the object at the end of its life, its deformation being the only physical evidence for such beliefs. Evidence of use or ritual damage is often only revealed when the conservator uncovers it.

The value of fragments as a means of invoking the whole object has been highlighted by the work of Chapman (Chapman 2000, Chapman and Gaydarska 2007). The concept of enchainment – the part derived from and representing the whole is seen, from Neolithic pottery fragments to the fragments of the 'true cross'. Consequently, a fragment had use in and of itself and it may be inappropriate to unquestioningly re-join it to other fragments of the same vessel, as this obscures its history as a separate valued object. The value of fragments and damage should always be considered by conservators prior to reassembly or restoration (2.3), (3.1).

It is tempting in this digital world to see artefacts as no more than an image, a pixel thin representation, identified by typology to a particular time and culture. This fails to consider any other sense; its weight and feel; but above all the sense of awe when you handle an ancient artefact. There can be a failure to understand that objects in a museum are a bank of information, historic documents of the past there to provide answers to questions, both now and for all time. All the objects in these case studies provide new information about the past, even those which have been in collections for some time (3.2), (3.3), (3.5). It is arrogant to think that the digital image we take now is all we will ever need to know. If we had relied on such 'records' in the past, for anything older than the 10th century we would only have fragile pen and ink drawings which lacked perspective. Every few years we ask new questions of the past and only the original object has the information. DNA from ancient bones allows us to identify individuals, races, gender even the diseases which killed them. Organic residues trapped in the pottery sherds of long excavated archaeological sites can be analysed to provide information on the diet of ancient peoples.

Analysis

To aid the identification of materials of which the object is composed (including previous conservation materials) and the decay processes which afflict it, analysis is often undertaken. This may be as simple as testing for iron with a magnet, examination under UV light or x-radiography (4.3),(4.7) to the identification of corrosion products, pigments or coatings using X-ray Fluorescence systems (XRF) (Energy Dispersive (EDXRF), Wavelength Dispersive (WDXRF) or portable energy dispersive (pXRF) are most usually seen), X-ray Diffraction (XRD), Fourier Transform Infra-red Spectroscopy (FTIR) or Scanning Electron Microscopy (SEM) (often used with EDX – an energy dispersive X-ray fluorescence analytical system) (2.1), (4.1), (5.4). Throughout the latter half of the 20th century the cost of analytical equipment has meant that few conservation laboratories owned such systems, though most could secure access where essential (2.1). Given the limited number of materials used before the 19th century, and the high frequency of certain corrosion products, conservators frequently use their experience and visual observation to identify the object material types and assess whether they are stable. We rarely test these assumptions, but these human systems are not infallible (4.1), (4.2). Materials such as adhesives, coatings and consolidants are often ‘identified’ by their reaction to known organic solvents as well as their visual appearance and the nature of their use (2.3). Where analytical facilities are available and used, there are often not clear cut simple answers (4.4). A series of ‘cautions’ are normally practised when analysing and interpreting archaeological material.

- Due to the effects of corrosion and soil, the exterior surfaces of artefacts, especially metal artefacts, have only limited correspondence with the material of which the object was originally made (Caple 2000: 86). Though portable X-ray fluorescence systems (pXRF) are increasingly providing non-destructive elemental analysis at reasonable cost, surface analysis can be misleading. The preference for non-destructive analysis can become a meaningless tyranny, especially when sampling from damaged and decayed surfaces can be undetectable or easily restored (3.3). A professional judgement of whether the benefit in information justifies the damage to the object in removing a sample is always appropriate.

- There is a need to retain samples for re-analysis (4.5) and for ensuring that data from the initial analysis is preserved, e.g. through publishing (2.1). When a programme of thin section petrological analysis was undertaken on Neolithic stone axes across museums in Britain, the analysts were sometimes surprised to find that sections had been previously cut from the axes but the museum curators were often unaware that such work had been approved by their predecessors with presumably no returned sample and no report submitted (Shotton 1969: 572).

- What information is actually required and which analytical system will best provide that information? Every analytical system has strengths and weaknesses, these must be understood. The repeated analysis of a corroded bronze Ancient Egyptian statue between the 1940s and the present day at Harvard Art Museums identified various corrosion products leading to different interpretations of the cause of active decay and different treatment proposals at different dates. When seen together (Brewer et al 2017) the fact that a variety of instruments were used; XRD, FTIR and Raman, each with different sensitivities to different corrosion minerals may well account for the differing results. Although the presence of a specific mineral was clearly demonstrated by the analytical system in each case, it was the assumptions made in relating the mineral to a specific decay mechanism and treating that as ‘the’ explanation of the object decay which was problematic (4.1).

- It is important to be familiar with the technology present in the period and culture of the object being analysed. With archaeological material there are often only a limited range of possibilities (2.1). The limited pigments available to secular medieval wall paintings in Britain in the 13th century, meant that simple non-destructive EDXRF analysis could identify the red pigment used; ochres (iron oxide), minium (lead oxide) or cinnabar (mercury sulphide) (Caple 2007: 165-170). However, the detection of iron and lead, or iron, lead and mercury on some of the red painted wall plaster samples from Dryslwyn Castle showed the artists mixed pigments which emphasises the need to sample in multiple places; not all reds are the same.

- In the case of objects in museums, analysis can reveal a history of previously unrecorded conservation treatments which it is essential to understand and document before one can accurately determine the nature of the archaeological artefacts (5.4). These previous treatments greatly influence the conservation treatments which can now safely be carried out – as was seen with Cuthbert’s Coffin (Cronyn and Horie 1985).

- If objects are to be preserved it is essential to correctly identify the decay mechanism affecting them in order that an appropriate treatment can be devised (3.3), (3.4), (4.1), (4.2), (5.4).

A single analysis of the surface without background knowledge of the period and its technology, using only one analytical technique with which you are unfamiliar can lead to meaningless, even potentially misleading results. Multiple samples analysed from throughout the object by a range of techniques with standards and comparative material, interpreted by an analyst / archaeologist or conservator familiar with the material and technology of the period provides much more meaningful information. Details of the analytical system and its operating conditions should always be given, so that the effects / biases in the system, such as non detection, can be correctly interpreted[7]. However, unnecessary sampling and analysis can waste time and needlessly damage the object. The benefit of every analysis must justify the cost and risks to the object.

Cleaning

The key information on most objects is present at the surface; that 1-2mm thickness of the surface which bears all the traces of decoration, signs of wear, manufacturing marks and evidence of repair. This thin ephemeral layer is also the one which endures constant damage and loss from use, the burial environment, excavation, and handling. Consequently, considerable effort is needed to recover and preserve the valuable and fragile traces of evidence present at such surfaces and avoid cleaning them away with hasty or excessive treatments (2.1), (3.4).

Corrosion and decay are a one-way process and cannot normally be reversed. For most archaeologically derived metal and organic objects there is no expectation that cleaning will return them to their original ‘as new’ or ‘when last used’ state. When cleaning an object you are always creating a new state in which the object exists. This new state seeks to be informative, moving the object away from the ‘random’ effects of decay and corrosion, to something closer to its original form. In the case of corroded iron and copper alloy this often means cleaning to the “original surface” located within the thickness of the corrosion layer; not always easy to find and sometimes not present at all. But this potentially provides the closest approximation to the object’s correct size and shape and is likely to be the most informative surface. Though the shape at the end of an object’s working life can often be retrieved, the colour and surface texture has invariably been altered (4.7), (5.1). Where evidence is encountered in the cleaning process, such as mineral preserved organics, it is recorded and normally retained in situ whenever it is meaningful (Cronyn 1990, Fell et al 2006, English Heritage 2008). This is an important consideration for anyone cleaning archaeological ironwork even if none is found (4.7).

Cleaning can occasionally weaken an object, and since the corrosion or adhering material may be stronger than the artefacts remains, there is increasing risk that damage may be done to the original. Thus, in many instances the cleaning of an archaeological object stops when the risk of damage outweighs the desired results (2.1).

Many artefacts recovered from excavation are obscured by soil and decay products; their value lies in their accurate identification and their relationship to the rest of the archaeological site. A large number of common iron objects such as knives and horseshoes can usually be identified from x-radiographs, and thus only partial cleaning is required to confirm the identification (6.2) and recover key information such as cross sections of the knife blades. (Caple 2000: 170-174). However, since X-radiography never reveals all the information about an object and clearly identifiable objects are needed for display and teaching, complete cleaning of objects (4.7) especially decorated objects (4.6) often remains necessary.

Cleaning with hand tools is invariably slow, painstaking, time-consuming work. Chemical or electrolytic stripping of corroded metal is much faster but loses the information present in the corrosion crust. For finds such as coin hoards where large numbers of almost identical artefacts are recovered from the same archaeological context, conservators working in conjunction with numismatists may clean some by hand, but many more by appropriately controlled chemical stripping in order to identify all the coins. Ascertaining the earliest, latest, forgeries and where the coins come from (mint marks) is essential in order to correctly interpret the hoard (Goodburn-Brown and Jones 1998).

Where cleaning is lighter and more original surface remains a further consideration of how the object is read by the visiting public comes into play. The presence of soil promotes decay / corrosion and it obscures the surface of the object. Museums and the public also dislike the uncared for appearance of 'dirty' objects, so for all these reasons soil / soiling is normally removed. On porous surfaces it is often difficult to remove all the ingrained dirt; continued cleaning will reduce the visible dirt but will increase the risk of damage to the object, which is clearly inappropriate, as well as increasing the time and thus cost of the treatment. It has, however, also been noted that the public, now assailed with all manner of replicas and reproductions, do not always believe that a very clean, seemingly flawless object, is an ancient artefact. Their perception, based on real life, is that old things look dirty and damaged. In the fleeting time that any member of the public will look at an object, museums want them to read it correctly and understand that it is a genuine artefact. Therefore, some soiling giving an ancient, aged appearance is perhaps appropriate. This leads to the concept of a 'Goldilocks point', not too clean (so it is seen as 'real') and not too dirty (so it doesn't seem uncared for). Thus, the extent of what cleaning is appropriate varies with public perception, and it changes over time and in different parts of the world. It also varies with artefact type; dirt and damage is expected on archaeological objects, but not on fine art. Conservators, often working in collaboration with curators and archaeologists, carefully consider the extent of cleaning for each and every object (2.1), (2.3), (3.4), (5.6).

Recording and Drawing

Whilst it is normally considered appropriate to record an object before and after treatment, what is recorded often requires professional judgement. A single image rarely records all that an object is. Three-dimensional objects require all sides to be imaged for a complete and accurate record. A re-assembled object is both the complete object and an assembly of pieces, thus there is value in recording the parts of an object (sherds of pottery or glass) prior to re-assembly. The image of fragments allows future conservators to know about the size, number and location of the pieces of which an object is composed; this also aids identification of any areas of fill or restoration. Amending digital images to highlight areas of restoration is clearly another way of meeting this requirement. The final image remains important as a record of the state of the object at a specific date – when it leaves the conservation laboratory. All later changes to the object from the effects of storage, damage on loan, deteriorating conservation treatments etc. can be judged by comparison to that image.

Concern has been voiced over the levels of 'hands on' skills in young conservators, as universities and other training institutions provide only a limited time for developing skills and give limited academic credit for it (Ashley Smith 2016). An example of such a skill is drawing as the drawn image remains widely used in archaeology and is still employed in archaeological reports. Small, damaged, corroded archaeological objects often make poor photographic images as details of shape and decoration are lost amongst the damage and colour variations from corrosion. Similarly photographs of waterlogged leather and wood are also often dark and uninformative; it is difficult to pick out toolmarks, wood grain and other features on black, reflective, wet surfaces. . A drawing allows the illustrator to apply the appropriate emphasis on the principal elements of form and decoration which enable an object to be identified, and its date, culture and function recognised; often through comparison with other drawn images. The use of cross sections shows the three dimensional form effectively and accurately indicate hollow elements – often key to the interpretation of the object's function and manufacture.

Beyond the benefits of an informative image, drawing is also a very useful educational tool as it makes students look hard at an object, and make decisions about it; is that corrosion or a break and is part of the object missing? For all these reasons there is still a need for archaeological conservators, especially student conservators, to learn how draw objects and implement the associated conventions; high levels of skill can be achieved (4.5) (Figure 1.4). However, it is worth noting that in a busy, professional setting, it's not always possible to illustrate every object and a quick sketch is often sufficient for simple objects.

In archaeology, the high costs of drawing is leading to increasing selection over what is illustrated and what is not; and as the relative costs of digital imaging and drawing change it is probable that more digital and fewer drawn images will be used. Digital images have the advantage of full colour rendering, so are important for all painted, dyed and pigmented surfaces. They can also be manipulated to emphasise important features (Caple 2012: Illustrations 6-20). Techniques, such as raking light for emphasising worn decoration and faint scratches, have been used for many years and continue to be useful (4.6). Creating Reflectance Transformation Imaging (RTI) (Earl et. al.2010; Andrés and Pons 2013) and 3D images (constructed via photogrammetry or laser scanning (Kuzminsky and Gardiner 2012) allow objects to be recorded and seen in greater detail. The benefits of accurate 3D copies of objects, has long been appreciated. In previous years it was achieved through moulding and casting (2.2), though it posed greater risk of damage to the object than digital image capture. However, in every case the cost involved in obtaining an image must be measured against the additional information provided or additional access to a wider audience (6.4), in practice cheaper simpler 2D image forms are often used.

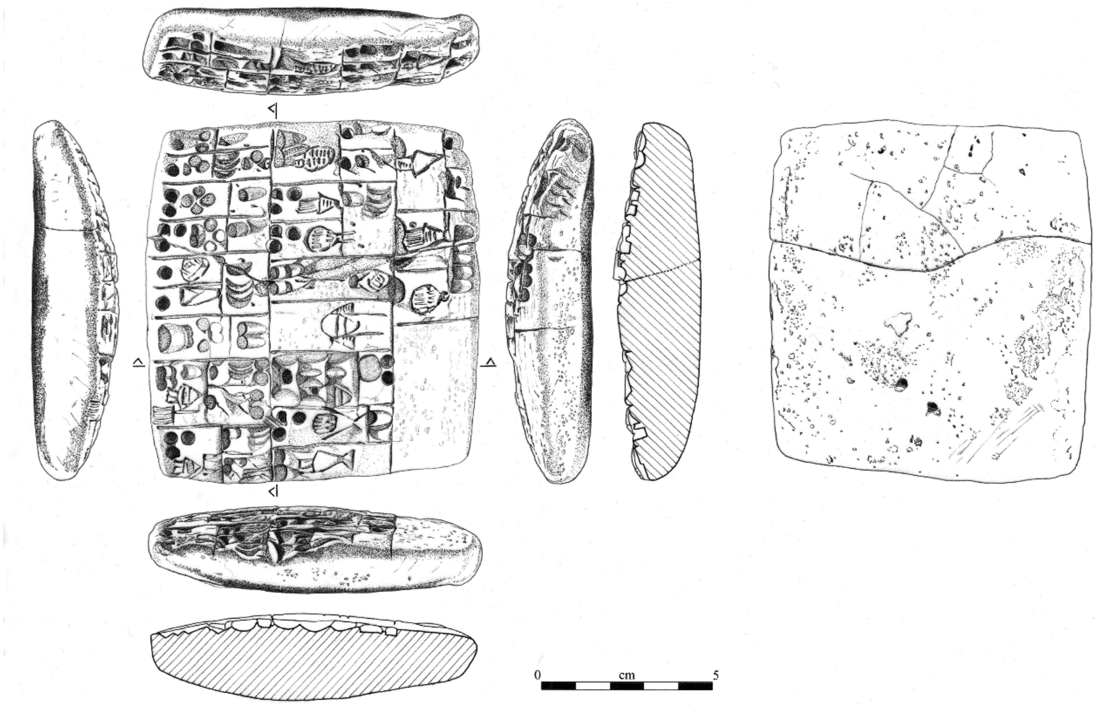

Figure 1.4 – Drawing of Cuneiform tablet by student conservator Maja Bolle (Bolle 2013)

Stabilisation

Freshly excavated archaeological artefacts can be chemically or physically unstable and making the object stable may typically involve removing unstable materials such as soluble salts (3.3), (4.6), adding stabilising chemicals (4.2) or a consolidant (5.1). However, stability and thus preservation is not an absolute state, it exists in reference to:

- The surrounding conditions. The object was likely at equilibrium within its burial conditions, following excavation it is necessary to stabilise the object with regard to museum conditions. In these circumstances interventive or preventive conservation can be seen as a continuum; you can manipulate one or the other or both to achieve stability. Interventive conservation has traditionally been used to make objects stable, only in rare cases, where funding is available, are unusual storage / display conditions created to maintain stability of the object 'as found', such as displaying Őtzi the iceman in refrigerated conditions (Őtzi 2020). This equates to storing biological specimens in jars of preserving liquid.
- Time. Immediate decay, such as the drying out, cracking, and warping of waterlogged wood, promotes a quick 'conservation' response. Slow long term degradation, such as the fading of coloured textiles can often go unnoticed and unaddressed.

In searching for a stabilisation solution one has to be wary of making interventive changes which are so substantial that you end up altering the very thing that you were trying to save; 'the Vietnam approach' (Sanchez and Allen 1990). Similarly, as materials age they change. Some of the conservation treatments previously believed to make objects stable, such as consolidating with soluble nylon, have proved damaging to the object in the longer term (Sease 1981). This led to the search for reversible treatments so we could undo them if the materials or methods proved unstable. This continues to be an important consideration in many treatments and a preference for using reversible consolidants or adhesives remains (2.3), (3.1). Equally important was the notion of minimal intervention since each treatment and reversal will take a toll on an object. Whilst it may be considered desirable to be minimally interventive, there is a need to accurately assess the risk of not intervening. In the case of wall paintings in the amphitheatre at Pompeii, uncovered in the 18th century; those left in situ have been lost due to the effects of frost and weathering, those removed and placed in the museum have survived (Cooley and Cooley 2002). Ultimately the desire for minimal intervention found expression in the preference for the control of the environment, which left the object as found (or as cleaned) and then maintained appropriate conditions (2.4), (3.4). However, whilst we have increasingly appreciated that the nature of the environment in which objects are displayed or stored determines if they are stable / unstable, we struggle with the time dimension; organisations come and go, policies and priorities change, as do managers. Slowly we are starting to appreciate how much of a challenge it is to maintain appropriate environments over long periods of time. This can lead us to consider / question the sustainability of some of our preventive conservation solutions.

In practice, our storage and display conditions are influenced by the desire to have easy access to objects and minimise initial costs. For example, storage of archaeological iron objects with a desiccant (conditioned silica gel) in semi-transparent re-sealable polythene boxes, which are permeable to water vapour, is frequently seen. Storage in metal tins or glass containers, which would be impermeable to water vapour and so could maintain low RH conditions for very long periods, is rarely seen. Choosing to store objects in conditions that allow swift access means we only rarely store at low temperatures or in environments where we control the gas levels such as anoxia. Although objects should be stabilised for the conditions which they can expect to face, these are rarely known; what is sustainable? For example, during a survey of the storage conditions for archaeological ironwork in the museums in the north east of England in 2006-7, it came as something of a surprise that more than 50% had no environmental control of their archaeological ironwork (Harder 2007). Issues of sustainability and resources come into focus when well-equipped excavations leave their excavated finds in poorly equipped museums, though this is a difficult issue to address without raising tensions between excavators and museums, between developers and local authorities, and even between nations.

Sustainability

The drive for long term sustainability of conserved artefacts has had two elements.

- Assessing the long term effectiveness of the stabilisation processes. Many of the objects found in museums received early stabilisation treatments, which are no longer considered effective and we find ourselves undoing past treatments and retreating objects (Pye 2001: 135), (2.3), (3.1), (5.2), (5.6), (6.1). Poor historic records mean that the hardest task is often to identify what has already been done to the object (3.4), (5.3), (5.4). Even when we have adequate treatment records, substantial studies are required to accurately assess the stability of interventive treatments carried out by previous generations e.g. (Ganiaris et. al. 1982; Paterakis and Hickey-Friedman 2011) or current practice (4.2). Such reassessments highlight the need to have accurate, detailed conservation records, additional records of factors concerning post interventive conservation treatment, such as storage conditions and packaging materials, which may well be crucial to long term stability, could usefully be kept[8].
- Managing the environment (movement, storage, display conditions) to minimise the risk to the artefact. The issue of managing risk to artefacts has most usually been considered in terms of transport and loans (6.1), but rarely extended to consider all aspects of on objects museum life. Key theoretical work in this area by Jonathan Ashley-Smith (1999) and Rob Waller (2003) recognised the benefit of considering collections rather than individual objects and in describing risk of damage in terms of object loss rates per year to facilitate comparison between different objects and risk types. An alternative to considering complete loss of the object is the idea of perceptible change. This has been broached in terms of the acceptability of the fading of colours for objects on display (Pretzel 2006).

As yet, few stabilisation treatments or storage conditions have been described in terms of their likelihood of achieving stability (Keene and Orton 1985; Keene 1994; Rimmer et al. 2013).

Restoration

The value which the public place on an object can change greatly through their knowledge of it and the empathy they feel for it. Crucially, they must recognise the object; understand what it is and how it functioned. A flat piece of shaped leather will mean little, but if that leather is stitched together to form a shoe it will be recognisable and thus have a display value. Additional information such as the fact that it's a child's shoe and retains evidence of wear demonstrating the child walked with a limp, may excite sympathy from a viewing public and make the object not just valued but memorable. However, in making the changes associated with reassembly, reshaping or restoring, the conservator is interpreting the evidence, making a judgement about how the past was, which is then inflicted on all future viewers of the object.

The re-assembly of broken fragments, a process often carried out unconsciously, can be beneficial for identifying the object, recording it through drawing or photography[9] and displaying its original form (2.3), (3.1), (4.4), 6.3). However, it may well be inappropriate if the vessel was deliberately broken (sacrificed / killed) as part of its use life. Such deliberate fragmentation should always be considered before re-assembly. 'Floating' pieces without an exact join or location, often previously incorporated, are usually no longer included in re-assembled vessels. Unless complete, the re-assembled forms are never as stable as separate bags of sherds and though satisfying a human need for 'everything in its right place' it is an indulgence. There should always be a good reason to spend precious time re-assembling an artefact.

In the 19th and early 20th century, whilst archaeology was still developing an awareness of what objects of the past actually looked like, bent and broken artefacts were routinely repaired and restored. However, after the reshaping of the Bush Barrow gold, questions were raised about the extent and necessity of reshaping (Caple 2000: 177-181), and there has been more concern to preserve the final form of the object. Objects such as the Ringlemere cup (Needham et. al. 2006), which may have been deliberately crushed, have been preserved in crumpled form and reshaped replicas made to show the original form. There is now consideration of these issues whenever reshaping takes places, however, it remains important to ensure that the objects stored and displayed in our museums have a meaningful form and not one which we know is the product of burial, excavation or storage (5.6), (6.2).

The restoration work of earlier generations was often generalised 'in the style of'; in recent decades there has been far greater concern for accuracy. Whilst the value of original material remains high, the value of restored material has fluctuated over the latter half of the 20th century; some objects have remained restored, others have been taken down some have been re-restored. Clear evidence of the original form is now required before restoration is considered appropriate. The extent to which the restored area mimics the colour, texture and decoration of the original varies between museums and can be dependant of the conservator's skill and ethical stance. In general there is far less emphasis on restoration with archaeological material than in other areas of conservation. Whilst there is general agreement that restoration should always be detectable; the extent of the effort required to detect such restoration work and who should be able to discern it, varies from museum to museum and conservator to conservator. The idea that restoration work is discernible by close inspection at a distance of 6 inches (20cms), though not as immediately apparent at distances of greater than 6 feet (2m) remains useful (3.1), (4.4), (6.4).

The further away in time and culture the object is from the present, the less certain we can be about its original appearance or function (3.2, 5.3). More recent objects with only slight damage are more likely to be accurately restored as there's certainty surrounding their original form and appearance. Such restoration is far less appropriate for highly damaged prehistoric artefacts. It is, however, also important to ensure the public are aware that the past was not filled with drab, broken, corroded, fragmentary artefacts such as we see today, but, whole, functional, complete objects often decorated in bright primary colours. Where physical restoration is too costly or would be too damaging to the original artefact a digital (2.1) or drawn reconstruction, or a replica, can usefully be created or commissioned.

Storage

The value of the objects in archaeological collections is high when there are good records to provide data on the context, date, culture and function, and whilst the objects remains in stable condition. As our knowledge grows about the instability of early museum storage materials; such as those that are emitting volatile organic compounds (VOCs), there is an increasing awareness that many objects bear the chemical and physical imprint of their storage. There is a need to avoid museum objects becoming merely biographers of the evolving nature of museum storage and display. Consequently the stability of earlier storage solutions is now being questioned and tested. In many cases the development of new materials / products[10], improvements in our ability to design and shape physical supports, appreciation of the risks in handling and moving objects, and awareness of the museum environment means that improvements in the storage for individual objects or whole collections can be identified and enacted (3.3), (5.2), (5.5), (5.6), (6.1).

Improving the supportive and protective nature of packaging around an object has the additional benefit that human beings read how things are presented and react accordingly. Knowing that a carefully packaged museum object will be perceived by future curators, archaeologists and conservators as having high value can be exploited by present day conservators to improve the care of their objects by creating supportive and protective packing (3.1), (4.4), (5.5), (5.6).

The rising cost of museum storage charges for archaeologists wishing to deposit material is causing archaeologists to become highly selective as they seek to reduce costs; discarding bone, unidentifiable ironwork and body sherds from pots, they frequently only retain identifiable metal artefacts and the rims of pottery vessels from selected contexts[11]. This leads to a bias in what is collected. In future our collections may say more about the financial restrictions and academic interests of the present day than the complete picture of the past. The prospect of reburial of museum or excavation artefacts collections in benign external conditions, as explored for underwater archaeological finds in the seabed at Marstrand Harbour, Sweden (Peacock et al 2008) remains an under researched and as yet a distant prospect.

Resources and Responsibilities

In many emergent nations, increasing numbers of archaeological excavations are being undertaken, new museums are being built and new heritage sites are being developed. These meet both the increasing demand for heritage tourism and the increasing enthusiasm from local residents for information about their own heritage. This allows local identity rooted in the past to be more clearly developed (and evidenced), a counterbalance to colonial histories, present political realities and mythical pasts. In such areas, conservation resources may be limited, consequently conservators, archaeologists and curators are often required to prioritise objects to be conserved, focussing on those with the highest archaeological and display value. In the UK at present (2020), after several years of cuts in public spending, many local authorities have closed museums and there are fewer conservators in post. However, there remains an appetite for exciting new displays of archaeological material. Consequently conservators, archaeologists and curators are also required to prioritise which objects are treated and to what extent. Many conservation projects have run into issues where limited time and resources curtailed analysis, research, cleaning, stabilisation and restoration work (4.1), (4.2), (5.1), (5.4), (6.3).

Conservators often work with curators, volunteers and other conservators as part of teams in museums. When dealing with conserving large, multi-media artefacts or undertaking re-storage or condition surveys of collections, such teams are essential (5.5). Such projects invariably require planning and organisation (6.1), where attributes such as good communication and clearly identified aims and objectives are required.

Technical and scientific developments have not only increased the capacity to stabilise archaeological objects but raised expectations. Media coverage often emphasises the achievement of the cleaned object, the impressive nature of the restored artefact and the crucial information recovered, but rarely refers to the resources required to achieve such results. This can provide the conservator with a problem of meeting or managing the unrealistically high public and political expectations with limited resources. In particular there is a failure by managers, trustees or the public to appreciate the cost of facilities used for long term storage. To increase awareness in both professional colleagues as well as the public over conservation issues, costs incurred, the need for higher levels of resources, and to find sustainable solutions, conservators increasingly need to engage in education and advocacy work (Jones and Holden 2008; Pye 2001: 136; Williams 2013). Many artefact research and conservation projects now lead to the creation of lectures, web sites, blogs and educational hands on sessions with children and adults (Bankhead n.d.; Garlick n.d.). Such outputs are increasingly part of the archaeological conservator’s job which could usefully be added to Figure 1.2.

Conclusion

An archaeological artefact can be considered a reluctant witness to the past. Through analysis, examination and research, the archaeological conservator extracts elements of the truth; the object's earlier form, what it is made of, its role in the past and details of what afflicts it now. Crucially, context information comes from the archaeologist and by researching comparative examples the artefact's (witness's) testimony can be tied to a specific time and place in the past. As the dirt and decay is (where appropriate) stripped away more evidence is unearthed and recorded. Finally, as all the falsehoods wrought by time are removed, the most useful truth which can be shown (without damaging or removing further evidence) is revealed. Care is taken not to bias through restoration what is then presented for public scrutiny. The artefact is subsequently treated in a sustainable way to preserve it in a suitably benign environment so it will last, unaltered, until examined again, as the artefact (witness) may have more to say when new questions are asked.

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End Notes

[1] The terms artefact and object are used interchangeably throughout this book.

[2] Most artefacts are identified by comparative analogy with objects from known dates and cultures which have been built up in museum collections and archaeological publications. The change in shape and decoration of artefacts has evolved over time in response to wider social change (fashion, technology, belief) as demonstrated by James Deetz (1977) in his study of New England gravestones. Throughout the archaeological process the simplest explanation which accounts for all the observed evidence, i.e. Occam's razor is always used. Where relevant, radiocarbon dating, dated items such as coins and inscriptions as well as correspondence with historical events also informs the process.

[3] Present day ethical standards in conservation are outlined by professional conservation and museum organisations: ICOM-CC (1984 definitions - http://www.icom-cc.org/47/about/definition-of-profession-1984/#.Xj7gZW52uM8)
ICON (Code of Conduct) https://icon.org.uk/system/files/documents/icon_code_of_conduct.pdf
ICON (Professional Standards) https://icon.org.uk/system/files/documents/professional-standards-2016.pdf
AIC (Code of Ethics) https://www.culturalheritage.org/about-conservation/code-of-ethics

[4] Different organisations have adopted different terms for groupings of values. English Heritage / Historic England currently (2019) talk in terms of site or artefacts having:
Evidential value: the potential of a place to yield evidence about past human activity.

Historical value: the ways in which past people, events and aspects of life can be connected through a place to the present - it tends to be illustrative or associative.

Aesthetic value: the ways in which people draw sensory and intellectual stimulation from a place.

Communal value: the meanings of a place for the people who relate to it, or for whom it figures in their collective experience or memory.

[5] In 1989 English Heritage created a formal 'management of archaeological projects' process (MAP), revised by 1991 as MAP2, which required a formal assessment phase after the excavation process was complete, that considered the post excavation work, looking at the value it brought and selecting whether to proceed with it as a whole or only proceed with the parts which delivered high value information, effectively cost vs. benefit analysis. This has now been replaced by 'Management of Research Projects in the Historic Environment' MoRPHE (Historic England 2015), which applies the same cost benefit ideas to all heritage projects. These, or equivalent processes, are widely practised in commercial archaeology.

[6] Metal detecting is legal in England, Wales and Northern Ireland with the landowner's permission, though not on Scheduled Ancient Monuments. Detectorists must declare finds of gold and silver, groups of coins over 300 years old and prehistoric metal assemblages as treasure (Treasure Act 1996). They are encouraged to report other finds through the Portable Antiquities Scheme (https://finds.org.uk/) Finds Liaison Officers. Many detectorists clean, research and identify their finds as part of their hobby using online guidance (Jones et. al. 2005).

[7] In the following case studies (chapters 2.1-6.4), unless otherwise stated, the EDXRF, pXRF, SEM and FTIR analytical equipment used was based in the Materials Analysis Laboratory of the Dept of Archaeology, Durham University. Details of the system are:

pXRF = *Brucker Tracer 5i* with a rhodium anode operated at 50kv in an air path with an 8mm diameter beam spot.

EDXRF = *Oxford Instruments ED 2000* with a silver anode, operated at 35kV in an air path, with a 3-5mm diameter beam spot.

SEM = *Hitachi TM3000* Scanning Electron Microscope, with *Oxford Instruments SWIFT EDX microanalysis* system

FTIR = *Perkin Elmer Spectrum Two* FTIR System, utilising a diamond attenuated total reflectance objective.

[8] The move from paper to digital records over the last 30 years has resulted in the need to digitise and transfer paper conservation records onto interogatable digital databases. This has still to happen or be completed for many institutions. The closure of conservation laboratories and museums makes access to their conservation records even more difficult.

[9] Objects re-assembled for identification and recording can always be taken down to facilitate safer storage which takes less space.

[10] Materials such as: Plastazote – a nitrogen blown closed cell polyethylene foam also known as Ethafoam, Correx – a twin walled fluted polypropylene sheet, Acid free boards, papers and tissue, as well as many other storage materials which have been subjected to Oddy tests to demonstrate their long term stability, are widely available and used in museums.

[11] Museums which accept archaeological material for archive issue detailed and proscriptive requirements and normally charge per box of finds deposited. A typical example is Lincolnshire County Council – The Collection ARCHAEOLOGICAL ARCHIVES DEPOSITION GUIDELINES 2012
https://www.thecollectionmuseum.com/assets/downloads/AADG_v3a_June_2012.pdf.
Those museums in the UK which accept archaeological archives are indicated on an interactive map supported by the Archaeology Data Service: http://archaeologydataservice.ac.uk/archives/view/sma_map/map.cfm.