Scottish Transport & Industry Collections Knowledge network

INDUSTRIAL MUSEUMS Scotland

2014

The Collection, Curatorship and Conservation of Large Objects

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IHCLtd

9/11/2014

Museums Galleries Scotland
Supporting Scotland's Museums

Contents

1.0 Introduction

This paper attempts to cover in the briefest form what is a large and disparate subject. However, it is hoped that it can stimulate a new confidence among museum staff and collectors in dealing with their large object collections; both on display and (often) in storage. Importantly, conservation work should not be avoided through lack of knowledge and it is hoped that this paper can go some way in remedying that.

"Large Objects" in this context means large industrially produced objects (including road, rail air and marine transport, working or static, machine tools, machinery, prime movers, indeed parts often integral to buildings themselves such as boilers, pumps lifts and cranes) present significant challenges for the heritage sector, whether in recognised museums or private collections. The primary issues with such objects revolve around **conservation**, **interpretation**, and **authenticity** but all of these pivot around the issue of **sustainability.**

"Sustainability" is an illusive term with many guises. It can mean the long term prospects and viability for the object itself, the cost of initial and ongoing conservation and, importantly, the cost of creating and maintaining the necessary environment within which it is kept – if such action is indeed possible. Driving forces can be costs, and importance and they can be cultural or even political or simply a hard choice driven by budgets.

There is no doubt that sustaining industrial collections is challenging.

Decision making in large object ~~c~~ollections has often revolved around the tension between using it and (possibly) losing it, 'Using' it to "self maintain", preserving it in a static condition, or storing it and maybe seeing it decay through neglect, or lack of funds.

Another challenge can be **authenticity**. This can be a subjective decision, based on a collection theme, volunteer pressure, or the urgent requirements of the object itself. At what point does an object lose its authenticity? At which point in its working life is it preserved? How many replacement parts, panels or new paint jobs does it take to reduce an object to a construct? At what point do curatorial and conservation staff have to compromise to save or use the object?

Some iconic railway locomotives have had so many parts changed through their life and numerous conservations that only the "spirit" remains; albeit in solid metal. This is not a criticism as this can be right thing to do in certain circumstances.

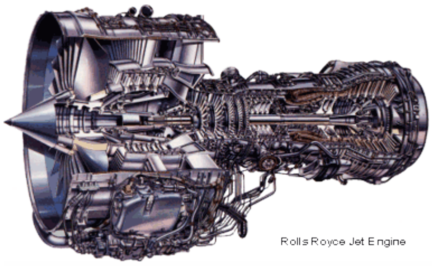
This short paper examines these types of challenges and explores ways that will allow the development of a sustainable approach to large industrial object conservation in museums and heritage collections.

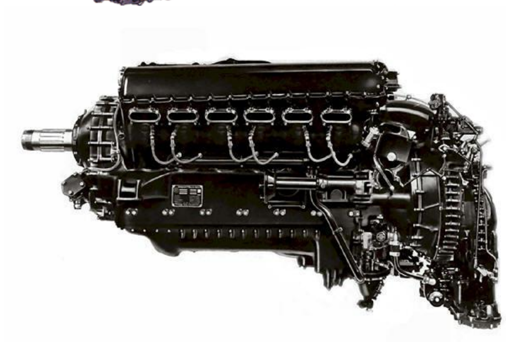
The conservation of large industrial objects is much akin to the engineering skills required to care for such objects during their working life in the context of their time. The objects are valuable "assets" in each circumstance, but for different reasons.

If we think of the approach required to maintain, say a modern jet aircraft engine, where high-level skills, correct tooling and meticulous record keeping is paramount, the conservation of say a WW2 Spitfire engine should be approached in a similar way albeit for different reasons and with different criteria.

The "value" of each is significant. The first has financial or **instrumental value**, due to its replacement cost and the obvious implications of failure. The second has an historic or **intrinsic value** due to its rarity and strong social history connections - but may have no real monetary value. The approach is therefore different, in that the modern aircraft engine will have worn or faulty parts replaced without question; its ongoing performance and safety being paramount.

The conserved object would have the worn parts carefully conserved, as they are part of its history. In each case the approach will be meticulous, but for different reasons. However this can become more complex if the historic engine is to take an aircraft into flight; where a possible dichotomy between safety and conservation may arise. This dichotomy is not unusual, albeit normally for less dramatic reasons.





Rolls Royce turbine and Merlin engine fitted to the Spitfire

Conversely the approach is similar in that high skill levels, good recording and a forensic, thoughtful approach is required.

This paper attempts to provide some very practical guidance for museum professionals, volunteers and private collectors in good conservation practices, as applied to large industrial objects.

2.0 Collecting large industrial objects

Acquisition

"**Acquisition"** means the legal transfer of ownership of an object(s) "**Acquire"** has a corresponding meaning in this context.

First, It is important that a **Collections Development Policy** is in place This ensures that clear decisions can be made based on previously agreed objective criteria. This applies to small collectors as well as museums and prevents being overwhelmed by loosely connected objects and loss of invaluable storage or exhibition space. The Museums Association Code of Ethics [extract] is quoted below:

Collect according to detailed, published policies that state clearly what, how and why the museum collects. Frame the acquisition policy in the light of the museum's stated mission. Specify criteria for future acquisitions that include topics, time periods and geographical areas. Collect only within acquisition policies, except in exceptional circumstances.

A collections development policy helps to shape the museum's collections by guiding acquisition and disposal. The policy is led by the museum's statement of purpose. It describes the history of the collections and the collections as they are now, as well as giving an overview on the priorities for development. The policy references the commitment from the museum to ensure and maintain the legal and ethical development of the collections.

http://www.museumsassociation.org/download?id=11114

The **development of collections** will be guided by:

- A museum's constitution and statement of purpose
- The legal and ethical basis on which the collections are held
- The public benefit derived from the use and management of the collections
- The resources required to appropriately manage and care for them
- The collections held by other museums and organisations collecting in the same or related areas and their purpose

http://www.artscouncil.org.uk/media/uploads/FINAL_201406_GuidanceSection2.pdf

Acquire an item only after thorough consideration of its long-term value and how it will be used.

Accept an item only if the museum can provide adequate, continuing long-term care for the item and public access to it, without compromising standards of care and access relating to the existing collections.

Examine carefully the implications of, and record the reasons for, accepting items that will not be immediately pending a final decision to accession into the accessioned into the permanent collection. (Acceptable reasons may include loan, demonstration, handling, testing or retention permanent collection.)

Museums Association [Code of Ethics; extract 5.1 to 5.4]

A further challenge in the acquisition of large industrial objects [see Figure xx] is very often their size and weight. This has implications for relocating, access to buildings, lifting, floor loading / protection and the ease of re-siting them within the collection. The implications are mainly direct and indirect costs and logistics, so detailed preplanning is essential – even before a decision is made to acquire.

There must be a procedure to follow when items are offered or considered for the museum's collection. It is important to gather as much information as possible from the potential donor in particular or other sources that may be available. The **acquisition committee** must assess the item according to the **collection policy** and make the decision.

WW1 German Howitzer built into a wall, Cumbrae

First Documentation

When an item is offered to the collection, this first point of contact with a potential donor is a very important time. Follow a procedure similar to that below:

In all accredited museums the standard form of receipt is a **Collections Trust Entry Form**. This is the recognised name for the receipt, which all will understand and should be encouraged to use.

Issue the donor with a numbered **receipt**, on which the following details should be recorded:

- Object description
- Donor's name, address, phone number and date
- Record as much information about the item as possible. This is when the item's provenance is recorded
- A clear statement to the effect that the item will be accorded the same degree of care as the museum's collection, but that the item has to be assessed by the museum committee to decide whether or not it is an appropriate acquisition into the collection.
- Signature of person on duty
- **Tag** the object with the receipt number.
- Refer the offered item to the **acquisitions committee**, who will assess according to the museum's collection policy
- If the item is not accepted, return it to the owner and record the decision on the museum's receipt copy
- For an item that is accepted a **Deed of Gift** form may be completed and signed by the donor. This is a formal process whereby ownership of the item is transferred from the donor to the museum. However it is not necessarily standard practise in all museums
- Send the donor a thank-you letter and file

Once this process is completed, the object should be placed in a safe and suitable environment for assessment. This should be done as soon as possible. The process of assessment is covered below, but documentation is important at this and at all subsequent stages See: http://www.collectionstrust.org.uk/standards-toolkit/collecting-information-about-objects

3.0 Research and other Curatorial documentation

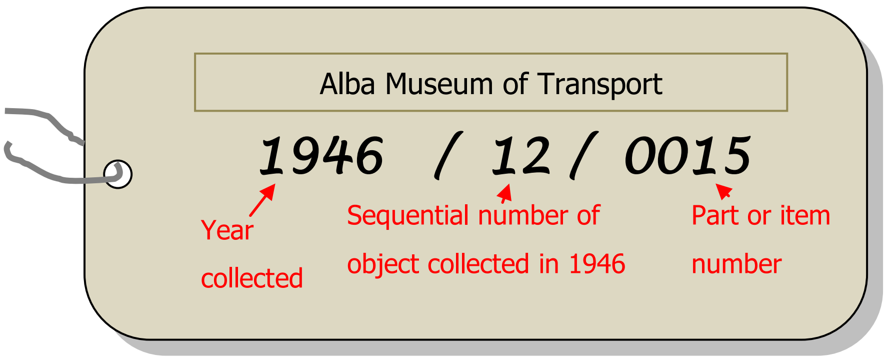
Bearing in mind the criteria set out in 2.0 above, it is assumed that a certain amount of knowledge has already been gathered about the object before it is acquired – or where that is not possible or less relevant, about the type of object. For example, a steam hammer may be collected because it came from a local maker or defunct local manufacturer – or it may be collected to generally illustrate heavy metal working. In either case as much information as possible must be gathered about *the* specific object, although the end focus may be slightly different. For example, the **social history** of the object may be very relevant in a local context.

Enough research should be carried out to justify the acquisition and that should be built upon once it is acquired.

Accessioning

Accessioning is the formal process of accepting **acquired** items into the permanent collection. The Object and its record is given an **accession number** which is a unique identifier; such as: The year / the sequence number for objects acquired that year / the item number of the group acquired from the donor, if more than one. So: **2000/27/2** would be the 27th object acquired in the year 2000 and the second of two [or more] objects donated as a group. If the object is dismantled, as is often the case with large industrial objects, the third number would refer to a specific dismantled part.

The object should then be tagged with the number and the receipt number removed. A permanent non ferrous unbreakable tag should be stamped with the accession number and soft-wired (again, non ferrous) to the object. Paper tags are unsuitable for industrial objects outside or indeed in store, although Tyvek tags are durable enough for the latter The normal practice is to number the object as follows:



Research and investigation

Research into the history of an object, its development history and that of where it was used or even who used it, helps to place it in its historic context and allows better technical and social interpretation. From a conservation viewpoint, the materials from which the object is made up, including those out of sight, should be listed in the object record. Internal deterioration of industrial objects is a significant issue and conservators should become fully aware of internal spaces and materials. This is a matter of some importance as an object earmarked for static display may some day be reassigned as a working object. Even if this doesn’t happen, internal deterioration will be unknown, which should not be the case for any object within a collection.

Assessment

Where possible it is desirable to carry out a detailed assessment soon after the object is collected. This will ensure that any risks and storage requirements are met and the object file is as up to date as possible. The assessment should be mindful of:

- Where the object was before acquisition?
- Was it stored or worked outside?
- Was it kept in a polluted environment?
- Does it contain oil, water, chemicals or any other hazardous substance?
- Might there be asbestos present?
- Are there loose flakes of possibly lead-based paints?
- What condition is it in?
- Is it surface rusted or heavily corroded?
- Are parts loose or fallen off?
- Can a cover(s) be removed to investigate internal condition?
- If it has moving parts, can it be ‘turned over’ or otherwise moved?
- Does the storage environments suit some parts but is detrimental to others?

The assessment should be accompanied by detailed and dated photographs giving an overall picture as well as focusing on problematic details.

Immediate Action

Hazards

This needs to be weighed up and considered with the storage or exhibiting environment in mind. However any hazards must be dealt with. Even in the short term. Where asbestos is present or suspected to be present it must be assessed by experts then if tests are positive, temporary sealing up of the specific part carried out and labelled by them. A report will be issued by the specialist, which must be placed on the object file and the general museum Risk Register if there is one.

The object should not be covered or sealed in its entirety – only at the points where a risk is present.

A plan should be made at this time for asbestos or other contaminant removal to a set timescale where possible. It is worth considering an "asbestos free" policy for the museum or collection. While this can be expensive, it is a responsible approach for future generations. Many museums have objects with asbestos present of which they are either unaware or unable to deal with.

Old electrical equipment seems innocuous but should be given particular attention. Oil filled switchgear or transformers pre 1970s contain oils which can have high levels of carcinogenic Polychlorinated Biphenyls, (PCBs) which must be drained and disposed of by a specialist. Such equipment can also contain mercury and asbestos.

Other issues

If the storage environment is poor; i.e. high RH or temperature fluctuations, the object should be placed on timber bearers or pallets on a dry or sheeted floor. Any covers that may allow condensation to dissipate should be removed or (better) backed off and spacers inserted.

Objects should not be sheeted in polythene or other impervious material other than to protect them from a leaking roof. If this is the case it is best to form a tent with the bottom left open to allow air circulation. Longer term dust covers must be breathable.

Drain off dirty oils such as engine oil and flush through where possible. Replace with fresh oil. Where the machine is not to be run, use a "stick" hypoid type oil but remember to record which oil is used in the object file.

Trapped rain water or other fluids should be drained off and the containment space dried and aired. If there is a risk of condensation, ensure the space can 'breathe.'

Use an automotive cavity wax if the storage environment fluctuates in temperature and RH. Remember, larger iron masses heat up and cool down more slowly than their surroundings so condensation is likely.

Assessment has one key objective. That is **getting to know the object intimately**; both on the surface and internally. Ideally there should be no gap in the knowledge of the object's condition. This does not necessarily mean that the operation of the object is clearly understood – that's a different range of knowledge and although it is desirable in the longer term, it is not necessary in immediately caring for it.

4.0 Storage and Environmental Control

Theoretically museums open to the public are often less ideal environments than good museum stores. Museums have to be heated to make the visitor's stay more comfortable and a wide range of artefacts require different **relative humidity (RH**) levels. Visitors give off significant amounts of moisture, both from their bodies and clothing on a wet day. Many systems may struggle to cope with the rise in RH levels. Most museums compromise by trying to maintain a constant temperature / RH. For mixed collections, a non-fluctuating relative humidity above 25% and below 65% is recommended. Many museums have set their relative humidity at 45% and gallery temperatures between 18 and 20 degrees Celsius. Lowering the temperature greatly increases the longevity of collections but is hard on the visitor.

Storage, on the face of it can be more effectively controlled, with few challenges from wet visitors and opening doors – and indeed less need to have cosy temperatures. However in reality many compromises have to be made away from the interface with the public due to lack of funding and a shortage of suitable buildings locally.

Large industrial objects, by their very nature, are challenging to store. They can often be disassembled and consist of a range of materials from iron through to timber, canvas, rope and other organic materials. Each has its own environmental requirements of temperature and humidity (RH) but in almost all cases, a compromise has to be reached. However that compromise must be made in the most informed way possible. Many museum stores are basically industrial buildings; hopefully dry and sometimes heated and / or RH controlled. They may be visited only periodically and rarely are remote **building management systems (BMS)** in place.

The control of museum and storage environments is a science within itself and is too complex to discuss in this brief text. It is also academic to many museums who struggle for suitable space and the costs involved in providing even the most basic of controls. Those institutions that are fortunate enough to have new or updated premises will hopefully have this issue under control. For the majority, some simple precautions will have to serve as a compromise. **What is important in all cases is being aware of what *is* happening within the space in question.**

Taking poorly informed measures can do more damage than none at, especially where ‘dry’ (hygroscopic) organic materials are concerned. Industrial objects may have more of these materials than is immediately apparent.

Example:

An early steam engine is kept dismantled in store for many years, awaiting the appropriate building and initiative to erect it as an exhibit. The store is a conventional, heated industrial unit. The engine is stored in numerous boxes and sacks with large iron parts stored on the floor on timber bearers. The massive wooden rocking beam and spring beams are stacked on bearers.

The engine’s working parts consist of jacketed cylinders and valve chests, bearings and valves, packing glands and piston rods. All of these iron parts and in particularly, the enclosures therein, must be kept at the lowest humidity practicable but the timber will prefer a higher level of RH. In both cases, fluctuating humidity and temperature is undesirable. For the iron parts – which will warm and cool more slowly than the surrounding changing temperature and RH levels – the risk of internal condensation is the greatest, where gland packing (probably hemp rope) has been left in place, it forms a reservoir for condensing and evaporating moisture.

In practical terms the iron is normally less at risk than the timber. The enclosed parts should be allowed to ‘breath’ and, if possible, covers removed with dirt and other organic materials and stored separately. The bare iron surfaces can then be treated with a microcrystalline wax or indeed something less sophisticated. (There are many high quality / lower cost non-setting cavity treatments available, normally used by the automotive or aerospace industries.) These can easily be removed with a suitable solvent.

Timber is another matter. It is often assumed that the least one can do is keep a building steadily warm. However dehumidification is a better method for RH control in store rooms, particularly those of small volume and with a small natural air exchange rate. Dehumidification also results in a lower average temperature, which is good for the collection. In this way the humidity level can be set to suit the organic materials, since the ferrous objects can be individually protected. However timber has an ideal RH, depending on its genus, age and condition. In time, the RH of the building and the timber will reach equilibrium so this has to be considered when setting the building RH.

Timber connected to metals or metals stored in timber boxes can have their own problems. Certain timbers produce acetic acid – oak is well known for it – which corrodes most metals. For example lead converts to lead carbonate when exposed to acetic acid. Timber boxes containing metal items should be ventilated or open and metal connections through timber should be removed where possible in storage. See: *V&A Conservation Journal July 1992 Issue 04*

There is much more that can be said on this subject, as no two stores or control systems will behave in the same way. If a building suffers a flood or a leaking roof over a timber component, it is safe to assume that the wood will absorb much more quickly than it will de-absorb. So raising the temperature to 'dry' the wood will increase the RH in the store. If the control system is designed to respond to rising RH by heating, the building may enter a 'runaway heating' situation.

For practical purposes it is always worthwhile testing the actual object with a % humidity meter and dehumidifying the space slowly to protect the surrounding iron or steel parts stored nearby.

Where iron and timber are fixed together there is a relationship which must be monitored. The giving up of moisture from the wood may well exacerbate local corrosion in the iron component. Indeed in some timbers, such as oak, the release of tannic and acetic acid in that moisture will accelerate the effect. This will also have an effect on lead or the lead content of bearings, etc. As with all things, a practical compromise has to be reached; the most valuable asset being an understanding of what is happening.

If RH control by heating is preferred, there are several ways of preventing 'runaway heating.' The feedback loop, in which the RH sensor relays ambiguous information to the control electronics, cannot be used. The temperature can be adjusted according to the time of year, to hold the temperature about 5C above the expected temperature, taken from averages over many years. The same average excess temperature can be achieved by heating with constant energy, after establishing by trial and error how many watts are needed. If the building is well insulated, well sealed and voluminous, with a very slow response to changes in the outdoor temperature and humidity, the problem can be avoided by installing a very low powered heating system, so that the temperature can only rise very slowly, ensuring that even a slow air exchange is enough to prevent a rise in RH.

The buffering effect of walls and floors have to be considered. Plastic painted walls and floors will increase the effect, thus slowing down swings in temperature and RH.

Long term storage

Again the qualities of the storage, along with the vulnerability of the object, are key factors in preparing for long term storage.

Storage outside is to be avoided where at all possible as any ferrous object will deteriorate at an accelerated rate when exposed to extremes of temperature and wetting. Sunlight can also take its toll, affecting plastics, paint, leather and other organic materials. Make no mistake - outside storage will cause damage.

Valuable metals, such as bronze bearings are also at risk from theft and are very expensive to replace, in monetary terms.

Environmentally controlled storage is ideal and, as long as the previously discussed criteria are observed, large ferrous objects can be stored indefinitely with an inspection regime established. Leaks from roofs, however small, can do incredible damage; for example over a packing case or bare iron surfaces. Objects must be moved and dealt with and the leak fixed.

Items should be stored on softwood timber bearers [avoid oak], without stacking and with good air circulation Permeable dust sheets can save much cleaning later. Polythene sheet must be used judiciously and always left open at the bottom to prevent condensation.

Clear labelling (not on paper) is essential with a record kept of the object's location within the store.

5.0 Conservation Practice; the ethos

Good practice in any field must be constantly aspired to. High standards of conservation must be the norm with anything that might compromise that being the subject of discussion, agreement and record. There are many variations of an appropriate Ethos Statement and each museum, collection and the professionals involved should have one. It can be very simple and backed up with more detail. Volunteers and contractors should read and "buy into" the ethos statement.

Here is one that suits from the Manual of Curatorship:

"The approach for the care of a large engineered object shall always be from a long-term conservation view-point. This must be a prerequisite for every action considered, planned or taken."

Manual of Curatorship

The following is a distillation of guidance points that apply to large objects, followed by a discussion of these points:

- The conservation works shall be carried out with the longest possible view in mind.
- No work shall be carried out that risks or loses existing fabric or parts.
- No work shall be carried out to existing fabric that cannot be reversed at a future date.
- All work must be carried out using the best traditional* engineering practices, which are closely akin to good conservation practices.
- However good conservation practices must take precedence at all times.
- All work shall be carried out using the tools and techniques appropriate to the time the object was made. Any deviation from this approach must be discussed and agreed by the curatorial staff.
- The historic object must only be worked upon after a full **Conservation Plan** is written and agreed. Those carrying out the work shall be fully trained and pre-skilled in good engineering and conservation practices.

*It is essential to adopt the correct approach to working on a conserved object. The skills required are very similar to that demanded of a "traditional" craftsperson. The use of the word "traditional" is meant to convey pride in the work and a sense of responsibility for the objects in their care.

This approach is closely related to good conservation practice. Good conservation practice means that the priority must focus on the object itself, and its preservation outweighs all other needs. "All other needs" may be modification for a temporary purpose or exhibition, a loan or where conversion to operating mode is considered.

Good conservation practice requires that an object, and the materials it is made from, must be preserved and maintained as far as possible in the form in which it was adopted. The debate goes on regarding whether or not an object should be conserved to its original condition. However the consensus at the time of writing is that an object be preserved, stabilised, or returned to the condition in which it functioned during the greater or most significant part of its useful life when it was being cared for and maintained by knowledgeable, responsible people as a valued asset.

It is important that the **terminology of conservation** is understood:

Conservation: The conservation of an object means that it will be treated in a manner that arrests or limits as far as possible further decay or risk and, to that end, good conservation practice will be applied. This may mean that very little is done and that only the environment is secured to ensure risk will be reduced. However, in many cases this is not possible. However "conservation" can include treatments and more intrusive work; albeit that minimum intervention is always the prerequisite.

Here is where it can become more complicated: " Minimum intervention" means in relation to the fabric of the object but does not preclude what may be significant dismantling in the way it was assembled; or "reverse engineering." A good example is the Tower of Pisa. Its increasing "lean" was corrected by a massive engineering project which undermined it, added a foundation and gradually rotated that foundation.

This was minimum intervention. Major intervention would have been taking down and rebuilding the tower.

Restoration: This term is ambiguous and is rightly treated with some caution by professional conservators. In some cases restoration may mean that constituent parts are repaired in line with best practice or even replicated. In the case of ironwork the preservation of the original fabric must be considered the norm.

Replication: The replication of missing components is often seen as necessary for better interpretation, completeness in the case of ornamental structures or if the object has to function. Replications should be carried out as honestly as possible using the techniques appropriate for the date of the object.

Recording of the object is of crucial importance in this. Photography or even 3D laser scanning is of significant benefit with accuracy to less than 3mm. Coupled with high quality digital photography rendering, this gives an unrivalled recording and management tool for the project. It also offers educational and interpretative potential. Drawing and measurement is also a valuable tool. A combination of all three works well.

Some general guidelines:

- Replacement castings or machined parts can only be considered where the original is missing or in danger of imminent failure. (this also applies to timber parts) This must only be considered if the original cannot be recovered.
- Any broken part must not be discarded but where possible, repaired or joined to a new part to make up the whole.
- Any new part must be clearly identified (date stamped) and recorded.

In practical terms this means:

- That the object is worked upon in the most sensitive way possible by using appropriate tools and skills.
- That the object is protectively treated to suit its environment for the longest term possible, using proven techniques and materials.
- That the long-term survival of the object must be considered in balance and ensured where attrition through operating will significantly compromise it.
- That unavoidable replacements are re-made in the same manner, marked with the current date and the work recorded.
- That repairs, changes or protective coatings are recorded and must always be reversible.
- That changes are made only when absolutely necessary and never as an "improvement" unless the object is at risk.
- That parts removed and not replaced for a sound reason are kept, conserved and recorded as part of the original object. Where possible they should be kept on the same site.
- That inappropriate methods are never used directly on the object without a considered review by the curatorial / conservation team and in exceptional circumstances
- That all staff, volunteers and contractors become immersed in a conservation culture, so that it leads their thinking while working with the object.

6.0 Practical Conservation

Hands-on engineering skills of any kind are not acquired overnight. Traditionally a five year apprenticeship as a fitter, machine millwright or turner was the norm. "Black trades" such as welder riveters, boilermakers or platers were the same. Some people come to engineering conservation from such a background; especially older volunteers. However these skills, invaluable as they may be, must be applied with a conservation mindset.

Conservators also arrive at engineering conservation from another discipline and while they have the ethos they lack the skills. Each must learn from and teach the other.

What about the young volunteer or technician who has no skills but may have a mechanical aptitude? They cannot realistically learn "on the job" as this would place heritage objects at risk. But they can learn by working alongside the few others who have the skills.

Courses on engineering conservation are held rarely but should be sought out where possible and where time and funds allow.

Engineering skill at its best is about approaching an object in a "holistic" way. It is about seeing the object, grasping its way of functioning and thinking almost three dimensionally of what may be inside. The period of the object will give clues to the level of sophistication to expected, the level of accuracy it is built with. This takes many years and much experience to attain this skill level, so it must never be underestimated. The acceptable pressure to exert on a tight bolt, the fragility of a casting, the touch developed using a micrometer… and so on.

However, creating the right working environment, encouraging research, aforethought and task planning develops a forensic approach which can mitigate for lack of experience and potential damage. Without doubt, mentoring by older craftsmen is invaluable but they too must take aboard the right conservation ethos.

The use of hand tools in a skilled and precise way must be learned before working on conserved objects. Being able to cut, dress and shape metal by hand, understanding the properties of metals and how each are worked differently should be mastered before a conservator or volunteer begins work.

Tools:

Power tools, such as polishers and angle grinders should normally be avoided unless their use is sanctioned, planned and strictly controlled. Scarring or cutting into metal surfaces, inadvertently removing patinas and historic surfaces is easy to do, making them risky to use in inexperienced hands. They are also potentially dangerous without the correct training.

Learn to use them on non-valuable objects and develop a light and precise touch that leaves no tell-tale marks. Certain attachments must normally be avoided, such as cutting or grinding discs, or rotary files.

Bronze brushes are preferred for cleaning both by hand, or attached to an angle grinder

Hand tools

A small range of hand tools can achieve a great deal in the right hands;

Spanners (wrenches in North America) should be of the ring or socket type if possible, putting equal stress on every corner of the nut. The spanner must be an exact fit. It is common to find metric and (American) AF spanners being used on whitworth nuts. Some may fit well but most don't. Many industrial museums have collected whitworth spanners, so use them where possible..

Open ended spanners must be used sometimes. Make sure they are a good fit and never use a hammer or extension tube

Socket sets are good tools to use. Again make sure they fit and never hammer them on

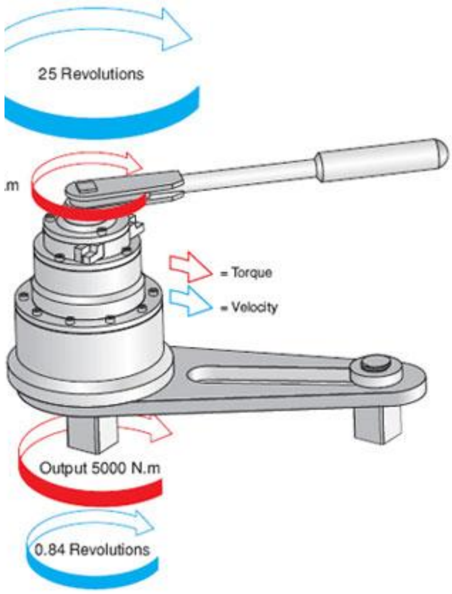
Remember that Whitworth spanners always fit the next size up (if the nut is war time or post war) for example a 7/8” Whitworth spanner will fit a 1” Whitworth nut if the object was made during or after the second world war. This is because hexagon sizes were reduced as a metal saving exercise and continued thus after the war. Avoid open ended spanners or adjustable spanners when possible as they can tear the corners off a tight or worn nut.

Never use a pipe wrench to remove nuts

Where a nut is very tight a single ended spanner called a **flogging spanner** may be used, but judiciously. This is struck with a hammer of appropriate weight (simple rule is that the hammer has to be heavier than the spanner) as a sharp blow will achieve more than gradual pressure on a coarse thread. However this often requires two people and great care with a perfectly fitting spanner. If two people are involved, one must hold the spanner tightly with a rope!

The spanner should be of a flat configuration to ensure that it does not rise off the nut when struck. The example on the left shows this and the striking point on each side at the end.

Where the use of a flogging spanner is inappropriate a **torque multiplier** is a useful tool. The illustration on the right shows how it operates. The operating ratchet on the top can also be a torque wrench. This can be set to a given torque to measure the force required. Even without a multiplier, a torque wrench is useful for ensuring even tightening and allowing settings to be recorded.



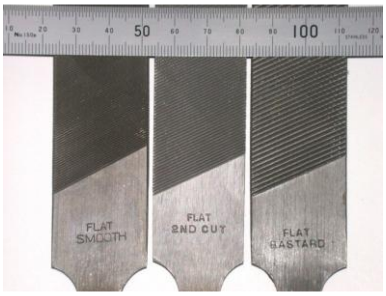
A **torque wrench** does a different job; it is used to tighten bolts to a precise torque, or rotating force. This mitigates the risk of shearing bolts and ensures even tightness.

The wrench has a rotating handle which sets the required torque

Metal abrading / cutting tools

Removing metal from an historic object is generally not the thing to do. However a part may have to be hand fashioned or a new (or old) bearing bedded in. Also the use of hand tools is fundamental in developing skills and developing empathy for metals.

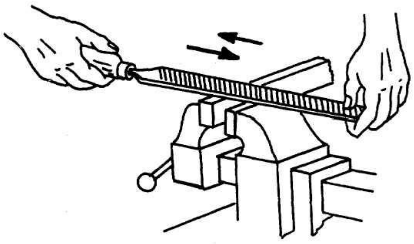
Cast and wrought iron, steel and brass alloys are the most common materials to be found on an historic engineered object and each requires their own technique.



The file is one of the basic tools of the metal-working craftsperson; usually the fitter. There are three main degrees of coarseness: **smooth, medium and coarse,** known as **smooth, 2nd cut and bastard**. Coarser files are known as rasps but are seldom used by engineers. The file has a pointed tail, called the tang. A wood handle is pushed onto this for easy use and safety. Files can be flat, half round, round, square or triangular – and come in all sizes. 250mm or 300 mm are the norm.

Skilled use of the file can finish metal to within 0.001" or 0.025 mm; (this is a good moment to note that inches ["] and decimal fractions thereof, are multiplied by 25.4 to convert to millimetres [mm] i.e. 6" = 152.4 mm. When a measurement is written thus: 6", the inference is that the size is accurate by careful rule or calliper measurement. When it is written: 6.000" it means that the accuracy is expected to be within a thousandth of an inch, three decimal points. The same applies for metric.)

Always remove metal on the forward stroke. Release pressure on the back stroke. Keep the file level all the way.



The scraper

This is the ultimate skill tool of the engineering fitter. It is used mostly on cast iron, brass alloys or white metals (all are bearing materials)

Scrapers do what they say; they have very sharp, hardened working edges on the front or side and are drawn sideways or pushed, to 'peel' metal off in curls. They can be flat, triangular, half round or hollow.

The use of the scraper is a skill that takes time to learn – not only to remove metal effectively but to remove it in the right proportions. An understanding of how the shaft and bearing are disposed to each other is also key in achieving a good result

Where a machine is to turn again, bearings can often be recovered without replacing them. The shaft is sparsely coated in 'engineers blue' and rotated in the bearing. This leaves a deposit; light and heavy where the shaft has touched the bearing.

The fitter then scrapes out the high points (darke
The process is repeated until an even light blue f
scraped out.

Figure

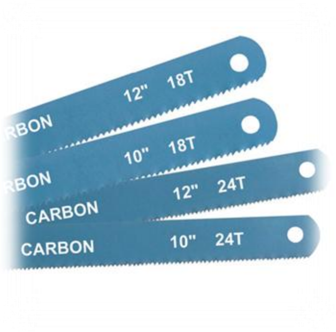
There are many things to learn when scraping or "fitting" a bearing. Not least, the fitter must be mindful of the three dimensional effect of what he/she is trying to achieve

This scraping technique is known as frosting. It can be used to achieve a flat smooth surface that can retain an oil film.

The main reason for including this brief piece on scraping is to highlight the skills of a traditional fitter. This is not to put the conservator or volunteer off but to give them something to aspire to. These skills are being lost rapidly and are something we must strive to pass on. You could say they are on the endangered skills list!

Cutting

Cutting metal by hand is normally carried out using a hacksaw. This tool also requires some practice to use properly as cutting a straight line may not be as easy as it looks. Choosing the correct blade for the metal being cut is important.



“Soft material” = coarse blade (less teeth per inch) hard material = fine blade (more teeth per inch. The blades shown above range from 18T to 24T (18 – 24 teeth per inch; more teeth = finer blade) the blade is fitted to the frame with the teeth cutting on the forward stroke.

All of these skills have to be taught in the first instance and from then on the person can develop the skill by practice. “Feel” and “eye” are important, as is stance; the right pressure the right line and so on. All comes with practice.

Cutting thin metal sheet is less easy with a hacksaw, so a guillotine or tin-snips are used. Shims can be cut, say for placing under a bearing where incremental differences in height can be achieved

Gripping

Mole grips (vice grips) and various types of cramps can be useful; particularly if the task is lightly manned. The use of a vice is essential and it must be firmly fixed to a heavy bench. The vice should have no less than 150mm opening. The vice shown here has a swivel base which is very useful. Any gripping tool can mark the object to be gripped, so make sure something soft intervenes.

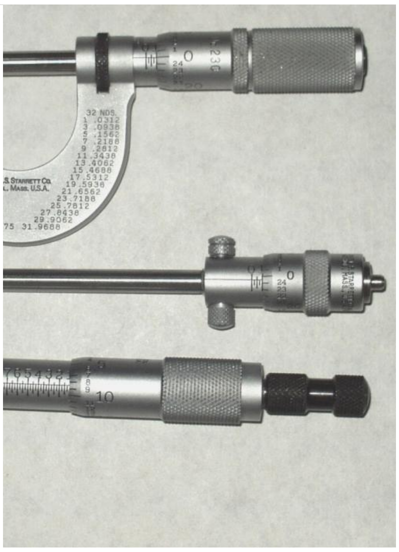
The tool to the left is variously known as a mole grip or vice grip. Beware of cheap versions. These should be used with the lightest setting necessary to avoid damage.

Mea

The vice here is fitted with protectors on the jaws. These must be used. Ply wood scraps make a good substitute. Never over-tighten a vice or use anything to extend the purchase on the handle.

There are many more tools than are listed here of course but one family that governs all is measurement. These are the three types of micrometer: 1: outside for measuring diameters or thickness, 2: inside for measuring bore diameters and 3: depth for measuring internal depth. These come in all sizes and with the right touch can measure to within one two-thousandth of an inch or one two hundred of a millimetre

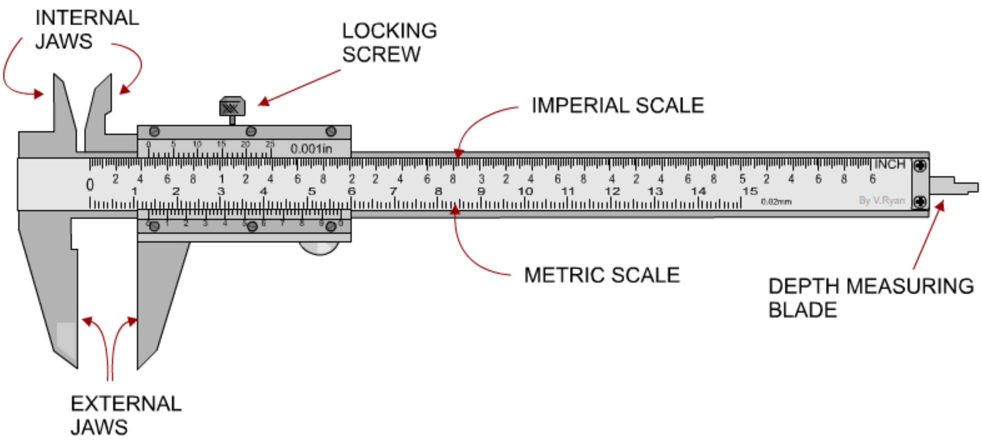
Steel rules (not rulers) are accurate enough down to 0.5 millimetre but not tape measures!



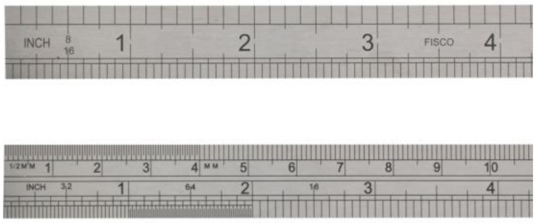
1

2

3

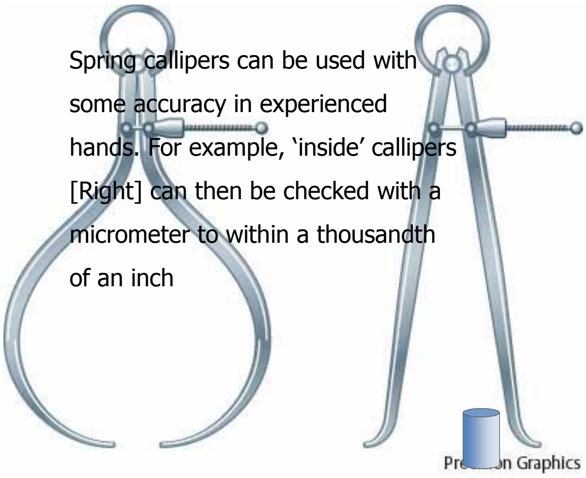


This the vernier calliper. It is more accurate than a steel rule but not as accurate as a micrometer. Nevertheless it is very useful; covering all three micrometer functions and quite inexpensive these days.



There is still a place for a steel rule (note: not a "ruler")

These should always be handy and never used for anything other than measuring! As can be seen by the fine divisions, a fair degree of accuracy in measuring is possible with some practice.



Spring callipers can be used with some accuracy in experienced hands. For example, 'inside' callipers [Right] can then be checked with a micrometer to within a thousandth of an inch

7.0 Conservation Documentation

The (Conservation) Plan

Aim

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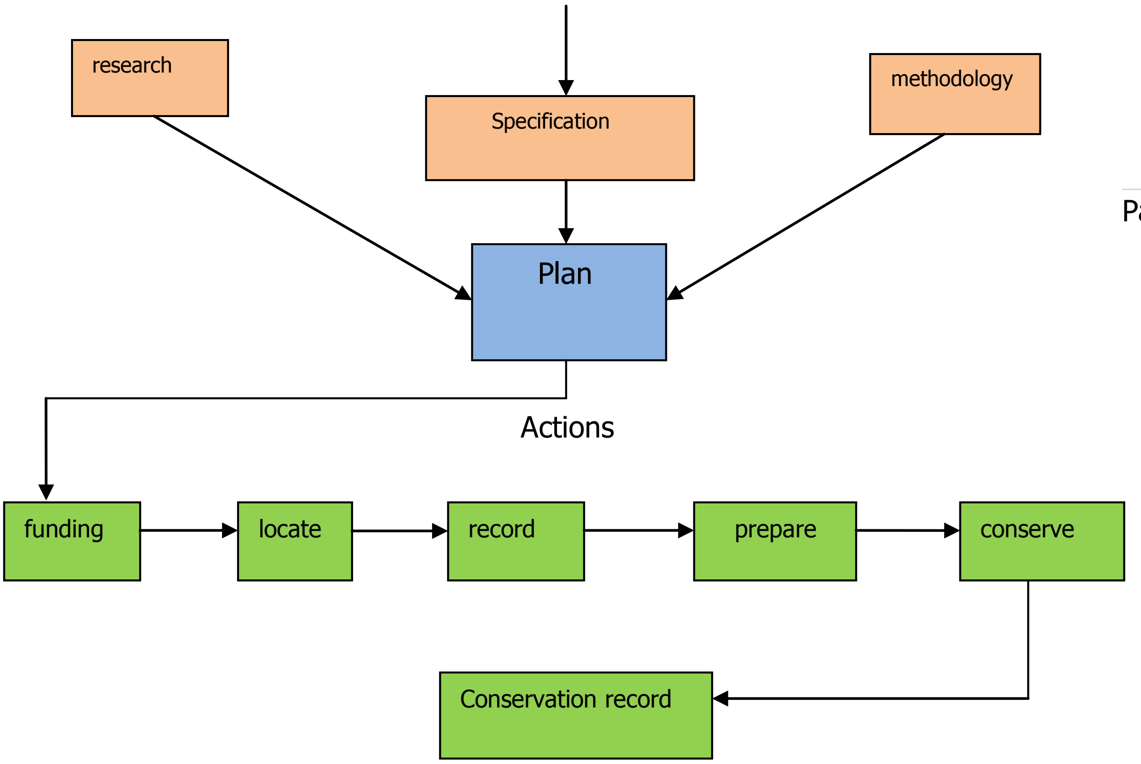

To meet any challenge, a **Strategy (or Aim)** is required**.** The *tactic*s deployed must be informed**.** This is the **Plan,** supported by **Research**, the **Methodology** and the **Specification.**

First a detailed costing should be prepared, **funding** secured and a budget established

Second, the conservation **location** must be chosen, with issues such as environmental conditions, light, security space, load bearing, lifting, and amenity. The destination of the object may also have a bearing.

Next the object must be r**ecorded** as far as possible before work begins, and on an ongoing basis thereafter.

Preparation must be comprehensive. Specific tooling, staff resources, coatings and treatments must all be considered to prevent delays or additional unseen costs.

Only then should the conservation work begin. Any variation from the Conservation Plan must be recorded and a reason given for the deviation

The **Conservation Record.** This will become the over-arching document that will contain all of the above, so each should be written to compliment the other.

Before conservation can begin a **plan** and **methodology** must be discussed written and agreed by the senior responsible person. It is not unusual to have to digress from the plan but that only means that the plan is revisited; not discarded. The plan ensures that the approach is thought through and that a clear aim is set down to begin with. All of these will form part of the **object conservation record file**

If an object is to be dismantled a set of object record sheets should be kept. This of course applies to a single object as well

Methodology (Method Statement)

This should include **how** the work is to be done as opposed to **what** is to be done (already in the Plan)

A sequence of operations shall be listed and problems noted / measurements taken listed alongside. Remember that it may not be the person that dismantles who rebuilds. However it is ill-advised to dismantle unless the plan is to dismantle, conserve and rebuild as a single project.

The tools required should be brought to the project as a result of the planning and in preparation. The tools used should be recorded in the conservation record. Images should be numbered and included in the record.

The appendices shows examples of **object record sheets**. This will eventually form part of the **Conservation Record**, This example was for a cast iron fountain that was to be dismantled then conserved. Paper copies can be used ‘on the job’ and filled out electronically at the end of the day’s / week’s work. This is often neglected but is an important record if kept and filled out in a meaningful way.

While all of this might seem a bit arduous, it should be remembered that by following this trail, you are contributing to the history of the object and recording your part in that history for those who follow. It also makes the task so much easier; particularly when different people are involved.

It also helps immeasurably in sustaining a focus and clear direction in achieving the **aim**.

8.0 Project Planning

Project planning is a vitally important part of any conservation project. This should begin with as much research material as possible put before the team. The team should decide on their **aim** for the object and the future role or purpose it is to serve within the museum or other collection. That role must be decided on by assessing the needs and importance of the object and if these will be compromised in any way by the aim.

The work needs to be planned as far as possible before physical work begins, bearing in mind human resources, funding and timescale. In most circumstances it is unwise to begin a project and then put it on hold because one or other of these factors presents a problem.

Before work starts:

- Write the **Conservation Plan**
- Write a **Method Statement*** that will achieve the agreed **Aims**
- Write the **Tasks Specifications****
- Prepare paper copies of **object record sheets**
- Record the greater object and its components, in situ
- Write a **Risk Assessment**; both for the object and the staff. Look out for: asbestos, particularly in gland packing and gaskets, contaminated oil, fuel, chemicals, flammables and lead paints. Mercury switches and asbestos can be found in old switch gear. Think about the need for hot work and plan a safe approach.
- The RA should never be seen as a “tick box” exercise.
- **Tag** and number as many parts as possible beforehand (stamped metal and wire)
- Prepare a suitable dry, **Work Area**. [if an object is to be dismantled, you will need at least twice the footprint of the object; that’s three footprints altogether]
- Organise shelves, hessian bags, boxes etc and work out a system of finding numbered parts when required
- Gather the necessary tools and safety equipment. A work bench and vice should be to hand. (Many industrial museums have stock of old tools that may be loaned; bearing in mind what was said above about properly fitting tools.)

9.0 Health and Safety issues

Awareness should be heightened of health and safety issues when writing the pre-start documentation - in particular**, the Risk Assessment.** The work area should be properly ventilated and Personal protective equipment, or PPE worn relevant to the task in hand. For example, power tools and hammering generate noise, dust and sparks so goggles, mask and ear protection will be necessary as well as the basic overalls, boots and gloves. The area should be designated and defined as a work area with signage specifying the basic required protection.

Remember to consider others who may beside you or in the area.

Preparing surfaces brings the risk of dust inhalation and skin exposure. Lead paints and putties, asbestos, silicates and other toxins can all be released when cleaning. Working with old or new hardwoods is a particular hazard due to the particulate hazard from the dust. Understand and assess the risks.

All applied treatments are supplied with Coshh [control of substances hazardous to health] assessments. This tells you how to use them safely and what precautions to take. Should you suffer from known allergies, read the contents part carefully. Do not use any product until you read the Coshh assessment.

Remember that dust on overalls, clothing and in the hair remains a hazard after the task is completed. Never eat 'on the job' and always wash thoroughly, including the face, before doing so.

10.0 Volunteer and staff training

Staff training is valuable but is not always practicable to cover every eventuality. Certain basics are required and can easily be missed. For example, a simple task like changing a worn-out grinding disc on a power grinder requires training to ensure the employer meets their obligations regarding duty of care. [Volunteers are classed as employees]. Such simple training can be cost effective by taking advantage of "train the trainer" courses provided by RoSPA or CITB, etc.

A safe working culture must be established and accepted as the norm - and it may be that the experienced 'old hand' may not have been imbued with that culture. It is important to point out any such shortfall to the person or indeed, ultimately to the supervisor.

Skills-training is also vital and indeed contributes towards safe working practice. Volunteer groups should be questioned in order to compile a list of individual special skills that can be passed onto others and the younger members of the group. This also enhances the sense of worth and engagement among volunteer groups.

Craft skills cannot be learned overnight and patience and practice is required as well as monitoring and acknowledgement. There is no shame in not knowing; only in not asking!

11.0 Vocabulary

This section includes words often used in relation to curation and conservation - and indeed traditional engineering, with the focus here being on large industrial objects. In this context the words have a specific or technical meaning. The Oxford English Dictionary otherwise applies. It is important that all disciplines come together in understanding these terms insofar as they are applied to engineering conservation. This helps convergence when an object is viewed by different disciplines and helps mitigate conflict of understanding.

These definitions are in the broader sense, with the specific “nuts and bolts” vocabulary following.

It is important to be clear on the usage of these words or terms. When more than one word is carelessly used to cover one thing, such as '**conservation**' and '**restoration**' the reader can either be confused or think there is little difference. However in this context the difference is important, with each meaning clearly different things.

Many of the definitions here are inspired by English Heritage’s excellent “*Conservation Principles, Policies and Guidance*” document but adjusted in some cases to better fit this context.

Accessioning

The formal process of accepting *acquired* items into the permanent collection.

Alteration/alter

Work intended to alter the function or appearance of an *object*

Asset

The object viewed as being of *material* or *intrinsic* value to the collection

Authenticity

Those characteristics that most truthfully reflect and embody the cultural and technical *heritage* of an *object*

Acquisition

The legal transfer of ownership of an *object*. “Acquire” has a corresponding meaning.

Conservation

The process of managing change to an *object* in ways that will best *sustain* its physical condition and *heritage values*, while recognising opportunities to reveal or reinforce those values for present and future generations.

Conservation Ethos

The ethical values that are common to all good conservation and conservators. This is about best possible practice while staying abreast of developments and new materials. Above all it is about trust and behaving in a way that is acknowledged as professional.

Context

Any relationships between an *object* and other objects or its surroundings that are relevant to its values.

Designation

The recognition of particular *heritage values* of a given object. This applies to buildings and other structures but should apply in the future to key *objects*.

Fabric

The material(s) from which an *object* is formed, including found debris and other matter from its setting

Harm

Change for the worse from inappropriate interventions, poor environment or neglect to an *object* and its *heritage values.*

Heritage

All inherited resources which *people* value for reasons beyond those of mere utility or monetary value

Heritage [Cultural]

Inherited *assets,* which *people* identify and value as a reflection and expression of their evolving knowledge, beliefs and traditions – and of their understanding of the beliefs and traditions of others.

Heritage [technical]

The history of developing technology

Heritage Values

A set of principles which recognise and affect curatorial and conservation aims and outcomes based on recognised societal and cultural mores.

Integrity

Wholeness, honesty

Intervention

Any action which has a physical effect on the *fabric* of the *object*

Intervention, minimum

The base line approach to *conservation*, meaning what is the least intrusive action taken that will have the most effective result. This does *not* necessarily mean the least actual work but refers to the risk of damage to the fabric. Reverse engineering an object – if it offers itself to that – is acceptable if there is a clear aim to be achieved by doing so. Intrusion into the *fabric* is not normally acceptable without clear justification arising from peer discussions.

Maintenance

Routine work regularly scheduled to keep the *fabric* of an *object* and its engineered parts, in good order.

Material (adj)

Relevant to, and having a substantial effect on, demanding consideration

Material (noun)

The defined fabric of an object or part of an object; vital to identify accurately for treatment or repair

Natural change

Change that takes place to an object without human *intervention*, or more accurately, in a museum environment, where that intervention is withheld. This change may require periodic *intervention* and management responses in order to sustain the object in its target condition as a significant heritage asset. This might include rubber tyres, leather, timber, ferrous metals, etc., or to the environment itself.

Object

An integral, fixed or free standing *heritage* item which may be in its original setting or historically associated with it, or has been collected. These may include items intrinsic to a historic building such as overhead cranes, winding or other stationary engines, installed machinery, etc.

Place

Any part of the historic environment, of any scale, that has a distinctive identity perceived by *people*. The '*place*' may contain a collection of *objects* or indeed be an object itself.

Preserve

To keep safe from harm.

[legal interpretation established by precedent]

Public

Those who interact with and learn from an *object* and its interpretation or those seen as an abstract group; present and future, who will benefit from the *preservation* of an *object*

Renewal

Comprehensive dismantling of an object, in order to replace critical parts that will save the object or allow it to operate.

Repair

Work beyond the scope of maintenance, to remedy defects caused by decay damage or through use. This does not include *restoration* or *alteration*. *Repairs* must be assumed to be carried out in a manner sensitive to the *object*.

Replication

Making a new part as an exact copy of an original, missing part or part removed as being at risk, using the same techniques, skills and materials. A **facsimile** differs in as much as it may look the same but is not. A missing flywheel on an engine, that will never run may be made in MDF to look the same as the iron original, thus helping interpretation of the object at a fraction of the cost.

Restoration

The act of returning an *object* to a known earlier state, on the basis of compelling evidence and without conjecture. Restoration should not be confused with *conservation, repair* or *alteration*.

Reversible

Action taken that is capable of being reversed in light of new information or techniques, so that the previous state is achieved. All conservation action should be *reversible.*

Transparent

Open to *public* scrutiny

Setting

The surroundings in which an object is experienced, its local or collection context, embracing present or past.

Significance [of an object]

The sum of the cultural and technical *heritage values* of an *object,* which should be set out in a 'statement of significance.'

Sustainability

The concept of sustainability has come to mean "living on the earth's income" rather than eroding or degrading the planet as an asset. In a museum context there is a slight difference. It is taken to mean that we must maintain, nurture and affirm the validity and importance of an object. The over-use of the word these days should raise a degree of caution and reflection on its use and meaning.

Sustainable curatorship and conservation is that which meets the needs of people today without compromising the ability of future generations to meet their own needs.

Sustainable conservation means that responsible action taken should be capable of ongoing *preservation* at the level of conservation first achieved. This use of the words is not always commonly agreed by museum professionals.

Value

An aspect or worth or importance attached by *people* to the qualities engendered by the object.

Value [aesthetic]

Value deriving from the ways in which *people* draw sensory and intellectual stimulation from an *object*.

Value [communal]

Value deriving from the meaning(s) of an *object,* for the *people* who relate to it or for whom it figures in their collective experience or memory.

Value [evidential]

Value deriving from the potential of an *object* to yield evidence of past human activity.

Value [historical]

Value deriving from the ways in which past people, events and aspects of life can be connected, through the *object*, to the present

Value-based judgement

An assessment that reflects the values of the person or group making the assessment.

Practical terms used in engineering and engineering conservation

The same tool can have different usage by different trades. Here engineering takes precedence as does Scots usage. Other names and countries are in brackets. Often makers names become generic.

Term or tool	description
Acme thread	a square profile or buttressed thread
AF	Across the flats; a way of measuring a spanner or nut
Ball pein (or peen) hammer	the standard engineer's hammer with a rounded end for peining. Comes in different weights
Bolt	Usually has a threaded end, plain shank and hexagonal / square end
Boss white paste	A linseed based putty for jointing threaded pipes
BSP thread	British standard Pipe or 'gas' similar to American NPT or API
Casting	An object formed by pouring molten metal (iron, steel, bronze, etc) into a mould
Centre punch (centre dab[Sco])	A pointed hardened tool for marking metal by striking
Coating	A general term used rather than say, paint
Cramps (clamps)	G shaped or sliding jawed tool for gripping objects together or to a bench
Dolly or Drift	A softer metal bar with a flat end used to drive an object on or off a shaft, etc
Easyout (stud	A hardened steel spiral tapered tool for extracting

extractor)	broken studs or bolts
File	A serrated tool for removing metal by hand
Flogger	A single ended spanner designed for hammering
Fox wedge	A hardened fine tapered wedge for spreading a gap
Fracture	The term used for a brittle failure rather than 'crack'
hacksaw	Junior or 12 inch
Jack	A lifting device, screw driven or hydraulic
Joggle (noun)	A temporary clamp welded to a plate to assist in alignment
Contd//	
Joggle (verb)	To pull and align parts together for fastening; usually plates
Mash (lump, club hammer)	A short shafted square headed hammer; a "miniature" heavy hammer
Micrometer	A screw operated measuring device
Moulding	Making a shape for casting in sand
Peining (peening)	Riveting over or amalgamating a metal surface or metal head with the ball end of a hammer
Pillar drill	A vertical drilling machine fixed to a single circular pillar
Pinch bar (sco) see tommy bar	A long lever with a turned end for lifting a heavy object a small amount
Podger	A spiked bar, similar to a pinch bar, for aligning holes
Pry bar (us)	Similar to pinch bar but more for opening crates, etc
Puddling	A process in the making of wrought iron
Rasp	A very coarse file for wood, lead, horn or other softer materials
Scraper	A sharp, side or front edged tool for peeling / dressing certain metals
Set screw	Similar to a bolt but thread all the way to the head
Shim	Flat metal plates used for packing to achieve a set gap or height
slag	Carbonised or 'burnt' metal sometimes within good metal
Spanner (wrench US)	Single or double ended tool for removing nuts (open or ring)
Stitching (metal)	A process that involves inserting metal pins across a fracture to draw it together then peined
Stud	A threaded bar with loose nuts for similar duty to a set screw.
Socket	A hexagonal 12 sided polygonal tool that fits over a nut, driven by a square drive and bar
Tommy bar (engl)	Same as pinch bar
trammel	Adjustable points on a bar to allow large diameters to be drawn
Treatment	Any process or application forming part of the conservation
Type (pronounced teep)	A set of hardened punches for marking letters or numbers on metal
Taps and dies	Devices for cutting threads by hand, internally and exptemally
Vice (vise)	A screw driven clamping device fixed to a bench
Whitworth thread	The standard coarse imperial thread used before metrication. Similar to the American UNC designation
Wrought iron	Literally 'worked' iron, hammered and rolled to give a malleable form
wrecking bar (us)	Similar to pry bar
Ongoing	

More common engineering machine tools (there are many variants of each)

machine	function

Lathe	Spins the work horizontally to be cut by a fixed tool
Drill (bench)	A vertical drilling machine fixed to a bench
Drill (Pedestal)	A vertical drilling machine fixed to the floor
Drill (radial arm)	Drill head mounted on a radial arm swung from a vertical pillar
Horizontal boring mill	An infinitely variable tool head mounted horizontally with the work fixed vertically to a movable horizontal table
Planer (planing machine)	The work is placed on a sliding reciprocating table and the tool head is mounted on an overhead bridge
Shaper (shaping machine)	A reciprocating head with tool on a horizontal plane cutting the work held in a movable vice
Vertical boring mill	Horizontal turn table carrying the work with an overhead sliding tool on a 'bridget' frame

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