Keeping a Promise to the Past

Iron Conservation

Iron is found in abundance on archaeological sites yet it remains one of the most unstable materials and therefore it is the most difficult to stabilize and preserve. Iron, or more correctly a variety of ferrous alloys, is grouped by type. Manufactured ferrous alloys usually contain other elements besides iron in their composition and these elements help to stabilize the iron when it is formed into objects. When iron is found on archaeological excavations it has most likely been processed and manufactured starting with iron ore. Because iron naturally wants to convert back to its most stable state -- i.e. the iron ore from which it is made -- it remains unstable through use, burial, and storage in archaeological collections.

The three main types of iron found on archaeological sites are:

- **Wrought Iron -** Commercially pure iron, contains low carbon content and often appears to have grains resembling wood. Usually larger items which are produced for support as these items cannot be brittle. Examples are architectural nails, beams, anchors and personal items.
- **Cast Iron -** Contains 95% carbon, and larger amounts of silicon and phosphorus. Has a very low melting point allowing it to be "cast" into objects using molds of various sorts. Often used for objects which tend to be less weight bearing or supportive such as cooking pots, cannon balls and architectural hinges.
- **Steel -** Mostly iron with a small amount of carbon and other alloying minerals; usually contains 1-3% slag content. Steel objects vary in size, complexity and function.

Archaeological iron from aerated damp sites appears brown- red- orange in color upon excavation and the shape, identity and details of the object may or may not be discernible. Iron corrodes very rapidly upon burial and the thick, voluminous corrosion can contain inclusions from the soil such as tiny pieces of rocks, shell, sand, coal, organics, and bone. The red-orange color of iron indicates it is an iron-oxide corrosion product of some type. The iron-oxide corrosion layers may also contain soluble salts such as chlorides, and non-soluble salts such as carbonates, sulfates, and phosphates .

Sometimes the entire iron object is consumed by this type of very aggressive corrosion and the original metal core is no longer present. When an iron object is exposed to a burial environment with little to no oxygen, a layer called magnetite forms next to the iron's surface. This is often identified during cleaning and is thin, dark gray or black in color and is dense and shiny. Iron corrodes so rapidly that the 'original surface' of the metal is quickly turned into voluminous corrosion products and therefore the original surface of iron objects can rarely be found. Sometimes the approximate shape of the object may be determined through careful cleaning, but surface decoration, including items such as inlay and wear patterns, along with other technological information, is usually lost or altered during the corrosion process. If the magnetite layer is intact it often protects such details and they will often be revealed during conservation cleaning of the object.

During burial other factors in the environment which can cause ferrous alloy to corrode include oxygen, pollutants, soluble and non-soluble salts, water, and micro-organisms. The pH of the soil is also a factor in determining how much corrosion forms on iron. In very acidic soils [pH 0-5] and very alkaline soils [pH 8+], iron rarely survives. Iron continues to remain unstable post-excavation, and exposure to unstable environmental factors will sometimes cause iron to continue to corrode while it is in the laboratory, on display or in storage. Some of these factors are high levels of humidity, unstable temperatures, pollutants and physical stress from handling. All of these will result in further deterioration unless precautions are taken to slow down or arrest this type of deterioration. It is therefore important to handle, store and exhibit metals in a clean, stable, dry environment so that post-excavation deterioration does not occur. Archival materials are best practice for implementing the long-term preservation of these fragile materials. For more information on the long-term storage of archaeological materials go to [Conservation FAQ on the SHA web page](#).

Case Studies in Iron Conservation

cock's head hinge (rollover)

battery spring from snaphaunce

knife blade

sewing needle

iron chain links

file

X-radiography of Archaeological Objects

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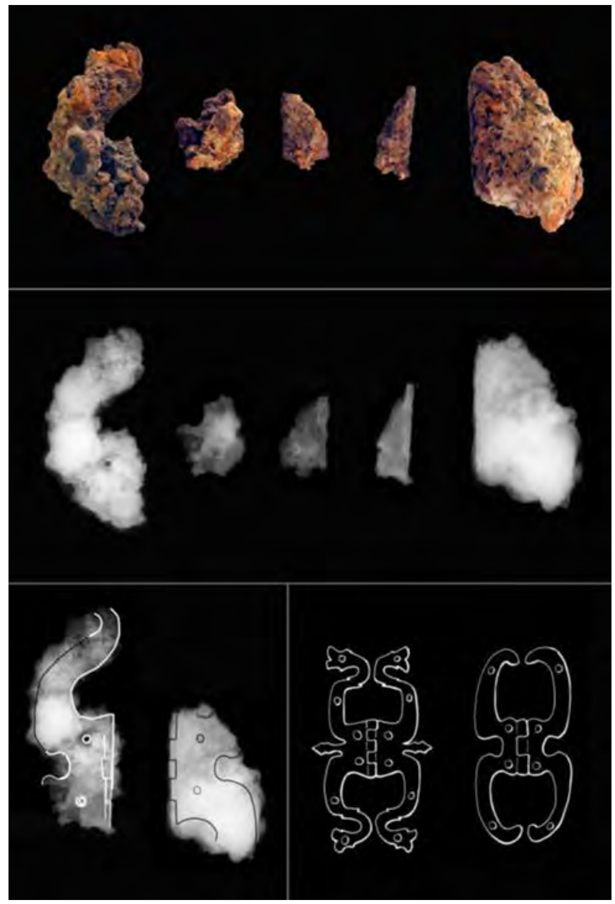
X-radiography of Archaeological Objects

Archaeological objects are typically x-rayed for several reasons:



1: To identify corroded objects: X-radiographs can reveal surfaces and shapes obscured by thick layers of corrosion and burial soil. Maker's marks or inscriptions, details, holes, tool marks and other forms of decoration can be identified in an x-radiograph. Different types of metals can also be identified if they are present.

2: To assess the condition of an object: areas of corrosion, cracks, wear, and other types of weakness are very obvious on a properly exposed x-radiograph.

3: To document an object: not all objects can be completely conserved, or may be preserved in an unconserved state for future study. X-radiographs are a good way to capture an image of an object at a point in time. This image can be compared to images taken in the future to determine if objects continue to degrade in storage.

19th-century iron padlock

Case Studies in Iron Conservation

Cock's Head Hinge

Conservator's Notes

When these fragments of iron were excavated in the 1970s from the St. John's Site little information was known about them. The iron fragments were stored together and listed in the inventory as 'hinge fragments?'. In 2002, the iron fragments were pulled for x-radiography during a detailed condition survey of the collections. After careful examination of the x-radiography results [see below] it became clear that the iron fragments contained pieces of what appeared to be a decorative hinge—with small nail holes and curved edges visible in the image.

Using tools such as x-radiography and computer technology, conservators and archaeologists are able to manipulate the images, revealing features not usually visible. In this case, fragments of a cock's head hinge were revealed. A cock's head hinge is a decorative hinge from the 17th century whose four points are shaped into the heads of a cockerel.

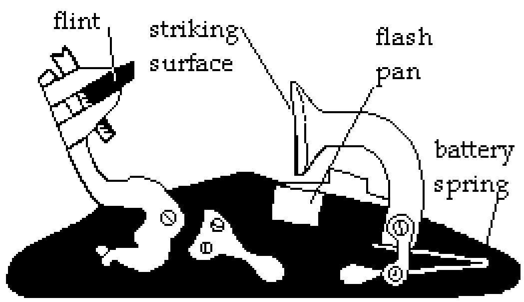
The hinges were most likely used on cupboards or furniture doors. The x-radiographs allowed the conservators to assess the condition of the hinge and establish a treatment plan for cleaning the fragments. The x-radiograph images were layered with a historical illustration of the hinge to reveal the parts of the hinge. Some of the artifacts were so corroded it was not possible to perform conservation treatment on them.

After initial discovery of the fragments of the first hinge, several other parts of the same hinge were identified and treated. These fragments were treated in the conservation laboratory and obscuring corrosion was removed using mechanical cleaning methods to reveal the surfaces and shape of the cock's head hinge. Although all 3 fragments came from the same context and probably the same hinge, they were unable to be joined after conservation.

Curator's Notes

Made of iron, cock's head hinges were very decorative and often used in built-in cabinetry and occasionally furniture. This specimen was found in a filled posthole near the kitchen outbuilding at the St. John's site which was occupied from 1638 to ca. 1715. This class of hinge was called a cock's head because of its resemblance to a rooster's head. The specimen illustrated to the right is an extant example from Lord Baltimore's house of Hook Manor in the county of Wiltshire, England.

Battery Spring from Snaphaunce



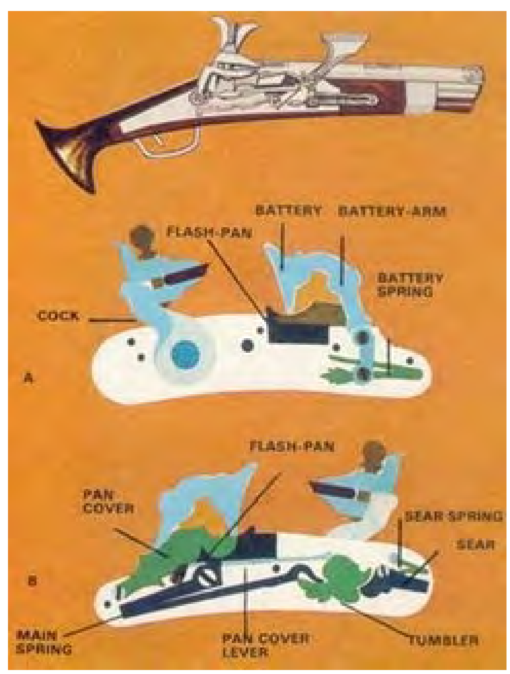
Conservator's Notes

This iron object was identified during a survey of the collections at St. Mary's City. The object was pulled for x-radiography due to its unique shape, but it was not identified at that time. The object was actually pulled because it was misidentified as a smoker's companion. But lucky for us, because otherwise it may not have been given such a high priority and therefore it may not have been sent to the conservation laboratory for cleaning. During conservation cleaning using air-abrasion techniques, the corrosion on this object was slowly lifted away. The shape was so unique that the conservator decided to take many of the during treatment (cleaning) shots revealed in the photograph above.

As more of the corrosion was removed, it became clear that the object was not a smoker's companion but it was interesting. The shape reminded us of a spring, but what kind? It was not until the object was shown to the curator that it was correctly identified. Military or armament items are not found in abundance at HSMC, and they are rarely found complete. There are many fragments of iron objects in the collections which are not able to be fully identified, but this important object opens up an entirely new category of object at the site.

Curator's Notes

This item is the battery spring from an early flint-ignition firearm known as a snaphaunce. The battery was the steel surface that the flint struck to produce the sparks which ignited the gunpowder. Snaphaunce locks were a vast improvement over the earlier match locks which used a smoldering "slow match" made of salt peter impregnated fiber. The snaphaunce developed in the last quarter of the 16th century in Europe. It incorporated the improvement of integrating the battery with the pan cover which held the priming powder. The tem "snaphaunce" means roughly "pecking hen" (from the Dutch) and derives from the action of the cock and the battery. The context of this discovery is a filled pit at the St. John's site dating to the first half of the 17th century.



Knife Blade

Conservator's Notes

This very small iron blade was pulled from the collections and sent to the conservation laboratory for treatment. The shape of the object indicated the artifact was some sort of knife blade but no other details were visible through the corrosion layers at that time. The blade is missing the very tip, but the tang where it was originally connected to a handle remained intact. The handle would have probably been made from wood or bone, and had disappeared completely while the knife was buried in the ground for over 300 years.

The ferrous-oxide corrosion products covering the knife upon excavation were quite dense, and contained chlorides and other non-soluble salt ions. The object was surface cleaned using mechanical cleaning techniques in the conservation laboratory to remove the corrosion and ions. During cleaning, detailed markings were revealed in the metal surface of the blade. The markings do not appear to be complete and represent marks applied by a maker or owner of the object. Maker's marks are often seen on the blade of a knife, opposite the side that is continually being re-sharpened or used the most.

Marks on metal artifacts are usually unique to the individual making or using the object and are used to represent that individual. They can be simple letters or numbers, an emblem, picture or symbol, or a combination of the above. Because the lines and marks on this object appear to be scratched into the surface of the iron, the mark was probably put there by the maker or owner, but it is very difficult to tell. A close up photograph [see below] of the object reveals several vertical lines which appear to be parts of letters. Some of the markings were disrupted by corrosion and are missing. It is very rare to even find markings still remaining on iron blades such as these after being buried so long. Some maker's marks can be traced to a person, country or city of origin and can indicate the movement of groups of people.

Maker's marks can also be found on other types of metal artifacts, such as copper alloys, lead alloys and silver. Some examples of these include the marks and dates often found on the interior of window leads, applied by the maker of the turned leads. Evidence of maker's marks has also been found on copper alloys at Historic St. Mary's City. Many of these appear to be clearer than those found on the iron blade, as the surface of the copper alloys does not deteriorate in the same way as iron in the ground. For an example of a copper alloy maker's mark please see copper alloy case studies. Note the difference in the maker's mark revealed in a copper alloy.

Curator's Notes

Conservation often unmasks very valuable information hiding beneath a layer of corrosion. This specimen bears a series of marks where it is traditional for knife blades to have maker's marks. This series of marks may be a maker's mark, or it could be an owner's identification mark. More research is needed to be sure.

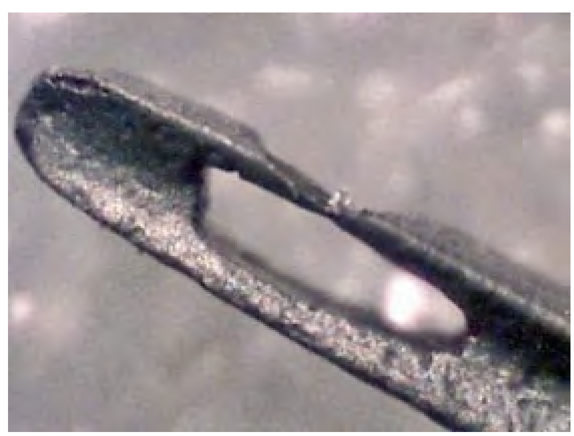
Sewing Needle

Conservator's Notes

Even the smallest objects that survive on archaeological sites can reveal the most interesting details. A very small, thin iron needle was recovered during excavation of the St. John's Site. Its dimensions are no bigger than 3 inches long by 1/8 inches in diameter. The fact that this object survived in the ground is very rare, but it also survived almost 40 years out of the ground in storage. The object was discovered in a box of other artifacts from the St. John's site with no special packaging or attention given to it. It looked like any other small iron object at the time. The details of the object were first discovered during an x-radiograph of the object. The eye of the needle was visible, and it seemed that the object was complete. Even though the object had survived both burial in the ground and storage afterwards, it is often very difficult to ensure the successful conservation treatment of such tiny pieces of metal.

In order to clean the object of obscuring corrosion products, some weight must be applied to the object to mechanically remove the layers of corrosion which had built up over time. It was decided for this object that it would be mounted in polyethylene foam for cleaning [Before treatment photo above] so that when pressure was applied during cleaning, the weight would be transferred to the foam behind the object. The corrosion on the object was carefully removed bit by bit to reveal details in the metal surface beneath. The iron object was so well preserved, in fact, the metal almost appeared silver, the original color of the iron when it was manufactured. The eye of the needle was completely intact as were thread groves and lines in the body of the needle. Digital photographs were taken under a microscope in order to view the details of the metal under magnification. Only a few very minor pits are visible in the metal surfaces, as well as a small area of loss near the edge of the eye. The object was packaged very carefully after cleaning to ensure its survival for many more years to come.

Curator's Notes



eye of needle

Steel or iron needles seldom survive in the archaeological record. The thinness of the iron and the susceptibility to corrosion work against preservation of these items. Needles are essential tools in the making of clothing. Throughout the colonial period, clothing generally represents the most expensive possessions of the common individual. Textiles themselves hardly ever preserve in the archaeological record, so that the tools for their making are all that much more important. While it would be interesting to suggest these items speak of gender roles, both men and women in the colonial era sewed. This is particularly the case in the 17th century when men generally greatly outnumbered women in early Maryland.

Iron Chain Links

Conservator's Notes

After years of burial, archeological iron is often found deteriorated, fragile and covered in corrosion products and soils. Its shape and function may not be the same as when the object was first manufactured, used or thrown away. Iron is one of the most unstable archaeological materials, and corrodes very rapidly once it is buried [iron page]. Objects that were once functional with moving parts may survive after years in the ground, but if they do, it is unlikely that the parts of the object will still be able to be moved in the same way they did before. Imagine leaving a bicycle outside unprotected for years, with the gears, brakes and bolts left in one position. After time and exposure to rain, pollutants in the air and the other elements of nature, it is more than likely that the metal components will have rusted and parts such as the gears will not slide smoothly on their track any longer. If caught soon enough it may be possible to reverse some of this process but the bike will not ever be like new again.

This iron hook has suffered the same type of deterioration as the bicycle mentioned above. After being buried in the ground for over three hundred years, the links of the hook are no longer able to be moved and they remain frozen in one position. Iron is very fragile when it is discovered upon excavation, and it is important not to move parts of an object such as this. Iron becomes very fragile, brittle and stressed during burial and most of the original strength of the iron is reduced, as the metal core is turned to corrosion products in the ground. Internal stress and micro-cracks can sometimes be a factor with corroded iron, causing it to crack and fall apart if pressure or movement is applied by force. It takes careful cleaning of the corrosion products to determine whether or not the iron links would be able to be moved again.

When an object such as this is chosen for conservation, it is important to remember that the reason for doing conservation is not to try to make the object “work” or “move” the way it was originally intended during manufacturing. Years of use before it was buried may have added to its immobility and that is part of its history. If the object is able to regain function during conservation treatment, then that is an added benefit to the treatment — but not the intended goal. The goal is to stabilize the object for future generations to enjoy it, whether it moves or not. And whether it is able to regain movement or not is part of the archaeological history of the object which should be preserved as well.

In the case of this iron hook, not only were the links immovable, but the original shape of the hook was misshapen, as the extended link lay back onto the metal of the hook. Conservation treatment of the object involved mechanical cleaning of the obscuring corrosion, which was acting like glue—holding the metal fragments together frozen in one spot. As more and more of the corrosion was removed through careful cleaning, the link loosened from its position during burial and returned to its original position. The two links were still intact with no cracks or breaks in the loops. After the object was fully cleaned of corrosion products, the surfaces were coated and treated to ensure the long-term stability of the pieces. Future movement will be kept to a minimum to ensure that the iron remains stable and no further stress is applied to the object.

Curator's Notes

It is difficult to determine the function of this chain link and hook. It was probably part of a more complex object which was broken in use and this part is the only representative of the object recovered. It could also simply be part of a chain which could be used for a wide variety of functions and activities.

File

Conservator's Notes

During the conservation treatment and cleaning of what appeared to be just another “bar” of iron, markings were discovered in the surfaces indicating that the objects were tools — files to be precise.

Curator's Notes

Tools used to make tools are particularly important to our understanding of past artisan and craft activity. There were very few craft specialists in the early Maryland colony. Most individuals were involved in the production of the staple cash crop tobacco. One of the exceptions to this generalization were blacksmiths. The repair and maintenance of iron tools and equipment required a specialist with special tools. This small, triangular file would have been used by a blacksmith in finishing detail work.