X-radiography as a Conservation Assessment Tool for Archaeological Collections

Howard Wellman
Maryland Archaeological Conservation Laboratory
Jefferson Patterson Park and Museum

Introduction

- This presentation will demonstrate how X-radiography can be used to document and assess large collections of bulk metal finds.
- But first, some history and an overview of the common uses of X-radiography in archaeology and conservation…

X-Radiography in Archaeology and Conservation

X-radiography has a long history of use in archaeological study:

- Röntgen first published X-radiographs in 1896.
- Within two years, Culin published a description of radiographs of Peruvian mummies and other objects by Dr Charles Leonard, University of Pennsylvania Museum.
- The technique quickly spread to the examination of other museum artifacts including ceramics and metals.

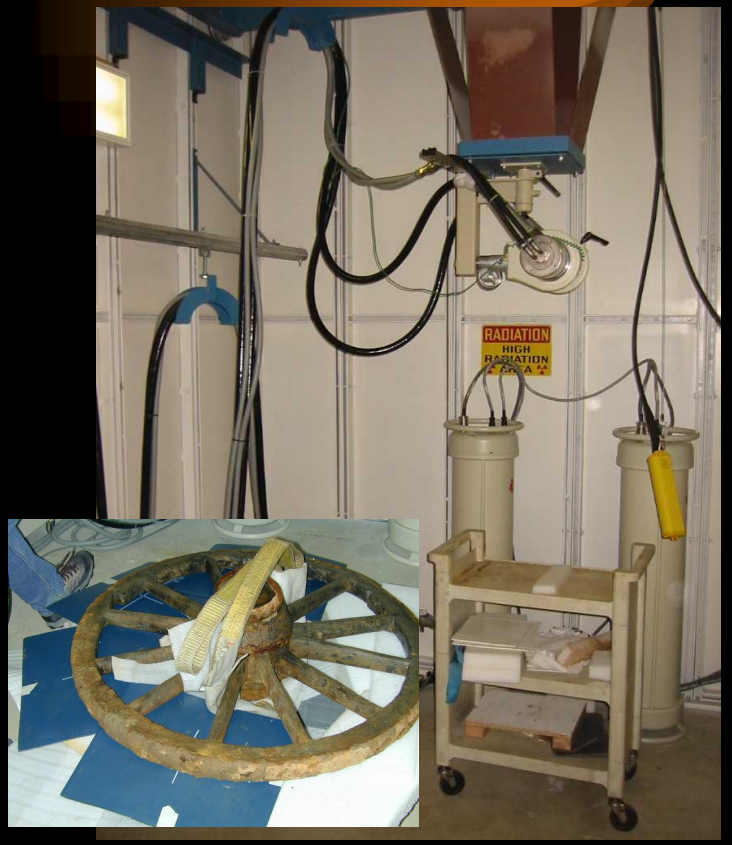
Currently, X-radiography is taught as a standard examination method in conservation degree programs.

Reference: *Radiography of Cultural Material,* Janet Lang and Andrew Middleton, Butterworth Heinemann, London, 1997.

X-radiographic equipment

There are two types of x-ray units:

- smaller self-contained X-ray cabinets which can accommodate objects and film sizes up to about 14x17 inches.
- and larger industrial grade x-ray tubes housed in lead-lined rooms which can be used to produce individual images or mosaics of larger objects, limited only by the size of the room.



Recent innovations in radiography include digital imaging which facilitates image manipulation and analysis. The image is captured on a reusable "film" that is processed and scanned by a laser scanner, then the digital image may be saved, printed, and manipulated.

X-Radiography in Archaeology and Conservation

X-radiographs are typically used for:

- Object Identification
- Reveal obscured detail
- Reveal composition and structure
  - Composite materials
  - Structural flaws
- Reveal alterations
- Bulk Condition Assessments
- Archival documentation
  - condition
  - form
  - dimensions
  - count

Object Identification

Iron objects can be particularly difficult to examine and identify due to thick concretions. X-radiographs show what is inside the soil & corrosion.

From vaguely discernable details…

Photos courtesy Maryland Archaeological Conservation Laboratory

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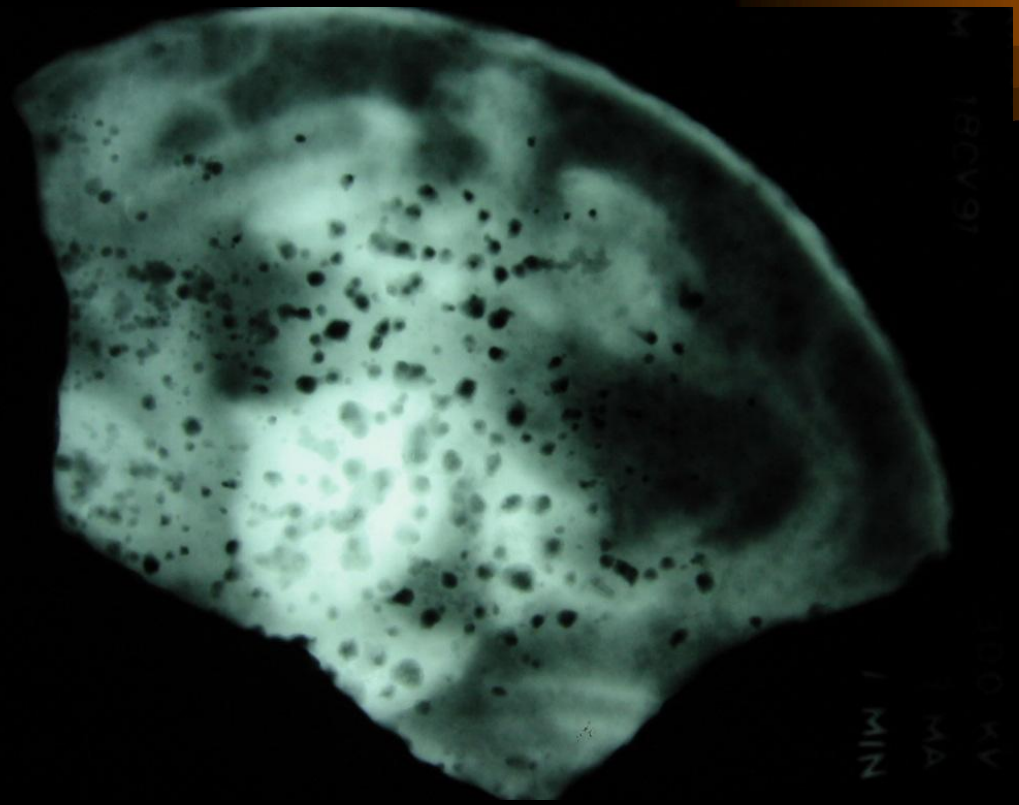
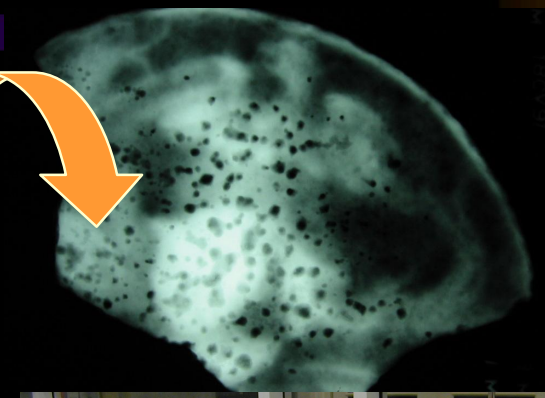


To a clearly defined object…

Photos courtesy Maryland Archaeological Conservation Laboratory

Revealing Obscured Detail

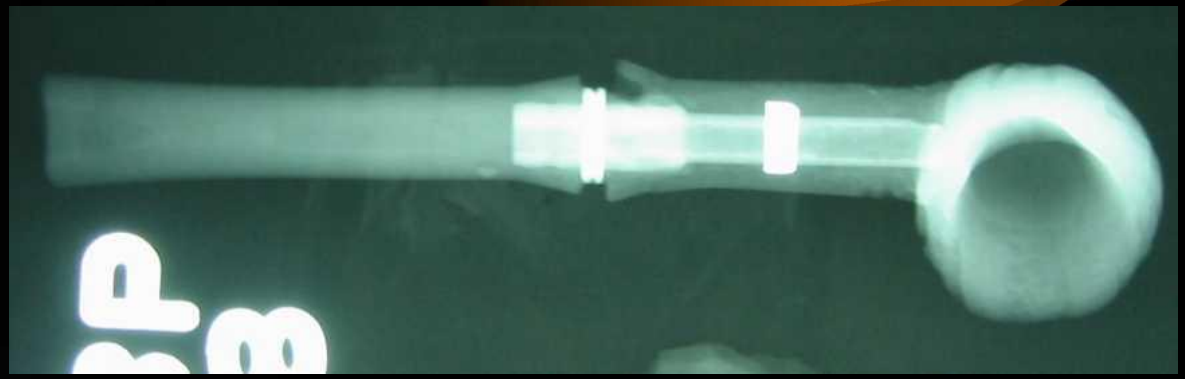
The X-radiograph can be used as a "roadmap" when removing soil and concretion during investigative cleaning.



Photos courtesy Maryland Archaeological Conservation Laboratory

Structure and Composition

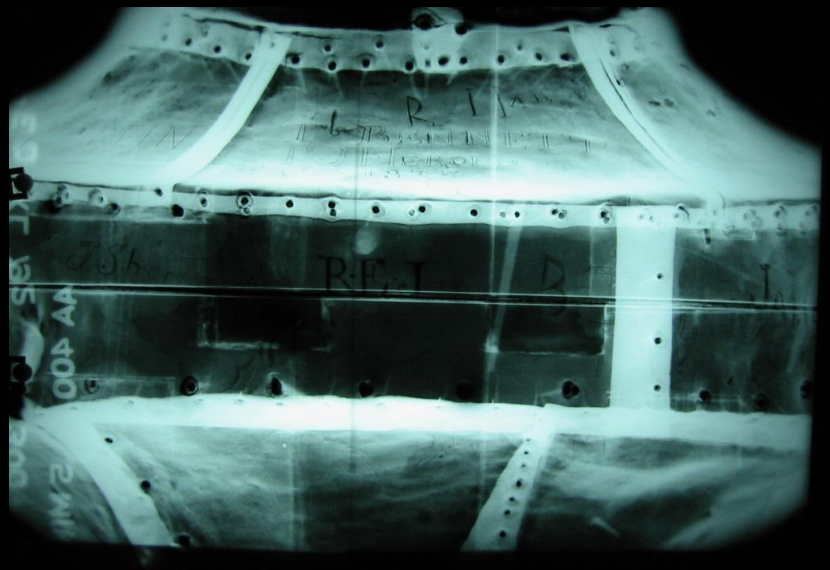
Internal structure and composite elements can be revealed



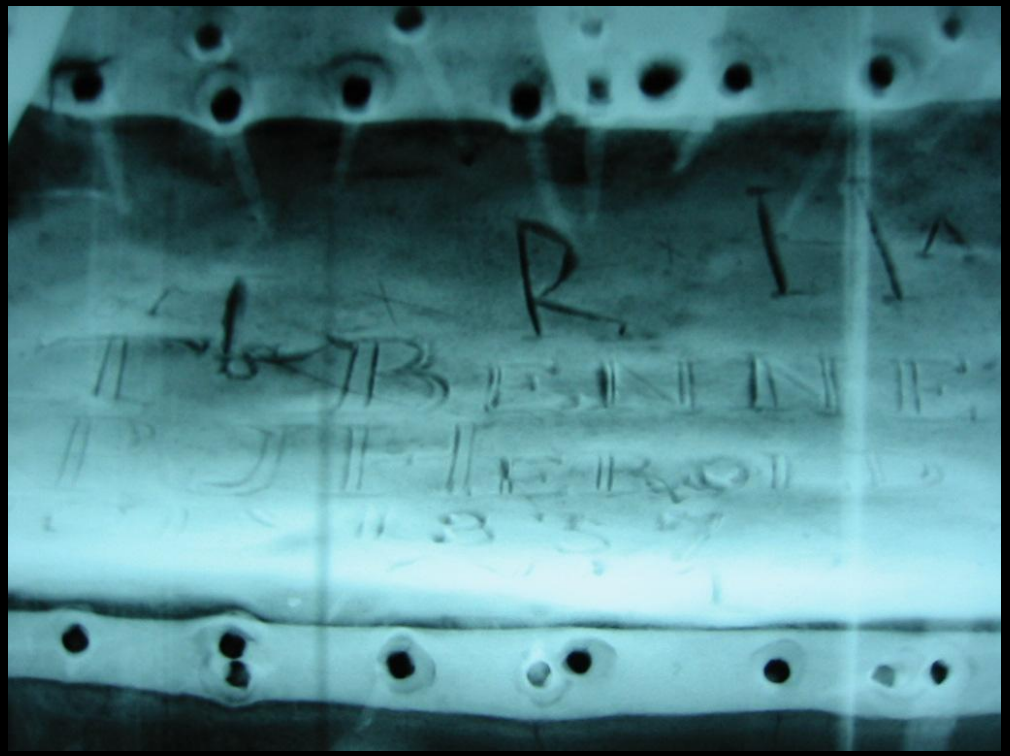
Photos courtesy Maryland Archaeological Conservation Laboratory

Documenting Historical Alterations

During conservation treatment, not all surfaces are cleaned or revealed, but previous alterations can be documented.



The historic paint layers will not be removed from this architectural element, but the alterations and graffiti are documented in the X-radiograph.



Photos courtesy Maryland Archaeological Conservation Laboratory

Assessments of Large Collections

Most archaeological sites yield large numbers of artifacts, and while only a small proportion need immediate attention, it still adds up...

Archaeological conservation differs from art object conservation because it frequently has to deal with large collections of bulk material, such as oyster shells or nails and metal scrap. One of the problems is determining how much to preserve and how. Few institutions have the resources to conserve every nail, even though they may all require some stabilization. So how does one choose which objects to actively treat? Clearly priorities must be set. Archaeologists and conservators may have widely different views on what makes an object a priority for preservation. All the factors must be considered when choosing which objects to treat, which ones to stabilize and which may not need any intervention.

Setting Priorities…

- Archaeological priorities are generally based on research potential defined by:
  - the quality of provenience
    - disturbed or undisturbed context
    - quality of measurements and documentation
  - the nature of the excavation
    - Test trenches, disturbance & “rescue” excavations.
    - Plow zone, surface collection, shovel test pits
    - Full site recovery with complete mapping, trench profiles, and deep undisturbed contexts.
  - whether the artifacts can be used to answer cultural questions

Setting Priorities…

Without any guidance regarding the archaeological significance of an object, a conservator will set an object's priority by its condition – is it stable? How long will it remain that way?

- Additional factors may include
  - how much time the object will take to stabilize
  - what the cost will be, and
  - the effects of treatment on the research potential of the artifact.

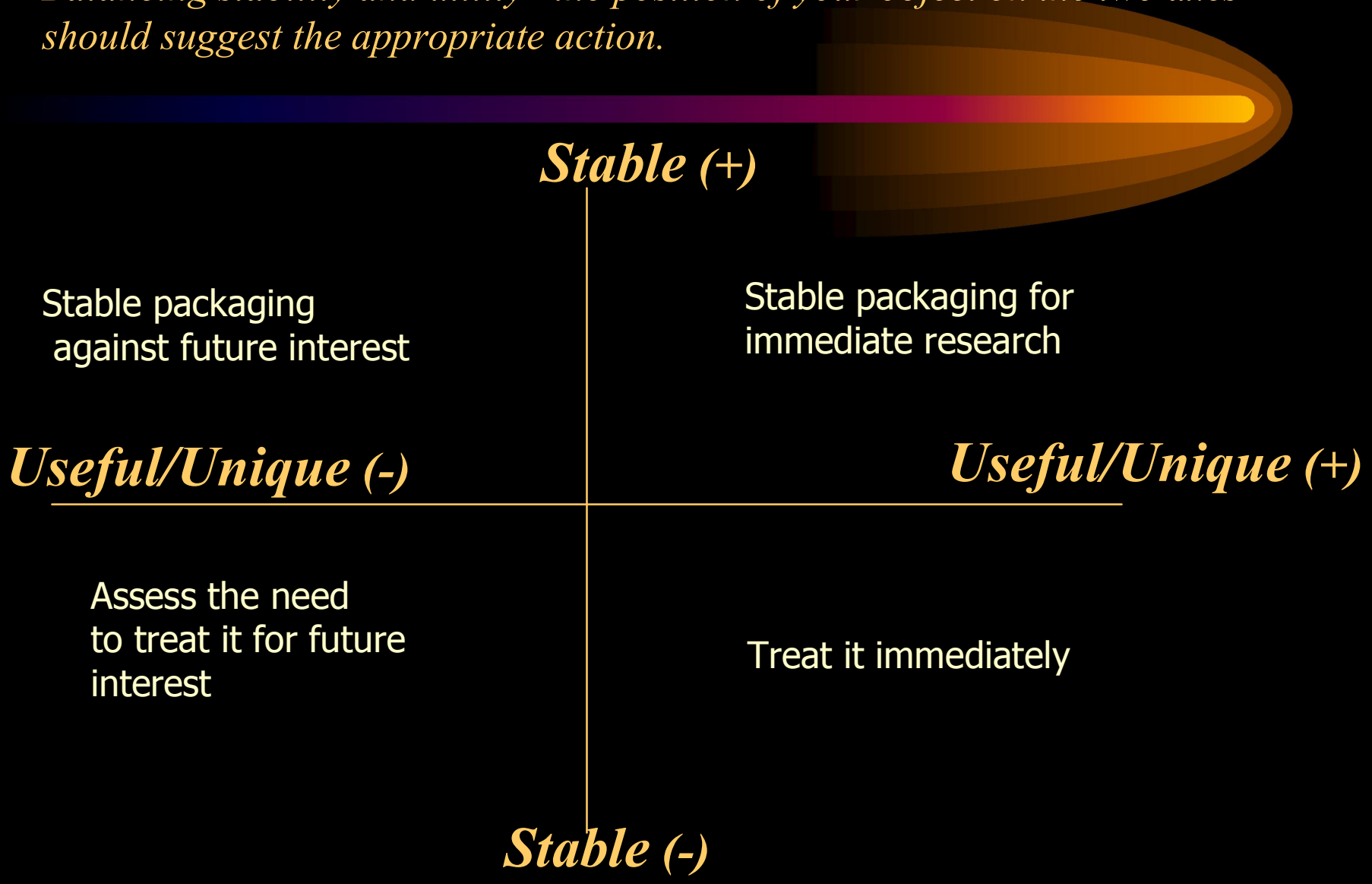
Reaching Consensus

Everyone's resources are limited, so how can we reach agreement on what and how much to conserve?

- Archaeological needs are driven by current research questions; resources are directed to the most immediately relevant artifacts.
- Conservation seeks to preserve and stabilize everything against future, often undefined, needs and questions.
- What will allow both needs to be met?

Sorting out needs and options

Balancing stability and utility –the position of your object on the two axes should suggest the appropriate action.



Putting it into practice

An example from the MAC Lab cataloging project, to illustrate the whole process…

- Simpsonville Mill, Howard County, MD
  - Late 18th to early 20th century mill town, with grist and sawmills, woolen factory, stores, cemetery, and residences.
  - 68 boxes of artifacts
    - 2100 "Lots" or separate proveniences
    - about 42,000 artifacts
    - 10-15% metal (mostly iron)

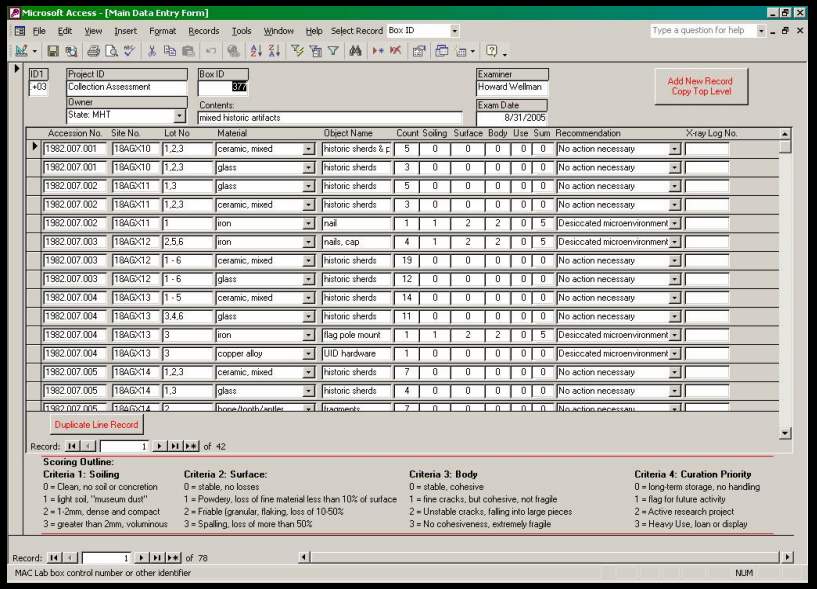
The Simpsonville Mill collection in storage, and a typical box of artifacts from one context, with mixed historic materials. (Note the bag of nails to the right, and the desiccated environment storage box to the left).

Photos courtesy Maryland Archaeological Conservation Laboratory

1st Step: Inspection & Recording

Standard conservation inspection allows about 15 minutes per box to visually inspect and take notes in an Access database. The main focus is on identifying immediate threats, such as mold growth on organic materials, or salt efflorescence on ceramics.

Visual inspections move fast, and are recorded on an Access database laid out with tick boxes and drop-down lists. Condition scores are assigned according to pre-defined criteria. This gives more time to cover individual entries for particular problems.



2nd Step: Individual Inspections

- Suspect objects, particularly all metals, get individual inspection & notes.
  - All metal is assumed to be unstable.
  - All metal is assigned desiccated storage, but unique, unusual, or diagnostic items with active corrosion are marked for treatment.
  - All metals are then X-radiographed...

3rd Step: X-ray Assessment

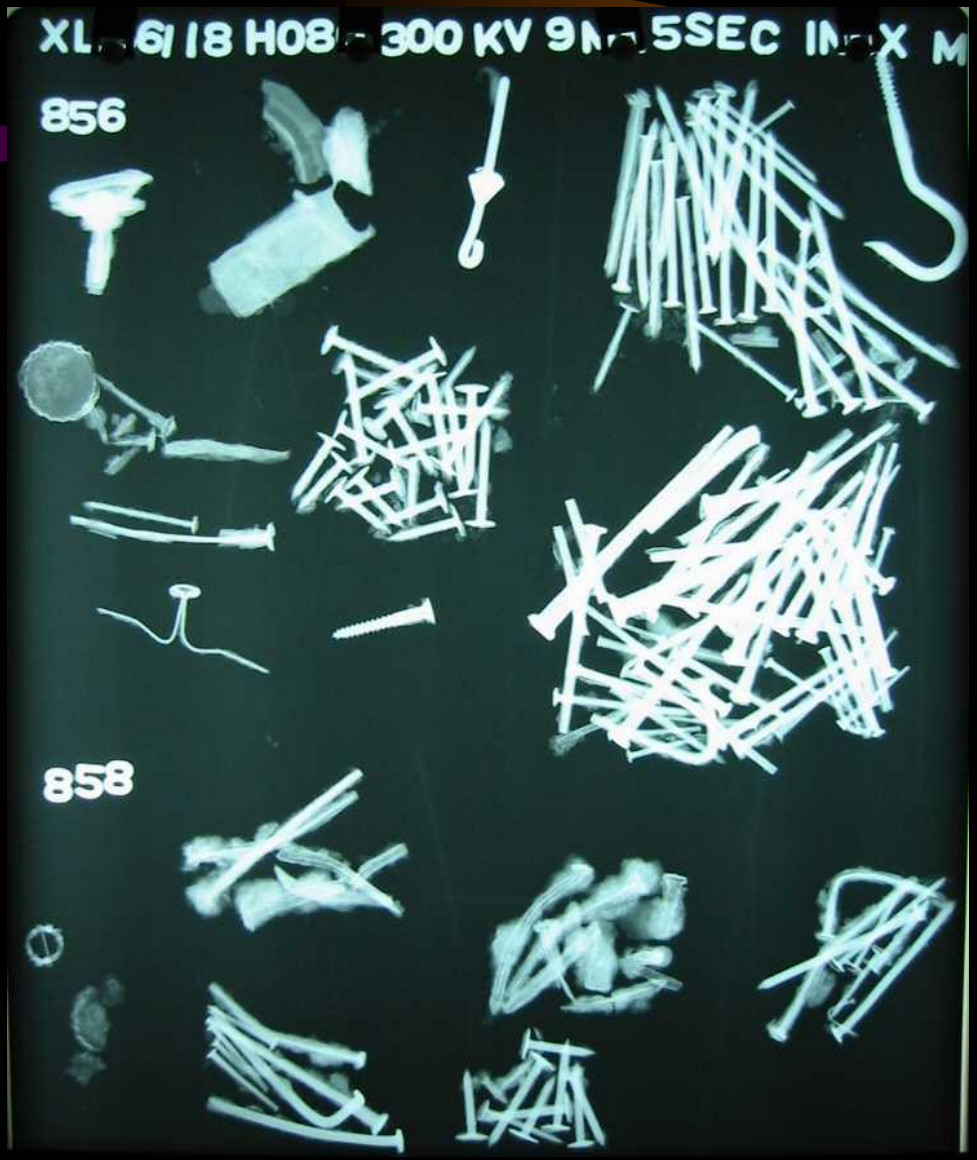
With some Conservation / Archaeology consulting...

A typical box of mixed metal artifacts. This box yields…

Photos courtesy Maryland Archaeological Conservation Laboratory

3rd Step: X-ray Assessment

this image which can be consulted by both conservators and archaeologists.



Photos courtesy Maryland Archaeological Conservation Laboratory

4th Step: Archaeological Prioritization

- The X-radiographs, lists of treatment recommendations and priority requests are passed to the archaeologists:
  - they assess priority & importance by provenience and research needs
  - and the list gets passed back to conservation with those notations.

5th Step: Priorities become treatment plans

Marking unique items for treatment, sampling bulk materials, and planning storage for the rest

The whole group of nails from one box.

The sample selected for conservation.

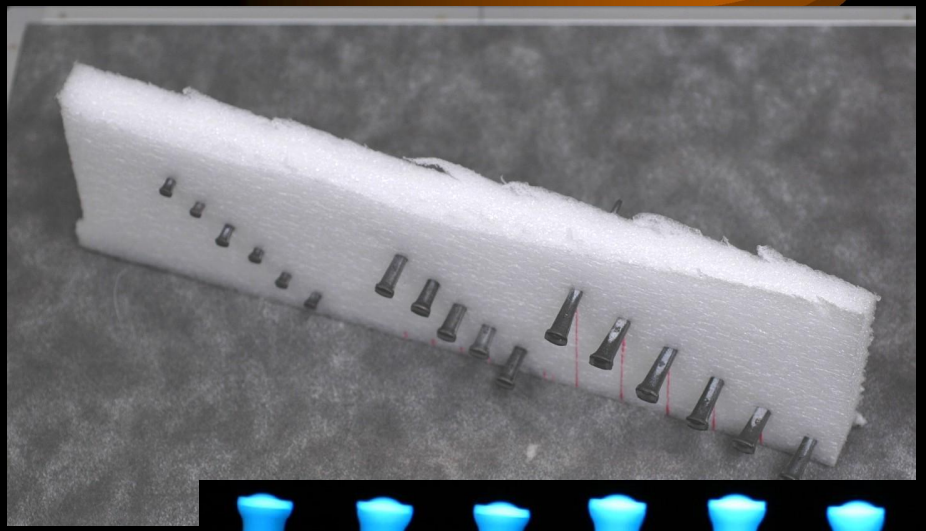
Photos courtesy Maryland Archaeological Conservation Laboratory

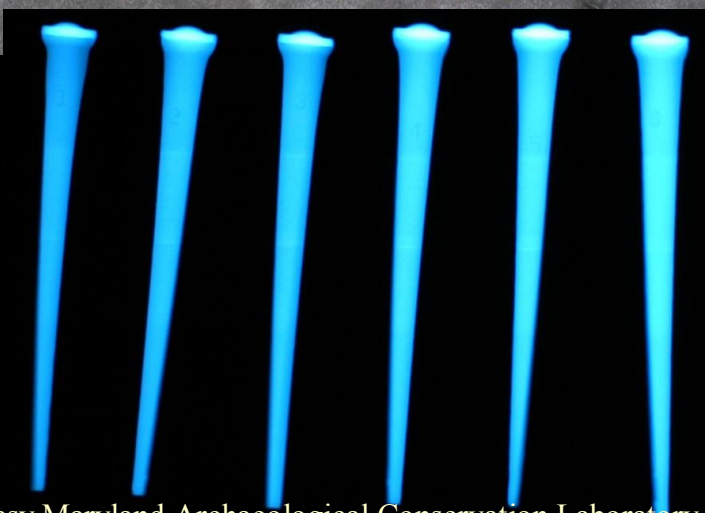
Testing the accuracy of X-radiographic images

The accuracy of the images captured is critical for interpretation of the finds, especially if the image is all you will have to work with.

Reproduction historic nails were imaged directly on the film surface, and these images proved to be very precise.

Then nails were suspended at 1cm intervals above the film surface. The distortion due to height (parallax) was obvious and predictable.





Photos courtesy Maryland Archaeological Conservation Laboratory

Cost effectiveness of X-radiography vs. long-term curation

It has been proven that X-radiographs accurately capture the dimensional, shape, form, and physical details necessary for most interpretive purposes.

A box of scrap metal can be imaged and sampled for much less than it will cost to curate.

That cost difference can be invested in the interpretation of the images, leading to much more complete and useful site reports.

Putting them to Use

The X-radiographs are used by everyone

The use of x-radiographs provides a simple and cost effective method to maximize the information potential of an artifact, or group of artifacts, and provides specialized information that can be used in the following ways:

- Conservation:
  - detailed examination prior to treatment proposal,
  - "roadmap" during cleaning and treatment
  - documentation of condition
- Research:
  - verify catalog records for:
    - artifact counts
    - style / type identification
    - dimensions
    - documentation

And to wrap it all up...

- The X-rays become archival documents, cross-indexed with treatment records and artifact catalogs.
- The treated artifacts become part of reference and display collections.